Sponsored data with ISP competition

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***Abstract*—We analyze the effect of sponsored data platforms when Internet service providers (ISPs) compete for subscribers and content providers (CPs) compete for a share of the bandwidth usage by the customers. Our analytical model is of a full information, leader-follower game. ISPs lead and set prices for sponsorship. CPs then make the binary decision of sponsoring or not sponsoring their content on the ISPs. Lastly, based on both of these, users make a two-part decision of choosing the ISP to which they subscribe, and the amount of data to consume from each of the CPs through the chosen ISP. User consumption is determined by a utility maximization framework, the sponsorship decision is determined by a non-cooperative game between the CPs, and the ISPs set their prices to maximize their profit in response to the prices set by the competing ISP. We analyze the pricing dynamics of the prices set by the ISPs, the sponsorship decisions that the CPs make and the market structure therein, and the surpluses of the ISPs, CPs, and users. We show that inter-ISP competition does not inhibit ISPs from extracting a significant fraction of the CP surplus. Moreover, the ISPs often have an incentive to significantly skew the CP marketplace in favor of the most profitable CP.**

I. Introduction

Market segmentation and discriminatory pricing are well known techniques that ISPs can use to increase revenues. A combination of inter-ISP competition, market expectations and regulatory issues have rendered such schemes to be not so prevalent on the user side. However, sponsored data or zero-rating is a price discrimination technique that is being introduced by ISPs in many markets as a consumer friendly innovation and is gaining increased adaptation. In this scheme, the content provider (CP) pays the ISP charges for its content that is consumed by the users while the users do not pay the ISP charges for the same.

Regulatory response to sponsored data, or zero-rating, has been varied. In many countries, it is deemed to violate net neutrality regulations and is hence banned, e.g., Canada, Brazil, India, Chile, Sweden, Hungary. In many other countries it is allowed alongside net neutrality regulations that disallow discriminatory QoS schemes, e.g., USA, UK, Netherlands, Germany [1]. Wherever allowed, it is expected that such schemes will become more prevalent and many companies are making plans to enter this 23 billion dollar market.[1] In this paper we study the effect of such services on the content provider market and on the surpluses of various stakeholders.

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[1] https://www.mobilemarketer.com/ex/mobilemarketer/cms/news/research/20919.html

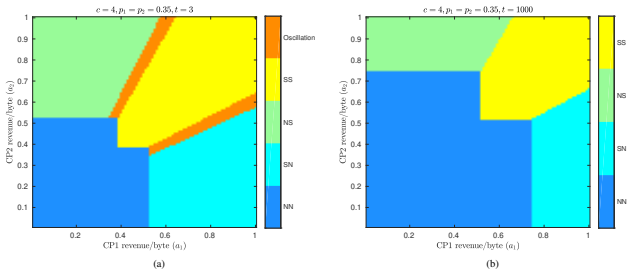

Fig. 1: Limiting sponsorship configurations as a function of CP1 and CP2 revenue for varying user stickiness (a) Small transportation cost (c) Large transportation cost

II. Model and results

We consider two competing ISPs and two competing CPs. Each ISP operates a zero-rating platform, and CPs have the option of sponsoring their content by joining the zero-rating platform of one or both ISPs. ISP j charges p_j dollars per unit of data to its subscribers and a sponsoring charge of q_j dollars per unit of data on CPs that zero-rate their content.[2] CPs derive their revenue via advertisements; CP i makes a revenue of a_i dollars per unit of data consumed by users. Users subscribe to exactly one of the two ISPs and consume content of the CPs through that ISP. Further, the volume of user consumption is determined by the ISP charges and the utility obtained.

We capture the strategic interaction between the users, CPs, and ISPs via a three-tier leader follower model— 1. ISPs 'lead' by setting sponsorship charges, 2. CPs respond to sponsorship charges by making the binary decision of whether or not to sponsor their content on each ISP, and 3. finally, the user base responds to the actions of the CPs by determining the fraction of subscribers of each ISP.

We assume that users derive a utility of $\psi_i(\theta)$ from consuming θ bytes of data from CP i and each user can consume maximum c bytes in a billing cycle. We model the distribution of users between ISPs using the *Hotelling model* [3]. We imagine the users as being distributed uniformly over the unit interval $[0, 1]$. ISP 1 is located at the left end-point of this interval, and ISP 2 is located at the right end-point. A user at position $x \in [0, 1]$ incurs a (virtual) transportation cost of tx to connect to ISP 1, and a (virtual) transportation cost

[2] Such usage-based pricing is prevalent in the mobile Internet space [2].

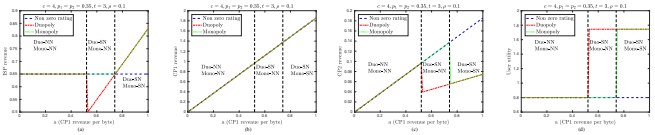

Fig. 2: Surplus of various entities when revenue per byte of CP1 is much higher than that of CP2 (a) ISP revenue (b) CP1 revenue (c) CP2 revenue (d) User surplus

$t(1-x)$ to connect to ISP 2. Since each (non-atomic) user connects to the ISP that provides the higher payoff (surplus minus transportation cost), the market split can be determined. The transportation cost captures the inherent *stickiness* of users to a certain ISP with higher value of t implying increased user stickiness. [3] Figure 1 shows the limiting behavior of the best response dynamics for different values of t. Note that as t grows, the region of the $a_1 \times a_2$ where the ISPs induce one or both CPs to sponsor shrinks which is a result of a *prisoner's dilemma* between the ISPs: When t is small, i.e., when inter-ISP user churn is significant, each ISP has the unilateral incentive to induce sponsorship even at small CP revenue rates, to benefit from the resulting increase in its subscriber base. However, once one ISP induces sponsorship, the other ISP is also incentivised to induce sponsorship to recover its lost market share. As a result, the ISPs arrive at an equilibrium that leaves them both worse off. On the other hand, when t is large, the ISPs induce sponsorship only when it is mutually beneficial for them to do so.

Figure 2 shows the surplus of various entities in monopoly (only one ISP), duopoly (two ISPs) and non zero rating scenario when the revenue of CP1 is much higher than that of CP2. We observe that except for intermediate values of CP1 revenue, where competition forces both ISPs to induce sponsorship prematurely, the surplus of all parties matches that in the monopoly case: the ISPs are able to extract a considerable fraction of CP surplus, and neither CP benefits from zero-rating. User surplus is enhanced due to zero-rating.

We observe a prisoner's dilemma between the ISPs for intermediate values of revenue where the ISP's enter into a mutually sub-optimal sponsorship equilibrium even when both CPs have comparable revenues; see Figures 3,4. For large CP revenue, we observe a prisoner's dilemma between the CPs as well, wherein both CPs end up sponsoring for large enough a, and in the process end up worse off than if neither CP had sponsored. Note that the user surplus is enhanced by sponsorship in this case also.

Proofs of the results stated in this section are omitted due to space constraints; these can be found in [4].

III. Policy Implications and Discussion

Our analyses show that data sponsorship practices grant ISPs considerable market power—indeed, our results highlight

[3] In practice, user stickiness may result from many considerations like inertia, high lead time to switch ISPs, and familiarity with the features and services offered by one's present ISP.

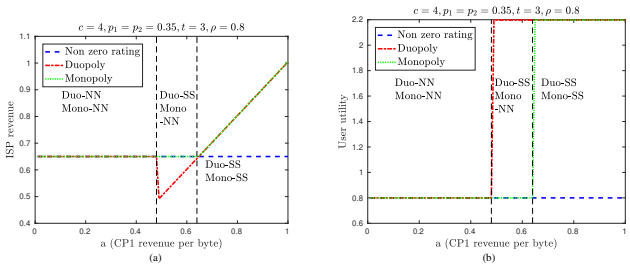

Fig. 3: (a) ISP revenue and (b) User surplus when difference in revenue per byte for CP1 and CP2 is small

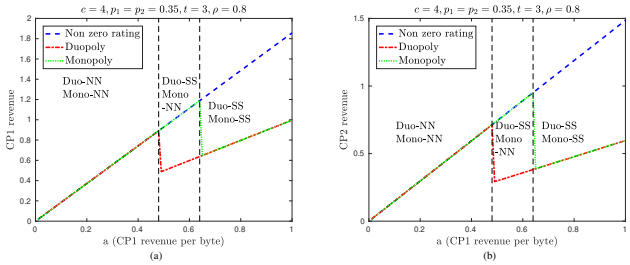

Fig. 4: (a) CP1 and (b) CP2 revenue when difference in revenue per byte for CP1 and CP2 is small

that this power is *not* diminished by inter-ISP competition. When ISPs lead in setting sponsorship prices, they do in such a way that a significant fraction of the CP surplus gets paid to the ISPs in the form of sponsorship costs. Even the sponsoring CP does not typically benefit from this process and on the other hand, less profitable CPs can suffer and be eliminated from the market. Thus the meta message from our analysis is that the zero rating, although good for the consumers in the short term because of the increase in their surplus, could in the long run have negative consequences on the CP marketplace. An important observation from our analysis is that zero rating drives consumption away from non-sponsored content.[4] Since this skew of user consumption in favor of sponsored content lies at the heart of the ISP market power, a possible regulatory intervention (other than disallowing data sponsorship entirely) could be to limit zero-rated content so as to leave room for non zero-rated content to also contend for user attention.

References

[1] Sandvine, "Best practices for zero-rating and sponsored data plans under net neutrality," White Paper, 2016. [Online]. Available: www.sandvine.com

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[3] H. Hotelling, "Stability in competition," in *The Collected Economics Articles of Harold Hotelling*. Springer, 1990, pp. 50–63.

[4] P. Vyavahare, D. Manjunath, and J. Nair, "Sponsored data with ISP competition," https://arxiv.org/abs/1906.00581, 2019.

[4] This has also been verified empirically. dflmonitor.eu has reported that the ISPs that provide zero rated content actually sell significantly less bandwidth to end users than those that do not zero-rate.