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Economics 201

Part 1: Product Curves

The point of this handout is to illustrate some basic points about product and cost curves. Product curves are discussed here, with cost curves coming in part 2. Below, we will address various ways of measuring output and learning how factors contribute to producing that output. When we measure the cost of production, we'll want to make some similar calculations there.

Consider Table 1 (next page). The table assumes that a firm is producing a specific good using varying amounts of labor (L) with a fixed amount of capital (K). To keep things simple, we'll assume that labor is individual laborers (people) and that capital is the number of machines used in production.

Assume that the production function for this firm is: $Q = 10 + 10L + 20L^2 - 0.6L^3$. Hiring more labor increases output (Q), but as the table demonstrates, output is increasing at a decreasing rate, because although output is increasing, the change in output starts getting smaller after the 12th unit of labor is hired. After hiring the 22nd laborer, we note that output actually begins decreasing as well. Quite obviously, no firm would ever hire labor at the point where doing so decreases output, and so we know that the most laborers that this firm would ever hire is 22.

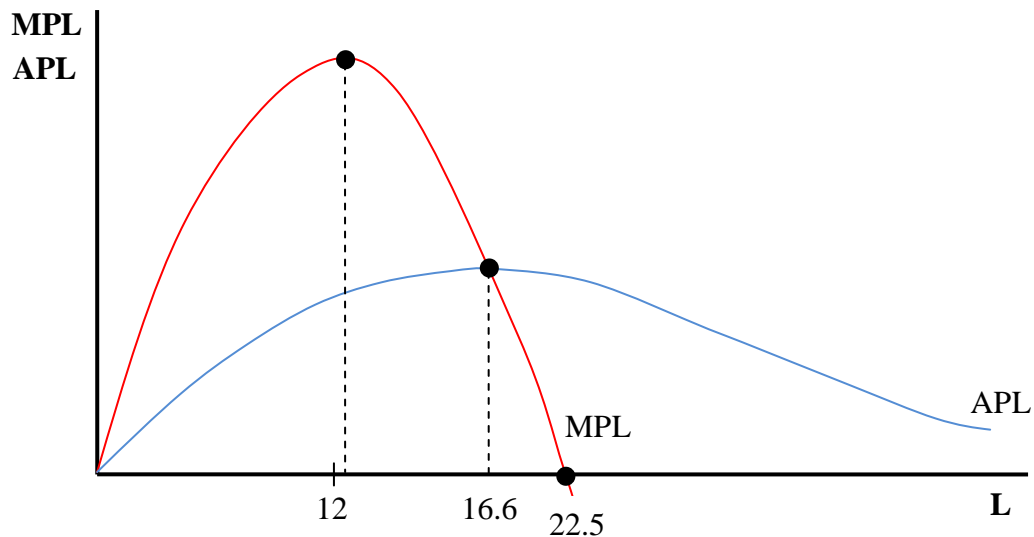
Once we know the output, we can determine how our variable factor contributes to the production of that output. One measure involves calculating the number of units of output that each laborer is responsible for producing on average. We call this the average product of labor (APL). The APL is calculated as Q/L . That value is calculated in column 4 of table 1. We see that APL increases until we hire between 16 and 17 laborers, and then decreases. APL continues to decrease, but never becomes negative (which makes sense if you only hire positive amounts of labor and can't produce a negative number of units).

Another way to view the effect of hiring more labor is to consider the impact of each unit of labor hired on output. We call this the marginal product of labor (MPL), and it's calculated as $\Delta Q/\Delta L$. Since we increase labor by 1 unit at a time, we can calculate MPL in this example as simply ΔQ . That value is presented in column 5 of table 1. We note that MPL also increases to a certain point (L = 12) and then begins decreasing, eventually becoming negative. Note that MPL becomes negative at the point where we observe output begin decreasing (after L = 22).

Table 1

L	K	Q	APL	MPL
0	4			
1	4	39.4	39.4	39.4
2	4	105.2	52.6	65.8
3	4	203.8	67.9	98.6
4	4	331.6	82.9	127.8
5	4	485.0	97.0	153.4
6	4	660.4	110.1	175.4
7	4	854.2	122.0	193.8
8	4	1062.8	132.9	208.6
9	4	1282.6	142.5	219.8
10	4	1510.0	151.0	227.4
11	4	1741.4	158.3	231.4
12	4	1973.2	164.4	231.8
13	4	2201.8	169.4	228.6
14	4	2423.6	173.1	221.8
15	4	2635.0	175.7	211.4
16	4	2832.4	177.0	197.4
17	4	3012.2	177.2	179.8
18	4	3170.8	176.2	158.6
19	4	3304.6	173.9	133.8
20	4	3410.0	170.5	105.4
21	4	3483.4	165.9	73.4
22	4	3521.2	160.1	37.8
23	4	3519.8	153.0	-1.4
24	4	3475.6	144.8	-44.2
25	4	3385.0	135.4	-90.6
26	4	3244.4	124.8	-140.6
27	4	3050.2	113.0	-194.2
28	4	2798.8	100.0	-251.4
29	4	2486.6	85.7	-312.2
30	4	2110.0	70.3	-376.6

If we take the information from table 1 and insert it into a graph, we have:



The graph shows several points where the relative position of the average and marginal product curves and reinforces our comments above, where we discuss how the average product of labor and marginal produce of labor are changing as more labor is hired. The graph also illustrates the fact that MPL and APL intersect at the point where APL is at a maximum.

Diminishing returns

Note that after about $L = 12$, the marginal product of labor begins to decrease. This coincides with a concept we call diminishing marginal returns (DMR). By definition, DMR occurs at the point where, as we hire more labor to work with some fixed amount of capital, output increases at a decreasing rate. This implies that the marginal product of labor is decreasing.