Lecture 3
Supply II (Startup & shut-down decisions)

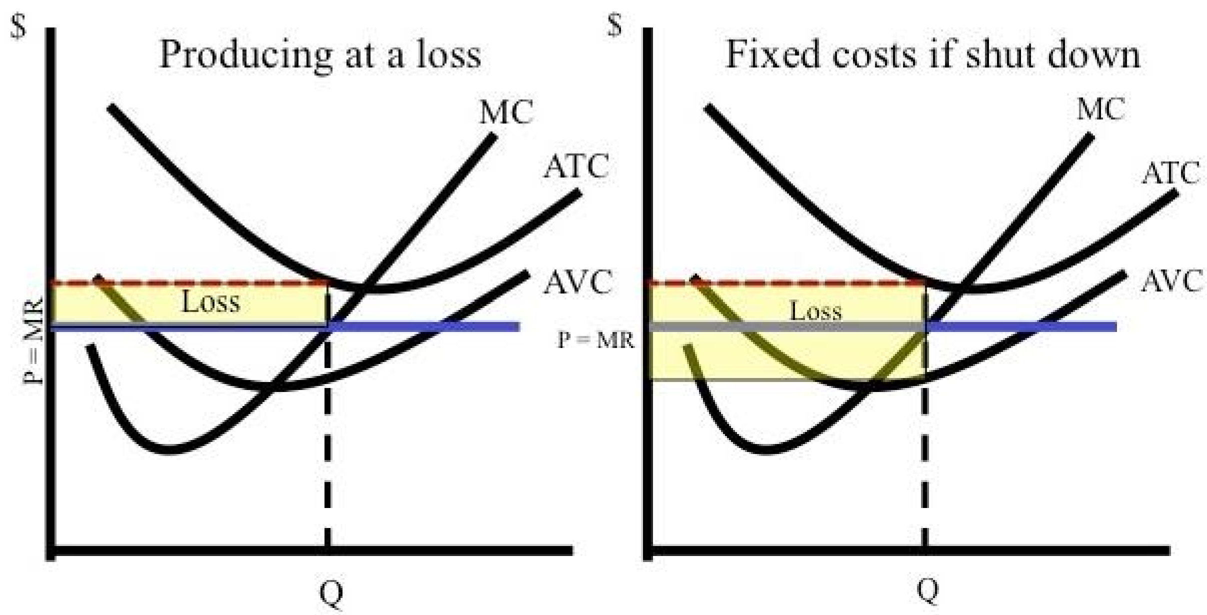
15.011/0111
Economic Analysis for Business Decisions

Oz Shy

Finding a firm's profit-maximizing output level: Shutdown decisions

Last class we concluded that a firm may choose NOT to produce. Today, we expand on this decision process by distinguishing "avoidable" from "unavoidable" and "sunk" costs

Here is a situation that the firm can minimize loss by producing in the short-run, and exit the industry in the long-run

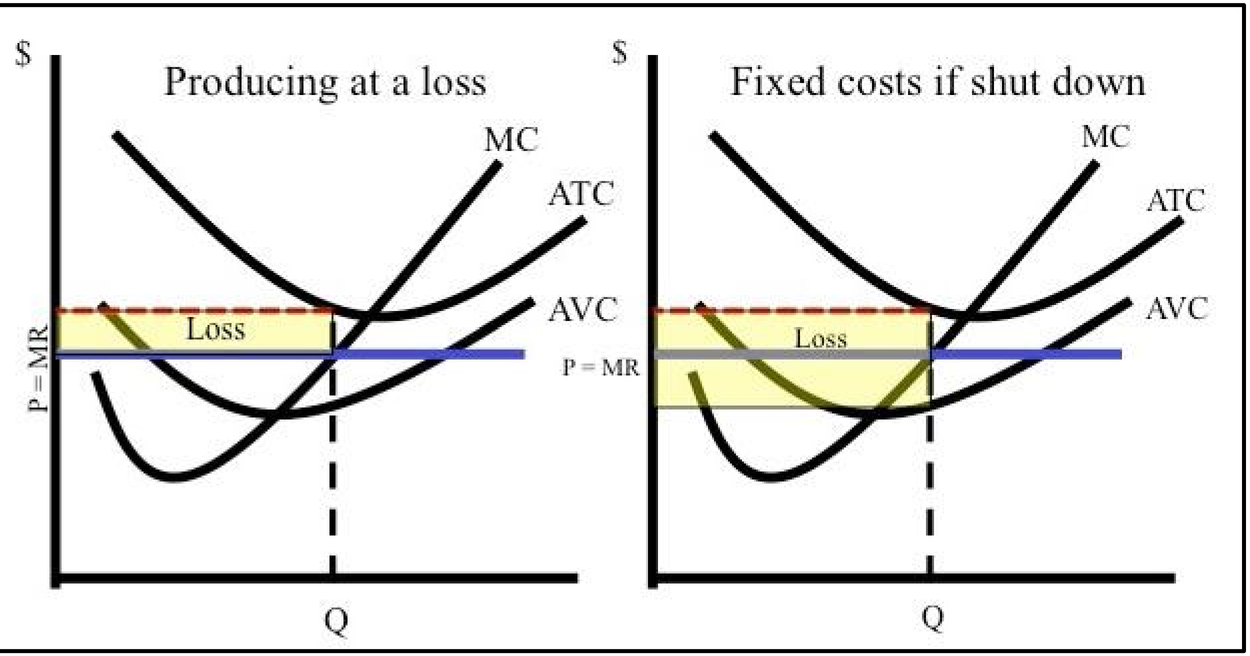


Why is that? Because this fixed cost is sunk (therefore, unavoidable)

Sunk cost does not have an effect on production decision

Shutdown decisions: Short-run versus long-run (summary)

1. If P ≥ min ATC, then produce Q units at P = MC(Q) in the SR and LR
2. If min AVC ≤ P < min ATC, then produce Q units at P = MC(Q) in the SR but exit in the LR



3. If P < min AVC, shut-down (exit) immediately

Dynamic considerations

- Investment in capital may generate a stream of revenue over a long period of time (not instantaneous)
- Example: Buying a truck, aircraft, building a facility
- How can cost and benefits can be compared?
- We can compare present value (PV), future value (FV), or by looking at annual rates of change

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Return on investment: Stream of profits, future value, present value,

- Let r denote the (yearly) interest rate: r = 5% (same as) r = 0.05
- \$100 investment today yields: 100 + 100 x 0.05=\$105 next year
- FV_2=\$100 + 100 x 1.05 + 100 $(0.05)^2$ = \$110.25 in 2 years
- How much \$100 next year is worth for you today?

$$PV = \frac{\$100}{1+r} = \frac{\$100}{1+0.05} = \$95.23$$

- How much \$100 2 years from now is worth for you today?

$$PV = \frac{\$100}{(1+r)^2} = \frac{\$100}{(1+0.05)^2} = \$90.70$$

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Remark: 1/(1+r) is called the discount factor

Project evaluation: Stream of profits, present value

- You consider an investment of c_0 (t=0 means now!) that would yield a cash flow of c_1 next year, c_2 on the second year, and c_3 on the third year, … and c_T on year T (last year)
- Note c_0 could be negative (initial investment in capital)
- Present value of this investment project is:

$$PV = c_0 + \frac{c_1}{1+r} + \frac{c_2}{(1+r)^2} + \ldots + \frac{c_T}{(1+r)^T}$$

Project A: Evenly-spread moderate cash flow

Project B: Longer investment period 'buys' high (delayed) yield

Project	t = 0	t = 1	t = 2	t = 3	PV (r=10%)	PV (r=20%)
A	-$200	$100	$100	$100	$48.69	$10.65
B	-$200	-$50	$100	$300	$62.58	$1.39
r					0.10	0.20

Dynamic considerations: An example

- Example: LC Airlines buys a new Airbus-320 for $150m
- Alternatively, it can invest the $150m and earn 10%/year
- Will provide service for 30 years, with no scrap value
- P&R approximate depreciation as 150/30 = $5m/year
- Note: In general, capital depreciates faster in earlier years
- Annual user cost of capital
  = Annual depreciation (loss of value) + foregone interest

1st year: 5 + 0.1 X 150 = $20m,
2nd year: 5 + 0.1 X 145 = $19.5m
10th year: 5 + 0.1 X 100 = $15m

Instead, we can express user cost of capital as a rate per dollar invested:

r_{UC} = depreciation rate + foregone interest rate

$$r_{UC} = \left(\frac{100\%}{30}\right) + 10\% = 13.33\%$$

Annuity: Infinite series of payments made at fixed time intervals (fixed interest rate, r)

$$PV = \frac{c}{1+r} + \frac{c}{(1+r)^2} + \dots = \frac{c}{r}$$

<u>Proof</u> (feel free to ignore this proof):

$$PV = \frac{c}{1+r} + \frac{c}{(1+r)^2} + \dots = \frac{1}{1+r}\left[c + \frac{c}{1+r} + \frac{c}{(1+r)^2} + \dots\right]$$

$$\Rightarrow PV = \frac{1}{1+r}[c + PV] \Rightarrow PV\left(1 - \frac{1}{1+r)}\right) = \frac{c}{1+r}$$

$$\Rightarrow PV = \frac{\frac{c}{1+r}}{1 - \frac{1}{1+r}} = \frac{c}{r}$$

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n-term annuity: Series of *n* payments made at fixed time intervals (fixed interest rate)

$$PV^n = \frac{c}{r}\left[1 - (1+r)^{-n}\right]$$

Proof (feel free to ignore this proof): $PV^n = PV^\infty - \frac{PV^\infty}{(1+r)^n}$

$$= \frac{c}{r}\left[1 - \frac{1}{(1+r)^n}\right] = \frac{c}{r}\left[\frac{(1+r)^n - 1}{(1+r)^n}\right]$$

$$= \frac{c}{r}\left[1 - (1+r)^{-n}\right]$$

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