Optimal Price/Advertising Menus for Two-Sided Media Platforms

Providers of media content and digital services (platforms) face a market with two sides. Consumers value the platform’s content or service and wish to use it, while advertisers value the consumers’ attention. Thus, the platform’s success in attracting the consumer is imperative for its success in attracting the advertiser. The converse is not usually the case, however, as consumers tend to perceive advertising as an annoyance (e.g., Goldstein et al., 2013; McCoy et al., 2007). Further, consumers vary in the degree to which they find ads annoying, with some indicating a willingness to pay to avoid ads while many others consider them a small disturbance (e.g., Accenture, 2016; Rao, 2013; McDonald and Cranor, 2010). We refer to a consumer’s level of advertising annoyance as their disutility for advertising.

Platforms tend to have incomplete information on consumer advertising disutility. However, many platforms use menu pricing to segment customers according to their preferences. Popular music and video streaming websites Pandora, Spotify, and YouTube all offer a free version of their product supported by ads, as well as a paid subscription version with no ads. YouTube’s parent company, Google, has gone even further by offering the Contributor service, which allows users to pay to avoid ad content on websites using Google’s advertising network. Naturally, these options allow consumers to self select the alternative that best serves their advertising preferences.

The prevalence of such menus in practice raises the question of how best to design them. In this paper, we consider the problem of choosing a menu of prices and advertising quantities in order to maximize the platform’s expected profit under incomplete information on consumer advertising disutility. We bring a mechanism design approach to this problem, using the revelation principle (Myerson, 1981) to cast the problem as a mathematical program. This introduces incentive compatibility constraints in the analysis of optimal pricing for two-sided platforms. These constraints present a technical challenge, as they create non-convexities in the problem’s feasible space, and thus limit the effectiveness of a typical analysis using the Karush-Kuhn-Tucker (KKT) conditions. Our work overcomes this obstacle by leveraging a Lagrangian dual method that adapts well to these non-convex problems. In particular, our approach exploits complementary slackness to identify an optimal solution, offering insight into which constraints drive the structure of the optimal menu. This allows us to characterize conditions leading to profit-maximizing menus that consist of options for free use with ads or paid subscription with no ads (we call this a “free use/no ads” menu), similar to what is observed in practice.
In monopoly, we demonstrate that, when compared to the complete information solution, the optimal menu under incomplete information: i) increases price and decreases advertising for high disutility consumers and ii) decreases price and maintains advertising levels for low disutility consumers. This gives low disutility consumers an incentive to choose the low advertising option that maximizes their surplus, allowing the platform to maximize its expected profit. Ensuring consumers choose the optimal menu item puts downward pressure on both the advertising level for high disutility consumers and the price for low disutility consumers. Further, we show that advertising levels for high disutility consumers decrease as the size of this segment decreases, suggesting that relatively low prevalence of high disutility consumers would lead to a menu option with no ads. This is suggestive of typical consumer advertising preferences on the internet, where relatively small segments of the population are willing to pay to reduce their exposure to advertising (e.g., Accenture, 2016; Rao, 2013; McDonald and Cranor, 2010).

Building on our approach for monopoly, we further consider a setting with competing platforms. We find that outcomes hinge critically on agents’ homing behavior: multi-homing agents use both platforms, while single-homing agents use one platform exclusively. First we consider the market assuming each type of homing behavior separately, then we consider a market allowing either outcome. Analyzing equilibria in each of these market settings increases difficulty relative to monopoly, as identifying a mutual best response between the platforms requires not only simultaneously maximizing profit for each platform, but also satisfying the agents’ participation and incentive constraints on each platform. Our analysis however, leverages these constraints, as considering them concurrently allows us to identify which constraints must bind in equilibrium.

We characterize the unique multi-homing equilibrium under complete information and show that, compared to monopoly, total advertising increases, while prices can also rise if competition for the consumer is low enough. This can occur because competition for the advertiser in duopoly decreases content subsidization by advertising revenues (Godes et al., 2009). Intuitively, even though the consumer is exposed to more ads and possibly higher prices, competition still results in higher utility because increased consumption causes a rise in total market surplus.

We are able to extend our analysis to establish more nuanced insight for competing platforms with incomplete information on consumer advertising disutility. When compared to monopoly, we show that the unique multi-homing equilibrium menu under incomplete information may call for asymmetric directions of price adjustment for different consumer types: a high disutility consumer may see a price decrease while a low disutility consumer sees a price increase.

On the other hand, we show that platforms competing for single-homing agents end up in Bertrand-like competition, lowering prices and driving platform profits down to zero in any equilibrium (under
complete or incomplete information). Thus, we demonstrate that rising prices in duopoly is a result of multi-homing behavior, as single-homing agents will always decrease price through competition.

We complete our equilibrium analysis by considering a market with no assumptions on homing behavior. In this market, we show the only pure strategy equilibrium candidates under complete information are the equilibria identified in the multi- and single-homing settings. Then, for each of these equilibrium candidates, we show that either platform can profitably deviate by inducing agents to choose the opposite homing behavior, implying there is no pure strategy equilibrium in this unrestricted market. Thus, our model predicts that platform competition may lead to market instability, which is suggestive of the frequently changing pricing and promotional tactics of the online media provision market.

Finally, we demonstrate the robustness of our approach by showing our results extend to a much larger class of pricing/advertising models. In particular, we show that our pricing functions are sufficient to achieve optimality among a class of general pricing functions, and our model can reproduce any equilibrium outcome of an alternative setting where the advertiser chooses an advertising rate. This establishes that our methodological approach is applicable to a more general class of pricing/advertising models, even though it might appear at first that these would require a different technique, or lead to different results. Further, this shows that the platform sets optimal prices to incentivize both sides of the market to implement consumption and advertising quantities that maximize the platform’s surplus, regardless of how ads are delivered.

References


