



Optimal Combination of Inputs

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Optimal Combination of Inputs

1. Optimal intensity is where $MP = MC$

a. Given a production function for labor applied to land, to find optimal intensity we need more information: the unit cost of workers, or wage rate. Since work is the unit on the abscissa this makes a horizontal line at the level of the wage rate.

b. Find optimal intensity where $MP = MC$. (Be sure MP is falling at that intersection, and understand why that is vital.)

c. This optimum is not max MP , AP , or TP , except by chance and in odd cases.

d. What is maximized? Net gain to the fixed input. In model where that is land, the gain is called rent.

i. There is a marginal gain on each worker. It is the $MP - MC$. View it geometrically as the area between those curves (remembering to subtract the area, if any, on the extreme left, where MC exceeds MP). This area continues growing until the marginal gain is zero, i.e. where the curves cross.

ii. There is an average gain per worker. This is $(AP - AC)$. AC is the same as MC here because the MC curve is flat. Multiply this average times W , the abscissa at this point, to get total gain. Show this area on a graph.

This is not the maximum gain/worker. Neither is it the maximum number of workers who might be used. Rather it is an optimum balance between the two. It maximizes the product of gain per worker times number of workers. From calculus recall that you maximize a product when the fractional increase in the growing factor equals the fractional decline in the shrinking one. (If this seems strange, review the notes on Rectangles.) You mathematicians who enjoy a challenge, prove that net gain figured this way is a maximum when $MC = MP$. Common sense plus faith in the consistency of mathematics tell us that it must be so.

2. Pressures to achieve optimal intensity

With AP greater than AC there is scope for managers to miss the mark, and many do, by wide margins, owing either to carelessness or to wrong-headed choice of policies. They can

apply too much or too little labor and so fail to maximize gain. This can occur undetected when the firm holds the fixed factor free and clear from debt, and carries it on the books at a low historical cost unrelated to its present market value. Its true social cost becomes invisible, giving the present owner or manager a nice surplus to cover any errors, not to mention high living, hobbies, hanky-panky, embezzlements, golden parachutes, and so on. That's why this kind of cushiony surplus is called "discretionary income" - you can blow it away and still keep going. On the quiet side the cushion may cover up simple laziness and routinization turned into obsolescence. Hobbies may include noble or moonstruck causes like religion, politics, or privateering in Nicaragua. Whatever, it all comes out of net gain.

If the manager is renting the fixed factor, that's different. Then the cost appears in the budget every year or month, forcing him to shape up or ship out. Again, if he just bought it and has to meet regular debt service, the cost is visible and it hurts not to put the resource to the highest and best use. Yet again where there are heavy taxes levied on the value of the land, regardless of use, the manager is under pressure to use it well. (This is one case where taxes actually sharpen incentives, rather than dulling them as is usual with other kinds of taxes.)

Thus lean firms are likely to economize better than fat ones. There is kind of constraint on fat firms if they are public corporations: the corporate raid or tender¹ offer. This got started in a big way in the late 1950s, after the CIA drove reformist *Presidente* Jacobo Arbenz Guzman from power in Guatemala, to pull United Fruit's chestnuts from the fire. These chestnuts comprised vast, underdeveloped farmlands. A former Rabbi in New York (I've forgotten the name) saw the latent value of these idle lands and raided U.F. (lovingly known down there as *El Polpo*, The Octopus) with a tender offer. The CIA wasn't set up to deal with this kind of threat (although the successful raider did die a spooky death - he "jumped" from a skyscraper window - a few years' later).

Many investors have come to specialize in corporate raiding, viewing the many firms whose liquidation value exceeds their going-concern value. Raiders have a bad name, and may be as bad

¹"Tender" offers are not tender on former managements, but may be harsh. Do not confuse them with love notes.

as their prey; but they are a factor that keeps some managements on their toes.

Corporate raiding is not a cure-all, however, and it does nothing about the firm that holds land primarily for the rise while neglecting the current use. The rise offsets the carrying costs, leaving little pressure to squeeze current income from productive operations. You may observe the results by driving through Riverside's citrus belt, for example, along Victoria Avenue with its dying trees.

3. The Fallacy of Maximizing the Average Product (a.k.a. "productivity," "efficiency," "benefit/cost ratio," "yields," etc.)

a. It is a Fallacy to use "productivity," meaning output/worker or sales/worker, as an index of good management or worker performance. Analysts often compare firms in those terms. International comparisons are often made in those terms. Divisions of a firm are compared in those terms. Such comparisons can be very misleading. A manager can raise output/worker by wasting capital or land, and this is often the explanation.

To be sure if a Department teaches more students per faculty member, and does it without needing expensive laboratories, experimental plots, special equipment, lab assistants, travel grants, and the like, that is a pretty good sign of superior net productivity. Such situations may occasionally be found in practise, and the implications are quite clear and unambiguous. But normally we find high apparent productivity tarnished by the presence of a high complement of associated inputs which obviously help account for the high output/worker.

If it is false to evaluate others in terms of simple productivity, it is worse to use it one's self as a goal, as a measure or standard of performance.

The word "efficiency" is even more intimidating than "productivity." Efficiency sounds so technical and heavyweight and irrefutably unanswerable: who can oppose efficiency except some soft-headed bleeding-hearts? Efficiency is a term commonly used by physicists. These are often intimidating people who are in command of mysteries and magic and speak cocksurely. The great respect paid to physical efficiency stems in part from a

misapplication of the prestige which has been won by the positive achievements of physicists.

b. The trouble with both productivity, as commonly used in the newspapers, and efficiency, as commonly used by physicists is that they are partial. In physics, energy efficiency means output/input. That much is ok, but input normally is defined and measured so as to exclude the cost of the conversion equipment. Input is defined in effect as maximum possible output from the fuel being used. Efficiency then becomes a performance standard with a maximum possible value of 100%, possibly approachable if cost is no object. But we never seem to care enough to spend enough to achieve 100% efficiency. Is a guilt trip in order?

If it costs \$500/month to finance and operate a machine to squeeze the last \$100/month of useful output from a quantity of fuel then common sense cries out against such "efficiency"; and we wonder if that really IS efficiency in meaningful terms? To use the fuel to its maximum potential we must use the capital in the machine, and the work of the operators, well below their potentials.

Physics is too simple - or too preoccupied with other complexities - for a comprehensive view of efficiency that accounts for all resources used as inputs. It achieves simple rules by abstracting from many elements of reality. Economics is, or may be, more comprehensive, when properly practised. It recognizes the value in all inputs, measures them, and strives for the best mix.

It is not only physics that elevates partial efficiency to a performance standard. Single-minded people are constantly coming up with new paradigms (or reviving old ones) where every value is measured only in terms of one input or output. There are "agricultural fundamentalists" (as they are known in the trade) to whom food and fiber are the only values. There are forest fundamentalists who believe that "wood is good," regardless of cost. We will see elsewhere in the course how this leads them to ignore interest cost and maximize mean annual increment.

"Biological maximization" is a value commonly held and cherished, or subconsciously assumed, in ag experiment stations. A pioneer critic of air pollution, a UCR professor from some years back, saw the damage of air pollution solely in terms of reduced crop yields, putting no value on human health.

After the OPEC price revolution of 1973 there were scores of energy fundamentalists who came out of the closet and wanted to measure all values only in terms of energy content. Some people think that only exports are worth producing -- other business is "parasitic." Others would sacrifice everything to water-efficiency: dam up every stream, run every waterfall through a turbine. (Some of those folks, alas, are even more partial -- they would save water from nature but then waste it in the fields.) You name it and you can find a zealot who thinks it is the only value worth conserving. The job of economists is to show how the market arbitrates among zealots. The job of managers is to apply economic rules within the firm.

c. Labor productivity as a performance standard is a form of partial efficiency where only labor appears in the base as an input. To move from partial efficiency to overall resource efficiency we add to the base the cost of the fixed inputs in our basic model. Remember of course to add them in such a way that they are commensurable with wage payments, which are a flow of \$ per unit of time.

$$S = W + G$$

where S = Sales, a measure in \$ of the total product
 W = Wage Bill, a measure in \$ of the work input
 and G = Gain to the fixed input of land, the excess of Sales over Wages

$$\text{Efficiency, } E = S/(W+G^*) = (W+G)/(W+G^*)$$

where G^* = maximum possible G , which is achieved when W , the independent variable, is at W^* , and S is S^* . (Remember that $G^* = S^* - W^*$).

$$E = 100\% \text{ when } G = G^*$$

Visualize this in a graph showing diminishing returns to labor, as we have done in class. G^* is a max, recall, when $S' = W'$. (S' is the marginal product and W' is the marginal cost of work.) Moving to the right on the graph you can raise Sales above S^* by adding more work-time, so why doesn't that increase Efficiency? Because S' , the addition to the numerator, is less than W' , the addition to the denominator. The ratio equals one at W^* , and the changes lower it below one.

Going back to where S/W is a max, E cannot be a max there unless G^* equals zero, meaning land has no value and is free.

The presence of G^* in the denominator dilutes the influence of W on Efficiency.

Moving from max S/W to the right, S' is greater than W' (i.e. the MP is greater than the MC of work) and this raises E when we add W , even though that lowers S/W . (It might not raise E if $W+G^*$ were less than S , but it is greater). So adding W raises E , until you arrive at W^* .

W^* is thus the input of W which maximizes net gain, G , and simultaneously maximizes efficiency, E . They are one and the same. The only reason we could ever think otherwise is that we are easily misled into understating the base of the ratio that defines E , by omitting G^* from it.

G^* , maximum possible net gain from the fixed input (which is land in our model), we will call the "potential" of land. In an open market the forces of competition tend to drive land rents to that level, imposing actual cash losses on any manager who rents land and fails to use it at the optimal intensity. In real estate this intensity has a name, the "highest and best use."

"Hey, Hold It!" you may cry at this point. "You said it was wrong to maximize the return to just one input, and here you are doing it for land. How about that?" Ah, but notice the difference between maximizing net gain to land, and maximizing the average product of land. Average product is not net of anything, it includes the contribution of other inputs. But when we go to net gain, that is clean and pure, it is the net contribution of the land after subtracting the cost of paying workers.

In popular discussion, "highest and best use of land" is often misunderstood or travestied by critics. They visualize skyscrapers rising in cow pastures. But such overuses fall to the right of W^* . There is a considerable range in Stage II in which adding variable inputs to land increases the total gross product but reduces the net product. Let us divide Stage II in two parts, IIA to the left of W^* and IIB to the right of W^* . Total product or sales is rising throughout; but net product, the gain to land, only rises through Stage IIA. Highest and best use goes no farther than that.

Remember, too, that the model we are using is symmetrical. We can reverse the roles of land and labor and get the same result. That is, paying a market rent for land and adding it to a fixed amount of labor we would find optimality where the net

gain to the fixed labor was a maximum. The payment to every input measures the net contribution of the input. That is what marginal productivity is all about; that is why it is such a beautiful and comprehensive theory.

Another way of perceiving the difference between partial efficiency and overall efficiency is to shift from product analysis to unit cost analysis. Cost curves are simply the reciprocals of the corresponding product curves. Minimum AVC is maximum partial efficiency or AP of the variable input. Minimum ATC is maximum overall efficiency as explained above -- provided you have put a correct value on the fixed inputs.

In some ways that cost approach is easier to grasp. The trouble with it is that it is so easy that students may follow it by rote without really understanding what they are doing, and without understanding how the value of fixed costs must be determined. I cannot repeat too often that the true fixed cost of land is its highest potential net gain, and that is often invisible to an owner whose forebears acquired it long ago at a low cost; or to any owner who has no debt on it, and is not subject to a high property tax rate.

An indirect way of stumbling into the Fallacy of Maximizing AP is to take "return on sales" as a performance standard. Return on sales is net gain divided by sales, or $(S - W)/S$. But that equals $1 - W/S$, which is a maximum when S/W is a maximum. S/W in our model is, of course, the AP of workers.

4. The Fallacy of Setting Naive Records

Some people think it is important to be Number One, *Ichiban*, *Numéro Uno*, *Deutschland Über Alles*, that sort of thing. They want to have the tallest building ever built -- an historically proven route to financial trouble. If they are engineers they want to build the tallest dam, the bulkiest dam, the dam impounding the most water, the somethingest dam, -- usually financed by others.

Among university presidents this weakness is known as the "edifice complex," a bias for bricks and mortar and a monument bearing one's name. This attitude lures the manager or investor deep into Stage IIB and toward the disaster zone where MP of the variable input approaches zero. It is a weakness in Peters and Waterman, with their belief in slogans and simplicity, to tolerate and see too much virtue in excesses of this kind.

Another route to this fallacy is the unrealistic standard of virtue. In administering public forests up north, for example, the B.C. Forest Service, consisting of good guys in rugged forest green uniforms, administer a policy called "close utilization." It is designed to prevent the sin of "high-grading," or taking the easy wood and leaving the culls and the trash behind. It forces loggers to extend themselves deep into Stage IIB. Virtue is rewarded, but the cost is paid by the public when loggers bid that much less to cut timber, knowing the extra costs that will be imposed on them. The net gains from the high-grade logs are dissipated in the requirement to salvage submarginal ones.

That kind of organizational behavior is known generically as "internalizing rents" and it is more widespread than you may dream. Another variant of this is to reinvest the rents within the enterprise, or some expansion thereof, to make a virtue of this, and call the new investment an "expense," thus concealing the true rent. The U.S. Forest Service uses this device to finance indefinite expansion of its road system, a waste now reaching epic proportions. The only question now is whether they will get a logging road to the top of Pike's Peak before the Army Corps of Engineers gets there with a navigable waterway.

The only value that is worth maximizing is net gain to the fixed factor. That is a bottom line, arrived at by maximizing a difference, the excess of sales over costs. This kind of maximizing is called "optimizing."