

Midterm Exam I

Macroeconomics I

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Problem 1: The calculation of Lecture 8

Remember the Example in Lecture 8.

Consumer: $\max_{C,l} \ln C + \ln l$ subject to $C \leq w(1 - l) + \pi$

$$\text{FOC} \quad \frac{C}{l} = w \quad (1)$$

$$\text{Binding budget constraint} \quad C = w(1 - l) + \pi \quad (2)$$

$$\text{Time constraint} \quad N^s = 1 - l \quad (3)$$

Firm: $\max_{N^d} (N^d)^{\frac{1}{2}} - wN^d$

$$\text{FOC} \quad \frac{1}{2}(N^d)^{-\frac{1}{2}} = w \quad (4)$$

$$\text{Output definition} \quad Y = (N^d)^{\frac{1}{2}} \quad (5)$$

$$\text{Profit definition} \quad \pi = Y - wN^d \quad (6)$$

Market clear:

$$N^s = N^d \quad (7)$$

Fill the following blanks for the step-by-step guide for algebraic calculation:

Step 1: Impose Market clear condition, so shrink all 7 equations to Q1 equations

① _____

(A) 4

(B) 5

(C) 6

(D) 7

Consumer: $\max_{C,l} \ln C + \ln l$ subject to $C \leq w(1 - l) + \pi$

$$\text{FOC} \quad \frac{C}{l} = w \quad (8)$$

$$\text{Binding budget constraint } C = w(1 - l) + \pi \quad (9)$$

$$\text{Time constraint } N = 1 - l \quad (10)$$

$$\text{Firm: } \max_N (N)^{\frac{1}{2}} - wN$$

$$\text{FOC } \frac{1}{2}(N)^{-\frac{1}{2}} = w \quad (11)$$

$$\text{Output definition } Y = (N)^{\frac{1}{2}} \quad (12)$$

$$\text{Profit definition } \pi = Y - wN \quad (13)$$

Step 2: replace l in terms of N using $l = 1 - N$

$$\text{Consumer: } \max_{C,l} \ln C + \ln l \quad \text{subject to } C \leq w(1 - l) + \pi$$

$$\text{FOC } \frac{C}{(\text{Q2})} = w \quad (14)$$

$$\text{Binding budget constraint } C = w(\text{Q3}) + \pi \quad (15)$$

② _____

- (A) $1 - N$ (B) $2 - N$ (C) $N - 1$ (D) $2 - N$

③ _____

- (A) $N - 3$ (B) $N - 2$ (C) $N - 1$ (D) N

$$\text{Firm: } \max_N (N)^{\frac{1}{2}} - wN$$

$$\text{FOC } \frac{1}{2}(N)^{-\frac{1}{2}} = w \quad (16)$$

$$\text{Output definition } Y = (N)^{\frac{1}{2}} \quad (17)$$

$$\text{Profit definition } \pi = Y - wN \quad (18)$$

Step 3: replace π and Y as N

$$\text{Consumer: } \max_{C,l} \ln C + \ln l \quad \text{subject to } C \leq w(1 - l) + \pi$$

$$\text{FOC } \frac{C}{(\text{Q2})} = w \quad (19)$$

$$\text{Binding budget constraint } C = w(\underline{\text{Q3}}) + \pi \quad (20)$$

$$\text{Firm: } \max_N (N)^{\frac{1}{2}} - wN$$

$$\text{FOC } \frac{1}{2}(N)^{-\frac{1}{2}} = w \quad (21)$$

$$\text{Profit definition } \pi = (\underline{\text{Q4}}) - wN \quad (22)$$

④ _____

- (A) N (B) $2N$ (C) $N^{\frac{1}{2}}$ (D) $N^{\frac{1}{4}}$

Step 4: Substitute $\pi(N)$ into Binding budget constraint and get

$$C = (\underline{\text{Q5}}) \quad (23)$$

⑤ _____

- (A) N (B) $N^{\frac{1}{2}}$ (C) $N^{\frac{1}{4}}$ (D) $N^{\frac{1}{8}}$

Step 5: With consumer's FOC and firm's FOC both equate to w , we can get another expression of C :

$$C = (\underline{\text{Q2}}) \times (\underline{\text{Q6}}) \quad (24)$$

⑥ _____

- (A) $\frac{1}{2}N^{-\frac{1}{2}}$ (B) $\frac{1}{2}N$ (C) $\frac{1}{4}N^{-\frac{1}{2}}$ (D) $\frac{1}{2}N$

Step 6: Let (23) equate (24) and we get N as

$$N = (\underline{\text{Q7}}) \quad (25)$$

⑦ _____

- (A) 1 (B) $\frac{1}{2}$ (C) $\frac{1}{3}$ (D) $\frac{1}{4}$

Step 7: Trace back to all unknowns given the value of N , we get

$$C = (\text{Q8}) \quad (26)$$

$$l = (\text{Q9}) \quad (27)$$

$$Y = (\text{Q10}) \quad (28)$$

$$\pi = (\text{Q11}) \quad (29)$$

$$w = (\text{Q12}) \quad (30)$$

8 _____

- (A) $\sqrt{\frac{1}{3}}$ (B) $\sqrt{\frac{1}{4}}$ (C) $\sqrt{\frac{1}{5}}$ (D) $\sqrt{\frac{1}{6}}$

9 _____

- (A) $\frac{3}{4}$ (B) $\frac{1}{3}$ (C) $\frac{1}{4}$ (D) $\frac{2}{3}$

10 _____

- (A) $\sqrt{\frac{1}{3}}$ (B) $\sqrt{\frac{1}{4}}$ (C) $\sqrt{\frac{1}{5}}$ (D) $\sqrt{\frac{1}{6}}$

11 _____

- (A) $\sqrt{\frac{1}{3}} - \frac{1}{3}\sqrt{3}$ (B) $\sqrt{\frac{1}{3}} - \frac{1}{6}\sqrt{3}$ (C) $\sqrt{\frac{1}{6}} - \frac{1}{3}\sqrt{3}$ (D) $\sqrt{\frac{1}{6}} - \frac{1}{6}\sqrt{3}$

12 _____

- (A) $\frac{1}{3}\sqrt{3}$ (B) $\frac{1}{2}\sqrt{2}$ (C) $\frac{1}{2}\sqrt{3}$ (D) $\frac{1}{2}\sqrt{2}$

Problem 2: Macroeconomic Analysis of H-1B Visa Fee Policy

Scenario

A new administration proposes a substantial fee, $t = \$100,000$, that should be paid by firms on every H-1B worker hired. We will analyze this policy using our one-period competitive equilibrium model.

Model Setup

- **Household:** Utility $U(C, l) = \ln C + \beta \ln l$; Time endowment $h = 1$.
 - **Firm:** Production $Y = zK^\alpha N^{1-\alpha}$, where N is the total labor demand.
 - **Government:** Balances its budget, $G = T + tN_H$.
 - **Parameters:** $z = 1, K = 1, \alpha = 1/3, \beta = 2$.
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Part I: Conceptual Foundations

- ⑬ The administration considers a massive \$100,000 fee per H-1B worker. According to the Lucas critique, why is a micro-founded model essential for analyzing such a large policy shift? _____
- (A) Because a large fee is a major policy change, it will fundamentally alter how firms decide to hire, making old statistical data unreliable.
- (B) Historical data on visa fees is likely inaccurate and cannot be trusted for forecasting.
- (C) Micro-founded models are the only models that can account for government spending.
- (D) The Lucas critique states that only small, incremental policies can be accurately modeled.
- ⑭ A U.S. software firm has \$10M in revenue. It pays \$2M for intermediate goods, \$4M in domestic wages, \$1M in H-1B wages, and \$500,000 in H-1B fees. Using the income approach, what is this firm's contribution to GDP? _____

- (A) \$7,500,000
- (B) \$8,000,000
- (C) \$2,500,000
- (D) \$5,500,000

Part II: The Perfect Substitutes Case

Assume H-1B (N_H) and domestic (N_D) workers are perfect substitutes, so total labor demand is $N = N_D + N_H$. The production function is $Y = N^{\frac{2}{3}}$. The domestic household's labor supply is perfectly inelastic at $N^s = \frac{1}{3}$.

- ⑮ What is the firm's labor demand curve, $N(w)$? _____
- (A) $N = \left(\frac{3w}{2}\right)^3$
 - (B) $N = \left(\frac{2}{3w}\right)^2$
 - (C) $N = \left(\frac{3}{2w}\right)^{\frac{3}{2}}$
 - (D) $N = \left(\frac{2}{3w}\right)^3$
- ⑯ Assuming that the US does not have any foreign labor supply, only the domestic ones. What is the equilibrium wage w^* ? _____
- (A) $\frac{2}{3}$
 - (B) $2 \times 3^{2/3}$
 - (C) $2 \times 3^{-2/3}$
 - (D) $\frac{3}{2}$
- ⑰ Now, the US government announce the H-1B program and allow foreign workers to enter with a fee $t > 0$. The firm must pay a fee of t for each H-1B worker. The market real wage is w . What is the firm's profit-maximization condition for hiring an H-1B worker? _____

(A) $MPN = w - t$

(B) $MPN = w$

(C) $MPN = w + t$

(D) $MPN = t$

⑱ In this perfect substitutes model, what is the equilibrium level of H-1B employment, N_H^* ? _____

(A) 0

(B) $1/3$

(C) It depends on the size of the fee t .

(D) It is negative.

⑲ The analysis in previous question suggests firms would hire zero H-1B workers. In reality, firms still hire them. What is the most plausible economic reason our simple model misses? _____

(A) Firms are not actually profit-maximizers.

(B) Domestic and H-1B workers are not perfect substitutes; H-1B workers may possess unique skills that command a higher effective MPN.

(C) The government forces firms to hire H-1B workers.

(D) The real wage for H-1B workers is secretly lower than for domestic workers.

Part III: The Cobb-Douglas Production Case

Now assume a more realistic scenario where the two labor types are imperfect substitutes. Let the production function be $Y = N_D^{1/2} N_H^{1/2}$. The supply of domestic labor is perfectly inelastic at $N_D = 1/4$, and the supply of H-1B labor is perfectly inelastic at $N_H = 1/4$.

⑳ What is the Marginal Product of a domestic worker, MPN_D ? _____

(A) $\frac{1}{2} \sqrt{\frac{N_D}{N_H}}$

(B) $\frac{1}{2} \sqrt{\frac{N_H}{N_D}}$

(C) $\sqrt{\frac{N_H}{N_D}}$

(D) $\sqrt{\frac{N_D}{N_H}}$

(21) Before the fee ($t = 0$), what is the equilibrium wage for domestic workers, w_D ? _____

(A) 2

(B) 1

(C) 4

(D) $1/2$

(22) Before the fee ($t = 0$), what is the total output (GDP) of this economy? _____

(A) $1/4$

(B) $1/2$

(C) 1

(D) 4

(23) Now, a fee of $t = 1/4$ is imposed on H-1B workers. What is the new wage paid *to* H-1B workers, w_H ? _____

(A) $1/2$

(B) $1/4$

(C) 0

(D) $-1/4$

(24) After the fee is imposed, what are the profits (π) of the representative firm? _____

- (A) 0
- (B) $1/8$
- (C) $1/4$
- (D) $-1/8$

- (25) In this Cobb-Douglas labor model with perfectly inelastic labor supply, who bears the full economic burden of the fee? _____
- (A) The firm owners (through lower profits).
 - (B) The H-1B workers (through lower wages).
 - (C) Domestic workers (through lower wages).
 - (D) The government.

Part IV: General Equilibrium Analysis

Let's return to the general model where the household's labor supply is NOT perfectly inelastic. Production: $Y = zK^\alpha N^{1-\alpha}$. Household utility: $U = \ln(C) + \beta \ln(l)$. The policy is an increase in TFP, z .

- (26) The production function is $Y = zK^\alpha (N_D^\gamma N_H^{1-\gamma})^{1-\alpha}$. The H-1B fee (t) is imposed only on N_H . How does this fee affect the firm's demand for **capital** (K)? _____
- (A) It has no effect on capital demand because the fee is on labor.
 - (B) The firm's demand for capital will decrease.
 - (C) The firm's demand for capital will increase.
 - (D) The rental rate of capital will fall, but demand will not change.
- (27) The H-1B fee (t) is a lump-sum amount per worker. How does this modify the firm's labor demand curve for H-1B workers? _____
- (A) It makes the labor demand curve steeper.
 - (B) It makes the labor demand curve flatter.
 - (C) It pivots the labor demand curve inward.
 - (D) It causes a parallel downward shift of the labor demand curve.

- ②⑧ The H-1B fees collected are used to fund government spending (G). From the representative household's perspective, how does the policy affect their budget constraint initially, before any wage changes? _____
- (A) It has no effect.
 - (B) It decreases their non-wage income ($\pi - T$) because firm profits (π) fall due to the new fee.
 - (C) It increases their non-wage income ($\pi - T$) because the government lowers other taxes (T).
 - (D) It increases their wage income (wN^s).
- ②⑨ The reduction in the household's dividend income (π) described in last question is an example of a: _____
- (A) Pure substitution effect, causing them to work more.
 - (B) Pure income effect, causing them to work more.
 - (C) Pure income effect, causing them to work less.
 - (D) Technology shock, causing them to be less productive.
- ③⑩ The policy shifts the demand for domestic labor to the right (as firms substitute away from H-1B workers), which tends to increase the domestic wage (w). How does this wage increase affect a domestic worker's labor supply? _____
- (A) It will definitely increase their labor supply.
 - (B) It will definitely decrease their labor supply.
 - (C) It has no effect on their labor supply.
 - (D) The effect is ambiguous, as the income effect (work less) and substitution effect (work more) oppose each other.
- ③① Assume for the US economy that the substitution effect of a wage change is stronger than the income effect. What is the shape of the labor supply curve? _____

- (A) Upward-sloping
- (B) Downward-sloping
- (C) Vertical
- (D) Horizontal

③② Let's assemble the full picture in a competitive equilibrium. The H-1B fee policy causes which two simultaneous shifts in the market for **domestic** labor? _____

- (A) Labor demand shifts right, and labor supply shifts right.
- (B) Labor demand shifts left, and labor supply shifts left.
- (C) Labor demand shifts right, and labor supply shifts left.
- (D) Labor demand for domestic workers shifts right, and the labor supply curve for domestic workers also shifts right.

③③ Given that both the labor demand and labor supply curves for domestic workers shift to the right, what is the predicted effect on the equilibrium for domestic workers? _____

- (A) Employment will increase, but the effect on the wage is ambiguous.
- (B) The wage will increase, but the effect on employment is ambiguous.
- (C) Both employment and the wage will definitely increase.
- (D) Both employment and the wage will definitely decrease.

③④ Recall the definition of unemployment rate as the people who are unemployment out of the labor force. What is the unemployment rate in our equilibrium model? _____

- (A) Unemployment increases.
- (B) Unemployment decreases.
- (C) Unemployment is always zero.
- (D) The effect on unemployment is ambiguous.

- 35) What is the most significant weakness of using this one-period (static) model to analyze the H-1B fee policy? _____
- (A) It cannot account for changes in firm profits.
 - (B) It cannot account for the consumer's choice between work and leisure.
 - (C) It ignores the dynamic effects on investment and capital accumulation over time.
 - (D) It assumes that both consumption and leisure are normal goods.
- 36) The model uses a representative household that owns the firm. How does this assumption simplify the analysis of the H-1B fee's effect on household income? _____
- (A) It allows us to ignore the effect on firm profits.
 - (B) It combines the wage and profit effects into a single household budget, showing that the household ultimately bears the cost of the fee through lower profits.
 - (C) It assumes that only H-1B workers pay the fee.
 - (D) It allows us to model workers and firm owners as having conflicting interests.