



Net Neutrality on the Internet: A Two-sided Market Analysis

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Network industries: two-sided pricing

- **Two-sided pricing:** network firms can set price(s) on either or both sides of a market
- Examples (vertically integrated):
 - Adobe Acrobat and Adobe Reader
 - Advertisers and users (in Internet search engines, Yellow Pages, newspapers)
 - Originating and terminating charges in (old) AT&T monopoly
 - Cantor Fitzgerald subsidized Salomon Brothers in secondary market for US Government bonds
- Examples (vertically disintegrated, components made by different companies):
 - Clients and servers
 - Operating systems and applications
 - Game platform/console and games (software)
 - Authors and readers in academic/scientific journals

Two-sided pricing in vertically disintegrated setups

- Who pays whom?
 - OSs subsidize applications
 - Game platforms collect royalties from games
 - In credit cards, issuers may pay users since they impose fees on merchants
 - The Visa and MasterCard networks have set a fixed percentage discount (price) between issuer and acquirer banks (price fixing?)
 - Newspapers could go from positive to zero price
 - In many academic journals readers pay, but opposite also possible (authors pay)
- Should we apply regulation? How?
 - When regulation is possible on both sides of the market
 - When regulation is possible on one side only
 - with cost-based pricing on the other side
 - with monopoly pricing on the other side
 - with duopoly pricing on the other side



Interview with Ed Whitacre

BusinessWeek November 7, 2005

- **How concerned are you about Internet upstarts like Google, MSN, Vonage, and others?**

“How do you think they're going to get to customers? Through a broadband pipe. Cable companies have them. We have them. Now **what they would like to do is use my pipes free, but I ain't going to let them do that** because we have spent this capital and we have to have a return on it. So there's going to have to be some mechanism for these people who use these pipes to pay for the portion they're using. Why should they be allowed to use my pipes?”

The Internet can't be free in that sense, because we and the cable companies have made an investment and for a Google or Yahoo! (YHOO) or Vonage or anybody to expect to use these pipes [for] free is nuts!”

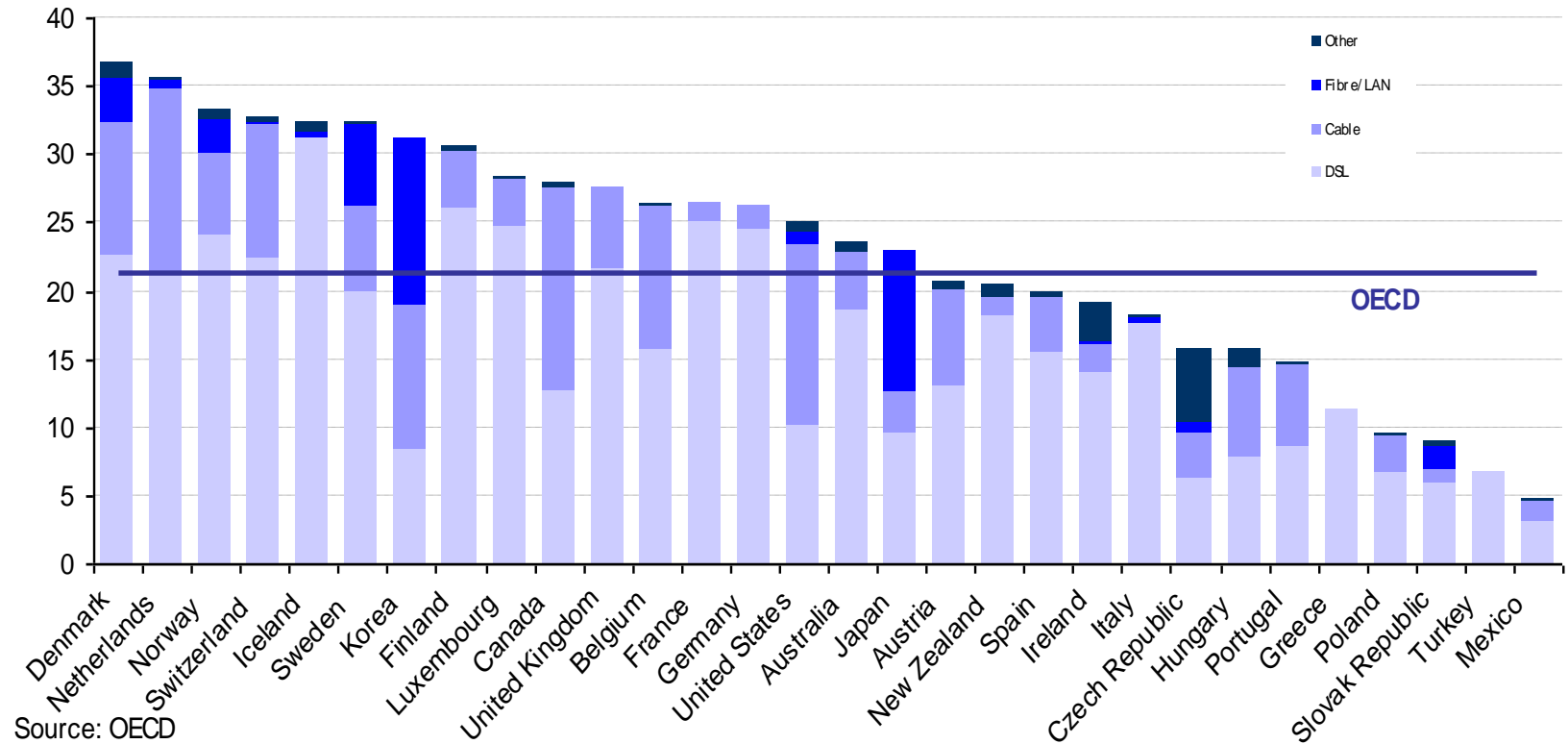


But both sides pay the transit on the Internet

- All hosts on the Internet pay according to bandwidth use: there is no “free lunch” on the Internet
- AT&T, Verizon, and others are paid by ISPs according to bandwidth use
- Actually Internet backbones are paid twice for any transmission, by the originator of traffic and by the terminator of traffic (through their respective ISPs)

US Lagging in Broadband

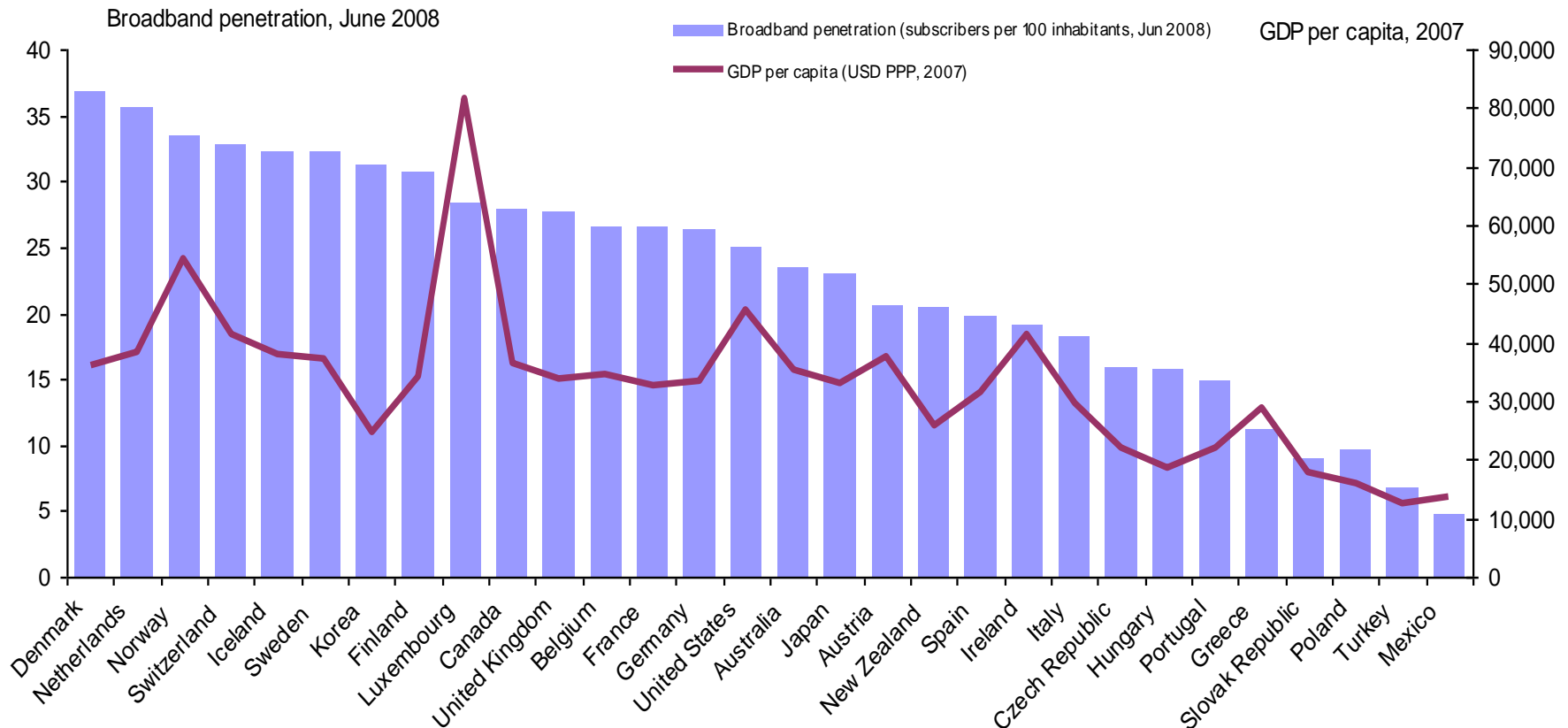
OECD Broadband subscribers per 100 inhabitants, by technology, June 2008



Source: OECD

US Lags Behind Poorer Countries

OECD broadband penetration and GDP per capita



Source : OECD



The Internet was based

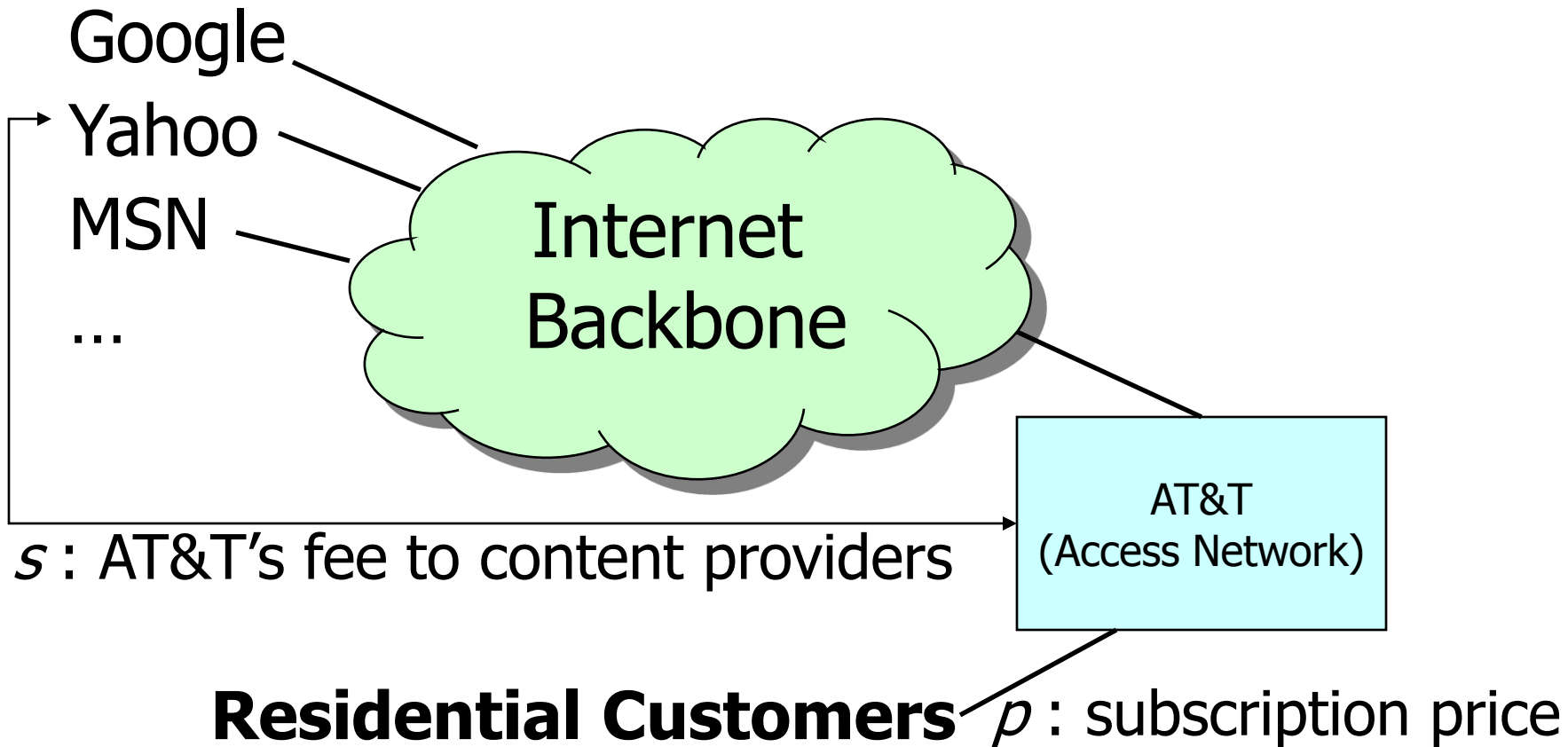
- on three basic separate levels of functions of the network:
 - (i) the hardware/electronics level of the physical network
 - (ii) the (logical) network level where basic communication and interoperability is established
 - (iii) the applications/ services level
- The Internet separates the network interoperability level from the applications/services level
- Unlike earlier centralized digital electronic communications networks, such as CompuServe, AT&T Mail, Prodigy, and early AOL, **the Internet allows a large variety of applications and services to be run “at the edge” of the network and not centrally**



So what does AT&T, Verizon and Cable TV companies want?

- Abolish the regime of “net neutrality”
- Set up a pricing schedule where, besides the basic service for transmission of bits, there will be additional charges by the broadband Internet access provider applied to the originating party (such as Google, Yahoo, or MSN).
- The new pricing model without net neutrality would be closer to the traditional pre-Internet telecommunications model where customers pay per service
- This would also be a very sharp departure from the way the Internet has been designed and run since its inception

Two-sided pricing in the absence of net neutrality





Varying Levels Of “Net Neutrality,” from Strictest to Weakest

Referring to pricing to the “other side” of the consumer market (that is to content and applications providers):

1. Absolute non-discrimination: no quality of service variations offered for money or for free
2. Varying quality of service offered according to type of info. packet but no fees are charged
3. Tiered service allowed but each tier is offered at the same price to all; no exclusivity or identity-based discrimination
4. Identity-based discrimination allowed
5. Exclusivity allowed



Six Consequences of Departure from Net Neutrality

1. Introduction on the Internet of *two-sided pricing* where a transmission company controlling some part of the Internet (here last mile access) will charge a fee to content or application firms “on other side” of the network
 - This paper’s main result: Starting to charge a positive price on the “other side” of the market is desirable to an access monopolist (or duopolists) but **not** desirable for society – more later in the presentation



Six Consequences of Departure from Net Neutrality

2. Introduction of prioritization which may enhance the arrival time of information packets that originate from paying content and application firms “on the other side,” and may also degrade the arrival time of information packets that originate from non-paying firms
 - The present plans of access providers are to create a “special lane” for the information packets of the paying firms while restricting the lane of the non-payers without expanding total capacity
 - By manipulating the size of the paying firms’ lane, the access provider can guarantee a difference in the arrival rates of packets originating from paying and non-paying firms, even if the actual improvement in arrival time for paying firms’ packets is not improved over net neutrality



Six Consequences of Departure from Net Neutrality

3. If the access providers choose to engage in “identity-based” discrimination, they can determine which one of the firms in an industry sector on the other side of the network, say in search, will get priority and therefore win
 - This can easily be done by announcing that prioritization will be offered to only one of the search firms, for example the one that bids the highest
 - Thus, the determination of the winner in search and other markets on the other side will be in hands of the access providers and not determined by innovative products or services on the other side
 - This can create very significant distortions since the surplus “on the other side” of the Internet is a large multiple of the combined telecom and cable TV revenue from residential Internet access



Six Consequences of Departure from Net Neutrality

4. New firms with small capitalization (or those innovative firms that have not yet achieved significant penetration and revenues) will very likely not be the winners of the prioritization auction

- This is likely to reduce innovation.
- Network externalities arise because a typical subscriber can reach more subscribers in a larger network
 - Under no net neutrality, access providers can limit the size and profitability of new firms on the “other side”



Six Consequences of Departure from Net Neutrality

5. The access networks can favor their own content and applications rather than those of independent firms
 - Examples: independent VOIP, video
 - This is likely to distort competition and reduce total surplus



Six Consequences of Departure from Net Neutrality

6. Since the Internet consists of a series of interconnected networks, any one of these, and not just the final consumer access ones, can, in principle, ask content and application providers for a fee
 - This can result in multiple fees charged on a single transmission and lead to a significant reduction of trade on the Internet



In this paper, we deal with the first issue by formally building a model of a two-sided market

- In terms of potential welfare reduction because of the six effects discussed above, we model the case that has the least reduction in total surplus compared with net neutrality
- Even though we make the best possible case for total surplus to increase when departing from net neutrality (by not focusing on factors two to six that are likely to reduce surplus), we find that typically total surplus decreases, both in monopoly and duopoly when we depart from net neutrality



Platform Monopoly: Consumers

A consumer's location (type) x_i indexes his/her preference for the Internet, so that consumers with a higher index place a lower value on the service

- Consumers pay a transportation cost t per unit of distance "traveled"
- Consumers are uniformly distributed according to their ideal points on the interval $[0,1]$ with the platform located at 0
- Consumer i 's utility is

$$u_i = v + bn_{cp} - tx_i - p$$

- v is the value of connecting to the Internet irrespective of content
- n_{cp} is the number of content providers
- b is the value a consumer places on an additional content provider
- p is the subscription price (assume linear prices)



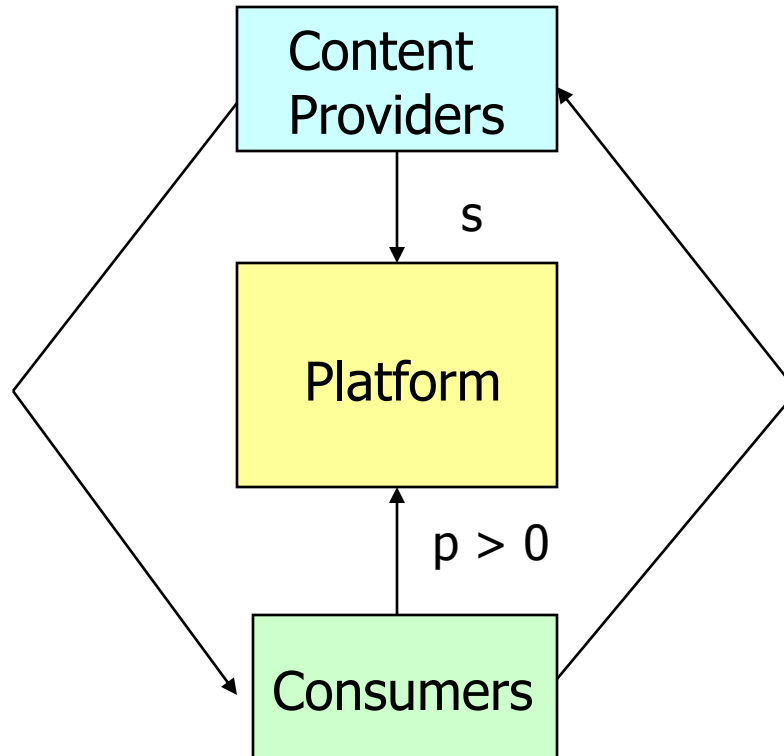
Platform Monopoly: Content Providers

- We make the simplifying assumption that content providers are independent monopolists, each in its own market, and therefore do not compete with each other
- Each content provider earns an_c from advertising where n_c is the number of consumers subscribing to the platform
- a is the value to a content provider of an additional consumer connected to the Internet
- Fixed cost of provider j is fy_j , with varying f
- Platform charges fee s to each content provider (linear prices)
- A content provider's profit is

$$\Pi_j = an_c - s - fy_j$$

Stylized Model

b = value
(network effect)
of extra content
provider to a
consumer



a = value
(network effect)
of extra
consumer to a
content provider



Demand and Provision of Content

- Given expected content n_{cp}^e , the marginal consumer is

$$x_i = n_c = \frac{v + bn_{cp}^e - p}{t}$$

- Given expected consumer demand n_c^e , the marginal (break-even) content firm is

$$y_i = n_{cp} = \frac{an_c^e - s}{f}$$

At fulfilled expectations, sales and content provision are

$$n_c(p, s) = \frac{f(v-p) - bs}{ft - ab} \quad \text{and} \quad n_{cp}(p, s) = \frac{a(v-p) - ts}{ft - ab}$$

- Platform monopoly maximizes

$$\Pi(p, s) = (p - c)n_c(p, s) + sn_{cp}(p, s)$$

- Maximizing wrt to p and s respectively gives

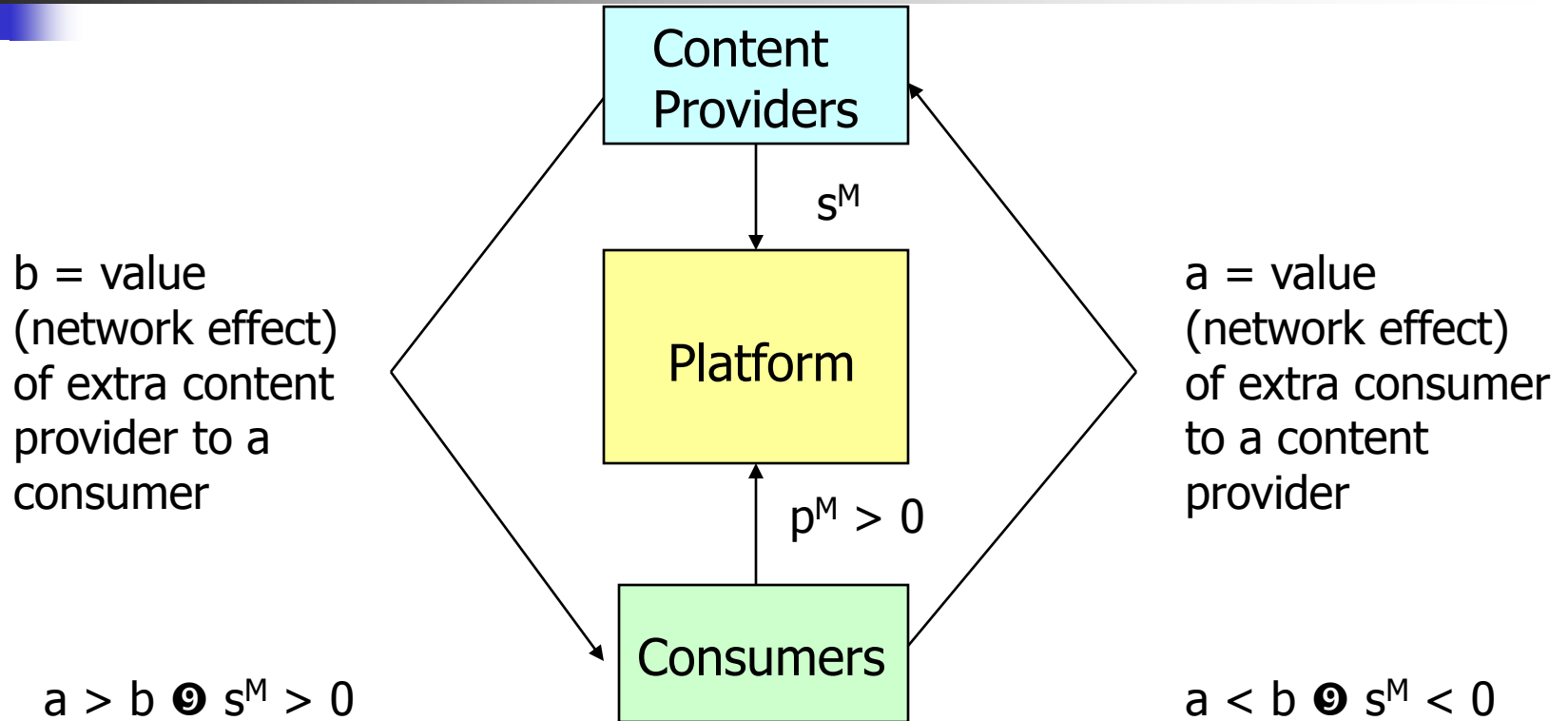
$$p(s) = \frac{f(v+c) - (a+b)s}{2f}, \quad s(p) = \frac{av + bc - (a+b)p}{2t}$$

- Unconstrained monopoly platform equilibrium prices

$$p^M = \frac{(2ft - ab)(v+c) - b^2c - a^2v}{4ft - (a+b)^2} \quad \text{and} \quad s^M = \frac{(a-b)f(v-c)}{4ft - (a+b)^2}$$

- $s^M > 0$ if $a > b$, i.e., when content providers value additional consumers more than consumers value additional content providers

Fee s^M to other side of the market



Internet consumers, access platform, and content providers
 Game platform consumers, game platform, and games

PC users, operating system, and applications
 Credit card issuing banks, credit card platform, and consumers



Net Neutrality

- Regulator imposes $s = 0$
- Platform maximizes

$$\Pi = (p - c)n_c$$

- Equilibrium subscription price

$$p^{NN} = \frac{v+c}{2}$$



Social Planner/Regulator Setting Two-sided Optimal Pricing

$$TS(p, s) = \Pi(p, s) + CS_c(p, s) + \Pi_{cp}(p, s)$$

$$CS_c(p, s) = \int_0^{n_c(p, s)} (v + bn_{cp}(p, s) - tx - p) dx$$

$$\Pi_{cp} = \int_0^{n_{cp}(p, s)} (an_c(p, s) - fy - s) dy,$$

Maximizing total surplus, the planner chooses below cost prices in both markets:

$$p^* = \frac{ftc - b(a+b)c - a(a+b)v}{ft - (a+b)^2} < c, \quad s^* = -\frac{bf(v-c)}{ft - (a+b)^2} < 0.$$



Regulator Chooses Optimal Pricing on One Side of the Market with Cost-based Pricing on the Other Side of the Market

- A total surplus maximizing planner/regulator in a two-sided market with network effects constrained to marginal cost pricing in the subscription market chooses below-cost pricing in the content market
 - The maximizer of $TS(c, s)$ is $s^{**} < 0$
- A total surplus maximizing planner/regulator in a two-sided market constrained to marginal cost pricing in the content market chooses below-cost pricing in the subscription market
 - The maximizer of $TS(p, 0)$ is $p^{**} < c$

Private and Social Incentives of Departing from Net Neutrality ($s = 0$) in the Presence of Monopoly Pricing $p(s)$ by the Platform

- The monopolist's incentive to increase the fee to content providers from zero to a small positive value is positive

$$\frac{d\Pi \Big|_{\frac{\partial \Pi}{\partial p}=0}}{ds} \Big|_{s=0} = \frac{d\Pi(p(s), s)}{ds} \Big|_{s=0} > 0$$

- The incentive of a planner to increase the fee to the content providers from zero to a small positive value taking into account that the monopolist chooses subscription price is negative

$$\frac{dTS \Big|_{\frac{\partial \Pi}{\partial p}=0}}{ds} \Big|_{s=0} = \frac{dTS(p(s), s)}{ds} \Big|_{s=0} < 0$$



Incentives to Marginally Change from Zero the Fees Charged to Content Providers

- Starting from the net neutrality regime of a zero fee to content providers, a platform monopolist choosing optimally his subscription price would like to marginally increase the fee to content providers above zero
- Starting from the net neutrality regime of a zero fee to content providers and facing a platform monopolist that chooses the subscription price, a total surplus maximizing planner/regulator will choose to marginally decrease the fee to content providers below zero



Optimal One-sided Regulation in the Presence of Monopoly on the Other Side of the Market

■ A regulator/planner setting a fee s to content providers expecting the platform monopolist to set his profit-maximizing subscription price $p(s)$ maximizes the constrained total surplus function

$$TS(p(s), s)$$

and chooses a below-cost fee to content providers

$$s^{***} < 0$$

provided that both consumers and content providers are sufficiently differentiated

- Even paying the below-cost fee, the platform makes positive profits



Comparisons of Platform Monopoly Equilibrium with and without Net Neutrality (2)

- If a content provider values more an additional consumer than a consumer values an additional content provider and for sufficient product differentiation, removing net neutrality regulation will lead to:
 - An increase in the fee content providers must pay for access;
 - Less content provided;
 - A decrease in price consumers pay for Internet access and more consumers purchasing Internet access;
 - An increase in platform profits and consumer surplus;
 - A decrease in content providers' profits;
 - A decrease in total surplus.



Comparisons of Platform Monopoly Equilibrium with and without Net Neutrality (3)

- Consumers' surplus is higher at private monopoly while total surplus is higher at net neutrality
- At monopoly, the consumers benefit from a lower subscription price since the monopolist has incentives to attract more consumers to generate extra revenue from charging content providers
- Although charging content providers leads to lower content provision, the direct effects of a lower subscription price dominate the total effect on consumers
- In contrast, total surplus takes into account the profits of content providers which are significantly higher under net neutrality
- Thus, despite consumers' surplus being lower at net neutrality, total surplus is higher



Platform Duopoly

- Two platforms $k=1, 2$ are located at $x=0$ and $x=1$ on the Hotelling line and charge consumers subscription prices p_1, p_2 and fees s_1, s_2 to content providers
- Consumers buy from either platform
- Content providers connect to both platforms if fees are reasonable
- Compute the duopoly non-cooperative equilibrium prices $p_1(s_1, s_2), p_2(s_1, s_2)$ given fees s_1, s_2
- Compute the duopoly equilibrium p 's and s 's



Private Incentive to Increase Fee to Content Providers

- The individual incentive for a platform to increase its fee to content providers from zero to a small positive value when the opponent is charging a zero fee is positive

$$\frac{d\Pi_1 \Big|_{\frac{\partial \Pi_1}{\partial p_1} = \frac{\partial \Pi_2}{\partial p_2} = 0}}{ds_1} \Big|_{s_1 = s_2 = 0} = \frac{d\Pi_2 \Big|_{\frac{\partial \Pi_1}{\partial p_1} = \frac{\partial \Pi_2}{\partial p_2} = 0}}{ds_2} \Big|_{s_1 = s_2 = 0} > 0$$



Social Incentives of Departing from Net Neutrality ($s = 0$) in the Presence of Platform Duopoly

- The incentive of a planner to increase the fee to the content providers from zero to a small positive value taking into account that the duopolists choose subscription price is negative
- The planner's objective function is the constrained total surplus function $TS(p_1(s_1, s_2), p_2(s_1, s_2), s_1, s_2)$ expecting that, given the fees he announces, the platforms will choose the non-cooperative equilibrium subscription prices $p_1(s_1, s_2), p_2(s_1, s_2)$

Optimal One-sided Regulation in the Presence of Duopoly on the Other Side of the Market

- In the presence of duopoly platform pricing $p_1(s_1, s_2)$, $p_2(s_1, s_2)$, starting with net neutrality $s_1 = s_2 = 0$, the regulator would like to decrease the fees to the content providers below zero

$$\frac{dTS \Big|_{\frac{\partial \Pi_1}{\partial p_1} = \frac{\partial \Pi_2}{\partial p_2} = 0}}{ds_1} \Big|_{s_1 = s_2 = 0} = \frac{dTS \Big|_{\frac{\partial \Pi_1}{\partial p_1} = \frac{\partial \Pi_2}{\partial p_2} = 0}}{ds_2} \Big|_{s_1 = s_2 = 0} < 0.$$

- A planner, maximize the constrained total surplus function and anticipating the duopolists subscription equilibrium prices, chooses negative fees to content providers
- Even after paying the subsidy to content providers, the profits of the duopoly platforms are positive at the resulting equilibrium



Comparing Unconstrained Duopoly with Duopoly Under Net Neutrality

Under net neutrality:

- Total surplus is higher
- Content sector and the platforms have higher profits
- Consumers are worse off



Conclusions

- Starting to charge a positive price on the “other side” of the market is desirable to an access monopolist (or duopolists) but **not** desirable for society
- More complex pricing schemes (take-it-or-leave-it contracts, identity-based price discrimination, degradation of “basic” service) are likely to hurt consumers even more

Alternative Formulation When “Other Side” Charges Directly Consumers

- p_0 platform price
- p_1, p_2, p_3 application prices
- s_1, s_2, s_3 fees to platform (or subsidies to applications)
- See Economides and Katsamakas, *Management Science*, 2006.

