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Letter

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Welfare Effects of Socially Conscious Platforms in Two-Sided Markets

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Abstract: This note presents a model of platform competition in a two-sided market, with one competing platform pursuing not only its own profit but also consumer surplus. We investigate how the presence of such a socially conscious platform affects market competition. Results indicate that greater emphasis as an objective put on consumer surplus by the socially conscious platform leads to higher market share. Creation of a larger network enhances the total benefits associated with indirect network externalities in the two-sided market. When the extent of indirect network externalities is sufficiently strong, increased network benefits can improve social welfare. By contrast, if indirect network externalities are weak, then the socially conscious platform might be detrimental to society.

Keywords: two-sided platforms, mixed oligopoly, corporate social responsibility

1 Introduction

Some large platforms such as those of Google, Apple, and Amazon are becoming important infrastructure supporting daily life. Moreover, some existing infrastructure is adopting a platform business model, as explained later herein (Busch et al. 2021).[1] This note specifically presents examination of the latter

1 The former is designated as the "infrastructuralization of platforms," whereas the latter is called the "platformization of infrastructure" in the concept note released by the Expert Group for the EU Observatory on the Online Platform Economy on Work Stream 2: Infrastructural Power of Platforms. The note is available at https://platformobservatory.eu/news/work-stream-concept-notes-of-the-expert-group/.

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transformation, which increasingly emphasizes the importance of studies of platforms that are governed for purposes beyond profit maximization. Such transformation might lead to competition between (semi)public and private platforms. The purpose of this note is to present an investigation of the effects of socially conscious public platforms on competition in two-sided markets, along with the welfare consequences of those effects.

Currently, many platforms pursue not only the maximization of their own profits. They also seek to bring value to a broader set of stakeholders, some of which are jointly operated by governments. For example, MaaS Global Ltd. has run a MaaS platform *Whim* under leadership of the Finnish government. The platform allows people to combine various modes of transportation seamlessly (e.g., trains, buses, taxis, cars, and bicycles).[2] In several cities in the EU, the Whim platform faces competition with private MaaS companies such as *Kyyti*.

Another example can be found in the online education market. That market includes numerous platforms that connect people who want to study online with universities and educational institutes that offer online courses. These platforms are also known as Massive Open Online Courses (MOOCs). *Coursera* and *edX* are regarded as major MOOC platforms. Although both are now private companies pursuing profit maximization, edX had been a non-profit organization until it was acquired by 2U, Inc. in July 2021 during the COVID-19 pandemic.

Additionally, public employment agencies exist in numerous jurisdictions around the world (e.g., *Jobcentre Plus* in the UK, *Pôle emploi* in France, *Bundesagentur für Arbeit* in Germany, and *Hello Work* in Japan). These public agencies co-exist with private job-matching platforms such as Hays, International Recruitment Company, Approach People Recruitment, and Indeed.

Against this background, we study a model of platform competition in which competing platforms pursue not only their own respective profits, but also consumer surplus in the market. In so doing, we extend the model of Armstrong (2006), which is a pioneering work of the literature on two-sided markets. Specifically, we let one of two competing platforms (say, platform A) maximize $O^A = \pi^A + \beta \cdot CS$, where π^A is platform A's own profit and CS represents consumer surplus. Parameter β can be regarded as representing the extent to which platform A cares about consumers. One might argue that β can also be interpreted as representing the degree of corporate social responsibility (CSR) of the platform

2 According to their web page, the Whim platform is intended "to offer our consumers a happy life without having to own a car and to use MaaS to give everyone a chance to live a sustainable life with freedom of mobility." Source: https://whimapp.com/about-us/.FigRetrieved August 22, 2022.

(e.g., Arya, Mittendorf, and Ramanan 2019; Hino and Zennyo 2017). This attempt has not been described in the literature related to two-sided markets.

We show that greater emphasis placed on consumer surplus (i.e., the greater the β) by the socially conscious platform is associated with fiercer platform competition (i.e., lower equilibrium prices). More importantly, an increase in β distorts the allocation of users across the competing platforms. Specifically, as β increases, the socially conscious platform gains more users, whereas the rival loses market share. As a specification of the Hotelling model, this distortion increases the total transportation cost of users, which reduces social welfare. At the same time, the creation of a large network helps enhance indirect network externalities in the two-sided market, which can be beneficial to social welfare. The latter effect can be dominant when the degree of indirect network externalities is sufficiently strong. Therefore, in such cases, an increase in β improves social welfare. Otherwise, if indirect network externalities are weak, the presence of socially conscious platforms can be detrimental to society because it forces users who would otherwise prefer the rival platform to change their participation decision.

Our results contribute not only to the literature describing two-sided markets (Rochet and Tirole 2003), but also to the vast literature explicating mixed oligopolies (De Fraja and Delbono 1989; Matsumura 1998). The closest study along this avenue of the literature is work by Fanti and Buccella (2016), who examine a duopoly model with direct network externalities. In that model, competing firms maximize a weighted average of their own profit and consumer surplus. They demonstrate in that study that, with network externalities, larger profits are earned by firms according to the greater emphasis the firms put on consumer surplus in their objectives. Nevertheless, Fanti and Buccella (2016) do not examine its effects on social welfare. Unlike that earlier study, we examine platform competition with indirect network externalities. Furthermore, we elucidate the welfare effects of socially conscious platforms on competition in two-sided markets. The derived results can provide novel insights into the relevant literature.

2 Model Description

We extend the work horse model of Armstrong (2006) in a manner that allows one of two competing platforms to have consumer surplus in its objective function. Specifically, platform A has the objective function of $O^A = \pi^A + \beta \cdot CS$, where π^A represents the profit of platform A and CS is consumer surplus (defined in detail below), whereas the rival platform B is a pure profit-maximizer, i.e., $O^B = \pi^B$. Parameter $\beta \in [0,1]$ measures the extent to which platform A cares about consumer surplus. The remaining part of the model is the same as that of Armstrong (2006), as described briefly below.

Two platforms, indexed by $j = A, B$, are competing in a two-sided market through which agents of two groups, indexed by $i = 1, 2$, can mutually interact. One can consider, for example, that side-1 agents are job seekers and side-2 agents are firms seeking workers. Job-matching platforms enable workers and firms to seek, respectively, preferable alternatives for employment and hiring.

Platforms A and B compete in prices à la Hotelling on both sides. Especially, platform j offers a membership fee of p_i^j for side-i agents. On each side i, a unit mass of agents is distributed uniformly along a unit interval, $x_i \in [0, 1]$, where platform A is located at 0 and platform B at 1. We use u_i^j to denote the utility by which an agent on side i gains from joining platform j, which is specified below.

$$\begin{cases} u_i^A(x_i) = v + \alpha_i n_{-i}^A - p_i^A - t_i x_i \\ u_i^B(x_i) = v + \alpha_i n_{-i}^B - p_i^B - t_i(1 - x_i) \end{cases} \tag{1}$$

Therein, v is the stand-alone benefit of joining a platform. We assume that v is so large that every agent joins either platform A or B. Parameter α_i denotes the degree of indirect network externalities that agents on side i derive from interaction with agents on the opposite side. Also, n_{-i}^j represents the number of agents on the *other* side who participate in platform j. Parameter t_i represents the transportation cost for side-i agents. Agents choose a platform to join (i.e., single-homing).

One can find agents of the threshold type on side i, denoted as X_i, who are indifferent between joining platforms A and B as shown below.

$$u_i^A(x_i) = u_i^B(x_i) \;\Leftrightarrow\; x_i = \frac{1}{2} + \frac{\left(\alpha_i n_{-i}^A - p_i^A\right) - \left(\alpha_i n_{-i}^B - p_i^B\right)}{2t_i} \equiv X_i\left(n_{-i}^A, n_{-i}^B\right) \tag{2}$$

with this threshold, the demands for platforms A and B on side i are written, respectively, as $n_i^A = X_i\left(n_{-i}^A, n_{-i}^B\right)$ and $n_i^B = 1 - X_i\left(n_{-i}^A, n_{-i}^B\right)$ for $i = 1, 2$. By solving the system of these four equations with four variables $\left(n_1^A, n_1^B, n_2^A, n_2^B\right)$, we derive the demand function as

$$n_i^j = \frac{1}{2} + \frac{\alpha_i\left(p_{-i}^{-j} - p_{-i}^j\right) + t_{-i}\left(p_i^{-j} - p_i^j\right)}{2(t_1 t_2 - \alpha_1\alpha_2)} \tag{3}$$

for $i = 1, 2$ and $j = A, B$. Platform j's profit is given as $\pi^j = \sum_{i=1}^2 \left(p_i^j - c_i\right) n_i^j$, where c_i represents the marginal cost of providing services to agents on side i, which are assumed to be equal across competing platforms.

The aggregate surplus of side-i agents is computed as follows.

$$CS_i = \int_0^{n_i^A} \left(v + \alpha_i n_{-i}^A - p_i^A - t_i x_i\right) \mathrm{d}x_i + \int_{n_i^A}^{1} \left(v + \alpha_i n_{-i}^B - p_i^B - t_i(1 - x_i)\right) \mathrm{d}x_i \quad (4)$$

We define consumer surplus as $CS = CS_1 + CS_2$ and social welfare as $W = \pi^A + \pi^B + CS$.

For the existence and uniqueness of equilibrium of the game, we impose the following assumption.

Assumption 1. $0 \leq \alpha < \min\left\{\frac{2-\beta}{2}, \frac{3-3\beta}{3-2\beta}\right\}$ and $\beta \geq 0$.

Assumption 1 ensures that the second-order conditions for maximization are satisfied in equilibrium and that all the equilibrium outcomes take a non-negative value. If Assumption 1 is violated (i.e., either α or β, or both, is sufficiently large), then the equilibrium profit of the socially conscious platform A takes a negative value.

3 Results

We solve the one-stage game for which platforms A and B determine their prices simultaneously and independently to maximize their objectives. Formally, the maximization problems are expressed as $\max_{(p_1^A, p_2^A)} O^A$ and $\max_{(p_1^B, p_2^B)} O^B$, where $O^A = \pi^A + \beta \cdot CS$ and $O^B = \pi^B$.

In the following, for the sake of simplicity, we put parametric assumptions of $\alpha_1 = \alpha_2 = \alpha$, $t_1 = t_2 = 1$ and $c_1 = c_2 = 0$ in addition to Assumption 1.

Solving the system of four first-order conditions of $\frac{\partial O^j}{\partial p_i^j} = 0$ for $i = 1, 2$ and $j = A, B$, one can derive the equilibrium prices, denoted as $\hat{p}_i^j$. In equilibrium, each platform j sets the same price for two sides, i.e., $\hat{p}_1^j = \hat{p}_2^j$ for $j = A, B$. Table 1 presents the full description of $\hat{p}_i^j$.

Using the equilibrium prices, one can derive the resulting demands $\left(\hat{n}_i^j\right)$, profits $(\hat{\pi}^j)$, consumer surplus $(\hat{CS}_i)$, and social welfare $(\hat{W})$, as presented in Table 1.

The following propositions describe how changes in β respectively alter the equilibrium prices, demands, profits, consumer surplus, and social welfare.

Table 1: Equilibrium outcomes.

	Platform $j = A$	Platform $j = B$
$\hat{p}_i^j$	$\frac{(1-\alpha)\{3(1-\alpha-\beta)+2\alpha\beta\}}{3-3\alpha-\beta}$	$\frac{(1-\alpha)\{3(1-\alpha-2\beta/3)+\alpha\beta\}}{3-3\alpha-\beta}$
$\hat{n}_i^j$	$\frac{3-3\alpha-\alpha\beta}{2(3-3\alpha-\beta)}$	$\frac{3-3\alpha-(2-\alpha)\beta}{2(3-3\alpha-\beta)}$
$\hat{\pi}^j$	$\frac{(1-\alpha)\left\{9(1-\alpha)^2-3(3-\alpha)(1-\alpha)\beta+\alpha(3-2\alpha)\beta^2\right\}}{(3-3\alpha-\beta)^2}$	$\frac{(1-\alpha)(3-3\alpha-2\beta+\alpha\beta)^2}{(3-3\alpha-\beta)^2}$
$\hat{CS}_i$	$v+\frac{9(1-\alpha)^2(-5+6\alpha)+6(1-\alpha)(8-12\alpha+3\alpha^2)\beta+(-10+16\alpha-5\alpha^2)\beta^2}{4(3-3\alpha-\beta)^2}$	
$\hat{W}$	$2v+\frac{(2\alpha-1)\left\{(3(1-\alpha)-\beta)^2+(1-\alpha)^2\beta^2\right\}}{2(3-3\alpha-\beta)^2}$	

Proposition 1. *An increase in β reduces all the equilibrium prices. Formally, $\frac{\partial \hat{p}_i^j}{\partial \beta} < 0$ holds for $i = 1, 2$ and $j = A, B$.*

Proof. The derivatives of $\hat{p}_i^A$ and $\hat{p}_i^B$ with respect to β are computed as follows.

$$\frac{\partial \hat{p}_i^A}{\partial \beta} = -\frac{6(1-\alpha)^3}{(3-3\alpha-\beta)^2} < 0 \tag{5}$$

$$\frac{\partial \hat{p}_i^B}{\partial \beta} = -\frac{3(1-\alpha)^3}{(3-3\alpha-\beta)^2} < 0 \tag{6}$$

□

An increase in parameter $\beta \in [0, 1]$ implies that platform A places greater emphasis on consumer surplus in its objective. Greater emphasis the platform A puts on consumer surplus implies lower prices it charges to agents of both sides. Lower prices set by platform A induce rival platform B to decrease prices because of the strategic complementarity of the game.

Proposition 2. *An increase in β increases the demands of platform A, but decreases those of platform B. Formally, for $i = 1, 2$, $\frac{\partial \hat{n}_i^A}{\partial \beta} > 0$ and $\frac{\partial \hat{n}_i^B}{\partial \beta} < 0$ hold.*

Proof. The derivatives of $\hat{n}_i^A$ and $\hat{n}_i^B$ with respect to β are given below.

$$\frac{\partial \hat{n}_i^A}{\partial \beta} = \frac{3(1-\alpha)^2}{2(3-3\alpha-\beta)^2} > 0 \tag{7}$$

$$\frac{\partial \hat{n}_i^B}{\partial \beta} = -\frac{3(1-\alpha)^2}{2(3-3\alpha-\beta)^2} < 0 \tag{8}$$

□

As shown in Proposition 1, an increase in β leads the competing platforms to reduce their prices. Its effect is greater for platform A than for platform B. In other words, platform A discounts prices more aggressively than the rival does. Consequently, platform A can attract more agents of both sides, whereas platform B loses its market share.

Proposition 3. *An increase in β reduces the profits of competing platforms.*

Proof. The derivatives of $\hat{\pi}^A$ and $\hat{\pi}^B$ with respect to β are given as presented below.

$$\frac{\partial \hat{\pi}^A}{\partial \beta} = -\frac{3(1-\alpha)^3\{(1-\alpha)(4\beta+3)-\beta\}}{(3-3\alpha-\beta)^3} < 0 \tag{9}$$

$$\frac{\partial \hat{\pi}^B}{\partial \beta} = -\frac{6(1-\alpha)^3\{3-3\alpha-(2-\alpha)\beta\}}{(3-3\alpha-\beta)^3} < 0 \tag{10}$$

□

Greater emphasis placed by platform A on consumer surplus is associated with fiercer price competition (Proposition 1). Given the fixed market demand of the Hotelling model, the consequently increased competition harms competing platforms unambiguously.

Proposition 4. *An increase in β increases consumer surplus. Formally, $\frac{\partial \hat{CS}_i}{\partial \beta} > 0$ holds for $i = 1, 2$.*

Proof. The derivative of $\hat{CS}_i$ with respect to β is given as shown below.

$$\frac{\partial \hat{CS}_i}{\partial \beta} = \frac{3(1-\alpha)^3(9-9\alpha-2\beta)}{2(3-3\alpha-\beta)^3} > 0 \tag{11}$$

□

Proposition 4 is the flip side of Proposition 3. That is, increased competition associated with an increase in β benefits consumer surplus at the expense of the competing platforms.

The aggregate effect on social welfare depends on the prevailing circumstances, as presented in the following proposition.

Proposition 5. *An increase in β increases social welfare if and only if $\alpha > 1/2$.*

Proof. The derivative of $\hat{W}$ with respect to β is calculated as $\frac{\partial \hat{W}}{\partial \beta} = \frac{3(1-\alpha)^3(2\alpha-1)\beta}{(3-3\alpha-\beta)^3}$, which can, under Assumption 1, take a positive value for $\alpha > \frac{1}{2}$. □

Greater emphasis the platform A puts on consumer surplus is associated with fiercer platform competition, consequently harming the platforms (Proposition 3) while benefiting consumers (Proposition 4). When the latter effect on consumers dominates the former one, then increased competition is desirable in terms of social welfare. Proposition 5 shows that this desirable consequence is more likely to occur when the extent of indirect network externalities across two sides is sufficiently strong.

It would be worth noting that, in the present model, the mass of agents is assumed to be the same across two sides. One can infer that there are more (resp. fewer) agents on side 1, which the socially conscious platform takes care of, than on side 2. In such cases, the socially conscious platform would have a greater (resp. smaller) incentive to reduce prices, making platform competition more (resp. less) intense. Accordingly, the platform profit decreases further in terms of Proposition 3 and consumer surplus rises further in terms of Proposition 4. However, it is ambiguous which effect is more likely to dominate the other one. Consequently, further investigations might be necessary for consequential effects on social welfare.

Finally, some caveats must be noted for our results, which might depend to some degree on the Hotelling specifications. When considering welfare implications derived in the Hotelling model with fixed market demand, changes in prices are well known not to affect the overall social welfare because they are merely a transfer of surplus between consumers and firms. This lack of price effects is also true for the present model. In such cases, for welfare implications, the allocation of agents across competing platforms affects the results. With $\beta = 0$, the competing platforms share the market equally (i.e., $n_i^j = 1/2$).

The presence of the socially conscious platform with $\beta > 0$ distorts the allocation of agents across the competing platforms. As presented in Proposition 2, the socially conscious platform attracts more agents of both sides. This distortion has positive and negative effects on social welfare when using the present model. First, the distortion increases the total transportation cost of agents, which consequently harms social welfare. Second, the distortion contributes to creation of a large network in which agents can enjoy greater benefits from indirect network externalities. The extent of the second effect depends crucially on the degree of indirect network externalities. If they are strong, then the second impact can be dominant.

It is expected to be important to explore the robustness of our results with other modeling specifications where total demand varies endogenously.

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