

MARKET ORIENTATION AND THE MULTIFACTOR PRODUCTIVITY OF CHEROKEE INDIAN FARMERS BEFORE REMOVAL

Matthew T. Gregg
Grinnell College

ABSTRACT

The efficiency of Cherokee Indian agriculture before removal has been debated since the early nineteenth century, yet no study has employed quantitative methods to estimate the multifactor productivity of these farmers. For this investigation I employed a unique census collected in 1835 to estimate Cherokee household-level technical efficiency and scale elasticities to determine which group (classified in terms of economic and racial characteristics) within this diverse Nation achieved the highest farm productivity. The analysis reveals that among non-slaveholding Cherokees—the majority of Cherokee households in the Southeast—market-oriented units that were unrelated to any particular household racial composition achieved the highest multifactor productivity.

In the wake of American independence, the federal government adopted a “civilization” policy that sought to acculturate Native American people. In the Southeast, the program initially fell into the hands of Benjamin Hawkins, the first U.S. Superintendent of Southern Indian tribes. He stated his role in this federally-sponsored plan in an 1807 speech:

The plan I persue [sic] is to lead the Indian from hunting to the pastoral life, to agriculture, household manufactures, a knowledge of weights and measures, money and figures, to be honest and true to themselves as well as to their neighbors, to protect innocence, to punish guilt, to fit them to be useful members of the planet they inhabit and lastly, letters.¹

According to the “master narrative,” the Cherokees were the most eager of all Indian groups to obtain the trappings of this acculturation program. Evidence of their adoption of Euro-American traditions included the creation of a federal government in 1827, complete with three branches and a written constitution, and the conversion of many to Christianity. Yet the most radical transformation

among the Cherokees was their development of a surplus-oriented agricultural economy. Their adoption of intensive agriculture has led some to believe that the Cherokees achieved agricultural productivity that paralleled or surpassed that of their white neighbors: "The young Republic's experiment in self-reproduction succeeded, in retrospect, better than either its authors or its beneficiaries could comfortably acknowledge."²

However, economic and social historians have taken a closer look into the Cherokees' progress to reveal a different picture, one which included an uneven degree of wealth accumulation and land efficiency. Derisive comments on this wide variance in farm productivity can be traced back to 1830 when Lewis Cass, the second Secretary of War in Andrew Jackson's administration, wrote an influential article on Indian removal in *The North American Review* in which he specified mixed-blooded Cherokees, a small subset of the population, as those who acquiesced in the acculturation program. In the same year, similar sentiments were expressed in the Report of the Indian Committee of the House, which identified only 230 mixed-blood Cherokee families as achieving any level of civilization.³ Years later, Cherokee historian William McLoughlin argued that certain Cherokees, in particular full-blooded Cherokees, were not wealth-seeking individuals who made efficient use of their land: "Although most full-bloods mastered the art of plowing, they did not really understand how to get the best yield from the land."⁴ In an analysis of the 1835 Cherokee census—which is adopted in this study—McLoughlin and Walter Conser, Jr., isolated the continuation of traditional farming practices as a main reason why the North Carolina (mainly full-blooded) Cherokees lagged behind the rest of the Nation in using their land efficiently. Therefore, most historians have identified the adoption of Anglo-American farm technology, which was related to the racial composition of a household, as an influential determinant of farm productivity.⁵

Household-level Cherokee agricultural data have been collected since 1835, but no one has tested this claim by estimating multifactor productivity of Cherokee farmers. This paper sets out the results from my estimating household-level technical efficiency and scale elasticities to determine how to best characterize differences in productivity across Cherokee society. My analysis supports the conclusion that historians overrate the importance of racial differences across non-slaveholding households—the majority of Cherokees prior to removal—and underrate the importance of the market orientation of households, which was unrelated to the racial composition of these Cherokee farms.

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1835 CHEROKEE CENSUS

A pre-removal Cherokee census was taken during the summer and autumn of 1835 under the leadership of Major Benjamin F. Currey, Superintendent of Cherokee Emigration. In Currey's words, the purpose of the census was "to be fully possessed of a knowledge of their number, the number of each man's houses, the number of his farms, with the quantity of land under cultivation, the proportions of tillable land . . . [so] the commissioners would be able to fix a true estimate upon the value of the country."⁶ The Cherokee Nation was contained within four Southeastern states: Alabama, Georgia, North Carolina, and Tennessee. Alabama, Tennessee, and North Carolina were each assigned one enumerator, but Georgia was assigned two, for it held roughly half of the Cherokee families living east of the Mississippi River. Cherokee translators accompanied enumerators to ensure accuracy of the data collected. The thirty-three census categories include such household-level data as the number of male and female black slaves, the age and gender of each household member, and the number of bushels of wheat and corn produced.

Table 1 presents summary statistics for each variable used in this study for both slaveholding and non-slaveholding Cherokees.⁷ The two groups are disaggregated and analyzed separately because they employed different production processes and displayed different household labor-force participation rates.⁸ Only a few Cherokee households, 190 families—or 8.11 percent of the sample—held slaves whereas the majority of households, 2,154 families—or 91.89 percent of the sample—operated non-slave farms. The few slaveholding Cherokees held larger farms than the non-slaveholding Cherokees. Slaveholders cultivated on average six times as many acres as their non-slaveholding counterparts. Because the number of acres cultivated was higher on slave farms, total corn and wheat output was also greater on slave farms; however, corn yields were not dramatically different. The larger number of bushels of corn raised generated higher levels of crops sold, so income from corn was higher on slave farms. Although Cherokees grew beans, squash, and potatoes, corn was by far the most common crop cultivated in their region. The exclusion of these other crops from the census does not appear to bias the productivity results.⁹

The racial composition of slaveholding and non-slaveholding households was disparate. A slaveholding household was the more likely to include a married white or a mixed-blooded Cherokee, a distinction frequently offered as evidence that race influenced assimilation and thus productivity. Because free-labor and slave-labor agriculture represent different production technologies, the impact

TABLE 1
1835 Cherokee Census - Summary Statistics

	Non-Slave		Slave	
	Mean	Std. Dev.	Mean	Std. Dev.
Cherokee Males under 18	1.64	1.42	1.76	1.54
Cherokee Males over 18	1.57	1.05	1.43	1.12
Cherokee Females under 16	1.53	1.34	1.64	1.36
Cherokee Females over 16	1.69	1.04	1.52	0.94
Total Cherokees	6.43	3.25	6.34	3.17
Male Slaves	-	-	3.55	6.59
Female Slaves	-	-	3.93	6.53
Married Whites	0.04	0.20	0.35	0.48
Full-bloods	5.53	3.64	1.20	2.55
Mixed-bloods	0.86	2.23	5.04	3.47
Acres Cultivated	12.65	16.04	78.98	80.63
Houses	2.75	2.42	9.43	7.91
Bushels of Wheat	0.24	2.91	10.04	27.83
Bushels of Corn		230.38	1128.53	1206.59
Bushels of Wheat Sold	0.04	0.78	2.15	10.23
Bushels of Corn Sold	18.73	54.55	324.95	649.56
Corn Income	\$9.21	\$27.07	\$160.37	\$313.43
Bushels of Corn Bought	1.84	9.73	28.35	150.87
Corn Expenditures	\$0.86	\$4.23	\$8.92	\$38.81

Notes: $N_{\text{Non-Slave}} = 2,154$. $N_{\text{Slave}} = 190$.

Source: 1835 Census Roll of the Cherokee Indians East of the Mississippi River and Index to the Roll, Records of the Bureau of Indian Affairs, Record Group 75.

of race on productivity is unclear.

Pooling the Cherokee data into economically and racially defined groups allows me to test my hypothesis that factors correlated to the racial composition

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of a household influenced productivity. I classified a Cherokee household as market-oriented if the family sold grain—669 families, or 31 percent of the non-slaveholding households, and 124 families, or 65 percent of the slaveholding households in the sample. Although grain surpluses were not usually shipped outside the Nation, other crops such as cotton were shipped to New Orleans or other port cities. Cattle drovers using public roads that crossed Cherokee lands bought corn for their livestock and created an incentive for the Indians to produce marketable surpluses. For some Cherokees, the amount supplied to the market was substantial; a few slaveholders sold over 3,000 bushels of corn to local markets, generating \$1,500 in income.

I categorized households by racial composition: married white in the household, all family members of mixed-blood, and all family members full-blooded Cherokee. A mixed-blood Cherokee household comprised solely "half-breeds" or "quadroons" and a full-blooded household all full-blooded Cherokees.

I estimated output for a production function by converting bushels of wheat into corn-equivalent bushels then aggregating with bushels of corn produced. I based corn-equivalent bushels on the nutritional value of food crops as measured against corn using an estimated nineteenth-century conversion rate of wheat to a bushel of corn at 1.104.¹⁰ To avoid double counting, I subtracted from total output the estimated amount of seed needed to obtain the same crops in the next year: 5 percent of the corn output and 12 percent of the wheat output.¹¹ I did not subtract feed requirements because I found no livestock data; any such data collected are likely to have been insubstantial since Cherokee animal husbandry in the early nineteenth century lagged behind that of white counterparts. I defined the output variable as

$$\text{CROP OUTPUT} = \text{CORN} * 0.95 + \text{WHEAT} * 0.88 * 1.104.$$

For both slaveholding and non-slaveholding Cherokees, I converted household field laborers into equivalent field hands by using male and female labor-force participation rates as weights. Two censuses taken in the mid-1820s provided the estimate of the percentage of white males in the married white census category. They reported that 69.2 percent and 70.2 percent of the total married white population in the Cherokee Nation were males.¹²

$$\text{ADULT MALES} = (\text{MALES} \geq 18) + (0.7 * \text{MARRIED WHITES})$$

$$\text{ADULT FEMALES} = (\text{FEMALES} \geq 16) + (0.3 * \text{MARRIED WHITES}).$$

I specified the household labor variable in two ways: (1) for slaveholding Cherokees, I adopted labor-force participation rates typically used in antebellum slave efficiency studies and tested the aggregation with econometric techniques; and (2) for non-slaveholding Cherokees, I determined the labor-force participation rates solely through econometric methods for there are no Cherokee labor-force estimates. Robert Fogel and Stanley Engerman estimated that males 16 years old and over had a 100 percent participation rate on slave farms, while males aged 10 to 15 had a labor-force participation rate of 17 percent. The 17 percent participation rate is an underestimation.¹³ For this study I used the four-state average from Thomas Weiss's estimation of the antebellum labor force for males between 10 and 15 but modified the participation rate slightly for the under-18 Cherokee male category. The average participation rate in Georgia, Alabama, North Carolina, and Tennessee in 1850, the earliest estimate available, was 46 percent. I adjusted the participation rate upward for Cherokee males under 18 to incorporate males over 15 who always worked on slave farms. Males under 10 did not typically work on these farms. The household field labor (or free labor) variable on slave farms is

$$\text{FREE LABOR} = (0.5 * \text{MALES} < 18) + (\text{ADULT MALES}).$$

I tested this aggregation with an OLS regression, and the estimates justify the free labor variable specification.¹⁴ Both Cherokee female variables—females over and under 16—were left out of the household labor variable because their contributions to grain output were statistically insignificant. Gender roles on Cherokee slave farms were not drastically different than those on their white neighbors' farms notwithstanding studies by ethnohistorians who have emphasized the importance of cultural persistence among Cherokee households. The change in traditional gender roles on Cherokee farms may be explained by the scarcity of non-agricultural work alternatives available for Cherokee males during the 1830s.

To determine which gender and age groups contributed to grain output on non-slave farms, I specified a regression model with logged output as the dependent variable. Moreover, I used males under and over 18, females under and over 16, capital, acres, and two soil type dummy variables as regressors. As with slaveholding Cherokees, the coefficients on females under and over the age

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of 16 are statistically insignificant, and the coefficients on both male age groups are statistically significant.¹⁵ I pooled the male age groups to determine whether aggregating them was appropriate then tested various linear combinations of males above and under 18. All except the linear restriction $\beta_{<18} = \beta_{\geq 18}$ were rejected at standard significance levels.¹⁶ So the household labor variable used on non-slaveholding households I specified as

$$\text{FREE LABOR} = (\text{MALES} < 18) + (\text{ADULT MALES}).$$

Since data are limited, I made no adjustment of the slave variable into equivalent field hands. The slave variable is the total number of black slaves, both male and female, held by each Cherokee household.

$$\text{SLAVE LABOR} = (\text{MALE SLAVES}) + (\text{FEMALE SLAVES}).$$

I specified the land variable as the number of acres cultivated then established three separate dummy variables, one for each soil type, to control for differences in soil quality. I relied on soil characteristics described by Eugene Hilgard to define the following soil types on Cherokee lands: soil type 1 (Piedmont counties) gray and red clay lands along with a hilly terrain; soil type 3 (Appalachian Hills region) siliceous and mountain lands in Tennessee and North Alabama; and soil type 8 (counties along the Cumberland Plateau) are found in fertile valley lands in the Blue Ridge and Smokey Mountains and in parts of the Cumberland Mountains.¹⁷

$$\begin{aligned} \text{LAND} &= \text{ACRES CULTIVATED,} \\ \text{SOIL}_1 &= 1 : \text{Household Located in Soil Type 1} \\ &0 : \text{Otherwise,} \\ \text{SOIL}_2 &= 1 : \text{Household Located in Soil Type 3} \\ &0 : \text{Otherwise,} \\ \text{SOIL}_3 &= 1 : \text{Household Located in Soil Type 8} \\ &0 : \text{Otherwise.} \end{aligned}$$

The physical capital variable is often disputable and hence the most troublesome input to specify in any productivity analysis. Historical census studies commonly include the value of livestock, buildings, implements, and

machinery in a physical capital variable. Unfortunately, the Cherokee census does not include the value of farming implements or livestock, so I used a proxy. A farmer who invested heavily in structures probably also invested heavily in farm implements. The proxy is needed not to determine the true impact of physical capital on output levels but to avoid the problems of omitted variables on regression estimates. The capital proxy is

$$\text{CAPITAL} = \text{NO. OF HOUSES.}$$

Prior studies have shown that the omission of a proxy variable, even if the variable contains measurement error, generates a greater degree of inconsistency in the coefficient estimates than if the proxy is included.¹⁸

MULTIFACTOR PRODUCTIVITY: THEORY AND EMPIRICAL METHOD

A multifactor productivity (MFP) index reflects the ratio of an index of outputs to an index of inputs. Thus, it is commonly expressed as

$$\text{MFP} = \text{Output Index/Input Index.} \quad (1)$$

In theory, multifactor productivity over cross-sectional data can vary because of differences in scale economies and in technical efficiency. A household that exploits all the available scale economies produces at a cost efficient level of output and is thus more productive than a household that operates at a smaller scale where increasing returns to scale exist.¹⁹

Technical efficiency, the ability to produce maximal output given a set of inputs, can arise from differences in competitive forces and skill levels among households. Theoretically market forces drive technical inefficiency to zero in a long-run competitive equilibrium. Since some households produced for market but others did not, market forces should have determined differences in productivity. Yet the most-skilled and experienced farmers were likely to be technically efficient and thus able to sell their excess crops on the market. The role of market forces on technical efficiency is unknown; but for this study, the correlation between market orientation and technical efficiency is more important than the effect of market forces on efficiency. Furthermore, if the white agricultural method was the "best-practice" method of farming, then the technical efficiency of the assimilated Cherokees—as implied by many historians—should have been greater than that of the traditionalists.

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To determine multifactor productivity for both slaveholding and non-slaveholding Cherokees, I estimated a stochastic production function frontier. This approach allowed me to control for such random effects as weather and measurement error. I will show efficiency scores with equation 2,

$$TE_i = \frac{y_i}{f(x_i; \beta) * \exp(v_i)}, \quad (2)$$

where TE_i represents the individual technical efficiency measures, y_i is an index of output, $f(x_i; \beta)$ is the deterministic production function, and $\exp(v_i)$ accounts for random noise.

I have specified the production function for both slaveholding and non-slaveholding Cherokees with a translog function. This flexible-form specification eliminates the restrictive scale and substitution properties of the Cobb-Douglas specification. I have represented this translog specification for both types of farms as

1. Non-Slaveholding Cherokees

$$\ln y_i = \beta_0 + \sum_{i=1}^3 \beta_i \ln x_i + \frac{1}{2} \sum_{i=1}^3 \sum_{j=1}^3 \beta_{ij} \ln x_i \ln x_j + \sum_{k=1}^2 \delta_k SOIL_i + v_i - u_i, \quad (3)$$

$$\beta_{ij} = \beta_{ji} \text{ for all } i \neq j,$$

2. Slaveholding Cherokees

$$\ln y_i = \beta_0 + \sum_{i=1}^4 \beta_i \ln x_i + \frac{1}{2} \sum_{i=1}^4 \sum_{j=1}^4 \beta_{ij} \ln x_i \ln x_j + \sum_{k=1}^2 \delta_k SOIL_i + v_i - u_i, \quad (4)$$

$$\beta_{ij} = \beta_{ji} \text{ for all } i \neq j,$$

where i is the i^{th} household, y_i is output, x_1 is free labor, x_2 is land, x_3 is capital, x_4 is slave labor, and $SOIL_1$ and $SOIL_2$ are the soil type dummies. I have specified the error term with two components: v_i is a two-sided random noise term, independently and identically distributed $N(0, \sigma_v^2)$, and u_i is a one-sided technical inefficiency effect term, independently and identically distributed $N^+(0, \sigma_u^2)$.²⁰ The technical efficiency of each household is determined by $(\exp(-u)) = \frac{y_i}{f(x_i; \beta) * \exp(v_i)}$, which is identical to equation (2).

Since the error term has two components, I estimated equations (3) and (4) as maximum likelihood. If I assume the v_i 's and u_i 's are independent, the log likelihood function becomes:

$$\ln L = -\frac{N}{2} \ln\left(\frac{\pi}{2}\right) - \frac{N}{2} \ln(\sigma_s^2) + \sum_{i=1}^N \ln[1 - \Phi(z_i)] - \frac{1}{2\sigma_s^2} \sum_{i=1}^N \varepsilon_i^2, \quad (5)$$

where N is the number of households, $\sigma_s^2 = \sigma_u^2 + \sigma_v^2$, $z_i = \frac{\varepsilon_i}{\sigma_s} \sqrt{\frac{\gamma}{1-\gamma}}$, $\gamma = \frac{\sigma_u^2}{\sigma_s^2}$, and $\Phi(\cdot)$ is the standard normal cumulative distribution function. Once I obtained the ML estimates of β , δ , γ , and σ_s^2 I could compute each household's technical efficiency. I used a method developed by George Battese and Tim Coelli²¹ to determine the point estimator of $E(\exp(-u))$ by

$$E(\exp\{-u\} | \varepsilon_i) = \frac{1 - \Phi\left(\sigma_* + \frac{\gamma \varepsilon_i}{\sigma_*}\right)}{1 - \Phi\left(\frac{\gamma \varepsilon_i}{\sigma_*}\right)} * \exp\left(\gamma \varepsilon_i + \frac{1}{2} \sigma_*^2\right), \quad (6)$$

where $\sigma_* = \sigma_u * \left(\frac{\sigma_v}{\sigma_u + \sigma_v}\right)$. Each estimate of household-level technical efficiency

must fall between 0 and 1; a 1 represents a household that is 100 percent technically efficient, and 0 represents a household that is 100 percent technically inefficient.

I applied the following restrictions on the non-slaveholding Cherokees to determine if the production function is homogenous:

$$\sum_{i=1}^3 \beta_{1i} = \sum_{i=1}^3 \beta_{2i} = \sum_{i=1}^3 \beta_{3i} = 0. \quad (7)$$

After testing these restrictions, I imposed an additional restriction to determine whether the underlying production structure is linearly homogenous; if it is, then every household may have faced a constant returns to scale technology regardless of the farm size. The restriction is

$$\sum_{i=1}^3 \beta_i = 1. \quad (8)$$

For the slave translog production function, there are four restrictions that impose homogeneity and five restrictions that impose linear homogeneity. These restrictions are as follows:

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$$\sum_{i=1}^4 \beta_{1i} = \sum_{i=1}^4 \beta_{2i} = \sum_{i=1}^4 \beta_{3i} = \sum_{i=1}^4 \beta_{4i} = 0, \text{ and} \quad (9)$$

$$\sum_{i=1}^4 \beta_i = 1. \quad (10)$$

Using likelihood ratio tests, I imposed homogeneity and linear homogeneity on both types of households. For slaveholding Cherokees, the null hypotheses of homogeneity and linear homogeneity were not rejected, implying that all slaveholding Cherokees faced constant returns to scale.²² Thus, doubling all inputs, regardless of the size of the farm and the racial composition of the household, would have led to a doubling of grain output. For non-slaveholding Cherokees, both null hypotheses were rejected, which implies that the scale economies on Cherokee non-slave farms depended on the size of the operation. Doubling the inputs would have led to the doubling of output on some non-slave farms and to more than doubling of output on other farms.²³ Thus, only for non-slave-holding Cherokees did larger farms generate higher productivity.

By only imposing the linear homogeneity restrictions on the slaveholding Cherokee data, I estimated both equations (3) and (4) by maximum likelihood; these results appear in Table 2. Before I performed the estimation, I divided each input variable by its respective mean, so the first-order coefficients are mean output elasticities. Each first-order coefficient is of the correct sign, and some of the cross products for both non-slaveholding and slaveholding Cherokees are highly significant. On both types of farms, the mean output elasticities of land and capital are highly significant. Because most non-slave Cherokee farms were small, the impact of additional capital and land should have been substantial and larger than a *ceteris paribus* increase in free labor. Also, since the number of acres cultivated was higher on slave farms, land productivity should have been lower than on non-slave farms and labor productivity should have been higher.

The inverse relationship between farm size and land productivity is common in agricultural productivity studies. Contemporaries commented on the low level of free labor productivity on both types of farms. An Alabama resident claimed, "it is notorious that in consequence of their habitual idleness all laborious pursuits tending to lucrative purposes are thought by them to be beyond their effect."²⁴ Of course, because the land productivity was high on both types of farms, the same contemporary statement would not have been true for a Cherokee farmer who possessed a large farm.

TABLE 2
Cherokee Non-Slave and Slave Farms – Translog Estimates

(Dependent Variable: ln Output)

Variable	Parameter	Non-Slave	Slave
Constant	β_0	0.741 (0.037)***	0.589 (0.095)***
ln Free Labor (x_1)	β_1	0.014 (0.036)	0.047 (0.055)
ln Land (x_2)	β_2	0.745 (0.020)***	0.689 (0.074)***
ln Capital (x_3)	β_3	0.312 (0.029)***	0.214 (0.087)***
ln Slave (x_4)	β_4		0.050 (0.073)
$(\ln x_1)^2$	β_{11}	0.015 (0.083)	0.004 (0.109)
$\ln x_1 \ln x_2$	β_{12}	-0.087 (0.034)**	0.156 (0.063)**
$\ln x_1 \ln x_3$	β_{13}	0.015 (0.047)	-0.064 (0.126)
$\ln x_1 \ln x_4$	β_{14}		-0.096 (0.068)
$(\ln x_2)^2$	β_{22}	0.047 (0.024)*	0.135 (0.081)*
$\ln x_2 \ln x_3$	β_{23}	-0.158 (0.028)***	-0.213 (0.096)**
$\ln x_2 \ln x_4$	β_{34}		-0.078 (0.079)
$(\ln x_3)^2$	β_{33}	-0.025 (0.054)	0.054 (0.213)
$\ln x_3 \ln x_4$	β_{34}		0.222 (0.118)*
$(\ln x_4)^2$	β_{44}		-0.048 (0.114)
Soil ₁	δ_1	-0.251 (0.030)***	-0.137 (0.102)
Soil ₂	δ_2	-0.159 (0.062)***	0.104 (0.099)
	σ^2	0.927 (0.044)***	0.897 (0.133)***
	Γ	0.809 (0.021)***	0.962 (0.030)***
log-likelihood		-2149.963	-153.227

Notes: The standard errors are shown in parentheses.

*, **, and *** represent statistical significance at the 10 percent, 5 percent, and 1 percent levels.

Source: See Table 1.

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For slaveholding Cherokees, the mean output elasticity of slaves is low and statistically insignificant. The low marginal productivity may be solely a function of the output variable, which does not contain labor-intensive crops such as tobacco and cotton. Yet land and slave labor were complements, so the small scale of the Cherokee slave farms, especially when compared to the thousand-acre slave farms in the Deep South, can also help explain the low level of slave labor productivity.

Finally, the high levels of the γ parameter in both regressions suggest that the variance of the technical inefficiency effects outweighs the variance of the random effects. This difference suggests the specified one-sided error term is advantageous because there was considerable variation in technical efficiency across both types of households. The translog functions for both farms are well-behaved and the output elasticities are consistent with economic theory, so the resulting technical efficiency measures are consistent measures of the efficiency levels on these farms.

VARIATIONS IN PRODUCTIVITY ACROSS CHEROKEE GROUPS

To determine which Cherokee group generated the highest multifactor productivity, I compared both scale elasticities and technical efficiency measures. The scale economies for the non-slaveholding Cherokees depended on the size of the farm. I calculated the scale elasticity on each farm by summing each output elasticity. The partial production elasticities for each input is shown by

$$\varepsilon_i = \beta_i + \sum_{j=1}^J \beta_{ij} \ln x_j, \text{ for all } i. \quad (11)$$

The returns to scale parameter is $\eta_{rs} = \sum_{i=1}^3 \varepsilon_i$ for each non-slaveholding household.

The second column of Table 3 shows that for non-slaveholding Cherokees the households that included married whites on average exploited scale economies. The difference in the mean scale elasticity between market-oriented, married white, and mixed-blooded households was trivial. Only the full-blooded families failed to exploit all the available scale economies and thus were substantially cost inefficient. Therefore, solely in terms of scale elasticities, both mixed-blooded categories achieved a greater degree of cost efficiency than the market-oriented group. I compared the scale elasticities and technical efficiency measures to determine which group was the most productive.

TABLE 3
Multifactor Productivity Across Categories

NON-SLAVEHOLDING CHEROKEES

Category	Technical Efficiency	Scale Elasticity	Technical Efficiency ¹
Market-Oriented Households	1.000	1.072	1.000
Married White Households	0.990	0.991	0.995
Mixed-blooded Households	0.973	1.053	0.982
Full-blooded Households	0.892	1.199	0.885

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Category	Technical Efficiency	Scale Elasticity	
Market-Oriented Households	1.000	1.000	
Married White Households	1.037	1.000	
Mixed-blooded Households	0.971	1.000	
Full-blooded Households	0.784	1.000	

¹The CRS restrictions were imposed to obtain multifactor productivity measures.
Source: See Table 1.

Table 3 displays the technical efficiency measures of the economic and race categories after I compared each category's mean technical efficiency measure to the mean technical efficiency of the market-oriented households. For non-slaveholding Cherokees, the results show that the market-oriented households were the most technically efficient: the married white and mixed-blooded households were 1 percent and 2.7 percent more technically *inefficient* than the market-oriented households. Cherokee households with married whites were on average 3.7 percent more technically efficient than the market-oriented households. Since each slaveholding household exhibited constant returns, the higher technical efficiency by households with married whites implies that a category based solely on a particular household's racial composition did

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generate the highest multifactor productivity on Cherokee-run slave farms. The ownership of black slaves was not new to Cherokee farmers but the use of black slaves in intensive agriculture was. The married whites who owned slaves were most likely full-time farmers who had more experience in slave agriculture than the Cherokee slaveholders. Also, most Cherokee slaveholders held a small number of slaves, some of whom may have been adopted into the slaveholders' families. This inclusion would have undoubtedly lowered the technical efficiency on these types of farm households even if they sold corn to the market.

But the most productive group among the non-slaveholding Cherokees is still undetermined since the greater technical efficiency of market-oriented households may have outweighed their lower cost efficiency. I determined the magnitude of each component of multifactor productivity by imposing the linear homogeneity restrictions on the non-slaveholding Cherokee data. The resulting technical efficiency measures are identical to multifactor productivity measures. These measures are shown in the last column of Table 3. When constant returns to scale restrictions are imposed on non-slaveholding Cherokees, the market-oriented households prove to be the most productive category of non-slaveholding Cherokees.

My results suggest that on the majority of Cherokee farms the groups defined solely in terms of the racial composition of the household did not generate the highest farm productivity. Economic theory suggests that to produce for the market, a household must be productive and likely more productive than non-market-oriented households. But who were the grain sellers? I addressed this question by specifying a Probit regression model with a dependent variable of one for the households that sold either corn or wheat to the market, and zero otherwise. The grain sellers include households with a married white, a mixed-blood, a farmer over the age of 18, and a reader of English. And I added to the regression the number of acres cultivated, houses, and households with multiple farms. Finally I constructed a locational dummy variable to isolate households close to the Federal Road, where most market activity took place, and another to isolate households along major rivers in the region.

I set out the results from this regression in Table 4. Both the unrestricted and restricted regressions show that once I controlled for these various factors, the racial composition of the household had no impact on the probability of selling crops to the market. Therefore, for non-slaveholding Cherokees, no specific racial composition of the household could channel superior productivity to generate marketable surpluses.

TABLE 4
Determinants of Non-Slaveholding Market Orientation

(Dependent Variable: 1 if Sold Bushels of Corn or Wheat, 0 Otherwise)

Variable	(1)	$\frac{\delta P(y=1 x)}{\delta x}$	
		(2)	
Constant	-1.599 (0.131)***	-0.486	-1.539 (0.162)***
Married Whites	0.098 (0.160)	0.017	0.067 (0.152)
Mixed-Blood	0.066 (0.125)	0.021	0.062 (0.120)
Acres	0.018 (0.002)***	0.006	0.018 (0.002)***
Houses	0.082 (0.013)***	0.029	0.081 (0.013)***
Proximity to Fed. Road	0.482 (0.067)***	0.151	0.513 (0.062)***
Proximity to Rivers	0.177 (0.113)	0.055	
Farmers > 18	0.376 (0.128)***	0.118	0.372 (0.128)***
Readers in English	0.009 (0.101)	0.003	
Multiple Farms	0.002 (0.086)	0.001	
Fraction of Correct Predictions	0.723		0.727

Notes: N=2,153. *** represents statistical significance at the 1 percent level.

In conclusion, the racial composition of a Cherokee household influenced productivity on both slave- and free-labor farms, but Cherokee farmers who achieved the highest level of productivity can be defined in economic terms without recourse to racial classifications. My application of cliometric methods to the 1835 Cherokee Census has clarified economic behavior among Cherokee Indians.

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NOTES

This study, an abridged version of a chapter from my dissertation, "A Measure of History: Cherokee Agricultural Productivity in Comparative Perspective, 1835-1850," was financially assisted by NSF Doctoral Dissertation Improvement Grant #0217185.

1. Claudio Saunt, *A New Order of Things: Property, Power, and the Transformation of the Creek Indians, 1733-1816* (Cambridge: Cambridge University Press, 1999), 139.
2. Mary Young, "The Cherokee Nation: Mirror of the Republic," *American Quarterly* 33, no. 5 (1981): 503-4. See also Wilma Dunaway, "Rethinking Cherokee Acculturation: Agrarian Capitalism and Women's Resistance to the Cult of Domesticity, 1800-1838," *American Indian Culture and Research Journal* 21, no. 1 (1997): 157.
3. Anthony F. C. Wallace, *The Long, Bitter Trail: Andrew Jackson and the Indians* (New York: Hill & Wang, 1993), 67.
4. William G. McLoughlin, *Cherokee Renaissance in the New Republic* (Princeton, NJ: Princeton University Press, 1986), 301.
5. William G. McLoughlin and Walter H. Conser, Jr., "The Cherokee in Transition: A Statistical Analysis of the Federal Cherokee Census of 1835," *Journal of American History* 64, no. 3 (1977): 678-703. Historians have debated the role of race in Southeastern Indian communities. For disparate views, see Saunt, *A New Order of Things*; and Theda Perdue, *"Mixed Blood" Indians: Racial Construction in the Early South* (Athens: University of Georgia Press, 2003).
6. George Nixon, "Records Relating to Native American Research: The Five Civilized Tribes," in *The Source: A Guidebook of American Genealogy*, ed. Arlene Eakle and Johni Cerny (Salt Lake City, Utah: Ancestry Pub. Co., 1984), 535.
7. I limited this study to corn-producing households that owned land and houses, 87.79 percent of the census, or 2,344 households. The restriction did not bias the sample. I ran a battery of tests to determine that the sample was representative of the entire Cherokee census. Gregg, "A Measure of History: Cherokee Agricultural Productivity in Comparative Perspective, 1835-1850" (PhD diss., University of Georgia, 2003), Chapter 2.
8. Since non-slave and slave farm production processes during the Antebellum Period were distinct, aggregating these two types of agriculture would lead to inconsistent technical efficiency measures. Elizabeth B. Field, "Free and Slave Labor in the Antebellum South: Perfect Substitutes or Different Inputs?" *Review of Economics and Statistics* 70, no. 4 (1988): 654-59.

9. There is no way to determine the crop mix for each household in the census. Yet the largest slaveholders, the likely cotton producers, achieved the highest technical efficiency in grain production among slaveholding Cherokees, so the production of cotton was probably minimal on Cherokee farms.
10. Roger L. Ransom and Richard Sutch, *One Kind of Freedom: The Economic Consequences of Emancipation* (Cambridge: Cambridge University Press, 1977), Table E.2, 247.
11. These seed requirements were listed in U.S. Patent Office reports on white farmers from the Upcountry shortly after removal. David F. Weiman, "Farmers and the Market in Antebellum America: A View from the Georgia Upcountry," *Journal of Economic History* 47, no. 3 (1987): 634 n. 26.
12. Elias Boudinot, *An Address to the Whites. Delivered in the First Presbyterian Church, on the 26th of May, 1826* (Philadelphia: W. F. Geddes, 1826).
13. Thomas Weiss, "U.S. Labor Force Estimates and Economic Growth, 1800-1860," in *American Economic Growth and Standards of Living before the Civil War*, ed. Robert E. Gallman and John J. Wallis (Chicago: University of Chicago Press, 1992), 49.
14. The following regression tests this aggregation:
- $$\ln Q_i = 5.310 + 0.048 \text{Men}_i + 0.083 \text{FL}_i + 0.008 \text{L}_i + 0.020 \text{K}_i + 0.335 \text{Soil}_i$$
- (0.14)** (0.06) (0.04)* (0.00)* (0.01)* (0.13)**
- where $\ln Q_i$ is log output, Men_i is Cherokee males over 18, FL_i is $\text{Men}_i + .5 * \text{Boys}_i$, where Boys_i is Cherokee males under 18, L_i is cultivated acres, K_i is the number of houses, and Soil_i is a soil type dummy. The coefficient on Men_i indicates whether the null hypotheses ($\beta_{\geq 18} = .5\beta_{<18}$) should be rejected since this coefficient can be rewritten as $\beta_{\text{men}} = \beta_{\geq 18} - .5\beta_{<18}$. The point estimate is statistically insignificant so the null hypothesis cannot be rejected. * and ** represent statistical significance at the 5 percent and 1 percent levels. Consequently, if the labor variable includes females, the first-order coefficient is still statistically insignificant in the stochastic frontier analysis.
15. The individual LR statistics for females above and below the age of 16 are 1.482 and 0.007, respectively. I rejected the null hypothesis that the coefficients on males under and over the age of 18 are individually zero because the LR statistic is 19.782 for males over 18 and 12.559 for males under 18.
16. The following regression tests the free labor variable specification:

$$\ln Q_i = 3.710 - 0.39 \text{Men}_i + 0.094 \text{FL}_i + 0.032 \text{L}_i + 0.078 \text{K}_i - 0.119 \text{Soil}_i$$

(0.07)** (0.30) (0.02)** (0.01)** (0.03)** (0.04)**

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- where $\ln Q_i$ is log output, Men_i is Cherokee males over 18, FL_i is $Men_i + Boys_i$, where $Boys_i$ is Cherokee males under 18, L_i is cultivated acres, K_i is the number of houses, and $Soil_i$ is a soil type dummy. The t statistic of -1.30 on Men_i shows that the null hypothesis ($\beta_{\geq 18} = \beta_{<18}$) should not be rejected. ** represents statistical significance at the 1 percent level. As with the non-slave data, the inclusion of female laborers does not influence the technical efficiency measures as the first-order coefficient on free labor is still insignificant.
17. Eugene W. Hilgard, *Report on Cotton Production in the United States, Also Embracing Agricultural and Physico Geographical Descriptions of the Several Cotton States and of California* (Washington, DC: U.S. Government Printing Office, 1884); and Roger Ransom and Richard Sutch, "Economic Regions of the South in 1880," Southern Economic History Project, Working Paper no. 3 (1971): 4, 7, 13.
 18. William H. Greene, *Econometric Analysis* (Upper Saddle Creek, NJ: Prentice Hall, 1993), 442-43.
 19. In "A Measure of History" (p. 92), I showed that the shape of the long-run average cost curve for non-slaveholding Cherokees is U-shaped.
 20. I could have used a number of nonnegative distributions or two-parameter distributions, but Christian Ritter and Leopold Simar showed that two-parameter distributions such as the truncated normal and gamma generate unreliable frontier estimates unless the sample size contains several thousand observations. Christian Ritter and Leopold Simar, "Pitfalls of Normal Gamma Stochastic Frontier Models," *Journal of Productivity Analysis* 9, no. 2 (1997): 167-82.
 21. George E. Battese and Tim J. Coelli, "Prediction of Firm Level Technical Efficiencies with a Generalized Frontier Production Function and Panel Data," *Journal of Econometrics* 38 (1988): 387-99.
 22. The test statistics for the homogeneity and CRS restrictions are 1.925 and 2.550, neither of which can be rejected at reasonable significance levels.
 23. The LR statistic on the CRS restrictions is 63.36 with a critical value of 9.49 at the 5 percent significance level, and the LR statistic on the homogeneity restrictions is 33.39 with a critical value of 7.81 at the 5 percent significance level.
 25. Claudio Saunt, "What Can Economic Historians Tell Us About Native American History?" (Comments Delivered at the Annual Meeting of the American Historical Association, Boston, 2001), 3.