Demand and Pricing for Telecom Services with Network and Price Effects

Q3) How does Apple manage to continuously increase the price of iPhones over the years?

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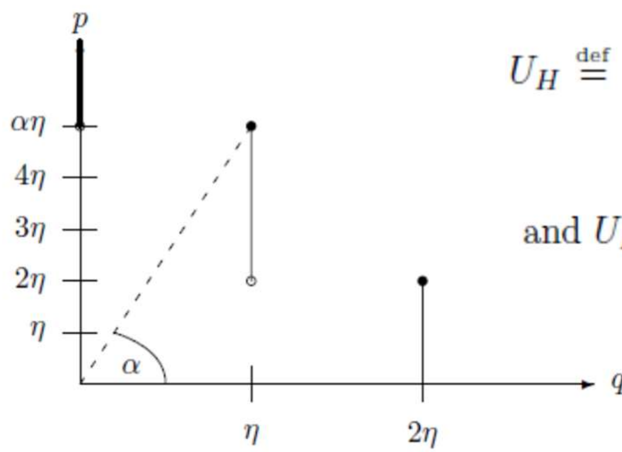
Kinked Demand Curves and Critical Mass

- Monopoly Service Provider
- Utility as a function of the network size and price
  - H: η number of High Value Subscribers
  - L: η number of Low Value Subscribers
  - α > 4

Groups of users behave similarly



$$U_H \stackrel{\text{def}}{=} \begin{cases} \alpha q - p & \text{connected} \\ 0 & \text{disconnected} \end{cases}$$

$$\text{and } U_L \stackrel{\text{def}}{=} \begin{cases} q - p & \text{connected} \\ 0 & \text{disconnected,} \end{cases} \tag{5.1}$$

Price Ranges

Low-price range $(0 \leq p < 2\eta)$: At this range, the quantity demanded is unique at the level of 2η consumers. To see this we need to show that both types of consumers gain a nonnegative utility. That is, $U_H = \alpha(2\eta) - p > 0$ and that $U_L = 2\eta - p > 0$, which follow directly from (5.1).

Medium-price range $(2\eta < p \leq \alpha\eta)$: At this range the consumer equilibrium involves only the type H consumers, whereas the type L are better off not buying. Suppose that $q = \eta$; then $U_H = \alpha\eta - p > 0$. However, even if all type L consumers also subscribe, $U_L = 2\eta - p < 0$, hence $q = \eta$ constitutes a consumer equilibrium at this price range.

High-price range $(p > \alpha\eta)$: In this range no one subscribes since $U_H = \alpha\eta - p < 0$ and $U_L = 2\eta - p < 0$.

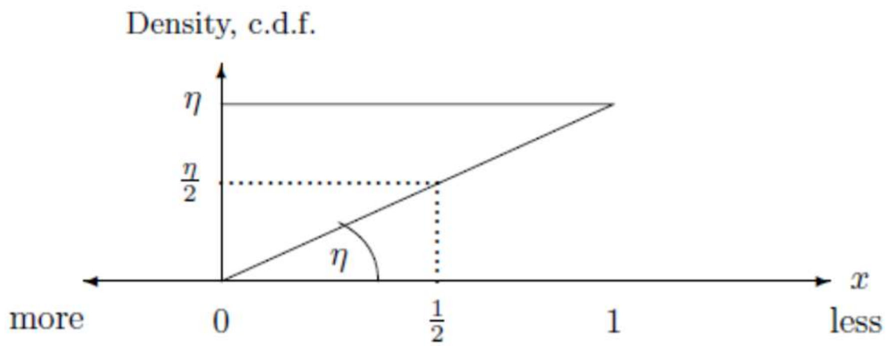
Social Welfare

$$
\begin{aligned}
W &\stackrel{\text{def}}{=} \eta U_H + \eta U_L + \pi && (5.5)\\
&= \begin{cases} \eta(\alpha\eta - p) + \eta 0 + \eta(p-\mu) - \phi & H \text{ connect} \\ \eta(\alpha 2\eta - p) + \eta(2\eta - p) + 2\eta(p-\mu) - \phi & \text{All connect} \end{cases} \\
&= \begin{cases} \alpha\eta^2 - \eta\mu - \phi & \text{Only } H \text{ connect} \\ 2\eta^2(\alpha+1) - 2\eta\mu - \phi & \text{All connect.} \end{cases}
\end{aligned}
$$

Problem

- No. of High-value customers: 200
- No. of low-value customers: 400
- Utility function of high-value customers: 5q-p
- Utility function of high-value customers: q-p
- Derive the kinked demand curve
- What is the net utility of each type of customers
- What is the profit (assuming cost of zero) for service providers
- What is the Social Welfare?

Demand for Telecom Services: Calculus Analysis

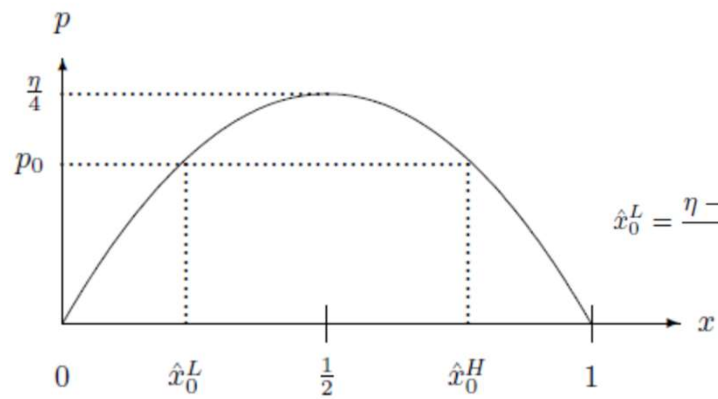


$$U_x = \begin{cases} (1-x)q^e - p & \text{if she subscribes} \\ 0 & \text{if she does not subscribe,} \end{cases}$$

$$0 = (1-\hat{x})q^e - p, \quad \text{or} \quad \hat{x} = \frac{q^e - p}{q^e}$$

$$p = (1-\hat{x})\eta\hat{x}$$

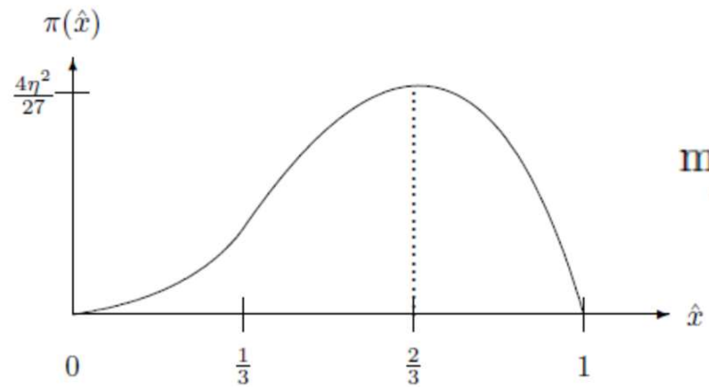
Demand for Telecom Services



$$\hat{x}_0^L = \frac{\eta - \sqrt{\eta(\eta - 4p_0)}}{2\eta} \quad \text{and} \quad \hat{x}_0^H = \frac{\eta + \sqrt{\eta(\eta - 4p_0)}}{2\eta}.$$

- Low levels: High-valuation customers subscribe to network
  - Smaller network size
  - Network effect dominates the price effect (inverse of typical downward sloping demand curve)
- High levels: Low-valuation customers also subscribe
  - Larger network size
  - Price effect dominates the network effect (downward sloping demand curve)

Profit Maximizing Monopoly



$$\max_{\hat{x}} \pi(\hat{x}) \stackrel{\text{def}}{=} p\eta\hat{x} = (1-\hat{x})(\eta\hat{x})^2.$$

- **A monopoly phone company maximizes its profit by setting its connection fee so that the number of customers exceeds half of the consumer population but is less than the entire population.**

Connection cost case

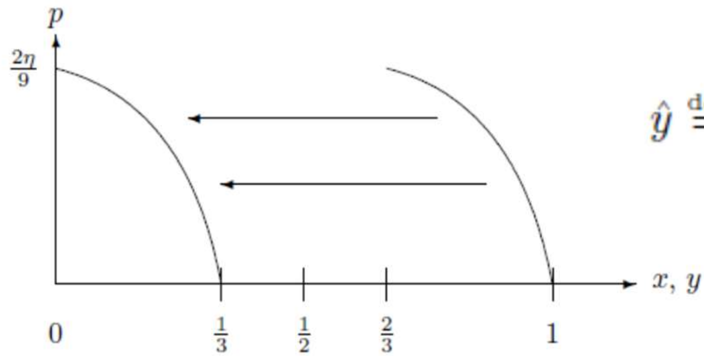
$$\max_{\hat{x}} \pi(\hat{x}) \stackrel{\text{def}}{=} (p-\mu)\eta\hat{x} - \phi = [(1-\hat{x})(\eta\hat{x}) - \mu]\,\eta\hat{x} - \phi,$$

$$\hat{x} = \frac{\eta + \sqrt{\eta(\eta - 3\mu)}}{3\eta}.$$

Invitations to Enter

- **Realization of network externalities by a monopoly requires a high output**
  - **Monopolist may be unable to commit to higher output**
- **May license the technology to a number of firms and invites them to enter and compete**
- **Competition Effect vs. Network Effect**
  - **Competitive effect: Expected increase in competition because of the increase in number of firms**
  - **Network Effect: Increases willingness to pay**
- **Invite when network effect > competitive effect**

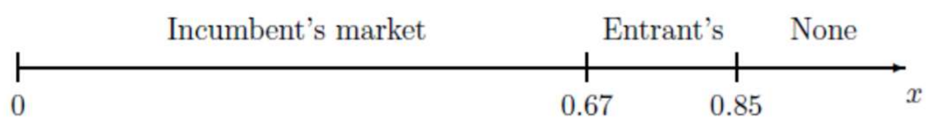
Second Entrant case



$$\hat{y} \stackrel{\text{def}}{=} \hat{x} - \frac{2}{3} = \frac{\eta + \sqrt{\eta(\eta - 4p_0)}}{2\eta} - \frac{2}{3}.$$

$$p = \frac{\eta(2 - 3\hat{y} - 9\hat{y}^2)}{9}, \quad \text{hence} \quad \pi = \frac{\eta(2 - 3\hat{y} - 9\hat{y}^2)}{9}\eta\hat{y}.$$

$$\hat{y} = \frac{\sqrt{7} - 1}{9} \approx 0.182, \quad p = \frac{\eta(23 - \sqrt{7})}{81} \approx 0.128, \quad \pi = \eta^2 \frac{14\sqrt{7} - 20}{729}. \tag{5.20}$$



Entry of New Service Providers

- **Entry into the telecommunication industry increases the utility of old and newly connected consumers, as well as the profit of the entering firm.**
    - **The proposition follows from the fact that old users gain because of the increase in the network size; new users gain because they are connected to this service; and the entering firm makes above normal profit.**

How does Apple manage to continuously increase the price of iPhones over the years?
What is the pricing strategy behind iPhone 7, iPhone 7 Plus, iPhone X

Leveraging Network Effect of one product in another

- Initially, there are profits to be made in both markets.
- But subsidizing market one with a free good can increase demand and profits in market two more than the loss in market one.