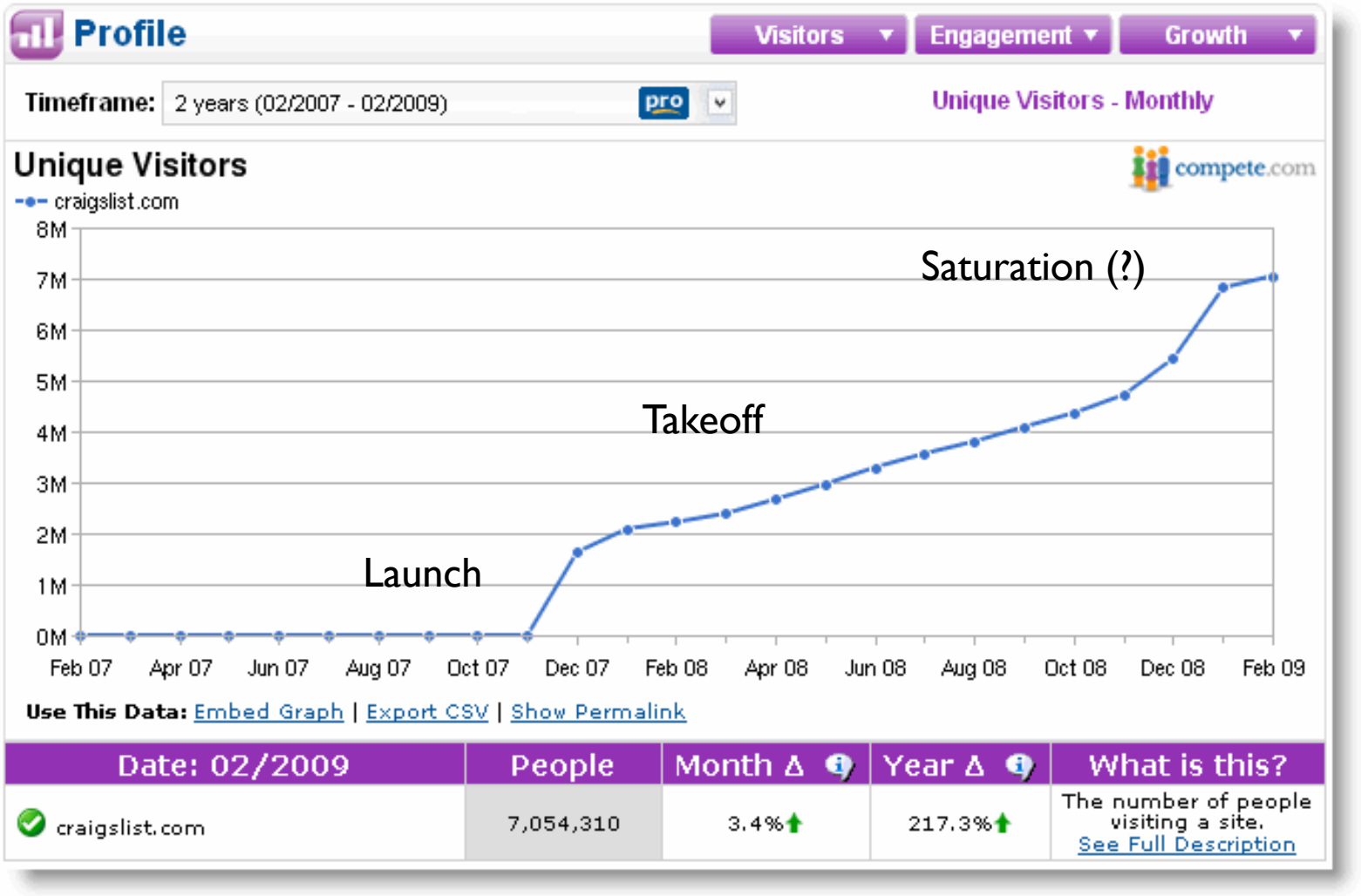
The Information Economy

Network Effects

Network Effects

- Network
  - Set of interconnected nodes
  - Real network (faxes) and virtual networks (Word users)
- Network effect (or network externality)
  - A's value depends on number of other users (and identity)
  - Positive network effects: email, videoconferencing
  - Negative network effects: congestion
- Scale economies
  - Network effects = demand-side scale economies
  - Different from supply-side scale economies (i.e. falling MC)
- Consider the following examples:
  - Electric cars, Gchat, Gmail.

Growth of a Network



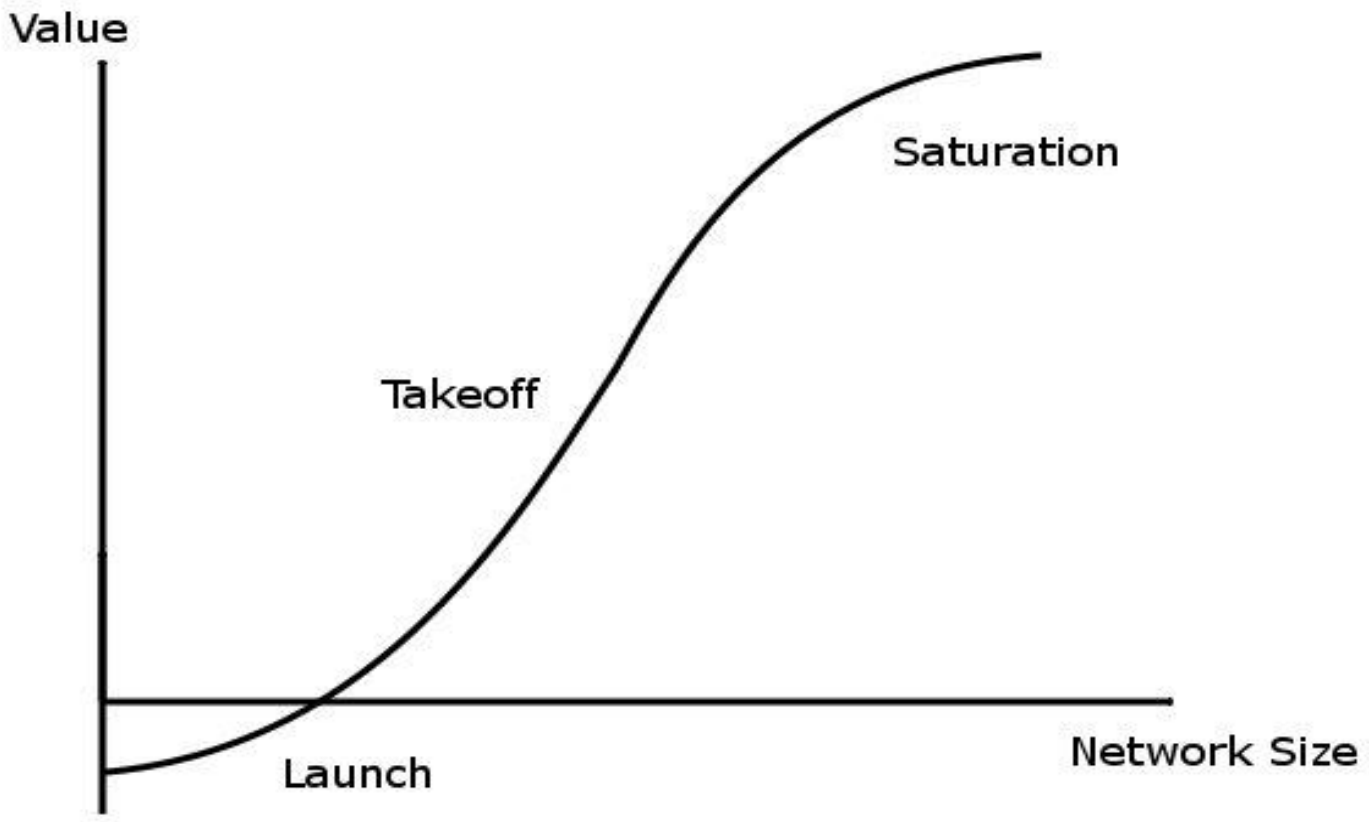
Demand Side

Strength of Network Effects

- How does V(N) vary? (Probably S-shaped)
  - Metcalfe's law: V(N)=k(N-1)
  - At start, growth may be quicker: care if friends are linked
  - Satiation if care about some links more than others
  - Continual growth if network becomes standard
- Demand for variety within network
  - Homebuying (MLS listings) vs. mortgage quotes (lending tree)
  - Examples: Mobility (credit cards), Novelty (DVDs)
- Demand for variety across networks
  - Standardization leads to loss of variety.
  - Example: People buy different cars despite network effects.
- Interconnection between users (Word vs. LaTeX)

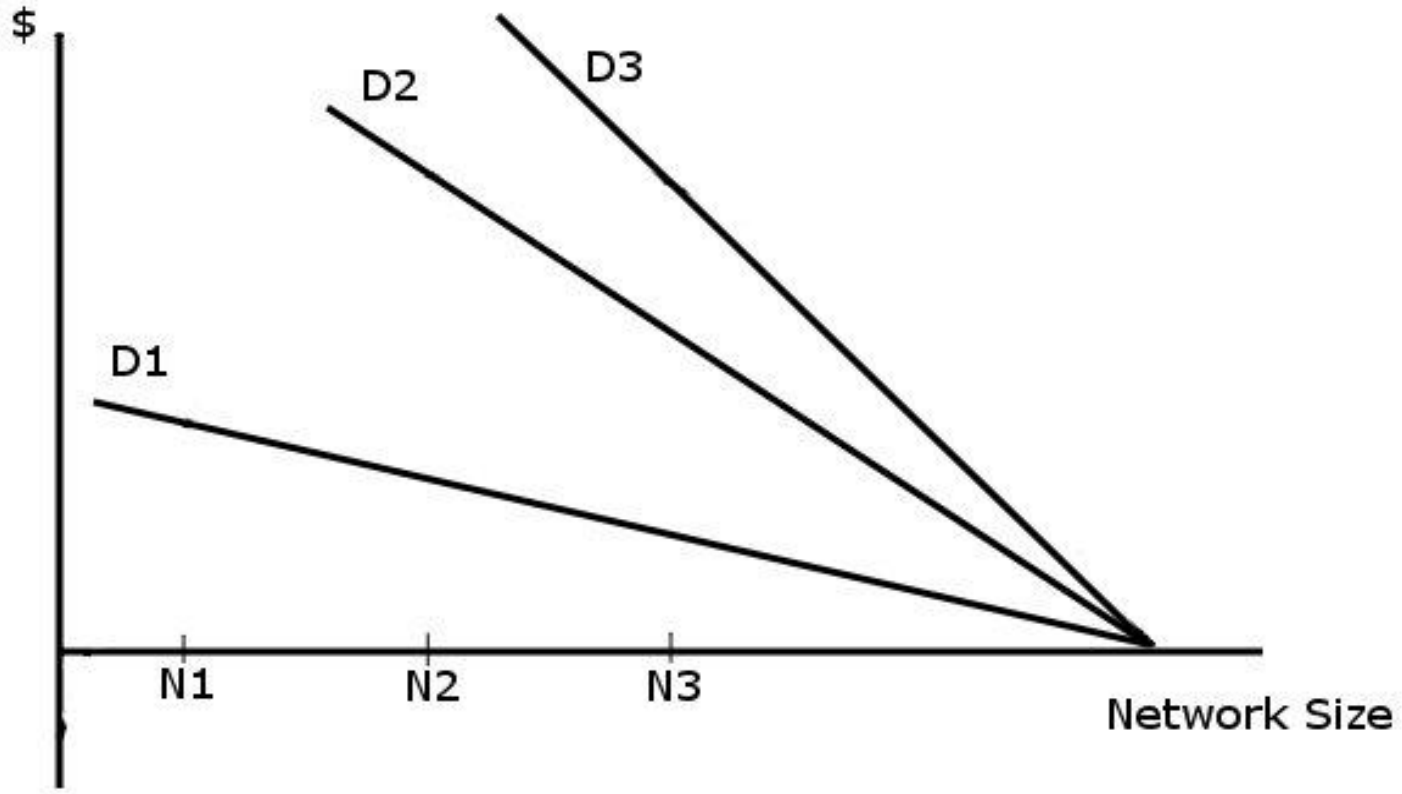
Agent's Values

- An agent's value rises as the network size grows



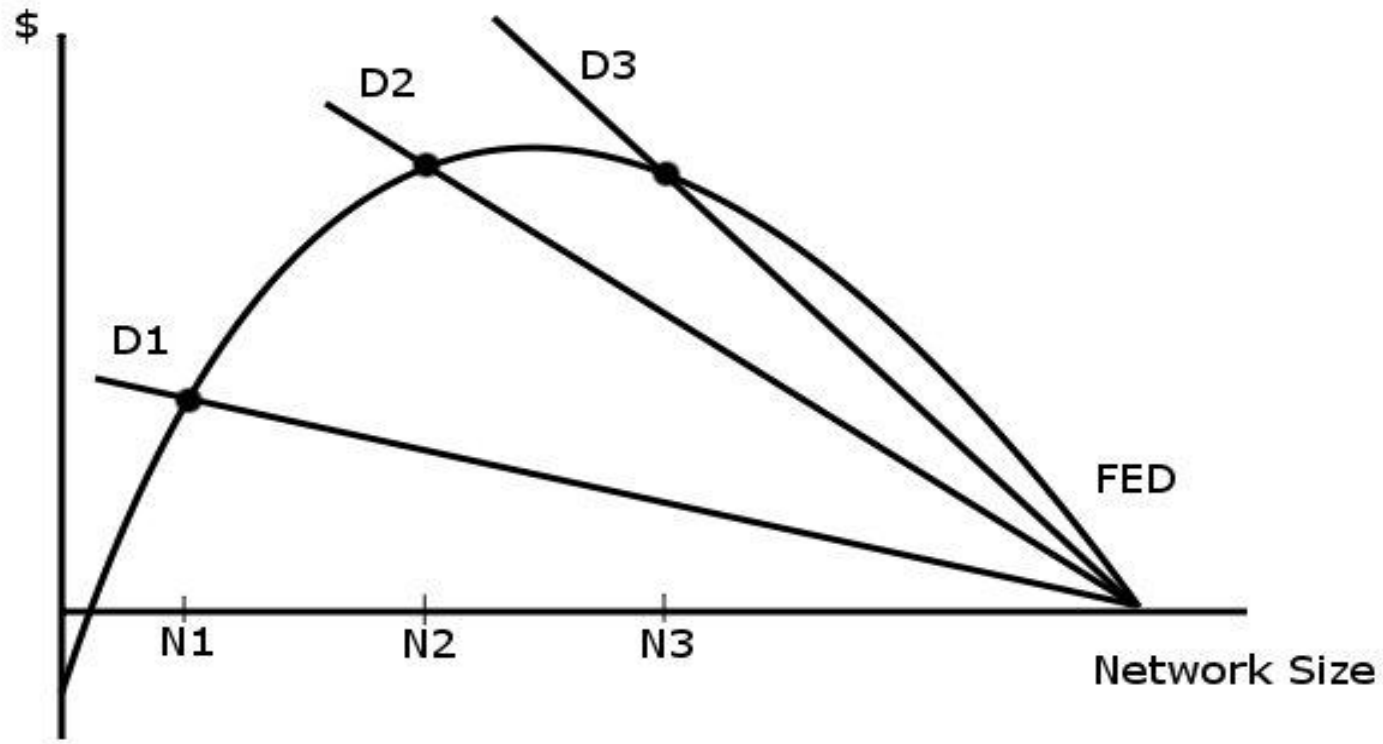
Demand Curves

- Demand curves corresponding to three network sizes



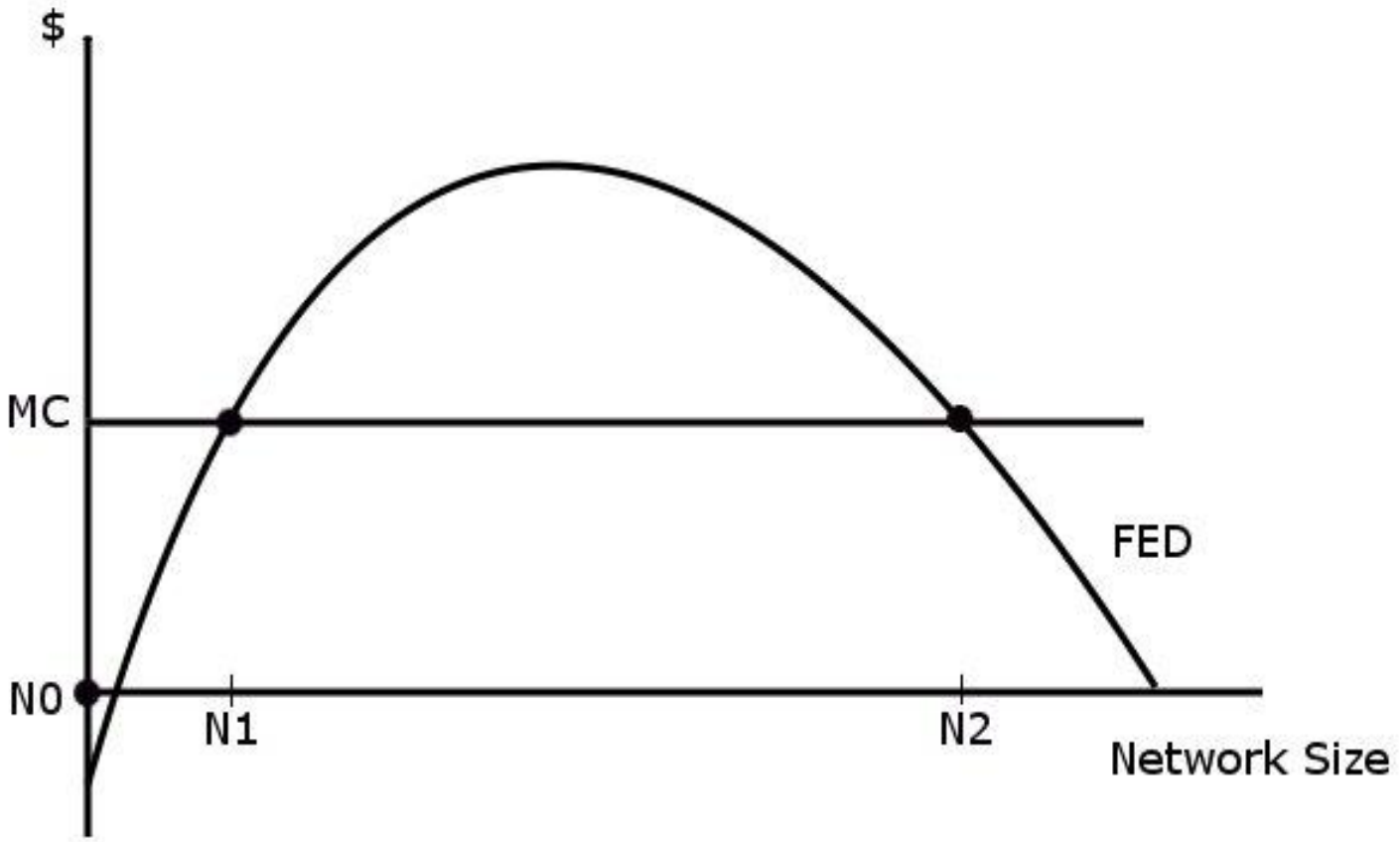
Fulfilled Expectations Demand Curve

- Values where expected demand equals realized demand
  - Intercept negative – positive homing cost, e.g. training, capital.



Perfect Competition (e.g. email, faxes)

- Marginal cost pricing yields three equilibria: N0, N1, N2.

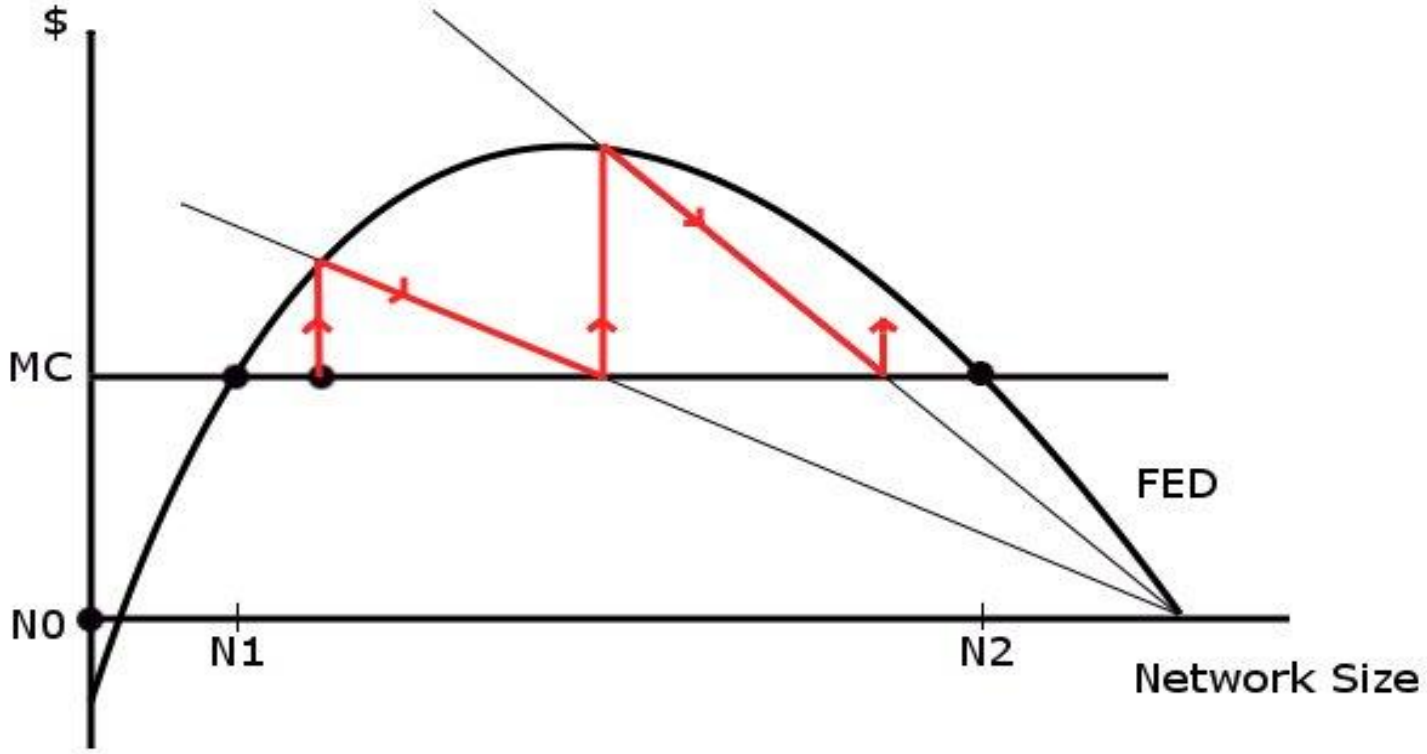


Role of Expectations

- Expectations are crucial
  - Homing cost and P>0 mean don't want to buy if N low.
  - Care about current base and expected future base.
  - Product will succeed if it is expected to succeed!
- Penguin problem
  - Consumer faces uncertainty about technology and future N.
  - No-one wants to adopt first.

Role of Expectations

- Equilibrium N1 is unstable (called "tipping point")
  - If start with N>N1, get virtuous cycle: N →N2.



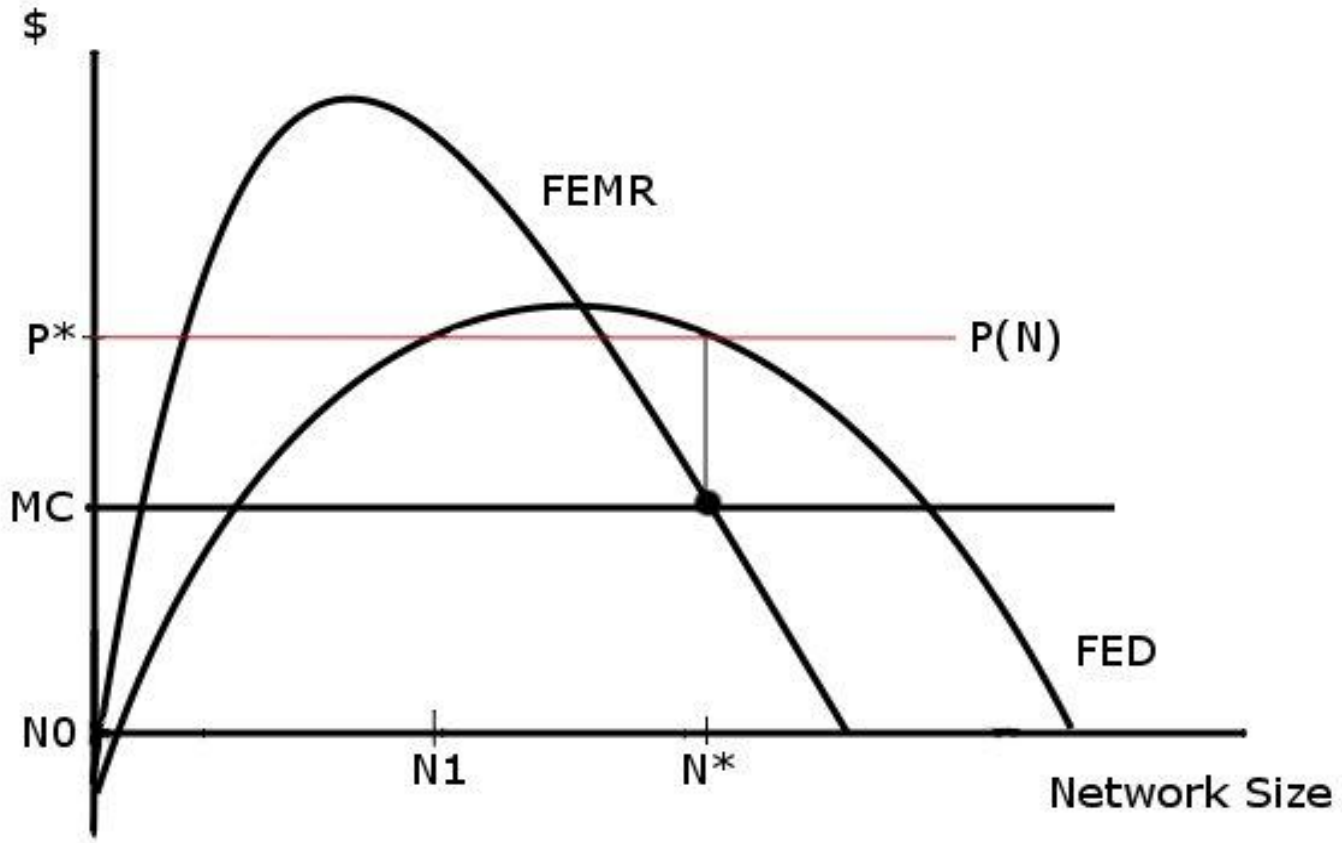
- Exercise: What happens if start with N<N1?

What to do about Expectations?

- Manage expectations directly
  - Product announcements (vaporware)
- Enable users to internalize externality
  - Encourage children to buy grandmother mobile phone.
- Give introductory discounts
  - Need network "sponsor" to have market power to overcome free-riding (unless all industry commits)
  - Risk of adverse selection (e.g. Xbox as DVD player)
- Have people sign contracts
  - "I'll adopt if at least N people do"
- Start with small networks (e.g. eHarmony)
  - Local vs. global network effects

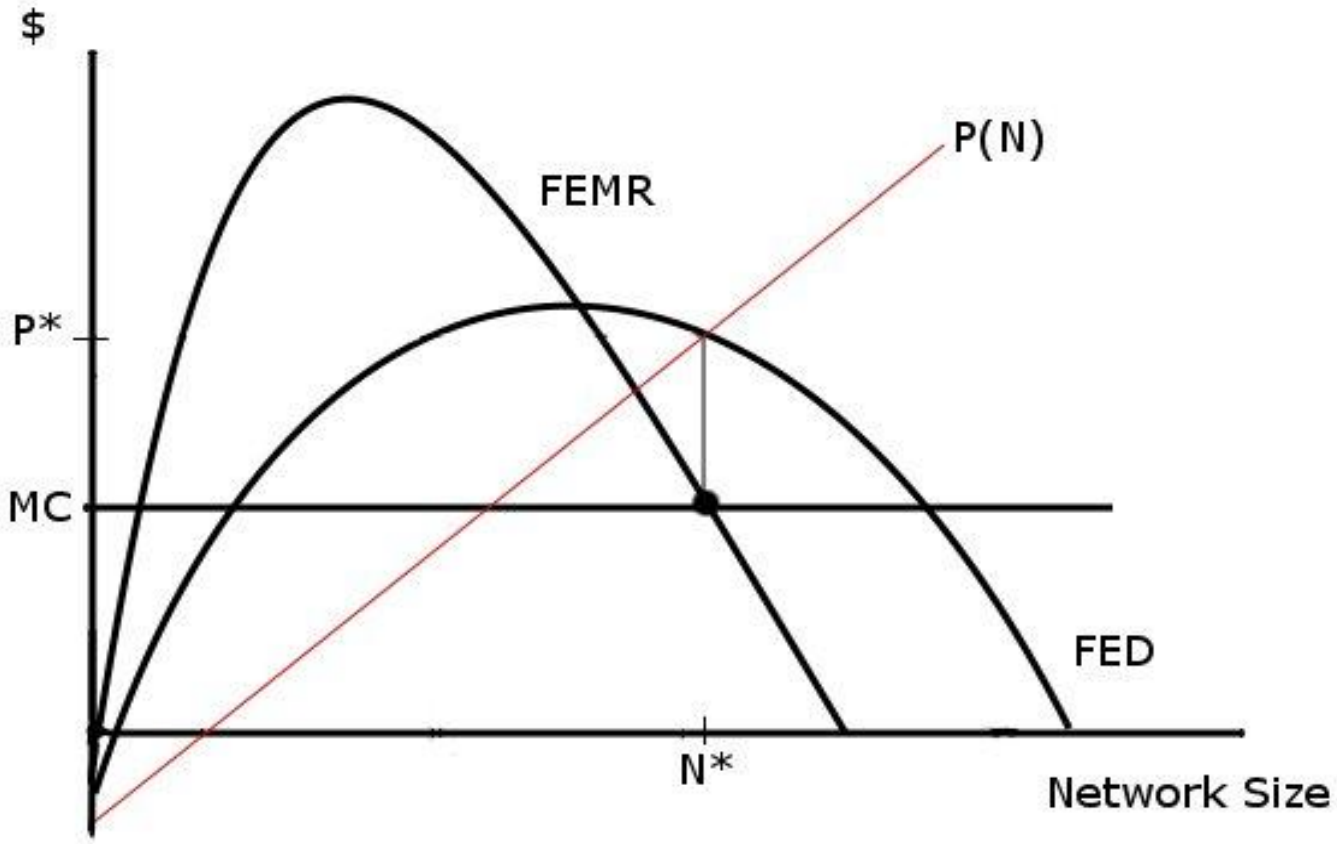
Monopoly Pricing (e.g. Word, eBay)

- At optimal quantity N*, MR=MC. Yields price P*.
  - But if charge price P*, there are three equilibria: N0, N1, N*



Monopoly: Unique Implementation

- By charging P(N) the firm can pick N* as only equilibrium
  - Analogous to introductory discounts for early adopters.



Monopoly Pricing: Formal Analysis

- Let n be market size, n^e be expected market size
  - Demand curve is $p(n;n^e)$.
  - Fulfilled expectations demand is $p(n;n)$, where $n=n^e$.
  - Cost $c(n)$
- Firm chooses n to maximize $\pi = np(n;n)-c(n)$.
  - Ignoring problem of multiple equilibria.
- The first order condition is

$$p(n;n)+n\frac{\partial p(n;n)}{\partial n}+n\frac{\partial p(n;n)}{\partial n^e}=\frac{\partial c(n)}{\partial n}$$

  - First and second terms – standard marginal revenue.
  - Third term – network effect, i.e. how increasing 'n' increases value of marginal user. Like an increase in marginal revenue.

How to Launch: Facebook

- Started at Harvard in February 2004
  - Built on existing social networks (75% of Harvard within month)
  - Easy to find friends (using course register)
  - Can invite friends (internalizing externalities)
  - Used influential people (Phoenix club)
- Expansion
  - Expanded through Universities (use existing social structure)
  - Surrounded holdout University to conquer (network effect)
- Ultimately successful because
  - Innovative (news feed, photos, Inbox, applications)
  - Privacy controls (people share more information)
  - Reliable

Two Technologies

- We have so far considered one technology
  - Two stable equilibria: N0 and N2
- If two technologies, A and B, there are three equilibria
  - A becomes dominant
  - B becomes dominant
  - Neither become dominant
- Multiple technologies might make "neither" more likely
  - Customers don't know who will win, and so wait.
  - Examples: AM stereo radio, Satellite radio, Cell phone standards

Strategy

Collective Switching Costs

- Network effects act like collective switching costs
  - Small switching costs are magnified.
- Entrant comes into industry (e.g. Gchat)
  - Need people to switch in coordinated way.
  - Problem where there are positive homing costs.
- Example: QWERTY vs. Dvorak
  - Dvorak is better layout – typing is quicker.
  - Costly to train on new system.
  - Typing interface has network effects.
- Sometimes new format work; sometimes not
  - Examples: CDs, DAT, DCC, Minidisc.

Compatibility Choices

- Backwards compatible – new technology reads old input
  - Word 07 reads .doc files
  - PS3 plays PS2 games
- Forwards compatible – old technology reads new input
  - Word 2003 converter for .docx files
  - But cannot save .docx files.
- Tradeoffs
  - Compatibility may cause loss of performance
  - Compatibility increases network effects
  - Lack of compatibility can force people to upgrade because of network effects

Closed Systems: Standards Wars

- Winner takes all competition? (e.g. Electricity, VCR)
  - Is multi-homing possible?
  - Strength of network effects
  - Demand for variety across networks.
- Pre-emption
  - First-mover advantage
  - Penetration pricing
  - Win over influential customers (early adopters)
- Expectations management
  - Vaporware – MS operating system, Apple devices
  - Make claims about network size, e.g. "world's largest"
- Vibrant market for complements

Example: Penetration Pricing

- Suppose N_1 early adopters and N_2 late adopters
  - All consumers have value v(N) from network size N
  - Ignore coordination problem among users
- Stage 2: Firm W has N_1 customers, L has none.
  - Equilibrium prices: $p_W = v(N_1+N_2)-v(N_2)$ and $p_L=0$.
  - Profits: $\pi_W=N_2\,[v(N_1+N_2)-v(N_2)]$, $\pi_L=0$.
- Stage 1: Neither customer has any customers.
  - Both firms lower prices until winner's profit=0
  - That is, $\pi = p_1 N_1+\pi_W=0$. This yields:

$$p_1 = -\frac{N_1}{N_2}[v(N_1+N_2)-v(N_2)]$$

Open vs. Closed

- Closed – system proprietary
  - Examples: iPhone, Betamax, IM, Mac, Windows
  - Competing for market
- Open – interface/specifications open to others
  - Examples: Android, VHS, email, PC, UNIX
  - Can be set by private firm (e.g. IBM and VGA) or by standard setting committee (e.g. ITU and telecoms)
  - Competing within market
- Compatibility decision may be one-sided or two-sided
  - Two-sided: Need permission of both parties.
  - One-sided: One sided can use adapter (e.g. WP open .doc files)
- Partial compatibility
  - MS and Netscape cooperated on secure transactions.

Why use Open?

- Is Open system crazy?
  - Potential for cut-throat competition after takes off (e.g. IBM)
  - Give IP away – make entry easier; lose competitive advantage.
- Advantages of Open
  - Increase network size and probability of takeoff (e.g. IBM)
  - Avoid market confusion (AM Stereo, Cell phone standards)
  - Customers avoid lock-in, which again helps takeoff
  - Harness creativity of other firms
- Making money from Open
  - Sell complements such as service (e.g. MySQL and Sun)
  - Sell enhancements (e.g. pdf and Adobe)
- Prefer open if weak (e.g. Netscape, T-Mobile)

Standard Setting

- Standards set by committees:
  - Examples: Safety standards (UL) or Telecoms (IYU)
  - Government (NIST) of Industry (IEEE)
- Establishing a standard
  - Pools patents and overcomes coordination problems
  - Forces firms in pool to charge "fair" prices
  - Commitment to be open
- But
  - Process lengthy
  - Process may fail (e.g. DVD "read" agreed before DVD "write")
  - Incentive to stay out of patent pool
  - Give up right to charge license fees