Fair cost sharing under platform two-sided intermediation

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Abstract. We study the pros and cons of the "fair cost sharing" proposal, which entitles the charging of a fraction of the traffic cost incurred by an access Internet Service Provider (ISP) to the Content Providers (CPs) that deliver content to the access ISP users. This study is conducted in a scenario where CPs host their content in a platform and where the platform operates two-sided pricing for the intermediation between CPs and users. Our hypotheses is that this two-sided pricing interacts in a relevant manner with the access ISP, which can only price the user side. We conclude that a cost sharing regulation, when complete pass-through is executed by a content aggregating platform, does not improve the ISP's profit and does not preclude the platform from obtaining profits either. Furthermore, we found that the value that the platform eventually captures is the value that the ISP would capture if the platform was absent.

Keywords: Fair cost sharing · Platform · Internet Service Providers.

1 Introduction

Net neutrality has been debated intensively since it first was advocated two decades ago. And it has been regulated worldwide, prominently in the US and in the EU. There are multiple approaches to the net neutrality concept. We focus on the one which prevents an access Internet Service Provider (ISP) to charge Content Providers (CPs) in order that the CPs can reach access ISP's subscribers [3].

It has been claimed by access ISPs that charging a side payment to the CPs, which is forbidden by net neutrality regulations, would contribute to the upgrade of the infrastructure needed to support the huge amount of traffic that flows from the CPs to the users. This rationale has recently been proposed under the concept of "direct compensation" or "fair cost sharing" [4].

We do not aim to contribute to the general debate on net neutrality under the current facade [6]. Instead, we will focus on the fact that CPs not only need access ISP in order to reach users that subscribe to their services, but

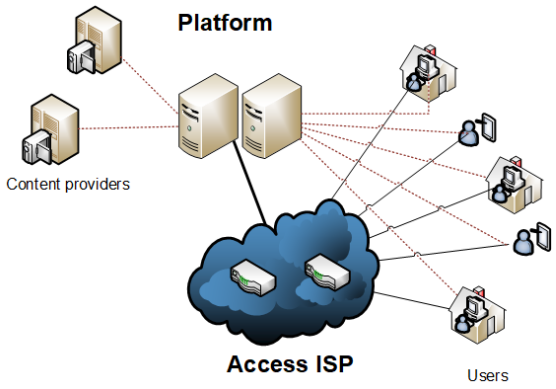

Fig. 1: Scenario

also need platforms (e.g., Google YouTube, Amazon Prime Video, Netflix) that intermediate and match CPs against users. These platforms do not abide to an equivalent net neutrality regulation, and therefore they have been applying two-sided pricing mechanisms since their inception, which allows them to actively manage the cross-network effects operating in such business models.

Our focus is then to analyze the pros and cons of enforcing a fair cost share regulation when access ISPs serve the content aggregated by big platforms, within a framework where the latter operate two-sided pricing in their business models. Our hypothesis is that platform two-sided pricing interacts in a relevant manner with the access ISP business model.

2 Economic Model

We model a scenario as depicted in Fig. 1. The users have access to an access ISP that provides access to the internet and to a platform that intermediates and matches users and CPs, among other service offerings. The CPs can only reach the users through the access ISP and only serve their contents through the platform, which is assumed to host the CPs' content. Therefore, the ISP and the platform are necessary for the users to subscribe and use the services provided by the CPs. And both ISP and platform create their respective stand-alone value with additional (although typically more basic) services.

2.1 Users' Subscription

We model a mass of N_u non-atomic users that are potential subscribers of both the access ISP and the platform, so that if they do subscribe to both of them, they will be able to enjoy the service provided by the CPs. The users are homogeneous in all their characteristics except in the value of the outside option. We assume

that the outside option of each user is drawn independently from a uniform distribution over the unity interval $[0, 1]$.

Each user is charged a fee β by the platform and a price b by the access ISP. We therefore assume that the ISP charges a flat-rate tariff.

The users derive a stand-alone value r_u from the combined platform-ISP service. And they derive an additional value that is increasing in the number of CPs offering their contents through the platform and the ISP. If the number of joined CPs is n_c, this additional value, assuming a linear dependence, is δn_c, so that δ models the intensity of the cross-group network effect that the CP side exerts on the user side.

Putting all the above modeling assumptions together, the expression for the utility that a user derives if he/she subscribes to the combined service is:

$$u = r_u + \delta n_c - \beta - b \tag{1}$$

Note that the above expression has similarities with the common modeling of the utility derived by the users of a platform when they are charged a participation fee $\beta + b$ [1]. Nevertheless, in this work, as it will be detailed below, these participation fees are charged by two independent agents.

Finally, since the outside option u_0 of each user is uniformly distributed in the unity interval, the number of users that will subscribe to the combined service n_u can be computed as:

$$\begin{aligned} \frac{n_u}{N_u} &= \text{Prob}\{u_0 \leq u\} = \\ &= \text{Prob}\{u_0 \leq r_u - \beta - b + \delta n_c\} \\ &= \begin{cases} 0 & \text{if } r_u - \beta - b + \delta n_c < 0 \\ r_u - \beta - b + \delta n_c & \text{if } 0 \leq r_u - \beta - b + \delta n_c \leq 1 \\ 1 & \text{if } 1 < r_u - \beta - b + \delta n_c \end{cases} \end{aligned} \tag{2}$$

2.2 CPs' Decision

We model a mass of N_c non-atomic CPs that are willing to offer their contents to the users, which are reachable by means of the combined platform-ISP service. The CP's business model is based on advertisement. The CPs are homogeneous in all their characteristics except in the benefit of the outside option, which we assume it is drawn independently from a uniform distribution over the unity interval $[0, 1]$.

A CP is charged a fee α by the platform and a price c' per traffic unit that is downloaded to the subscribers. If we assume that an average traffic ω is downloaded from a CP to a user, we can denote by $c = c'\omega$ the price per user that is charged to the CP.

The CP derives a stand-alone benefit r_c from the combined platform-ISP service. And it gets an advertising revenue γ per user. Since the number of subscribers is n_u, this additional revenue is γn_u, so that we can interpret γ as

the intensity of the cross-group network effects that the user side exerts on the CP side.

Putting all the above modeling assumptions together, the expression for the profit that a CP obtains if joins to the combined service is:

$$\Pi_c = r_c + \gamma n_u - \alpha - c n_u = r_c - \alpha + (\gamma - c) n_u \tag{3}$$

Again, note that the above expression has similarities with a setting where the CPs are charged both a participation fee α and a transaction fee c [5].

Finally, since the outside option Π_0 of each CP is uniformly distributed in the unity interval, the number of CPs that will join to the combined service n_c can be computed as:

$$\begin{aligned} \frac{n_c}{N_c} &= \text{Prob}\{\Pi_0 \leq \Pi_c\} = \\ &= \text{Prob}\{\Pi_0 \leq r_c - \alpha + (\gamma - c) n_u\} \\ &= \begin{cases} 0 & \text{if } r_c - \alpha + (\gamma - c) n_u < 0 \\ r_c - \alpha + (\gamma - c) n_u & \text{if } 0 \leq r_c - \alpha + (\gamma - c) n_u \leq 1 \\ 1 & \text{if } 1 < r_c - \alpha + (\gamma - c) n_u \end{cases} \end{aligned} \tag{4}$$

2.3 Platform's Decisions

The platform charges a fee β to each subscriber and a fee α to each joined CP, so that it gets a revenue equal to

$$\Pi_p = \alpha n_c + \beta n_u. \tag{5}$$

We neglect the variable costs incurred by the platform, so that the platform will set the two-sided price $\{\alpha, \beta\}$ in order to maximize Π_p.

2.4 ISP's Decisions

The access ISP gets revenues from the subscribers equal to $b n_u$. As regards the costs, we assume that only traffic-related variable costs are incurred, and the marginal cost is constant and equal to k'. As argued above, the total aggregated traffic from all joined CPs and all subscribers is equal to the product $n_u n_c \omega$.

We assume that a cost share can be enforced and that the platform is able to pass-through all this share fee to the corresponding CPs. The cost share is denoted by c' per traffic unit, or $c = c'\omega$ per CP-user transaction.

The profits are therefore given by:

$$\Pi_u = b n_u - (k - c) n_u n_c, \tag{6}$$

where $k = k'\omega$, and $0 \leq c \leq k$ is assumed. The access ISP will set b in order to maximize Π_u.

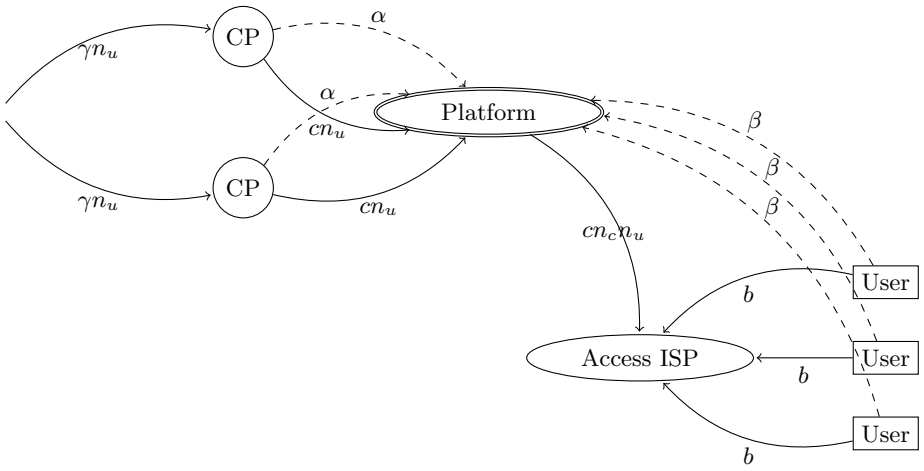

Fig. 2: Platform and ISP payment flow model

3 Analysis

Fig. 2 summarizes the payments flow described above in the model.

We assume the following sequence of decisions:

1. A cost share fee c is set.
2. The platform sets $\{\alpha, \beta\}$ and the ISP sets b.
3. The users and the CPs decide whether to subscribe/join or not.

We therefore assume that the pricing decisions by the platform and the access ISP are taken simultaneously and independently.

Furthermore, once prices are set by the access ISP and the platform, the subscription decisions by users and CPs are modeled under the assumption of a fulfilled-expectations equilibrium, where agents (users or CPs) from one side form the same expectations on the participation of the agents of the other side and these expectations turn out to be correct. That is, the number of subscribers n_u and joined CPs n_c will be the solution $\{n_u, n_c\}$ to the system of the two equations (2) and (4) [2, p.83]. We assume that $1 - \delta(\gamma - c)N_u N_c > 0$, so that the demand functions n_u and n_c are decreasing with their own prices.

We restrict our analysis to interior equilibrium solutions $\{n_u, n_c\}$, that is $0 \leq r_u - \beta - b + \delta n_c \leq 1$ and $0 \leq r_c - \alpha + (\gamma - c)n_u \leq 1$. And we will solve the ISP's and platform's profit maximization problems through the First Order Conditions.

4 Results

We compare the scenario described in the previous sections, where the platform is *present* and implements a two-sided pricing, against a baseline scenario, where

the platform is *absent*. In the baseline scenario, no fees $\{\alpha, \beta\}$ are charged and it is assumed that the content can still match the users.

We discuss the results in terms of ISP profits (Figs. 3, and 13), platform profits (Figs. 4 and 14), number of subscribers (Figs. 8 and 15), number of joined CPs (Figs. 9 and 16), users/consumers' surplus (Figs. 10 and 17), CP surplus (Figs. 11 and 18), and social welfare (Figs. 12 and 19)

The Consumers' and CPs' surpluses are respectively computed as follows:

$$CS \equiv N_u \int_0^u u \, 1 \, du_0 \tag{7}$$

$$CPS \equiv N_c \int_0^{\Pi_c} \Pi_c \, 1 \, d\Pi_0. \tag{8}$$

And the Social Welfare is the sum of the surpluses of all agents:

$$SW = CS + CPS + \Pi_p + \Pi_u. \tag{9}$$

The parameters used are $N_u = 10$, $N_c = 1$, $\delta = 0.3$, $\gamma = 0.3$, $k = 1$ and $c = 0.3$ if not stated otherwise. When the platform is present, the stand-alone benefits are $r_u = 1$ and $r_c = 1$; when the platform is absent, these are lower and set to $r_u = 0.7$ and $r_c = 0.7$. For all parameters values, the concavity of the profit functions are assured, so that the Nash equilibrium exists.

We conduct below comparative statics, that is, we characterize the equilibrium of the two-stage game described above as one parameter is varied across a range of values. Specifically, we analyze the effect of parameter c (Section 4.1), which is the cost share that the CPs must contribute to the access ISP; and of parameter γ (Section 4.2), which quantifies the per subscriber advertising revenue for the CP.

4.1 Comparative Statics: c

The parameter c varies between 0 and 0.45.

The results show that, when the platform is present, the ISP and the users are better off for low c, but worse off for high c (Fig. 3 and Fig. 10). However, the CPs are better off when the platform is present (Fig. 11). The overall effect of the platform presence, when measured by the social welfare, is positive when c is low and negative when c increases.

When the platform is present, the results show that an increase in the cost share benefits mostly the platform (Fig. 4), and there is no relevant change for the ISP (Fig. 3). The CPs are the main agents that get harmed. This result is made possible by a combination of pricing decisions (Figs. 5,6,7): β increasing, b decreasing and α decreasing (even negative). The overall effect of an increase in c is beneficial, however, as far as the social welfare is concerned (Fig. 12).

When the platform is absent, there is an even larger positive impact of an increase in c.

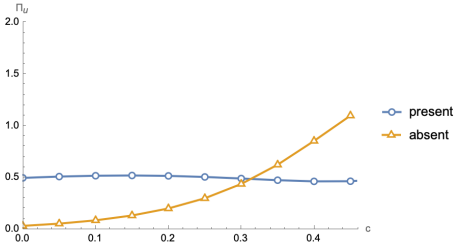

Fig. 3: Access ISP's profit as a function of c

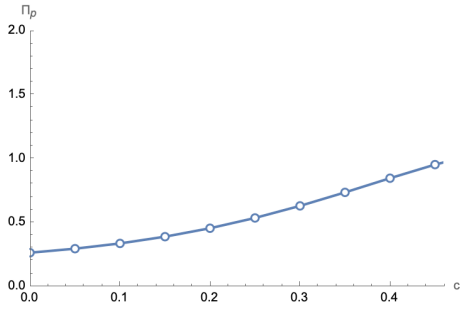

Fig. 4: Platform's profit as a function of c

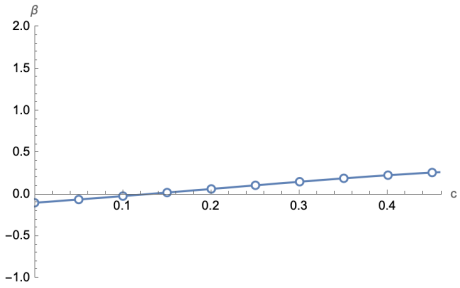

Fig. 5: β as a function of c

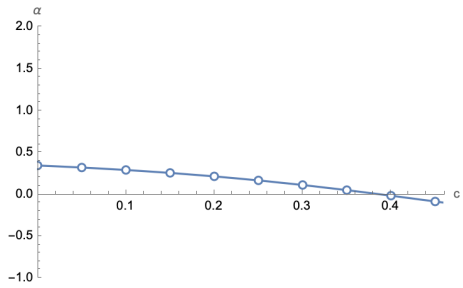

Fig. 6: α as a function of c

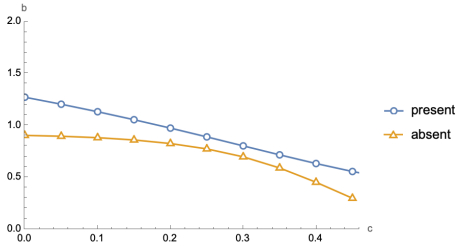

Fig. 7: b as a function of c

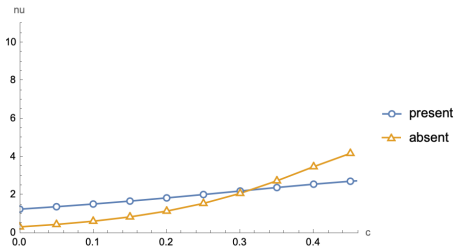

Fig. 8: Number of subscribers as a function of c

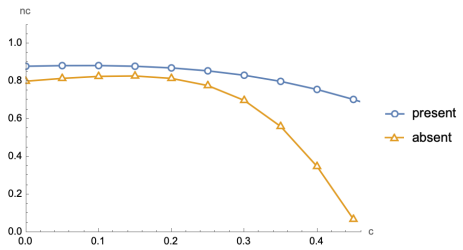

Fig. 9: Number of joined CPs as a function of c

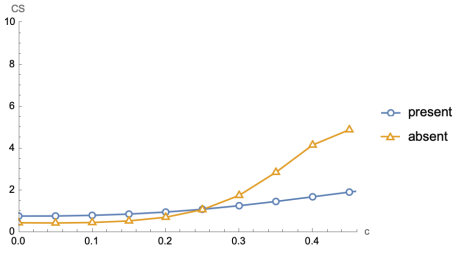

Fig. 10: Consumers surplus as a function of c

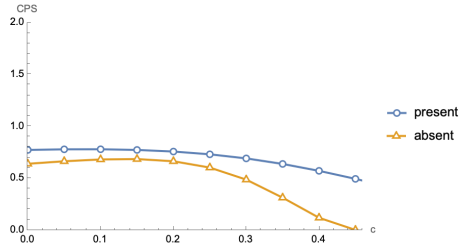

Fig. 11: CPs surplus as a function of c

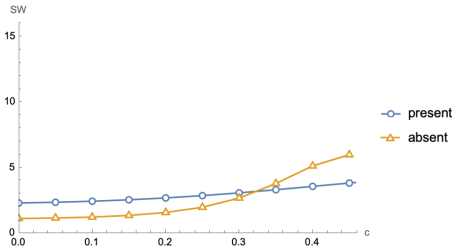

Fig. 12: Social welfare as a function of c

4.2 Comparative Statics: γ

The parameter γ varies between 0.16 and 0.30.

The results show that, when the platform is present, the ISP is worse off for low γ, and it gets indifferent as γ increases (Fig. 13). The users are worse off (Fig. 17). The CPs are better off (Fig. 18). And the overall effect is detrimental for low γ and slightly beneficial for high γ (Fig. 19).

When the platform is present, the ISP and the CPs capture the value of an increase in γ (Figs. 13 and 18), while the platform and the users lose value (Figs. 14 and 17), and the overall effect is slightly detrimental (Fig. 19). When the platform is absent, the users lose value more rapidly and the overall effect of the increase is now clearly detrimental.

5 Conclusions

The conclusions are that a cost sharing regulation, when complete pass-through is executed by a content aggregating platform, does not improve the ISP's profit and does not preclude the platform from obtaining profits either. Furthermore, despite the fact that higher cost shares are always detrimental for the CPs, they are less detrimental when the platform is present. And the value that the platform captures is the value that the ISP captures when the former is absent. Finally, the social welfare, driven mostly by the consumer surplus, is higher when the platform is present only for low values of the cost share.

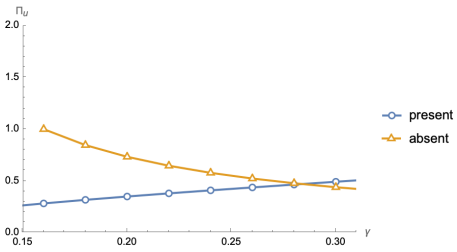

Fig. 13: Access ISP's profit as a function of γ

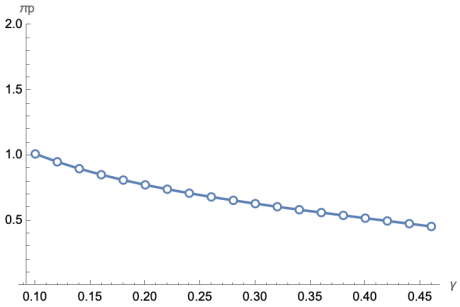

Fig. 14: Platform's profit as a function of γ

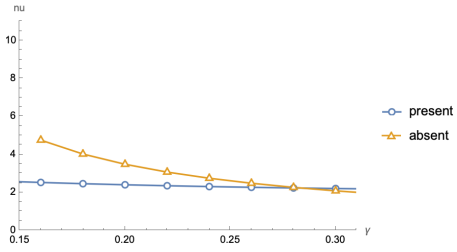

Fig. 15: Number of subscribers as a function of γ

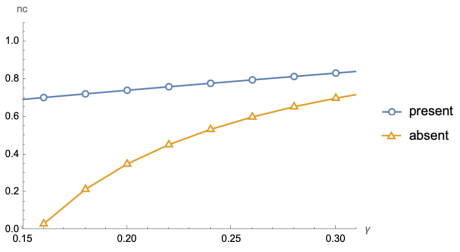

Fig. 16: Number of joined CPs as a function of γ

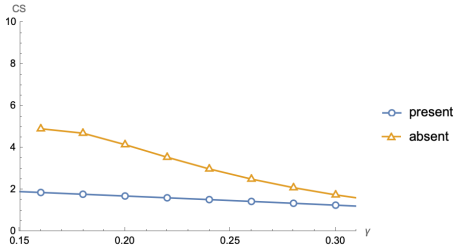

Fig. 17: Consumers surplus as a function of γ

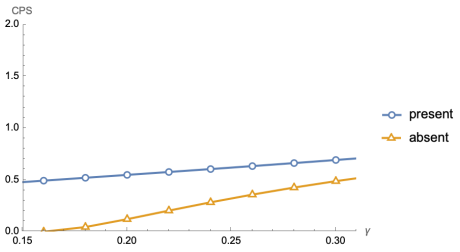

Fig. 18: CPs surplus as a function of γ

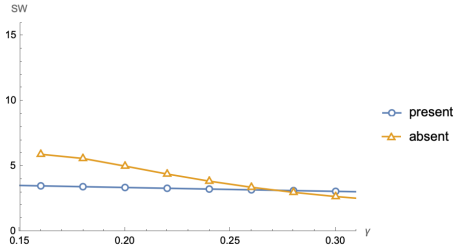

Fig. 19: Social welfare as a function of γ

The above conclusion would argue in favor of the effectiveness of the two-sided platform pricing in counteracting the harm on CPs incurred by a cost-sharing regulation.

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