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Two-sided markets: Evaluating the impact of a platform ban

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Academic Year 2023/2024

Abstract

This paper investigates the economic consequences of banning a media platform, focusing on the impact on the agents populating the market. Drawing on models from Anderson and Peitz [1], we analyze two-sided media markets where platforms offer content to ad-averse consumers and advertisers seek to reach those viewers. The agents on the two sides are assumed to be atomless. Platforms determine the number of ads they will host, and then the other participants decide which platform to join. The main model applies an aggregative game approach to characterize equilibrium actions and evaluate how a government ban affects platform profits, consumer surplus, and advertiser surplus. In a single-homing scenario, the results suggest that a ban leads to increased profits for remaining platforms and higher total advertiser surplus, but at the expense of consumer surplus due to higher advertising levels and reduced platform variety. We further extend the analysis to multi-homing consumers, showing that the ban damages consumers. Focusing on intermediate opportunity cost advertisers, they are better off in the presence of fewer platforms, provided the fraction of multi-homing viewers is sufficiently low.

Contents

1. Introduction

The influence of media platforms on various aspects of human life has increased in the last decades. Enikolopov et al. [2], using the geographical penetration of the social media platform VKontakte (VK) as an instrument, investigate its effect on protest participation during the 2011-2012 elections in Russia. They estimate a positive impact of the social network's penetration, showing that it is mainly related to lower coordination costs. Social media platforms facilitate information sharing, reducing the cost of coordinating the protests. On the other hand, faster information flows may lead to the creation of *echo chambers* if the users mostly share the content of like-minded individuals. Gorodnichenko et al. [3] examine information diffusion in social media and the potential impact of bots on shaping public opinion. Starting from a sentiment analysis of the posts on Twitter during the 2016 E.U. Referendum ("Brexit") and the 2016 U.S. Presidential Election, the authors estimate a stronger information diffusion between agents with similar beliefs. Recent studies underline the possible consequences of social media usage on mental health issues such as anxiety and depression. Braghieri et al. [4], exploiting differences in Facebook adoption rates across colleges, estimate the detrimental impact of Facebook on the users' mental health which, in turn, affects their academic performances.

Media platforms also represent a point of contact between consumers, who are active users, and firms that place advertising to garner viewers' attention.

The contribution of this paper is to evaluate the welfare implications of a media platform ban through the application of the models provided by Anderson and Peitz [1]. Banning a social media platform is one of the most drastic measures governments may consider to mitigate the negative consequences of its usage. The most frequent drivers of such extreme interventions are concerns for national security, political stability, misinformation, and cultural sensitivities.

The thematic discourse analysis conducted by A. Kumar [5] found that Indian TV news coverage of the TikTok ban indicates media alignment with government viewpoints.

Wisdom Okereke Anyim [6], conducts a qualitative analysis of mass media and legal documents, and underlines the negative economic consequences of the Twitter ban in Nigeria. Its introduction affects the information flow between commercial partners and induces losses of jobs, investment hostilities, and business failures.

To get a complete picture, this paper evaluates the impact of a ban on consumers, advertisers, and the platforms themselves. Two theoretical models from the literature on two-sided markets are replicated to investigate this issue. The study focuses on two-sided markets where three groups of agents interact: viewers, advertisers, and ad-financed media platforms. Our paper belongs to the literature on two-sided markets (Rochet and Tirole [7]; Armstrong [8]). We consider two-sided media markets where platforms offer consumers "free" access and determine the level of advertising to hosts (Gabszewicz et al. [9]; Anderson and Coate [10]; Peitz and Valletti [11]). Anderson and Peitz [1] analyze the effects of exogenous changes at equilibrium to establish whether see-saws arise, i.e. to understand when consumers' and advertisers' interests are not aligned. We reproduce the competitive bottleneck and the alternative advertisers' heterogeneity models provided by Anderson and Peitz [1] to evaluate the consequences of a ban when viewers dislike advertising. Both model specifications rely on the assumption that the agents on the two sides are atomless. Competing platforms choose the level of advertising to maximize their profits, and then consumers and advertisers choose which platform to join. Proper assumptions on the agents' preferences link changes in the platforms' optimal choices to variations of their surpluses. A relaxed competition between the platforms[1] increases the ad levels and the profits of the incumbents while a more intensive competitive environment has the opposite effect. Therefore, it is possible to evaluate the welfare consequences of a change in the number of platforms by analyzing its implications on the platforms' equilibrium choices.

The first model, where viewers single home and fully participate, is described in Chapter 3 and 4 and relies on an aggregative game structure to define platforms' equilibrium actions. Our results indicate that the ban leads to higher platform profits and total advertiser surplus while decreasing consumer surplus. However, this model has some limitations. The assumptions of single-homing and full participation, may not fully capture the real-world dynamics of all the types of two-sided media markets. Ad-financed television and radio broadcasters with single-homing viewers are two examples that properly fit the described assumptions.

The model with alternative heterogeneity considers the presence of multi-homing consumers. Advertisers differ in the opportunity cost of dealing with platforms and obtain equal benefits when they reach a consumer. Each platform hosts its unique fraction of single-homing viewers and the same multi-homing ones. In this section, we directly apply the results obtained by Anderson and Peitz [1] relative to the case of exogenous entry. Assuming platform symmetry it is possible to show that a ban can increase overall ad levels. In this scenario, both single-homing and multi-homing consumers are

[1] In the sense that there are fewer platforms in the market.

worse off. Intermediate-cost advertisers are better off if there are not too many multi-homing viewers. Despite the assumption that users fully participate may be unrealistic in the social media context, this second model represents a starting point to evaluate the effect of a platform ban when the viewers multi-home.

The structure of the paper is outlined as follows. In Chapter 2, we introduce the aggregative game framework used to describe equilibrium actions and comparative statics. The two following chapters are inherent to the competitive bottleneck model. Chapter 3 is dedicated to the assumptions about the agents populating the market. In Chapter 4 we deliver equilibrium characterization and establish the ban's consequences under consumers' single-homing. The final chapter presents the alternative heterogeneity model and the authors' findings to illustrate the impact of the ban in a two-sided multi-homing environment.

2. Aggregative Game Approach

This chapter introduces the aggregative game toolkit, provided by Anderson et al. [12] and associated with Anderson and Peitz [1]. Consider a two-sided market populated by a discrete number of platforms t. Platform i, with $i = 1, ..., t$, optimal choice under oligopoly depends on the competitors' ones. The aggregative game structure is appropriate when players' actions are interdependent and their profits, $\Pi_i(\phi_i, \Phi)$, can be defined as a function of their action ϕ_i and the *aggregate* Φ. The latter, $\Phi = \sum_{i=1}^{t} \phi_i + \phi_0$, is defined as the sum of platforms' actions and the constant outside option ϕ_0. Thus, players choose the optimal action that maximizes their profits $\Pi_i(\phi_i, \phi_i + \sum_{j \neq i}^{t} \phi_j)$.

First-order conditions for each i are:

$$\frac{\partial \Pi_i(\phi_i, \Phi)}{\partial \phi_i} + \frac{\partial \Pi_i(\phi_i, \Phi)}{\partial \Phi} = 0, \qquad i = 1, ..., t. \tag{2.1}$$

and implicitly determine the *inclusive best reply functions*, $\phi_i = b_i(\Phi)$, representing platform i's action that brings the sum, including the outside option, to Φ^*. Therefore, the aggregate at equilibrium, $\Phi^* = \sum_{i=1}^{t} b_i(\Phi^*) + \phi_0$, represents the point where the sum of the $b_i(\Phi)$ intersects the 45-degree line. Assuming that players' actions exhibit strategic complementarity, then inclusive best reply functions are increasing in Φ (Anderson et al. [12] for details). A competitiveness assumption, meaning that profits decrease in the aggregate, implies the negative sign of the second term in the first-order conditions.

Equilibrium exists and is unique, provided that inclusive best reply functions are continuous and $\sum b'_i(\Phi^*) < 1$. The second condition is essential for equilibrium uniqueness under strategic complementarity and it is verified if:

$$b'_i(\Phi) < \frac{b_i(\Phi)}{\Phi} \tag{2.2}$$

Condition 2.2 is equivalent to the required slope property, indeed, at equilibrium summing over i yields $\sum b'_i(\Phi^*) < 1$. An exogenous change that increases the equilibrium aggregate, by strategic complementarity, i.e. $b'_i(\Phi) > 0$, raises other platforms' inclusive best replies.

3. Market participants

The environment described in this section replicates the one associated with Anderson and Peitz [1]. Agents on both sides are assumed to be atom-less. The market is populated by a discrete number of platforms t. Each one attracts viewers, providing them with content, and the advertisers interested in consumers' attention. Platforms decide their level of advertising, and then participants on the two sides choose which platform to join. Appropriate assumptions on agents' preferences lead to an aggregative game representation of the equilibrium.

3.1 Media consumption

The consumers fully participate implying that they are prepared to see the entire bundle of content offered by the platforms. The continuum of viewers is assumed to single-home and allocate media consumption depending on the *relative attractiveness* of the platform. The single homing assumption is verified when viewers join no more than one platform for each period in consideration. Decision-making processes whose nature is well described by the Choice Axiom[1] provided by Luce [13], are said to have independence from irrelevant alternatives (IIA).

[1]It states that the probability that an option is chosen over a set does not depend on the other options in the pool.

Thus, it is possible to denote the demand for platform i with the fractional form associated with Luce [13]:

$$d_i = \frac{u(q_i)}{\sum_{j=o}^{t} u(q_j)}, \qquad i = 1, ..., t \tag{3.1}$$

where $u(q_i)$ is a value function representing the attractiveness of platform i and the denominator is the total value or *total attractiveness* of the media market. The *net quality* of platform i, $q_i = v_i - \lambda n_i$, is determined as the difference between the *gross quality*, v_i, and λn_i, the cost or benefit to join a platform hosting n_i advertisements. The paper is focused on media markets where advertising is a nuisance, therefore, the analysis is restricted to consumers with $\lambda > 0$.

Moreover, assume:

Assumption 1. *$u(q_i)$ is positive, increasing, log-concave, and twice continuously differentiable (Anderson and Peitz[1]: Assumption 1).*

Higher-quality platforms deliver higher utility to consumers and attract a larger fraction of viewers. The random utility model described by Anderson and Peitz [1] leads to a direct relation between the denominator in 3.1 and viewer benefits from the media sector; under the said model specification, consumer surplus is determined by:

$$CS = \mu ln(\sum_{j=o}^{t} u(q_j)) \tag{3.2}$$

where $\mu > 0$[2]. The form above implies that the consumer surplus is an increasing function of the denominator in 3.1, in the sense that an increase in the total quality of the media market benefits consumers.

[2]This is the positive standard deviation of the random utility model mentioned by Anderson and Peitz[1]. More details are provided by Anderson(1992)[14].

3.2 Advertisers

Users are prepared to see all the ads hosted by a given platform under full participation. Consumers' single-homing assumption implies that advertisers must place an ad on the specific platform on which the viewers are active to reach their attention. This setting refers to two-sided markets where platforms control access to the exclusive consumers they host, generating a competitive bottleneck.[3]. Moreover, assume that placing more than one ad per platform is not beneficial to advertisers and that their profits, before advertising expenses, are positively related to the consumers reached but, independent of other advertisers' presence. Therefore, the decision to join is taken platform by platform, regardless of other channels chosen. The advertisers are ranked in terms of descending *per-viewer willingness to pay* to reach users. The *marginal advertiser per-viewer willingness to pay* when there are n_i advertisements on platform i is denoted with $w(n_i)$.

Assume that

Assumption 2. *$w(n)$ is twice continuously differentiable and has non-increasing inverse elasticity,*$(\frac{nw'(n)}{w(n)})' \leq 0$ *(Anderson and Peitz[1]: Assumption 2).*

A necessary condition for $(\frac{nw'(n)}{w(n)})' \leq 0$ to hold is that $w(n)$ is concave or at least not too convex[4]. The condition of non-increasing inverse elasticity in price corresponds to assuming that the demand function is characterized by non-decreasing elasticity. Assumption 2 covers all log-concave inverse demand functions and encompasses constant elasticity demand as a boundary case.

[3]The competitive bottleneck to which I refer is from Anderson and Peitz [1] and is parallel to the one outlined by Armstrong [8]. This model represents two-sided markets where one side of the market deals with a single platform while the other, willing to reach all the consumers, prefers to deal with as many platforms as possible. Thus single homing and the assumptions about advertisers' profit imply there is no competition to attract advertisers.

[4]The related proof is relegated in the Appendix.

Platforms decide their level of advertising n_i and attract all the advertisers with a per-viewer willingness to pay higher than $w(n_i)$. The net advertiser surplus per viewer takes the form:

$$AS(n) = \int_o^n (w(x) - w(n))\, dx \tag{3.3}$$

Since d_i represents the portion of consumers that join platform i, the net advertiser surplus on the said platform can be defined as $d_i AS(n_i)$. Therefore, the total surplus to advertisers is:

$$TOTAS = \sum_{i=1}^{t} d_i AS(n_i) \tag{3.4}$$

The expression above measures the aggregate benefit to the advertisers' side.

3.3 Platforms

The agents in the center of the two-sided market decide the number of advertisements to host. Under monopoly, the optimal level n^m is chosen to maximize the *revenue per viewer*. The latter is denoted by $R(n) = nw(n)$ and, as a consequence of assumption 2, it is strictly log-concave[5] over the pertinent range of n. Thanks to the formulation of the revenue per viewer, it is possible to rewrite the net advertiser surplus as:

$$AS(n) = \int_o^n (w(x) - w(n))\, dx = \int_o^n w(x)\, dx - R(n), \tag{3.5}$$

where $\int_o^n w(x)\, dx = GAS(n)$ is the gross advertiser surplus.

The following property, introduced by Anderson and Peitz [1], is related to the *pass-through* literature related to Weyl and Fabinger [15]. Consider that:

Lemma 3.1. *if* $(\frac{nw'(n)}{w(n)})' \leq 0$*, then* $(\frac{AS(n)}{R(n)})' \geq 0$.[6] *(Anderson and Peitz [1]: Lemma 1)*

[5] The Appendix contains the proof of the strict log-concavity of $R(n)$.

[6] The proof for lemma 3.1 is included in the appendix.

The condition above is crucial to evaluate the impact of an exogenous change on the total surplus to advertisers. Lemma 3.1, represents a link between changes in the platforms' profits and variations in $AS(n)$.

The profit realized by platform i is:

$$\Pi_i = d_i R(n_i) = \frac{u(q_i)}{\sum_{j=o}^{t} u(q_j)} R(n_i) = \frac{u(v_i - \lambda n_i)}{\sum_{j=o}^{t} v_j - \lambda n_j} R(n_i) \tag{3.6}$$

Platform i, given its v_i, choose n_i and implicitly decide its attractiveness $u(q_i)$. Assuming that platform's i action is denoted with $\phi_i = u(q_i)$, implies that the aggregate is $\Phi = \sum_{i=1}^{t} u(q_i) + u(q_0)$ where $u(q_0)$ is the constant action of the outside option. The implicit and inverse relation between the selected advertising level and the platform's action is formulated as:

$$n_i'(\phi_i) = -\frac{1}{\lambda u_i'(q_i)} \tag{3.7}$$

This property establishes that when advertising is a nuisance the number of ads hosted by platform i is inversely related to its attractiveness $u(q_i)$. Essentially, a player who takes a higher action is choosing a lower level of advertising.

Thus, it is possible to write the profit in the form:

$$\Pi_i(\phi_i, \Phi) = \frac{\phi_i}{\Phi} R(n_i(\phi_i)) \tag{3.8}$$

This formulation of the profits is suitable for the aggregative game approach since it is a function of its action and the aggregate.

4. Equilibrium and comparative statics

Two-sided markets well described by the assumptions of Chapter 3 have an aggregative game representation of the equilibrium since, for $\lambda > 0$, platforms' choices are interdependent[1]. The first part of the chapter reproduces the equilibrium characterization and the comparative statics associated with Anderson and Peitz [1]. The second evaluates the government ban's impact on the other platforms' profits and the surplus of single-homing consumers.

4.1 Characterization of platforms optimal choices

Platform i's action is a monotonic function of the number of ads hosted. Then, each player implicitly chooses n_i. Following the aggregative game approach, it is

[1] For any $\lambda \neq 0$ platform choices exhibit strategic interactions. Contrarily, if viewers are indifferent to advertising, consumers demand d_i does not depend on n and each platform would choose as a monopolist, setting $n^m = \operatorname{argmax}_n R(n)$.

possible to write first-order conditions as in 2.1:

$$\begin{aligned} &\frac{\partial \Pi_i(\phi_i,\Phi)}{\partial \phi_i} + \frac{\partial \Pi_i(\phi_i,\Phi)}{\partial \Phi} = \\ &= \frac{\partial \frac{\phi_i}{\Phi} R(n_i(\phi_i))}{\partial \phi_i} + \frac{\partial \frac{\phi_i}{\Phi} R(n_i(\phi_i))}{\partial \Phi} = \\ &= R'(n_i(\phi_i))n_i'(\phi_i)\frac{\phi_i}{\Phi} + R((n_i(\phi_i)(\frac{1}{\Phi} - \frac{\phi_i}{\Phi^2}) = 0 \end{aligned} \tag{4.1}$$

Rearranging equation 4.1 follows that:

$$R'(n_i(\phi_i)) = -\frac{R((n_i(\phi_i)(\frac{1}{\Phi} - \frac{\phi_i}{\Phi^2})}{n_i'(\phi_i)\frac{\phi_i}{\Phi}} \tag{4.2}$$

The numerator of the equation above is positive[2] and $n_i'(\phi_i) < 0$, it follows that $R'(n_i(\phi_i)) > 0$ at equilibrium. This is equivalent to stating that platforms, competing for viewers that dislike advertising, host fewer ads than monopolists. Substituting 3.7 and recalling that $\phi_i = u(q_i)$ it is possible to reorganize the FOCS in 4.1 as:

$$\begin{aligned} \frac{\phi_i}{\Phi} &= 1 + \frac{R'(n_i(\phi_i))}{R(n_i(\phi_i))} n_i'(\phi_i)\phi_i \\ &= 1 - \frac{R'(n_i(\phi_i))}{R(n_i(\phi_i))} \frac{u(q_i)}{\lambda u'(q_i)} \end{aligned} \tag{4.3}$$

The left-hand side of the equation 4.3 is increasing in ϕ_i while the right one, denoted with $f_i(\phi_i)$, is decreasing[3]. As a result, the first-order conditions in 4.1 uniquely define platforms' actions ϕ_i as a function of the aggregate, the inclusive best reply functions $b_i(\Phi)$. The equilibrium actions satisfy the following properties:

Lemma 4.1. *If assumptions 1 and 2 hold then inclusive best reply functions are continuously differentiable and satisfy* $0 < b_i'(\Phi) < \frac{b_i(\Phi)}{\Phi}$ *(Anderson and Peitz [1]: Lemma 2).*

[2] $R(n_i)$ is positive by definition and $(\frac{1}{\Phi} - \frac{\phi_i}{\Phi^2}) = \frac{\Phi - \phi_i}{\Phi^2}$ is positive too since $\Phi - \phi_i > 0$.

[3] The Appendix contains the proof about the negativeness of $f_i'(\phi_i)$.

The proof for lemma 4.1 is relegated in the Appendix. Platforms' actions exhibit strategic complementarity since $b_i(\Phi)$ is an increasing function of Φ, nevertheless, the related contribution to the aggregate decreases. An exogenous decrease in Φ, in the sense that competition is relaxed, leads to a decline in the inclusive best reply functions. Equation 3.7 relates a decrease in the best reply to an increase in the level of advertising, thus platforms set the level of ads closer to the monopoly one n^m. The second condition in lemma 4.1 represents the key slope property in 2.2, which implies equilibrium existence and uniqueness[4].

Assuming no cross share-holdings or joint ownership, the only difference between asymmetric platforms is their gross quality v_i. Thus, the order of platforms' content quality in asymmetric markets determines the rank of economic outcomes, market shares, and number of advertising hosted. The following comparative analysis considers two different platforms α and β :

Proposition 4.2. *In equilibrium, if $v_\alpha > v_\beta$ than $d_\alpha > d_\beta$, $n_\alpha > n_\beta$ and $\Pi_\alpha > \Pi_\beta$ (Anderson and Peitz [1]: Proposition 1).*

Greater quality platforms host more advertising and attract more users despite the higher costs, formally $\lambda n_\alpha > \lambda n_\beta$. Platform profit, defined as $\Pi_i = d_i R(n_i)$, follows the same order. These results, associated with Anderson and Peitz [1], are analogous to a competition model where firms differ on product quality. The ones that sell higher quality products can set higher prices and attract a larger market share.

Recalling that advertisers are ranked in terms of decreasing willingness to pay, those with a larger one choose to join all the platforms, and the ones with a lower $w(n)$ join only the higher quality platforms.

[4] Anderson and Peitz [1] show that the equilibrium exists and is unique in the proof of the related Proposition 1.

4.2 Comparative statics: platforms and users

The impact of a variation in the equilibrium aggregate on consumer surplus and platforms' profits can be analyzed through an appropriate combination of the agents' preferences and the results of the previous section.

This chapter and the subsequent one consider the platform characterization and the results provided by Anderson and Peitz [1]. A platform is considered an *insiders* (I) if its inclusive best reply is affected by the exogenous change. Otherwise, it belongs to the *outsiders* (O). The second group includes the platforms whose equilibrium choices are unaffected by the considered policy intervention[5]. A change in the aggregate, denoted as $\Phi^* = \sum_{i=1}^{t} b_i(\Phi^*) + u(q_0)$ can be related to shifts of the inclusive best reply functions of the insiders or changes in the number of firms operating in the market. A policy intervention that induces variations in the aggregate has the opposite effect on consumers and outsider platforms.

4.2.1 Platforms profits

The effect on the insiders' profits depends on the specific characteristics of the intervention. The other platforms, namely outsiders, satisfy the following[6]:

Lemma 4.3. *A policy intervention that leads to variation in the aggregate induces an opposite change in profit for any outsider platform, i.e.* $\frac{\partial \Pi_i}{\partial \Phi} < 0$ *for* $i \in O$ *(Anderson and Peitz [1]: Lemma 4).*

An exogenous upward shift of the equilibrium aggregate would increase the inclusive best reply functions of the incumbent platforms. Thus, the outsiders

[5] A policy intervention that binds only for a subset of the platforms, does not change the actions of the others.

[6] The proof for lemma 4.3 is contained in the Appendix.

implicitly set a lower level of advertising when the aggregate increases. Their profits $\Pi_i = d_i R(n_i)$ decreases due to lower demands and revenues per viewer.

4.2.2 Consumer surplus

Platforms decide their attractiveness by setting the level of advertising. The sum of their actions and the constant action[7] represent the total attractiveness of the media market. The effect of a change in the equilibrium aggregate is immediate when the random utility model associated with Anderson and Peitz [1] holds. Consequently, consumer surplus at equilibrium is defined as $CS = \mu ln(\sum_{j=1}^{t} b_j(\Phi^*) + u(q_0)) = \mu ln \Phi^*$. It follows that:

Lemma 4.4. *Consumer surplus is an increasing function of the aggregate.*

In other words, the users are better off when the aggregate quality of the provided content is higher.

4.3 The impact of a government ban: platform profits and consumer surplus

The effects of an exogenous change on consumer surplus and platform profits can be depicted directly from changes in the equilibrium aggregate. Policy interventions that induce an upward shift in the insiders' inclusive best reply functions increase the aggregate and the actions of the outsiders[8]. In more

[7]The constant action $u(q_0)$ may represent the attractiveness of a public media platform without advertising.

[8]Anderson and Peitz [1] describe an ad cap intervention that directly shifts up the inclusive best reply of the insiders, decreasing their profits and increasing the aggregate. Outsiders' actions increase by strategic complementarity and their profits fall. Reasonably consumers would benefit from the lower ad levels on all the platforms.

concrete terms, an exogenous change that reduces the ad levels of the insiders, by strategic complementarity reduces the ad levels of all the other platforms and their profits fall for all $i \in O$[9]. Consumers would benefit from the higher quality of the content provided, in fact, their surplus increases by lemma 4.4. When the intervention induces a fall in Π_i for $i \in I$, it damages all platforms[10].

Exogenous changes that induce a variation in the number of firms lead to proportional changes in the consumer surplus. The results about platform entry provided by Anderson and Peitz [1] prove that consumer surplus increases with exogenous[11] entry and other platforms' profits decrease. The efficient[12] entry of a new platform shifts up the equilibrium aggregate and the effects on the considered agents follow from lemma 4.3 and 4.4.

Government interventions aimed to ban one platform for reasons related to the maintenance of national security, political stability, or traditional social values represent an exogenous change that induces a downward shift in the equilibrium aggregate. The ban is assumed to be effective, in the sense that users are unable to access the banned platform that no longer belongs to the considered two-sided market[13]. The aggregative game structure and the relative findings are appropriate for analyzing the impact of a government ban on platforms' profits and consumer surplus.

The banned platform, precluded from operating within the designated market, belongs to the group of insiders while the remaining ones are denoted as

[9]When lemma 4.3 holds the outsiders' profits decrease with an exogenous shift in the aggregate.

[10]The *advertising regulation* modeled by Anderson and Peitz [1] is an example.

[11]The authors consider cases where the entry is related to regulatory measures.

[12]In essence, an exogenous entry is efficient if the new platform is the more efficient between potential entrants and has a lower attractiveness than the existing platforms.

[13]Examples of effective bans of social media platforms are the cases where the intervention prohibits or sanctions the use of technologies (VPN) that helps to circumnavigate the ban.

outsiders. The second group is not directly affected by the introduction of the ban but their actions would vary in response to a change of the aggregate. The direct effect of the intervention is a decrease in the number of platforms and the equilibrium aggregate[14]. The equilibrium actions of the remaining platforms decrease by strategic complementarity, reinforcing the first fall of the aggregate. Indeed, the indirect effect of a ban is an increase in the outsiders' levels of advertising. When viewers single-home, the outcomes for consumer surplus and platform profit can be directly depicted from lemma 4.3 and 4.4. The former implies that outsiders' profits increase when the aggregate falls, that is to say, the incumbents benefit from reduced competition when a platform is banned from the market. Ad-averse consumers would suffer from higher advertising levels and lower platform variety, in fact, their surplus drops by lemma 4.4. Therefore, when users are assumed to single-home and adv are a nuisance, it is possible to establish that:

Proposition 4.5. *The ban of one platform:*

- *Increases the profits of remaining platforms.*
- *Decreases consumer surplus.*

The effects on consumer surplus and platforms' actions can be depicted in a simplified setting without relying on the aggregative game structure. Platform symmetry, i.e. $v_i = v \forall i$, implies that each player maximizes the same profit function $\Pi = dR(n)$[15]. Anderson and Peitz [1] show that the symmetric optimal choice n^* is a decreasing function of t, the number of platforms in the market.

[14]The insider's best reply function is positive right before it is banned. Thus the equilibrium aggregate, $\Phi^* = \sum_{i=1}^{t} b_i(\Phi^*) + u(q_0)$, shifts down when the platform becomes inaccessible in the given market.

[15]From proposition 4.2 we have that $v_\alpha = v_\beta$ implies $\Pi_\alpha = \Pi_\beta$.

Banning one platform would increase the ad levels of the outsiders. More advertising and less variety damage consumers.

The results above rely on assumptions that do not consider the presence of multi-homing users while representing a theoretical model to evaluate the consequences of a ban when viewers single home.

5. Total advertiser surplus and users' homing decisions

The consequences of exogenous changes in the number of platforms on the total advertiser surplus are depicted unambiguously with the help of further conditions related to Anderson and Peitz [1].

The total surplus to advertisers denoted at equilibrium with $TOTAS = \sum_{i=1}^{t} d_i^* AS(n_i^*)$[1], increase with the ban if the market is fully covered[2]. Nevertheless, the impact on $TOTAS$ is unclear in a partially covered market where advertisers may benefit from the higher ad levels, but they could also damaged by the lower number of viewers reached[3].

A simpler setting with symmetric platforms is useful to derive additional intuitions about the consequences on the total advertiser surplus. The latter, under platform symmetry and before the imposition of the ban, can be written

[1]Where $d_i^* = \frac{b_i(\Phi^*)}{\Phi^*}$

[2]The market is fully covered when, at equilibrium, platforms attract all the consumers, meaning cases where the outside option has no attraction. Under this specification, the advertisers' side obtains the benefit of a lower price $w(n)$, associated with a higher n_i, without any loss in the total number of consumers reached ($\sum_{i=1}^{t} d_i$).

[3]When the outside option has a positive attractiveness, i.e. $u(q_0) > 0$, a fraction of the banned platform' consumers would choose q_0 after the intervention. Hence, the fraction of active users, $\sum_{i=1}^{t} d_i$, would be lower and the advertisers reach fewer consumers.

as $TOTAS = \sum_{i=1}^{t} d^* AS(n^*) = td^* AS(n^*)$. The aggregate and the inclusive best reply functions rise when one platform is banned. Higher levels of advertising and improved consumer access[4] implies that $d^B AS(n^B) > d^* AS(n*)$, where the superscript B indicates the new equilibrium after the ban. It follows that the total advertiser surplus increases if $(t-1)d^B AS(n^B) > td^* AS(n*)$, which is verified for t large enough.

The condition in lemma 3.1, linking changes in the revenues per viewer to variations in the advertiser surplus, represents a sliding door to show the impact of an exogenous change on their total surplus. Anderson and Peitz [1] establish the presence of see-saws by proving that $TOTAS$ scales down when entry decreases the total profits of the platforms. Following the same reasoning it is possible to verify the positive effect on the total surplus to advertisers if the ban increases total platform profits. Therefore, when users single-home and dislike advertising:

Proposition 5.1. *The ban of a platform increases total advertiser surplus if it increases total platform profits.*

Proof. It is possible to rewrite the condition about the impact on platforms' profits as:

$$\sum_{i=1}^{t-1} d_i^B R(n_i^B) > \sum_{i=1}^{t} d_i^* R(n_i^*) \tag{5.1}$$

that is equivalent to:

$$\sum_{i=1}^{t-1} d_i^B R(n_i^B) \frac{AS(n_i^*)}{R(n_i^*)} > \sum_{i=1}^{t} d_i^* R(n_i^*) \frac{AS(n_i^*)}{R(n_i^*)} \tag{5.2}$$

Recalling that $n_i^B > n_i^* \forall i \in O$ the condition in lemma 3.1 can be reformulated as:

$$\frac{AS(n_i^B)}{AS(n_i^*)} > \frac{R(n_i^B)}{R(n_i^*)} \Rightarrow \frac{AS(n_i^B)}{R(n_i^B)} > \frac{AS(n_i^*)}{R(n_i^*)} \tag{5.3}$$

[4]The users of the banned platform join one of the remaining or choose the outside option. Moreover, $AS(n)$ increases for a lower n by definition.

Combining the last inequality with the one in equation 5.2 it holds that:

$$\begin{aligned} \sum_{i=1}^{t-1} d_i^B R(n_i^B) \frac{AS(n_i^B)}{R(n_i^B)} > \sum_{i=1}^{t} d_i^* R(n_i^*) \frac{AS(n_i^*)}{R(n_i^*)} \Rightarrow \\ \sum_{i=1}^{t-1} d_i^B AS(n_i^B) > \sum_{i=1}^{t} d_i^* AS(n_i^*), \end{aligned} \tag{5.4}$$

and proposition 5.1 follows. □

Therefore, regardless of market coverage assumptions, the condition on total platform profits is sufficient to determine the positive impact on the total advertiser surplus.

5.1 Evaluating the impact of a ban under multi-homing assumptions

This section investigates the effects of the ban on the two sides of the market when a constant fraction of users join more than one platform. The aggregative game structure is not well-suited for consumers' multi-homing assumptions if the advertiser differs based on their willingness to pay to contact viewers[5]. To address this issue, Anderson and Peitz [1] introduce an alternative hypothesis about advertisers' heterogeneity. This twisted model specification delivers symmetric equilibrium characterization and comparative statics for a change in the number of platforms. Advertisers are assumed to have the same benefit r from reaching a viewer and differ in the cost w of joining a platform. The fraction of multi-homing consumers is m, then the single-homing one is $(1-m)$. The content demand of single-homing viewers on platform i, d_i, remains the one defined by equation 3.1. Each platform attracts its exclusive portion of

[5] Anderson and Peitz [1] evidence the reasons for this incompatibility in the last chapter and the Online Appendix.

single-homing consumers $d_i(1-m)$ and the same multi-homing viewers m. The authors, assuming that $u(q_i)$ is linear, the platforms are symmetric and the cost w comes from a uniform distribution, prove the existence of a negative relation between platform optimal choice on n^* and the number of platforms t. Shifting our attention to the other side, it is crucial to consider two types of advertisers. The high opportunity cost one ($w = \hat{w}$) is indifferent to participate or not while the advertiser with low opportunity cost ($w = \tilde{w}$) is indifferent between joining one or more platforms. The advertisers $w \in (\tilde{w}, \hat{w})$ single-home, the ones with an opportunity cost $w > \hat{w}$ are not active and the remaining with $w < \tilde{w}$ multi-home. Anderson and Peitz [1] establish that $\hat{w}$ decreases with t when the fraction of multi-homing viewers is sufficiently low. The consequences of a ban follow from the results provided by this alternative model.

Introducing an exogenous and effective ban reduces the number of symmetric platforms. The optimal choices of the remaining one increase since n^* is a decreasing function of t. Single-homing consumers are damaged by the lower variety and the greater n while multi-homing ones suffer only the higher advertising levels. The opportunity cost of the high-type $\hat{w}$ increases with a lower t if there are not too many multi-homing viewers. Thus, the non-active advertisers with a cost opportunity in the vicinity of $\hat{w}$ would be active and better off right after the ban. Focusing on the ones with intermediate cost opportunity and discounting the low-cost type it is possible to establish that the introduction of the ban is beneficial to the advertisers' side of the market.

Conclusion

The economic implications of a media platform ban in the context of two-sided markets, are complex and impact all involved agents. The models considered in this analysis provide significant insights into the consequences of a ban, though they come with limitations related to simplifying assumptions.

The competitive bottleneck model evaluates the impact of the intervention when viewers single home and are prepared to view all the advertisements hosted by a platform. The related results indicate that a ban leads to increased profits for the remaining platforms, while consumers, damaged by the higher ad levels, are worse off. The positive impact on advertisers can be demonstrated under the assumption that the ban increases the total profit of the platform. Although the effect of advertiser surplus is unclear a priori, the additional condition ensures unambiguous results.

Social media users may participate in multiple platforms simultaneously, something that the first model does not account for. The alternative heterogeneity model considers advertisers' heterogeneity in cost and evaluates how both single- and multi-homing viewers are affected by platform bans. It finds that, under symmetry, the ban leads to increased levels of advertising on the remaining platforms. Single-homing consumers suffer more due to reduced platform variety and higher ad exposure while multi-homing consumers mainly face more advertising. Advertisers with intermediate opportunity costs are better off after the ban if the fraction of multi-homing consumers remains low. Although the assumption of full participation may once again be unrealistic, this second model provides a baseline to assess the impact of a platform ban when viewers multi-home.

To fully understand the impact of a ban on platforms, advertisers, and consumers in the context of social media, future theoretical researches need to incorporate an assumption of consumers' limited attention.

Appendix

A.1 Proofs

This section delves into the proofs presented by Anderson and Peitz, focusing on the particular case of ad-averse consumers, where $\lambda > 0$.

A.1.1 Non-increasing inverse elasticity

The aim is to show that the non-increasing inverse elasticity defined in assumption 2 implies a specific characterization for $w(n)$. Rewrite the derivative with respect to n of the inverse elasticity:

$$\begin{aligned} \left(\frac{nw'(n)}{w(n)}\right)' &= \left(w'(n)\frac{n}{w(n)}\right)' = \\ &= w''(n)\frac{n}{w(n)} + w'(n)\left(\frac{n}{w(n)}\right)' = \\ &= w''(n)\frac{n}{w(n)} + w'(n)\left(\frac{1}{w(n)} - \frac{nw'(n)}{w(n)^2}\right) \end{aligned} \tag{5}$$

For non-increasing inverse elasticity, it holds that:

$$w''(n)\frac{n}{w(n)} + w'(n)\left(\frac{1}{w(n)} - \frac{nw'(n)}{w(n)^2}\right) \leq 0 \tag{6}$$

The second term in the equation above is negative since both n and $w(n)$ are positive while $w'(n)$ is negative. Thus, to ensure that the inequality in 6 holds $w(n)$ must be concave or not too convex.

A.1.2 Strict log-Concavity of R(n)

The purpose is to demonstrate that assumption 2 implies log-concavity of the platform revenue per viewer. Following Dharmadhikari and Joag-Dev [16], $R(n)$ is log-concave over the relevant range of n if its logarithm is concave over the same interval.

Consider the first derivative of the logarithm of $r(n)$:

$$\Big(ln(R(n))\Big)' = \frac{R'(n)}{R(n)} \tag{7}$$

Hence to verify log-concavity of $R(n)$ is sufficient to show that the derivative with respect to n of 7 is negative:

$$\begin{aligned} \left(\frac{R'(n)}{R(n)}\right)' &= \left(\frac{w(n) + nw'(n)}{nw(n)}\right)' = \\ = \left(\frac{1}{n} + \frac{w'(n)}{w(n)}\right)' &= \left(\frac{1}{n}\left(1 + \frac{nw'(n)}{w(n)}\right)\right)' = \\ = -\frac{1}{n^2}\left(1 + \frac{nw'(n)}{w(n)}\right) &+ \frac{1}{n}\left(1 + \frac{nw'(n)}{w(n)}\right)' = \\ = \frac{1}{n}\left(\frac{nw'(n)}{w(n)}\right)' &- \frac{1}{n^2}\left(1 + \frac{nw'(n)}{w(n)}\right) \end{aligned} \tag{8}$$

The second term in the equation above can be reformulated as:

$$-\frac{1}{n^2}\left(1 + \frac{nw'(n)}{w(n)}\right) = -\frac{1}{n}\left(\frac{w(n) + nw'(n)}{nw(n)}\right) = -\frac{1}{n}\left(\frac{R'(n)}{R(n)}\right) \tag{9}$$

It follows that:

$$\left(\frac{R'(n)}{R(n)}\right)' = \frac{1}{n}\left(\frac{nw'(n)}{w(n)}\right)' - \frac{1}{n}\left(\frac{R'(n)}{R(n)}\right) \tag{10}$$

The first term in 10 is negative assuming that the inverse elasticity is non-increasing while the second one is also negative when $R'(n) > 0$, verified at equilibrium if $\lambda > 0$. Therefore, as long as it is increasing and under assumption 2, $R(n)$ is strictly log-concave.

A.1.3 Proof of Lemma 3.1

The definition of net advertiser surplus in equation 3.5 implies that we can rewrite the derivative with respect to n of the ratio in lemma 3.1 as:

$$\left(\frac{AS(n)}{R(n)}\right)' = \left(\frac{GAS(n) - R(a)}{R(n)}\right)' = \left(\frac{GAS(n)}{R(n)}\right)' \tag{11}$$

Verifying that $\frac{GAS(n)}{R(n)}$ is not decreasing is equivalent to show that $\left(\frac{R(n)}{GAS(n)}\right)' \leq 0$. Substituting the two elements in the ratio of the previous inequality with their integral formulation gives:

$$\begin{aligned} &\left(\frac{\int_o^n R'(x)\,dx}{\int_o^n w(x)\,dx}\right)' \leq 0 \\ \Rightarrow &\frac{R'(n)\int_o^n w(x)\,dx - w(n)\int_o^n R'(x)\,dx}{(\int_o^n w(x)\,dx)^2} \leq 0 \\ \Rightarrow &R'(n)\int_o^n w(x)\,dx - w(n)\int_o^n R'(x)\,dx \leq 0 \end{aligned} \tag{12}$$

Rearranging and manipulating the previous equation it holds:

$$\frac{R'(n)}{w(n)}\int_o^n w(x) \leq \int_o^n \frac{R'(x)}{w(x)} w(x) \tag{13}$$

Recalling that:

$$\left(\frac{R'(n)}{w(n)}\right)' = \left(\frac{w(n) + nw'(n)}{w(n)}\right)' = \left(1 + \frac{nw'(n)}{w(n)}\right)' = \left(\frac{nw'(n)}{w(n)}\right)' \tag{14}$$

The assumption about non-increasing inverse elasticity implies that $\frac{R'(n)}{w(n)}$ is a non-increasing function of n, thus, the inequality in 13 holds and the needed condition in lemma 3.1 is verified.

A.1.4 The right hand side of 4.3 is decreasing

Denoting:

$$f_i(\phi_i) = 1 + \frac{R'(n_i(\phi_i))}{R(n_i(\phi_i))} n_i'(\phi_i)\phi_i = 1 + g(n_i(\phi_i)) \tag{15}$$

It is clear that 15 is well defined for $\lambda > 0$. Consider the first derivative with respect to ϕ_i of $f_i(\phi_i)$:

$$\begin{aligned} f_i'(\phi_i) = n_i'(\phi_i)g'(n_i(\phi_i)) = n_i'(\phi_i)\left(\frac{R'(n_i(\phi_i))}{R(n_i(\phi_i))}n_i'(\phi_i)\phi_i\right)' = \\ = n_i'(\phi_i)\left(\left(\frac{R'(n_i(\phi_i))}{R(n_i(\phi_i))}\right)'(n_i'(\phi_i)\phi_i) + \left(\frac{R'(n_i(\phi_i))}{R(n_i(\phi_i))}\right)(n_i'(\phi_i)\phi_i)'\right) \end{aligned} \tag{16}$$

Taking into account that $n_i'(\phi_i) = -\frac{1}{\lambda u_i'(q_i)}$ and $\phi_i = u_i(q_i)$, the former expression can be rewritten as:

$$f_i'(\phi_i) = n_i'(\phi_i)\left(-\left(\frac{R'(n_i(\phi_i))}{R(n_i(\phi_i))}\right)'\left(\frac{u_i(q_i)}{\lambda u_i'(q_i)}\right) - \left(\frac{R'(n_i(\phi_i))}{R(n_i(\phi_i))}\right)\left(\frac{u_i(q_i)}{\lambda u_i'(q_i)}\right)'\right) \tag{17}$$

The first term inside the brackets is positive because $u_i(q_i)$ satisfies assumption 1 and $R(n_i(\phi_i))$ is strictly log-concave. The second term is positive or equal to zero since $R'(n_i(\phi_i)) < 0$ at equilibrium and $u_i(q_i)$ is log-concave. Thus $f_i'(\phi_i)$ has the same sign as $n_i'(\phi_i)$, which is negative under the assumption that advertising is a nuisance. Thus, the first-order conditions in 4.3 define a unique best-reply function for any level of Φ.

A.1.5 Proof of Lemma 4.1

The aggregate, defined by equation 4.2 as $\Phi = \frac{\phi_i}{f_i(\phi_i)}$, is continuously differentiable since, by assumptions 1 and 2, $f_i(\phi_i)$ is so. Therefore, the inclusive best reply function, the inverse of the previous formulation of Φ, is continuously differentiable. Verifying that platforms' actions exhibit strategic complementarity, i.e., $b_i'(\Phi) > 0$, is equivalent to showing that $\Phi(\phi) = \frac{\phi_i}{f_i(\phi_i)}$ is an increasing function of ϕ. In fact:

$$\Phi'(\phi) = \frac{f_i(\phi_i) - \phi f_i'(\phi_i)}{f_i(\phi_i)^2} \tag{18}$$

is positive, provided that $f_i'(\phi_i) < 0$. It is possible to rewrite the last condition in lemma 4.1 as follows:

$$b_i'(\Phi) < \frac{\phi}{\Phi} \Rightarrow \frac{f_i(\phi_i)^2}{f_i(\phi_i) - \phi f_i'(\phi_i)} < \frac{\phi}{\Phi} \tag{19}$$

Substituting the equilibrium condition $\frac{\phi}{\Phi} = f_i(\phi_i)$ it holds:

$$\frac{f_i(\phi_i)^2}{f_i(\phi_i) - \phi f_i'(\phi_i)} < f_i(\phi_i) \Rightarrow \frac{f_i(\phi_i)}{f_i(\phi_i) - \phi f_i'(\phi_i)} < 1 \tag{20}$$

The condition above is verified since $f_i'(\phi_i)$ is proved to be negative in the previous section.

A.1.6 Proof of lemma 4.3

The derivative of $\Pi_i = d_i R(n_i)$ with respect to the aggregate can be written as:

$$\frac{\partial \Pi_i(\phi_i, \Phi)}{\partial \Phi} = \frac{\partial d_i}{\partial \Phi} R(n_i) + \frac{\partial R(n_i)}{\partial \Phi} d_i \tag{21}$$

The first term on the right side is negative since $R(n_i) > 0$ while the derivative of d_i with respect to Φ is :

$$\frac{\partial d_i(\phi_i, \Phi)}{\partial \Phi} = \frac{\partial \frac{\phi_i}{\Phi}}{\partial \Phi} = \frac{\partial \frac{b_i(\Phi)}{\Phi}}{\partial \Phi} = \frac{(b_i'(\Phi)\Phi - b_i(\Phi))}{\Phi^2} \tag{22}$$

The last equation is negative if:

$$b_i'(\Phi)\Phi - b_i(\Phi) < 0 \Rightarrow b_i'(\Phi) < \frac{b_i(\Phi)}{\Phi} \tag{23}$$

that is verified under lemma 4.1 and $\frac{\partial d_i}{\partial \Phi} R(n_i) < 0$.

The change in the aggregate is evaluated at equilibrium, then it is possible to define the equilibrium ad level as a function of the related inclusive best reply function and $R(n_i) = R(n_i(b_i(\Phi)))$. The second term on the right side of equation 21 is reformulated as:

$$\frac{\partial R(n_i)}{\partial \Phi} d_i = R'(n_i) n_i'(\phi_i) b_i'(\Phi) d_i \tag{24}$$

The last two factors are positive by definition. The product $R'(n_i)n_i'(\phi_i)$ is negative for $\lambda > 0$ because $R(n_i)$ is increasing at equilibrium and the latter is negative when consumers dislike advertising. It follows that $\frac{\partial \Pi_i(\phi_i,\Phi)}{\partial \Phi} < 0$ for all $i \in O$.

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