# "Compatibility and the Product Life Cycle in Two-Sided Markets." Review of Network Economics Volume 12, Issue 2, 2013

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# What is “Two-Sided markets”?

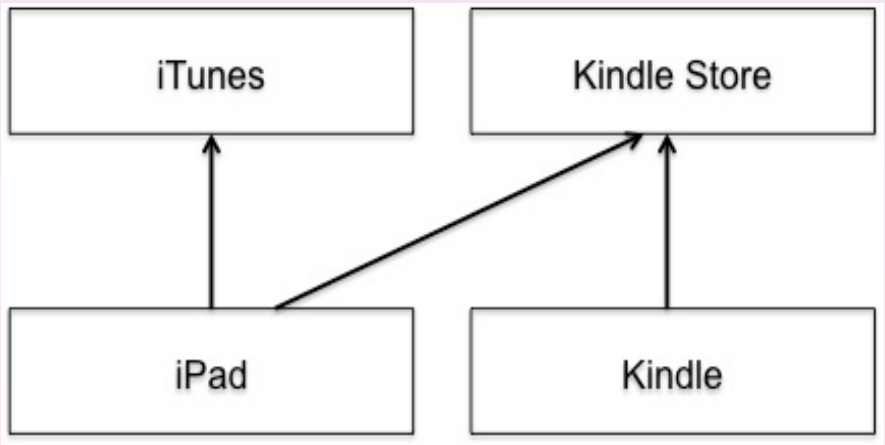
## What is the two-sided markets (or platform business)?

Platforms enable interactions between other kind of end-users and try to get the two sides “on board” by appropriately charging each side. [Rochet and Tirole, 2006] (e.g. shopping mall, video game, and e-book reader)

# What is “Compatibility”?

E-book reader industry

- Amazon chooses compatibility.
- Apple chooses incompatibility.




Why do these rivals choose opposite strategies with regard to compatibility?

# What we study

- Duopoly model of compatibility decisions in two-sided markets.
- The product life cycle and market share affects the compatibility strategy.
- Two-sided platform has two source of profit; hardware and software.
- Choosing compatibility
  - increases the revenue from software.
  - decreases the revenue from hardware.

# Main results

- The equilibrium depends on the stage of the product life cycle and market share.

| Stage | Equilibrium | Major profit center |
|---|---|---|
| Introductory | (IC,IC) | Hardware device. |
| Growth | (IC,C)<br>(C,IC) | Large platform; Hardware.<br>Small platform; Royalties. |
| Mature | (C,C) | Royalties from content. |

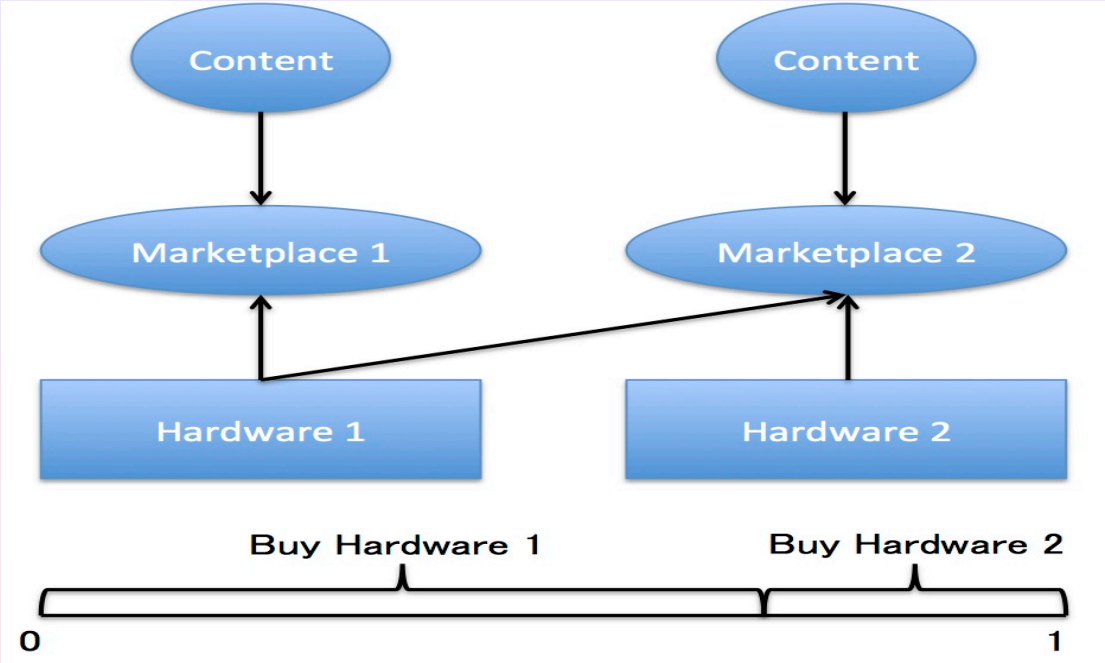
# Related Literature

Previous literature about compatibility in two-sided market.

1. Doganoglu and Wright [2006]
2. Casadesus-Masanell and Ruiz-Aliseda [2008]
3. Miao [2009]
4. Viecens [2011]

- These previous papers focus on competition given the structure of compatibility.
- The contribution of our work lies in showing the equilibrium structure of compatibility.
- This paper is the first one which shows the interesting point that the equilibrium structure of compatibility changes over the product life cycle.

# Platforms and Content Providers




- Two content providers, $i = 1, 2$.
  - $\rho_{ij}$: price of content $i$ sold to consumers who own hardware $j$.

# Platforms and Content Providers

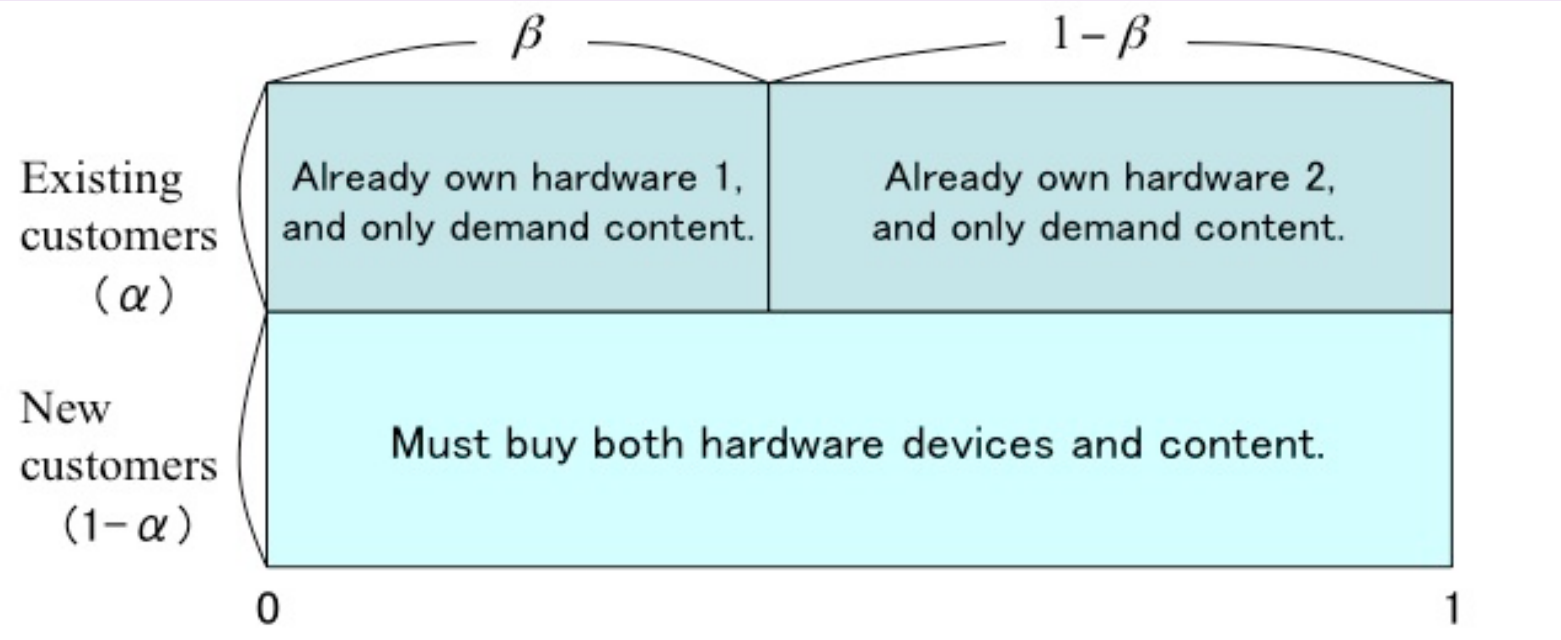
- Two platforms, $i = 1, 2$.
  - $p_i$: Hardware price (marginal cost equals to 0).
  - $r$: Royalty rate (exogeneous).
  - C or IC: Compatibility decision. ($\delta_i$ takes on 1 if platform $i$ chooses compatibility.)
- The profit function of platform $i$ is given by

$$\pi_i = p_i D_i + r\rho_{ii} D_i + \delta_i r \rho_{ij} D_j \quad (i, j = 1, 2, \quad i \neq j),$$

where $D_i$ denotes the demand for the hardware device.

# Consumers

- Population of consumers.



# Consumers

- Consumers' decision
  - Hotelling model of product differentiation.
    - The hardware devices are differentiated along the unit interval [0, 1].
    - Ideal points of consumers are distributed uniformly with a unit density.
    - $t$: Constant proportional disutility.
  - $v$: The benefit derived from consumption of the hardware device.
  - $w(N)$: Benefit from $N$ varieties of content.
    - where $w(1) < w(2)$ and $w(2) - w(1) < w(1)$.

# Consumers

- The utility function of a new customer who is located at $x$, buys a hardware device $i$, and uses its available contents is written as

$$u_i = w(N_i) - \rho_{ii} - \delta_j \rho_{ji} + v - p_i - t|x - x_i|.$$

  - $N_i$ is the amount of available content for hardware device $i$
  - $x_i$ is the location of hardware $i$.

# Timing of Game

1. The two platforms choose between compatibility and incompatibility; IC or C.
2. Platforms set their hardware prices ($p_i$), and the new consumers purchase one of them.
3. Content providers set their content prices ($\rho_{ij}$), and the customers purchase.

# Market structures

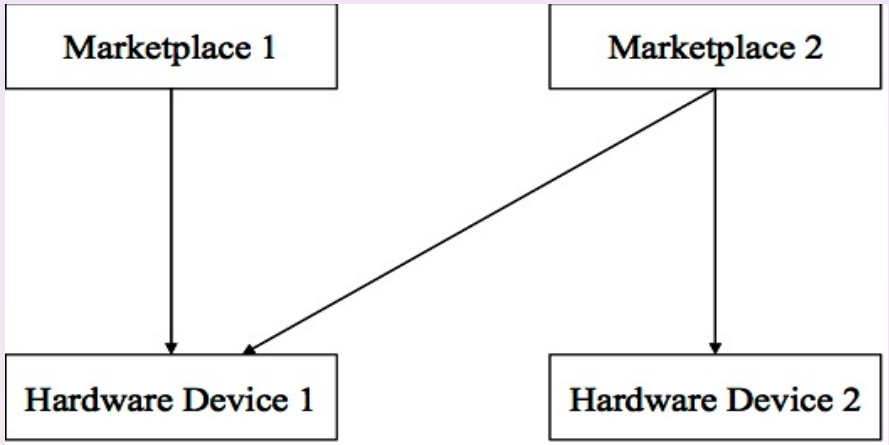
Given the compatibility decisions in stage one, there are four possible market structures:

1. Incompatible platforms in which both platforms choose incompatibility; (IC, IC).
2. Compatible platforms in which both platforms choose compatibility; (C, C).

3,4. Asymmetric market structures in which one platform chooses incompatibility and the other chooses compatibility; (IC, C) or ; (C, IC).

# The stage three

Here, we consider the Case 3: (IC,C)




- From Church and Gandal [2000], we can derive the content price.
  - When $N_2 = 1$, content price $\rho_{22} = w(1)$.
  - When $N_1 = 2$, content prices
    $\rho_{11} = \rho_{21} = w(2) - w(1) \equiv \Delta w$.

# The stage two

The utility functions of new customers are

$$\begin{cases} u_1 = w(2) - \rho_{11} - \rho_{21} + v - p_1 - tx \\ \quad\; = 2w(1) - w(2) + v - p_1 - tx \\ u_2 = w(1) - \rho_{22} + v - p_2 - t(1-x) \\ \quad\; = v - p_2 - t(1-x) \end{cases}$$

The location of a new customer who is indifferent between the two hardware devices is

$$\frac{2w(1) - w(2) + t - p_1 + p_2}{2t}.$$

# The stage two

From this, we can derive the demands for hardware devices as follows:

$$D_1 = \frac{(W + t - p_1 + p_2)(1 - \alpha)}{2t},$$

$$D_2 = \frac{(-W + t - p_1 + p_2)(1 - \alpha)}{2t},$$

$$\text{where, } W \equiv 2w(1) - w(2).$$

The profit functions of the platforms are

$$\begin{cases} \pi_1 = p_1 \cdot D_1 + r\rho_{11}(D_1 + \alpha\beta) \\ \pi_2 = p_2 D_2 + r\rho_{22}(D_2 + \alpha(1 - \beta)) \\ \qquad\qquad + r\rho_{21}(D_1 + \alpha\beta) \end{cases}$$

# The stage two

- From the first-order conditions for profit maximization, we have the equilibrium prices, demands, profits, consumer surplus, and social surplus.
- Similarly, we can have the equilibrium under other three market structures as shown in following table.

| | (IC, IC) | (C, C) | (IC, C) |
|---|---|---|---|
| $\pi_1$ | $\frac{t}{2}(1-\alpha)+\alpha\beta rw(1)$ | $\frac{t}{2}(1-\alpha)+r\Delta w$ | $\frac{\{3t+(1-r)W+r\Delta w\}^2}{18t}(1-\alpha)$ $+\alpha\beta r\Delta w$ |
| $\pi_2$ | $\frac{t}{2}(1-\alpha)+\alpha(1-\beta)rw(1)$ | $\frac{t}{2}(1-\alpha)+r\Delta w$ | $\frac{9t^2+\{(1-r)W+r\Delta w\}^2}{18t}(1-\alpha)$ $+\frac{\alpha rw(1)+rw(2)-(1-\alpha-\alpha r+3\alpha\beta r)W}{3}$ |

# The stage one

- Compare the equilibrium profits shown in Table.

**Lemma**

*It follows that*

$$\begin{aligned}
\beta > \beta_1(\alpha) &\iff \pi_1(\mathrm{IC},\mathrm{IC}) > \pi_1(\mathrm{C},\mathrm{IC}),\\
\beta > \beta_2(\alpha) &\iff \pi_2(\mathrm{IC},\mathrm{C}) > \pi_2(\mathrm{IC},\mathrm{IC}),\\
\beta > \beta_3(\alpha) &\iff \pi_1(\mathrm{IC},\mathrm{C}) > \pi_1(\mathrm{C},\mathrm{C}),\\
\beta > \beta_4(\alpha) &\iff \pi_2(\mathrm{C},\mathrm{C}) > \pi_2(\mathrm{C},\mathrm{IC}),
\end{aligned}$$

# The stage one

where

$$\beta_1(\alpha) = \frac{6t(b+r\rho)-(b+r\rho)^2}{18tr\rho} - \frac{6t(b-2r\rho)-(b+r\rho)^2}{18tr\rho\cdot\alpha},$$

$$\beta_2(\alpha) = -\frac{6t(b-2r\rho)-(b+r\rho)^2}{18tr\rho} + \frac{6t(b-2r\rho)-(b+r\rho)^2}{18tr\rho\cdot\alpha},$$

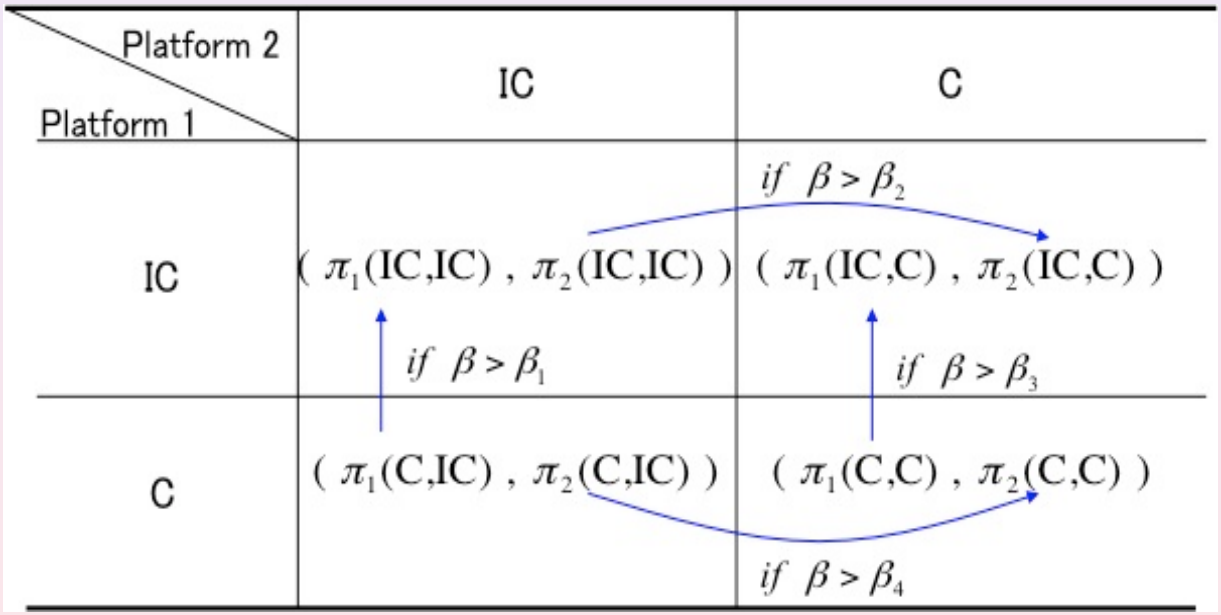
$$\beta_3(\alpha) = \frac{6t(b+r\rho)+(b+r\rho)^2}{18tr\rho} - \frac{6t(b-2r\rho)+(b+r\rho)^2}{18tr\rho\cdot\alpha},$$

$$\beta_4(\alpha) = -\frac{6t(b-2r\rho)+(b+r\rho)^2}{18tr\rho} + \frac{6t(b-2r\rho)+(b+r\rho)^2}{18tr\rho\cdot\alpha},$$

$$\beta_1+\beta_2=1, \quad \text{and} \quad \beta_3+\beta_4=1.$$

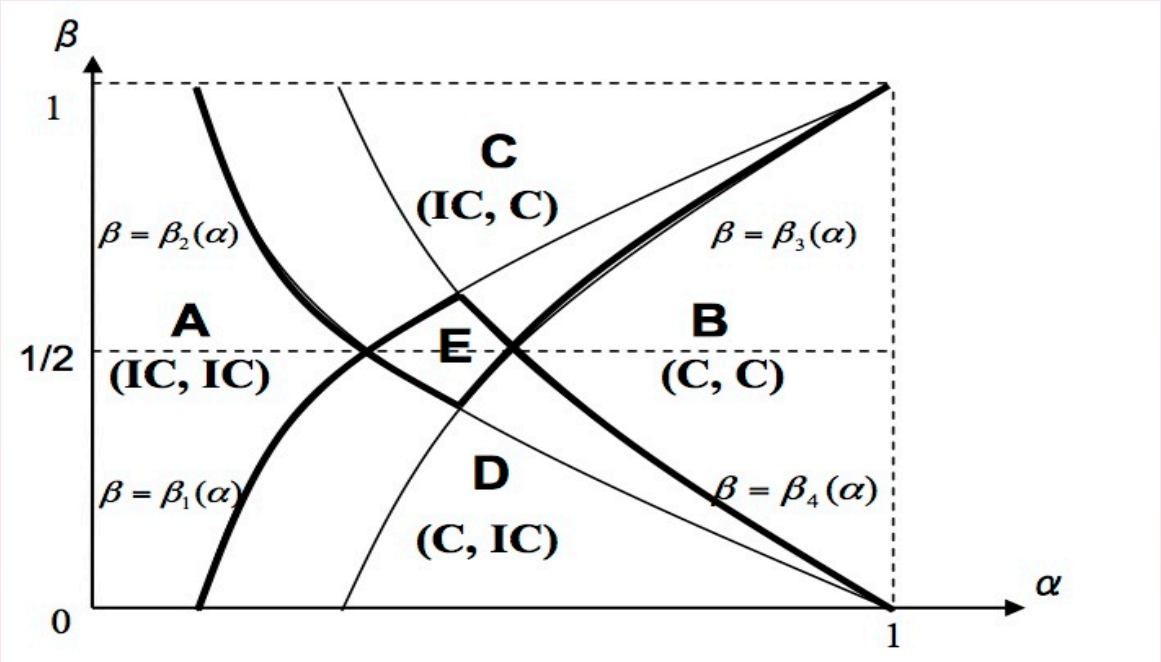
# The stage one

Summarize the lemma in payoff matrix.



# The stage one

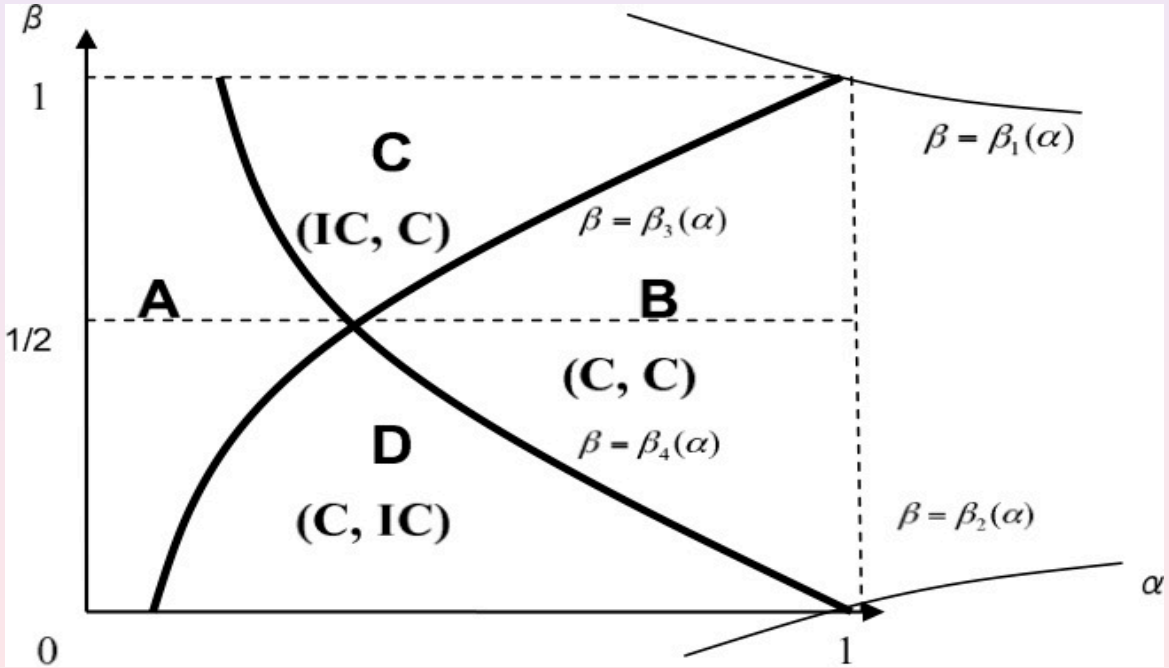
**Proposition 5a** We suppose that $0 < r < \frac{2w(1)-w(2)}{w(2)}$ and $t > \frac{((1-r)W+r\Delta w)^2}{6(W-rw(2))}$.



# The stage one

**Proposition 6a** We suppose that

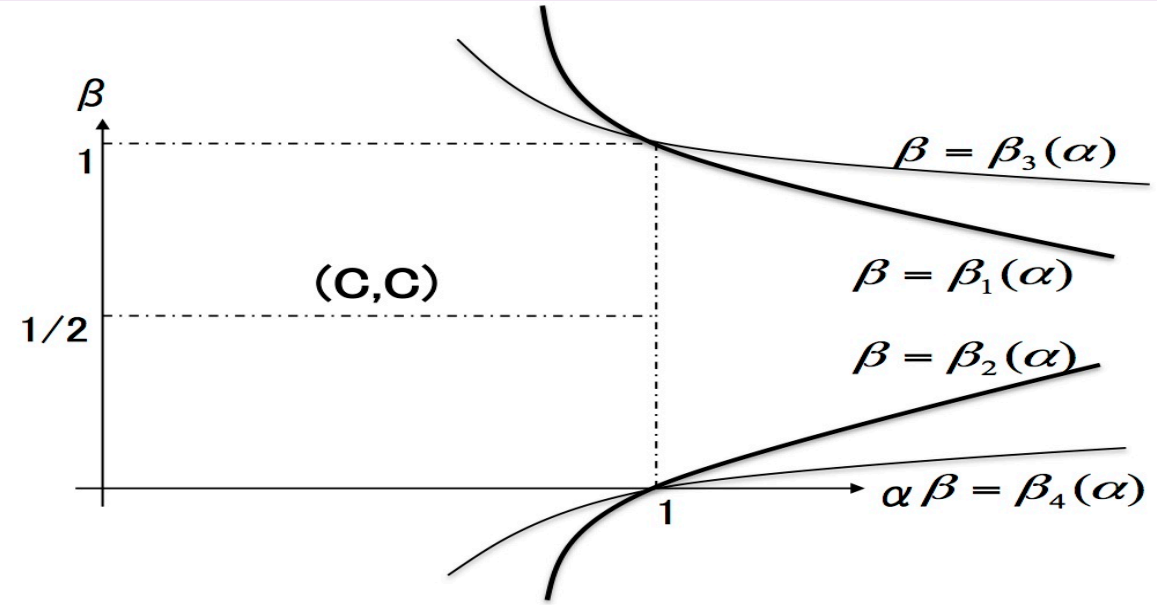
$$0 < r < \frac{2w(1)-w(2)}{w(2)} \text{ and } \frac{(1-r)W+r\Delta w}{6} < t < \frac{\{(1-r)W+r\Delta w\}^2}{6\{W-rw(2)\}}.$$



# The stage one

**Proposition 7a** We suppose that

$$\frac{2w(1)-w(2)}{w(2)} < r < 1 \text{ and } t > \max\left(\frac{\{(1-r)W+r\Delta w\}^2}{6\{rw(2)-W\}}, \frac{\{(1-r)W+r\Delta w\}}{6}\right).$$



# Conclusion

- The purpose of this paper was to understand how the product life cycle affects the compatibility strategy of platforms in two-sided markets.
- The sort of example we have in mind is the market for electronic books.
  - For the small platform (Amazon), the profitable choice is to make its content compatible and gain royalties from expanding the sale of content.
  - For the large platform (Apple), the profitable choice is to make its content incompatible and maintain its share of the hardware market.

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