LIBRARY
OF THE
MASSACHUSETTS INSTITUTE
OF TECHNOLOGY
working paper
department
of economics

EXPLAINING THE RELATIVE EFFICIENCY OF SLAVE
AGRICULTURE IN THE ANTEBELLUM SOUTH:
COMMENT

Paul A. David and Peter Temin

Number 201 June 1977

massachusetts
institute of
technology

50 memorial drive
cambridge, mass. 02139
EXPLAINING THE RELATIVE EFFICIENCY OF SLAVE AGRICULTURE IN THE ANTEBELLUM SOUTH: COMMENT

Paul A. David and Peter Temin

Number 201       June 1977

The views expressed here do not necessarily represent those of the Department of Economics or the Massachusetts Institute of Technology.
EXPLAINING THE RELATIVE EFFICIENCY OF SLAVE AGRICULTURE IN THE ANTEBELLUM SOUTH: COMMENT*

Paul A. David and Peter Temin

Robert Fogel and Stanley Engerman published *Time on the Cross* in 1974. After an initial flurry of laudatory reviews in the popular press, our review in the September, 1974, issue of *The Journal of Economic History* exposed for the first time the lack of professional standards in the book. We argued in that review that Fogel and Engerman's "finding" that Southern agriculture was more "efficient" than Northern was basic to Fogel and Engerman's arguments that slaves were superior workers and that blacks today should take pride in the accomplishments of the slave system. We argued, further, that this "finding" was beset by grave conceptual and empirical flaws that rendered it worthless.

Fogel and Engerman (1977) have returned to their productivity calculations in an attempt to reconstruct this foundation of their argument. Alas, 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. Their response to our criticism of the way they measured land in their agricultural production function was to remove land from the
production function entirely, and their new results do not advance the discussion.

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

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 the measurement of "efficiency", Fogel and Engerman aggregated the outputs of different farms by a fixed-weight index, with national market prices as the weights. Their implicit assumption was that only the size of this composite index, and not its composition, was important. This would be true if the relevant portion of the production-possibility frontier 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," used here as a proxy for all non-cotton crops. The line PP' is drawn to show the ratio of (assumed) market prices. If it also shows the
FIGURE 1
shape of a representative production-possibility frontier, then the relative locations of different production-possibility curves is shown unambiguously by which price lines the outputs lay on. Output on a higher price line indicates that production was on a higher production-possibility curve. On the other hand, if the production-possibility frontier was curved, as shown by VV' in Figure 1, this correspondence 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. But if different producers faced different prices, or if they were prevented by climactic reasons from producing the same composition of output, or if they took something extraneous to Figure 1—like risk—into account in choosing the composition of output, then the correspondence between price lines and production-possibility frontiers is absent.

In the case of antebellum agriculture being discussed here, the assumptions needed to preserve this correspondence clearly are absent. A succession of investigators have demonstrated that the supply of cotton was almost completely inelastic; since the South did not produce cotton exclusively, the production-possibility frontier could not have been flat. ¹ Cotton could not be grown in the North. And small Southern farmers either faced different prices or took into considera-
tion factors other than those considered in plantation managers' decisions. The measure of productivity used by Fogel and Engerman shows the ability of different types of agriculture to generate revenue at national market prices. It says nothing about the relative location of production-possibility frontiers or a fortiori, about the efficiency of particular factors of production.

On the contrary, as we and others have argued (Paul David, et al., 1976, Chs. 5,7) and as we will show below, the difference in revenue comes from the ability or willingness to grow cotton, not from a presumed difference in the efficiency of labor.

Fogel and Engerman argue in their recent article 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 Southern land inputs were underestimated in their original productivity calculations, they made an allowance for the poor Southern transportation system, reestimated the Southern land input, and recalculated Southern agricultural productivity. 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 show that Fogel and Engerman'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 confirms the importance of our criticism.

To understand Fogel and Engerman's calculations, it is necessary to start with their equation (1), which is reproduced here for convenience:

\[
\frac{G_s}{G_n} = \frac{Q_s}{Q_n} \left( \frac{L_s}{L_n} \right)^{\alpha_L} \left( \frac{K_s}{K_n} \right)^{\alpha_K} \left( \frac{T_s}{T_n} \right)^{\alpha_T}
\]

This equation can be written as follows, where \( X_i \) stands for everything that does not involve land \((T)\) and the subscripts have been changed to reflect Fogel and Engerman's concern in their article for productivity differences within the South:

\[
\frac{G_i}{G_O} = \frac{X_i}{X_T} \left( \frac{T_i}{T_O} \right)^{\alpha_T}
\]

Fogel and Engerman do 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 data as they appeared in TOTC. The second gives a "corrected" series. If we call the entries in Table 6, \( a_{ij} \), and the entries in Table 7, \( b_{ij} \), the calculation involv-
ed in getting from \( b_{i1} \) to \( b_{i2} \) can be represented as follows:

\[
b_{i2} = \left( \frac{a_{91}}{a_{91}} \right)^{1/4} b_{i1}
\]

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 \( \alpha_T \) in equations (1) and (2) equals .25. And the ninth row of Table 6 is the ratio of the value of improvements to the total value of land and improvements. The latter, of course, is Fogel and Engerman's original measure of land input. The correction formula, then is:

\[
\begin{bmatrix}
\frac{V_o}{T_o} \\
\frac{V_i}{T_i}
\end{bmatrix} \alpha_T
\]

\[
k_i = \begin{pmatrix}
\frac{V_o}{T_o} \\
\frac{V_i}{T_i}
\end{pmatrix}
\]

where \( V_i \) is defined to be the value of improvements for farm size \( i \).

Multiplying \( \frac{G_i}{G_0} \) by \( k_i \) shows the effect of Fogel and Engerman's "correction":
Fogel and Engerman's "correction" consists of simply replacing the value of land by the value of improvements in the productivity calculation. In response to our criticism of their valuation of land, Fogel and Engerman have removed land from their production function entirely!

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 a practical point of view, Fogel and Engerman have responded to our criticism that the Southern land and improvements input was too low by reducing it still further. Their new calculations are even further from what they are supposed to be than the original ones.

It is not our purpose here to redo Fogel and Engerman's calculations correctly. Indeed we have argued and argue above that the conceptual apparatus they are using is in-
appropriate to the task at hand. Nevertheless, we cannot resist exploring the implications of a correction that at least moves us in the right direction. Fogel and Engerman 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 for unimproved land in well-located plantations. Since Fogel and Engerman show the price difference between well-located and their actual land to have been approximately $10 for all Southern farms other than plantations, we can get corrected values of $T_1$ by adding ten times the average number of acres in a farm to the actual value.\(^2\)

Substituting the corrected values of $T_1$ for Fogel and Engerman's in equation (2) yields the following replacement for column 2 of Fogel and Engerman's Table 7, where the productivity of the smallest Southern farms is still defined as 100:
Table 1
Revised "efficiency" figures for Southern farms

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Free farms</td>
<td>100</td>
</tr>
<tr>
<td>1-10 slaves</td>
<td>114</td>
</tr>
<tr>
<td>11-50 slaves</td>
<td>159</td>
</tr>
<tr>
<td>51+ slaves</td>
<td>174</td>
</tr>
</tbody>
</table>

It will be noted that the lack of productivity difference between free farms and the smallest slave farms, used by Fogel and Engerman to refute the argument that the productivity of Southern farms was due to cotton, has disappeared. In fact, the calculated ratio of Fogel and Engerman's efficiency index for cotton ($A_c$) to their efficiency index for other crops ($A_o$) derived by Fogel and Engerman's own methods now ranges from a low of 3.1 to a high of 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).³

In addition, the calculated productivity of free Southern farms is reduced—not raised as Fogel and Engerman's 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** efficient than
free Northern farms, despite the advantage they had at market prices of being able to grow cotton. Plantations do not change their position relative to Northern farms by this adjustment, since the value of their lands was assumed not to have suffered by lack of transportation facilities, even though they change relative to other Southern farms. It follows that some Southern farms were more efficient than Northern and some less. If the interregional calculations were done farm by farm, the variance undoubtedly would preclude any significant differences between the regions.

It must be remembered always that the concept of efficiency is distorted from its usual meaning by the curvature of the production possibility frontier. Southern farms that are shown to be more efficient than Northern were benefitting from their ability to grow cotton; it is not possible to say how much of the calculated "efficiency" is due to cotton rather than skill or hard work. It is our contention, strikingly supported by the new data presented by Fogel and Engerman in their article, that it was due almost entirely to cotton. For free Southern farms, the calculated difference in efficiency understates the true difference, since these farms gained from their ability to grow cotton.

We do not present these calculations with any feelings of finality. Comparable adjustments for the North could be made, and other changes as well. For example, our calculations imply that unimproved Southern land was worth approximately
six times as much as Northern, once the locational disadvantage is eliminated. This could easily be a major overstatement. But the direction of our calculations is the correct one.

Two conclusions are clear: First, the "corrections" proposed by Fogel and Engerman are not corrections at all; they are spurious calculations that divert us even more than before from this historical reality. Second, an appropriate correction for transportation costs—rough though this one is—confirms strikingly the contentions that we and Wright made.
Footnotes

*Professors of Economics, Stanford University and Massachusetts Institute of Technology. We would like to thank Gavin Wright for comments. David would like to thank the National Science Foundation and Temin would like to thank the Charles Warren Center for Studies in American History, Harvard University, for financial support.

1 Peter Temin, Gavin Wright, 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 Metzer for a demonstration that the labor requirements of cotton and "corn" were complementary.

2 If better located, better quality, and more easily cleared land was improved first, then Fogel and Engerman's estimates in row 4 of their Table 6, from which our $10 was taken, underestimate the locational component in the value of land.

3 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 ratios shown above also show. Far from refuting our contention, the revised
data--rough as they are--confirm it most strikingly.

4 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.
Bibliography
