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# Content provision and compatibility in a platform market\*

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## Abstract

This paper studies the ambiguous welfare effects of compatibility in a platform market with endogenous content provision. Compatibility can be particularly harmful if it leads to reduced content but can be beneficial if content is sufficiently increased.

*Keywords:* Two-sided market; Compatibility; Content creation; Platform; Standard.

*JEL-Classification:* D43; L13; L14.

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# 1 Introduction

This paper considers compatibility in a platform (or two-sided) market which is characterized by the interaction of three distinct parties: a platform (or intermediary) tries to attract two different groups of customers that use the platform only if the other side does so too (e.g., Rochet and Tirole, 2003; Armstrong, 2006). Such demand interdependencies are, for instance, relevant in the software industry where platforms (e.g., game consoles, media players, operating systems) bring together users (gamers etc.) and application developers (content providers etc.). In this context, compatibility (that is, the search for a common standard) is an important aspect reflected in so-called ‘standard wars’ (e.g., VHS/Betamax, Blu-ray/HD DVD). However, it has only received relatively little attention in the literature so far.

We analyze platforms’ compatibility choices in a competitive-bottleneck setup with single-homing users and multi-homing content developers. The main difference with existing duopoly models (Doganoglu and Wright, 2006; Alexandrov, 2012) is that we allow for endogenous content both under incompatibility and compatibility.<sup>1</sup> In existing models, it is assumed that compatibility means that a larger number of customers on each market side can interact with each other. In other words, the amount of content available to a user rises with compatibility. In contrast, we show that the amount of content does not necessarily increase with compatibility but may also decrease. Our key assumption is that participation of content providers is endogenous. We identify two effects of compatibility on content creation: a market-size effect and a price effect. Due to the market-size effect, content providers have access to a larger number of users which increases the incentives to develop content. The price effect is novel: compatible platforms may have lower incentives to subsidize the creation of content. If this effect is sufficiently strong, content provision may be lower when platforms become compatible. However, we also characterize situations where compatibility results in lower license fees and thereby increases the amount of available content.

Regarding welfare, our results are more ambiguous than in existing models.

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<sup>1</sup>Miao (2009) investigates a monopolist’s incentives to introduce compatibility in a two-sided market.

We show that for uniformly distributed development costs, user surplus always decreases if products become compatible. This result only partly carries over to nonuniform distributions. In particular, compatibility can be particularly harmful to users as they may suffer from both higher prices and less content. However, we also characterize situations (assuming a nonuniform distribution of development costs) where user surplus can be higher. In those situations, a positive content effect may compensate for higher prices.

## 2 Model

The model we use is a competitive-bottleneck model with single-homing users and multi-homing content developers (Armstrong, 2006; Choi, 2010). Two symmetric platforms offering differentiated services to users are located at opposite ends of a line of unit length (Hotelling, 1929). Platforms compete for users by setting a user price  $p_i$  and for content providers by setting a license fee  $l_i$  (where  $i \in \{1, 2\}$ ). Marginal costs and fixed costs are normalized to zero. Introducing a common standard making platforms compatible leads to fixed costs  $F$  per platform.

Users are uniformly distributed along the line. The utility of a user who is located at  $x$  and who buys access to platforms 1 or 2, respectively, is given by

$$u_1 = v + \theta n_1 - p_1 - \tau x \tag{1}$$

and

$$u_2 = v + \theta n_2 - p_2 - \tau(1 - x). \tag{2}$$

Users derive an intrinsic utility of  $v$  from connecting to a platform. Moreover, the utility increases with the amount of content  $n_i$  that is available on a platform. Users value each additional unit of content with  $\theta$  and incur transportation costs of  $\tau$  if the platform's location differs from the user's preferred location.

Assuming that the market is covered,<sup>2</sup> the market share of a platform  $i$  can

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<sup>2</sup>To this end, it is assumed that the intrinsic utility  $v$  is sufficiently high.

be derived from equations (1) and (2):

$$s_i = \frac{1}{2} + \frac{p_j - p_i}{2\tau} + \frac{\theta(n_i - n_j)}{2\tau}. \quad (3)$$

There is a unit mass of content providers. Each content provider can offer one variety of content and may multi-home, i.e., offer content at both platforms. There are fixed investment costs  $f$  for offering content. Content providers are heterogeneous with respect to these costs which are uniformly distributed on the unit interval for now. Content providers generate income of  $\phi$  per user reached.

Thus, the profit of a content provider offering content on platform  $i$  is

$$\pi = \phi s_i - l_i - f.$$

Content providers offer their product on platform  $i$  if  $\pi \geq 0 \Leftrightarrow f \leq \phi s_i - l_i$ . Hence, the amount of available content on platform  $i$  is equal to

$$n_i = \phi s_i - l_i. \quad (4)$$

The timing is as follows: in the first stage, platforms jointly decide whether to introduce compatibility or not (see also Doganoglu and Wright, 2006, and Alexandrov, 2012). In the second stage, platforms simultaneously set prices for users and license fees for content providers. In the third stage, users and content providers decide which platform(s) to join.

### 3 Analysis

#### Incompatibility

Incompatibility means that content produced on one platform cannot be accessed by users of the rival platform. Thus, platform market shares on the user side depend on the amount of content available for the platform. Similarly, content providers' incentives to produce content depends on the available number of users that can be reached on a platform. Hence, the

demand of users and content providers is interrelated. Then, solving equations (3) and (4) simultaneously gives demands in terms of prices only:

$$s_i = \frac{1}{2} + \frac{p_j - p_i}{2(\tau - \theta\phi)} + \frac{\theta(l_j - l_i)}{2(\tau - \theta\phi)}$$

and

$$n_i = \frac{\phi}{2} + \frac{\phi(p_j - p_i)}{2(\tau - \theta\phi)} - l_i + \frac{\theta\phi(l_j - l_i)}{2(\tau - \theta\phi)}.$$

Platforms choose prices for users and content developers so as to maximize total profits given by

$$\Pi_i = s_i p_i + n_i l_i.$$

Optimal symmetric prices under incompatibility are then set at<sup>3</sup>

$$p^* = \tau - \frac{3\theta\phi + \phi^2}{4}$$

and

$$l^* = -\frac{\theta - \phi}{4}.$$

The user price is lower than the standard Hotelling price (e.g., Choi, 2010): the price decreases with the size of the network effects  $\theta$  and  $\phi$ . The license fee increases with the per-user profit  $\phi$  but decreases with the benefit users get from an additional unit of content  $\theta$ . The intuition for this is simple: if users value content highly (i.e.,  $\theta$  is large), platforms set a low license fee to attract a large amount of content to become more attractive for users. As  $\theta$  becomes sufficiently large, platforms subsidize content providers (i.e.,  $l^* < 0$ ).

Given platforms' pricing strategies, the equilibrium amount of content on each platform is

$$n^* = \frac{\theta + \phi}{4}.$$

It is well known that compared to the efficient level in a competitive-bottleneck model, there are too few content providers on each platform as the license fee is excessive (Armstrong, 2006). Hence, an important factor for the wel-

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<sup>3</sup>We focus on market-sharing equilibria which can be guaranteed by assuming that horizontal differentiation is sufficiently large:  $8\tau > \theta^2 + 6\theta\phi + \phi^2$ .

fare effects of introducing compatibility is whether it attracts a larger number of content providers.

The resulting platform profits amount to

$$\Pi^* = \frac{\tau}{2} - \frac{\theta^2}{16} - \frac{3\theta\phi}{8} - \frac{\phi^2}{16}. \quad (5)$$

## Compatibility

Compatibility means that the two platforms agree on a common standard: content created by any content provider can be used on both platforms, i.e., the same amount of content is available on either platform. Hence, user market shares depend only on user prices

$$s_i = \frac{1}{2} + \frac{p_j - p_i}{2\tau}.$$

It immediately follows that the equilibrium user price is identical to the standard Hotelling price of  $p^{**} = \tau$ .

Content providers can reach all users via either platform. Hence, as there is no differentiation among platforms from the developers' point of view, platforms face Bertrand competition. As a result, the license fee is competed to zero:  $l^{**} = 0$ . The equilibrium amount of content is then

$$n^{**} = \phi \quad (6)$$

and equilibrium platform profits are

$$\Pi^{**} = \frac{\tau}{2} - F. \quad (7)$$

## Comparison

This subsection evaluates the welfare effects of introducing compatibility. We start with users: their surplus depends on the user price and the access to content. Due to the indirect network effects, user prices are higher under compatibility than under incompatibility which hurts users.

The impact of introducing compatibility on the amount of content is less clear: on the one hand, a larger market size is available for content providers under compatibility. This effect tends to increase the incentives to create content. On the other hand, the license fee is affected by introducing compatibility. This effect may go either way: if content providers are subsidized under incompatibility, the effect is negative. Otherwise, it is positive.

In total, if content providers are charged a positive price under incompatibility, compatibility leads to a lower fee and, hence, this tends to increase the available amount of content. In turn, the total effect on equilibrium content due to compatibility is positive. However, if providers are subsidized under incompatibility, the two effects oppose each other and the overall impact depends on the strength of the two effects. We summarize:

**Proposition 1.** Compatibility decreases content provision if  $n^{**} < n^* \Leftrightarrow 3\phi < \theta$  and increases content provision otherwise.

In many markets, there is the worry that the multi-homing side (i.e., the content providers) faces excessive prices. In our model, such situations would correspond to cases where  $\phi > \theta$  so that the license fee is positive. Our results then suggest that compatibility plays a useful role through lower license fees and an increase in the amount of content.

Neglecting any constants, user surplus is given by  $\Xi = v + \theta n - p$ . In equilibrium, user surplus under incompatibility and compatibility amounts to

$$\Xi^* = \frac{\phi^2 + \theta^2}{4} + \theta\phi - \tau$$

and

$$\Xi^{**} = \theta\phi - \tau.$$

Comparing user surplus across the two regimes, we find that users are better off under incompatibility. Hence, for uniformly distributed developing costs, even if the amount of content rises when products are compatible, this effect is small and cannot compensate for the increase in the user price. We point out, however, that this finding is not robust and relies on the assumption of a uniform distribution. More generally, with a nonuniform



distribution, either effect can dominate (see the discussion below).

Next we consider total welfare. First note that platforms agree on compatibility if profits increase. This is the case if fixed costs are not too high:

$$F < \frac{\theta^2}{16} + \frac{3\theta\phi}{8} + \frac{\phi^2}{16} =: F_p.$$

Total welfare depends on the provision of content to users, i.e., on the license fees. However, it does not depend on user prices as these are mere transfers between users and platforms. Thus, total welfare consists of the following elements: benefits of produced content (for users and content providers), costs of producing content, and fixed costs for introducing compatibility. Total welfare  $\Psi$  with and without compatibility is given by

$$\Psi^* = \frac{3(\theta + \phi)^2}{16}$$

and

$$\Psi^{**} = \theta\phi + \frac{\phi^2}{2} - 2F.$$

Compatibility is socially desirable only if

$$F < -\frac{3\theta^2}{32} + \frac{5\theta\phi}{16} + \frac{5\phi^2}{32} =: F_s.$$

Comparing  $F_p$  and  $F_s$  yields:

**Proposition 2.** Compatibility is insufficient if  $\phi > 5\theta/3$ . It is excessive if  $\phi < 5\theta/3$ .

The private incentives to choose compatibility can be insufficient or excessive. The result that compatibility can be insufficient is also obtained in a model with multi-homing and a fixed number of content developers. Doganoglu and Wright (2006) show that due to partial multi-homing, price competition is rather weak under incompatibility which results in too little incentives to introduce compatibility. The mechanism for insufficient compatibility is different in our paper. From a social-welfare perspective, compatibility is particularly desirable if content is increased, that is, if  $\phi$  is relatively large

(see *Proposition 1*). Besides the fixed cost, the private incentives to introduce compatibility depend on how compatibility affects the income streams of users and content providers. Revenues from users are increased due to relaxed price competition but this effect has no impact on total welfare. However, with lower license fees for content providers, there is lower license fee income which reduces the incentives to invest in compatibility. This, however, would be desirable from a total welfare perspective. As a result, the private incentives to introduce compatibility may be insufficient.

### **Alternative distributions of $f$**

Let the cost be distributed on the unit interval according to the distribution function  $G(f) = f^\gamma$ . This formulation nests the base model with  $\gamma = 1$ . With  $\gamma < 1$  ( $\gamma > 1$ ), the distribution function is concave (convex) meaning that many developers have a rather low (high) investment cost.

We perform the same analysis as before but analytical results are cumbersome to derive. Thus, we present our main results graphically. Setting  $\theta = 0.3$  and  $\phi = 0.8$ , the effect of compatibility on user surplus is ambiguous and depends on the distribution of the development cost. *Figure 1* plots the user surplus in both scenarios and shows that the effect of introducing compatibility becomes positive when the share of high-cost content is sufficiently large (i.e., large  $\gamma$ ). *Figure 2* decomposes the effect into the price and the content effect. Whereas both effects become smaller as  $\gamma$  becomes larger, the figure illustrates that the content effect becomes relatively more important.

[FIGURES about here]

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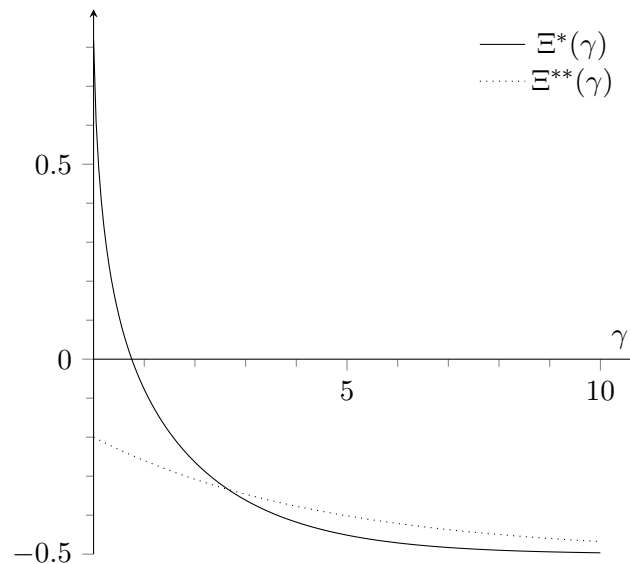


Figure 1: Comparison of user surplus in both scenarios for  $\theta = 0.3$ ,  $\tau = 0.5$ , and  $\phi = 0.8$ .

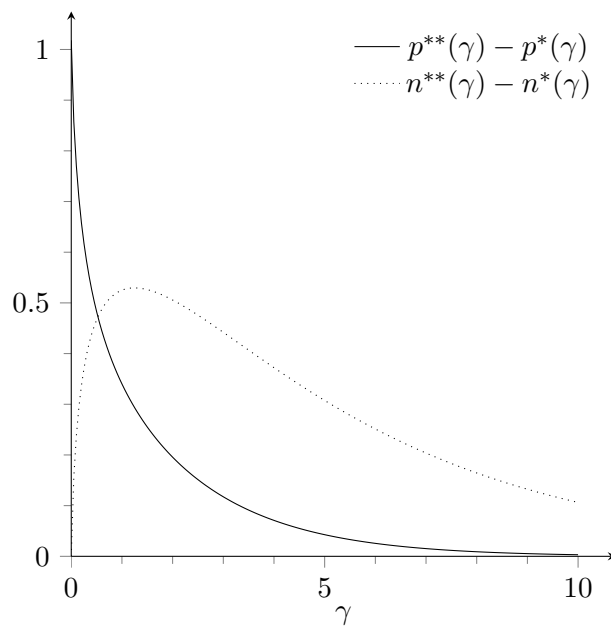


Figure 2: Effect of compatibility on price and content for  $\theta = 0.3$  and  $\phi = 0.8$ .