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Application compatibility and affiliation in two-sided markets

Masayoshi Maruyama[a,*], Yusuke Zennyo[b]

[a] Kobe University, Graduate School of Business Administration, Japan
[b] Osaka University of Economics, Faculty of Economics, Japan

HIGHLIGHTS

- The paper analyzes the decisions on application compatibility by platforms.
- We show that compatibility is not a possible equilibrium unless the cost is zero.
- The asymmetric decisions on application compatibility represent equilibria.
- We show that the asymmetric equilibria are harmful to content providers and users.

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ABSTRACT

This paper analyzes the unilateral choices of application compatibility by platforms and the endogenous affiliations of two different groups (content providers and users). We find a novel result that for both platforms to unilaterally choose application compatibility is not an equilibrium unless the cost for achieving application compatibility is zero. We also find that asymmetric equilibria exist with regard to other content, where one platform chooses incompatibility while the other platform chooses compatibility and that, these asymmetric equilibria are harmful both to the content providers and to users, compared to the (out-of-equilibrium) outcome where both platforms choose application compatibility.

1. Introduction

We consider the possibly asymmetric unilateral choices of *application compatibility* by platforms in two-sided markets. Application compatibility should be distinguished from another form of compatibility which is inherently symmetric: joint adoption of a common standard. Our analysis is based on the model of endogenous affiliation by two different groups formulated by Rasch and Wenzel (2014), which we extend to a situation in which compatibility or not becomes an independent choice of each firm, rather than being an industry-wide uniform standard as in the previous literature (e.g., Doganoglu and Wright, 2006; Rasch and Wenzel, 2014).

A platform can choose application compatibility by providing a specific app that enables users of hardware devices operating on other standards to purchase and use content that the platform supplies in its marketplace. The empirical phenomenon we have in mind is exemplified by the market for e-books. Amazon has chosen application compatibility by making it possible for Apple iPad users to view e-books purchased from its Amazon Kindle Store. In contrast, Apple has chosen application incompatibility, meaning that the users of Amazon's Kindle cannot view e-books purchased on Apple's iTunes. Our question is whether such asymmetric application compatibility could emerge as a non-cooperative Nash equilibrium, and if so whether it is consonant with maximum industry profit or maximum social welfare.

* Corresponding author.
E-mail address: mmaru@kobe-u.ac.jp (M. Maruyama).

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Contrary to the existing literature,[1] we explore the equilibrium structure of application compatibility with endogenous affiliation by two different groups, and characterize its efficiency properties.[2] We find a novel result that for both platforms to unilaterally choose application compatibility is not an equilibrium unless the cost for achieving application compatibility is zero. Furthermore, asymmetric equilibria may exist (one firm choosing application compatibility and the other not), but if so, it is harmful both to the content providers and to users, compared to the (out-of-equilibrium) outcome where both platforms choose application compatibility.

2. Model

As in Rasch and Wenzel (2014), two platforms, $i = 1, 2$, each enable interaction between consumers and content providers. Denote by θ the marginal benefit that each consumer derives from a unit of content. Similarly, denote by ϕ the profit that each content provider earns per consumer reached. We extend the Rasch and Wenzel framework to accommodate *application compatibility*, which enables consumers on the rival platform to interact with content providers on its platform. Each platform selects between incompatibility (IC) and compatibility (C) to maximize its profit. Each platform incurs a fixed cost F in achieving compatibility. Denote by δ_i the following function.

$$\delta_i = \begin{cases} 0 & \text{if platform } i \text{ chooses application incompatibility,} \\ 1 & \text{if platform } i \text{ chooses application compatibility.} \end{cases}$$

Each consumer needs to purchase a hardware device to interact with content providers. Each platform provides a hardware device i at a price p_i. Consumers are assumed to be uniformly located along the unit interval $x \in [0, 1]$, with the two platforms located at opposite endpoints. Each consumer purchases one hardware device only and incurs a constant proportional disutility τ per unit length. We assume that the benefit derived from a hardware device v is large enough for all consumers to purchase one hardware device. We also consider that each consumer buys any usable content. Therefore, we can write the utility function of a consumer $u_i(x)$ who is located at x and buys a platform i ($i = 1, 2$) as follows:

$$\begin{cases} u_1(x) = v + \theta(n_1 + \delta_2 n_2) - p_1 - \tau x \\ u_2(x) = v + \theta(n_2 + \delta_1 n_1) - p_2 - \tau(1 - x) \end{cases}$$

where n_i is the number of content providers that affiliate with platform i.

Each content provider needs to pay a lump-sum license fee l_i to platform i. Content providers are heterogeneous in terms of the fixed investment cost for offering content f, which is uniformly distributed along the unit interval [0, 1]. Thus, we can write the profit function of a content provider $\pi_i(f)$ offering content for platform i as follows.

$$\pi_i(f) = \phi(s_i + \delta_i s_j) - l_i - f$$

where s_i is the share of a hardware device i. We assume that content providers can offer content for both platforms (so-called multi-homing) if it is profitable. The profit of a content provider under multi-homing is

$$\begin{aligned} \pi_M(f) &= \phi(s_1 + s_2) - l_1 - l_2 - f \\ &= \phi - l_1 - l_2 - f. \end{aligned}$$

Table 1
Equilibrium.

	(IC, IC)	(C, C)	(IC, C)
p_1	$\tau - \frac{3\theta\phi+\phi^2}{4}$	τ	τ
p_2	$\tau - \frac{3\theta\phi+\phi^2}{4}$	τ	τ
l_1	$\frac{\phi-\theta}{4}$	0	0
l_2	$\frac{\phi-\theta}{4}$	0	$\frac{\phi}{2}$
s_1	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
s_2	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
n_1	$\frac{\phi+\theta}{4}$	$n_1 + n_2 = \phi$	0
n_2	$\frac{\phi+\theta}{4}$		$\frac{\phi}{2}$
Π_1	$\frac{\tau}{2} - \frac{\theta^2}{16} - \frac{3\theta\phi}{8} - \frac{\phi^2}{16}$	$\frac{\tau}{2} - F$	$\frac{\tau}{2}$
Π_2	$\frac{\tau}{2} - \frac{\theta^2}{16} - \frac{3\theta\phi}{8} - \frac{\phi^2}{16}$	$\frac{\tau}{2} - F$	$\frac{\tau}{2} + \frac{\phi^2}{4} - F$
CS	$v - \frac{5}{4}\tau + \frac{\theta^2+4\theta\phi+\phi^2}{4}$	$v - \frac{5}{4}\tau + \theta\phi$	$v - \frac{5}{4}\tau + \frac{\theta\phi}{2}$
PS^C	$\frac{(\theta+\phi)^2}{16}$	$\frac{\phi^2}{2}$	$\frac{\phi^2}{8}$
SW	$v - \frac{\tau}{4} + \frac{3}{16}(\theta+\phi)^2$	$v - \frac{\tau}{4} + \theta\phi + \frac{\phi^2}{2} - 2F$	$v - \frac{\tau}{4} + \frac{\theta\phi}{2} + \frac{3}{8}\phi^2 - F$

Each platform makes a decision about application compatibility and sets a price p_i for consumers and a lump-sum fee l_i for content providers to maximize its profit $\Pi_i = s_i p_i + n_i l_i - \delta_i F$ with the following timing. First, platform i chooses whether to make its content compatible with the rival's hardware device. Second, platform i sets a hardware price p_i and a lump-sum fee l_i. Third, consumers buy a hardware device and content providers decide whether to provide content for each platform. Finally, consumers purchase any usable content.

3. Equilibrium

We attain the same results as Rasch and Wenzel (2014) for the symmetric cases of compatibility decisions in which both platforms choose either incompatibility (IC, IC) or compatibility (C, C). We omit the details of the analysis and provide the results in Table 1.

3.1. Incompatibility–compatibility

We now consider the asymmetric case (IC, C) in which platform 1 chooses incompatibility while platform 2 chooses compatibility. The utility function of a consumer who purchases hardware device 1 or 2 is respectively given by

$$\begin{cases} u_1(x) = v + \theta(n_1 + n_2) - p_1 - \tau x \\ u_2(x) = v + \theta n_2 - p_2 - \tau(1 - x). \end{cases}$$

The type of consumer that is indifferent between the two hardware devices is characterized by

$$u_1 = u_2 \iff x = \frac{1}{2} + \frac{p_2 - p_1}{2\tau} + \frac{\theta n_1}{2\tau}.$$

Hence, the share for hardware device 1 or 2 is respectively given by

$$\begin{cases} s_1 = \dfrac{1}{2} + \dfrac{p_2 - p_1}{2\tau} + \dfrac{\theta n_1}{2\tau} \\ s_2 = \dfrac{1}{2} + \dfrac{p_1 - p_2}{2\tau} - \dfrac{\theta n_1}{2\tau}. \end{cases}$$

The profits of a content provider that respectively affiliates with platform 1 or 2 is given by

$$\begin{cases} \pi_1(f) = \phi s_1 - l_1 - f \\ \pi_2(f) = \phi - l_2 - f \geq \pi_M(f) = \phi - l_1 - l_2 - f. \end{cases}$$

[1] Casadesus-Masanell and Ruiz-Aliseda (2008) and Viecens (2011) focus on competition given the structure of application compatibility.

[2] In a companion paper to this one, Maruyama and Zennyo (2013) show that the structure of application compatibility changes over the product life cycle given the affiliation by content providers.