

Economic Efficiency and Full Use of Sites

By Dr. Mason Gaffney

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Economic Efficiency and Full Use of Sites

Mason Gaffney

Conventional production economics contains a standard conundrum and trap for the unwary wherein the "max average product" (AP) of a variable input (V) applied to a fixed input (F) is not the most efficient conbination of inputs. This is counter-intuitive and the source of some confusion for students. The instructor goes on to find another point where the marginal logic is satisfied, and net gain is maximized, but there is a nagging lack of comprehensive evaluation. What about overall efficiency of all inputs--shouldn't that be maximized?

In analyzing costs, conventional analysis handles a corresponding problem quite adequately. Unit costs (AC) are the reciprocal of AP, so minimizing AC is the same as maximizing AP (although it remains to see which AC corresponds to which AP). Costs are divided into fixed (AFC) and variable (AVC). These are added to get average total cost (ATC). AFC falls with growing output (P), from which it is geometrically obvious that ATC troughs to the right of the trough of AVC. See Fig. 1.

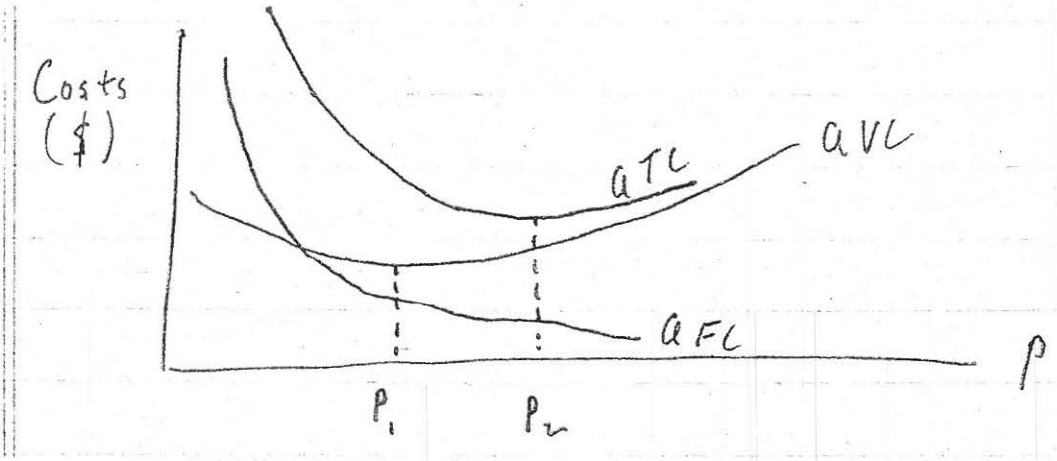


Fig. 1: Conventional Cost Analysis

ATC is satisfyingly comprehensive; and the behavior of AFC is satisfyingly easy to understand. Evidently AVC (V/P) is the reciprocal of AP (P/V). Marginal cost ($\Delta V/\Delta P$), (not shown on Fig. 1), is the reciprocal of marginal product ($\Delta P/\Delta V$). Thus those cost curves are just another perception of the corresponding productivity curves. But something is missing. Conventional analysis lacks productivity curves that are the reciprocals of AFC and ATC. We need to provide a simple operational procedure for constructing such curves, explaining their meaning, and integrating them into standard productivity analysis, to the end of getting a measure of total productivity.

One way would be to do the cost analysis first. Then:

$$\text{Comprehensive Average Product} \equiv \text{CAP} = \frac{1}{\text{ATC}} = \frac{1}{\text{AVC} + \text{AFC}} = \frac{1}{\frac{V}{P} + \frac{F}{P}} = \frac{P}{V + F} \qquad (1)$$

$\frac{P}{V + F}$ peaks when ATC troughs, and the peak maximizes output per unit of all inputs, or total factor productivity.

It would be better, however, to teach this by a method that is fully compatible with the geometric way in which productivity curves are normally introduced, requiring no detour through cost curves and algebra so that productivity analysis may be self-contained and self-explanatory.

To accomplish this, a good method is to add the value of the fixed input (F) to the value of the variable inputs (V) in defining the abscissa. (To make the inputs commensurable we must bypass the conventional step where V is expressed in purely physical units; we measure V in $.) The case is simplest if we know exogenously the value of F. Then we can begin with Fig. 2.

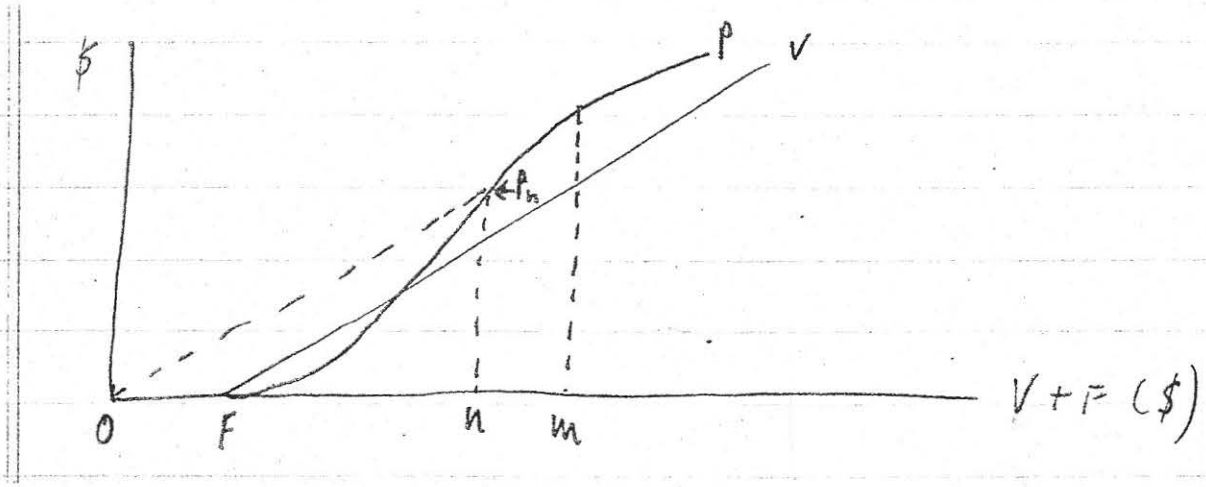


Fig. 2: Standard production function, beginning from F rather than 0.

Fig. 2 shows a standard S-shaped production function, P. It differs from the conventional in that P begins from F rather than from 0. OP_n is a radius vector whose slope is $\frac{P}{V + F}$. This is total factor productivity, the same as overall efficiency, and is what should be maximized. It is what we have called "Comprehensive Average Product" (CAP).

The slope of OP_n is maximized when n = m. This is where P parallels V, so that MP = MC; where P - V is a max; where P - V = F; where OP_n tan P; and where $\frac{P}{V + F}$ is max at a value of unity or 100%. m represents the "highest and best" use of F.

The conventional AP is the slope of a line FP_n (not drawn on Fig. 2), a radius vector anchored at F rather than 0. This slope is (P/V), steeper than the CAP, $\frac{P}{V+F}$. $\frac{P}{V}$ peaks at a point which is not optimal and which therefore occasions much confusion. Part of this confusion is visited upon college freshman and is regarded as good clean fun by instructors, a bit of hazing to sharpen the wits. Unfortunately the confusion does not end there but persists at all levels where partial productivities (most often "labor productivity") are cited and compared normatively, even by some mature economists, and frequently by others. It is more than likely that the confusion leads in some cases to serious underuse of fixed assets, either directly by misleading the managers or indirectly by helping bad managers rationalize their laxity.

From Fig. 2 we can now derive Fig. 3 which contrasts Comprehensive Average Product (CAP) with what we shall henceforward call Partial Average Product (PAP).

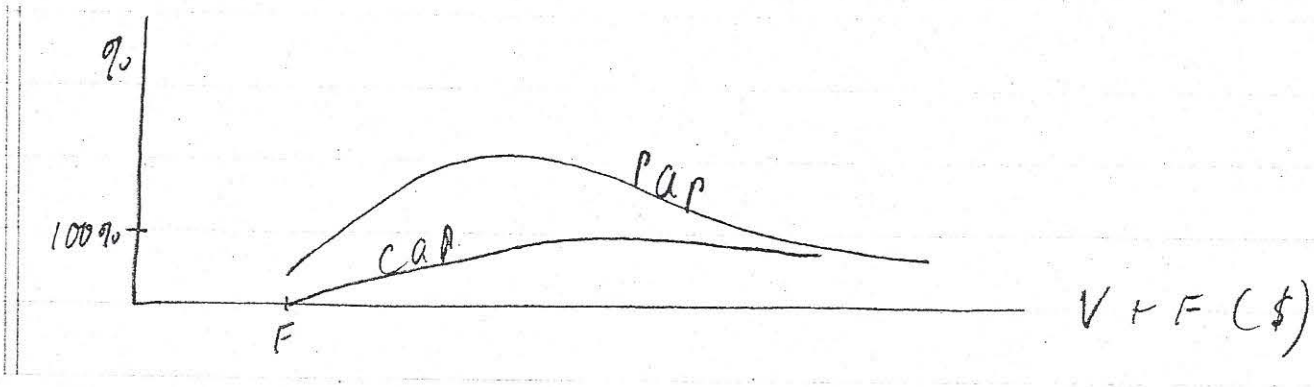


Fig. 3: PAP, or $\frac{P}{V}$, and CAP, or $\frac{P}{V+F}$, derived from Fig. 2.

The relationship of PAP and CAP is expressed most simply as a ratio:

$$\frac{CAP}{PAP} = \frac{\frac{P}{V+F}}{\frac{P}{V}} = \frac{V}{V+F} \qquad (2)$$

CAP ranges from 0% of PAP when V = 0 up towards 100% of PAP when V is much larger than F.

It is too bad we cannot derive CAP from PAP by simply adding or subtracting something simple (as we convert AVC into ATC by adding AFC). But it is still a fairly simple business. PAP has 2 parts. CAP is $\frac{V}{V+F}$ of it. The rest of the fraction is the complement of CAP, $\frac{F}{V+F}$. Moving to the right, as V grows, the CAP/PAP ratio rises steadily. The high value of PAP at its max, when V is less than optimal, is an illusion if it makes us think

that the V input is responsible for high $\frac{P}{V}$. What is responsible is the heavy complement of F, which PAP arrogates deceivingly to the apparent credit of V, leaving nothing to reward F. To be sure, the marginal product of V at this point is P/V; and that of F is zero. But F has an opportunity cost higher than what is being imputed to it.

The case is a shade more involved--but only by a shade--in the event that the value of F is not known exogenously, but has to be found endogenously in the very process of solving the problem of finding max efficiency.

This case is not uncommon, owing to the imperfection of markets for fixed assets. Dam sites, for example, are commonly acquired free, and also made unalienable, so there is neither an historical cost nor an exogenous opportunity cost for this fixed asset. Neither is there any chance to expand or contract the site by incremental purchases or sales of contiguous land of homogeneous character, because dam sites are unique and separated by mountains. Many privately held lands are treated and regarded in somewhat the same way for a battery of reasons: they were acquired long ago at low cost; sale of the company or family base is considered unthinkable; appreciation offsets carrying costs; sale would trigger taxes; the land market is sticky; the land is held by estates or other weakly motivated organizations; etc.

Such conditions often result in "lazy land" which can create (or fail to help solve) serious social problems by producing less goods, employing fewer workers, and wasting public infrastructure which is ready to serve the land but then must be extended past it to serve remote substitute lands. At the worst this "infrastructure" takes the form of a military force designed to "serve" remote lands by capturing them from other powers. Public as well as individual good is served by bringing lands to full economic utilization, or "highest and best use," obviating imperialistic designs on foreign lands.

To define highest use endogenously we can use 2/3 of the original logic, from Fig. 2: maximize P - V; and equate MP and MC. This is familiar logic which we need not repeat. However we cannot use the abscissa (V + F), as on Fig. 2, because F is not given. We therefore use V as the abscissa in Fig. 4:

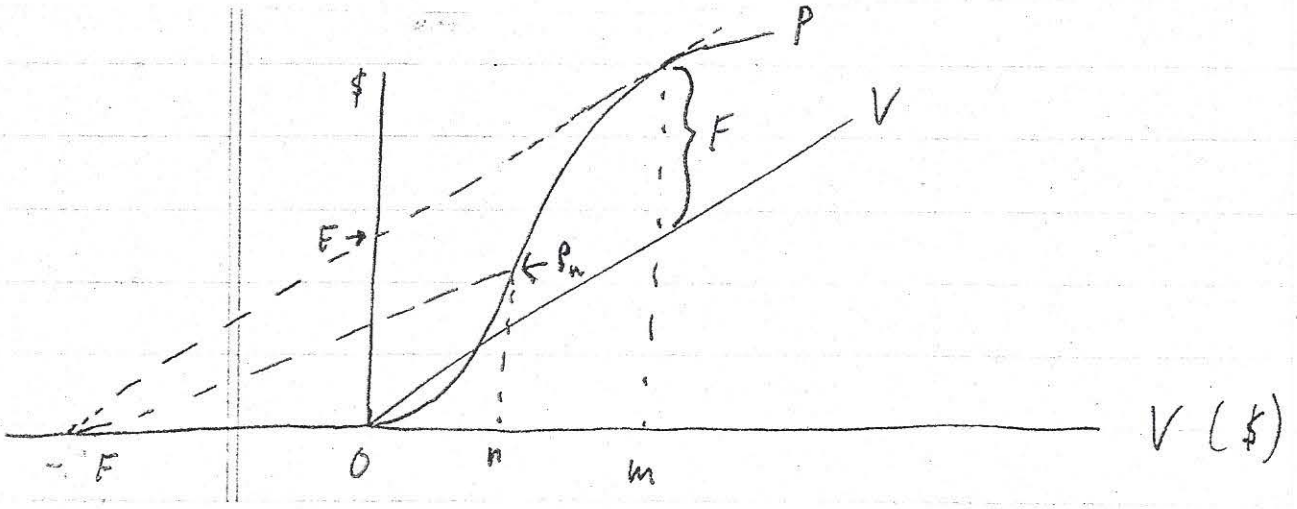


Fig. 4: Standard production function with F derived endogenously.

Fig. 4 is the same as Fig. 2 with all points shifted to the left by F. F is first found endogenously by maximizing (P - V). At that point a tangent line is run back to the ordinate and abscissa. This line is parallel to V, with slope equal to one. Its y-intercept is F, and its x-intercept is -F. A radius vector is then run from -F as the anchor out to P_n. As before, the slope of the radius vector is CAP, or $\frac{P}{V + F}$.

In effect what this procedure does is to take the highest and best use of a site and treat it as an opportunity cost. All other intensities of use are less than 100% efficient. Only the highest use achieves 100% efficiency. The others fall short because they commit a site of value F to a use whose product, P, is less than F + V.

The practical import of the concept is to create a paradigm which makes it clear that the underuse of valuable fixed assets is inefficient; that true overall efficiency is only found by valuing the fixed asset in its highest use and testing other uses against that. It provides an easy procedure for escaping from the fallacy of using PAP to evaluate efficiency, and moving directly from that to a correct measure.

Another important benefit from using this approach is to keep us alert that "fixed costs" are not fixed. It is the input that is fixed, not its cost. We suspect that one reason some economists hasten away from the productivity way of analyzing variable factor proportions to the unit cost approach is because "fixed cost" sounds so firm, so senior, like a prior claim on the product that simply must be met, come what may. We have seen what trouble the advocates of marginal-cost pricing meet when they try to price below ATC.

But the logic of marginal productivity analysis makes it clear that when fixed assets are underutilized the owner of fixed assets should get little or nothing. These distributive implications disturb some people deeply; they seek refuge in "fixed costs." Very likely they will continue to; but now we have a complete analytical paradigm in place for other analysts who can contemplate invading the "fixed" claims of property holders.

Needed Additional Work

To make all units commensurable I have measured them in $, by explicit assumption. I have also, by implicit assumption, measured them all as periodic flows. Thus F, sometimes exemplified as site "value," means annual rental value. This leaves out all questions of time. The present analysis must obviously be expanded therefore before it is anything but an introduction to the overall questions of optimal factor proportions. It is intended only to clear up one nagging point which has been left dangling in the conventional literature of economics.

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