Information Gatekeepers on the Internet and the Competitiveness of Homogenous Product Markets

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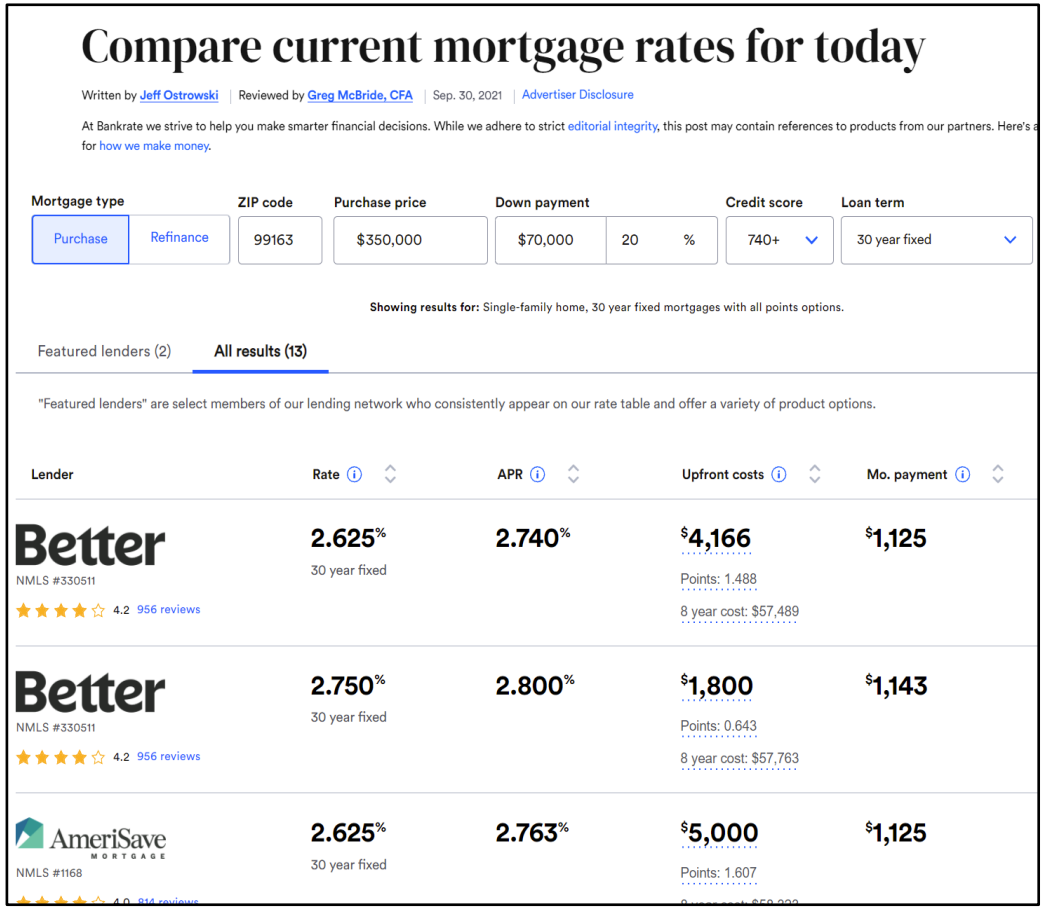
Background

- Today there is access to information with a click of a button which helps consumers find the best deal.
- There are sites that list prices charged by different firms, such as mortgagequotes.com now known as bankrate.com for mortgages.
- In information markets, the gatekeepers or owners of the site receive most of their revenue from advertisements.



Source: Screenshot from https://www.bankrate.com/

- While consumers have this access to price information, price dispersion still exists in equilibrium.

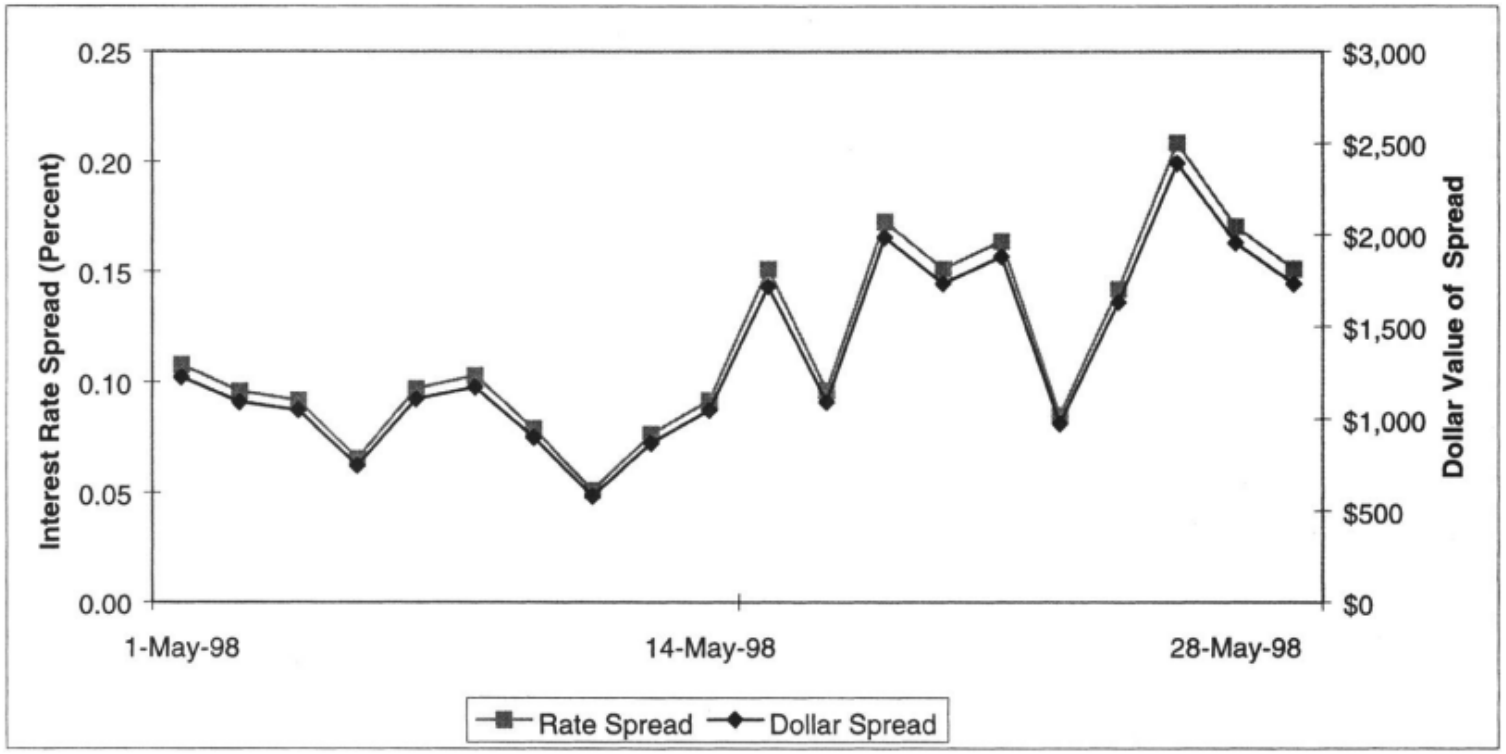


FIGURE 1. AVERAGE SPREAD IN THE DISTRIBUTION OF MORTGAGE RATES, 50 U.S. STATES AND THE DISTRICT OF COLUMBIA, MAY 1998.

Source: Computed from data obtained at *www.mortgagequotes.com.*

Questions

- Does a profit-maximizing gatekeeper have an incentive to maximize consumer and firm participation in the market for information?
- Can price dispersion in the product market persist when all consumers have access to a list of firm prices?
- How much will a monopoly gatekeeper charge subscribers and advertisers, and are these fees socially optimal?
- Does the establishment of a market for information enhance social welfare?

Relation to Existing Literature

- **Salop and Stiglitz 1977, Shilony 1977, and Varian 1980** looked at advertising and price competition in homogenous product markets where all firms advertise on central clearinghouse like a newspaper (exogenous) and consumers may look at advertisements with a subscription (endogenous).

- **Butters 1977, Grossman and Shapiro 1984, Stegeman 1991, etc…** looked at the situation where firms advertise by targeting consumers by direct-mail ads (endogenous) and consumers may look at them (exogenous).

  - **Baye and Morgan** blend the literature at hand in this paper and assume firms advertise on the information site (endogenous), consumers may look at advertisements with a subscription (endogenous), and the site gate-keepers set fees for all parties (endogenous).

I. The Model

- There is continuum of consumers and each has a demand of q(p).
- There are n local firms with identical products and each area has one firm that serves an equivalent share of consumers.

- In absence of information site, consumers buy at their local firm at r

$$\pi(r) = \frac{(r-c)*q(r)}{n}$$

p ϵ [c,r], where p is local price of product

c ≥ 0, where c is marginal cost

r ϵ [c, ∞]is monopoly price of product

- In presence of information site, consumers can buy from any firm at p

$$\pi(p) = \frac{(p-c)*q(p)}{n}$$

- Consumer surplus at price p,

$$S(p) \equiv \int_p^\infty q(t)dt \text{ so } S(r) > \varepsilon$$

ε >0, where ε is cost for consumer to visit store

- The gatekeeper announces fees so consumers and firms must decide if they will participate of not in the information site
  - $\phi \geq 0$, where ϕ is advertising fee paid by firms
  - κ ≥ 0, where κ is subscription fee paid by consumers

II. Consumer Shopping Decisions

- **Proposition 1 (P1):** In any shopping subgame that is reached in equilibrium, the behavior of subscribers and nonsubscribers is as follows:
  - (i) Nonsubscribing consumers visit and purchase from their local firms
  - (ii) Subscribing consumers (a) first visit the gatekeeper's site and (b) purchase at the lowest price available there. (c) If no prices are listed, subscribing consumers visit and purchase from their local firm.

III. Firm Pricing and Advertising Decisions

→*Now we let firms optimally choose whether to advertise to the information site or not, based on P1.*

- **Proposition 2 (P2):** A firm that does not advertise its price on the gatekeeper's site charges the monopoly price.

- **Proposition 3 (P3):** Suppose the gatekeeper sets an advertising fee ϕ, a fraction μ > 0 of consumers subscribe to the gatekeeper's site, and firms optimally determine their advertising and pricing decisions. Then in a symmetric Nash equilibrium,

  - (i) Each firm advertises its price with probability

$$\alpha^*(\mu, \phi) = \max(0,\ 1\ - \left(\frac{n\phi}{(n-1)\mu\pi(r)}\right)^{1/(n-1)})$$

- **P3:** continued
  - (ii) When a firm advertises, its distribution of advertised prices is given by the c.d.f.

$$F^*(p;\ \mu,\phi) = \frac{1}{\alpha^*}\ (1\ -\left(\frac{(1-\alpha^*)^{n-1}\mu\pi(r)+ n\phi+(1-\mu)(\pi(r)-\pi(p))}{n\mu\pi(p)}\right)^{1/(n-1)}\ )$$

defined on $[p_0, r]$, where $p_0 = \pi^{-1}\left(\frac{n^2\left(\frac{\phi}{n-1}\right)+(1-\mu)\pi(r)}{(n-1)\mu+1}\right)$

  - (iii) With probability $(1-\alpha^*)$, a firm does not advertise and sets its price at r. Each firm earns profits of

$$E\pi_i^* = \begin{cases} \dfrac{\phi}{(n-1)} + \dfrac{(1-\mu)}{n}\pi(r) & if\phi < \dfrac{(n-1)}{n}\mu\pi(r) \\ \dfrac{\pi(r)}{n} & otherwise \end{cases}$$

IV. Consumer Subscription Decisions

→*Now we let consumers optimally choose whether to subscribe to the information site or not, based on P3.*

- **Proposition 4 (P4):** Suppose the gatekeeper sets advertising and subscription fees $\phi \in \left[0, \frac{(n-1)}{n}\pi(r)\right]$, $\kappa \in [0, \kappa^*(\phi) = \beta(\phi, \mu = 1)]$, and firms and consumers act optimally. Then only the following types of symmetric equilibria may arise:

  - (a) *Inactive Market for Information*:

    For each $\phi \in \left[0, \frac{(n-1)}{n}\pi(r)\right)$ and $\kappa \in [0, \kappa^*(\phi)]$, there exists an equilibrium in which no consumers subscribe ($\mu^* = 0$) and

    firms do not advertise ($\alpha^* = 0$). In this equilibrium, all firms charge the monopoly price r, and each firm earns expected profits of $\frac{\pi(r)}{n}$.

- **P4:** continued

  - (b) *Active Market for Information with Partial Consumer Participation:*

    For each $\phi \epsilon \left(0, \frac{(n-1)}{n}\pi(\mathrm{r})\right)$and $\kappa \epsilon(0, \kappa^*(\phi))$, there exists an equilibrium in which a fraction $\mu^* \epsilon \left(\frac{n\phi}{(n-1)\pi(r)}, 1\right)$ of consumers subscribe, μ^* solves $\beta(\phi, \mu^*) = \kappa$.

    Each firm advertises with probability $\alpha^* = 1 - \left(\frac{n\phi}{(n-1)\mu^*\pi(r)}\right)^{1/(n-1)}$, and the advertised price is drawn at random from the cdf $F^*(p\colon \mu^*, \phi)$ defined in Proposition 3. Firms that do not advertise charge monopoly price r, and each firm earns expected profits of $\frac{\phi}{(n-1)} + \frac{(1-\mu^*)}{n}\pi(r)$.

- **P4:** continued

  - (c) *Active Market for Information with Full Consumer Participation:*

    For each $\phi \in \left[0, \frac{(n-1)}{n}\pi(r)\right]$ and $\kappa \in [0, \kappa^*(\phi)]$ there exists an equilibrium in which all consumers subscribe $(\mu^* = 1)$.

    Each firm advertises with probability $\alpha^* = 1 - \left(\frac{n\phi}{(n-1)\mu^*\pi(r)}\right)^{1/(n-1)}$, and the advertised price is drawn at random from the cdf $F^*(p: 1, \phi)$ defined in Proposition 3. Firms that do not advertise charge monopoly price r, and each firm earns expected profits of $\frac{\phi}{(n-1)}$.

V. Gatekeeper Fee-Setting Decisions

→*Now we let advertising and subscription fees be endogenous.*

- **Proposition 5 (P5):** Suppose the gatekeeper can select any $(\phi, \kappa)\ \epsilon\ \left[0, \frac{(n-1)}{n}\pi(r)\right] * [0, \kappa^*(\phi)]$, participants in the product market behave optimally, and K is sufficient small. Then the symmetric equilibrium that maximizes the gatekeeper's payoff entails:

  - (a) Full consumer participation in the market for information $(\mu^* = 1)$;

  - (b) Firm behavior in accordance with P3;

- **P5:** continued

  - (c) An advertising fee

$$\phi^* = argmax_{\phi\epsilon[0,\frac{(n-1)\pi(r)}{n}]} \{ S(p_0(\phi)) - S(r) + \varepsilon(1-(1-\alpha(\phi))^n + n\alpha(\phi)\phi - \int_{(p_0(\phi)}^{r} ((1-\alpha(\phi)F^*(p;1,\phi))^n + \alpha(\phi)F^*(p;1,\phi)q(p)dp \}$$

  - (d) A subscription fee

$$\kappa^*(\phi^*) = \{S(p_0(\phi^*)) - S(r) + \varepsilon(1-(1-\alpha(\phi^*))^n - \int_{(p_0(\phi^*)}^{r} ((1-\alpha(\phi^*)F^*(p;1,\phi^*))^n + \alpha(\phi^*)F^*(p;1,\phi^*)q(p)dp \}$$

TABLE 1—COMPARATIVE STATICS FOR UNIT AND LINEAR DEMAND

1.	$\Delta\phi^*/\Delta n$	$-$
2.	$\Delta\alpha^*/\Delta n$	$-$
3.	$\Delta n\alpha^*/\Delta n$	$+$
4.	$\Delta\kappa^*/\Delta n$	$+$
5.	$\Delta[n\alpha^*\phi^*/(n\alpha^*\phi^* + \kappa^*)]/\Delta n$	$-$

VI. Welfare Issues

→*We have seen that consumers and gatekeepers typically gain with an information site while firms lose. How do Information sites impact overall societal welfare? Is it worth it?*

- **Proposition 6 (P6):** Suppose frictions in the product market are negligible (ε is sufficiently small). In the equilibrium that maximizes a monopoly gatekeeper's expected profits, the fees charged for advertising and subscriptions exceed the socially optimal levels.

- **Proposition 7 (P7):**
  - (a) The establishment of a market for information increases (decreases) social welfare when

$$\mathrm{K} \;\leq (>)\; \left(1 - \left(\frac{n\phi^*}{(n-1)\pi(r)}\right)^{\frac{n}{n-1}}\right)\varepsilon \;+$$

$$\underbrace{\int_{(p_0}^{r} \{\big(S(p)+\pi(p)\big)n\alpha(1-\alpha F(p))^{n-1}f(p)dp + \big(S(r)+\pi(r)\big)((1-\alpha)^n - 1)\}}$$

Deadweight Loss $(\Delta) \geq 0$ i.e. creation of a market should reduce deadweight loss or equal 0

  - (b) A profit-maximizing monopoly gatekeeper may establish a market for information even though doing so reduces social welfare.

VII. Competing Gatekeepers

→We have seen gatekeepers tend to charge fees for both firms and consumers above socially optimal levels, but if there is competition would fees decrease?

- A simple look at competition between gatekeepers, shows that even if a new information site offered lower fees for firms, consumers, or both firms and consumers the cost of switching to a new site may be too large to consumers.
- If consumers don't switch to the new site, it will not be advantageous for firms to pay fees to advertise on the new site i.e. facebook versus orkut.
- Therefore, with the presence of network externalities, the equilibrium described in P5 remains valid under competition so fees for both firms and consumers would not decrease.

VIII. Conclusions

- Does a profit-maximizing gatekeeper have an incentive to maximize consumer and firm participation in the market for information?
    - From P5, the gatekeeper wants full consumer participation and some firm participation so some price dispersion exists for better profits.
- Can price dispersion in the product market persist when all consumers have access to a list of firm prices?
    - From P5, it does persist unless full firm participation takes place.

- How much will a monopoly gatekeeper charge subscribers and advertisers, and are these fees socially optimal?
    - Monopoly gatekeepers will charge subscribers and advertisers rates based on P5 and these fees tend to be above socially optimal by P7.
- Does the establishment of a market for information enhance social welfare?
    - By P7, it can enhance social welfare and it cannot.

Thank you

- Please feel free to ask questions or make comments.

Complementary Network Externalities and Technological Adoption

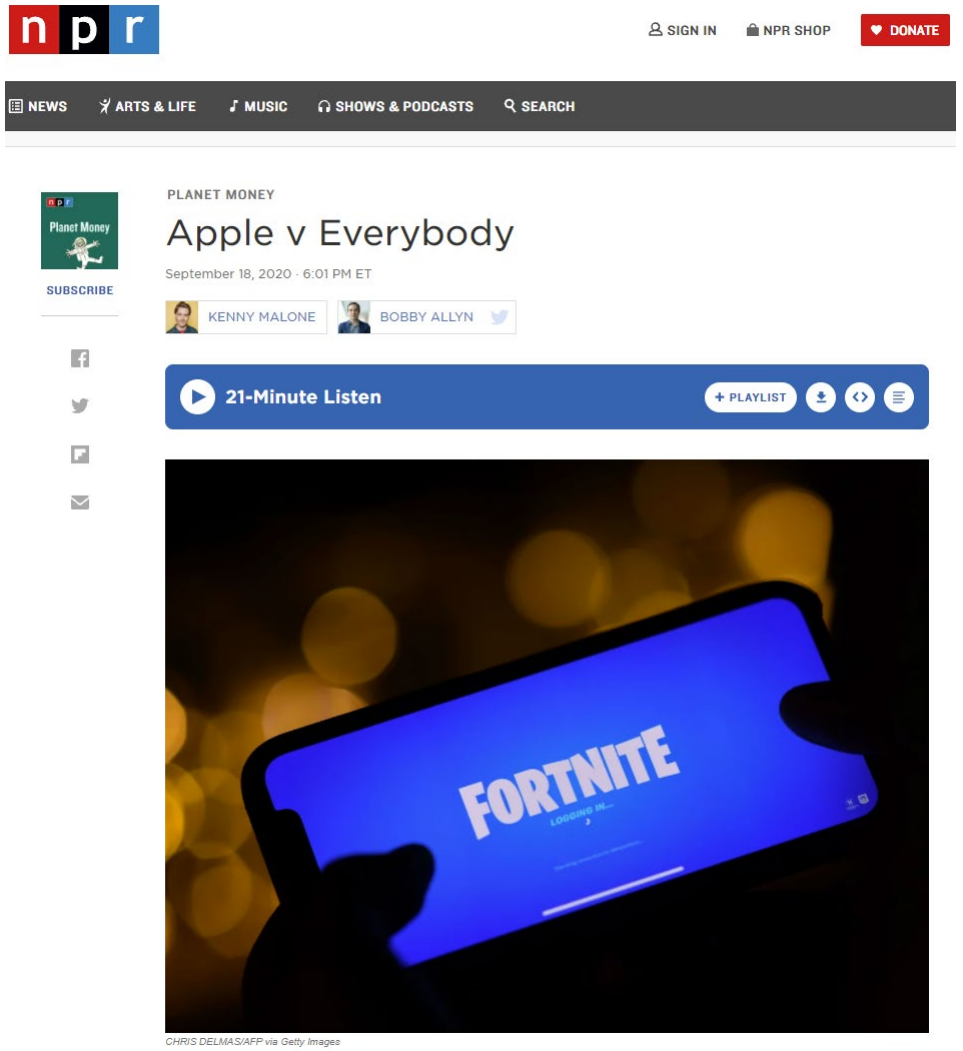
Author(s): Jeffrey Church and Neil Gandal

Source*: International Journal of Industrial Organization, 1993, pp 239-260
(*utilized 1991 working paper)

Presented by: Suhina Deol

I. Introduction

- Software availability is also a major driver of hardware success among consumers.
- Today, many i-Phone users are switching to other devices to play some of their favorite games such as Fortnite.
- In this paper, the authors explore networks of hardware and software products.



Source: Screenshot from https://www.npr.org/

- To model complementary networks of hardware and software products, let the networks be described by three features:
  - (1) The absence of vertical integration due to market structure.
  - (2) Software production has development costs which are large comparative to marginal production costs. This can influence the technological adoption.
  - (3) Consumer preferences are modelled with a CES utility function. A consumer chooses between two competing hardware systems (h=A or B) based on software availability (i), price of software (p_i^h), and price of hardware (p_h). Note that a software product is not compatible with more than one hardware and consumers value all available products equally in terms of functionality.

Questions

- Which technology does the market adopt?
- Does the nature of competition in the software industry affect which technology the market adopts?
- Is the technology adopted socially optimal?
- If the market pattern of adoption is inefficient, what kind of contractual arrangements between hardware and software firms internalize the network externality and redress the inefficient adoption pattern.

Relation to Existing Literature

- **Farrell and Saloner (1985, 1986a, 1986b)** looked at demand side coordination problems associated with direct network externalities.

- **Katz and Shapiro (1985, 1986a, 1986b)** explored the behavior of oligopolistic producers in a single network with direct network externalities.

  - **Church and Gandal** are concerned with indirect network externalities and look at multiple networks.

II. Consumer Preferences

- To minimize expenditure on buying a hardware product, we have

$$L = \sum_{i=1}^{N} p_i^h \, x_i + q_h(\bar{u} - (\sum_{i=1}^{N} x_i^{\frac{1}{\beta}})^{\beta})$$

p_i^h is price of software variety i on network h

x_i is the amount of software good i consumed

ß is consumer's preference for variety and ß >1 so network benefit function is concave

q_h is magnitude of network externality or shadow price of utility

$\bar{u}$ is fixed utility level

- We get the following system of demand equations from the Lagrangian, where y is expenditure, p_h is price of a h unit, and N_h is number of software varieties,

$$x_i\left[p_i^h, p_h, q_h\right] = \frac{(y-p_h){q_h}^{1/(\beta-1)}}{(p_i^h)^{\beta/(\beta-1)}}, \forall\, i$$

$$q_h\left(p_1^h, p_2^h, \ldots, p_N^h\right) = \left(\sum_{i=1}^{N} (p_i^h)^{-1/(\beta-1)}\right)^{(1-\beta)},$$

$$\text{if } p_i^h = p_j^h = p^h \text{ then } q_h = \frac{p^h}{N_h^{\beta-1}}$$

and then get the indirect utility function

$$V(p_h, q_h) = \frac{(y-p_h)}{q_h}, \text{if } p_i^h = p_j^h = p^h \text{ then } V(p_h, q_h) = \frac{(y-p_h)N_h^{\beta-1}}{p^h}$$

- As consumers play the adoption game, they will select the hardware system that gives them a higher expected surplus based on prices hardware firms set and have some expectations about q_h.

- So we have two Nash equilibria:

  1. All consumers adopt hardware h=A

  2. All consumers adopt hardware h=B

III. Production Technology

- To develop software, we have
  - F_h is the fixed cost and $F_A \neq F_B$
  - s is the constant marginal cost of production

  Fixed costs are much larger than marginal cost of production.

- To develop hardware, we have
  - c_h is the constant marginal cost of production

IV. The Software Industry

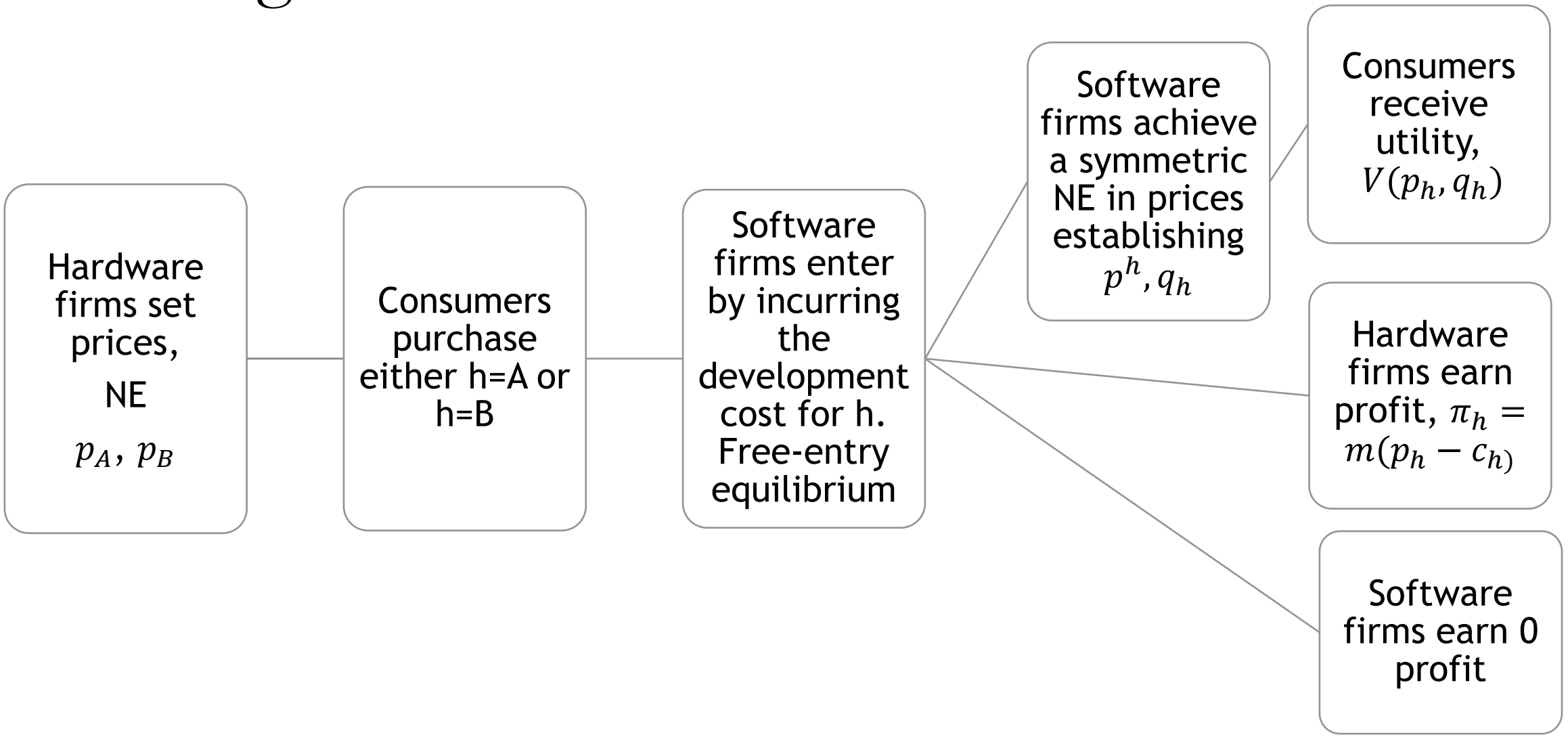
- Based on the adoption decision of hardware by consumers, software firms determine what software to develop.

- The equilibrium price will depend on the nature of competition. The number of software firms is determined endogenously by which technology is adopted.

- Software firms may be
  1. Bertrand competitors (B) or
  2. monopolistic competitors (M).

- The game, on the next slide, will be solved by backwards induction.

Timing and Structure of Model



- Under both types of competition, the authors solve for software prices, magnitude of network externality, net profits for a representative software firm, and free-entry number of firms.

- It is found that equilibrium software price for any number of firms, profits of representative software firm, and number of firms required to drive profits to zero for any hardware price are all higher under Bertrand competition than monopolistic competition.

- Regardless of nature of competition or which network is adopted, the following proposition must hold for a complementary network to exist.
  - **Proposition 1:** The welfare of a consumer on a network increases, ceteris paribus, as the aggregate number of consumers on the network increases.

V. The Market Pattern of Adoption

- To induce consumers to adopt their hardware-software, the hardware firm (h) will charge the lowest price c_h for its product which induces the maximum number of software firms to enter the market. This gives consumers the maximum surplus, $V[\widehat{q_h}, c_h] = \frac{(y-c_h)}{\widehat{q_h}}$.

- **Proposition 2:** The standard adopted by the market is the technology of firm A if

$$\frac{(y-c_A)}{\widehat{q_A}} > \frac{(y-c_B)}{\widehat{q_B}} .$$

  The technology supplied by firm B will always be adopted if

$$\frac{(y-c_A)}{\widehat{q_A}} < \frac{(y-c_B)}{\widehat{q_B}} .$$

- The adoption of technology looks at the tradeoff between the large fixed costs in software development and production cost of hardware.

- **Corollary 1:** Under conditions of Bertrand competition in the software industry, where m is the size of the consumer cohort, technology A is adopted in the market if:

$$F_A \left(\frac{(m(\beta-1)(y-c_A)+(1-\beta)F_A)}{\beta F_A}\right) * \left(\frac{(m(\beta-1)(y-c_A)+F_A)}{\beta F_A}\right)^{\beta-1} > F_B \left(\frac{(m(\beta-1)(y-c_B)+(1-\beta)F_B)}{\beta F_B}\right) * \left(\frac{(m(\beta-1)(y-c_B)+F_B)}{\beta F_B}\right)^{\beta-1}$$

Under conditions of monopolistic competition in the software industry, technology A is adopted in the market if:

$$(y - c_A) > \left(\frac{F_A}{F_B}\right)^{(\beta-1)/\beta} * (y - c_B)$$

VI. The Socially Optimal Adoption Pattern

- Let a social planner select hardware price, software price, and number of software varieties to maximize consumer surplus. The maximized surplus of the consumer cohort, m, if hardware h is optimally provided by the social planner is

$$V_h^s = \mathrm{m} * v_h * (N_h^s)^{\beta-1}$$

  v_h defines a continuum of optimal hardware prices and the corresponding optimal software price

  N_h^s is the number of software products the maximizes consumers utility

- **Proposition 3:** The adoption of technology A is socially preferred to the adoption of technology B if

$$(y - c_A) > \left(\frac{F_A}{F_B}\right)^{(\beta-1)/\beta} * (y - c_B)$$

VII. Comparison Between the Market Pattern of Adoption and the Socially Optimal Pattern of Adoption

- The optimality of market adoption depends on the nature of competition.
- **Proposition 4a:** If the competition in the software industry is monopolistic, the market pattern of adoption is optimal.
- **Proposition 4b:** If competition in the software industry is Bertrand, the technology which has the lowest fixed cost of software development is overadopted.

VIII. Hardware Subsidization of Software Development

- The authors no longer assume free-entry of software firms into the market and investigate the scenario where hardware firms contract with software firms which impacts conditions of market entry.

- When the software industry has monopolistic competition, the hardware firm can provide the greatest consumer surplus by allowing price to equal marginal cost.

- When the software industry has Bertrand competition, there are three types of contractual arrangements between hardware and software firms to consider.

- 1. A hardware firm may fund a subsidy that raises its price above marginal cost. It may do this may covering α percent of the fixed cost of software development for all software firms. The optimal subsidy is the one which maximizes technology surplus and it is found by maximizing the utility of the consumer subject to the budget constraint. However, the negative consequences of raising hardware price is greater than the positive impact of lowering software price and increase number of software firms.
  - This contractual arrangement would never be beneficial.

- 2. If there is a case where the hardware firm must provide some knowledge or component to the software firms to help them develop software, then the hardware firm can increase technology surplus by controlling terms of entry.
  - This contractual arrangement could be beneficial if an optimal licensing fee was set.

- 3. A hardware firm could increase the benefit of its merchandise by using re-sale price maintenance. In exchange for access to its technology, it could increase technology surplus by controlling terms of entry.
  - This contractual arrangement could be beneficial software firms were required to charge monopolistically competitive prices.

- **Proposition 5:** Subsidizing entry into the software industry decreases the surplus of a network. However, if the hardware firms are able to control access to the technology required to develop software, they can increase the surplus offered by a network by charging a licensing fee.

- **Proposition 6:** If hardware firms can stipulate the terms of entry to the software firms and they either charge the optimal license $\widehat{\alpha_h} F_h$ or they allow access on the condition that the software firms set their price at ßs, then the market pattern of adoption is efficient.

IX. Conclusion

- Which technology does the market adopt?
  - The technology which provides the greatest surplus to consumers.

- Does the nature of competition in the software industry affect which technology the market adopts?
  - Yes, if the competition in the software industry is monopolistic, the ratio of fixed costs of software development matters drives the decision.
  - If competition in the software industry is Bertrand, the focus is on the price of software which depends on number of software firms.

- Is the technology adopted socially optimal?
  - If the competition in the software industry is monopolistic, the market pattern of adoption is socially optimal.
  - If competition in the software industry is Bertrand, the technology which has the lowest fixed cost of software development is overadopted. The adoption pattern of the market is inefficient and not socially optimal.

- If the market pattern of adoption is inefficient, what kind of contractual arrangements between hardware and software firms internalize the network externality and redress the inefficient adoption pattern.
  - A re-sale price maintenance in the software market or the require of a license fee on software firms.

Thank you

- Please feel free to ask questions or make comments.