ECN 594: Two-Part Tariffs and Self-Selection

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January 4, 2026

Plan

1. **Two-part tariffs: structure and intuition**
2. Optimal two-part tariff (homogeneous consumers)
3. Heterogeneous consumers (brief)

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4. Self-selection: versioning and menu design
5. Incentive compatibility and individual rationality
6. Worked example: optimal menu

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Non-linear pricing

- So far: price discrimination by **selection by indicators**
  - Requires observable characteristics (student ID, location, etc.)
- Now: **non-linear pricing**
  - Price per unit depends on quantity purchased
  - Consumers *self-select* into how much to buy
- Key example: **two-part tariffs**

Two-part tariff structure

- A two-part tariff has the form:

$$\text{Total payment} = F + p \times q$$

- F: fixed fee (membership, connection charge)
- p: per-unit price (price per unit consumed)
- q: quantity consumed
- **Examples:**
  - Golf club: membership fee + greens fee per round
  - Phone plan: monthly fee + per-minute charges
  - Costco: annual membership + price per item

Worked example: Gym membership

- **Question:**
- A gym knows each member has demand $q = 20 - 2p$ (visits per month).
- $MC = 2$ per visit.
- What is the optimal two-part tariff (F, p)?
- How much profit per member?

Take 3 minutes to solve this.

Worked example: Gym membership (solution)

Solution

- **Step 1:** Set $p = MC = 2$
- At $p = 2$: $q = 20 - 2(2) = 16$ visits
- **Step 2:** Compute CS at $p = 2$
  - Max WTP (intercept): $p = 10$ when $q = 0$
  - $CS = \frac{1}{2} \times 16 \times (10 - 2) = \frac{1}{2} \times 16 \times 8 = 64$
- **Step 3:** Set $F = CS = 64$
- **Optimal tariff:** \$64/month + \$2/visit
- **Profit per member:** \$64 (all from the fixed fee!)

Why is this "non-linear"?

- Average price per unit: $\frac{F+pq}{q} = p + \frac{F}{q}$
- As q increases, average price **decreases**
- This is a quantity discount!
- The pricing is "non-linear" because total payment is not proportional to quantity

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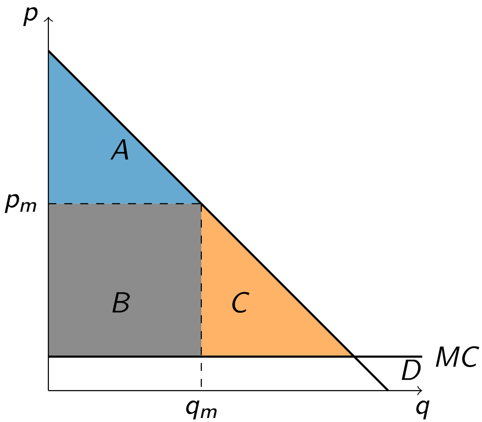
Why use two-part tariffs?

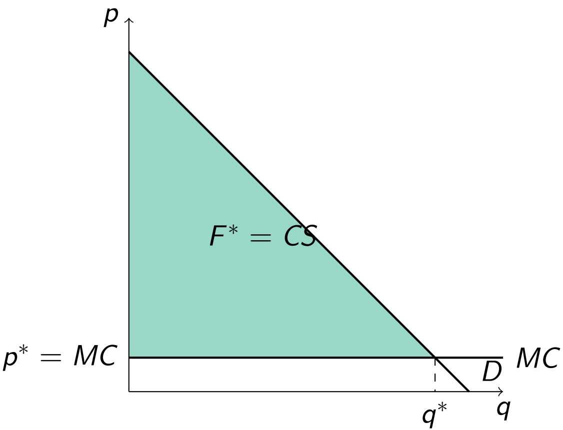


- Under uniform pricing at p_m:
  - CS $=$ Area A
  - Profit $=$ Area B
  - DWL $=$ Area C
- Monopolist "leaves money on the table"
- Can we do better?

Optimal two-part tariff: homogeneous consumers

- Assume all consumers are identical (same demand curve)
- **Key insight:** Use F to extract surplus, use p to maximize total surplus
- **Step 1:** Set $p = MC$
  - This maximizes total surplus (eliminates DWL)
- **Step 2:** Set $F = CS(p = MC)$
  - Extract all consumer surplus through the fixed fee

Optimal two-part tariff: graphically



- Set $p^* = MC$
- Consumers buy q^* (efficient quantity)
- Set $F^* =$ entire green triangle
- Profit $= F^* - 0 = F^*$
- **Result:** Firm captures ALL surplus

Worked example: Two-part tariff

- **Question:** Individual demand is $q = 15 - 2.5p$. Marginal cost is $MC = 0$.
- (a) What is the optimal uniform price and profit per consumer?
- (b) What is the optimal two-part tariff and profit per consumer?

Take 5 minutes to solve this.

Worked example: Two-part tariff (solution)

Solution

- **(a) Uniform pricing:**
  - Inverse demand: $p = 6 - q/2.5$
  - $MR = 6 - 2q/2.5 = 6 - 0.8q$
  - Set $MR = MC$: $6 - 0.8q = 0 \Rightarrow q = 7.5$
  - Price: $p = 6 - 7.5/2.5 = 3$
  - Profit: $\pi = 3 \times 7.5 = 22.5$ per consumer
- **(b) Two-part tariff:**
  - Set $p = MC = 0$
  - At $p = 0$: $q = 15$
  - $CS = \frac{1}{2} \times 15 \times 6 = 45$

Welfare effects of two-part tariffs

- Compared to uniform monopoly pricing:
- **Producer surplus:** Increases (captures all surplus)
- **Consumer surplus:** Decreases to zero
- **Total surplus:** Increases (DWL eliminated!)
- **Efficiency vs equity tradeoff:**
    - More efficient (no DWL)
    - Less equitable (consumers get nothing)

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What about heterogeneous consumers?

- Reality: consumers have different demand curves
- Problem: if F is too high, some consumers don't participate
- **Tradeoff:**
  - High F: extract more from high-value consumers, but lose low-value ones
  - Low F: serve more consumers, but extract less per consumer
- Optimal F balances these effects
- Often: $p > MC$ (to extract more from high-demand consumers through variable pricing)

Worked example: Two-part tariff with two types

- **Question:**
- Type H: demand $q_H = 10 - p$, 100 consumers
- Type L: demand $q_L = 5 - p$, 200 consumers
- $MC = 0$
- Compare: (a) $F = 50, p = 0$ vs (b) $F = 12.5, p = 0$

Take 3 minutes to solve this.

Worked example: Two-part tariff with two types (solution)

Solution

- **(a)** $F = 50, p = 0$**:**
  - Type H: $CS = \frac{1}{2}(10)(10) = 50 \geq F$ ✓ joins
  - Type L: $CS = \frac{1}{2}(5)(5) = 12.5 < F$ doesn't join
  - Profit $= 50 \times 100 = \$5,000$
- **(b)** $F = 12.5, p = 0$**:**
  - Type H: $CS = 50 \geq 12.5$ ✓ joins
  - Type L: $CS = 12.5 \geq 12.5$ ✓ joins
  - Profit $= 12.5 \times 300 = \$3,750$
- **Better to serve only H!** (in this case)

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The self-selection problem: why can't we just ask?

- **Why not ask consumers their WTP directly?**
- Everyone would claim to be a low-value buyer!
- **Information asymmetry:**
  - Consumers know their type
  - Firm does not
  - Consumers have incentive to misreport
- **Solution:** Design options so that revealing type is in consumers' interest

Self-selection: the idea

- **Problem:** Seller cannot directly observe consumer types
  - Can't tell who has high vs low willingness to pay
- **Solution:** Design a **menu** of options
  - Different options appeal to different types
  - Consumers "self-select" into revealing their type
- Also called: screening, menu design, second-degree price discrimination

Self-selection: versioning

- **Versioning:** Offer different "versions" of a product
  - High-quality version for high-value consumers
  - Low-quality version for low-value consumers
- **Examples:**
  - Airline tickets: business class vs economy
  - Software: Pro vs Basic editions
  - iPhone Pro vs iPhone
- **Damaged goods:** Sometimes firms deliberately reduce quality
  - Tesla: software-limited battery range
  - 19th century French rail: roofless third-class cars

The menu design problem: setup

- Two consumer types: H (high-value) and L (low-value)
- Two product versions: Full and Stripped-down
- Willingness to pay:

	Full	Stripped-down
Type H	v_H^F	v_H^S
Type L	v_L^F	v_L^S

- Assume: $v_H^F > v_L^F$ and $v_H^S > v_L^S$ (H values both more)
- Also: $v_H^F - v_H^S > v_L^F - v_L^S$ (H values upgrade more)

Consumer choice: self-selection

- Consumer surplus from each option:

$$CS_{\text{Full}} = v^F - p_F$$
$$CS_{\text{Stripped}} = v^S - p_S$$

- Each consumer chooses the option with highest CS
- (If both negative, consumer doesn't buy)

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Constraints on pricing

- **Incentive Compatibility (IC):** Each type prefers "their" option

$$\begin{aligned} \mathrm{IC}_H: &\quad v_H^F - p_F \geq v_H^S - p_S \\ \mathrm{IC}_L: &\quad v_L^S - p_S \geq v_L^F - p_F \end{aligned}$$

- **Individual Rationality (IR):** Each type is willing to participate

$$\begin{aligned} \mathrm{IR}_H: &\quad v_H^F - p_F \geq 0 \\ \mathrm{IR}_L: &\quad v_L^S - p_S \geq 0 \end{aligned}$$

- Also called: participation constraints

Key insight: which constraints bind?

- In the optimal menu:
  - IC_H binds: H is just indifferent between Full and Stripped
  - IR_L binds: L gets zero surplus from Stripped
- **Intuition:**
  - Extract all surplus from L (low type has no "outside option")
  - H gets some surplus (to prevent them from mimicking L)
- This is called: "no distortion at the top"

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Worked example: Airline pricing

- **Question:**
- Business travelers (B): WTP \$800 for flexible, \$400 for restricted
- Leisure travelers (L): WTP \$300 for flexible, \$250 for restricted
- 100 of each type. $MC = 100$ for both ticket types.
- Design the optimal menu (prices for flexible and restricted).

Take 4 minutes to solve this.

Worked example: Airline pricing (solution)

Solution

- **Step 1:** Set IR_L to bind: $p_R = 250$ (L gets zero surplus)
- **Step 2:** Set IC_B to bind:

$$
\begin{aligned}
800 - p_F &= 400 - 250 \\
p_F &= 800 - 150 = 650
\end{aligned}
$$

- **Check L doesn't want flexible:** $300 - 650 = -350 < 0$ ✓
- **Profit:**

$$\pi = (650 - 100) \times 100 + (250 - 100) \times 100 = 55,000 + 15,000 = 70,000$$

- B gets rent of \$150 (to prevent mimicking L)

Worked example: Versioning

- Two product versions. $MC = 300$ for both.
- 1 million type H consumers; 2 million type L consumers
- Willingness to pay:

	Full	Stripped
Type H	1500	800
Type L	600	500

- **Questions:**
- (a) Profit from selling only Full at $p_F = 1500$?
- (b) Profit from $p_F = 1500$, $p_S = 500$?
- (c) Profit from $p_F = 1200$, $p_S = 500$?

Take 5 minutes to solve this.

Worked example: Versioning (solution part a)

Solution

- **(a) Only Full at $p_F = 1500$:**
  - Type H: $CS = 1500 - 1500 = 0 \geq 0$ ✓ (buys)
  - Type L: $CS = 600 - 1500 = -900 < 0$ (doesn't buy)
- Only H buys
- Profit $= (1500 - 300) \times 1\text{M} = \$1.2\text{B}$

Worked example: Versioning (solution part b)

Solution

- **(b)** $p_F = 1500$**,** $p_S = 500$**:**
- Type H:
  - $CS_F = 1500 - 1500 = 0$
  - $CS_S = 800 - 500 = 300 \leftarrow$ **higher!**
- Type H buys Stripped! (IC violated)
- Type L: $CS_S = 500 - 500 = 0$ (buys Stripped)
- Everyone buys Stripped
- Profit $= (500 - 300) \times 3\text{M} = \$600\text{M}$
- **Worse than (a)!** The

Worked example: Versioning (solution part c)

Solution

- **(c)** $p_F = 1200$, $p_S = 500$**:**
- Type H:
  - $CS_F = 1500 - 1200 = 300$
  - $CS_S = 800 - 500 = 300$
- H is indifferent $\rightarrow$ buys Full (IC binds!)
- Type L: $CS_F = 600 - 1200 = -600$, $CS_S = 500 - 500 = 0$
- L buys Stripped (IR binds!)
- Profit $= (1200 - 300) \times 1\text{M} + (500 - 300) \times 2\text{M} = \$1.3\text{B}$
- **Best of the three!**

Lessons from the example

- The optimal menu satisfies:
  1. IC for H binds: H just willing to buy Full over Stripped
  2. IR for L binds: L gets exactly zero surplus
- H gets "information rent" (surplus of 300)
  - This is the cost of preventing H from mimicking L
- Price gap $p_F - p_S$ must be $\leq v_H^F - v_H^S$ (otherwise H switches)

Why “damaged goods”?

- Sometimes the low-quality version costs *more* to produce!
- Example: Tesla battery-limited car
  - Same car, same battery, just software restriction
  - **Why?** To prevent high-value buyers from choosing the cheap option
- By making the low-quality version less attractive to H types, the firm can:
  - Charge more for the high-quality version
  - Still serve the low-value market

Classic example: Intel 486 processor

- Intel 486DX: full-featured processor
- Intel 486SX: same chip, but with math coprocessor **disabled**
- 486SX costs **more** to produce (extra step to disable!)
- **Why?**
  - Creates price discrimination without observable characteristics
  - Business users (need math) pay more for 486DX
  - Home users (don't need math) self-select into 486SX
- Same logic as Tesla battery restrictions today

iPhone storage: versioning in action

- iPhone comes in 128GB, 256GB, 512GB versions
- Cost difference to Apple: maybe $20-30
- Price difference to consumers: $100-200
- **Why such large price gaps?**
  - High-value users (professionals, photographers) need more storage
  - They're willing to pay much more
  - Low-value users self-select into smaller storage
- This is versioning through product attributes

Self-selection: cookbook summary

1. Compute consumer surplus for each type, for each option:

$$CS = WTP - price$$

2. For each type, find the option with highest CS
3. Check that CS ≥ 0 (otherwise they don't buy)
4. Compute profit given consumer choices
5. To find optimal prices: set IC for H and IR for L to bind

Summary: When does each type of price discrimination apply?

Type	**Key requirement**	**Examples**
Selection by indicators	Observable characteristic	Students, seniors, geographic regions
Two-part tariffs	Can charge fixed + variable	Gym, Costco, phone plans
Self-selection (versioning)	Can offer different versions	Airline classes, software editions

- All require: **market power** and **inability to resell**

Connection to demand estimation

- Demand estimation gives us **elasticities by consumer type**
- This directly informs pricing strategy:
  - **Selection by indicators:** Different prices for observable groups
  - **Versioning:** Design features that appeal differently to types
- **Example:** If demand estimation shows:
  - Business travelers inelastic, value flexibility
  - Leisure travelers elastic, value low price
- $\Rightarrow$ Offer flexible tickets at high price, restricted at low price

Preparing for the midterm

- **Topics covered so far:**
  1. Demand estimation: logit, Berry inversion, elasticities, IVs
  2. Consumer surplus: log-sum formula
  3. Price discrimination: selection by indicators, two-part tariffs, self-selection
- **Key skills:**
  - Compute elasticities from logit model
  - Apply Lerner index to find optimal prices
  - Set up and solve menu design problems with IC/IR constraints
- Next lecture: Review session with practice problems

Key Points

1. **Two-part tariff:** $F + p \times q$ (fixed fee + per-unit price)
2. **Optimal (homogeneous):** Set $p = MC$, $F = CS$ at that price
3. Two-part tariffs increase efficiency but reduce consumer surplus to zero
4. **Self-selection:** Design menu so types reveal themselves
5. **IC constraint:** Each type prefers "their" option
6. **IR constraint:** Each type willing to participate (CS ≥ 0)
7. Optimal menu: IC binds for high type, IR binds for low type
8. High type gets "information rent"; low type gets zero surplus

Next time

- **Lecture 6:** Review for Midterm
  - Demand estimation: logit, Berry inversion, IVs
  - Pricing: monopoly, price discrimination, two-part tariffs
  - Practice problems
- **HW1 due before Lecture 6**