Principle of Microeconomics
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Midterm Brief Review

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1 Principles of Econ

a. **Optimization** → $\underset{x_1,x_2}{max}\, u(x_1, x_2)$, *s.t. BC:* $p_1x_1 + p_2x_2 = I$.
Equilibrium → results of optimization
Empiricism → verify and analyze theories and hypotheses with data

b. Positive Economics → objective, testable; actually do.
Normative Economics → subjective, preferable; ought to do. *(e.g. fairness)*

c. The trade-off between Efficiency and Equity

2 Economic Methods

a. Models are simplified descriptions or simulations of our real world, assumptions and exogenous variables needed.

b. Correlation $\nRightarrow$ Causation.

c. By conducting experiments, economists can measure and verify the cause-and-effect relationship. (→ Empiricism)

3 Optimization

a. Comparative Statics the comparison of 2 different outcomes after exogenous variables change.
e.g. check "variable α's influence" on target function $v(x_1, x_2)$ → take $\frac{\partial v(x_1,x_2)}{\partial \alpha}$ and verify relationship.

b. Measures [**1**] Optimization in Levels: consider the <u>total</u> net benefit ($TR - TC$ in a whole), [**2**] Optimization in Differences: consider the <u>change</u> of the net benefit (Δ marginal analysis)

⇒ both methods get the exact same solution.

4 Demand, Supply & Equilibrium

a. Demand [**1**] Changes in quantity demanded: movement along the demand curve, causing by its own-price change. [**2**] Shifts of the demand curve: shift in line, causing by all the other factors.

b. Supply **[1]** Changes in quantity supplied: movement along the supply curve, causing by its own-price change. **[2]** Shifts of the supply curve: shift in line, causing by all the other factors.

c. Equilibrium given demand function and supply function, the equilibrium occurs when:

$$Q_D = Q_S$$

Sovle P^*, and then we get $Q^* \Rightarrow e^*(Q^*, P^*)$.

5 Consumer & Incentive

The buyer's problem has two parts: **[1] Preference(Utility), [2] BC: Budget Constraint (Prices).**

a. $MRS = -\frac{MU_1}{MU_2} = -\frac{p_1}{p_2} \Rightarrow$ **Optimal**: $\frac{MU_1}{MU_2} = \frac{p_1}{p_2}$. (or say $\frac{MB_1}{MB_2} = \frac{p_1}{p_2}$, MB stands for Marginal Benefit)

b. Elasticity :
We only introduce and use **Arc** Elasticity of Demand (Midpoint formula) to solve problems in Principle of Economics. But since the sign features of arc elasticity are actually the same as those of **Point** Elasticity, which you all might largely use in Sophomore year and beyond(assuming you're in Econ major), I will display both below and simply use Point Elasticity for further explanations.

Arc [Own-price(ε_1), Cross-price(ε_{ij}), Income(ε_{iI})]:

$$\begin{cases} arc\,\varepsilon_1 = \frac{\Delta x_1/[(x_1''+x_1')/2]}{\Delta p_1/[(p_1''+p_1')/2]} = \frac{\Delta x_1}{\Delta p_1}\frac{\bar{p_1}}{\bar{x_1}}, \\ arc\,\varepsilon_{ij} = \frac{\Delta x_i/[(x_i''+x_i')/2]}{\Delta p_j/[(p_j''+p_j')/2]} = \frac{\Delta x_i}{\Delta p_j}\frac{\bar{p_j}}{\bar{x_i}}, \\ arc\,\varepsilon_{iI} = \frac{\Delta x_i/[(x_i''+x_i')/2]}{\Delta I/[(I''+I')/2]} = \frac{\Delta x_i}{\Delta I}\frac{\bar{I}}{\bar{x_i}}. \end{cases} \tag{1}$$

Just beware that we're dealing with the Arc ones, so don't forget to use the midpoint formula.

Features (using **Point** for expl.):

[1] $\varepsilon_1 = \frac{\partial x_1}{\partial p_1}\frac{p_1}{x_1}$. If $\varepsilon_1 < 0$: Ordinary good $\Leftrightarrow$ satisfies Law of Demand. Otherwise, Giffen good.

[2] $\varepsilon_{ij} = \frac{\partial x_i}{\partial p_j}\frac{p_j}{x_i}$. Suppose x_i, x_j are ordinary goods $\Rightarrow$ If $\varepsilon_{ij} > 0$: Substitutes. Otherwise, Complements.

[3] $\varepsilon_{iI} = \frac{\partial x_i}{\partial I}\frac{I}{x_i}$. If $\varepsilon_{iI} > 0$: Normal good. Moreover, $\varepsilon_{iI} > 1$: Luxuries; $0 < \varepsilon_{iI} < 1$: Necessities. Otherwise, Inferior good.

[4] In terms of abs value $|\varepsilon_1|$: $\underline{|\varepsilon_1| > 1}$ $\Rightarrow$ **Elastic Demand** (flatter); $\underline{|\varepsilon_1| < 1}$ $\Rightarrow$ **Inelastic Demand** (steeper); $\underline{|\varepsilon_1| = 1}$ $\Rightarrow$ **Unit Elastic Demand** (rectangular hyperbola e.g. Cobb-Douglas)

c. Total Revenue change :
On the elastic segment of demand curve, TR decreases when P increases.

$$\underline{TR(\downarrow)} = P(\uparrow) \cdot Q(\downarrow_{large})$$

On the inelastic segment of demand curve, TR increases when P increases.

$$\underline{TR(\uparrow)} = P(\uparrow) \cdot Q(\downarrow_{small})$$

6 Sellers & Incentives

The seller's problem has three parts: **[1] Production, [2] Costs(Oppor.Cost), [3] Revenue.** We assume the market structure here is "**Perfectly Competitive**", which implies that both suppliers and consumers are "price takers"(P: exogenous) and suppliers has free cost of entering and exiting the market.

Ultimate goal for firms: Profit Maximization π.

a. Production Function :
For **A**: Product shock(exogenous), **K or k**: Capital(exogenous), **L or n**: Labor(endogenous)

$$Q = AF(K, L) \Leftrightarrow y = AF(k, n)$$

$$\begin{cases} MPL = AF_n(k,n) = \frac{\partial AF(k,n)}{\partial n}, \\ MPK = AF_k(k,n) = \frac{\partial AF(k,n)}{\partial k}. \end{cases} \tag{2}$$

Now considering costs, **w**: real wage rate, a firm's profit(dividends) can be like:

$$d = AF(k, n) - wn$$

Given {A, k, w}:

$$\max_{(n)} d = AF(k, n) - wn$$

From all above, we can observe some **results**: **[1]** FOC: $MPL \geq 0$, $MPK \geq 0$ **[2]** SOC: Marginal Product diminishes (n $\uparrow \Rightarrow$ MPL $\downarrow$, k$\uparrow \Rightarrow$ MPK $\downarrow$) $\Leftrightarrow$ **"Law of Diminishing Returns"** **[3]** A firm's marginal gain is MPL, while its marginal cost is w.

b. Costs of Production :
If a firm uses inputs, it must consider the production costs.
In the short-run, Total Cost can be represented as the sum of Variable Cost and Fixed Cost:

$$TC = VC + FC$$

We can divide the TC equation by quantity Q, obtaining:

$$\frac{TC}{Q} = \frac{VC}{Q} + \frac{FC}{Q} \Rightarrow ATC = AVC + AFC$$

where **ATC** stands for Average Total Cost, and so on. **Graph: U-shaped.** (Expl.: The first half of ATC is similar to AFC since Q is yet small. While Q is large enough, the other half of ATC is more alike to AVC.)

Now we further introduce the idea of Marginal Cost (**MC**), which measuring the additional costs induced by additional Q. We then mathematically define:

$$MC = \frac{\partial TC}{\partial Q} = \frac{\Delta TC(Q)}{\Delta Q} = \frac{\Delta VC}{\Delta Q} + \frac{\Delta FC}{\Delta Q} = \frac{\Delta VC}{\Delta Q}$$

Apparently, we're calculating how the marginal, or changing, units of output (ΔQ) affect the change in total cost (ΔTC). It is worth noting that FC is a constant, implying Fixed Cost is literally FIXED and won't vary with the change in quantity of output: $\frac{\Delta FC}{\Delta Q} = 0$.

Another crucial point is that **MC will always intersect ATC at ATC's minimum point.** Mathematically, this statement can be easily verified:

Proof. Since the extremum occurs when $FOC = 0$, let

$$\frac{dATC}{dQ} = 0 \Rightarrow \frac{d(\frac{TC}{Q})}{dQ} = \frac{(MC \cdot Q) - TC}{Q^2} = \frac{MC - ATC}{Q} = 0$$

Because ATC is U-shaped, we have the minimum when $MC = ATC$. At this point, which is the **Efficient Scale**, a firm can **minimize production cost**. ■

c. Revenue & Profits :
Total Revenue (**TR**), Average Revenue (**AR**), Marginal Revenue (**MR**):

$$\begin{cases} TR = P \cdot Q \\ AR = \frac{TR}{Q} = P \\ MR = \frac{\Delta TR}{\Delta Q} = P \end{cases} \tag{3}$$

Thus, we have our first relation: $MR = AR = P$.

Now consider the ultimate **Profit Maximization problem**:

$$max\, \pi = TR - TC$$

yielding $FOC = 0$:

$$\Rightarrow \frac{\Delta \pi}{\Delta Q} = \frac{\Delta TR}{\Delta Q} - \frac{\Delta TC}{\Delta Q} = MR - MC = 0$$

So, a firm optimizes its profit when output Q^* satisfies the relation: $MR = MC$. Additionally, based on MR=P, we can conclude the final relation that **maximize profit**: $P = MR = MC$. ■

$$\Rightarrow max\, \pi = TR - TC = (P \cdot Q^*) - (ATC \cdot Q^*) = (P - ATC) \cdot Q^*$$

d. Shutdown :
A short-run decision of temporarily stop producing if $TR < VC$ ⇔ **Shutdown point**: $P = P^{exit} = AVC$, i.e., shutdown when $P = SMC \leq AVC = P^{exit}$. (SMC: Short-run MC)

→ *Why shutdown only when* $TR < VC$ *?* Consider 2 cases:
(1) continue to produce: $\pi_1 = TR - TC = TR - (VC + FC) = (TR - VC) - FC$
(2) shutdown: $\pi_s = TR - TC = TR - (VC + FC) = 0 - (0 + FC) = -FC$
$\forall_{TR} | TR < VC, \pi_s > \pi_1 \Rightarrow$ better shutdown. ■

Based on the previous inference, we know the Short-run Supply Curve is the upper segment of SMC lying above AVC.