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# **Producer Characteristics and Peanut Cost Efficiency in the Southeast: Implications of the Farm-Level Impacts of the 2002 Farm Act**

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*Selected Paper prepared for presentation at the Annual Meetings of the Southern Agricultural Economics Association, Little Rock, Arkansas, February 5-7, 2005*

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## **ABSTRACT**

Peanut production efficiency in the Southeast is analyzed for assessing farm-level impacts of the 2002 Farm Act. Stochastic frontier analysis utilizes data from 2001 Peanut Farm Survey. Results show that production efficiency cannot be attributed to quota ownership. Certain other farm attributes, such as size and age, are also important

## **1. Introduction**

Peanuts are one of the crops whose production was, until recently, regulated by a quota system, which was a price-quantity policy control. The 2002 Farm Act dealt away with quantity controls and significantly lowered price support by replacing the quota system with the Marketing Assistance Loan Program. As a result, quota holders lost the quota rental payments, whereas quota renters were relieved of them, and farmers are no longer constrained in production quantities or output destination. These changes have significant distributive and income effects,

and they affect producers with different efficiency characteristics differently. While a decrease in output price and elimination of quantity controls drives less efficient growers out of peanut production, it benefits more efficient ones. The impact of the 2002 Farm Act on farm-level peanut production efficiency has not been well understood, however. While a decrease in output price and elimination of quantity controls drives less efficient growers out of peanut production and benefits more efficient ones (Dohlman *et al.*, 2004), no research focused on the relationship between quota ownership and production efficiency. This paper evaluates peanut production cost efficiency under the quota system explicitly incorporating quota ownership in the analysis in order to assess the farm-level impacts of the recent changes in the industry.

The empirical analysis utilizes data from the 2002 Southeast Peanut Farm Costs and Returns Survey that was conducted in the spring of 2002 by Georgia, Alabama, and Florida NASS, and sponsored by the National Center for Peanut Competitiveness, the National Peanut Board, the Southern Peanut Farmers Federation, University of Georgia, Auburn University, and the University of Florida. The survey data provide important insights into the peanut production, as the last similar survey of the Southeastern region was conducted in 1996. While the 2002 survey did not capture the effects of the 2002 Farm Bill, efficiency analysis permits construction of a cost frontier, which makes it possible to study the effect of quota ownership on efficiency, and thus derive implications for the effects of the policy changes on different farms.

The choice of analytical approach is motivated by analysis of relative (dis-)advantages of the approaches used for efficiency analysis and by data availability. The nature of peanut production satisfies the assumptions required for cost efficiency estimation better than those of profit maximization required for production efficiency analysis. In addition, the survey contains only data on variables required for cost function but not for production function estimation.

This paper does not intend to assess in detail the new program's impacts on efficiency of individual growers, as the new policy environment has introduced uncertainty and numerous adjustment pressures for the peanut growers (Dohlman, et al.). It only tests whether quota ownership and other factors specific to peanuts growing in the Southeast impact peanut costs efficiency.

The rest of the paper is structured as follows. Section 2 provides a brief overview of peanut farm support policies and discusses how they affect production and cost efficiency. Section 3 describes different efficiency estimation methodologies and motivation of the choice of analytical techniques. Section 4 describes the data and presents estimation results, together with discussion of policy implications. Section 5 concludes.

## **2. Changes in Peanut Farm Support Policies**

The 2002 Farm Act dealt away with the quota support system that, being preceded by a similar system of acreage allotments (part of the supply management policy) introduced in the mid-1950, existed since 1981. Under the quota support, both price and quantity controls were imposed on peanut production. The quantity of peanuts grown for domestic consumption for “edible purposes” was limited by the annual quota limit. This quota was fixed and was an asset that belonged to some farmers (and non-farmers) and did not to others. As a result, some producers rented quota quantities (in lbs) from quota owners, which was equivalent to buying the right to grow “edible” peanuts. The advantage of growing “quota” peanuts was in the fact that these peanuts could be sold at a higher price that varied between \$600 and \$680 per ton over the years. Any additional quantities not covered by the quota (so-called “additional”) had to be sold at much lower prices for non-edible purposes or exported.

The 2002 Farm Act replaced the quota system with a Marketing Assistance Loan Program (MLP) that lifted the quantity restrictions on peanut production and introduced a price floor in the form of marketing loan rate. Under the MLP, producers can move the crop into the marketing loan (government storage) as a pledge for a current loan rate of \$355 per metric ton (the price floor). At the end of the post-harvest period, farmers can either forfeit the loan (give up the “collateralized” peanuts and keep the loan rate) or repay the loan at the lower of the loan rate or the loan *repayment* rate that is set equal to “weekly posted prices” and is announced by the USDA.

While the mechanics of the interaction among the producers, crop processors, and the government within the framework of the MLP are quite complicated leaving a researcher with some ambiguities about its overall impact (see Nadolnyak, Revoredo, and Fletcher), it is clear that lifting the quantity restrictions and substituting the fixed support price with a much lower price floor is going to affect producers differently. The effects of this transfer are particularly interesting with regard to those quota owners who are peanut growers. These growers must have chosen producing versus renting out because they believed they could make a better use of their asset by growing peanuts themselves. This suggests that quota owners may be more efficient than non-owners. On the other hand, with a half a century-long history of production support, one might expect the ‘privileged’ quota owners to be less cost efficient than quota renters, which would make them the first to cease peanut production.

These adverse effects on quota owners were the main objection from some of the peanut producers to the 2002 Farm Act changes in peanut policies. Although data on who has left the industry are not yet available, the methodology employed in this paper allows us to explore whether the arguments above are correct.

Besides, unleashing some market forces emphasizes cost and production efficiency, which is likely to lead to production expansion by more, and contraction by less, efficient producers. Given that the Southeast is an important peanut growing region and that the competition from foreign producers is growing (Dohlman *et al.*), understanding the impact of current agricultural policies on the peanut production efficiency in this region is particularly timely and important.

## **2. Methodology**

This paper uses stochastic frontier analysis to study peanut production efficiency. The stochastic frontier approach is an econometric technique based on assuming a specific functional form for the cost or production frontier. In its simplest form, the approach posits a stochastic model for a cross-sectional frontier with a two-component disturbance specification: one error term is the usual two-sided noise component, while the other is a one-sided disturbance component associated with inefficiency (Fare, Grosskopf, and Lovell, 1994). The main advantage of this approach is that it accommodates statistical noise by allowing deviations from the frontier to be associated with both inefficiency and random factors, thus avoiding possible overestimation of inefficiency.

A cost frontier model, instead of a production frontier model, is estimated for several reasons. First, the survey data contain detailed information on input prices, cost shares, and output value but does not contain data on physical input quantities and output prices, which makes cost efficiency analysis the only viable choice of methodology.

Second, Khumbakar and Lovell argue that, unlike the production frontier analysis, which is concerned with technical efficiency only and does not impose any behavioral assumptions,

cost frontier analysis implies cost minimization. The cost minimization assumption is appropriate in circumstances when input prices, rather than input quantities, are strictly exogenous. This condition is usually satisfied in competitive and in some regulated industries. Peanut production is competitive, which implies that input and output prices are indeed exogenous. Besides, the producers' ability to rent quota before 2002 meant that the influence of quantity output constraints was significantly reduced. In addition to that, Kumbhakar and Lovell argue that, when not all inputs are variable due to either contractual arrangements or short-run fixity, and when outputs are not storable, as in the case of peanut storage, variable costs minimization frontier is appropriate. From a theoretical perspective, Chambers shows that, under some regularity conditions, duality principles ensure consistency between variable cost function and production function and, therefore, either describes farming activity equally well. This approach has been used in empirical analysis (Hazarika and Alwang).

Based on these considerations, the stochastic variable cost frontier analysis is used for estimating peanut cost minimization function and testing for a possible impact of quota ownership on inefficiency. In this analysis, the cost function is of the form  $C_i \geq c(y_i, w_i, \mathbf{b})$ , where  $C_i$  is the actual (variable) cost of producer  $i$ , and  $c(\cdot)$  is the efficient cost function of output  $y_i$ , input prices or shares  $w_i$ , and a vector of coefficients. The difference between the actual and the efficient cost is captured in the error term  $e_i$  that consists of two parts: the truly random shock  $v_i$  and the cost inefficiency term  $u_i$  that is random but non-negative. While several distributional assumptions about  $u$  and  $v$  are possible, they are always assumed to be independently distributed:

$$v_i \sim iid N(0, \mathbf{s}_v^2); \quad (1)$$

$$u_i \sim iid N^+(0, \mathbf{s}_u^2);$$

With these specifications, it is possible to derive marginal density, mean, and variance of  $e_i = u_i + v_i$ . Using these, an expression for conditional distribution of  $u$  given  $e$  can be obtained:  $f(u|e)$ . Thus, estimating the cost function that incorporates  $e_i$  using either MLE or method of moments provides estimates of the cost inefficiency term,  $u_i$ . The measure of cost inefficiency,  $CE_i$ , can be expressed as

$$CE_i = \frac{c(y_i, w_i; \mathbf{b})}{E_i} = E(\exp\{-u_i\} | e_i). \quad (2)$$

This measure provides inefficiency information that is producer-specific.

The impact of various factors on the inefficiency  $u_i$  is followed by estimation of equation:

$$\hat{u}_i = \sum_l \mathbf{g}_l z_{li} + \mathbf{e}_i, \quad (3)$$

where  $\mathbf{z}_i$ 's are the variables that explain the inefficiency (Kalirajan, Pitt, and Lee).

Peanut production cost efficiency is estimated by two methods. The first is a two-stage method that consists of maximum likelihood estimation of a stochastic cost frontier followed by OLS estimation of an equation relating predicted cost inefficiency to its potential determinants. This approach, however, has been criticized because the model of predicted inefficiency effects contradicts the assumption of identically distributed  $u_i$ 's from the first stage. Battese and Coelli proposed a method that combines the estimation into a single step by assuming that  $u_i$  is

distributed independently but not identically as truncations of the normal distribution,

$N^+(Z_i \mathbf{g}, \mathbf{s}_u)$ . Thus, the mean of the cost inefficiency effect is modeled as a function of  $Z_i$ 's. This specification permits the coefficients in  $\mathbf{g}$  to be estimated together with the coefficients of the cost frontier. This one-stage estimation is also performed for each of the models estimated.



The functional forms most commonly used for cost frontier estimation are Cobb-Douglas and translog (Kumbhakar and Lovell, 2000). The Cobb-Douglas specification is simple and allows the focus to be on the error term:

$$\ln E_i = \mathbf{b}_0 + \mathbf{b}_y \ln y_i + \sum_n \mathbf{b}_n \ln w_{ni} + v_i + u_i. \quad (4)$$

Since a cost frontier must be linearly homogeneous in input prices, either the parameter restriction  $\mathbf{b}_k = 1 - \sum_{n \neq k} \mathbf{b}_n$  must be imposed prior to estimation, or incorporated in the equation above as:

$$\ln \left( \frac{E_i}{w_{ki}} \right) = \mathbf{b}_0 + \mathbf{b}_y \ln y_i + \sum_n \mathbf{b}_n \ln \left( \frac{w_{ni}}{w_{ki}} \right) + v_i + u_i. \quad (5)$$

A single output translog cost frontier function is more flexible but requires more regressors:

$$\begin{aligned} \ln E_i = & \mathbf{b}_0 + \mathbf{b}_y \ln y_i + \sum_n \mathbf{a}_n \ln w_{ni} + \frac{1}{2} \mathbf{b}_{yy} (\ln y_i)^2 \\ & + \frac{1}{2} \sum_n \sum_k \mathbf{a}_{nk} \ln w_{ni} \ln w_{ki} + \sum_n \mathbf{a}_{yn} \ln y_i \ln w_{ni} + v_i + u_i \end{aligned} \quad (6)$$

where  $w$  is a vector of input prices involved in production of a single output,  $y_i$ .

#### 4. Data and Empirical Results

The data used in the analysis were taken from the 2002 Southeast peanut farm costs and returns survey. The survey was conducted by the Georgia NASS in cooperation with Alabama and Florida NASS and sponsored by the National Center for Peanut Competitiveness, National Peanut Board, Southern Peanut Farmers Federation, University of Georgia, Auburn University, and the University of Florida. The survey was conducted between March and April of 2002. Of

the 740 survey questionnaires distributed across the Southeast peanut production area, only 189 growers responded. Most of the respondents were peanut growers from Georgia, the largest peanut producing state in the country.

The survey questionnaire contains a wide array of questions grouped by several topics into the following cost components:

- land operated and commodities produced;
- peanut acreage and seeding;
- farm production costs and returns, including seeds, fertilizer, chemicals and pesticides, labor, vehicles and tractors, irrigation, peanut quota ownership and renting, peanut marketing and miscellaneous expenses and other crop costs;
- farm assets and debts;
- demographic characteristics.

Given that frontier methods can be used to estimate variable cost function (Kubhakar and Lovell), the fact that variable cost functions describe farming well since they better reflect short-run cost-minimizing behavior (Chambers), and considering poor quality of the data on quasi-fixed input prices, a variable cost function is estimated using both Cobb-Douglas (equations 4 and 5) and translog (equation 6) specifications.

The two estimation approaches described in the methodology section are applied to each functional form and the results tested to identify the best specification. According to the two-stage approach, a stochastic frontier model assuming a half-normal distribution is estimated first and the results are used to predict the inefficiency term, which is then regressed on quota ownership and other variables that were hypothesized to affect efficiency. As this approach has been criticized on the grounds of violating the assumption of identical distribution of  $u_i$ 's, a

second approach to inefficiency estimation was applied, which follows Battese and Coelli and estimates inefficiency and its dependence on a set of covariates jointly by assuming that  $u_i$ 's are not identically distributed but that  $u_i \sim N^+(Z_i\mathbf{g}, \mathbf{S}_u)$ .

The variables used in the stochastic frontier analysis are summarized in Table 1. The cost variable represents variable costs per acre and includes the value of labor and the costs of seeds, fertilizer, pesticides, fuel, electricity, farm supplies, and marketing. Output is measured as the per acre value of the total farm peanut production. The input prices in log form are per hour wage to paid labor, and per acre costs of seeds, fertilizers, pesticides, and materials. The last category groups together fuel, electricity, farm supplies, and marketing costs. In order to impose the homogeneity restriction, the cost variable and all input prices were divided by the cost of materials.

The main variable hypothesized to affect inefficiency is *QUOTA*, measured as percentage of peanut quota owned relative to the total peanut quota used (own and rented). The variable *SIZE* captures the impact of farm size on cost efficiency and is measured as a log of peanut acres planted/harvested. Dohlman *et al.* find that, in the Southeast, peanut producers have relatively smaller farm size (averaging 816 acres compared to 1,583 acres in the Southwest) but lower production costs and therefore, other things equal, farm size may be an important determinant of cost efficiency. In addition, peanut farmers in the region were found to be on average 10 years older than those in the Southwest (average age 42 years) suggesting a role for operator age as a variable that may affect efficiency which is controlled for in the regression via the variable *OAGE*. Operator age is also an indicator of experience in peanut growing and, together with education, they proxy for management skills of the operator.

Education is included as *OEDU*, which is an index of education varying from 1 to 5, where 1 stands for incomplete high school, 2 stands for completed high school, 3 stands for some college education, 4 stands for completed Bachelor degree, and 5 stands for graduate school. Inclusion of educational level is important because the 1998-2002 ARMS data indicate that, despite their superior performance, Southeastern farm operators have the lowest educational attainment in terms of both high school and college completion compared to the rest of the country.

The results from the two-stage regression estimation approach are given in Table 2, Panel A. The data do not seem to fit perfectly into the Cobb-Douglas function estimated by the half-normal stochastic frontier model. As expected, all input prices have positive coefficients but only the coefficients of the price of paid labor and of the price of seeds are statistically significant. The sum of these coefficients is less than one, which suggests the existence of increasing returns to scale. The coefficients of fertilizers and pesticides are close to but not significant at the 10 percent level. One reason for this result could be the relatively small number of observations, as only 66 responses could be used in this model. The most seemingly irrational result is that the output coefficient does not conform to the requirements of the cost function, as it is negative although statistically insignificant. A rational explanation based on well known facts about peanut production support history will be provided shortly.

In the estimation of a stochastic frontier model, the variance parameters are also important. The estimates of the variance of the inefficiency component  $\sigma_u^2$  (0.378) and of the random disturbance to the cost  $\sigma_v^2$  (0.219) show that deviations from the frontier due to inefficiency are higher (1.73 times) than deviations due to factors outside of operators' control. The hypothesis that producers are efficient (that is,  $\sigma_u^2 = 0$ ) is rejected at 5 percent level.

Panel B of Table 2 shows the results from the second stage estimation, where the inefficiency estimate is regressed on *QUOTA*, *SIZE*, *OAGE*, *OAGE2*, and *OEDU*. While the ownership of quota has positive effect on inefficiency, it is not significant. However, larger peanut operators seem to be less inefficient, which suggests possible “efficiency economies of scale”. In addition, experience affects inefficiency as inefficiency decreases with operator’s age up to about 51, since when the trend is reversed. However, operator’s educational level does not seem to be significant.

Results of the single-stage truncated-normal stochastic frontier model are presented in Table 3. This model estimates the mean of the cost inefficiency effect as a function of quota ownership and demographic variables. As should be expected, the data seem to fit this model better. All coefficients of input prices are positive and statistically significant. The coefficient of the output value is now positive but still insignificant. The variance of the inefficiency term is significantly reduced and most of the deviations from the frontier are now due to factors outside of operators’ control. Quota ownership, the main variable of interest, still does not affect efficiency, while larger peanut producers are again more efficient. The effect of age is similar to the results from the two-stage model, but now the reversal of the age effect is estimated to occur much later, at 61 years.

Results of the translog functional form estimation are presented in Table 3. A major limitation of the translog form applied to small datasets as the one used in this paper is that only a few input prices/cost shares can be used. To limit the number of explanatory variables, inputs were aggregated in three groups: (1) paid labor, (2) seeds, fertilizers and pesticides, and (3) materials as defined in the Cobb-Douglas specification. Homogeneity restrictions were imposed

by dividing input prices and the cost variable by the input price of the “materials” cost component.

Table 4, Panel A, shows the results of the first stage half-normal stochastic frontier cost function estimation. The data do not fit the translog functional form perfectly. The coefficient of the price of paid labor is positive and significant as expected, and its second derivative is negative, but not significant. The coefficient of input price of seeds, fertilizers, and pesticides is not significant and its second derivative is positive and significant, which violates standard cost function properties. The coefficient of the output value has the incorrect sign but it is not statistically significant. The efficiency hypothesis ( $\sigma_u^2 = 0$ ) is rejected here at the 8 percent level and deviation from the cost frontier due to inefficiency are 1.5 times as high as deviations due to the exogenous shocks to producers’ costs.

Panel B of Table 4 shows results of the second stage estimation. Ownership of quota still does not seem to influence inefficiency while, again, the results show that larger producers are less inefficient than smaller producers. Also, according to this specification, operator age and educational level do not explain cost inefficiencies.

Table 5 shows the results of the truncated-normal stochastic frontier model with translog specification estimated in a single step using the Battese and Coelli technique. There are no qualitative differences between this model and the model shown in Table 4.

The lack of significance of some of the input prices and the output value is not unusual in this type of analysis. Chambers states that, in empirical work, stochastic *cost* frontier models perform worse than stochastic production frontiers either because the functional forms are inappropriate or because of limited data availability and/or quality constraints. In addition, the small sample size of the survey, which necessitates aggregation of inputs, the regulated nature of

peanut production before 2002, and rigidities in the input markets, may all contribute to some of these results.

However, some of the “unorthodox” results presented in this paper might have rational explanations. For example, without knowing the background of peanut production support policies, the finding that the output coefficient (yield per acre) in the cost function is negative although statistically insignificant seems confusing. However, it can be explained by the following peculiarity of the “pre-2002” support system. Under the quota support program that existed before 2002, the quota, *i.e.*, the volume of peanuts to be produced for edible purposes, was tied to specific land plots. This was because the original quota was granted on peanut growing land (allotments), which was subsequently replaced by quota quantities in order to curb growing harvests of quota peanuts due to technological progress in agriculture. Nevertheless, the quota peanuts still had to be grown on the same allotments (or within the same county) that were granted originally, which meant that producers could not switch production to more fertile land, as this would invalidate the quota. These quota land plots, or allotments, have vastly different qualities and peanut production potential – while some land was fertile enough to bring high yields even without applying high volumes of fertilizer and other agricultural inputs, other areas required more inputs but this still did not result in proportional yield increases. It is the inability of the producers to allocate efficient land to peanuts due to the quota constraints that led to the observed lack of positive dependence between the yields and per acre costs in the estimation results. This finding is confirmed by evidence of massive reallocation of peanut acreage that took place after 2002 (Dohlman). However, this should not be attributed to producer inefficiency, as producers, in fact, did not have the freedom of allocating the land for peanut planting.

The finding that peanut cost efficiency increases with farm size may be indicative of the long-observed relatively high management costs of peanut production in comparison to other crops. This was confirmed by an observation that, while the average cost for such staple crops as corn, soybeans, and wheat, is usually decreasing and convex, the average peanut production costs for a fixed farm size are U-shaped. It has been suggested that this cost function indicates that the costs of crop management increase faster than the crop volume. If we accept this suggestion, the results presented in this article indicate that crop management efficiency (crop management costs) is proportionate (inversely related) to the farm size.

To determine whether the Cobb-Douglas or the translog functional forms better represent the true cost function, a generalized likelihood ratio test of the form  $L = -2[LLH_0 - LLH_A]$  is performed where  $LLH_0$  and  $LLH_A$  are the values of the log-likelihood function under the null and the alternative hypotheses. Coelli shows that the statistics for  $L$  has chi-squared distribution, with degrees of freedom equal to the number of restrictions imposed under the null hypothesis. The number of restrictions imposed under the null here is 6 (that is the number of coefficients that appear in the translog but not in the Cobb-Douglas specification). Given these restrictions, the critical value is 12.59 at the 5 percent level, which is higher than the estimated 6.202 given the results of the two specifications. Thus, this test fails to reject the null hypothesis that the Cobb-Douglas functional form is an appropriate representation of the cost function. Given the results of this test both the two-stage and one-stage Cobb-Douglas functional forms consistently show no influence of quota ownership on efficiency, with the one-stage producing the best results.

In sum, estimation results show no impact of quota ownership on the peanut production cost efficiency. Results point to increasing returns to scale in peanut production and show the



impact of producer characteristics on cost efficiency. Specifically, larger farms are more efficient and efficiency increases with operator's age up to about between 50 years and decreases henceforth, while the education level, as measured by the index of education, does not affect inefficiency.

#### **4. Conclusions**

The paper studies the impact of quota ownership on the efficiency of peanut production in 2001 in order to draw conclusions about the likely farm-level impacts of the 2002 Farm Act. Data from the 2002 Southeast Peanut Farm Costs and Returns Survey are used in a stochastic cost frontier analysis utilizing both Cobb-Douglas and translog functional forms. The stochastic frontier approach was chosen because the nature of competitive but regulated peanuts production satisfies the assumptions required for cost efficiency estimation better than those of profit maximization and because the survey data contained variables appropriate only for this type of analysis. This paper contributes to the discussion of the likely farm-level effects of the 2002 Farm Act, which dealt away with the quota support policies and introduced a price floor in the form of the marketing assistance loan program. Results of the stochastic frontier analysis provide insights into likely farm-level impact of peanut production and trade "liberalization". The results show that quota ownership did not affect cost efficiency. Specifically, there is no link between the quota ownership and peanut production cost efficiency. This means that the advent of the 2002 Farm Act put the quota owners engaged in peanut farming in no worse position than other peanut growers, which implies that they should not be expected to be the first to go out of business. The results also suggest that other producer characteristics, such as farm size and

operator's age, impact cost efficiency, while education does not, which provides some interesting insights into the differences among major peanut growing regions.

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## **TABLES**

**Table 1.** Data description and summary statistics

	Mean	Std. Dev.	Min	Max
Output (value of peanuts in \$ per acre)	722	226	312	1514
Total Cost (value in \$ per acre)	658	246	320	1812
Price of capital (\$ per acre)	139	114	41	987
Price of own labor (per hour wage rate)	31	13	2	126
Price of land (\$ per acre)	51	20	21	134
Price of fertilizer (\$ per acre)	40	31	0	135
Price of seeds (\$ per acre)	64	38	7	131
Price pf pesticide (\$ per acre)	121	131	0	377
Price of paid labor (per hour wage)	12	9	3	70
Price of materials (\$ per acre)	61	38	15	184

QUOTA (% of quota owned)	43	38	0	100
SIZE (total acres planted)	166	217	4	1500
OAGE (Operator age in years)	50	13	25	81
OEDU (Index of education)	2.72	0.92	1.00	5.00

**Table 2. Panel A.** Cobb-Douglas stochastic frontier—normal/half-normal model

Log VC	Coefficient	Standard Error	t	P>t
<i>Log output value</i>	-0.091	0.159	-0.57	0.566
<i>Log price of labor</i>	0.318	0.055	5.81	0
<i>Log price of seeds</i>	0.285	0.051	5.59	0
<i>Log price of fertilizer</i>	0.084	0.055	1.52	0.129
<i>Log price of pesticides</i>	0.074	0.046	1.58	0.113
<i>Constant</i>	-3.029	1.028	-2.95	0.003
<i>sigma_v</i>	0.219	0.051		
<i>sigma_u</i>	0.378	0.097		
Chi2	133.83			
Log-Likelihood	-16.767			
Observations	66			

**Table 2. Panel B.** OLS on the predicted inefficiency term

Log VC	Coefficient	Standard Error	t	P>t
QUOTA	0.000	0.001	-0.16	0.875
OEDU	0.013	0.022	0.57	0.573
OAGE	-0.026	0.011	-2.47	0.017
OAGE2	0.000	0.000	2.51	0.015
<i>Constant</i>	1.203	0.263	4.57	0
R-squared	0.28			
Adj R-sq	0.22			
Observations	66.			

**Table 3.** Cobb-Douglas stochastic frontier—normal/truncated-normal model

	Coefficient	Standard Error	t	P>t
<i>LogVC</i>				
<i>Log output value</i>	0.0966	0.1359	0.71	0.477
<i>Log price of labor</i>	0.3791	0.0463	8.18	0
<i>Log price of seeds</i>	0.2426	0.0359	6.76	0
<i>Log price of fertilizer</i>	0.0832	0.0444	1.87	0.061
<i>Log price of pesticide</i>	0.0606	0.0279	2.17	0.03
<i>Constant</i>	-3.9554	0.8953	-4.42	0
<i>mu</i>				
<i>QUOTA</i>	0.001	0.0016	0.63	0.531
<i>SIZE</i>	-0.3941	0.0864	-4.56	0
<i>OAGE</i>	-0.0579	0.0271	-2.14	0.032
<i>OAGE2</i>	0.0005	0.0002	1.89	0.059
<i>OEDU</i>	-0.0877	0.082	-1.07	0.284
<i>Constant</i>	3.5747	0.87	4.11	0
<i>sigma_u2</i>	0.0008	0.004		
<i>sigma_v2</i>	0.0563	0.0096		
<i>Chi2</i>	233			
<i>Log-Likelihood</i>	-0.914			
<i>Observations</i>	65			

**Table 4. Panel A.** Translog stochastic frontier—normal/half-normal model

<i>LnVC</i>	Coefficient	Standard Error	t	P>t
<i>lny</i>	-4.2672	3.3590	-1.27	0.204
<i>lny2</i>	0.5055	0.4970	1.02	0.309
<i>Labor</i>	2.1385	1.1900	1.8	0.072
<i>Supplies</i>	-0.6707	1.2588	-0.53	0.594
<i>LS</i>	0.0204	0.1288	0.16	0.874
<i>LY</i>	-0.3075	0.1896	-1.62	0.105
<i>SY</i>	0.1310	0.1948	0.67	0.501
<i>LL</i>	-0.0834	0.0821	-1.02	0.309
<i>SS</i>	0.2073	0.0481	4.31	0
<i>Constant</i>	12.8137	11.5408	1.11	0.267
<i>sigma_v</i>	0.2397	0.0515		
<i>sigma_u</i>	0.3577	0.1055		
<i>Chi2</i>	257.09			
<i>Log-Likelihood</i>	-27.863			
<i>Observations</i>	70			

**Table 4. Panel B.** OLS on the predicted inefficiency term

	Coefficient	Standard Error	t	P>t
<i>QUOTA</i>	0.0000	0.0004	0.00	0.997
<i>SIZE</i>	-0.0688	0.0138	-4.97	0.000
<i>OEDU</i>	0.0069	0.0147	0.47	0.640
<i>OAGE</i>	0.0016	0.0011	1.49	0.139
<i>Constant</i>	0.5181	0.0916	5.66	0.000
<i>R-squared</i>	0.247			
<i>Adj R-squared</i>	0.215			
<i>Observations</i>	70			

**Table 5.** Translog stochastic frontier—normal/truncated-normal model

	Lnvc	Coef.	Std. Err.	z	P>z
LnVC					
	<i>Lny</i>	-1.5419	2.8193	-0.55	0.584
	<i>lny2</i>	0.0499	0.4184	0.12	0.905
	<i>Labor</i>	2.5002	0.9788	2.55	0.011
	<i>Supplies</i>	-1.6665	1.0550	-1.58	0.114
	<i>LS</i>	0.0086	0.0966	0.09	0.929
	<i>LY</i>	-0.3524	0.1528	-2.31	0.021
	<i>SY</i>	0.2800	0.1620	1.73	0.084
	<i>LL</i>	-0.0793	0.0659	-1.20	0.229
	<i>SS</i>	0.1840	0.0403	4.56	0.000
	<i>Constant</i>	5.1088	9.6789	0.53	0.598
mu					
	<i>QUOTA</i>	0.0021	0.0024	0.88	0.378
	<i>SIZE</i>	-0.5934	0.1402	-4.23	0.000
	<i>OEDU</i>	0.0489	0.0878	0.56	0.577
	<i>OAGE</i>	0.0041	0.0064	0.65	0.518
	<i>Constant</i>	1.8537	0.6085	3.05	0.002
	<i>sigma2</i>	0.0666	0.0117		
	<i>gamma</i>	0.0490	0.1052		
	Chi2	376			
	Log-Likelihood	-4.015			
	Observations	70			