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Optimal Structure of the Ginning Industry in the Southern High Plains of Texas

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This study addresses the optimal structure of the cotton ginning industry in the Southern High Plains of Texas, assuming a monopolistically competitive market structure. Employing survey, regression, simulation, and mathematical programming techniques, the study determines the optimal structure of the ginning industry. Results indicate that a restructuring of the ginning industry in the Southern High Plains of Texas could save the industry about \$15 million per season.

The ginning industry in a sixteen-county region of the Southern High Plains of Texas (SHPT) has gone through changes in both structure and the level of sophistication of ginning machinery. The number of active gins in Texas has decreased from 783 in 1980 to 406 in 1994. This reduction has occurred in conjunction with an increase in average gin size (Texas Cotton Ginners' Association). Some of this reduction in the number of gins has been due to mergers and the creation of cooperatives among gins. However, many of the smaller gins have either become inactive or have shut down.

These structural changes may also have been the result of technological changes that have taken place in the cotton ginning industry during the last decade. Rapid technological changes in cotton harvesting, seed cotton storage and handling, gin feeding, and bale packaging and handling systems have virtually eliminated many of the menial tasks that were traditional to farming and ginning, while reducing cost and increasing the efficiency of production (Texas Almanac). These technological advancements have led to intense competition among gins for seed cotton, which has forced gin managers to reduce costs through the attainment of higher gin volumes.

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Investment requirements for new high capacity gins have more than doubled during the last decade, while revenue received for ginning services has increased at a much slower rate. A number of gins are currently operating at annual volumes which are too small to cover all costs, while others continue to adopt new capacity-expanding technologies. Whether the ginning industry is currently experiencing excessive costs as a result of changes that have taken place in its organizational structure is not known.

Previous research has shown that states such as Oklahoma (Eshleman), Arkansas (Capstick et al.), and Missouri (Rudel et al.), and some counties in Texas (Cleveland and Blakley) would benefit from structural changes in their ginning industries. Many of these studies are out of date. Further, virtually all previous attempts to identify an optimum structure for a ginning industry have assumed a perfectly competitive market structure. This study constitutes a departure from the conventional treatment in that it demonstrates that the structure of the ginning industry in the SHPT satisfies all of the characteristics of Chamberlin's monopolistic competition. The objective of this study was to derive the optimal organizational structure of the cotton ginning industry in the SHPT under the assumption of monopolistically competitive market structure.

Conceptual Framework

Myers argued that the Texas High Plains cotton ginning industry should be characterized as monopolistically competitive due to the existence of product differentiation in the market. Chamberlin stated that a general class of product is differentiated if any significant basis exists for distinguishing the goods (or services) of one seller from those of another. Differentiation of the product may also be based on the conditions surrounding a product's sale such as the convenience of the seller's location, the general tone or character of his establishment, his way of doing business, his reputation for fair dealing, courtesy, efficiency, and all the personal links which attach his customers either to himself or to those employed by him.

In the case of cotton ginning, the product is the service of ginning provided by the gins. The condition relevant to the ginning industry in the SHPT is the convenience of the sellers' locations. These spatial considerations determine the degree of differentiation of the ginning service. Myers argued that a cotton producer may choose one gin over another because of lower transportation costs of cotton from farm to gin and the convenience of the ginner's location. The significance of differences between individual gins and their products, as a result of spatial considerations, is limited due to pressure from competing gins in the surrounding area, which prevents any individual gin from obtaining a regional or spatial monopoly. The existence of spatial product differentiation in the SHPT ginning industry is hypothesized to reflect a monopolistically competitive market structure.

When the product is differentiated, as in the case of cotton ginning, the demand curves for the individual gins are downward sloping and tangent to the average cost curve as shown in figure 1. The monopolistically competitive price (P_{MC}^*) yields higher prices to the gin than the perfectly competitive price (P_{PC}^*) and the quantity ginned by an individual gin, Q_{MC}^* , is lower. Given the cost and demand

Figure 1. Equilibrium for a monopolistically competitive gin

curves, any level of production higher or lower than the Q^*_{MC} results in less than maximum profits to the gin. Given the structure of the monopolistically competitive market, one might assume instability. But the price is stable, much like the perfect competitor's price, because it is the only price that is consistent with maximum profits for the ginner. The monopolistically competitive price and the purely competitive price always diverge when the product is differentiated. The difference between $0Q^*_{PC}$ and $0Q^*_{MC}$ is what Chamberlin refers to as the excess capacity inherent to the monopolistically competitive market structure.

Technology improvements in the ginning industry can affect physical efficiency, effective capacity, or both. A useful way to look at the effects of the introduction of a new capacity increasing technology is to consider a long-run planning horizon. A graphical explanation is presented in figure 2. When a gin adopts a new technology, the effective capacity of the gin is increased and the average cost of production is decreased. The decrease in the average cost is represented by a move from the short-run average cost function (AC) of a smaller plant to the short-run average cost function (AC') of a larger plant (figure 2).

However, not all firms are capable of the large lump sum investment required for the technology adoption. The firms which adopt the technology can increase their market share because of their ability to provide the service at a lower cost.

Figure 2. Effects of a cost-reducing technology innovation

And the firms which are not capable of adopting the technology are likely to lose market share and experience negative profits. Gins which do not possess the ability to withstand extended periods of negative profits will exit the industry, thus shifting the remaining gins' demand curves upward. This process will continue until a final equilibrium is obtained when the new individual demand curves are tangent to the AC' . The long run results show a decrease in price at P_3^* with an increase in quantity ginned at Q_3^* , with fewer and larger gins in the industry (figure 2).

Methods and Procedures

A mail survey was administered to all of the active cotton gins (127) in the SHPT during the spring of 1996 to determine the current cost structure and the processing capacity of the cotton ginning industry. The initial survey was succeeded by a follow-up reminder one week after the first mailing. A second reminder was sent three weeks after the first mailing and included another copy of the survey. A final reminder was sent approximately one week following the second.

The participating ginners provided the ginning cost per bale, which was further classified by gin size to determine size related cost characteristics. Four gin size groups were established in order to categorize the survey responses. The groups were separated according to the hourly rated processing capacity (bales per hour; bph) of the gins as follows: Group 1—0 to 14 bph; Group 2—15 to 21 bph; Group 3—22 to 28 bph; and Group 4—greater than 28 bph.

Average per bale ginning costs were calculated for each group. The transportation cost per bale per mile was then determined for module cotton using

$$(1) \quad TC_{PB} = \frac{MHC}{BPM}$$

$$(2) \quad TC_{PBPM} = \frac{TC_{PB}}{\text{Miles}}$$

where TC_{PB} is the transportation cost per bale, MHC is the module hauling charge, BPM is the bales per module, TC_{PBPM} is the transportation cost per bale per mile, and Miles is the number of miles each module is transported.

The total costs of transporting and processing cotton in the SHPT under the current structure were also determined using equations (3) and (4). The average ginning cost per bale for each gin size group was multiplied by their respective current market share in the SHPT to determine the current total ginning cost for the industry. The current total transportation cost for the industry was calculated by multiplying the current market share of each gin size group by the transportation cost per bale per mile and the average module hauling distance:

$$(3) \quad TTC = \sum_{s=1}^4 MS_s * TC_{PBPM/s} * HD_s$$

$$(4) \quad TGC = \sum_{s=1}^4 MS_s * GC_{PB/s}$$

where TTC and TGC are the total transportation and total ginning costs for the industry, respectively. MS_s is the market share (bales) for size group "s," $TC_{PBPM/s}$ is the previously determined transportation cost per bale per mile for size group "s," HD_s is the average module hauling distance for size group "s," and $GC_{PB/s}$ is the ginning cost per bale for size group "s."

The currently existing amount of excess capacity in the SHPT was calculated for the four gin size categories. From the survey data, an average hourly excess capacity for each gin size group was determined by first subtracting the average processing rate per gin from its rated capacity. These average hourly excess capacities were multiplied by the average season length in hours to yield an average seasonal excess capacity for gins in each size group. The average seasonal excess capacity for a gin in each size group was multiplied by the number of gins in their respective size groups to obtain total seasonal excess capacities for each gin size groups. The total seasonal excess capacity for the SHPT ginning industry was determined by adding the excess capacities for the four gin size groups.

A nonlinear programming model was developed to determine the optimum size, number, and location of gin plants in the SHPT ginning industry. The sixteen-county region was divided into sixty-four sections by using a quadrant specification in each county. Based on survey results, four alternative sizes of gins (in terms of hourly capacity) were specified as follows: Size 1—14 bph, Size 2—21 bph, Size 3—28 bph, and Size 4—greater than 28 bph. The possible number of each size gin per county was determined by the model. The model assumed stripper harvesting to be the sole harvesting method and imposed module transportation of cotton from farm to gin. The model allowed gins to procure cotton not only from the quadrant in which they are located but also from other quadrants, which was not necessarily in the same county as the gin. The transportation cost parameter values were calculated using survey data. The supply of cotton in each quadrant was calculated by taking a five-year average of cotton produced in each county and dividing it equally among its four quadrants.

The specification of the optimization model is as follows:
objective function

$$(5) \quad \text{Minimize } \text{TOTALCOST} = \sum_i (\text{GINCOST}_i + \text{TRNCOST}_i); \quad \text{for } i = 1 \text{ to } 4$$

subject to

$$(6) \quad \text{GCOST}_{i,j} = \left[\alpha_i + \beta_i \left(\frac{1}{\text{FUNCSUP}_{i,j}} \right) \right]; \quad \text{for } i = 1 \text{ to } 4, \quad j = 1 \text{ to } n$$

$$(7) \quad \text{GINCOST}_i = \sum_j \text{GCOST}_{i,j} * \text{FUNCSUP}_{i,j}; \quad \text{for } i = 1 \text{ to } 4, \quad j = 1 \text{ to } n$$

$$(8) \quad \text{TRNCOST}_i = \sum_s \sum_j (\text{TCOST}_{i,s,j} * \text{COT}_{i,s,j}); \quad \text{for } i = 1 \text{ to } 4, \quad j = 1 \text{ to } n, \\ S = 1 \text{ to } 64$$

$$(9) \quad \text{FUNCSUP}_{i,j} = \sum_s (\text{COT}_{i,s,j}); \quad \text{for } i = 1 \text{ to } 4, \quad j = 1 \text{ to } n, \\ S = 1 \text{ to } 64$$

$$(10) \quad \text{FUNCSUP}_{i,j} \leq \text{EFFCAP}_{i,j}; \quad \text{for } i = 1 \text{ to } 4, \quad j = 1 \text{ to } n$$

where i represents the four alternative gin sizes, S represents the sixty-four source quadrants, j represents the destination gins, TOTALCOST is the total cost to the ginning industry which includes ginning cost (GINCOST) and transportation cost (TRNCOST) from farm to gin, GCOST is the average cost per bale per destination gin, GINCOST is the total cost of ginning for the gin groups, FUNCSUP is a function to define the supply of cotton going to each gin, TRNCOST is the total cost of transportation for the gin groups, $\text{COT}_{i,s,j}$ is the amount, in bales, of cotton transported from supply point " S " to the destination gin " j " of size " i ", $\text{TCOST}_{i,s,j}$ is the per bale cost of transporting cotton from supply point " S " to the destination gin " j ", and $\text{EFFCAP}_{i,j}$ is the effective capacity per size " i " gin given a predetermined level of excess capacity.

Each of the four average cost curves used in equation (6) was estimated using the results from GINMODEL, a computerized ginning cost simulation program. GINMODEL calculates the cost of ginning using the relationships specified by both technical and economic input data. Results from GINMODEL were used to estimate average cost curves for each of the four possible gin sizes which were used in the optimization model. Four typical gin specifications were estimated for the four gin size categories.

Output data from GINMODEL consists of total and per bale ginning costs. These costs are calculated for processing utilization levels ranging from 10 to 100%. The output data is arranged in a cost matrix across these utilization levels. The average cost curves for each of the separate plant configurations were estimated using the ordinary least squares procedure. An inverse specification was used to capture the nonlinear nature of the average cost curves. The regression was performed across the utilization levels and yielded an estimated average cost equation with average cost as the dependent variable and utilization level (the number of bales at each level) as the independent variable.

The excess capacity inherent to a monopolistically competitive market structure, as given in the $EFFCAP_{i,j}$, should be calculated using the average cost and demand curves of individual gins as discussed in the previous section. However, a precise calculation of excess capacity was not possible due to a lack of data needed to estimate gin-specific demand relationships. Alternatively, it was conjectured that the excess capacity currently imposed by the market on each gin size group should closely approximate the excess capacity inherent to a monopolistically competitive market. Thus, the difference between average reported effective capacity and the rated capacity from the survey was used as a proxy for excess capacity for gins in their respective size groups.

The optimization model was solved to minimize the total cost to the industry by taking the given constraints and identities into account. This procedure determined the optimum size, number, and location of cotton gins throughout the SHPT while allowing for the level of excess capacity that is inherent to the hypothesized market structure.

Results

Survey Results

The gin survey resulted in forty-eight acceptable returned questionnaires, representing a usable response rate of approximately 38%. The responding gins were categorized into the previously determined size groups. The percentages of responding gins in each group were 21.28%, 27.66%, 19.15%, and 31.91%, respectively.

The average rated hourly capacity of the responding gins was approximately 23 bph. The average processing rate of responding gins was, however, about 17 bph. This difference indicates that gins in the SHPT did not operate at full capacity and, on average, had an excess capacity of approximately 6 bph. The length of the ginning season in 1995 ranged from thirty to 120 days with an average ginning season of seventy-one days. On average, gins operated nineteen hours per day, with an average down-time of about five hours, which included

three hours for shift change and clean-up. Finally, the average maximum seasonal capacity of responding gins was just over 30,000 bales.

The average total cost of ginning a single 480 pound bale of cotton for the 1995 ginning season was about \$48.49. The average cost of ginning was calculated for each of the four previously determined size groups of gins to provide additional insight. Per bale average costs were \$49.47 for gins with processing rates below 14 bph (Size 1 gins). Gins processing between 14 and 21 bales per hour (Size 2 gins) had a per bale average cost of \$47.51 and gins processing between 21 and 28 bales per hour (Size 3 gins) experienced a per bale average cost of \$46.49. The larger gins, processing more than 28 bph (Size 4 gins), experienced a per bale average cost of \$42.18. These results indicate that the average total cost per bale decreased as the size of the gin increased, demonstrating the existence of economies of size in the SHPT ginning industry. Larger gins were able to achieve a lower per bale cost by spreading their fixed costs across a larger number of bales.

Current Total Industry Costs

The per bale average costs for the different size gins were multiplied by the amount of cotton currently ginned by each size group to obtain an estimate of the current total ginning cost of the SHPT ginning industry. Because data for the amount of cotton currently ginned by each size group in the SHPT are unavailable, the percentage market shares of each size group as determined from the survey were assumed to correspond to their respective market shares in the region. These estimated market share proportions for each size group were then multiplied by the total 1995 cotton crop for the SHPT region to arrive at the total market shares for each group.

The current total cost of ginning for the SHPT ginning industry was calculated to be \$95.36 million (table 1). It was estimated that the smallest gins (less than 14 bph) accounted for \$21.58 million, or about 23% of the total industry ginning cost. Gins processing between 14 and 21 bph accounted for \$26.94 million, or about 28% of the total industry ginning cost. The group of gins processing between 21 and 28 bph comprised about 19% (\$18.25 million) of the total industry ginning cost. Larger gins with processing rates greater than 28 bph accounted for \$28.59 million, or about 30% of the total industry ginning cost.

Table 1. Current industry cost calculations

Bph	# Bales Ginned	Trans. Cost/Bale	Total Trans. Cost	Ginning Cost/Bale	Total Ginning Cost	Total Industry Cost
0-14	436,240	\$4.90	\$2,137,576.00	\$49.47	\$21,580,793.00	23,718,369.00
14-21	567,030	4.90	2,778,447.50	47.51	26,939,595.00	29,718,042.50
21-28	392,575	4.90	1,923,617.50	46.49	18,250,812.00	20,174,429.50
>28	654,155	4.90	3,205,359.50	42.18	28,592,258.00	31,797,617.50
Total	2,050,000		\$10,045,000.50		\$95,363,458.00	\$105,408,458.50

Table 2. Excess capacity calculations under current industry structure

Bph	Hourly Excess Capacity	Hours Ginning Daily	Number of Days in Season	Number of Gins/ Size Group	Total Excess Capacity
0-14	3.05	19	71	27	111,090
14-21	3.71	19	71	35	175,168
21-28	5.80	19	71	24	187,781
>28	10.28	19	71	41	568,577
Total					1,042,616

Table 1 also provides the estimation procedure used to determine the current transportation cost to the industry. Each size group's market share of cotton was multiplied by the average transportation cost per bale per mile and then by the average distance traveled for each size group. The transportation cost per bale for each size group did not vary significantly and thus was held constant, but the previously determined market shares varied by group. The total transportation cost for gins processing below 14 bph was \$2.14 million, for gins processing between 14 and 21 bph was \$2.78 million, for gins processing between 21 and 28 bph was \$1.92 million, and for gins processing greater than 28 bph was \$3.21 million. The total transportation cost was calculated at \$10.05 million. The total cost of both transporting and processing cotton in the SHPT region was estimated at \$105.41 million. This process of determining costs utilized all 127 of the currently existing gins in the SHPT ginning industry.

The total amount of currently existing excess capacity in the SHPT ginning industry was calculated by first determining the average excess capacities for the gins in each size group. The average excess capacity for size groups 1-4 was calculated at 3.05 bph, 3.71 bph, 5.8 bph, and 10.28 bph, respectively. After accounting for the average number of hours gins operate daily and the average length of the ginning season in days, seasonal excess capacities of 4,114 bps, 5,005 bps, 7,824 bps, and 13,868 bps per gin were obtained for gin size groups one through four, respectively (table 2). A total seasonal excess capacity for the SHPT ginning industry was estimated at 1,042,616 bales by considering the number of gins that currently exist in each size group. The total seasonal capacity of the industry was determined to be approximately 3.1 million bales by adding the total number of bales ginned to the seasonal excess capacity of each group. Thus, the excess capacity for the industry was estimated to be about 34%.

Nonlinear Programming Model Results

The optimal size, number, and location of cotton gins in the SHPT were determined with the use of a nonlinear spatial optimization model. The individual components of the model as discussed in the "Methods and Procedures" section are presented here along with the results of the optimization model.

The results of the four estimated cost curves used in the nonlinear programming model to determine the ginning costs at specific gins are as follows:

$$\begin{aligned}
 (11) \quad & \text{14 bph Gin:} & \text{AverageCost} &= 24.29 + 508214.90 * \left(\frac{1}{\# \text{ Bales}} \right) \\
 & & & (132.44) \quad (546.86) \\
 & & \text{SER} &= 0.387 \quad R^2 = 0.9999 \\
 (12) \quad & \text{21 bph Gin:} & \text{AverageCost} &= 21.56 + 593836.70 * \left(\frac{1}{\# \text{ Bales}} \right) \\
 & & & (166.68) \quad (603.95) \\
 & & \text{SER} &= 0.273 \quad R^2 = 0.9999 \\
 (13) \quad & \text{28 bph Gin:} & \text{AverageCost} &= 21.39 + 623010.20 * \left(\frac{1}{\# \text{ Bales}} \right) \\
 & & & (165.08) \quad (474.31) \\
 & & \text{SER} &= 0.274 \quad R^2 = 0.9999 \\
 (14) \quad & \text{Greater than 28 bph Gin:} & \text{AverageCost} &= 20.95 + 673988.80 * \left(\frac{1}{\# \text{ Bales}} \right) \\
 & & & (24.03) \quad (60.78) \\
 & & \text{SER} &= 1.865 \quad R^2 = 0.9978.
 \end{aligned}$$

The associated R^2 , SER, and t-values of each coefficient are presented below each estimated equation. All of the estimated cost equations had R^2 values over 0.99 and highly significant t-values for the estimated coefficients.

The lowest capacity gin provided the lowest average cost for producing any number of bales within its capacity. In other words, the per bale costs for larger plants fell below those for smaller plants only for levels of output exceeding the seasonal capacities of the smaller plants. Economies of plant utilization were thus found to be greater than economies of plant size.

The nonlinear programming model determined the number of gins needed to gin all of the cotton at the lowest possible cost to the industry, which accounted for both the cost of transportation and the cost of ginning. Overall, the optimal solution yielded four gins of Size 1 (14 bph), eight gins of Size 2 (21 bph), four gins in Size group 3 (28 bph), and forty-five gins of Size 4 (greater than 28 bph), giving a total of sixty-one gins (a comparison of the current and optimal gin configuration for the sixteen counties of the SHPT is presented in table 3). Size groups 1, 2, and 3 accounted for 17.5% of the total market share of available cotton. The largest size gins processed the remaining 82.5% of the cotton as determined in the optimal solution. The percentage market shares of each gin size in the optimal solution differed significantly from the percentage market shares of each group in the current structure. The three smallest size groups (1, 2, and 3) had significant

Table 3. Current and optimal gin configuration for the Texas Southern High Plains

County	Current Number of Gins	Optimal Number of Gins	Distribution of Gins by Size (bph)
Andrews	0	2	2—Size 4 gins
Bailey	8	4	3—Size 2; 1—Size 4 gins
Cochran	2	5	1—Size 2; 1—Size 3; 3—Size 4 gins
Crosby	8	5	2—Size 1; 3—Size 4 gins
Dawson	13	4	2—Size 3; 2—Size 4 gins
Gaines	13	8	1—Size 2; 7—Size 4 gins
Glasscock	2	2	1—Size 2; 1—Size 4 gins
Hockley	12	3	1—Size 1; 2—Size 4 gins
Howard	5	1	1—Size 4 gin
Lamb	12	3	3—Size 4 gins
Lubbock	15	5	5—Size 4 gins
Lynn	11	6	1—Size 3; 5—Size 4 gins
Martin	9	2	2—Size 4 gins
Midland	1	1	1—Size 4 gin
Terry	10	6	1—Size 2; 5—Size 4 gins
Yoakum	6	4	1—Size 1; 1—Size 2; 2—Size 4 gins
Total	127	61	

decreases in market share, while the market share of the largest gin size group increased over 50% from its current level.

Most previous studies have found optimal gin structure configurations to include fewer large gins operating at near their full capacities. However, with the relaxation of the assumption of perfect competition in the industry and the incorporation of the nonlinear average cost curves, this study found an optimal solution which included both large and smaller gins. Transportation costs represent a very small percentage of the total cost of cotton handling and processing, making it economical to transport cotton to larger gins to realize the savings in ginning cost. Although savings could be incurred from the utilization of the economies of size of larger gins, several smaller gins were still present in the optimum structure. In areas with smaller amounts of cotton production, a large gin processing at a very low utilization of its capacity had a much higher processing cost per bale than a small gin processing at a level nearer its capacity.

Table 4 presents a summary of the total costs of the optimal ginning industry structure for the SHPT. The total industry cost under the optimal structure as determined by the nonlinear optimization model was \$90.19 million. The total cost of transportation to the industry was \$7.41 million, representing only 8.22% of the total cost of handling and processing the cotton. The remaining 91.78% of the total cost constitutes the ginning cost of \$82.78 million. The total ginning costs for gin size groups 1-4 were \$3.46 million, \$8.55 million, \$5.13 million, and

Table 4. Summary of Texas Southern High Plains ginning industry costs

Category	Ginning Cost	Transportation Cost	Total Costs
Size 1 gins	\$3,463,224.83	\$156,377.75	\$3,619,602.58
Size 2 gins	8,549,522.48	570,868.45	9,120,390.93
Size 3 gins	5,126,433.20	374,377.88	5,500,811.08
Size 4 gins	65,639,359.25	6,311,955.37	71,951,314.62
Total cost	\$82,778,539.76	\$7,413,579.45	\$90,192,119.21

\$65.64 million, respectively. The transportation costs were \$156,377.75, \$570,868.45, \$374,377.88, and \$6.31 million for gin sizes 1–4, respectively.

A comparison of the total ginning cost between the optimal gin configuration determined in the study and the current configuration is presented in table 5. The total savings in transportation cost of the optimal structure over the current structure for all gin sizes is \$2.63 million. The three smallest gin sizes realized savings and the Size 4 gins experienced an increase in transportation cost. This net decrease in transportation cost is due to two reasons. First, the transfer of cotton from the smaller gins in the current structure to the larger gins in the optimal structure caused less cotton to be ginned at the smaller gins, thereby reducing the transportation cost for the small gin groups. Second, the locational pattern given by the optimal structure allowed for savings over the current structure.

Table 5. Cost savings of the optimal structure over the current structure

Cost Item	Current Cost	Optimal Cost	Cost Savings of Optimal
Transportation			
Size 1	\$2,137,576.00	\$156,377.75	\$1,981,198.25
Size 2	2,778,447.50	570,868.45	2,207,579.05
Size 3	1,923,617.50	374,377.88	1,549,239.62
Size 4	3,205,359.50	6,311,955.37	-3,106,595.87
Subtotal	\$10,045,000.50	\$7,413,579.45	\$2,631,421.05
Processing			
Size 1	\$21,580,793.00	\$3,463,224.83	\$18,117,568.17
Size 2	26,939,595.00	8,549,522.48	18,390,072.52
Size 3	18,250,812.00	5,126,433.20	13,124,378.80
Size 4	28,592,258.00	65,639,359.25	-37,047,101.25
Subtotal	\$95,363,458.00	\$82,778,539.76	\$12,584,918.24
TOTAL	\$105,408,458.50	\$90,192,119.21	\$15,216,339.29

Ginning cost savings were realized by the three smallest gin sizes, while the Size 4 gins saw a substantial increase in ginning costs. In the optimal solution, a fewer number of smaller gins were present and were processing near their capacities at a reduced average ginning cost per bale, such that total ginning costs to the industry were reduced. The total ginning cost savings for the optimal gin structure over the current gin structure for all gin sizes amounted to \$12.58 million. These cost savings were generated by the ability to move cotton to gins in quantities which permitted a higher capacity utilization than the current structure.

The total number of gins in the SHPT decreased from 127 in the current structure to sixty-one under the optimal structure. All gin size groups saw a reduction in gin numbers with the exception of greater than 28 bph gins, which had an increase of four gins. The increase in gin numbers for this size group accounted for some of the increase in costs. The total annual cost savings associated with the optimal structure over the current structure amounted to \$15.22 million (table 5), representing a 14.44% decrease from the current level of costs.

Conclusions

The SHPT cotton ginning industry was characterized, consistent with Myers' conceptualization, as monopolistically competitive in this study. In other words, some level of excess capacity over and beyond the necessary downtime was hypothesized to be inherent in the market structure of the ginning industry.

Results indicate that a restructuring of the SHPT ginning industry could save the industry \$15 million per season in transportation and ginning costs. Several factors may be influencing this structural inefficiency in the ginning industry. First, the industry is currently characterized by the existence of a large amount of excess capacity. Even though the ginning industry is hypothesized to inherently contain some level of excess capacity, the current structure is inducing an excess capacity that is far beyond what would be expected under optimal conditions. Too many gins are currently operating below their effective capacities and thus are contributing to excessive ginning costs. Further, the existing locational distribution of gins appears to be sub-optimal.

Contrary to previous research findings, the optimal structure, as determined by this study, included sixteen smaller gins out of a total of sixty-one gins. The benefits of the economies of plant utilization had a more pronounced effect on the optimal solution when the excess capacity inherent in a market characterized by monopolistic competition was introduced. Thus, smaller gins processing at a level near their effective capacities were found to be more cost effective than large gins processing the same number of bales. At processing levels exceeding the capacities of the smaller gins, the larger gins, however, achieved a lower cost. The model thus resulted in an optimal solution that included several smaller gins operating close to their effective capacities.

This study represents the first analytical attempt to determine optimal organization of the cotton ginning industry under the assumption of a monopolistically competitive market structure. Its significance is twofold. First, it sheds some light on the likely future structure of the cotton ginning industry in the SHPT. The results of this study suggest that the SHPT ginning industry will experience a movement from small and medium size gins to larger and more efficient

gins in the future. It is expected that many of the smaller gins will eventually become inactive and there will be fewer but larger gins in the industry. However, the industry will still require some small gins in areas of low cotton production. Another important contribution of this study is that it provides an empirical framework that could be pivotal in future research with a similar focus.

The model used in the determination of the optimal ginning industry structure is designed to account for excess capacity inherent in the monopolistically competitive market structure. However, due to the void of secondary/primary data on price and quantity relationships for different size gins, a precise determination of excess capacity was not possible. Estimates of excess capacity had to be derived from the survey responses and were used in the model. In addition, it is recognized that the optimal solution assumes a five-year average supply distribution for the study area and a typical harvest weather pattern. It is important to note, however, that the conceptualization and the empirical procedure developed in this study may be directly applied without any modification, when a better estimate of excess capacity is available and if a considerable change in total supply of cotton is experienced.

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