Platform economics

Network effects

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- What are network effects ?
- i) $f(n) = 0$ ii) $f(n) = -n$
- Are these kind of network effects usual ?
- What is the most common type of network effect in platform economics ?

- What are network effects ?
- i) $f(n) = 0$ ii) $f(n) = -n$
  - i) : No network effect. The user doesn't care about size of platform
  - ii) : Negative network effect. The more users, the less attractive the platform
- Are these kind of network effects usual ?
  - In platform economics we're not used to negative network effects. However, it exists in real estate, transportation ... Even for some kind of platforms with overloading.
- What is the most common type of network effect in platform economics ?
  - Positive network effects, AKA snowball effect

User's utility : $r + f(n) - A$, with $A = 0.4$

- $f(n) = 0$
  - From user's utlity we have indifferent user : $\hat{r} = 0.4$
  - We want to find the mass of consumers whose utility is positive. With $G(\hat{r}) = \hat{r}$ consumers with a negative utility, mass of joining users is $1 - G(\hat{r}) = 0.6$
- $f(n) = -n$
  - Same method, but with network effects, we have to find the expected number of users at the equilibrium n^e. Thus, mass of users is given by $1 - G(\hat{r}) = 0.6 - n^e$
  - At the equilibrium expected number of users is the actual number of user (cf self fulfilling prophecy,). Thus : $n = n^e = 0.6 - n \Rightarrow n^* = 0.3$

- $f(n) = 0$
  - No price paid by the consumer so with $\pi = profit$
    - $\pi = A(users) = A(1 - G(\hat{r}))$
    - From user's utility $\hat{r} - A = 0 \Rightarrow A = \hat{r} = G(\hat{r})$
    - $\pi = A(1 - A)$,
    - To optimize this we want to find the first order condition (FOC, where the first order derivative is zero). $\frac{\partial \pi}{\partial A} = 1 - 2A = 0 \Rightarrow A^{opt} = 0.5$
- $f(n) = -n$
  - Same method but with $G(\hat{r}) = \hat{r} = A + n$ coming from user's utility
    - $\pi = A(1 - G(\hat{r}) = A(1 - (A + n))$
    - Number of users ? Same as before : fixed point of mass of users function : $1 - G(\hat{r}) = n \Rightarrow 1 - A - n = n \Rightarrow n = \frac{1-A}{2}$
    - $\pi = \frac{1}{2}A + \frac{1}{2}A^2$
    - FOC : $\frac{\partial \pi}{\partial A} = \frac{1}{2} - A = 0 \Rightarrow A^{opt} = \frac{1}{2}$
- "Before user makes his decision to join" condition : why does it make a difference ?

- Pareto Social optimum is the maximum of the total surplus, taking into account profit of producer and user net benefit. Let's find total surplus in the market
- Profit, same as previous slides : $\pi = A(1 - G(\hat{r}) = A(1 - \hat{r})$
- Users net benefit :
  - If they don't join : 0
  - If they join : user's utility function so $r - A + f(n)$
  - Thus, benefit of all users is the sum of their individual utility. As we use a a total mass $N = 1$, and mass of users $(1 - G(\hat{r}) = 1 - \hat{r}$, we have with $g(x) = 1$:
  - $\int_{\hat{r}}^{1} g(x)(x - A + f(n))dx = \int_{\hat{r}}^{1} xdx + \int_{\hat{r}}^{1}(-A + f(n))dx$
  - $= \frac{1}{2}(1 - \hat{r}^2) + (1 - \hat{r})(-A + f(n))$
- Thus, total surplus is
  - $A(1 - \hat{r}) + \frac{1}{2}(1 - \hat{r}^2) + (1 - \hat{r})(-A + f(n)) = (1 - \hat{r})(\frac{1}{2} + \frac{1}{2}\hat{r} + f(n))$

- $f(n) = 0$
  - Total surplus : $\frac{1}{2}(1 - \hat{r}^2$, Which is maximized for $\hat{r} = 0 \Rightarrow A = 0$ (lowest value of A : free). This means that without network effect, and because there is no cost for the platform, free access is the optimal pricing.
- $f(n) = -n$
  - Total surplus : $(1 - \hat{r})(\frac{1}{2} + \frac{1}{2}\hat{r} - n) = \frac{1}{2}(1 - \hat{r})(1 + \hat{r} - 2n)$
  - Using $\hat{r} = A + n$ and $n = \frac{1-A}{2}$ from previous question we have
  - $\frac{1}{2}(1 + A + n - 2n)(1 - A - n) = \frac{1}{2}(1 + A - \frac{1-A}{2})(\frac{1}{2} - \frac{1}{2}A)$
  - $\frac{1}{2}(\frac{1}{2} + \frac{3}{2}A)(\frac{1}{2} - \frac{1}{2}A) = \frac{1}{8}(1 + 3A)(1 - A)$
  - FOC : $\frac{\partial \frac{1}{8}(1+3A)(1-A)}{\partial A} = 0 \Rightarrow \frac{3}{2} - \frac{3}{2}A - \frac{1}{2} - \frac{3}{2}A = 0 \Rightarrow A = \frac{1}{3}$
  - Thus, prices are lower if the social planner decides. Negative network effects decrease the net benefits of users : For any additional user, less users want to join the network. The platform therefore charges a higher price when negative network effects are present compared to the case of no network effects to reduce the number of users and therefore increase their welfare

$$\begin{cases} 0 & if \quad n \leq 1/2 \\ 1/2 & if \quad n > 1/2 \end{cases}$$

- Non linear network effect : cf critical mass
- What if we set prices to 0.5 and 0.6 with pessimistic expectations ?
    - From user's utility, we have: $\hat{r} = A - f(n)$, and we recall $n = 1 - G(\hat{r})$
    - For $A = 0.5$, we have $\hat{r} = 0.5$ and $n = 0.5$. This means price $A = 0.5$ works with rational expectation because $n = 0.5 \in [0; \frac{1}{2}]$. Profit $\pi = nA = 0.5 * 0.5 = 0.25$
    - For $A = 0.6$, we have $\hat{r} = 0.6$ and $n = 0.4$. So Still rational. Profit $\pi = nA = 0.6 * 0.4 = 0.24$

- Pessimistic : $f(n) = 0$
  - Thus, indifferent consumer : $\hat{r} = A - 0$ and mass of joining consumers is $1 - G(\hat{r}) = 1 - A$
  - Rationality of expectations $\Leftrightarrow 1 - A \leq \frac{1}{2} \Rightarrow A \geq \frac{1}{2}$
  - But at the same time, $r \leq 1 \Rightarrow A \leq 1$
  - So for $\frac{1}{2} \leq A \leq 1$ pessimistic expectations are rational, with $1 - A$ users joining at equilibrium.
- Optimistic : $f(n) = \frac{1}{2}$
  - Thus, indifferent consumer : $\hat{r} = A - 0.5$ and mass of joining consumers is $1 - G(A \hat{-} 0.5) = 1 - A + 0.5$
  - of expectations $\Leftrightarrow 1 - A + 0.5 > \frac{1}{2} \Rightarrow 1 > A$
  - So for $A < 1$ optimistic expectations are rational, with $min(1, 1.5 - A)$. users joining at equilibrium

- Profit with optimistic expectations : $\pi_{opt} = A(1.5 - A)$
  - $\frac{\partial \pi_{opt}}{\partial A} = 1.5 - 2A = 0 \Rightarrow A^*_{opt} = 0.75$ and $n^* = 0.75$, which is rational
- Profit with pessimistic expectations : $\pi_{pes} = A(1 - A)$
  - $\frac{\partial \pi_{pes}}{\partial A} = 1 - 2A = 0 \Rightarrow A^*_{pes} = 0.5$ and $n^* = 0.5$, which is rational
- Profit maximizing price with optimistic expectations higher than pessimistic expectations one : goes along with intuition.

- Difference between profit with optimistic expectations and profit with pessimistic expectations :
  - $\pi_{opt} = A^*_{opt} \cdot n^* = 0.75 \cdot 0.75 = 0.5625$
  - $\pi_{pes} = A^*_{pes} \cdot n^* = 0.5 \cdot 0.5 = 0.25$
  - $\pi_{pes} - \pi_{opt} = 0.3126$, which is the price the platform would be willing to pay up to the difference in profits
- To ensure optimistic expectations, the platform may allow first 0.5 users to join for free, in order to reach critical mass.

- There is no marginal cost and positive externalities so everybody should join the network to maximize total surplus.
- Same definition of total surplus than in question 1.c.
- Then $\textit{Total surplus} = \int_{0}^{1}(x + \frac{1}{2} - A)dx + A = 1$
- For optimistic expectations, setting any price $A \leq 0.5$ ensures that everybody wants to join the network. Total surplus would always be 1, with $1 - A$ going to users and A to the network operator.

How to distinguish between equilibria ?

- Pareto-Dominance :
  - Is an equilibrium better for all players than anorhter one ?
- Selection by an agent with market power :
  - Is it plausible that the platform can select the equilibrium ? (Advertising, free membership ...)
- Stability :
  - Convergence or divergence towards equilibrium ? Tipping examples and definition of critical mass

- $u_A \geq u_{-B} \Rightarrow v + n_{A,t} \geq n_{B,t} \Rightarrow n_{A,t} - n_{B,t} \geq -v$. A fan joins A if the network is big enough.
- $u_{-A} > u_B \Rightarrow n_{A,t} > v + n_{B,t} \Rightarrow n_{A,t} - n_{B,t} > v$. All consumers join A if B fans join network A : lock in to A.
- Competition with incompatible goods has a strong propension to monopoly : the equilibria correspond to lock-in situation (cf VHS vs Betamax) .
- Tipping often lead to lock-in situation (counter-example : Playstation vs Xbox),

- Incompatibility : You want to take the risk of losing the market to win the whole market (All-in strategy). cf fight between standards
- Compatibility : You don't want to compete for the market, but in the market, you compete to maximize your market share.
- Goods compatiblity : benefits small networks and lower barrier to entry, less propension to monopoly (for users : better welfare, as people are able to use several platforms simultaneously).
- Firms usually fight to impose their own standard as it will give them the assurance to have comparative advantages over their competitor. They also want to differentiate in order no to compete between themselves
  - Battle of the sexes : disagreement on the way to achieve compatibility
  - Pesky little brother : smallest want compatibility but biggest refuse it
  - Standard war : all platforms want to impose their own standard

- Same with $f(n) = \sqrt{n}$
  - Intuition ?
  - Same questions, with price $A = 0.4$, profit maximization ...
- With $f(n) = \begin{cases} 0 & if \quad n \leq 1/2 \\ \text{n}^2 & if \quad n > 1/2 \end{cases}$
  - Consistency of rational expectations ?
  - Comparison with previous non linear network effect ?
  - Matches intuition ?

- Handbook : *The economics of Platforms, Concepts and strategy*, Paul Belleflamme and Martin Peitz
- Papers :
  - William Brian Arthur (1989) *Competing Technologies, Increasing Returns, and Lock-In By Historical Events*. Economic Journal 99(394), pp. 116-131.
  - Michael L. Katz and Carl Shapiro (1985*Network Externalities, Competition, and Compatibility*
  - Nicholas Economides (1996) *The Economics of Networks*
  - Jean-Charles Rochet and Jean Tirole (2003) *Platform Competition in Two-Sided Markets*