Social Media and News: Attention Capture via Content Bundling

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Abstract

The growing influence of internet platforms acting as content aggregators is probably the most important challenge facing the media industry. We develop a simple model where consumers allocate their attention between an advertising-supported newspaper and a social platform. By strategically bundling its own social content with news, the platform increases the share of attention it receives. Content bundling harms the newspaper, but its impact on news quality is heterogenous: a high-quality newspaper invests more, while a low-quality one invests less. We consider various extensions of our framework, allowing for personalized newsfeed, subscriptions, multiple newspapers, and switching costs for consumers.

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1 Introduction

With hundreds of millions of daily active users, a few large social networks have become the dominant online media outlets for most people. The largest among these, Facebook has reached over two billion active members across the globe who, on average, spend about an hour each day on the platform. In line with its significant consumer attention share, Facebook captured almost $40 billion of advertising revenues in 2017, corresponding to 19% of worldwide digital advertising. Other successful social platforms include Tencent's WeChat in China and VKontakte in Russia.

If, in their early days, social networks were mostly used as a way for users to share personal stories and pictures (which we refer to as user-generated content, or UGC, throughout the paper), their role has progressively evolved into one of content aggregation: an important share of the content displayed on their websites is produced by third-party publishers, who use the platforms as an alternative to their own website to reach consumers.

The news industry in particular has been affected by this change: studies show that more than 50% of consumers use social media as a source of news, and 14% as their main source (Gottfried and Shearer, 2016; Mitchell et al., 2017; Reuters, 2016). Facebook has recently surpassed Google as the main external source of traffic to newspapers' websites (Alpert, 2015; Constine, 2016).[1] Recently, heated controversies have made the headlines: platforms have been accused of fostering echo chambers, or of not doing enough to prevent the spread of fake news. Some of their critics argue that platforms should be held responsible for the content displayed on their websites.[2]

From an economic standpoint, the situation is a double-edged sword for publishers: while social platforms provide the opportunity to reach a wider audience, newspapers worry about the platform's growing power, for fear of losing their privileged relationship with readers, and eventually a large share of their revenues (Thompson, 2015; Constine, 2018). This, in turn, may have an adverse effect on newspapers' incentive to invest in news quality. These issues are the focus of the present paper.

Our starting point is that news is but one type of content that can be consumed on a social platform, with UGC representing a large share of what is shown on the platform. Given the abundance and heterogeneity of available content, and the scarcity of attention, one of the platforms' key functions is to determine which content is seen by its users. In particular, a major strategic choice concerns the relative prominence of news versus other kind of content in consumers' "newsfeed".[3] For a platform, the optimal trade-off is

[1]For some news providers, Facebook's dominance is even more pronounced. For example, Buzzfeed, a leading online publisher valued at close to $1.5 billion derives 75% of its traffic from Facebook.

[2]While our results concerning the impact of social networks on news quality are directly relevant to these topics, we do not focus on these. See, for example, Bakshy, Messing, and Adamic (2015) or Allcott and Gentzkow (2017).

[3]See for instance Constine (2016) and Bradshaw (2017) for reports on how platforms such as Facebook

driven by two considerations, which play a key role in our analysis: (i) News and UGC are imperfect substitutes, with consumers having heterogenous preferences. Catering to users' preferences ensures that they spend more time on the platform. (ii) News content is produced by external publishers, while UGC is produced by the platform's users, so that it is "cheaper" for the platform to show the latter type of content.

Building on these points, we develop a simple model of competition for attention between a social platform and a newspaper that allows us to make two contributions. First, we shed light on the platform's incentives to use *content bundling* (i.e. showing news alongside UGC) as a strategy to capture consumers' attention. Second, we draw out the implications of content bundling on the news industry, in particular with respect to news quality, newspapers' profits and consumers' news consumption. We show that content bundling generally harms newspapers. Regarding quality, we identify opposing forces governing the incentives to invest. We find that the impact of content bundling is heterogeneous across publishers: high-quality ones invest more under content bundling, while low-quality ones invest less. Thus, our model predicts that content bundling is likely to increase the variance of quality in the news market. We also find that quality is more likely to increase in environments with many newspapers, or if the newspaper can adopt a subscription model.

In our basic framework, a social platform and a newspaper (or publisher), both advertising-supported, compete for consumers' attention.[4] The newspaper produces news stories and maintains a website, which only offers news content. The social platform relies on its users to produce UGC, such as personal stories or pictures. On its website, the platform can bundle UGC with content produced by the newspaper, in which case the platform and the newspaper share advertising revenues.

Consumers have limited attention, and are heterogeneous in their demand for news, that is in the share of their attention they would like to devote to news content. The demand for news also depends on its quality, which is the result of an investment by the newspaper. Consumers can freely allocate their attention across the two websites, but, when on the platform, have to consume the mix of content that is offered to them.

By bundling news and UGC, the platform diverts some news consumption away from the newspaper's website, and onto its own. Moreover, for a given quality of news, content bundling increases total news consumption by distorting upwards the consumption of consumers with a low demand for news. However this increase in news consumption is

and Snapchat have redesigned their newsfeeds. Facebook's recent announcement to change its newsfeed in favor of UGC in the context of the "fake news" controversy has generated particular interest (Bromwich and Haag, 2018).

[4]Below, we also explore a model with advertising *and* subscription when we consider the relevant case of a *personalized* social media newsfeed. We will make the case then that a subscription model only makes sense under the assumption of (significant) newsfeed personalization.

never large enough to compensate the newspaper for the fact that a part of it occurs through the platform. The driving force behind this result is that the extent of content bundling (i.e. the share of news content that platform users are exposed to) is strategically chosen by the platform so as to increase its advertising revenues, which comes at the expense of the newspaper.

Regarding the newspaper's incentives to invest in quality, we find that content bundling has a positive effect if and only if the cost of quality is small. In other words, our model predicts that a high-quality newspaper should invest more under content bundling, while a low-quality one should invest less. The rough intuition for this result is that, faced with increased competitive pressure by the platform's content bundling, the newspaper can react either by saving on cost (i.e. reducing quality) or by investing more in quality to attract more consumer attention. When the cost of quality is high, the newspaper tends to do the former, i.e. decreases the investment in quality, while it does the opposite when the cost of quality is low. More precisely, content bundling has a heterogeneous effect on the sensitivity of consumers' demand for news: low types become less responsive to increases in quality, while high types become more responsive. When the quality level is initially high (i.e. when the cost of producing quality is small), the effect on the high types becomes stronger, leading equilibrium quality to increase. This finding is important in a context of general concern for the quality of news in the age of social media. Our results indicate that the effect of social networks on news providers is not uniform, and could result in an increase in the dispersion of quality.

Our baseline model, analyzed in Sections 3 and 4, considers a single newspaper with an advertising-based revenue model and a social platform that engages in uniform content bundling. In Section 5 we explore the practically relevant case of personalized content bundling by the platform and we extend the analysis to a hybrid (advertising- and subscription-based) revenue model for the newspaper. We show that personalization does not change our main results. When considering subscriptions, our analysis brings some support to the claim that paywalls can help newspapers cope with dominant platforms: we find that the optimal price for the newspaper goes up under content bundling. Interestingly this higher price goes hand in hand with a higher quality, an effect more pronounced when the cost of quality is small. Next, Section 6 extends our framework to allow for competition between many newspapers. We again show that newspapers are made worse-off by content bundling, but we find that news quality increases. Finally, in Section 7 we discuss in detail some of our assumptions and explore the limitations of the model. Specifically, unlike in the baseline model, we allow for content bundling to generate various efficiency gains. In that section we also study a setup where the newspaper can opt-out and prevent the platform from bundling news and UGC.

2 Relevant literature

The Internet has had a dramatic effect on the news industry, with a joint decrease of circulation and advertising revenue for the printed press (see Peitz and Reisinger, 2015, for an overview). In their online transition, newspapers have also experienced various challenges, among others self-cannibalization (Gentzkow, 2007), consumer switching behavior (Athey, Calvano, and Gans, 2018), or copyright violation (Cagé, Hervé, and Viaud, 2017).

An issue which is particularly relevant to this paper is the emergence of news aggregators, such as Yahoo News or Google News (see Jeon, 2018, for a survey). As in our paper, the central question is how these intermediaries impact the consumption of news as well as the quality of content produced. On the theory side, Jeon and Nasr (2016) and Dellarocas, Katona, and Rand (2013) model aggregators as enabling consumers to find high-quality news more easily. They find that the entry of an aggregator tends to increase competition among websites, leading to higher quality. The impact on newspapers profit depends on which effect is stronger: business stealing or market expansion. Rutt (2011) studies how the presence of an aggregator affects newspapers' choice of business model, and shows that it has different effects on the quality provided by free versus paying outlets. In George and Hogendorn (2012), the aggregator reduces the cost of multi-homing for consumers. Unlike here, in these papers aggregators are non-strategic and do not produce their own content, but merely replicate the experience of a newspaper. Even though we also have a trade-off between business stealing and market expansion, our focus on social network leads us to emphasize a different set of issues.

A recent series of empirical papers examine the impact of aggregators on the news industry. Using disputes between Google News and Spanish publishers (Athey, Mobius, and Pal (2017), Calzada and Gil (2016)) or the Associated Press (Chiou and Tucker (2017)), empirical research finds that Google News increases overall news consumption. In particular, Athey, Mobius, and Pal (2017) document that this effect is mostly present for small publishers, who cannot rely on brand recognition to attract users and therefore benefit most from the aggregator. In relation to the theoretical work on aggregators, these papers suggest that the demand-expansion effect of aggregators dominates. George and Hogendorn (2013) studies the consequences of a redesign of Google News, and find that news aggregators can potentially also change the composition of news consumption. Sismeiro and Mahmood (2018) study the impact of social media on news consumption using a global outage of Facebook in 2013.

Our work specifically focuses on social networks as news intermediaries, the major difference being that these platforms also host user-generated content (UGC) that directly competes with the content of publishers (see Luca (2015) for a summary of the economics literature on UGC). This is relevant because, increasingly, it is such platforms (as opposed to search engines) that generate traffic to news content. Yildirim, Gal-Or, and Geylani (2013) study the effect of UGC on the horizontal competition between news providers, but they do not consider the presence of an endogenous intermediary as we do. Theoretical research on UGC and social networks specifically is scarce and focuses mostly on network formation.[5]

In our model, the platform allocates consumers' attention by choosing the mix of content that it displays. In this respect it is similar to a search engine, which allocates traffic through its ranking and design (see de Cornière and Taylor (2014) or Burguet, Caminal, and Ellman (2015)). However, in these papers the intermediary enjoys an exogenous bottleneck position: consumers have to use the search engine to find content. In contrast, our mechanism is one where the allocation of attention while on the platform (i.e. content bundling) determines how consumers allocate their attention between the platform and the newspaper. The gatekeeping role of the platform thus emerges endogenously.

Our framework assumes multi-homing but we abstract away from the core concern of the multi-homing literature applied to media, namely that it may lead to inefficient (duplicate) advertising when an advertiser is present on multiple publishers (see, Ambrus, Calvano, and Reisinger (2016), Athey, Calvano, and Gans (2018), and Anderson, Foros, and Kind (2018) for a detailed treatment of this issue). As Alaoui and Germano (2016), we also assume that consumers are time constrained in their consumption of media and our results resonate with theirs in that competition between content suppliers (including the social network) distort consumers' media consumption. However, we focus on consumers' time allocation across qualitatively different content providers and we abstract away from the editorial process of publishers when multiple topics are present.

3 Baseline model

We consider a model where consumers can consume two kinds of content: news and UGC. UGC is produced by a monopolist social platform (indexed by 0), at no cost, and its quality is exogenous. News are produced by a monopolist newspaper, indexed by 1.[6]

News quality is denoted q, and the associated cost to the newspaper is denoted $c(q)$, increasing and convex. As we explain below, a higher quality of news acts as a demand

[5] See, for example Bala and Goyal (2000) and Jackson and Wolinsky (1996) for earlier models, and Jackson (2010) for a review. See also Zhang and Sarvary (2015) who consider local network effects.

[6] The model can also be interpreted as there having several newspapers who are local monopolists, i.e. such that a consumer is only interested in the content of one newspaper. Under this alternative assumption the platform knows which newspaper each consumer is interested in. We discuss substitutability between newspapers in Section 6.

shifter. For our purpose the precise meaning of news quality is not essential and our model is consistent with several interpretations of quality (e.g. the accuracy of reporting, the scope of issues covered by the newspaper or even the presentation of news content). However, our framework requires quality to be a vertical attribute, valued by all consumers. Notice that this interpretation is not consistent with the idea that consumers have heterogeneous views on what constitutes high quality as, for example, in the literature on media bias (see Gentzkow, Shapiro, and Stone, 2015; Puglisi and Snyder Jr, 2015, for recent surveys of media bias).[7]

Consumers have heterogeneous preferences regarding content. A consumer of type θ who consumes a quantity x of news (of quality q) and y of UGC derives a utility $U(x, y, q, \theta)$, non-decreasing in x and y. We assume that $U_{x,\theta} \geq 0$,[8] i.e. that high types have a larger marginal utility for news content. News quality increases the marginal utility of news consumption: $U_{x,q} > 0$. However, this effect is weaker for higher levels of quality: $U_{x,q,q} \leq 0$.[9] We assume that θ is distributed according to a continuous c.d.f. F, of density f, on a support $[\underline{\theta}, \overline{\theta}]$. In the baseline model, θ is a consumer's private information. We relax this assumption in Section 5, when we allow the platform to personalize consumers' newsfeed.

Each consumer has one unit of attention. The *attention constraint* is thus: $x + y \leq 1$. For a given quality q, a type θ consumer's demand for news $\hat{x}(\theta, q)$ is the solution to

$$\max_{x,y} U(x, y, q, \theta) \quad \text{s.t} \quad x \geq 0, \quad y \geq 0 \quad \text{and } x + y \leq 1.$$

From our assumptions, $\hat{x}(\theta, q)$ is non-decreasing in both its arguments. Similarly, $\hat{y}(\theta, q)$ is the demand for UGC. We assume that consumers have no outside option, so that the attention constraint is always binding and $\hat{y}(\theta, q) = 1 - \hat{x}(\theta, q)$.[10]

Example: For the sake of illustration, we sometimes assume that θ is uniformly distributed on $[0, 1]$ and we use the following utility function:

$$U(x, y, q, \theta) = (\theta + q)x - \frac{(1 - y)^2}{2}. \tag{1}$$

[7] See also Angelucci and Cagé (2016) for a model where newspapers can invest more in "hard news", which is a horizontal feature.

[8] $U_{x,\theta}$ is the cross derivative of U with respect to x and θ.

[9] $U_{x,q,q}$ is the third-order partial derivative. At this point, we impose no restriction on the sign of $U_{x,q,\theta}$, that is, we do not specify whether high types' or low types' demand for news is more sensitive to quality.

[10] The main results would carry over to a setup where consumers have an outside option with decreasing marginal value, so that $x + y$ would be endogenous. See Section 7 for a discussion.

A consumer's demand for news is then $\hat{x}(\theta, q) = \min\{\theta + q, 1\}$. We refer to this as the *additive model*. It allows us to obtain closed-form solutions.[11]

Even though consumers have preferences over content, they cannot directly choose which content they consume. Instead, they allocate their unit of attention across two websites: one operated by the newspaper, and one by the platform. While the newspaper's website can only offer news content, the key feature of our model is the platform's ability to display news from the newspaper alongside its own UGC. Such *content bundling* is a strategic choice: the platform decides the share λ of news that consumers are exposed to when they visit its website. If a consumer spends t_0 units of time on the platform's website, he therefore consumes a quantity $t_0(1-\lambda)$ of UGC, and a quantity $t_0\lambda$ of news (on top of the news he gets directly from the newspaper's website).[12]

In the baseline model, websites are purely advertising-supported - an assumption we relax in Section 5. We normalize the monetary value of one unit of attention by a consumer to one. Unlike other papers in the media literature (see, e.g., Anderson and Jullien, 2015, for a survey), we treat the quantity of advertising on either website as exogenous. Thus, when a consumer spends t_1 units of time on the newspaper's website (what we call direct traffic), the newspaper generates direct revenues of t_1. The newspaper also derives revenues from indirect traffic, i.e. from the news stories that consumers are exposed to while on the platform's website. More specifically, we assume that if the platform shows a share λ of news and if a consumer spends t_0 units of time on its website, the newspaper's indirect revenue is $t_0\lambda(1-\phi)$, where $\phi \in [0,1]$ is the share of news-related ad revenues that the platform keeps for itself. The platform's revenue is then $t_0(1-\lambda+\lambda\phi)$.

One can interpret the $(\phi, 1-\phi)$ sharing rule either as explicit payments from the firm collecting the revenues to the other, or, more broadly, as capturing the idea that (i) direct traffic is more valuable to the newspaper than indirect traffic, and (ii) the platform would prefer to show UGC if the allocation of attention was fixed. Under this second interpretation, one could imagine that the sum of the revenues adds up to more or less than one. Provided that the sum is not too far away from one, our results will continue to apply.[13]

[11] Our model can accommodate different interpretation of news quality using different preference structures. Therefore, we have explored other utility specifications. In particular, we sometimes mention results obtained under the multiplicative model, where $U(x, y, q, \theta) = \theta q x - \frac{(1-y)^2}{2}$ and $\hat{x}(\theta, q) = \min\{\theta q, 1\}$. Closed-form solutions are then harder to obtain.

[12] There are several ways through which one can read news on Facebook including clicking on a sponsored link by the newspaper, opening a story shared by a friend, or just seeing a post by the newspaper's Facebook page. We do not make a distinction between these cases. For now, we assume that, when on the platform, consumers consume all content presented in their newsfeed. We discuss the implications of relaxing this assumption in Section 5.

[13] We allow for a sum of shares larger than 1 in Section 7, where we also explore the case with an endogenous ϕ.

More generally, note that our baseline model assumes that, beyond being the sole provider of UGC, the platform does *not* provide additional benefits either to consumers or the publisher. In particular, one could consider three sources for such benefits: (i) news could be more valuable to readers on the platform because it is consumed within the reader's social network (e.g. it has been shared by a friend or may also contain friends' comments), (ii) the platform may save consumers' switching costs between sites, i.e. most of them can find *all* their content needs on one site and, finally, (iii) the platform may make advertising more efficient for the publishers because of its better targeting capability, given its extensive data on consumers. While platforms regularly claim these benefits, there is little direct evidence on their importance. For example, newspapers claim that they are better at presenting their content to consumers who are distracted by other things in the newsfeed. Similarly, switching costs between websites are typically negligible. Finally, there is evidence that newspapers earn far less from their advertising on Facebook than on their own sites and most would certainly prefer monetizing their audience directly (Swoyer, 2017).

Moreover, the primary goal of the baseline model is to properly tease out the strategic effects of content bundling, which is difficult to do if the above factors are all simultaneously considered. Nevertheless, it is important to evaluate the impact of these potential benefits by assessing how large they need to be to change our results. We do so in Section 7 by extending the baseline model explicitly taking into account these factors. We find that they need to be really large to reverse our key conclusions.

Timing and equilibrium: The timing is as follows: at $\tau = 1$, the newspaper chooses a quality q, publicly observed, and incurs the cost $c(q)$. We view q as a long-term strategic choice. At $\tau = 2$, the platform chooses the share of news λ it shows to its users. At $\tau = 3$, consumers observe λ and choose $t_0(\theta, q, \lambda)$, the time they spend on the platform as a function of their type, of the quality of news and of the platform's content mix. The resulting news consumption is $x = \lambda t_0 + t_1$. We look for subgame-perfect equilibria.

4 Equilibrium analysis

4.1 Benchmark: UGC-only newsfeed

As a benchmark, we start with the case in which the platform cannot bundle news content alongside UGC (i.e. $\lambda = 0$).

After observing q, consumers choose how much attention to allocate to the platform and to the newspaper. Because the platform only offers UGC, and there are no costs associated to switching from one website to the next, consumers can consume their desired mix of content. A consumer of type θ then spends $\hat{x}(\theta, q)$ units of time on the newspaper's website, and $\hat{y}(\theta, q) = 1 - \hat{x}(\theta, q)$ on the platform. The total time spent on the newspaper's website and the newspaper's profit are therefore

$$T_1(q, \lambda)|_{\lambda=0} = \int_{\underline{\theta}}^{\overline{\theta}} \hat{x}(\theta, q) dF(\theta) \quad \text{and} \quad \pi_1(q, 0) = T_1(q, 0) - c(q). \tag{2}$$

Profit is concave in q, and the optimal quality for the newspaper, denoted $\tilde{q}$, is the solution to

$$\frac{\partial T_1(\tilde{q}, 0)}{\partial q} = c'(\tilde{q}). \tag{3}$$

Let $\tilde{\pi}_1$ be the newspaper's associated profit.

Example: In the additive model ($\hat{x}(\theta, q) = \min\{\theta + q, 1\}$) with a uniform distribution of types on $[0, 1]$, the total time spent on the newspaper is

$$T_1(q, 0) = \int_0^1 \hat{x}(\theta, q) d\theta = \int_0^{1-q} (\theta + q) d\theta + \int_{1-q}^1 1 d\theta = \frac{1 + 2q - q^2}{2}.$$

If the cost of quality is $c(q) = cq^2/2$, the equilibrium quality level and profit in the benchmark are

$$\tilde{q} = \frac{1}{1 + c} \quad \text{and} \quad \tilde{\pi}_1 = \frac{2 + c}{2 + 2c}. \tag{4}$$

We now turn to the analysis of the game where the platform can freely choose λ and proceed by backward induction.

4.2 Consumers: allocation of attention with content bundling

At $\tau = 3$, if news quality is q, a consumer of type θ would like to consume a quantity $\hat{x}(\theta, q)$ of news. By spending t_0 units of time on the platform, and $1 - t_0$ on the newspaper, he gets a quantity of news, $x(t_0, \lambda) = t_0 \lambda + (1 - t_0)$ and a quantity of UGC, $y(t_0, \lambda) = t_0(1 - \lambda)$.

If $\lambda \geq \hat{x}(\theta, q)$, the consumer's demand for news is more than satisfied by the platform alone. Such a consumer then decides to spend all his time on the platform, $t_0(\theta, q, \lambda) = 1$. Similarly, if $\hat{x}(\theta, q) = 1$, the consumer allocates all his attention to the newspaper, that is $t_0(\theta, q, \lambda) = 0$. Finally, consumers for whom $1 > \hat{x}(\theta, q) > \lambda$ can achieve their optimal content mix by spending $t_0(\theta, q, \lambda)$ on the platform such that

$$t_0(\theta, q, \lambda)(1 - \lambda) = \hat{y}(\theta, q) \Leftrightarrow t_0(\theta, q, \lambda) = \frac{\hat{y}(\theta, q)}{1 - \lambda} = \frac{1 - \hat{x}(\theta, q)}{1 - \lambda}.$$

We denote by $\hat{\theta}_1(q, \lambda)$ the solution to $\hat{x}(\theta, q) = \lambda$, i.e. the largest type who does not visit the newspaper, and by $\hat{\theta}_2(q)$ the smallest solution to $\hat{x}(\theta, q) = 1$, i.e. the lowest type who does not visit the platform. We sometimes omit the arguments and simply write

$\hat{\theta}_1$ and $\hat{\theta}_2$. Consumers with $\theta < \hat{\theta}_1$ single-home on the platform. Consumers with $\theta > \hat{\theta}_2$ single-home on the newspaper's website. The rest of the consumers multi-home between the two websites. Lemma 1 below summarizes consumers' behavior.

Lemma 1. ***(Optimal allocation of attention)*** *When the newspaper is of quality q and the platform shows a share λ of news content, a consumer of type θ allocates a share $t_0(\theta, q, \lambda)$ of his attention to the platform, where*

- $t_0(\theta, q, \lambda) = 1$ *if* $\theta \leq \hat{\theta}_1$,
- $t_0(\theta, q, \lambda) = \frac{1-\hat{x}(\theta,q)}{1-\lambda}$ *if* $\theta \in \left(\hat{\theta}_1, \hat{\theta}_2\right)$,
- $t_0(\theta, q, \lambda) = 0$ *if* $\theta \geq \hat{\theta}_2$.

In the benchmark where $\lambda = 0$, consumers allocate a share $\hat{x}(\theta, q)$ of their attention to the newspaper. When $\lambda > 0$, that share is lower because part of the demand for news is already satisfied by visiting the platform. More generally, any increase in λ shifts attention from the newspaper to the platform, a point we elaborate on when we discuss the choice of λ. While this effect does not directly affect consumers such that $\theta > \hat{\theta}_1$, whose consumption of news is still $\hat{x}(\theta, q)$, it introduces a consumption distortion on lower types, who, even though they stop visiting the newspaper, end up consuming too much news relative to what they would like ($\lambda > \hat{x}(\theta, q)$).[14] Lemma 1 implies the following intermediary result:

Proposition 1. *Suppose that news quality is fixed at some level q. Total news consumption is a non-decreasing function of λ. In particular, for a given q, news consumption is higher under content bundling* ($\lambda > 0$) *than under the benchmark* ($\lambda = 0$).

Proof. A consumer's news consumption is $\max\{\hat{x}(\theta, q), \lambda\}$, which is non-decreasing in λ. ■

Proposition 1 highlights the potential benefit that the newspaper can derive from content bundling: news consumption goes up, and the newspaper gets a positive share of the revenues generated by news consumption through the platform. After endogenizing the choices of λ and q, we will see that this effect is never strong enough so as to make the newspaper better-off than under the benchmark.

[14] "Too much news" does not mean that consumers are forced to consume news content that brings them negative utility. They enjoy the news content ($U_x \geq 0$), but would prefer UGC instead.

4.3 Platform: optimal content bundling

At $\tau = 2$, suppose that news quality is q. If the platform displays a share λ of news content, the total amount of attention that it receives is

$$T_0(q, \lambda) = \int_{\underline{\theta}}^{\overline{\theta}} t_0(\theta, q, \lambda) dF(\theta). \tag{5}$$

Each unit of attention generates a revenue $(1 - \lambda + \lambda\phi)$, so that the platform's profit is $\pi_0(q, \lambda) = (1 - \lambda + \lambda\phi)T_0(q, \lambda)$.

The platform's trade-off is the following: by showing more news content (increasing λ), the platform can receive more of the consumers' attention, by the logic discussed in the previous subsection. However, showing more news leads to lower advertising revenue per-unit of attention. The next proposition gives a lower bound on the optimal λ:

Proposition 2. *The optimal content bundling strategy is such that $\lambda^*(q) \geq \hat{x}(\underline{\theta}, q)$.*

Proof. Take $\lambda < \hat{x}(\underline{\theta}, q)$, i.e. $\hat{\theta}_1(q, \lambda) < \underline{\theta}$. By Lemma 1, all consumers with $\theta \leq \hat{\theta}_2(q)$ spend $t_0(\theta, q, \lambda) = \frac{1-\hat{x}(\theta,q)}{1-\lambda}$ units of time on the platform.[15] The platform's profit is

$$\int_{\underline{\theta}}^{\hat{\theta}_2} (1 - \lambda + \lambda\phi) t_0(\theta, q, \lambda) f(\theta) d\theta = \int_{\underline{\theta}}^{\hat{\theta}_2} \left(1 - \hat{x}(\theta, q) + \lambda\phi \frac{1 - \hat{x}(\theta, q)}{1 - \lambda}\right) f(\theta) d\theta.$$

This is an increasing function of λ, so $\lambda^*(q)$ must be no smaller than $\hat{x}(\underline{\theta}, q)$. ■

Intuitively, an increase in λ only harms the platform through the consumers who spend all their time on its website. For these consumers, a higher λ translates into less revenue per-unit of attention and a constant attention. The other consumers, who allocate their attention so as to consume their preferred mix of content, adjust their behavior following an increase in λ by spending more time on the platform. The platform continues to fully monetize their (unchanged) consumption of UGC, and on top of that it captures a share of the revenue associated with their news consumption. This is why the platform will always provide at least the minimal demand for news in the population, $\hat{x}(\underline{\theta}, q)$.

Additive model: Figure 1 illustrates the result for the additive model. The figure depicts the allocation of attention between news and UGC depending on the value of λ. Panel (a) shows the case of the benchmark where $\lambda = 0$ and each type θ consumes his desired quantity of news, $\hat{x}(\theta, q)$ through the newspaper's website (*direct* news consumption). The platform's revenue corresponds to the white area. In panel (b), the platform sets $\lambda = \hat{x}(\underline{\theta}, q)$. The relative consumption of news and UGC does not change, but part of

[15]Recall that $\hat{\theta}_2(q)$ is the smallest solution to $\hat{x}(\theta, q) = 1$ and thus does not depend on λ.

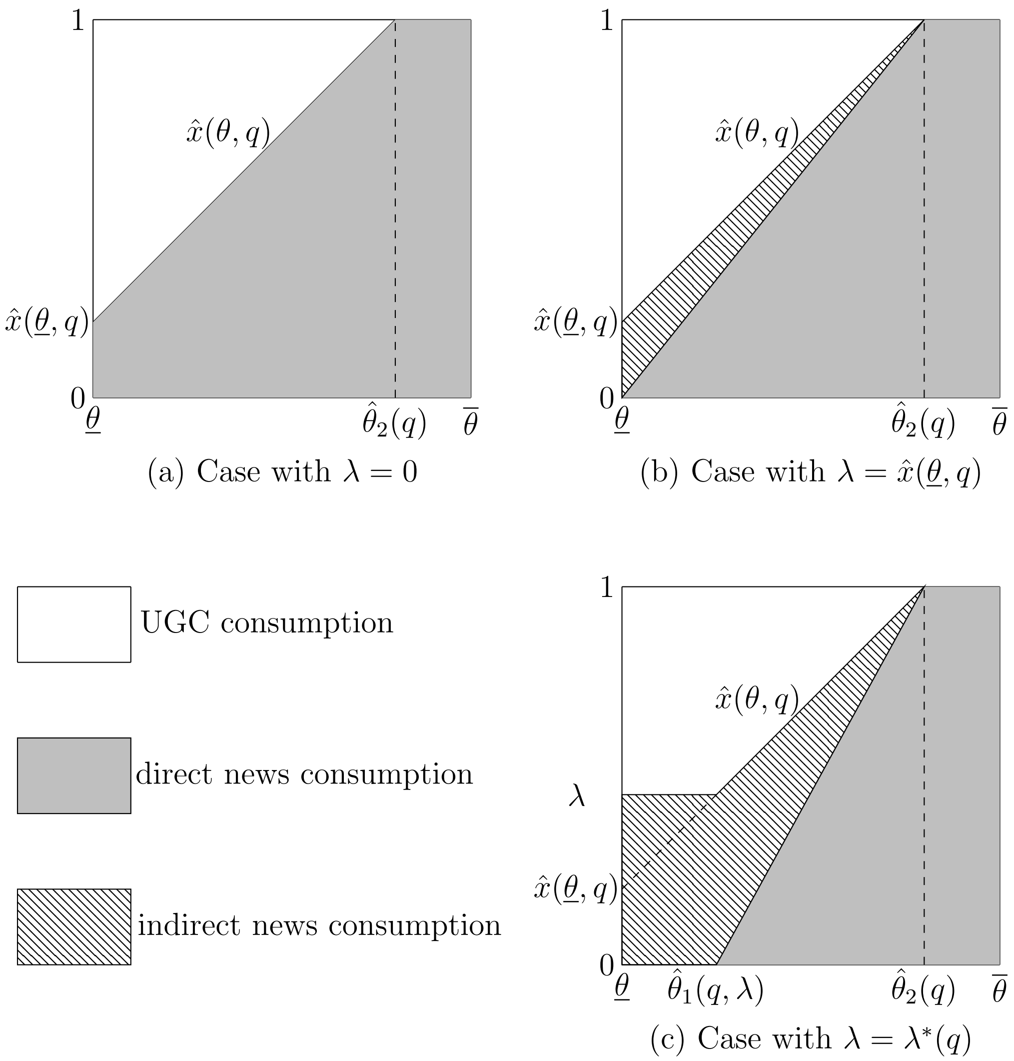

Figure 1: Content consumption for different values of λ. We assume $\hat{x}(\theta, q) = \theta + q$, $\theta \hookrightarrow \mathcal{U}[0, 1]$, $q = 1/5$, $\phi = 1/3$. See discussion in the text.

the news consumption happens through the platform (*indirect* news consumption). The platform's revenue equals the white area plus ϕ times the dashed area, and therefore is larger than in panel (a). In panel (c), λ is chosen optimally: the types $\theta < \hat{\theta}_1(q, \lambda)$ consume more news than they would like (and therefore the platform generates less revenue from them), but all the types between $\hat{\theta}_1(q, \lambda)$ and $\hat{\theta}_2(q)$ spend more time on the platform in order to maintain their desired consumption of UGC.

Analytically, in the additive model, we have $\hat{\theta}_1(q, \lambda) = \lambda - q$ and $\hat{\theta}_2(q) = 1 - q$. Using Lemma 1 to obtain t_0 and t_1, the total time spent on the platform is, for any $\lambda \geq q$:[16]

$$T_0(\lambda, q) = \int_0^{\hat{\theta}_1} 1 d\theta + \int_{\hat{\theta}_1}^{\hat{\theta}_2} \frac{1 - (\theta + q)}{1 - \lambda} d\theta = \frac{1 + \lambda - 2q}{2}. \tag{6}$$

[16]Which is always true in equilibrium, by Proposition 2.

The platform's profit $(1-\lambda+\lambda\phi)T_0(\lambda, q)$ is maximized for $\lambda^*(q) = q + \frac{\phi}{2(1-\phi)}$. The first term ($q$) corresponds to the demand for news of the lowest type ($\theta = \underline{\theta} = 0$). Beyond this quantity, the platform's optimal strategy depends on the share ϕ of revenues it captures when it shows news: for large values of ϕ the platform has an incentive to show a lot of news content to its users.

4.4 Newspaper: choice of quality

Besides understanding the strategic incentives of the platform to provide news content to its users, we seek to assess the effects of content bundling on the news industry, i.e. on the newspaper's profit and choice of quality. The newspaper's profit is

$$\pi_1(q,\lambda) = T_1(q,\lambda) + (1-\phi)\lambda T_0(q,\lambda) - c(q) \equiv R_1(q,\lambda) - c(q),$$

where $R_1(q,\lambda)$ denotes the newspaper's advertising revenues. We assume that the primitives are such that this profit is quasi-concave in q.[17] Similarly, define $R_0(q,\lambda) \equiv (1-\lambda(1-\phi))T_0(q,\lambda)$, which represents the platform's revenues. Notice that $R_0(q,\lambda) + R_1(q,\lambda) = T_0(q,\lambda) + T_1(q,\lambda) = 1$ for any (q,λ).

In period $\tau = 1$, acting as a Stackelberg leader,[18] the newspaper knows that the platform will choose $\lambda = \lambda^*(q)$. Its objective function is thus

$$\pi_1(q,\lambda^*(q)) = R_1(q,\lambda^*(q)) - c(q) = 1 - R_0(q,\lambda^*(q)) - c(q).$$

Because $\lambda^*(q)$ maximizes $R_0(q,\lambda)$, the envelope theorem implies that $\frac{d\pi_1(q,\lambda^*(q))}{dq} = \frac{\partial \pi_1(q,\lambda^*(q))}{\partial q}$. Using the notation $\lambda^* = \lambda^*(q^*)$, the newspaper's first-order condition then writes

$$(1-(1-\phi)\lambda^*)\frac{\partial T_1(q^*,\lambda^*)}{\partial q} = c'(q^*). \tag{7}$$

Comparing (3) and (7), one can distinguish two effects of content bundling by the platform: a softening effect and a composition effect. The softening effect corresponds to the smaller return to a marginal increase in direct traffic T_1, from 1 (in the benchmark) to $1-(1-\phi)\lambda^*$. When the platform bundles content, the newspaper collects a share of its revenues, and increasing T_1 is less valuable. The softening effect reduces the incentives to invest in quality under content bundling.

The composition effect works as follows: under the benchmark, an increase in q raises the news consumption of all types between $\underline{\theta}$ and $\hat{\theta}_2$ by $\frac{\partial \hat{x}}{\partial q}dq$. With content bundling, only the consumers with $\theta \in [\hat{\theta}_1, \hat{\theta}_2]$ change their behaviour.[19] However these consumers are

[17] This is true in the additive model with uniform distribution of types.

[18] We would obtain the same result if q and λ were chosen simultaneously.

[19] The fact that λ will increase following a rise in q does not affect the newspaper's marginal trade-off, by the envelope theorem.

more responsive than under the benchmark: their demand increases by $\frac{1}{1-\lambda}\frac{\partial \hat{x}}{\partial q}dq$. The overall sign of the composition effect, and therefore the effect of content bundling on news quality, is ambiguous in general.

Focusing on the additive model allows us to obtain further results.

Proposition 3. *Suppose that $\hat{x}(\theta, q) = \min\{\theta + q, 1\}$, that θ is uniformly distributed on $[0, 1]$, and that $c(q) = cq^2/2$. Equilibrium quality is lower under content bundling than under the benchmark if $c > 1$, and higher if $c < 1$.*

Proof. Using equation (6) we have $T_1(q, \lambda) = q + \frac{1-\lambda}{2}$. Solving equation 7 then leads to

$$q^* = \frac{2 - \phi}{2(1 + c - \phi)}. \tag{8}$$

Comparing this to the benchmark quality level (see Equation (4)) then gives the result. ■

The intuition for this result is not straightforward. To understand it, let us fix λ,[20] and look at the return on investment under the benchmark and under content bundling. Following a small increase in quality dq, consumers such that $\theta < \hat{\theta}_1$ increase their news consumption by $\frac{\partial \hat{x}}{\partial q}dq = dq$ under the benchmark. Under content bundling their news consumption is fixed at λ. In other words, low types do not provide any incentive to invest under content bundling.

For $\theta \in [\hat{\theta}_1, \hat{\theta}_2]$, a small increase in quality dq leads to an increase in news consumption of $\frac{\partial \hat{x}}{\partial q}dq = dq$ under the benchmark. The mass of such consumers is $\hat{\theta}_2 - \hat{\theta}_1 = 1 - q - (\lambda - q) = 1 - \lambda$, so that the increase in revenue from these consumers is $(1 - \lambda)dq$.[21] Under content bundling, the increase in the direct traffic from each of these consumers is $\frac{1}{1-\lambda}\frac{\partial \hat{x}}{\partial q}dq = \frac{dq}{1-\lambda}$. Such an increase in direct traffic is valued at $1 - \lambda(1 - \phi)$ (see (7)). Given that there are $1 - \lambda$ such consumers, the total increase in revenue from these higher types is $(1 - \lambda(1 - \phi))dq > (1 - \lambda)dq$: they provide more incentives to invest under content bundling.

Putting things together, the return on investment is equal to $(\hat{\theta}_1 + (1-\lambda))dq = (1-q)dq$ under the benchmark, and $0 + (1 - \lambda(1 - \phi))dq$ under content bundling. The latter term is more likely to dominate the former when q is large, which happens when the cost c is small.

A similar result holds in the multiplicative model ($\hat{x}(\theta, q) = \min\{\theta q, 1\}$): content bundling increases quality, if and only if, the cost of producing quality is low.[22]

[20] The envelope theorem logic implies that the newspaper takes λ as given.

[21] Of course λ plays no role in the benchmark. The term $1 - \lambda$ only comes from the partition of consumers we use to facilitate the comparison with the case of content bundling.

[22] For the multiplicative model, we can only obtain closed-form results for the case where c is small. When c is large we rely on numerical results. Details are available from the authors upon request.

Proposition 3 suggests that content bundling has a heterogeneous effect on newspapers: high-quality newspapers (with low c) react to content bundling by increasing their level of investment, while low-quality newspapers reduce their quality under content bundling. A testable prediction of the model is that content bundling should increase the variance of the distribution of quality. Notice that this results holds independently of ϕ.

4.5 Welfare analysis

Effect on the newspaper

While in equilibrium news quality may increase or decrease, we find that the newspaper's profit unambiguously declines with content bundling by the platform:

Proposition 4. *The newspaper's profit is lower under content bundling than under the benchmark.*

Proof. Because λ is chosen optimally by the platform, we have, for any q, $R_0(q, \lambda^*(q)) > R_0(q, 0)$. This is true in particular for $q = q^*$: $R_0(q^*, \lambda^*) > R_0(q^*, 0)$. Since $R_0(q, \lambda) + R_1(q, \lambda) = 1$, the previous inequality rewrites $R_1(q^*, \lambda^*) < R_1(q^*, 0)$. Substracting $c(q^*)$ from each side, we get $\pi_1(q^*, \lambda^*) < \pi_1(q^*, 0)$. By revealed preferences, we know that $\pi_1(q^*, 0) \leq \pi_1(\tilde{q}, 0)$, which implies that $\pi_1(\tilde{q}, 0) > \pi_1(q^*, \lambda^*)$. ∎

Even though content bundling by the platform may soften competition and increase total news consumption, it cannot benefit the newspaper. The reason is that λ is chosen optimally by the platform to increase its revenue, which mechanically reduces the newspaper's revenue. The potential saving on costs is never enough to compensate this loss. The result again does not depend on ϕ, nor on the consumer demand specification. We further discuss the robustness of this result in Section 7.

Effect on consumers

For a given quality level, content bundling harms consumers because it distorts lower types' consumption towards too much news. If news quality decreases, consumers are therefore unambiguously worse-off under content bundling. They can be better-off only if quality increases enough to offset the distortion. Figure 2 illustrates this phenomenon in the additive model. Surplus increases when both c and ϕ are small. When c is small quality goes up under content bundling. A small value of ϕ implies that $\lambda = q + \frac{\phi}{2(1-\phi)}$ is also small, so that the distortion of content consumption is not too large.

Regarding total welfare (that is, if we take the costs of producing quality into account), we obtain a similar figure, albeit with a smaller area where content bundling is desirable. Indeed, a higher quality comes at a higher cost, so that consumer surplus gains are partially

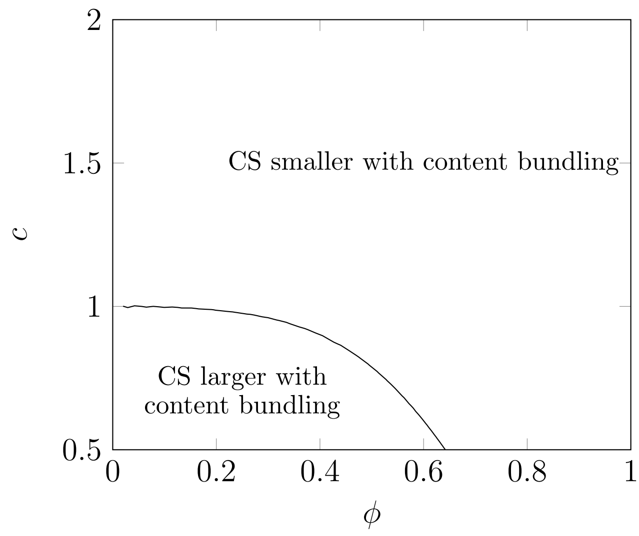

Figure 2: Effect of content bundling on consumer surplus, CS.

offset by profit losses. In terms of the magnitude of the effect, numerical results suggest that surplus and welfare gains in the lower left area are small relative to surplus and welfare losses in the other areas.

5 Personalized newsfeed

One important assumption of the preceding analysis is that the platform offers the same mix of content to everyone. While helpful to obtain insights regarding the key effects of content bundling, the assumption overlooks two considerations of practical relevance. First, platforms such as Facebook do customize the mix of content they offer to consumers, using the considerable amount of data they have gathered about them. For instance, a consumer who often clicks on news stories will be shown more of these. Second, consumers also exert some control over the content they consume while on the platform. If a consumer is not interested in a news story, she has the option of skipping it by scrolling down. In our baseline model the cost of skipping a story was assumed to be large, because we wanted to emphasize the curating role of the platform.

In this section we consider the extreme opposite assumption, i.e. that the mix of content consumed through the platform is perfectly personalized. This could either come from the platform observing consumers' types θ, or from consumers' ability to costlessly skip content.[23] We thus assume that the platform can observe consumers' types and can condition λ on both q and θ.

[23] In the latter case the platform would set $\lambda = \hat{x}(\overline{\theta}, q)$. A consumer of type θ would skip all the news stories beyond $\hat{x}(\theta, q)$ and therefore consume her ideal mix.

5.1 Advertising-only business model

Here we revisit the results from the previous section. The timing is as follows: at $\tau = 1$, the newspaper chooses q. At $\tau = 2$ the platform observes q and θ, and chooses $\lambda(\theta, q)$. At $\tau = 3$, consumers optimally allocate their attention between the newspaper and the platform.

We make the tie-breaking assumption that consumers who only want to consume news allocate all their attention to the newspaper.[24] The results can be summarized as follows:

Proposition 5. *When the platform can personalize the newsfeed:*

1. *The platform chooses $\lambda(\theta, q) = \hat{x}(\theta, q)$.*
2. *Consumers such that $\hat{x}(\theta, \hat{q}) < 1$, i.e. $\theta < \hat{\theta}_2(\hat{q})$ allocate all their attention to the platform.*
3. *The newspaper's profit is lower than without content bundling.*
4. *News quality can be higher or lower than under the benchmark.*

Proof. Given θ and q, the platform clearly wants to offer $\lambda(\theta, q) = \hat{x}(\theta, q)$: showing less news would induce the consumer to allocate some of his attention to the newspaper, while consuming the same amount of UGC. Showing more news would not increase the time spent on the platform, but would reduce the profitability of this time. Consumers with a positive demand for UGC (such that $\theta < \hat{\theta}_2(\hat{q})$) then find it optimal to allocate all their attention to the platform, and thus only consume news indirectly. Then the newspaper's profit is:

$$\pi_1(q) = (1 - \phi) \int_{\underline{\theta}}^{\hat{\theta}_2(q)} \hat{x}(\theta, q) f(\theta) d\theta + \int_{\hat{\theta}_2(q)}^{\overline{\theta}} 1 f(\theta) d\theta - c(q),$$

which can be rewritten

$$\pi_1(q) = T_1(q, 0) - \phi \int_{\underline{\theta}}^{\hat{\theta}_2(q)} \hat{x}(\theta, q) f(\theta) d\theta - c(q).$$

It follows that the newspaper's profit is lower than under the benchmark, $\tilde{\pi}_1 = \max_q T(q, 0) - c(q)$.

The first-order condition is

$$\pi_1'(q) = 0 \Leftrightarrow \frac{\partial T_1(q, 0)}{\partial q} - \phi \left(\frac{\partial \hat{\theta}_2(q)}{\partial q} f(\hat{\theta}_2(q)) + \int_{\underline{\theta}}^{\hat{\theta}_2(q)} \frac{\partial \hat{x}(\theta, q)}{\partial q} f(\theta) d\theta \right) = c'(q).$$

[24] Even though the platform would offer them a personalized mix of only news, so that they would be indifferent between the websites. This tie-breaking assumption could be justified, for instance, if there was a minimal amount of UGC, $\epsilon > 0$ that the platform had to show.

Comparing this to the first-order condition without content bundling (see equation (3)), we see that quality is higher under personalized content bundling if

$$\frac{\partial \hat{\theta}_2(q)}{\partial q} f(\hat{\theta}_2(q)) + \int_{\underline{\theta}}^{\hat{\theta}_2(q)} \frac{\partial \hat{x}(\theta, q)}{\partial q} f(\theta) d\theta < 0. \tag{9}$$

The first term is non-positive, because $\frac{\partial \hat{\theta}_2(q)}{\partial q} \leq 0$: a higher quality of news cannot reduce the share of consumers who want to only consume news. The second term is non-negative: a higher q leads all consumers to demand more news content. The overall effect is therefore ambiguous. ■

With personalization, there are two changes compared to the benchmark of no bundling. (1) increasing the demand for news of "interior" consumers (those who also consume UGC) is less valuable to the publisher, because they will consume this extra content through the platform. (2) Turning a marginal UGC consumer into an exclusive news consumer brings a larger payoff. For instance, take a consumer such that $\hat{x}(\theta, q) = 0.9$. Suppose that a Δ increase in quality makes her only want to consume news ($\hat{x}(\theta, q + \Delta) = 1$). In the benchmark without content bundling, the gain to the publisher over this consumer is $\hat{x}(\theta, q + \Delta) - \hat{x}(\theta, q) = 0.1$. Under personalized bundling, the gain is $\hat{x}(\theta, q + \Delta) - (1 - \phi)\hat{x}(\theta, q) = 0.1 + 0.9\phi$.

Example: In order to say more, we again focus on the additive model with types uniformly distributed on $[0, \overline{\theta}]$.

If $\overline{\theta} < 1 - q$, all consumers want to consume an interior mix of news and UGC, and thus spend all their time on the platform. We then have $R_1(q) = (1 - \phi) \int_0^{\overline{\theta}} (\theta + q) \frac{d\theta}{\overline{\theta}}$. The marginal revenue is then $R_1'(q) = 1 - \phi$. In the benchmark without content bundling, the newspaper's revenue would be $\tilde{R}_1(q) = \int_0^{\overline{\theta}} (\theta + q) \frac{d\theta}{\overline{\theta}}$, for a marginal revenue $\tilde{R}_1'(q) = 1 > R_1'(q)$.

If $\overline{\theta} \geq 1 - q$, the newspaper's revenue with customization is $R_1(q) = (1 - \phi) \int_0^{1-q} (\theta + q) \frac{d\theta}{\overline{\theta}} + \int_{1-q}^{\overline{\theta}} \frac{d\theta}{\overline{\theta}}$: the low types only visit the platform, while the high types only visit the newspaper. The marginal revenue is $R_1'(q) = \frac{1-(1-\phi)q}{\overline{\theta}}$. In the benchmark without content bundling, the newspaper's revenue when $\overline{\theta} \geq 1 - q$ is $\tilde{R}_1(q) = \int_0^{1-q} (\theta + q) \frac{d\theta}{\overline{\theta}} + \int_{1-q}^{\overline{\theta}} \frac{d\theta}{\overline{\theta}}$, and the marginal revenue is $\tilde{R}_1'(q) = \frac{1-q}{\overline{\theta}} < R_1'(q)$.

Figure 3 illustrates the equilibrium quality choice under the benchmark and under personalized content bundling: just like for Proposition 3, content bundling increases quality when the cost is low ($q^*_{c_L} > \tilde{q}_{c_L}$) and reduces quality when the cost is high ($q^*_{c_H} < \tilde{q}_{c_H}$).

The above analysis delivers results that are consistent with our baseline model with uniform content bundling. The only difference is that there is no distortion of news

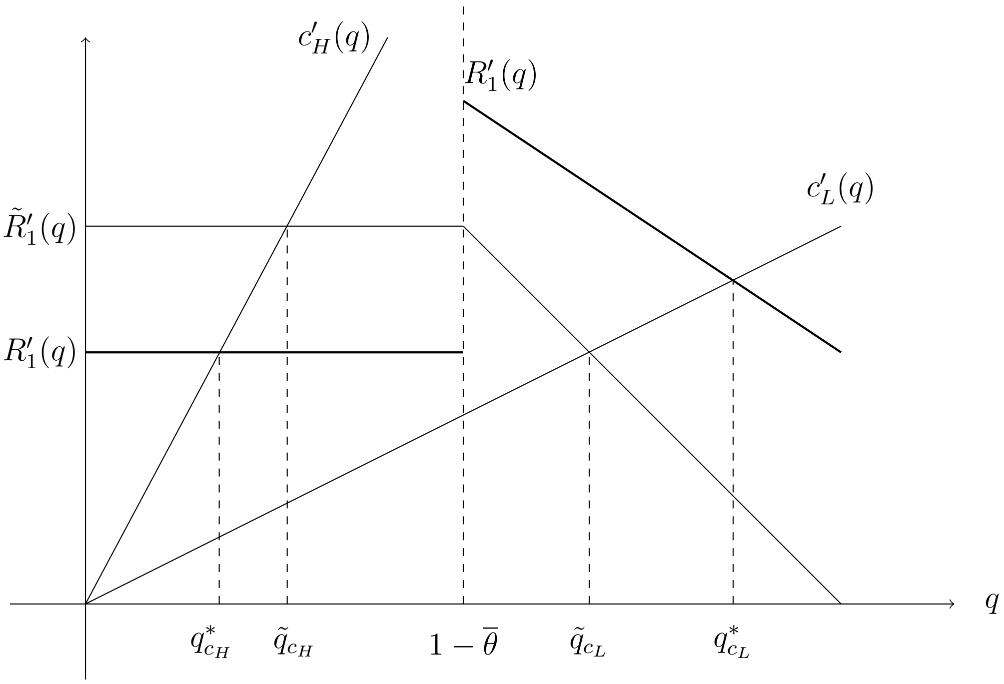

Figure 3: Equilibrium with personalized newsfeed. When the marginal cost of quality is low ($c'_L(q)$), equilibrium quality goes up with content bundling (from $\tilde{q}_{c_L}$ to $q^*_{c_L}$). When marginal cost is high ($c'_H(q)$), quality goes down (from $\tilde{q}_{c_H}$ to $q^*_{c_H}$).

consumption under personalized content bundling. Therefore, consumers benefit if and only if quality increases.

5.2 Subscriptions

Many industry observers (e.g. Thompson, 2017) argue that a shift towards subscription-based business models could help newspapers cope with the threat posed by social platforms. We now investigate this claim, using the framework with personalization. This framework seems more appropriate to study this issue. Indeed if only subscribers can access an article, the assumption that everyone consumes the same content mix on the platform appears particularly ill-suited.

To consider subscriptions, suppose that the gross utility from content consumption is $U(x, y, \theta, q) = 2((\theta + q)x - \frac{(1-y)^2}{2})^{1/2}$. When a consumer gets his optimal content mix, his utility is therefore $\theta + q$.[25] Suppose that the newspaper charges a price p for access to its content. Consumers therefore have to choose between consuming their optimal mix and paying p,[26] or consuming only UGC at no cost. The latter option delivers a utility of $U(0, 1, \theta, q) = 0$.

[25]We take an increasing transformation of the utility function (1) so as to generate a linear demand function.

[26]With personalization consumers get their optimal mix with or without content bundling.

The timing is as follows: at $\tau = 1$ the newspaper sets its quality q and price p. At $\tau = 2$ consumers decide whether to subscribe. At $\tau = 3$ the platform observes consumers' types and whether they have subscribed, and offers a personalized mix of content.[27] At $\tau = 4$ consumers decide how to allocate their attention among the two websites.

We assume that θ is uniformly distributed on $[0, 1]$ and that the cost of quality is $c(q) = \frac{cq^2}{2}$.[28]

Benchmark: no content bundling A consumer of type θ subscribes if and only if $\theta + q \geq p$. The profit of the newspaper can then be written as

$$\tilde{\pi}_1(q, p) = p(1 + q - p) + \int_{p-q}^{1} \min\{\theta + q, 1\} d\theta - \frac{cq^2}{2}. \tag{10}$$

The first term represents revenues from sales, and the second term is the advertising revenues. For a given q, the optimal price is $\tilde{p}(q) = \frac{1+q}{3}$. For a given price, the optimal quality is $\tilde{q}(p) = \frac{1+p}{c}$. The optimal values of q and p are thus

$$\tilde{q} = \frac{4}{3c - 1} \quad \text{and} \quad \tilde{p} = \frac{1 + c}{3c - 1}. \tag{11}$$

Content bundling Given that the platform offers a personalized mix, the decision to subscribe is the same as under the benchmark. The difference is that the consumers who read their news through the platform (i.e. such that $\theta + q < 1$) generate less advertising revenue ($1 - \phi$ instead of 1). The profit of the newspaper is then

$$\tilde{\pi}_1(q, p) = p(1 + q - p) + (1 - \phi) \int_{p-q}^{1-q} (\theta + q) d\theta + \int_{1-q}^{1} 1 d\theta - \frac{cq^2}{2}. \tag{12}$$

For a given q, the optimal price is $p^*(q) = \frac{1+q}{3-\phi}$. For a given price, the optimal quality is $q^*(p) = \frac{1+p}{c}$. The optimal values of q and p are

$$q^* = \frac{4 - \phi}{3c - 1 - c\phi} \quad \text{and} \quad p^* = \frac{1 + c}{3c - 1 - c\phi}. \tag{13}$$

We have the following:

Proposition 6. *Under content bundling:(i) The newspaper's profit goes down. (ii) News quality and price go up. (iii) The increase in quality is larger if c is small.*

Proof. (i) By choosing $q = q^*$ and $p = p^*$ under the benchmark, the newspaper does better than under content bundling. It does even better if it chooses $q = \tilde{q}$ and $p = \tilde{p}$.

[27] Again, an alternative interpretation is that non-subscribers can costlessly skip the links to newspaper articles that they cannot read.

[28] The first-order conditions in the general case do not allow us to say anything about the direction of change in quality and price with content bundling.

Point (ii) follows from simple algebra. (iii) Notice that $q^* = \tilde{q}$ when $\phi = 0$. Because $\frac{\partial^2 q^*}{\partial c \partial \phi} < 0$, the difference $q^* - \tilde{q}$ is smaller when c is large. ■

The main effect of content bundling is to shift up the price-reaction function $p(q)$, while keeping $q(p)$ unchanged. This explains why both q and p go up with content bundling. The intuition is the following: when choosing its price, the firm trades-off the change in revenue from infra-marginal consumers with the change in revenue from marginal consumers. Marginal consumers generate revenue through their subscription and the advertising they are exposed to. With content bundling, this advertising occurs through the platform, and is therefore less valuable to the newspaper. It is therefore less costly to lose a marginal consumer following a price increase.

Our result is consistent with the claim that newspapers should rely more on subscriptions as a source of revenue. However, the subscription model doesn't entirely shield the newspaper from the negative effect of content bundling. Importantly, even though quality always goes up here, there is also an increase in the dispersion of quality under content bundling, as in the model without prices.

6 Multiple publishers

While our model with a single newspaper can be interpreted as there being several local monopolist newspapers, the restriction to cases where there is no substitutability between these is not innocuous. Indeed, it drives to a certain extent the "softening effect": all the news that a user consumes through the platform come from the monopolist newspaper, who therefore has less of an incentive to compete with the platform for direct traffic. The setup with a single newspaper also ignores the fact that social media may represent an opportunity for newspapers to reach new consumers, who would not read them otherwise.

To capture these ideas, suppose that there is a continuum of symmetric newspapers on the market. Each newspaper has a mass one of traditional readers, who decide how to allocate their time between the newspaper and the social platform. When a traditional reader of newspaper i visits the platform, he is exposed to UGC and news, in proportions $1 - \lambda$ and λ. Due to the atomistic nature of the market, we assume that the news a consumer is exposed to while on the platform comes from different outlets than his usual newspaper. Newspapers are local monopolists in the sense that consumers cannot read other newspapers directly. However, on the platform, they are perfect substitutes: consumers only care about the quality of news, not about which newspaper they read. Advertising revenues are the same as in the baseline model. In particular, the platform captures a share ϕ of revenues when it displays news.

The timing is the following: at $\tau = 1$ newspapers simultaneously choose their quality q, at a cost $c(q)$. The quality of a newspaper is observed by the platform and by its traditional readers. At $\tau = 2$ the platform chooses the share of news it displays, λ. Consumers observe λ. At $\tau = 3$ consumers decide how to allocate their time between their usual newspaper and the platform. We look for a perfect Bayesian equilibrium where firms play a symmetric strategy and consumers form rational expectations about newspapers' quality choice (aside from their usual one, which they observe).

We restrict ourselves to the additive model: reading an amount x of news of quality q delivers a utility of $(\theta + q)x$, while reading an amount y of UGC delivers a utility of $-\frac{(1-y)^2}{2}$. We also assume quadratic costs: $c(q) = cq^2/2$, and a uniform distribution of θ over $[0, 1]$.

Benchmark (no content bundling): Without content bundling consumers have the choice between news from their usual newspaper and UGC from the platform. Each consumer then spends a share $\hat{x}(\theta, q)$ of his time reading news. The situation is the same as in the baseline model with a single newspaper: newspaper i's profit is

$$\tilde{\pi}_i(q_i) = \int_0^1 \hat{x}(\theta, q_i)d\theta - cq_i^2 = \int_0^{1-q_i} (\theta + q_i)\, d\theta + \int_{1-q_i}^1 d\theta - \frac{cq_i^2}{2} = \frac{1 + 2q_i - (1+c)q_i^2}{2}.$$

The equilibrium quality is then $\tilde{q} = \frac{1}{1+c}$.

Content bundling: At $\tau = 3$, suppose that a consumer's usual newspaper has quality q_i and that the news quality he expects to obtain while on the platform is q^*. The consumer then chooses the time he spends on the platform, t_0, so as to maximize

$$(1 - t_0)(q_i + \theta) + t_0\lambda(q^* + \theta) - \frac{(1 - (1-\lambda)t_0)^2}{2}.$$

The first term is the utility derived from spending $(1 - t_0)$ units of time reading newspaper i. The second term is the utility from reading news of quality q^* through the platform. The third term is the utility from UGC consumption. The solution to this maximization problem is $t_0(\theta, \lambda, q, q^*) = \max\{\min\{\frac{1-q-\theta-(1-q^*-\theta)\lambda}{(1-\lambda)^2}, 1\}, 0\}$. Let $\hat{\theta}_1(\lambda, q, q^*)$ be the largest solution to $t_0(\theta, \lambda, q, q^*) = 1$, and $\hat{\theta}_2(\lambda, q, q^*)$ the smallest solution to $t_0(\theta, \lambda, q, q^*) = 0$.

At $\tau = 2$, the platform chooses λ to maximize its profit. Because newspapers are atomistic, λ does not depend on a single newspaper's decision. If all newspapers except a finite number play q^*, the platform receives a total amount of attention $T_0(\lambda, q^*) = \frac{1+\lambda-2q^*}{2}$ per Equation (6). Its profit is then maximized by setting $\lambda(q^*) = \min\{q^* + \frac{\phi}{2(1-\phi)}, 1\}$.

At $\tau = 1$, suppose that newspaper i expects all other newspapers to play q^*. Its profit writes

$$\pi_i(q_i) = \int_{\max\{\hat{\theta}_1(\lambda,q_i,q^*),0\}}^{\min\{\hat{\theta}_2(\lambda,q_i,q^*),1\}} (1 - t_0(\theta, \lambda, q_i, q^*))\, d\theta + \int_{\min\{\hat{\theta}_2(\lambda,q_i,q^*),1\}}^{1} 1 d\theta$$
$$+ \lambda(1-\phi)\left[\int_0^{\max\{\hat{\theta}_1(\lambda,q^*,q^*),0\}} 1 d\theta + \int_{\max\{\hat{\theta}_1(\lambda,q^*,q^*),0\}}^{\min\{\hat{\theta}_2(\lambda,q^*,q^*),1\}} t_0(\theta, \lambda, q^*, q^*) d\theta\right] - c(q_i). \quad (14)$$

The first two integrals represent direct traffic to the newspaper, i.e. traffic from its usual readers, who actually observe the choice q_i. The first integral is traffic by the usual readers who also visit the platform, while the second corresponds to usual readers who do not. The term between brackets corresponds to indirect traffic, i.e. consumers who access the newspaper through the platform: the third integral corresponds to consumers who only visit the platform, while the fourth one represents consumers who also spend time on their usual newspaper. Importantly, these consumers do not observe the actual q_i chosen by newspaper i, but rather form an expectation over the quality of news they expect to receive on the platform q^*, so that indirect traffic is not sensitive to q_i.

In a symmetric configuration, we have $\hat{\theta}_1(\lambda, q^*, q^*) = \lambda - q^* \geq 0$ and $\hat{\theta}_2(\lambda, q^*, q^*) = 1 - q^* < 1$. The first-order condition for a symmetric equilibrium can then be written:

$$\int_{\hat{\theta}_1(\lambda(q^*),q^*,q^*)}^{\hat{\theta}_2(\lambda(q^*),q^*,q^*)} -\frac{\partial t_0(\theta, \lambda(q^*), q^*, q^*)}{\partial q} d\theta - c'(q^*) = 0 \Leftrightarrow \int_{\lambda(q^*)-q^*}^{1-q^*} \frac{d\theta}{(1-\lambda(q^*))^2} = cq^*$$
$$\Leftrightarrow q^* = \frac{1}{c(1-\lambda(q^*))}. \quad (15)$$

Comparing q^* and $\tilde{q}$, we have the following result:

Proposition 7. *In the model with monopolistic competition with additive preferences, equilibrium quality is higher with content bundling. Newspapers' profits are lower.*

Remember that in the baseline model with a single newspaper and additive preferences content bundling could lower equilibrium quality. The intuition for the reversal of the result in a model with monopolistic competition is as follows. First, content bundling no longer creates a softening effect: when a consumer reduces the time he spends on newspaper i's website and increases the time he spends on the platform, newspaper i does not get any indirect revenue from that consumer. Therefore, the cost for a newspaper of losing direct traffic is the same with and without content bundling. Second, with content bundling, direct traffic to newspaper i is more sensitive to q_i under monopolistic competition than under monopoly. Indeed, under monopoly, investment in quality by the newspaper also increases the quality of news that consumers get while on the platform. Under competition on the other hand, an increase in q_i makes newspaper i more attractive without changing the value consumers expect to get from the platform. Formally, we have

$-\frac{\partial t_0(\lambda,\theta,q_i,q^*)}{\partial q_i}|_{\text{competition}} = \frac{1}{(1-\lambda)^2} > \frac{1}{1-\lambda} = -\frac{\partial t_0(\lambda,\theta,q)}{\partial q}|_{\text{monopoly}}.$

To achieve tractability, we have assumed that indirect traffic to newspaper i does not depend on q_i, i.e. that the platform grants equal prominence to newspapers irrespective of their quality. If the platform were to favor high-quality newspapers, then this would increase incentives to invest even further, reinforcing Proposition 7.

7 Discussion: Efficiency gains, newspaper opt-out

In our baseline model, content bundling by the platform does not create value directly: for a given quality q, consumer surplus is lower than under the benchmark, and the increase in the platform's revenue is exactly offset by a decrease in the newspaper's revenue. The only positive effect is indirect: content bundling sometimes increases incentives to provide quality, which benefits consumers. In this section we investigate how various potential efficiency gains related to content bundling might affect our main results.

We also study the possibility for the newspaper to opt-out and prevent the platform from practicing content bundling.

7.1 Increase in advertising revenue

Several results (e.g. the first-order condition (7) and Proposition 4) use the fact that $R_0(q, \lambda) + R_1(q, \lambda) = 1$ for any q and λ. In particular, it is a key step in the proof of Proposition 4, which states that the newspaper is worse-off under content bundling. This comes from two primitives of our model: (i) attention generates the same revenue on the newspaper's website and on the platform, and (ii) the total amount of attention is exogenous (in particular, it does not depend on news quality).

A first potential efficiency gain could be that the platform is better than the newspaper at monetizing attention, so that the total industry revenue depends on how consumers allocate their attention. Better targeted advertising by the platform would be a leading explanation for such a fact.

One simple way to modify our model to account for this is to assume that, when the platform shows news, its per unit revenue is ϕ and the newspaper's revenue is δ, with $\phi + \delta \geq 1$. In that case it is no longer true that the newspaper is automatically worse-off under content bundling, because of the associated efficiency gain. For instance, in the additive model with quadratic costs $c(q) = q^2/2$, the newspaper is better-off under content bundling if and only if $\delta + \phi^2 > 1$.[29] To get a sense of the strength of the condition,

[29] Calculations are available from the authors.

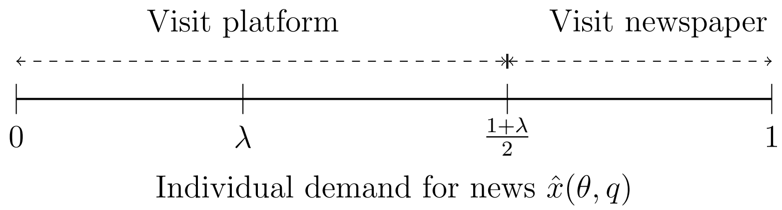

Figure 4: Consumer decision under single-homing

suppose that the platform gets a 30% share of the revenue, i.e. that $\phi/(\phi+\delta) = 0.3$.[30] Then the condition for the newspaper to benefit from content bundling would be that $\phi + \delta > 1.23$, i.e. that the platform generates a 23% efficiency gain. The minimal value for δ is then $0.7 \times 1.23 \simeq 0.86$: having its content shown through the platform is only 14% less profitable than when consumers visit the newspaper directly.

Regarding (ii), an alternative model would be such that consumers choose t_0 and t_1, at a cost $K(t_0 + t_1)$. This would for instance capture the existence of an outside option. In the proof of Proposition 4, the assumption that $R_0 + R_1 = 1$ allows us to claim that $R_1(q, \lambda(q)) < R_1(q, 0)$. This result would not change under the alternative model with an outside option for consumers: for a given quality level, content bundling reduces the utility of low types (they end up consuming too much news) and leaves higher types indifferent. Therefore content bundling would not lead any type of consumer to increase the overall attention she gives to the two websites, but would still induce consumers to spend relatively less time on the newspaper's website.

7.2 Switching costs

Another potential efficiency gain of content bundling is that it brings a "one-stop shopping" experience: consumers do not need to navigate various websites to consume different content. To see this clearly, suppose that consumers incur very large switching costs and are thus forced to single-home.

If the platform offers a share λ of news, a consumer has a choice between consuming a mix $(x, y) = (\lambda, 1-\lambda)$ on the platform and a mix $(x, y) = (1, 0)$ on the newspaper's website. The platform therefore attracts all the consumers of type θ such that $U(\lambda, 1-\lambda, \theta, q) \geq U(1, 0, \theta, q)$. To analyze this model we focus on the additive model, defined in (1).

Suppose that the platform offers $\lambda \geq q$.[31] Then, consumers who choose to use the platform are such that $|1 - \hat{x}(\theta, q)| > |\lambda - \hat{x}(\theta, q)|$, i.e. such that $\hat{x}(\theta, q) < \frac{1+\lambda}{2}$ (see Figure 4). The total time spent on the platform is then $T_0^{SH}(q, \lambda) = \frac{1+\lambda-2q}{2}$. Notice that this is precisely the time spent on the platform when consumers can multi-home at no cost (see

[30]The 30-70 split is common in the industry.

[31]This is true when there is content bundling, by the same logic as Proposition 2.

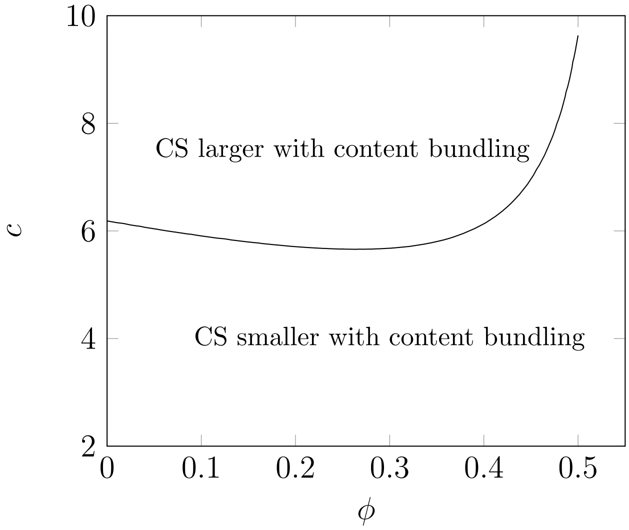

Figure 5: Change in consumer surplus, CS when consumers single home.

Equation (6)). The equilibrium values of λ and q are therefore the same as in Section 4. In particular, $T_1(q, \lambda) = \frac{1+2q-\lambda}{2}$ and $q^* = \frac{2-\phi}{2(1+c-\phi)}$.

Under the benchmark, the consumers who visit the newspaper are such that $\theta + q \geq 1/2$, i.e. $T_1(q, 0) = \frac{1}{2} + q$. The solution to $\max_q\{T_1(q, 0) - cq^2/2\}$ is $\tilde{q} = 1/c$, which is always larger than q^*. Intuitively, the marginal effect of q on T_1 is the same in both cases, but under content bundling the value of inducing a consumer to switch is smaller because the newspaper receives a share of the revenues if the consumer visits the platform.

Regarding profits, Proposition 4 still applies.

Proposition 8. *In the additive model with single-homing consumers, both newspaper's quality and profit are lower under content bundling than under the benchmark.*

Even though quality unambiguously goes down under content bundling, consumers may be better-off than under the benchmark because content bundling allows them to consume both news and UGC. This is illustrated in Figure 5. Notice though that c must be quite large for consumers to be better-off under content bundling in contrast to the multi-homing case (Figure 2). Under single-homing, quality always decreases, but more so when c is small.

7.3 Enhanced news consumption

Our baseline model treats news consumption on and off the platform as a homogenous experience. While this may be a reasonable first-order approximation, in practice platforms like Facebook and Twitter allow users to consume news in different ways, for instance by sharing stories that are particularly relevant to them, their friends or their followers, by commenting on individual articles and engaging in discussions with their network, or simply by expressing their reaction by clicking on the approptiate button ("like", "sad", etc.).

Suppose that these features of the platform environment increase the value of news consumption through the platform: using the additive model, let us assume that the utility from consuming a quantity x of news of quality q through the platform generates a utility $\gamma x(q+\theta)$, versus $x(q+\theta)$ if consumption occurs through the newspaper's website, with $\gamma > 1$ measuring the magnitude of the efficiency effect.

For simplicity let us also assume that the platform offers a personalized mix to its users. This implies that, under content bundling, the platform offers $\lambda(\theta, q) = \min\{\gamma(\theta+q), 1\}$ and all consumers allocate all their attention to the platform.[32]

The profit of the newspaper is equal to

$$\Pi_1^*(q) = (1-\phi)\int_{\underline{\theta}}^{\overline{\theta}} \lambda(\theta, q) dF(\theta) - \frac{cq^2}{2} \tag{16}$$

We find that it is possible for the newspaper to be better-off under content bundling, if it increases demand for news significantly ($\gamma \geq \overline{\gamma}$). However, the threshold $\overline{\gamma}$ is quite large. For instance, when $c = 1$ and $\phi = 0.2$, the threshold is $\overline{\gamma} \simeq 2.6$, meaning that the platform needs to increase the value of news consumption by 156% for content bundling to be profitable (See Figure 6).

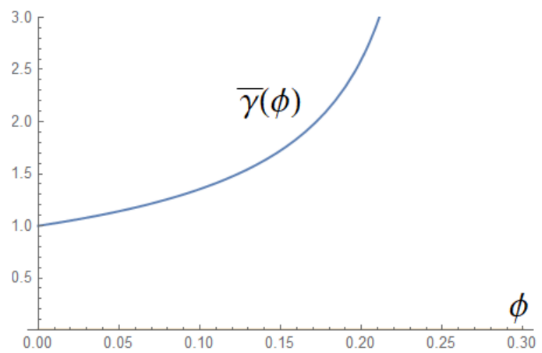

Figure 6: Threshold for the newspaper to benefit from content bundling, $\overline{\gamma}$.

7.4 Newspaper opt-out

In practice, a newspaper with sufficient resources has the ability to remove its content from social platforms, or at least to make it harder for the platforms to show news. Given the adverse effect of content bundling on the newspaper's profit, here, we investigate how the ability to opt-out affects the equilibrium outcome.

[32]Even those who only consume news do so through the platform.

Consider the following extension of our baseline model: at $\tau = 0$, the platform offers a contract of the form (F, ϕ) to the newspaper. F is a fixed payment, and ϕ is the share of the advertising revenue that the platform keeps whenever it shows some news to its consumers.[33] At $\tau = 1$ the newspaper accepts or rejects the contract, and chooses a quality q. At $\tau = 2$ the platform chooses λ if the newspaper has not opted-out; $\lambda = 0$ otherwise. At $\tau = 3$ consumers observe q and λ and optimally allocate their attention among the two websites.

Starting from $\tau = 1$, the game is the same as in our baseline model. In particular, if the newspaper rejects the contract, its profit is $\tilde{\pi}_1$. To be accepted, the contract must then deliver a payoff at least equal to $\tilde{\pi}_1$ to the newspaper. Of course the platform does not need to offer more, and so in equilibrium the newspaper is indifferent between accepting and rejecting the offer. The platform's profit is then equal to the industry profit minus $\tilde{\pi}_1$.

At $\tau = 0$, the platform therefore chooses ϕ so as to maximize the industry profit. Because the industry revenue is constant and equal to one, the profit is maximized when the cost - i.e. the quality - is minimized. One way to do so is to offer $\phi = 1$, i.e. to not share revenue with the newspaper. Indeed in that case, at $\tau = 2$, the platform finds it optimal to choose $\lambda = \hat{x}(\overline{\theta}, q)$ i.e. the highest desired news consumption for a quality q in the population, because by doing so it ensures that consumers spend all their time on its website (no consumer wants more news than what the platform offers). Unlike when $\phi < 1$, there is no cost for the platform associated with showing news, because it keeps all the revenue. The newspaper then anticipates that it will get no direct traffic no matter its quality choice, and therefore chooses to not invest in quality.

Proposition 9. *When the platform offers a contract and the newspaper can opt-out, equilibrium quality of news is minimal.*

Note that opting out is only relevant when the newspaper is a monopolist. With multiple newspapers (see Section 6), even though newspapers' profit is lower with content bundling (by a similar argument as under monopoly), newspapers face a prisoner's dilemma: opting-out of the platform leads a newspaper to lose indirect traffic from consumers who would not have read it otherwise, and does not allow to increase direct traffic from its usual readers. It is therefore not a viable strategy for newspapers.

8 Concluding remarks

Social networks have gained tremendous importance in the last decade, claiming a significant share of consumer attention. They have achieved such prominence by leveraging

[33] Absent the fixed payment the newspaper would always reject the offer, as per Proposition 4. This simple two-part tariff is actually enough to maximize profit, so there is no need to study more involved schemes (e.g. contracts dependent on q).

network effects *and*, more recently, by successful content bundling, whereby third party content is presented in their users' "newsfeed". This strategy, in turn, has started to fundamentally transform media production and consumption, a phenomenon of general public interest given the importance of a healthy news industry. We have developed a simple model of competition for attention between a social platform and newspapers, allowing us to shed light both on the strategic motives for content bundling and on its implications for the news industry.

By bundling news content with UGC, the platform increases the share of attention it receives from consumers: part of their demand for news is satisfied by the platform, which induces them to spend less time on the newspaper's website. For consumers with a relatively low demand for news, content bundling results in a monopolization of attention by the platform. Even though content bundling increases total news consumption (for a given quality of news), we find that the newspaper is always worse-off. The driving force behind this result is that the platform strategically chooses the share of news it shows to consumers so as to maximize its revenue, which mechanically reduces the newspaper's revenue.

Regarding the quality of news content, we uncover several opposing forces that make the overall effect of content bundling markedly different for low- and high-quality newspapers. In particular, our analysis suggests that under content bundling, quality is more likely to decrease for low-quality newspapers and increase for high-quality ones. Thus, our model predicts that quality dispersion is likely to be larger in the presence of modern social networks. This finding - which is empirically testable - is also somewhat reassuring given the public concern for the general health of the news industry and for the quality of news in particular. An increased dispersion of news quality in the presence of social media is indeed consistent with the appearance of low-quality sources (e.g. "listicles", click-bait, fake news outlets) on the one hand, but it suggests that high-quality news outlets (e.g. *The New York Times*, *The Economist*) are likely to invest even more in news quality.

These results hold both when the platform offers the same mix to every consumer and when it can perfectly personalize its content. In the latter case, we also provide some support to the claims that newspapers should rely more on subscriptions to cope with dominant platforms. When subscriptions are available to newspapers, content bundling leads to a joint increase in the price and the quality of news. We have also explored the implications of content bundling in an environment with many newspapers. While the strategic incentive to use content bundling and the negative effect of newspapers' profits remain unchanged, the model predicts an increase in quality under content bundling, more pronounced when costs are small.

In order to keep the model parsimonious, we have abstracted away from several interesting considerations. In particular, the structure of the social network is notably absent from the analysis. An interesting avenue for future research would be to study environments where consumers have heterogenous preferences and where the social network exhibits homophily. We have also mostly abstracted away from users' behavior on the platform, regarding, for instance, their decision to share news article or to produce UGC.

Our analysis focused on the impact of a social network on news publishers. Our model readily applies to publishers in other content domains (e.g. games, videos) who also seek to be present in consumers' 'newsfeed' on social media. Beyond social networks narrowly defined, the modeling framework also seems to be applicable to a broader set of interactions between multi-sided platforms and third-party 'content' providers.

For example, video distribution platforms such as Netflix, Hulu or Amazon Prime Video all offer third-party content alongside shows they produce themselves. Here, the role of newspapers is played by movie studios or TV networks who can monetize their content independently but are attracted by the platforms' customer base. In the e-commerce sector, Amazon.com also offers consumers the possibility to buy some products from third-party merchants or from Amazon itself. In the search engine market, Google oftens displays a result box that contains information produced by a website (e.g. a definition, the rating of a merchant or of a movie), with a small link to that website. While some consumers may click that link, many will simply stop there, having obtained the relevant information. This practice has been denounced by some websites (e.g. Yelp) who argue that it makes it difficult for them to attract visitors. This case raises issues of copyright protection, and also of efficiency gains.

These examples share some of the characteristics of our framework, and some of our insights might apply there as well. However they also have some specific features, which are not captured by our model. This calls for future research in this area.

References

Alaoui, Larbi and Fabrizio Germano (2016). "Time Scarcity and the Market for News". *Working Paper,* April.

Allcott, Hunt and Matthew Gentzkow (2017). "Social media and fake news in the 2016 election". *Journal of Economic Perspectives* 31.2, pp. 211–36.

Alpert, I. Lukas (2015). "Publishers Warily Embed With Facebook". *The Wall Street Journal*.

Ambrus, Attila, Emilio Calvano, and Markus Reisinger (2016). "Either or both competition: A" two-sided" theory of advertising with overlapping viewerships". *American Economic Journal: Microeconomics* 8.3, pp. 189–222.

Anderson, Simon P, Øystein Foros, and Hans Jarle Kind (2018). "Competition for advertisers and for viewers in media markets". *The Economic Journal* 128.608, pp. 34–54.

Anderson, Simon P and Bruno Jullien (2015). "The advertising-financed business model in two-sided media markets". *Handbook of Media Economics*. Vol. 1. Elsevier, pp. 41–90.

Angelucci, Charles and Julia Cagé (2016). "Newspapers in times of low advertising revenues".

Athey, Susan, Emilio Calvano, and Joshua S Gans (2018). "The impact of consumer multi-homing on advertising markets and media competition". *Management Science* 64.3, pp. 1574–1590.

Athey, Susan, Markus Mobius, and Jeno Pal (2017). "The Impact of Aggregators on Internet News Consumption". *Working Paper, Stanford University* January.

Bakshy, Eytan, Solomon Messing, and Lada A Adamic (2015). "Exposure to ideologically diverse news and opinion on Facebook". *Science* 348.6239, pp. 1130–1132.

Bala, Venkatesh and Sanjeev Goyal (2000). "A Noncooperative Model of Network Formation". *Econometrica* 68.5, pp. 1181–1229.

Bradshaw, Tim (2017). "Snapchat redesigns app in new effort to challenge Facebook". *Financial Times* 29 November.

Bromwich, Jonah Engel and Matthew Haag (2018). "Facebook Is Changing. What Does That Mean for Your News Feed?" *The New York Times*.

Burguet, Roberto, Ramon Caminal, and Matthew Ellman (2015). "In Google we trust?" *International Journal of Industrial Organization* 39, pp. 44–55.

Cagé, Julia, Nicolas Hervé, and Marie-Luce Viaud (2017). "The Production of Information in an Online World: Is Copy Right?"

Calzada, Joan and Ricard Gil (2016). "What Do News Aggregators Do? Evidence from Google News in Spain and Germany".

Chiou, Lesley and Catherine Tucker (2017). "Content aggregation by platforms: The case of the news media". *Journal of Economics & Management Strategy* 26.4, pp. 782–805.

Constine, Josh (2016). “Facebook puts friends above publishers in “News Feed Values” and ranking change”. *Techcrunch.*

— (2018). “How Facebook stole the news business”. *Techcrunch.*

De Cornière, Alexandre and Greg Taylor (2014). “Integration and search engine bias”. *RAND Journal of Economics* 45.3, pp. 576–97.

Dellarocas, Chrysanthos, Zsolt Katona, and William Rand (2013). “Media, Aggregators, and the Link Economy: Strategic Hyperlink Formation in Content Networks”. *Management Science* 59.10, pp. 2360–79.

Gentzkow, Matthew (2007). “Valuing new goods in a model with complementarity: Online newspapers”. *American Economic Review* 97.3, pp. 713–744.

Gentzkow, Matthew, Jesse M Shapiro, and Daniel F Stone (2015). “Media bias in the marketplace: Theory”. *Handbook of media economics.* Vol. 1. Elsevier, pp. 623–645.

George, Lisa and Christiaan Hogendorn (2012). “Aggregators, search and the economics of new media institutions”. *Information Economics and Policy* 24.1, pp. 40–51.

— (2013). “Local News Online: Aggregators, Geo-Targeting and the Market for Local News”.

Gottfried, Jeffrey and Elisa Shearer (2016). “News Use Across social Media Platforms”. *Pew Research Center,* May 26.http://www.journalism.org/2016/05/26/news-use-across-social-media-platforms-2016/.

Jackson, Matthew O. (2010). *Social and Economic Networks.* Princeton University Press, NJ.

Jackson, Matthew O. and Asher Wolinsky (1996). “A Strategic Model of Social and Economic Networks”. *Journal of Economic Theory* 71.108, pp. 44–74.

Jeon, Doh-Shin (2018). “Economics of News Aggregators”.

Jeon, Doh-Shin and Nikrooz Nasr (2016). “News Aggregators and Competition among Newspapers on the Internet”. *American Economic Journal: Microeconomics* 8.4, pp. 91–114.

Luca, Michael (2015). “User-Generated Content and Social Media”. *Handbook of Media Economics* Volume 1B.Chapter 12, pp. 563–92.

Mitchell, Amy, Jeffrey Gottfried, Elisa Shearer, and Kristine Lu (2017). “How Americans Encounter, Recall and Act Upon Digital News”. *Pew Research Center,* February 9.http://www. journalism.org/2017/02/09/how-americans-encounter-recall-and-act-upon-digital-news/.

Peitz, Martin and Markus Reisinger (2015). “The Economics of Internet Media”. *Handbook of Media Economics* Volume 1A.Chapter 10, pp. 445–530.

Puglisi, Riccardo and James M Snyder Jr (2015). “Empirical studies of media bias”. *Handbook of media economics.* Vol. 1. Elsevier, pp. 647–667.

Reuters (2016). *Reuters Institute Digital News Report.* Oxford University, UK.

Rutt, James (2011). "Aggregators and the News Industry: Charging for Access to Content". *Net Institute* Working Paper.October, #11-19.

Sismeiro, Catarina and Ammara Mahmood (2018). "Competitive vs. Complementary Effects in Online Social Networks and News Consumption: A Natural Experiment". *Management Science*.

Swoyer, Alex (2017). "Newspapers plan suit against Google, Facebook over lost ad revenue". *The Washington Times*.

Thompson, Ben (2015). "The Facebook Reckoning". *Stratechery*.

Thompson, Derek (2017). "How to Survive the Media Apocalypse". *The Atlantic*.

Yildirim, Pinar, Esther Gal-Or, and Tansev Geylani (2013). "User-Generated Content and Bias in News Media". *Management Science* 59.12, pp. 2655–66.

Zhang, Kaifu and Miklos Sarvary (2015). "Differentiation With User-Generated Content". *Management Science* 61.4, pp. 898–914.