

Lecture 3: Supply and production economics

FOR 4684

Natural Resource Economics and Management



School of Forest Resources



Production Economics

- Production function shows relationship between inputs and outputs
- Assumptions for our discussion
 - Pure competition – producer is price taker
 - Price of inputs also constant – quantity of inputs purchased won't affect their price.
 - Short run economics, there are some fixed costs

$$O = f(i_1, i_2, i_3, \dots, i_n)$$

Fixed costs are those which are not related to quantity of production, and they must be paid. (Insurance, debt, administrative costs)

Long-run vs. short-run:

In the long-run, there are no fixed costs.

In the short-run, there are fixed costs.

Example of production costs

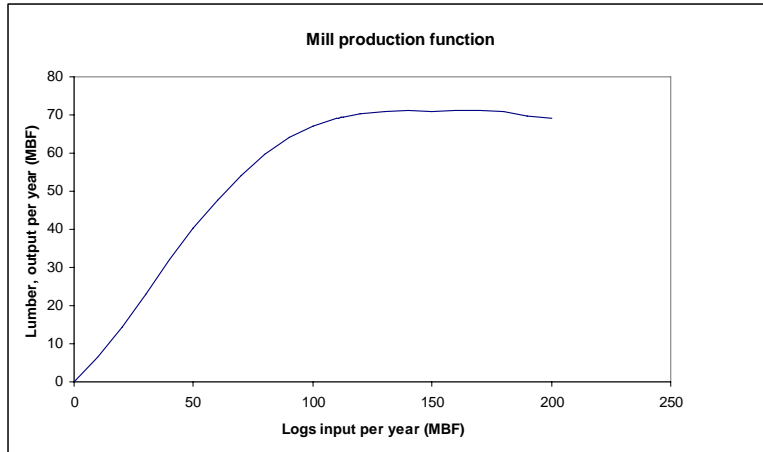
- Portable sawmill
- Variable costs:
 - Revenue = \$650 / MBF lumber milled
 - Cost of logs = \$85 / MBF (log scale)
 - Cost of fuel per MBF of logs processed = \$5
 - Cost of labor = \$10 / MBF of logs processed
- Fixed costs:
 - Management, maintenance, insurance and debt repayment: \$23,000 per year
 - Normal return to capital (10%) on \$30,000 mill: \$3,000 / year
- Production rates are 75 – 125 bf / hour, or about 1000 bf / day
- This information is used to develop a production function or production table...



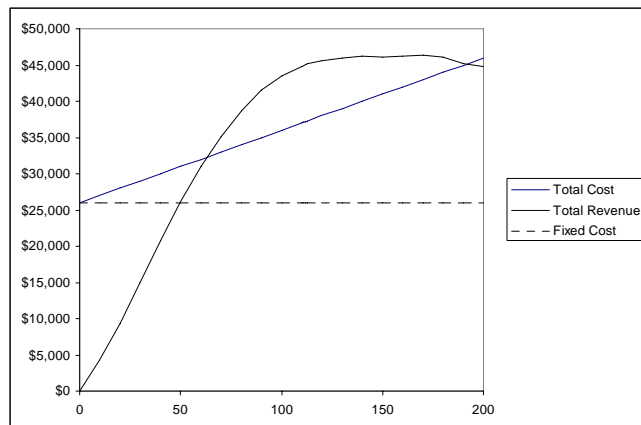
Mizer-mill production values

Logs Input (MBF / yr)	Lumber Output (MBF / yr)	Total Revenue	Marginal Revenue \$ / MBF logs	Fixed Cost	Total Cost	Marginal Resource Cost	Excess Profit
0	0	\$0	\$0.00	\$26,000	\$26,000	\$0	-\$26,000
10	6.5	\$4,225	\$422.50	\$26,000	\$27,000	\$100	-\$22,775
20	14.3	\$9,295	\$507.00	\$26,000	\$28,000	\$100	-\$18,705
30	23	\$14,950	\$565.50	\$26,000	\$29,000	\$100	-\$14,050
40	32	\$20,800	\$585.00	\$26,000	\$30,000	\$100	-\$9,200
50	40.2	\$26,130	\$533.00	\$26,000	\$31,000	\$100	-\$4,870
60	47.7	\$31,005	\$487.50	\$26,000	\$32,000	\$100	-\$995
70	54	\$35,100	\$409.50	\$26,000	\$33,000	\$100	\$2,100
80	59.6	\$38,740	\$364.00	\$26,000	\$34,000	\$100	\$4,740
90	64	\$41,600	\$286.00	\$26,000	\$35,000	\$100	\$6,600
100	67	\$43,550	\$195.00	\$26,000	\$36,000	\$100	\$7,550
110	69	\$44,850	\$130.00	\$26,000	\$37,000	\$100	\$7,850
111	69.19	\$44,974	\$123.50	\$26,000	\$37,100	\$100	\$7,874
112	69.36	\$45,084	\$110.50	\$26,000	\$37,200	\$100	\$7,884
113	69.52	\$45,188	\$104.00	\$26,000	\$37,300	\$100	\$7,888
120	70.2	\$45,630	\$78.00	\$26,000	\$38,000	\$100	\$7,630
130	70.8	\$46,020	\$55.08	\$26,000	\$39,000	\$100	\$7,020
140	71.2	\$46,280	\$42.71	\$26,000	\$40,000	\$100	\$6,280
150	71	\$46,150	\$26.00	\$26,000	\$41,000	\$100	\$5,150
160	71.2	\$46,280	\$16.25	\$26,000	\$42,000	\$100	\$4,280
170	71.3	\$46,345	\$8.13	\$26,000	\$43,000	\$100	\$3,345
180	70.9	\$46,085	-\$4.87	\$26,000	\$44,000	\$100	\$2,085
190	69.6	\$45,240	-\$22.75	\$26,000	\$45,000	\$100	\$240
200	69	\$44,850	-\$35.75	\$26,000	\$46,000	\$100	-\$1,150

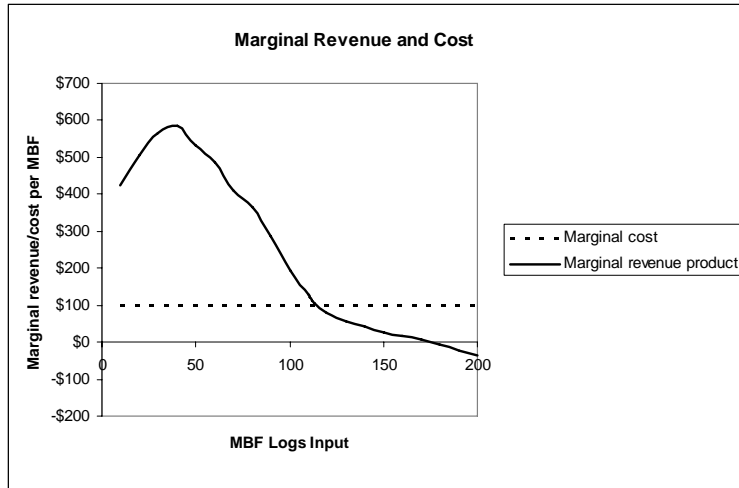
Graph of mill production function



Graph of total cost and revenue



Graph of marginal costs and revenues




Optimal production schedule

- From table, profit is maximized with an input of 113 MBF of logs per year.
 - Difference between total revenue and total costs greatest at this point
 - Marginal cost = marginal revenue (price) at this point.



Allocation of total revenue

- Employee wages
- Materials and supplies
- Depreciation
- Research, administration, insurance, royalties, leases, etc.
- Return to capital
 - Interest on debts
 - Return to equity
 - Income and other taxes
 - Dividends to stockholders
 - Retained earnings



Now let's look at optimum production level and individual supply

A different way of looking at the same data...

- Marginal analysis per unit of output, rather than looking at output as a function of inputs...
- We will use the same data for the wood-mizer sawmill, but look at it from an OUTPUT-centered view...

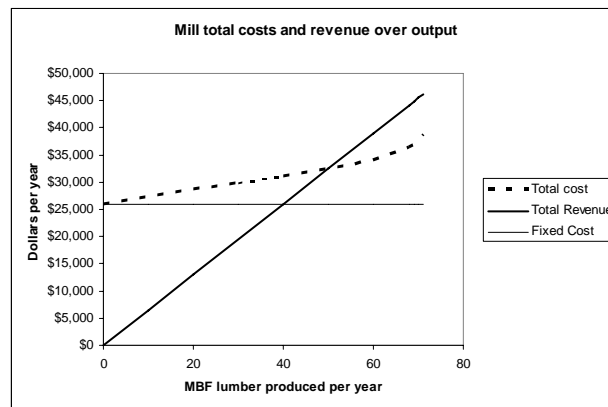
Original data: Marginal analysis per unit of inputs...

Logs Input (MBF / yr)	Lumber Output (MBF / yr)	Total Revenue	Marginal Revenue Product \$ / MBF logs	Fixed Cost	Total Cost	Marginal Resource Cost	Excess Profit
0	0	\$0	\$0.00	\$26,000	\$26,000	\$0	-\$26,000
10	6.5	\$4,225	\$422.50	\$26,000	\$27,000	\$100	-\$22,775
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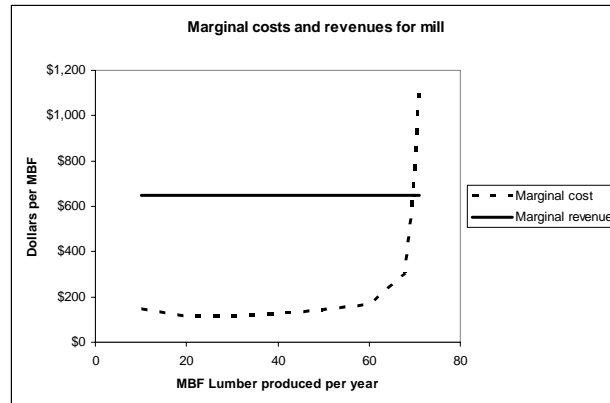
New view: marginal analysis per unit of output

Lumber Output	Log Input	Total Revenue	Marginal Revenue	Fixed Cost	Total Cost	Marginal Cost	Excess Profit
0	0	\$0	0	\$26,000	\$26,000	0	-\$26,000
10	14.7	\$6,500	650	\$26,000	\$27,470	\$147	-\$20,970
20	26.1	\$13,000	650	\$26,000	\$28,610	\$114	-\$15,610
30	37.5	\$19,500	650	\$26,000	\$29,750	\$114	-\$10,250
40	49.9	\$26,000	650	\$26,000	\$30,990	\$124	-\$4,990
50	63.8	\$32,500	650	\$26,000	\$32,380	\$139	\$120
60	80.5	\$39,000	650	\$26,000	\$34,050	\$167	\$4,950
68	104.8	\$44,200	650	\$26,000	\$36,480	\$304	\$7,720
69	110	\$44,850	650	\$26,000	\$37,000	\$520	\$7,850
70	117	\$45,500	650	\$26,000	\$37,700	\$700	\$7,800
71	128	\$46,150	650	\$26,000	\$38,800	\$1,100	\$7,350

Graph of total costs and revenue



Marginal costs and revenues



Lessons from the graphs and table

- To maximize profit
 - Increase production until the unit costs of production equal the marginal revenue or price of the product. This is where $MR=MC$.
- The firm's supply curve can be determined by this cost structure.

Determining a firm's supply curve

Lumber Output	Log Input	Total Revenue	Marginal Revenue	Fixed Cost	Total Cost	Marginal Cost	Excess Profit
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10	14.7	\$6,500	650	\$26,000	\$27,470	\$147	-\$20,970
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71	128	\$46,150	650	\$26,000	\$38,800	\$1,100	\$7,350

- If the price of lumber is \$114, the mill will produce 30 MBF of lumber.
 - Why? Revenue of \$114/MBF is greater than average variable cost of \$100/MBF, so mill will make \$14/MBF towards paying off fixed costs.
 - Mill will lose money, and unless it can raise prices or change its cost structure, it will go out of business as soon as the owners can get out of the fixed cost obligations (i.e. - sell the mill)

Determining a firm's supply curve

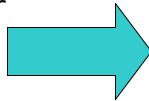
Lumber Output	Log Input	Total Revenue	Marginal Revenue	Fixed Cost	Total Cost	Marginal Cost	Excess Profit
0	0	\$0	0	\$26,000	\$26,000	0	-\$26,000
10	14.7	\$6,500	650	\$26,000	\$27,470	\$147	-\$20,970
20	26.1	\$13,000	650	\$26,000	\$28,610	\$114	-\$15,610
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70	117	\$45,500	650	\$26,000	\$37,700	\$700	\$7,800
71	128	\$46,150	650	\$26,000	\$38,800	\$1,100	\$7,350

- If the price of lumber is \$124, the mill will produce 40 MBF of lumber.
 - Why? Again, this is where $MC=MR$. To produce more than 40 MBF would mean unit costs are higher than unit revenue.
 - Note that the mill's fixed and variable costs are still higher than revenue at an output of 40 MBF per year, so eventually, the mill would shut down.

Determining a firm's supply curve

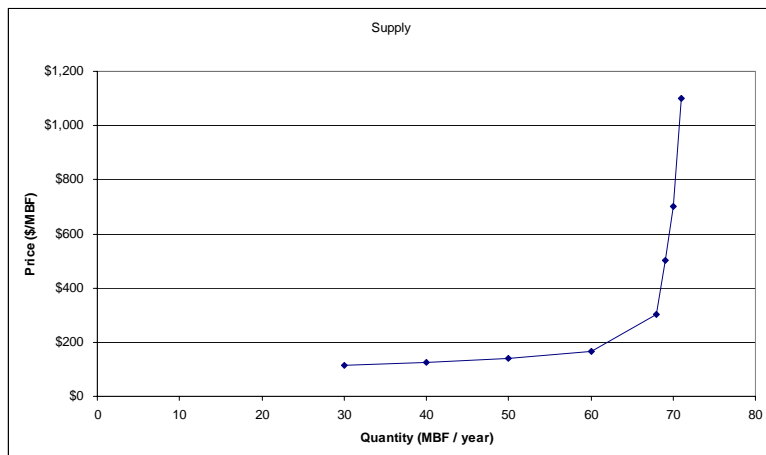
Lumber Output	Log Input	Total Revenue	Marginal Revenue	Fixed Cost	Total Cost	Marginal Cost	Excess Profit
0	0	\$0	0	\$26,000	\$26,000	0	-\$26,000
10	14.7	\$6,500	650	\$26,000	\$27,470	\$147	-\$20,970
20	26.1	\$13,000	650	\$26,000	\$28,610	\$114	-\$15,610
30	37.5	\$19,500	650	\$26,000	\$29,750	\$114	-\$10,250
40	49.9	\$26,000	650	\$26,000	\$30,990	\$124	-\$4,990
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70	117	\$45,500	650	\$26,000	\$37,700	\$700	\$7,800
71	128	\$46,150	650	\$26,000	\$38,800	\$1,100	\$7,350

- Continuing on, given price for lumber, this mill's supply table will be:



If the price of lumber is...	This mill will produce...
\$114	30 MBF / year
\$124	40 MBF / year
\$139	50 MBF / year
\$167	60 MBF / year
\$304	68 MBF / year
\$502	69 MBF / year
\$700	70 MBF / year
\$1100	71 MBF / year

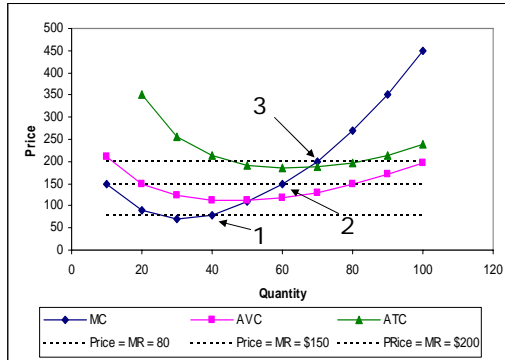
Mill's individual supply curve



Let's look abstractly at cost curves

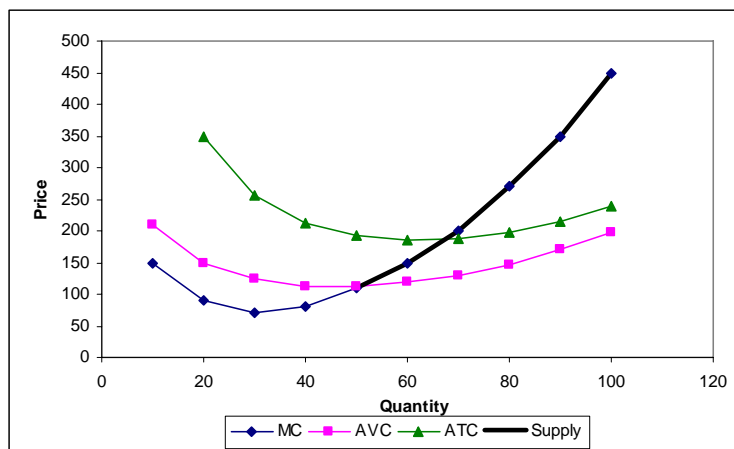
Output	Fixed Cost	Variable Cost	Marginal Cost	Total Cost	ATC	AVC
10	4000	2100	150	6100	610	210
20	4000	3000	90	7000	350	150
30	4000	3700	70	7700	257	123
40	4000	4500	80	8500	213	113
50	4000	5600	110	9600	192	112
60	4000	7100	150	11100	185	118
70	4000	9100	200	13100	187	130
80	4000	11800	270	15800	198	148
90	4000	15300	350	19300	214	170
100	4000	19800	450	23800	238	198

1 →
2 →
3 →



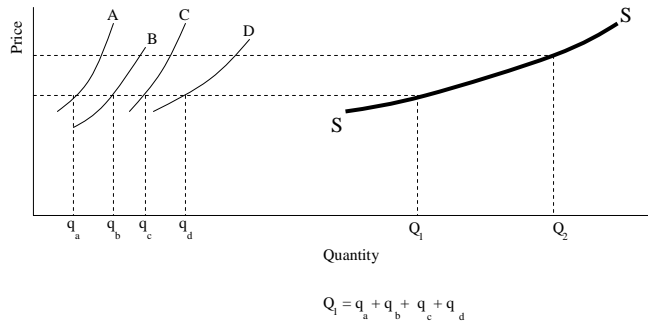
- Point 1: If price for output is \$80/unit, production stops immediately, firm not covering variable costs
- Point 2: If price is \$150/unit, MR is below total costs, firm is losing money, but production will continue in short run.
- Point 3: If price is \$200/unit, MR is above total costs, firm is making profit.

An individual firm's short-run supply curve...



... is the same as it's marginal cost curve above average variable costs.

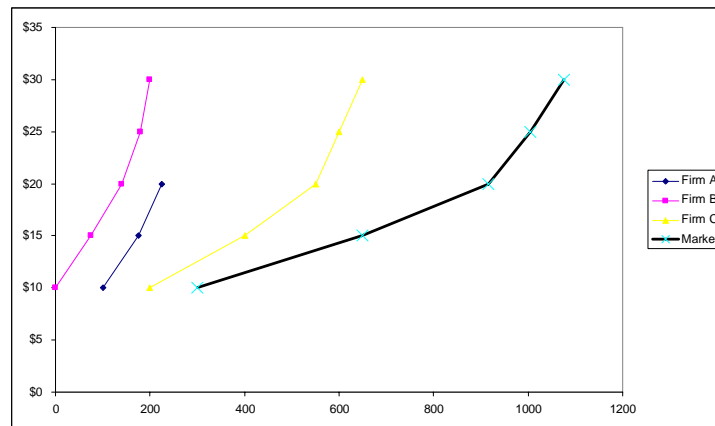
Summing firms' supply curves into a market supply curve



Summing up individual firm's supply into a market supply...

Price	Quantity produced by			Market Supply
	Firm A	Firm B	Firm C	
\$10	100	0	200	300
\$15	175	75	400	650
\$20	225	140	550	915
\$25	225	180	600	1005
\$30	225	200	650	1075

Individual and market supply curves

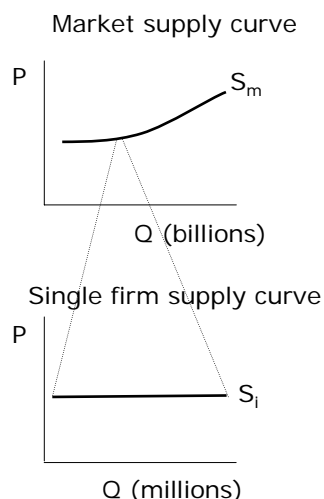


Non-perfect competition

- If there are only a few buyers in a market:
 - *Oligopsony* exists
 - Firm is an *oligopsonist*
- If there is only one buyer in a market
 - *Monopsony* exists
 - Firm is a *monopsonist*
- In both oligopsony and monopsony, firm(s) face upward sloping supply curves for inputs.
- Can you think of examples of these market types?

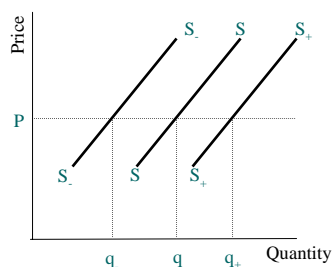
Question about market vs. firm supply curves...

- If we have individual firm's with upward sloping supply curves for their output, why can we assume that when they are buying, they face a horizontal, or nearly horizontal, supply curve?
- Answer:
 - Market supply curves are generally flat (see previous slide) and it takes tremendous quantity to change price.
 - Like with individual demand curves, any single firm buys such a small quantity that they don't see any increase in price.



Supply shifts

- Firms entering and leaving the market
- Changes in:
 - Price inputs
 - Production technology
 - Natural disasters
 - Substitute input price changes
- An increase in supply means that at a given price, P , the quantity offered in the market increases.
 - S to S_+ so at price P , q to q_+
- A decrease in supply means that at a given price, P , the quantity offered in the market decreases.
 - S to S_- so at price P , q to q_-





Next lecture...

Supply and demand
interactions