

Complementation, Scale, and the MNP
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Complementation, Scale, and the MNP

1. The Marginal Net Product (MNP)

A way to handle complementation is with the concept of Marginal Net Product. As you add labor, add a machine with each worker, and deduct the cost of the machine from the Marginal Gross Product.

The MNP of an input is the added gross product less the associated cost of needed supporting inputs, that are added with it. Thus, the value of another professor of entomology is the value of his teaching and research less the cost of labs and experimental plots and assistants and secretaries and overhead that go with having another professor. In business and investing, people deal with net products constantly; they just don't call them that. They speak instead of "the bottom line," which is like the net product. Marginal Net Product is simply the ***change*** in the bottom line.

This device leads easily into analysis of economies of scale, because if you can add a machine you can add anything, so that we are released from the assumption that the "fixed factor" must remain fixed forever. It becomes a ***parameter*** (remember this word), a temporary constant whose value may change from case to case.

2. Making Land the Independent Variable

You may create a comprehensive model for use as a framework on which all the matters discussed in the course are included and tied together. You take land, hitherto fixed, as the independent variable. (Reread that last sentence: it suddenly changes the ground rules radically.) Then, for each amount of land you add, also add the optimal complementary inputs. Their cost/acre declines as acres increase, manifesting economies of scale (a.k.a. "indivisibilities" of the complementary inputs). If yields also rise, you may be on a roll, in which case keep going. (I say "may be" because "yields" are strictly a physical measure, and you may be buying superior land, so watch your output/land-value, not just output/acre.) However, after some expansion,

output/land-value[1] declines too, manifesting diseconomies of scale. Optimal scale is that which maximizes ANP.

Notice how we are now handling more variables at once, even though the results may be represented graphically in two dimensions.

To incorporate time in the model, measure inputs and outputs as discounted cash flows, annualized by the simple process of multiplying them times the IPF (Installment Plan Factor). See paper on "Basic Mathematics of Finance."

You can have lots of fun analyzing cross section data with this or similar models, using sources like the U.S. Census of Agriculture, or the FORTUNE 500, which rank firms by size and provide data on inputs and outputs. Too bad the course is so short, we could go over the findings. See paper on "Contrasts between Large and Medium-sized Firms."

Developing skill and sophistication is learning to handle more and more variables at once. Thus one matures from relying on simple rules to applying complex ones that are more applicable to the many situations met in practice.

3. The Marginal Net Product (MNP) and the simple Marginal Product (MP): How are they Related?

MNP is equal to MP, for small increments of an input. "So why bother with it?" I hear you cry. I promise you three good reasons; first, let's see why they are equal.

The MP is a systems concept. See paper on "The MP as a Systems Concept." That means whenever we add a unit of W (our variable factor) we must withdraw a little of the Fixed Factor (FF) from each of the prior units of W, and transfer it to support the newly added unit - customarily called the "last"

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[1]Note the importance of specifying output/land-value, rather than output/acre. Remember, in economics we measure inputs by value. The tendency of expanding firms to lower output/land-value is often (indeed normally) obscured by the convention of recording "yields," which means output/acre. Expanding firms normally acquire superior lands, so their yields may rise while output/land-value is falling. To the traditionally-trained agronomist the yields are what he sees; the land value is invisible.

unit. For example, if W is a fruit tree, we take a little ground from each of the prior stems to make room for the last one. This crowds the prior ones a bit, and lowers their yield. Then we debit the MP with the resulting drop in yield from the prior trees. The MP is the physical yield of the last stem ***less the drop in yield from all the others***. To miss subtracting this drop would be to miss the whole point of what "Marginal Product" means. The yield of the last stem, by itself, is the same as all the others, i.e. it is the Average Product. The MP of one stem is the AP less [W times the drop of AP].

That drop in yield is exactly the MP of the ground transferred. It is, that is, what that area of land adds to the total product when the number of stems remains constant. In a reasonably good land market, this MP of ground equals its market price: that is what we would pay to put the last tree on new ground instead of crowding the old. Thus, given those premises, the MP and the MNP are equal (for small changes in acreage).

I'll run that by you again. This time, though, I'll use ground (G) as the variable input. Add an 11th acre to 10 prior acres, and work it by taking workers from the first ten. Debit the 11th with the drop in yield from the first 10. But that drop in yield is the MP of the workers transferred. In equilibrium, this is also their wage, which is exactly what we would pay should we opt instead to work the 11th acre with newly hired workers.

The upshot? The MP is really already a MNP, only we expressed that originally by calling it a "systems concept." This talk about adding needed complementary inputs is just making explicit what was already implicit.

4. Why bother with the MNP?

Now for three good reasons for introducing you to MNP.

(1), It gives you better understanding of MP to see why it equals MNP. Quite possibly, the economists who introduced MNP may not have understood it themselves. They apparently thought they were advancing on MP by noting that when you add a worker digging ditches you have to supply another shovel, too. They saw workers and capital growing only in lockstep: one worker, one shovel. They did not see that "fixed" land and capital is fixed only in quantity, not form; that factor proportions can be varied by adapting. It is also possible the innovators understood

perfectly well, but were struggling to communicate with others who needed some help. Who knows? - it doesn't matter now. Just remember, a manager may change the proportions in which he combines inputs, by adapting. See paper on "The Fallacy of Fixed Proportions."

(2), When we add more than one small increment of the variable input, the curve of MNP falls less than the curve of MP. They are equal only for small changes. The MP curve falls as you add more W because you crowd the FFs more and more. The MNP curve shows what happens when you avoid that crowding by letting some or all of the FFs increase, too. (There can be several MNP curves, depending on what you treat as fixed and what you let grow. When you are planning you have that power, and you had better exercise it or you will get in a rut and lose out.)

(3), a landowner is often locked into a fixed parcel and cannot expand because neighboring lands are not for sale or rent. Only about 2% of all land changes owners each year - it is the stickiest market going. You may have to pay premium prices to expand. Or, you may have to find the new land at some distance from where you are, imposing extra costs. You may have to deal with the local monopolist. In such cases, the MNP will be distressingly lower than the MP, forcing you to crowd more and more onto a small space. The excess of MNP over MP for small owners creates great tensions, with corresponding high rewards for those who can resolve them.

(4), MNP is a powerful tool we need to analyze economies of scale. We can use it to analyze what happens when a firm grows and is free to increase every input. This course is too short, but it is so used in M. Gaffney, 1961, "Land and Rent in Welfare Economics," in Marion Clawson (ed.), *Land Economics Research*, Baltimore: The Johns Hopkins University Press.

5. "Cash flow" and MNP.

Cash flow is a standard business term that illustrates the utility of MNP as a working concept. Here we take an increment to investment as the independent variable. The cash flow from a capital outlay is the resulting gross revenue less the associated expenses. Thus, cash flow is close to net product, and marginal cash flow is close to marginal net product. (For the main difference, see #6.)

Example: cash flow from an office building is the gross rent less the expenses of utilities, maintenance, supervision, repairs, taxes,[2] and so on. Those in the trade use this lingo daily, and so will you if you get into or near real estate.[3] No one has yet figured out how to live without it, so chances are 100% that you will.

We are not here concerned with the details, but the principle: when you add a new input you have to add and/or adapt lots of others to support it, and the basis of decision is the net return to the new input, which is less than the gross.

6. Cash flow vs. net return.

Cash flow and net product are not the same as net true <u>return</u> on capital (TRK), although they're getting close. To get TRK, you subtract depreciation. Annual depreciation depends on economic life: a little each year if life is long; a lot each year if life is short. There are right and wrong ways of doing this, which we analyze later in the course. For now, just prorate depreciation equally over economic life (called the "straight-line" method), to keep it simple. Cash flow above that is the net return to capital -- its TRK. (Depreciation is the return <u>of</u> capital; TRK is the return <u>to</u> or <u>on</u> capital.)

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[2]Usually cash flow is defined as before deduction of <u>income</u> taxes, but this varies with the context. It will not concern us here.

[3]In negotiating various deals it is useful sometimes to distinguish different kinds of expenses, so there is net cash flow, net-net, and triple net, each representing the subtraction of an additional expense.