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# Explaining the Relative Efficiency of Slave Agriculture in the Antebellum South: Comment

By PAUL A. DAVID AND PETER TEMIN\*

The publication of Robert Fogel and Stanley Engerman's (hereafter, F-E) book *Time on the Cross* was greeted by a flurry of laudatory notices in the popular press. Our review article in 1974 began the process of critical reevaluation by economists and quantitative historians which has exposed the serious methodological and substantive errors that permeate *Time on the Cross*.<sup>1</sup> In the original critique, to which F-E (1977) have chosen to reply, we focused attention upon the central position occupied by their "findings" concerning the relative "efficiency" of slave agriculture. The validity of these findings was seen to be of crucial importance within the larger structure of F-E's proposed reinterpretation of American Negro slavery. Based on their conclusion that southern agriculture enjoyed a total factor productivity advantage vis-à-vis free northern farming, they argued that the plantation regime rendered slaves "superior" workers and that blacks today should take pride in the accomplishments of their captive forebears whose diligence and skill made American slavery an economically efficient system. Putting aside the difficult factual, ethical, and emotional questions surrounding the extent of acquiescence (or active cooperation) in the plantation system by slaves, we argued that F-E's method of demonstrating (southern)

plantation agriculture's "relative efficiency," compared with free (northern) farming, was badly flawed. Indeed, we found conceptual and empirical errors so grave that they invalidated F-E's findings on this key issue.

Fogel and Engerman (1977) have returned to their productivity calculations in an attempt to reconstruct this foundation of their argument, but their attempt only further undermines their intellectual edifice. They did not discuss the theoretical objections to their calculation at all, and they performed new calculations that are even more distorted than the old. In responding to our criticisms of the way they measured land inputs in calculating relative factor-productivity averages for farms in the North and South, and for different classes of farms and plantations within the South, they have entirely eliminated land as an input in the agricultural production function. Although the results of these productivity recalculations have been seized upon by F-E to argue that our theoretical objections are of no empirical importance, these new "corrected" figures compound rather than correct the original error.

We substantiate these propositions in three steps. First, we restate and clarify the theoretical objections to F-E's procedures. Second, we demonstrate that F-E (perhaps inadvertently) have removed land from their agricultural production function. And third, we show the effect of a rudimentary correction of their productivity figures that at least moves in the right direction.

The issue of efficiency is important to F-E because they based their argument that slaves were more productive workers than free white farmers on the presumed greater efficiency of southern agriculture. As employed in this argument, greater efficiency

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<sup>1</sup>Fogel and Engerman's (1977) reply to their critics overlooks the more comprehensive appraisal of *Time on the Cross*, published under the title *Reckoning with Slavery*, in which we were joined by Herbert Gutman, Richard Sutch, and Gavin Wright.

refers to superior technical efficiency, the ability to produce a specified set of outputs using a smaller amount of inputs than that required by another productive entity. But F-E measured the efficiency with which southern and northern farms generated *revenue*—what we call “revenue efficiency”—which differs conceptually from technical efficiency. Relative technical efficiency can be inferred from relative revenue efficiency under certain circumstances, but not under those which are appropriate to the historical case at hand.

The output mix of southern and northern farms, and even of different sized farms within the South, was very different. In particular, no cotton was grown in the North, and smaller southern farms had smaller proportions of cotton in their output. In their measurement of efficiency, F-E aggregated different farm products in a fixed-weight index, with national market prices as the weights. Their implicit assumption was that only the size of this aggregate index, and not its composition, mattered in establishing relative levels of technical efficiency for slave and free farms, and for southern and northern agriculture. This would be true if the relevant portion of the production-possibility frontier describing combinations of farm output attainable from a given set of inputs were linear and parallel to the slope of relative prices, but it is not true if the production-possibility frontier was curved.

Consider Figure 1. The two axes measure the production of cotton and “corn,” the latter being taken here as a proxy for all noncotton products. The line *AB* is drawn to reflect the ratio of (assumed) market prices. If it also indicates the shape of a representative production-possibility frontier (using a standard input bundle), then the relative locations of the production-possibility frontiers for different types of farms are shown unambiguously by which price lines their respective outputs lie on. Output on a higher price line indicates that production was on a higher production-possibility frontier.

On the other hand, if the production-

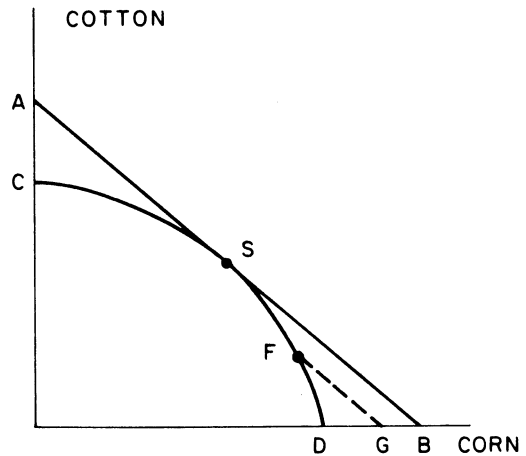


FIGURE 1

possibility frontier was curved, as shown by *CD* in Figure 1, this correspondence between the relative positions of price lines and production-possibility frontiers does not necessarily exist. It exists only if the different producers faced the same relative prices *and* were profit maximizers, for then we can assume that each one produced at a point analogous to point *S* in Figure 1. (*S* is the point of maximum revenue, and therefore, given the cost of the standard input bundle, the point of maximum profit). But if different producers faced different prices, or if they were prevented by climatic reasons from producing the same composition of output, or if they took risk or some other thing extraneous to the analysis of Figure 1 into account in determining the composition of output, then the simple correspondence between price lines and production-possibility frontiers is absent. By definition, every point on the production-possibility frontier *CD* is technically efficient: *F* and *S* show points of equal *technical* efficiency. Yet *F* is less *revenue* efficient than *S* at the prices indicated by *AB*.

In the case of antebellum agriculture being discussed here, the assumptions needed to infer the existence of greater or lesser technical efficiency from observations of revenue efficiency clearly are absent. Cotton could not be grown in the North; farms

in that region were restricted to the X axis of Figure 1. Further, a succession of investigators has demonstrated that the supply of cotton was almost completely price inelastic; since the South did not produce cotton exclusively, the southern production-possibility frontier could not have been linear.<sup>2</sup> Therefore, equal *technical* efficiency in "corn" production in the North and South would imply higher *revenue* efficiency in the cotton producing South.

Within the South, small farmers either faced different prices or took into consideration factors other than those considered in plantation managers' decisions, since the proportion of different crops grown differed among farms in the South.<sup>3</sup> The measure of productivity used by F-E shows the ability of different types of farming units to generate revenue at national market prices. It says nothing about the relative location of production-possibility frontiers, and a fortiori, nothing about the technical superiority or inferiority of particular factors of production such as slaves and free farm laborers.

On the contrary, as we and others have argued (see David et al., chs. 5, 7) and as we will reconfirm below, measured differences in revenue efficiency arise predominantly from differences in the ability or willingness to grow cotton, not from any presumed difference in the efficiency of slave and free labor.

The argument can be clarified by reference to Figure 1. Let *CD* in Figure 1 represent the southern production-possibility frontier. Then *S* shows where profit-maximizing plantations produced, and *F* indicates the position of equally efficient small southern farms who produced rela-

<sup>2</sup>See Temin, Wright, and Stephen DeCanio. Even if these investigators have underestimated the elasticity of supply of cotton, it would be hard to argue that the Southern transformation curve was flat. See Jacob Metzger for a demonstration that the labor requirements of cotton and corn were complementary.

<sup>3</sup>Alternatively, the production-possibility frontier might have had a different shape for different sized southern farms. If so, then the argument about differences within the South is exactly like the argument on North-South differentials.

tively less cotton than the large plantations. Northern farms producing on the corn axis (since cotton would not be grown in the North) at *D* would be less revenue efficient than southern farms at *F* or *S*, but no less technically efficient. Since we do not know the exact shape of the southern production-possibility frontier, we cannot infer from the location of a point on the corn axis whether it lies above or below the southern production-possibility frontier—unless it lies at or beyond a point like *G*. Given the uniform price ratio between cotton and corn indicated by *AB*, a northern farm producing at *G* would appear on a revenue efficiency par with a small slave farm producing at *F*, and less revenue efficient than a large plantation more specialized in cotton production at *S*. Yet, given a southern production-possibility curve passing through both *S* and *F*, the northern farm at *G* was actually technically superior to the southern farms in the only activity in which both regions could engage—corn production.

Fogel and Engerman argued in their recent article (1977) that our insistence on the importance of cotton is misplaced and that their calculations show this theoretical problem to be insignificant. Starting from our contention that using market values of land as a measure of land inputs underestimated the land input of all but the largest and best located southern plantations in their original productivity calculations, they made an allowance for the depressing effect on southern land values of the poor southern transportation system, reestimated the southern land input, and recalculated agricultural productivity for different sized southern farms. Since their new results showed that farms of two different sizes (having different product mixes) had the same productivity, they concluded that the curvature problem just described was unimportant.

We now turn to their calculations and their new estimates of relative productivities. We will demonstrate that F-E's new figures are even more biased than the old ones and that an appropriate adjustment

for the lack of transportation facilities in the South (using F-E's own data) confirms the importance of our criticism.

To understand Fogel and Engerman's calculations, it is necessary to start with their equation (1), which defines their efficiency index for the South. We reproduce it here for convenience:

$$(1) \quad G_s/G_n = \frac{Q_s/Q_n}{(L_s/L_n)^{\alpha_L}(K_s/K_n)^{\alpha_K}(T_s/T_n)^{\alpha_T}}$$

This equation can be rewritten as follows, letting  $X_i$  stand for all the terms that do not involve land ( $T$ ) and altering the subscripts to reflect F-E's concern in their article with productivity differences among different sized farms *within the South*:

$$(2) \quad G_i/G_o = \frac{X_i}{(T_i/T_o)^{\alpha_T}}$$

Fogel and Engerman (1977) did not give their correction formula explicitly, but it can be inferred from examination of the data in their Tables 6 and 7. The first column of Table 7 gives the relative productivity indexes as they appeared in F-E (1974). The second gives a "corrected" series. If we label the entries in Table 6,  $a_{ij}$ , and the entries in Table 7,  $b_{ij}$ , the calculation involved in getting from  $b_{i1}$  to  $b_{i2}$  can be represented as follows:

$$b_{i2} = (a_{91}/a_{9i})^{1/4} b_{i1}$$

where  $a_{91}$  and  $a_{9i}$  are the appropriate entries in row (9) of Table 6. This formula can be verified by performing the appropriate calculations.

The meaning of this correction factor can be seen by expressing it in terms of the symbols of equations (1) and (2). The fourth root was used because  $\alpha_T$  was set equal to .25 by F-E when they employed equations (1) and (2). The ninth row of Table 6 gives F-E's new estimates of the ratio of the value of improvements to the total value of land and improvements,  $V_i/T_i$ . The denominator ( $T_i$ ), of course, was F-E's original measure of land input. The correction formula, then, is

$$(3) \quad k_i = \left( \frac{V_o/T_o}{V_i/T_i} \right)^{\alpha_T}$$

where  $V_i$  is defined to be the value of improvements for farm size  $i$ .

Multiplying  $G_i/G_o$  as defined in equation (2) by  $k_i$  reveals the effect of F-E's correction:

$$(4) \quad \frac{G_i}{G_o} k_i = \frac{X_i}{(T_i/T_o)^{\alpha_T}} \left( \frac{V_o/T_o}{V_i/T_i} \right)^{\alpha_T} \\ = \frac{X_i}{(V_i/V_o)^{\alpha_T}}$$

Fogel and Engerman's correction of their original productivity estimates consists of simply removing the value of land and improvements and replacing it by the value of improvements alone. In response to our criticism of their valuation of land, F-E have entirely eliminated land inputs from their production function!

This clearly is inappropriate from a theoretical point of view. An agricultural production function that does not include land is exceedingly hard to interpret.

From the practical point of view, F-E have responded to our criticism that their measures of the land and improvements input for all but the largest plantations (and therefore for southern agriculture as a whole) were too low, by *reducing* them still further. The new calculations therefore move the relative productivity indexes for slave farms in the South upwards, in just the opposite direction to that called for by criticism which Fogel and Engerman appear to accept as justified.

It is not our purpose here to redo F-E's productivity calculations properly. Indeed we argued originally and have been obliged to reassert here that the conceptual apparatus they are using is inappropriate to the task of ascertaining the relative technical efficiency of free and slave agriculture. Nevertheless, we cannot resist exploring the implications of a correction that would at least move the productivity calculations in the right direction. Fogel and Engerman (1977) argued that the difference between the value of unimproved southern land in

the largest plantations and in all other size farms (shown in row (4) of their Table 6) was due to location. It follows that the value of well-sited plantation land should be used instead of the actual value of land in smaller, less well-located farms to correct for the locational disadvantage of these smaller southern farms.

In other words, the value of land used in the original calculation should be replaced by the product of the average number of acres in farms and the price of unimproved land on well-located plantations. Since F-E's figures show the price difference between well-located and their actual unimproved land to have been approximately \$10 an acre for all southern farms other than plantations, we can get corrected values of  $T_i$  by adding ten times the average number of acres in a farm to the actual value.

Substituting the corrected values of  $T_i$  for F-E's in equation (2) yields the estimates shown in the first column of our Table 1, which may be compared with the "corrected" indexes from F-E's Table 7. The productivity of the smallest southern farms, those without slaves, is defined as 100 in both cases.

The previous identity between the productivity levels calculated for free farms and the small (1-15) slave farms, which F-E relied upon to refute the argument that the apparent productivity advantage of southern slave farms was due in large part to their relative concentration upon growing cotton, has disappeared. Indeed, the corresponding revision of the ratio of the efficiency index for cotton ( $A_c$ ) to the efficiency index for other crops ( $A_o$ )—cal-

culated by F-E's own methods, using the crop mix data for farms in these two size categories—now is found to be 3.1 instead of the ratio of 1.1 that F-E presented. The range of alternative estimates of this ratio ( $A_c/A_o$ ) now runs from 3.1 to 10.8. The variance of these numbers is not surprising, given the roughness of our correction, and each separate calculation confirms the hypothesis that cotton was more efficient than other crops (recalling always the unusual meaning of efficient in this context).<sup>4</sup>

In addition, the calculated productivity of free southern farms is reduced—not raised as F-E's (1977) calculations would have us believe—by this adjustment. It falls to four-fifths of its old level  $[(1/2.92)^{1/4} = .77]$ . Free southern farms now appear to be *less* revenue efficient than free northern farms, despite the advantage they had in being able to grow cotton—given the prevailing market prices of that crop. Even though the productivity position of the large plantations changes relative to other southern farms, their position relative to that of northern farms is unaltered by virtue of the adjustment we have carried out. This is so because the value of the large plantations' lands was assumed not to have been depressed by poor transport facilities. It follows, therefore, that some southern farms were more revenue efficient than northern farms, and some less. Were the interregional comparisons to be made farm by farm, rather than by preaggregating the input and output data, the variance among the productivity ratios for individual farming units undoubtedly would be so large as to preclude finding any statistically significant differences in revenue efficiency between the major regions.

On the premise that the southern production-possibility curve had the general curvature indicated in Figure 1, the revenue efficiency comparison which places northern farms at a point between *G* and *B* in

<sup>4</sup>The estimates for  $A_c$  range from 2.54 to 4.86, with mean 3.63. The estimates for  $A_o$  range from .45 to .88, with mean .62. In no case is the estimate of  $A_c$  close to the estimate of  $A_o$ , as the range of estimates confirms. Far from refuting our contention, the revised data—rough as they are—confirm it most strikingly.

TABLE 1—REVISED "EFFICIENCY" FIGURES FOR SOUTHERN FARMS (Free Farms = 100)

	Corrected for Omission of Land	F-E (1977)
Free farms	100	100
1-15 slaves	114	101
16-50 slaves	159	133
51+ slaves	174	148

Figure 1 permits us to infer that northern farms were more *technically* efficient than southern farms in the production of corn. Indeed, the calculated inferiority of free southern farms in terms of revenue efficiency must understate the extent of their technical efficiency disadvantage vis-à-vis northern farms, since the former enjoyed the revenue benefits of being able to crop some cotton.

We do not present the results of our revised productivity calculations with any claims to finality. Comparable adjustments of the land input measures for the North could be made, and other changes as well.<sup>5</sup> The revisions we have undertaken simply rectify the most recent distortions introduced by F-E and reestablish the importance of crop mix effects upon measures of relative revenue efficiency.

Thus, the concluding point on which we want to insist is the difference between the concepts of revenue efficiency and technical efficiency when the production-possibility frontier is curved. Those southern farms that are found to be more revenue efficient than northern farms were benefiting from their ability to grow cotton. It is not possible to say precisely how much of the calculated "efficiency" differences in such cases is due to growing cotton, rather than to the managerial skills and methods of or-

<sup>5</sup>For example, considering just the matter of land inputs, our calculations imply that unimproved southern land was worth approximately six times as much as northern unimproved land, once the locational disadvantage is eliminated. This might well be a major overstatement. On the other hand, it could also reflect the realities of 1860. The North was well settled, and only poor or inaccessible land in the North was still unimproved.

ganization adopted by planters and overseers, or to the sheer hard work extracted from slave labor. Our contention is that it was due almost entirely to cotton. That interpretation is supported not only by the econometric evidence on crop mix effects previously adduced by Wright (see David et al., ch. 7), but has been seen here to be entirely consistent with the data presented in F-E's latest contribution.

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