International Journal of Industrial Organization 31 (2013) 723–737

Contents lists available at ScienceDirect

International Journal of Industrial Organization

journal homepage: www.elsevier.com/locate/ijio

The role of online platforms for media markets — Two-dimensional spatial competition in a two-sided market

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ARTICLE INFO

Available online 31 May 2013

JEL classification:
D43
L11
L21
L82

Keywords:
Multidimensional horizontal competition
Two-sided markets
Media economics
Online media

ABSTRACT

We analyze the market for online and offline media in a model of two-dimensional spatial competition where media outlets sell content and advertising space. Consumer preferences are distributed along the style and type of news coverage where the distance costs may vary across dimensions. For integrated provision of online and offline platforms we show that entering the online market reduces average profits and may even constitute a prisoner's dilemma. Specialized provision may yield polarization in the style and type dimensions. This is in contrast to the maximum–minimum differentiation result previously established in the literature on multidimensional horizontal competition. We show that maximal differentiation in both dimensions occurs due to the discrete nature of the type dimension and asymmetric advertising markets.

1. Introduction

In the information age, consumers demand news media to be perfectly tailored to their needs with respect to the content and, perhaps more importantly, the format of the distribution channels. This forces media outlets to consider expanding or even replacing traditional distribution channels with online platforms. In a recent survey, the Newspaper Association of America revealed that the platform type is highly relevant for consumer utility: 60% of the interviewees strongly agreed to the statement "I like to follow the local newspaper *in whatever format is convenient for me*" (Newspaper Association of America, 2012).[1] In this paper, we analyze possible outcomes of online strategies we observe in reality: Media outlets may introduce an online platform that duplicates their offline content, they may specialize in either online or offline provision, or they may refrain from entering the online market altogether. This allows us to draw conclusions about how the future landscape of online and offline platforms might look like.

First, we show that not all of these strategies increase media outlets' profits in comparison to the status quo without online platforms. The reason is that integrated media outlets cannot capitalize on the technology dimension of consumer preferences. Second, when specializing in one platform each, we show that media outlets may polarize in technologies and style of coverage by providing maximally differentiated content on platforms of different types. A possible outcome would be that online platforms focus on tabloid-style "soft" content while "hard" news coverage is published on offline platforms. Providers of hard news follow a traditional style of journalism with in-depth coverage and a rather neutral and sober tone in their articles. Topic-wise, they lean towards covering a recent Congress debate rather than a crime story. Providers of soft news, on the contrary, write more informally and cover more sensational news stories.[2] In the type dimension, we account for the fact that online and offline platforms cater to different needs of consumers as indicated in Table 1. While offline platforms apparently offer a rather agreeable reading experience, online platforms are strong in items related to

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[1] Note that 90% of the interviewees "generally agree" to this statement. This shows that the vast majority of individuals place value on receiving the news in their preferred type of medium.

[2] For print media, the term "broadsheet" (originally referring to the size of the paper the newspaper is printed on) is often used for newspapers with hard news coverage. Correspondingly, newspapers with predominantly soft news are referred to as "tabloids" (providing shorter articles typically printed on smaller pages). For a detailed definition of hard and soft news see for instance (Lehman-Wilzig and Seletzky, 2010).

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http://dx.doi.org/10.1016/j.ijindorg.2013.05.003

Table 1
User preferences for online and offline platforms.

	Print	Online
Is a relaxing way for me to read the news paper	66	42
Provides a satisfying reading experience for me	61	45
An easy way to get a complete view of the news	45	49
Easy format for sharing stories with others	32	61
Makes it easy to stay informed no matter where I go	30	61
Easy platform for using search for further information	20	64

Note: Interviewees were asked how well the statements describe printed or online newspapers. Results show percentage of interviewees strongly agreeing to the respective statement (5–6 rating on a 1–6 agreement scale). Base: 3376 individuals were surveyed. Data source: (Newspaper Association of America, 2012).

mobility and interactivity. The relevance consumers place on each of these items is reflected in their type preference.

Our paper builds on three main assumptions: (i) gross substitutability between platforms, (ii) the demand for consumption of news coverage does not grow once online platforms are established, i.e. consumers continue to single-home, and (iii) media outlets offer content of the same style of coverage in their online and offline editions. Recent empirical work shows that online and offline platforms are substitutes in terms of crowding-out offline readership. Supporting (i), Simon and Kadiyali (2007) show for the US consumer magazine market that providing an online platform results in an average audience loss of 3–4%. Kaiser (2006) obtains a similar reduction of around 4% in offline readership when studying the market for German magazines. Fig. 1 depicts how the use of online and offline news platforms has evolved in the US. The figure suggests a high degree of substitutability as the increase in online consumption has been compensated largely by a decrease in newspaper consumption. In line with (ii), the time individuals spend on news consumption has remained rather stable between 1994 – a year in which online news platforms were yet to fully emerge – and 2010. A possible explanation for the substitution between online and offline platforms is that approximately two thirds of the most successful online news platforms in terms of traffic and loyalty are owned and run by "legacy media", i.e. their offline counterparts (Waldman, 2011). This makes it less appealing for consumers to seek out the offline counterpart since the contents are (almost completely) identical. As outlined in (iii), we focus on cases where media outlets that use both technology types operate the platforms under the same brand name and thus offer contents of the same style — take for instance the *New York Times* and *nytimes.com* (for hard news coverage), or the *New York Post* and *nypost.com* (for soft news coverage).

Our main results predict that profits of media outlets that offer both an online as well as an offline platform are reduced compared to the situation without online platforms, and that polarization often occurs once media outlets specialize in offering one platform each. Some observations in the data could appear consistent with these outcomes. Using US data, the Federal Communications Commission shows that aggregate profits online were unable to offset the decrease in profits offline; more accurately, comparing media outlets' profits in 2005 and 2010, each dollar in offline profits was replaced by around 4 cents online (Waldman, 2011). Other sources quote a 1:7 relation between the gains in the online newspaper market and the losses in the print market offline (Pew Project for Excellence in Journalism, 2011). The drop in profits may have also been triggered by outside options for readers and advertisers not captured in our model. Readers may choose news aggregator platforms over online newspapers, and advertisers may place their ad with providers like Google Ads and Craigslist. We are explicitly focusing on *online newspapers* that publish original content rather than news aggregator platforms (like Yahoo.com or News.Google.com).[3] As for polarization in the type and style dimensions, US newspaper data provide supportive evidence: Between 2007 and 2010, 246 newspapers closed down their offline edition while 18 of them continued to offer an online platform (specialization in types). About 73% of these online news platforms fulfil the characteristics of tabloids and soft news which is in line with our findings.[4] Furthermore, Fenton (2009) conducts interviews with media professionals from traditional as well as new media sources and finds that online news platforms lean towards providing more soft news than offline platforms.

The paper is organized as follows. In the next section, we relate to the existing literature on media markets and in particular online media. In the subsequent section we introduce our general analytical framework before we focus on the integration scenario in Section 4. Section 4.1 derives the conditions for media outlets to offer an online platform in addition to their offline platform and illustrates the prisoner's dilemma media outlets may face in an uncoordinated equilibrium. In Section 5 we analyze equilibria where firms decide to specialize on one platform each. Section 6 concludes with a summary of our main findings.

2. Literature

Following the seminal work by Anderson and Coate (2005) numerous studies have focused on the interaction between two sides of the media market namely the consumers and the advertisers (see for instance Anderson and Gabszewicz, 2006; Dukes and Gal-Or, 2003; Reisinger, 2012).[5] Yet, the development of an additional source of differentiation in the form of online and offline technologies has been largely ignored in the theoretical discussion of media markets. We fill this gap by extending the conventional two-sided market framework to a model that features two-dimensional spatial competition along the *style* and the technological *type* of media content. Our model builds on the framework introduced by Anderson and Coate (2005) where two media outlets compete on the consumer and on the advertising market. While consumers choose only one platform, i.e. they single-home, advertisers may place their messages on multiple platforms. Similar to Armstrong (2006) and Peitz and Valletti (2008) we allow media outlets to charge direct prices to consumers.

The analysis of two-dimensional spatial competition goes back to Tabuchi (1994) who established the so-called *principle of maximum–minimum differentiation*: Firms aim at relaxing price competition while preferring a central location at the same time. Therefore, it is generally optimal to maximally differentiate in one dimension — which suffices to relax price competition, and minimally differentiate in the other dimension — which has the advantage of better market access. Irmen and Thisse (1998) and Ansari et al. (1998) extend this setup to multiple horizontal dimensions and allow for heterogeneity in preferences for the respective attributes. We deviate from Tabuchi's model with respect to three key characteristics of the media market: First, our type dimension is a discrete form of product differentiation which implies that only maximum or minimum differentiation can occur. This is a decisive feature of media markets because outlets can choose between two distinct technologies, online and offline platforms. Second, we allow for different distance costs in the style and type dimensions. Third, media outlets compete in a two-sided market environment with potentially asymmetric advertising markets. In contrast to previous findings, we show that a polarized provision of media i.e. maximal differentiation in both dimensions may represent a Nash equilibrium.

[3] Although news aggregator platforms represent powerful alternatives to the platforms in our model, we focus on the response of traditional media to the advent of online platforms assuming that it is not possible for them to become an aggregator platform.

[4] See (Waldman, 2011). 7 out of the 18 either focus exclusively on local news or on sports and are therefore excluded from the analysis.

[5] For more general contributions on two-sided markets see (Rochet and Tirole, 2003; Rochet and Tirole, 2006), (Rysman, 2009), (Caillaud and Jullien, 2001; Caillaud and Jullien, 2003) for two-sided markets and the internet, (Kind et al., 2008) for two-sided markets and public policy.

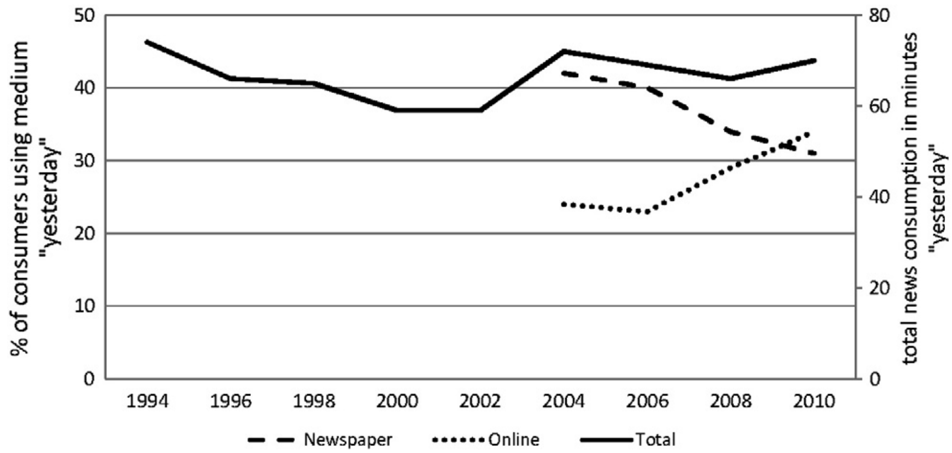

Fig. 1. Media use before and after introduction of online platforms.
Note: The percentage of consumers reading a newspaper (online newspaper) is indicated by the dashed (dotted) line and corresponds to the left scale (% of consumers using medium "yesterday"). Total time budget (solid line) includes TV and radio news consumption and corresponds to the right-hand scale (total news consumption in minutes "yesterday"). Before 2004, no data were collected on online news consumption. Note that online news platforms were introduced in the mid-nineties. Data are based on telephone interviews conducted with a random sample of 3006 individuals living in the U.S., interviews under the direction of Princeton Survey Research Associates International. Data source: (Pew Project for Excellence in Journalism, 2011).

The number of theoretical contributions dealing with the particularities of online platforms is still limited and most contributions focus on the advertising side of the market. For instance, Athey et al. (2012) argue that consumers' switching behavior between online platforms has led to the observable decline in media outlets' ad revenues. They name the emergence of digital media as the trigger to this development but do not model consumers' choice explicitly. Our paper focuses on consumer behavior and differs in a number of dimensions: Competition for consumers is not restricted to online platforms but includes offline platforms as well, and consumers don't switch between outlets (multi-homing) since we consider a static game. Furthermore, in Athey et al. (2012) there exists no difference in the style the platforms offer to consumers and the expected value from impressing a consumer (ad effectiveness) is identical across platforms, both of which are important differentiators in our model. Gentzkow (2007) analyzes the effects of the introduction of online news for consumer welfare and media profits. In the empirical study of newspaper readership in Washington, DC, he finds that online platforms have a significant crowding-out effect on offline platforms. This supports our assumptions of gross substitutability between platforms and single-homing consumer. Bergemann and Bonatti (2011) develop a model of informative advertising with heterogeneous consumers where the targeting ability is subject to the media type. They show that an online platform decreases the revenues of the competitor's offline platform more than an additional offline platform would. The relevance of platform types for consumer responses to advertising has been shown empirically by Goldfarb and Tucker (2011a,b) for instance in the context of advertisements for alcoholic beverages. We adapt the notion of asymmetric advertising markets and allow for different ad effectiveness across technologies.

Against this background, our paper contributes to the literature by accounting for technological characteristics of online and offline media in a model of two-dimensional spatial competition with two-sided markets. We identify two general scenarios that may constitute a Nash equilibrium: the integration scenario where both media outlets offer online as well as offline editions, and the specialization scenario where each media outlet publishes its content on a single platform. Which of the two scenarios arises in equilibrium is, in turn, subject to the fixed costs associated with entry to the online market. For the integration scenario we show that media outlets lose from uncoordinated entry to the online market. In the specialization scenario we demonstrate that the principle of maximum-minimum differentiation does not necessarily hold with a discrete attribute of differentiation. In fact, polarization equilibria with maximum differentiation in both dimensions may occur (i) for symmetric advertising markets and strong preferences for the style of coverage and (ii) for asymmetric advertising markets and strong preferences for the technological type of coverage.

3. Model setup

3.1. Media outlets

In conventional models of product differentiation, spatial competition for consumers is one-dimensional e.g. firms compete in prices and one horizontal dimension. A common characteristic to distinguish consumer preferences for different media is the preference for style in the sense of "hard" or "soft" content. In addition to the *style of content*, we introduce the *type of medium*, as media outlets may offer an online as well as an offline platform of their given content. These two product characteristics are specified as horizontal dimensions of product differentiation. In our setup, media outlet $i \in A, B$ may provide content of different style $\sigma_i \in [0,1]$ on platforms of different types θ_j with $j \in ON, OFF$. The media outlets derive profits from advertising as well as from selling copies (or charging fees) to consumers. The timing is such that media outlets first decide upon their location in the two dimensional space and second upon the consumer prices they set for online and offline editions. The consumer prices feed back into the advertising revenues because advertising prices are determined by the number of consumers the respective platform attracts. Since the type dimension is a discrete choice of alternative technologies, the type of medium θ_j is maximally differentiated with $\theta_{ON} = 0$ and $\theta_{OFF} = 1$.[6] On the style dimension, firms choose locations σ_A and σ_B, respectively. Without loss of generality we derive all results in the following for $\sigma_B \geq \sigma_A$.

In the first part we consider a scenario of integrated provision of online and offline platforms while the second part focuses on a specialized provision of media. The first scenario refers to media outlets of specific style publishing online and offline at the same time. We assume that media outlets do not provide two platforms of different styles at the same time because this conflicts with brand recognition

[6] Note that consumer preferences vary continuously in the type dimension. In contrast, media outlets face a discrete location choice since there are two well specified alternative technologies.

of the outlet.[7] The second scenario accounts for a specialization of media outlets in one *type–style* combination. These scenarios evolve subject to the size of the platform fixed costs and are determined by media outlets' decision to operate one or two platforms which precedes the location choice in the *type–style* space.

The advertising revenues are denoted by $\tau_{i,j}$ where the supply of advertising space per platform is exogenously fixed and normalized to unity. Concerning the argument that the supply of space is larger online, we follow Athey et al. (2012) who regard the consumers' attention span as the limiting factor for advertising rather than the available advertising space. Alternatively, media outlets face technological and/or legal restrictions that result in capacity constraints for advertisements.[8] This yields the profit function of media outlet i:

$$\Pi_i = \sum_{j\in ON,OFF}\left[n_{i,j}p_{i,j} + \tau_{i,j} - C\right], i\in A, B, \tag{1}$$

where $n_{i,j}$ and $p_{i,j}$ represent consumer demand and consumer prices, respectively. In line with most of the literature on media markets, we refrain from unit costs.[9] However, platforms incur fixed costs denoted by $C > 0$ for staff and technical equipment when taking up their service.

3.2. Advertisers

We consider a sufficiently large number of price-taking advertisers. Each advertiser derives a return of $\beta_j \in]0,1[$ per message perceived by a potential customer on the respective platform (i.e. the probability of a media consumer buying the advertised product).[10] Accordingly, the inverse demand function for advertisements is a function of media-consumer demand[11]:

$$\tau_{i,j} = \beta_j n_{i,j}. \tag{2}$$

Alternatively, the advertising market could be modeled as in Anderson and Coate (2005) and Peitz and Valletti (2008) where consumers incur nuisance costs from advertisement and media platforms choose the revenue maximizing combination of consumer prices and amount of advertisement. For clarity, we model the advertising market in the most simple fashion yet our key results are robust to the inclusion of nuisance costs.[12]

There is a notable difference between the ad effectiveness of online and offline platforms. On the one hand, consumers can be easily tracked online which implies that advertisements are targeted towards a certain consumer profile which increases the ad effectiveness (see Bergemann and Bonatti, 2011). On the other hand, online media allows consumers to circumvent advertisements more easily. To account for such differences in ad effectiveness, we allow the advertising price per viewer β_j to be type-specific. In what follows, we use $\Delta = \beta_{OFF} - \beta_{ON}$ to denote the difference in the ad effectiveness between platform types.

[7] This assumption is well justified since we observe media outlets to provide both technology types but we are not aware of outlets that simultaneously publish “soft” (tabloid journalism) and “hard” (broadsheet journalism) editions.

[8] In Germany, for instance, advertising slots are limited to 12 min per hour. Alternatively, think of the page size or the number of pages being binding restrictions. For online media, the screen size (or the resolution of the screen) limits the number of ads.

[9] Notice that positive unit costs would increase the consumer prices of media while profits would remain unaffected such that all our results are robust to the inclusion of positive unit costs.

[10] See (Gabszewicz et al., 2002; Gabszewicz et al., 2004) for a similar description of the advertising market.

[11] This corresponds to the *Cost Per Mille* (CPM).

[12] We derive the corresponding results for a setup that includes nuisance costs and endogenous choice of advertisement volume in an online appendix available at: www.cae.ethz.ch/people/vehrlicm.

3.3. Consumers

On the consumer market, preferences for style of coverage and type of medium are uniformly and continuously distributed in a two-dimensional space $\mathfrak{L} = \{(\theta,\sigma)\in\mathbb{R}^2 : 0\le\theta\le1, 0\le\sigma\le1\}$. The mass of consumers is set to unity with each consumer choosing exactly one of the four platforms on the market. Hence, the utility function of a representative consumer located at $\underline{\sigma}, \underline{\theta}$ when consuming an i, j-platform is:

$$U_{i,j}\left(\underline{\sigma}, \underline{\theta}\right) = \overline{u} - p_{i,j} - k\left(\underline{\sigma} - \sigma_i\right)^2 - h\left(\underline{\theta} - \theta_j\right)^2, \tag{3}$$

where $\overline{u}$ is a sufficiently large reservation utility. In equilibrium, each individual consumes one medium at a price $p_{i,j}$. The importance of obtaining the “right” media product is captured by the weight of the disutility parameters k, $h > 1$ such that the representative consumer above faces distance costs of $k\left(\underline{\sigma} - \sigma_i\right)^2 + h\left(\underline{\theta} - \theta_j\right)^2$ from choosing platform i, j.

4. Integrated provision of online and offline platforms

Our benchmark scenario refers to integrated provision of online and offline platforms by each media outlet. For instance, this can be observed for newspapers that provide their content also online. We derive the subgame perfect Nash equilibrium via backward induction. In the first stage, media outlets A and B simultaneously decide upon their locations in the style dimension σ_A and σ_B. In the second stage, they simultaneously set consumer prices on their online and offline platforms. In the final stage, consumers choose one of the four platforms as their source of information.

The market space of the i, j platform is given by

$$M_{i,j} = \left\{\sigma, \theta\in\mathbb{R}^2; U_{i,j} \ge U_{-i,-j}, U_{i,j} \ge U_{-i,j}, U_{i,j} \ge U_{i,-j}\right\}, \tag{4}$$

where $-i$ and $-j$ denote the competitor of outlet i and the opposing platform type of j. Accordingly, the boundaries of the market spaces are orthogonal to the connecting lines between the locations of the platforms. Our analysis focuses on equilibria that yield strictly positive demand for all platforms and satisfy the condition of gross substitutability $\frac{\partial n_{i,j}}{\partial p_{-i,-j}} > 0 \wedge \frac{\partial n_{i,j}}{\partial p_{-i,j}} > 0 \wedge \frac{\partial n_{i,j}}{\partial p_{i,-j}} > 0$ (see Anderson et al., 1989). This implies that there exists an individual who is indifferent between all four platforms.[13]

The market shares of each platform are illustrated in Fig. 2 where the intersection of the two lines indicates the preferred style–type-mix of the pivotal consumer $\hat{\sigma}, \hat{\theta}$. Using Eq. (3) we can derive the consumer who is indifferent between online and offline platforms for given outlet $i \in A, B$ and the consumer who is indifferent between the two styles for given type $j \in ON, OFF$:

$$\hat{\theta}_i = \frac{1}{2} - \frac{p_{i,ON} - p_{i,OFF}}{2h} \quad \text{and} \quad \hat{\sigma}_j = \frac{\sigma_A + \sigma_B}{2} - \frac{p_{A,j} - p_{B,j}}{2k(\sigma_B - \sigma_A)}. \tag{5}$$

Consumers with $\theta < \hat{\theta}_i$ choose the online platform of media outlet i, and the remaining consumers choose the offline option. Likewise, consumers with $\sigma < \hat{\sigma}_j$ opt for any platform j of media outlet A while the remaining choose outlet B. With gross substitutability and positive demand for all platforms it must be that $\hat{\sigma} = \hat{\sigma}_{ON} = \hat{\sigma}_{OFF}$ and $\hat{\theta} = \hat{\theta}_A = \hat{\theta}_B$. Accordingly, the price differential between the two styles

[13] Gross substitutability between platforms is a valid assumption on the media market as it requires that there exists a marginal information for which a consumer is indifferent about the source from which to consume it. While we can state the equilibrium conditions also without the assumption of gross substitutability abandoning gross substitutability precludes analytical solutions.

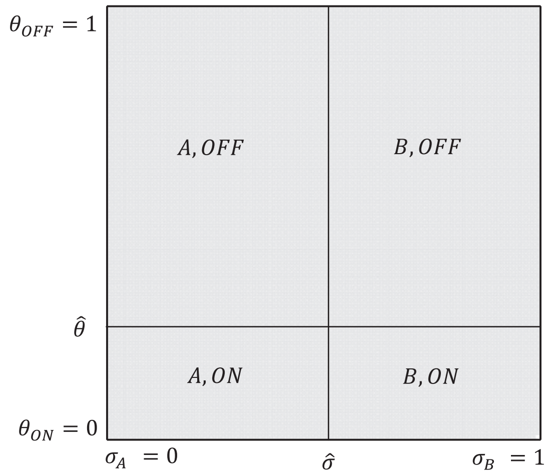

Fig. 2. Consumer market shares. *Note*: This figure illustrates the consumer demand for a medium of type $j \in ON, OFF$ of media outlet $i \in A, B$ for $h = 3/2$ and $\beta_{ON} = 1/8$, $\beta_{OFF} = 1/2$.

has to be equal for both types. Likewise, the price differential between the online and offline platforms has to be equal across styles. The four quadrants in Fig. 2 represent the demand for the four platforms which can be calculated using the cutoffs in the $\theta - \sigma$-space as displayed in Eq. (5):

$$n_{A,j} = \frac{\left(h + p_{A,-j} - p_{A,j}\right)\left[\left(\sigma_A^2 - \sigma_B^2\right)k + p_{A,j} - p_{B,j}\right]}{4(\sigma_A - \sigma_B)hk},$$
$$n_{B,j} = \frac{\left(h + p_{B,-j} - p_{B,j}\right)\left[(\sigma_A - \sigma_B)(2 - \sigma_A - \sigma_B)k + p_{B,j} - p_{A,j}\right]}{4(\sigma_A - \sigma_B)hk}. \qquad (6)$$

Facing the above demands, media outlets choose the profit-maximizing price levels for the respective platforms and decide upon their optimal location in the style dimension. This leads us to the first proposition.

Proposition 1. *For integrated provision a unique equilibrium is characterized by two symmetric media outlets providing both online and offline platforms at the same time where one outlet focuses on "soft" and the other on "hard" news coverage*:

$$\begin{aligned} p_{i,OFF} &= k - \beta_{OFF}, \quad n_{i,OFF} = \frac{h + \Delta}{4h}, \quad \Pi_{i,OFF} = \frac{k(h + \Delta)}{4h} - C \\ p_{i,ON} &= k - \beta_{ON}, \quad n_{i,ON} = \frac{h - \Delta}{4h}, \quad \Pi_{i,ON} = \frac{k(h - \Delta)}{4h} - C \\ &\text{with } \sigma_A = 0, \ \sigma_B = 1 \end{aligned} \qquad (7)$$

- *Each of the two outlets serves half of the market.*
- *Offline platforms receive the larger market share if they convey advertisements more effectively than online platforms and vice versa.*
- *Media outlets cannot capitalize on the second dimension of horizontal competition such that their total profits are independent of the type preference* (h)*. Likewise, an asymmetry in ad effectiveness* (Δ) *plays no role for total equilibrium profits.*

Proof. See Appendix A

With a uniform distribution of consumers and full differentiation in the style dimension, each of the two outlets serves half the market ($n_{i,OFF} + n_{i,ON} = 1/2$). The market split between the online and offline platforms is given by $\hat{\theta}_i = \frac{1}{2} - \frac{\Delta}{2h}$ which implies that the platforms with the higher ad effectiveness receive the larger market share. Media outlets allocate consumers optimally between their two platforms by subsidizing the respective consumer prices differently. For instance, if offline advertisements are more effective than online advertisements, i.e. $\Delta = \beta_{OFF} - \beta_{ON} > 0$, offline platforms charge lower consumer prices and therefore attract a larger share of the consumers than the online counterpart. The reverse holds true for $\Delta < 0$. The type preference mitigates the effect of ad effectiveness on market shares such that $\hat{\theta}_i$ converges to 1/2 for large enough h. Regarding total profits $\Pi_i = \Pi_{i,OFF} + \Pi_{i,ON} = k/2 - 2C$ integrated provision does not allow firms to capitalize on consumers' type preference but only on the style preference. The intuition is as follows: For consumers with strong type preference there are two platforms of different outlets competing in prices which prevents rent extraction in this dimension. For strong style preference, the competing platforms are hosted by the same outlet which sets prices by jointly maximizing the profits of both platforms. Moreover, total profits are independent of ad effectiveness because firms use the entire advertisement revenues for subsidizing consumer prices.

4.1. Entry to the online market

Starting from the historical situation where media outlets provide only offline content, this section analyzes firms' entry decisions to the online market. We contrast the integration equilibrium from above with a situation in which there are only offline platforms, and a situation in which only one of the two outlets provides an online platform in addition to the offline platforms.[14]

4.1.1. The world without online platforms

Suppose both media outlets offer only an offline platform to consumers and advertisers. Accordingly, consumers' decision boils down to choosing the preferred style between offline platforms of A and B. Thus, the pivotal consumer is characterized by $U_{A,OFF} = U_{B,OFF}$. Consumers with $\sigma < \hat{\sigma}_{OFF}$ choose platform A while all remaining choose B. The equilibrium of the three-stage game is derived analogously to above and we denote the equilibrium values of the scenario without online platforms by ~. As one would expect, the two platforms maximize the difference in the style dimension such that $\sigma_A = 0, \sigma_B = 1$ represents a unique equilibrium. Prices, demand, and profits are given by[15]:

$$\tilde{p}_i = k - \beta_{OFF}, \quad \tilde{n}_i = \frac{1}{2}, \quad \tilde{\Pi}_i = \frac{k}{2} - C. \qquad (8)$$

This equilibrium reflects the standard result of spatial competition in a two-sided market. The incentive to set prices above marginal costs is reduced by the negative externality of consumer prices on advertising revenues. The higher the ad effectiveness the lower are consumer prices. As prices and the intensity of style preferences are equal for both platforms, each of them serves half of the market. Again, media profits are increasing in consumers' disutility k from obtaining the wrong style of coverage.

In this context, we define two strategies media outlets can pursue: First, they may *comply* with the offline equilibrium and limit their news coverage to the offline platform. Second, they may *deviate* and enter the online market. The profits of the deviating firm are denoted by $\Pi_i^{deviate}$ — provided that the other firm complies, and the profits of the complying firm are denoted by Π_i^{comply} — provided that the other firm deviates. Recall that symmetric profits are $\tilde{\Pi}_i = \frac{k}{2} - C$, and $\Pi_i = \frac{k}{2} - 2C$ for

[14] Integrated provision of online and offline platforms could be compared to three alternative configurations: 1) both firms providing only online platforms 2) firms operating on different technologies providing the same style of content 3) firms operating on different technologies providing different style of content. In Appendix E we show that our key findings carry over to these configurations.

[15] The details of the derivation of the equilibrium are shown in Appendix B.

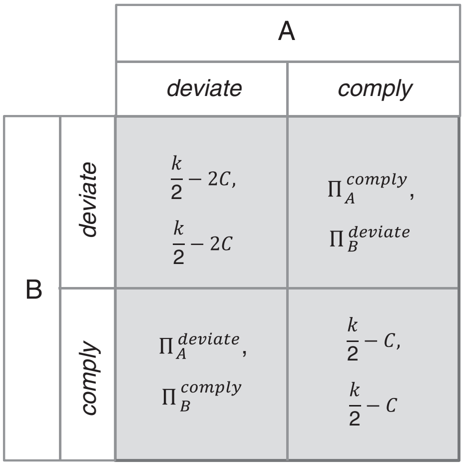

Fig. 3. Payoff matrix.
Note: Π_i^{deviate} and Π_i^{comply} are as in Eq. (**10**).

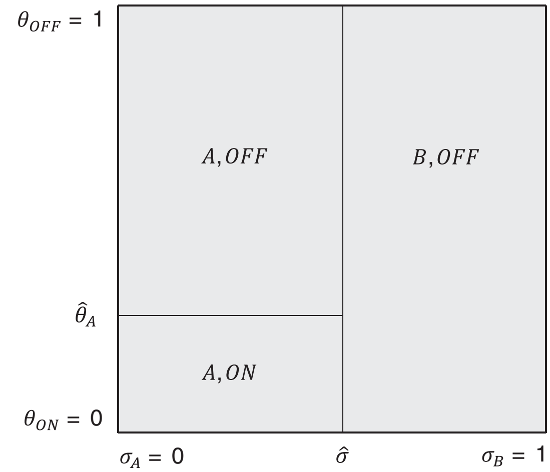

Fig. 4. Market shares, unilateral provision of an online platform.
Note: This figure illustrates the consumer demand for a platform of type $j \in ON, OFF$ of media outlet A and offline demand for platform B with $h = k = 2$ and $\beta_{ON} = 1/8$, $\beta_{OFF} = 1/2$.

both firms complying and both firms deviating, respectively. Fig. 3 illustrates the payoff matrix of the firms' entry decision.

4.1.2. Unilateral provision of an online platform

In the following, we focus on the case where media outlet A deviates from offering their content only offline. Yet, any results are identical if B was the deviating firm, since both firms are symmetric ex ante. Suppose media outlet A is the only provider of online content and consumers can choose between the offline platform of B and any platform of A. The equilibrium allocation of consumers to platforms requires $U_{A,OFF} = U_{B,OFF}$, $U_{A,ON} = U_{B,OFF}$, and $U_{A,OFF} = U_{A,ON}$ to hold. The pivotal consumer is located at[16]:

$$\hat{\theta}_A = \frac{h + p_{A,OFF} - p_{A,ON}}{2h}, \quad \hat{\sigma}_{OFF} = \hat{\sigma}_{ON} = \frac{\sigma_A + \sigma_B}{2} - \frac{p_{A,OFF} - p_{B,OFF}}{2k(\sigma_B - \sigma_A)}. \tag{9}$$

These market areas correspond to demands $n_{A,ON} = \hat{\theta}_A \hat{\sigma}_{OFF}$, $n_{A,OFF} = \left(1 - \hat{\theta}_A\right)\hat{\sigma}_{ON}$, and $n_{B,OFF} = 1 - \hat{\sigma}_{OFF}$ which are employed to compute the reaction functions and the profit-maximizing prices for all three platforms. Given these prices, outlets choose their location in the style dimension by maximizing profits with respect to σ_A and σ_B. In Appendix C we show that $\sigma_A = 0$, $\sigma_B = 1$ represents a unique Nash equilibrium as long as Π_A^{deviate} and Π_A^{comply} are both positive. With the equilibrium locations it is straight forward to obtain equilibrium values for demand, consumer prices, and profits[17]:

$$\begin{aligned}
&\Pi_B^{\text{comply}} = \frac{\left[(h-\Delta)^2 - 24hk\right]^2}{1152h^2k} - C, \quad n_{B,OFF} = \frac{1}{2} - \frac{(h-\Delta)^2}{48hk}, \\
&p_{B,OFF} = k - \frac{\Delta^2}{24h} - \frac{2(\beta_{ON} + 11\beta_{OFF}) + h}{24} \\
&\Pi_A^{\text{deviate}} = \frac{\left[(h-\Delta)^2 + 24hk\right]^2}{1152h^2k} - 2C, \quad n_{A,OFF} = \frac{(3h+\Delta)\left[(h-\Delta)^2 + 24hk\right]}{192h^2k}, \\
&n_{A,ON} = \frac{h-\Delta}{8h} + \frac{(h-\Delta)^3}{192h^2k} \\
&p_{A,ON} = k - \frac{\Delta^2}{12h} - \frac{4(2\beta_{ON} + \beta_{OFF}) - 5h}{12}, \quad p_{A,OFF} = k - \frac{\Delta^2}{12h} - \frac{2(\beta_{ON} + 5\beta_{OFF}) + h}{12}
\end{aligned} \tag{10}$$

In the unilateral deviation case, the market areas are $\hat{\theta}_A = \frac{h-\Delta}{4h}$ and $\hat{\sigma} = \frac{1}{2} + \frac{(h-\Delta)^2}{48hk}$ as illustrated in Fig. 4. Comparing the equilibrium demands to the scenario where both firms provide both platforms shows that the market-split line is – for given h and Δ – shifted towards more offline consumption. This is because competition in the offline segment is more intense than in the online segment which yields heavier subsidies on offline prices than on online prices. The subsidy on offline prices also increases compared to the situation where both firms provide online platforms.[18]

With the results for the equilibria without online platforms and with three active platforms at hand, we can state the following predictions:

Proposition 2. *Suppose that initially, both media outlets provide only offline platforms and do not coordinate their entry to the online market. This yields the following equilibria:*

- *For low fixed costs $C < C^*$, media outlets find themselves in a prisoner's dilemma situation: Both outlets enter the online market, reducing their individual profits. The higher h and k, and the lower Δ, the more likely is such an equilibrium.*
- *For intermediate levels of fixed costs $C \in]C^*, C^{**}[$, one of the outlets provides both online and offline platforms while the other continues to offer only an offline platform. Average profits fall compared to the initial situation. The higher h, and the lower k and Δ, the more likely is such an equilibrium.*
- *For high fixed costs $C > C^{**}$, media outlets specialize in providing one platform each. The higher k and Δ, and the lower h, the more likely is a specialization equilibrium.*

Proof. For entry to the online market to be the result of a prisoner's dilemma, three conditions must hold: (i) aggregate profits from both firms complying are larger than aggregate profits if both firms deviate $\Pi_i > \tilde{\Pi}_i$, (ii) the gains from deviating from the equilibrium without online platform must be positive for the firm that enters the online market $\Pi_i^{\text{deviate}} > \tilde{\Pi}_i$, and (iii) the profits from being the only firm not offering an online platform must be lower than the profits when both firms are active in both markets $\Pi_i^{\text{comply}} < \Pi_i$.

[16] Notice that all three market lines have to intersect at one point because $U_{A,OFF} = U_{B,OFF}$ and $U_{A,ON} = U_{B,OFF}$ yield the same critical $\hat{\sigma}$ for given $\hat{\theta}_A$.

[17] A more detailed derivation of the equilibrium with unilateral provision of an online platform is presented in Appendix C. Notice that all equilibrium values for a scenario with B deviating and A complying are analogous.

[18] The price difference $p_{A,OFF} - p_{A,ON} = \Delta$ can be positive or negative in the integration equilibrium depending on the differences in ad effectiveness (see Eq. (7)) while $p_{A,OFF} - p_{A,ON} = \frac{1}{2}(\Delta + h) > 0$ in the unilateral deviation equilibrium (see Eq. (10)).

Comparing Eq. (7) to Eq. (8) shows immediately that (i) is fulfilled for any positive level of fixed costs. Conditions (ii) and (iii) require:

$$\Pi_A^{deviate} > \frac{k}{2} - C \quad \wedge \quad \Pi_B^{comply} < \frac{k}{2} - 2C$$
$$\Leftrightarrow C < C^{**} = \frac{48hk(h-\Delta)^2 + (h-\Delta)^4}{1152h^2k} \quad \wedge \quad C < C^{*} = \frac{48hk(h-\Delta)^2 - (h-\Delta)^4}{1152h^2k}. \tag{11}$$

Note that (iii) is always binding because $C^* < C^{**}$. Hence, if fixed costs fall below C^*, uncoordinated behavior results in an equilibrium where both outlets enter the online market and each individual outlet is worse off compared to the situation without online media. Given that prices are non-negative, we can show that $\frac{\partial C^*}{\partial k} > 0$, $\frac{\partial C^*}{\partial h} > 0$, and $\frac{\partial C^*}{\partial \Delta} < 0$.

For intermediate level of fixed costs $C \in]C^*, C^{**}[$ it follows from Eq. (11) that outlet A provides both online and offline platforms while B sticks to a single offline platform. Since the model does not determine whether A or B initiates deviation, two symmetric equilibria exist. Average profits of both firms complying are unambiguously greater than average profits under unilateral provision of an online platform if

$$2\tilde{\Pi}_i > \Pi_A^{deviate} + \Pi_B^{comply} \Leftrightarrow C > \frac{2(h-\Delta)^4}{1152h^2k}. \tag{12}$$

For non-negative prices $C^* > \frac{2(h-\Delta)^4}{1152h^2k} \Leftrightarrow k > \frac{3\left(h^2+\Delta^2\right) - 6h\Delta}{48h}$ holds because it follows from Eq. (10) that $p_{A,OFF} \geq 0 \Leftrightarrow k > \frac{4\left(h^2+\Delta^2\right) + 4h^2}{48h} + \frac{2\beta_{ON} + 10\beta_{OFF}}{12}$. Thus, Eq. (12) is satisfied for $C \in]C^*, C^{**}[$. For the range of intermediate fixed costs we obtain $\frac{\partial (C^{**} - C^*)}{\partial h} > 0$, $\frac{\partial (C^{**} - C^*)}{\partial k} < 0$, $\frac{\partial (C^{**} - C^*)}{\partial \Delta} < 0$.

If fixed costs for setting up a media platform are higher than C^{**}, none of the firms finds it profitable to open up a second platform because $\Pi_A^{deviate} < \tilde{\Pi}_i$ for $C > C^{**}$ and a specialization equilibrium occurs. Note that $\frac{\partial C^{**}}{\partial k} < 0$, $\frac{\partial C^{**}}{\partial h} > 0$, and $\frac{\partial C^{**}}{\partial \Delta} < 0$. □

Our model suggests that firms' decision to engage in running an online platform in addition to their offline counterpart depends on the level of platform fixed costs, the degree of type and style preferences, and on the relative effectiveness of advertisements. For intermediate level of fixed costs only one of the outlets enters the online market while both enter if platform fixed costs are sufficiently low. In both cases average profits of media outlets fall compared to the state without online platforms. These findings are certainly in line with stylized facts suggesting that on average online editions of traditional newspaper do not increase aggregate profits (see Section 1). So far, we neglected potential synergies between online and offline platforms which imply that the fixed costs of integrated provision are less than $2C$. Accounting for synergies renders a prisoner's dilemma as well as unilateral provision of an online platform more likely because $\Pi_i^{deviate} > \tilde{\Pi}_i$ and $\Pi_i^{comply} < \Pi_i$ will be satisfied already for higher levels of fixed costs.[19] However, the question remains what happens if fixed costs for setting up an online platform are higher than the critical level $C > C^{**}$ and none of the firms finds it profitable to enter the online market in addition to the offline market. Due to the preferences of consumers to access some news coverage online, it may well be that one of the firms shuts down its offline platform and decides to provide online media, only. We next determine the equilibria if media outlets specialize on one platform each.

5. Specialization of media outlets

In this section, we observe only two platforms because each of the two media outlets chooses to provide either an online or an offline platform. In order to make use of the duopoly market power, it is never optimal for firms to cluster at the same location in the style and in the type dimension. In the following we analyze whether the principle of maximum–minimum differentiation remains robust in our framework with a discrete dimension and asymmetric two-sided markets. Moreover, we show under which circumstances media outlets strive for maximal differentiation in styles or types.

If both firms locate on the same boundary line – i.e. provide the same type – a max–min equilibrium evolves. We refer to this constellation as *type-collusion*. Likewise, a max–min equilibrium may arise on the style dimension with $\sigma_A = \sigma_B = 1/2$ and one firm providing online content while the other firm provides an offline platform. We refer to this constellation as *style-collusion*. Lastly, a *polarization* of firms may occur which means that media outlets differentiate into different platform types and maximize the distance in the style dimension as well. Fig. 5 illustrates the possible constellations in the specialization scenario where the first two column represent the max–min outcomes and the third column the polarization cases. Note that the two constellations of style-collusion as well as the two polarization constellations are perfectly symmetric such that it is sufficient to analyze only one of each.

5.1. Style-collusion

In case firms collude in the style dimension with $\sigma_A = \sigma_B = \frac{1}{2}$, the pivotal consumer who is indifferent between online and offline platforms is characterized by $\hat{\theta} = \frac{h + p_{i,OFF} - p_{-i,ON}}{2h}$. From the corresponding demand functions we can derive a unique equilibrium for optimal prices and profits given by:

$$\begin{aligned} p_{i,OFF} &= h - \frac{2\beta_{OFF} + \beta_{ON}}{3}, & p_{-i,ON} &= h - \frac{2\beta_{ON} + \beta_{OFF}}{3} \\ n_{i,OFF} &= \frac{1}{2} + \frac{\Delta}{6h}, & n_{-i,ON} &= \frac{1}{2} - \frac{\Delta}{6h} \quad \forall\ i \in [A,B]. \\ \Pi_{i,OFF} &= \frac{(3h+\Delta)^2}{18h} - C, & \Pi_{-i,ON} &= \frac{(3h-\Delta)^2}{18h} - C \end{aligned} \tag{13}$$

Hence, in the style-collusion equilibria profits are not necessarily symmetric. If offline media's ad effectiveness is higher than online media's ad effectiveness, i.e. $\Delta > 0$, profits of the firm specializing in

Style-Collusion	Type-Collusion	Polarization
$\pi_{A,ON}(\sigma_A = 1/2)$, $\pi_{B,OFF}(\sigma_B = 1/2)$	$\pi_{A,ON}(\sigma_A = 0)$, $\pi_{B,ON}(\sigma_B = 1)$	$\pi_{A,ON}(\sigma_A = 0)$, $\pi_{B,OFF}(\sigma_B = 1)$
$\pi_{A,OFF}(\sigma_A = 1/2)$, $\pi_{B,ON}(\sigma_B = 1/2)$	$\pi_{A,OFF}(\sigma_A = 0)$, $\pi_{B,OFF}(\sigma_B = 1)$	$\pi_{A,OFF}(\sigma_A = 0)$, $\pi_{B,ON}(\sigma_B = 1)$

Fig. 5. Possible constellations with specialization.
Note: This figure illustrates the six constellations of the two media outlets in the style–type space that may occur in the specialization scenario. For style-collusion firms maximize market access by locating in the middle of the style dimension. Type-collusion may apply for online as well as for offline platforms.

[19] Suppose integrated provision requires fixed costs $(1+\mu)C$ where $0 < \mu < 1$. This implies that unilateral deviation is profitable already for $C < \frac{C^{**}}{\mu}$ and a prisoner's dilemma occurs once fixed costs fall below $C < \frac{C^*}{\mu}$.

providing offline content exceed those of the firm offering an online platform. The reverse is true if $\Delta < 0$. As long as online and offline platforms have the same ad effectiveness, profits and prices are symmetric and reduce to $\Pi_{i,j} = \frac{h}{2} - C$ and $p_{i,j} = h - \beta_j$, respectively.

5.2. Type-collusion

In the equilibria where firms collude in the type dimension the prices and profits of the two firms are given by:

$$\begin{aligned} p_{A,j} &= p_{B,j} = k - \beta_j \\ \Pi_{A,j} &= \Pi_{B,j} = \frac{k}{2} - C \qquad \forall\ j \in [ON, OFF]. \end{aligned} \tag{14}$$

This has already been derived in Section 4.1 for both firms providing only offline platforms. Since firms use the whole advertising revenues to subsidize the consumer prices it is evident that the profits are identical if media is limited to online platforms. In both instances, firms maximize the distance between each other in the style dimension and serve half of the market each.

Comparing Eq. (13) to Eq. (14) shows that media outlets prefer collusion in the style dimension over collusion in the type dimension as long as there is no asymmetry on the advertising market, and $h > k$. The reverse is true for $k > h$. Hence, with symmetric advertising markets, the distance-cost parameters unambiguously determine the dominant attribute as in Irmen and Thisse (1998).

Once we introduce an asymmetry on the advertising market, style-collusion may cease to be an equilibrium even if the type preference exceeds the style preference. The firm operating on the less effective advertising market has an incentive to deviate and move to a location on the opposing side of the unit square where the competitor is located if either the style preference is sufficiently large or the type preference is sufficiently low[20]:

$$k > h - \frac{2|\Delta|}{3} + \frac{\Delta^2}{9h}. \tag{DC}$$

If the dominance condition (*DC*) is satisfied, style-collusion cannot represent a Nash equilibrium. Suppose $\Delta > 0$ and condition (*DC*) is met. Then the provider of online media can benefit from shifting to offline media because this raises the advertising revenues per copy sold. In the course of this type shift, a maximum differentiation in styles will occur as the mutually best location response. Similarly, if $\Delta < 0$, the provider of offline media has an incentive to deviate from the style-collusion equilibrium and provide online media which results in the type-collusion equilibrium. Only if $k < h - \frac{2|\Delta|}{3} + \frac{\Delta^2}{9h}$, style-collusion may represent a Nash equilibrium.

Regarding the max–min constellations, the parameters Δ, h, and k unambiguously determine whether collusion in the type or in the style dimension occurs. Higher absolute levels of differences in ad effectiveness $|\Delta|$, and higher values of style preference k raise the probability of a type-collusion equilibrium while a higher level of type preference h makes a style-collusion equilibrium more likely. If the preferences for the two attributes are identical and the advertising markets are symmetric, both type- and style-collusion equilibria may occur.[21]

[20] Comparing the profits in Eqs. (13) to (14) for the cases $\Delta > 0$ and $\Delta < 0$ immediately yields condition (*DC*). Note that the outlet on the platform with the lower ad effectiveness has an incentive to shift from style- to type-collusion for any $k > 1$ if the type preference is very low i.e. if $h < \frac{1}{2} + \frac{|\Delta|}{3} + \frac{\sqrt{3+4|\Delta|}}{2\sqrt{3}}$.

[21] A further factor operating in favor of style-collusion would be style-specific fixed costs. This would imply that moving in one or the other direction incurs different costs for the firms such that the location equilibrium depends upon this cost function. Overall, incorporating style-specific fixed costs makes style-collusion in the less costly style a more likely outcome. Differentiation in styles occurs only as long as k is sufficient to compensate the difference in fixed costs.

5.3. Polarization

Polarization implies that both firms locate at opposing corners in the style–type space. We focus here on a situation where A provides an online platform of style $\sigma_A = 0$ and B provides an offline platform of style $\sigma_B = 1$ as indicated in the first row of the polarization outcomes in Fig. 5. We omit the second polarization candidate due to perfect symmetry. The derivation of the demand, prices and equilibrium profits is somewhat more involving in the polarization cases. A location of the two firms on opposing corners implies that the market-split lines are no longer orthogonal to the type or style dimensions but become diagonals in the style–type space. A polarization of firms gives four possible divisions of the market areas as illustrated in Fig. 6.

For the pivotal consumers located on the market-split line, the indifference condition $U_{A,ON}(\sigma_A = 0) = U_{B,OFF}(\sigma_B = 1)$ has to be fulfilled. Using this condition jointly with Eq. (3), we can infer the slope of the market-split line:

$$dU_{A,ON} = dU_{B,OFF} \Leftrightarrow \frac{d\theta}{d\sigma} = -\frac{k}{h}. \tag{15}$$

We define σ_1 and θ_1 such that $(\sigma_1, 0)$ and $(0, \theta_1)$ are on the market-split line. Similarly, we define σ_2 and θ_2 such that $(\sigma_2, 1)$ and $(1, \theta_2)$ lie on the market-split line. These intercepts of the market-split lines in Cases 1–4 are illustrated in Fig. 6 where we also indicate the conditions each case imposes on σ_1, σ_2, θ_1, and θ_2.

Using again the indifference condition of pivotal consumers, the intercepts can be stated as functions of attribute preferences and prices:

$$\begin{aligned} \sigma_1 &= \frac{h + k + p_{B,OFF} - p_{A,ON}}{2k}, \qquad & \theta_1 &= \frac{k}{h}\sigma_1 \\ \sigma_2 &= \sigma_1 - \frac{h}{k}, & \theta_2 &= \frac{k}{h}(\sigma_1 - 1). \end{aligned} \tag{16}$$

With the intercepts it is straightforward to calculate the demands for the two platforms in all four cases. Since we assume a uniform distribution of consumers in the style–type space and our utility functions represent a subcase of the more general preferences in Caplin and Nalebuff (1991) there exists a unique price equilibrium in pure strategies for all four polarization cases in Fig. 6.[22] The equilibrium prices are used to compute the corresponding profits and are plugged into the intercepts from Eq. (16). Note that the market lines in all four cases are unambiguously determined by σ_1. Hence, the profits and the market areas in the polarization cases are characterized by:

$$\begin{aligned}
&\text{Case 1:} \\
&\sigma_1 = \frac{h + k - \Delta + \Psi_1}{8k}, \qquad \Pi_{A,ON} = \frac{\sigma_1^3 k^2}{2h} - C, \\
&\Pi_{B,OFF} = \frac{2h - \sigma_1^2 k}{2h}[k(3\sigma_1 - 1) - h + \Delta] - C \\
&\text{Case 2:} \\
&\sigma_1 = \frac{3(h+k) - \Delta}{6k}, \qquad \Pi_{A,ON} = \frac{(3k - \Delta)^2}{18k} - C, \qquad \Pi_{B,OFF} = \frac{(3k + \Delta)^2}{18k} - C \\
&\text{Case 3:} \\
&\sigma_1 = \frac{7(h+k) - \Delta - \Psi_2}{8k}, \quad \Pi_{A,ON} = \frac{2h - (1 - \sigma_2)^2 k}{2h}[k(2 - 3\sigma_2) - h - \Delta] - C, \\
&\Pi_{B,OFF} = \frac{(1 - \sigma_2)^3 k^2}{2h} - C \\
&\text{Case 4:} \\
&\sigma_1 = \frac{3(h+k) - \Delta}{6k}, \qquad \Pi_{A,ON} = \frac{(3h - \Delta)^2}{18h} - C, \qquad \Pi_{B,OFF} = \frac{(3h + \Delta)^2}{18h} - C \\
&\text{where } \Psi_1 \equiv \sqrt{(h - \Delta)^2 + 2(17h - \Delta)k + k^2}, \\
&\qquad\quad \Psi_2 \equiv \sqrt{(h + \Delta)^2 + 2(17h + \Delta)k + k^2}.
\end{aligned} \tag{17}$$

[22] For the derivation of the equilibrium prices see Appendix D.

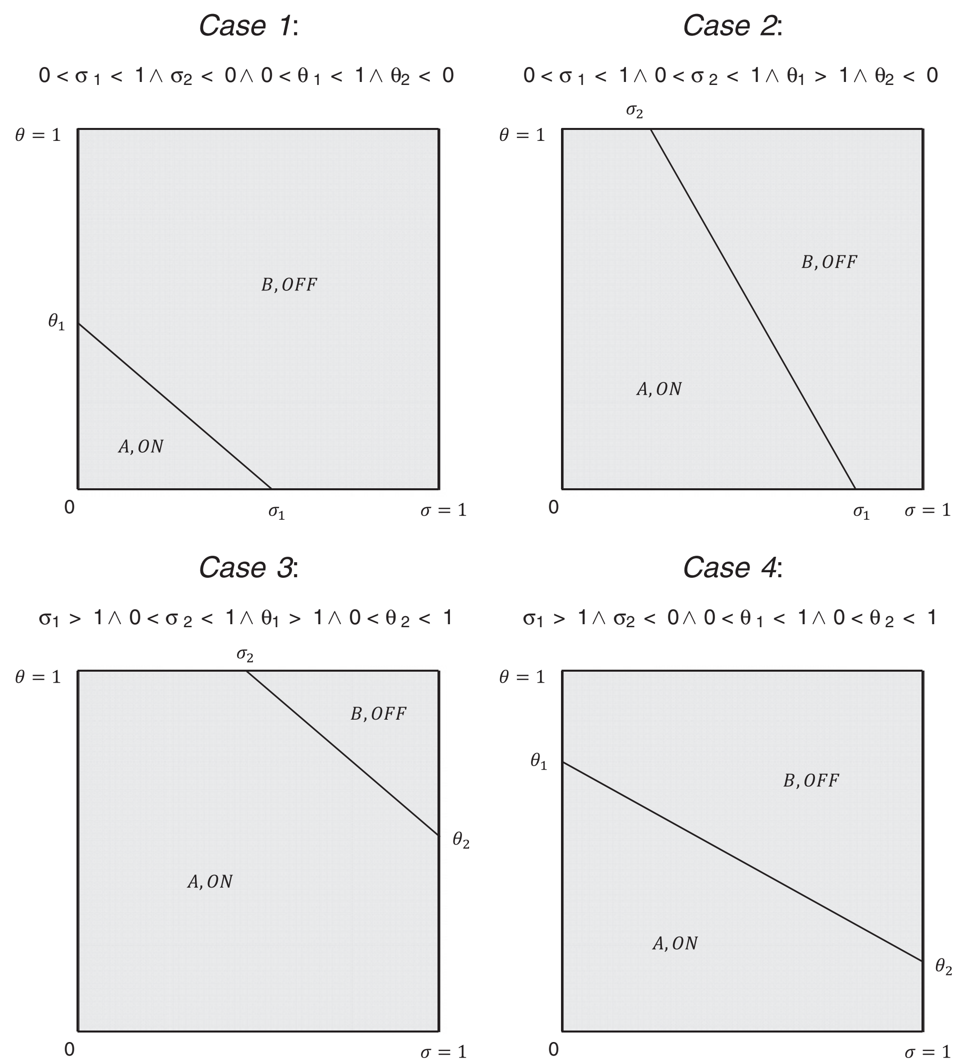

Fig. 6. Polarization cases.
Note: These figures illustrate the potential market areas for a polarization of firms where A provides an online edition of style $\sigma_A = 0$ and B an offline edition of style $\sigma_B = 1$. Each case is only defined if the respective inequalities regarding intercepts σ_1, σ_2, θ_1, and θ_2 are satisfied.

Using Eq. (16), Eq. (17) and the conditions Cases 1–4 impose on σ_1, σ_2, θ_1, and θ_2 as indicated in Fig. 6, tedious but otherwise routine calculations reveal that the following parameter configurations have to be satisfied for each of the polarization cases to occur:

$$\begin{aligned}
&\text{Case 1}: \ \Delta > 0 \ \wedge \ k-\frac{\Delta}{3}<h<k+\frac{\Delta}{3} \\
&\text{Case 2}: \ \Delta \geq 0 \ \wedge \ k > h+\frac{\Delta}{3} \ \vee \ \Delta<0 \ \wedge \ k > h-\frac{\Delta}{3} \\
&\text{Case 3}: \ \Delta<0 \ \wedge \ k+\frac{\Delta}{3}<h<k-\frac{\Delta}{3} \\
&\text{Case 4}: \ \Delta \geq 0 \ \wedge \ h > k+\frac{\Delta}{3} \ \vee \ \Delta<0 \ \wedge \ h > k-\frac{\Delta}{3}.
\end{aligned} \tag{18}$$

Accordingly, Case 1 is only defined if offline ad effectiveness is higher than online ad effectiveness. Similarly, Case 3 requires that online advertisements are more effective than its offline counterparts. Moreover, both cases are restricted to rather homogeneous style and type preferences: The type preference h must lie in an interval of one third times the absolute difference in ad effectiveness on both sides of the style preference parameter k. Cases 2 and 4 may occur for $\Delta \gtreqless 0$ and require a sufficient heterogeneity between the preference parameters in the two dimensions: The preference parameters have to differ by at least one third times the absolute difference in ad effectiveness. Case 2 (4) corresponds to situations where the type preference is greater (smaller) than the style preference. Remarkably, none of the polarization cases is defined for identical distance costs in the type and style dimensions.

5.4. Equilibria with homogeneous style and type preferences

In the following we contrast the polarization with the collusion equilibria and determine the parameter configurations for which the one or the other apply. For homogeneous style and type preferences we obtain:

Proposition 3. *If preferences for the two attributes are sufficiently homogeneous and advertising markets are asymmetric, i.e.* $k-\frac{|\Delta|}{3} < h<k+\frac{|\Delta|}{3}$, *a unique specialization equilibrium is characterized by collusion in the platform type offering the higher ad effectiveness. For symmetric advertising markets,* $k = h$ *implies that both type- and style-collusion constitute equilibria.*

Proof. If $k-\frac{|\Delta|}{3}<h<k+\frac{|\Delta|}{3}$, Case 1 and Case 3 represent potential polarization equilibria (see Eq. (18)). Case 1 is a candidate for $\Delta > 0$ while Case 3 is a candidate for $\Delta < 0$. In Case 1, firm A provides an online platform even though offline media permits higher advertising prices.

Hence, A could have an incentive to deviate from the corner diagonally opposite of the competitor's location to a location on the same axis as the competitor; that is to provide an offline platform instead of an online platform. Recall that symmetric profits under type-collusion are $\Pi_{i,j}=\frac{k}{2}-C$. Using the profits from Eq. (17), deviating towards type-collusion is beneficial for firm A if

$$\frac{\sigma_1^3 k^2}{2h}-C<\frac{k}{2}-C \;\Leftrightarrow\; \sigma_1^2\theta_1<1. \tag{19}$$

Note that from Eq. (16) we can substitute $\sigma_1=\frac{k}{h}\theta_1$. Moreover, we have shown in Eq. (18) that Case 1 is only defined for $0<\sigma_1<1$ and $0<\theta_1<1$. Therefore, firm A gains from deviating and polarization cannot represent a Nash equilibrium for $k-\frac{|\Delta|}{3}<h<k+\frac{|\Delta|}{3}$ and $\Delta>0$. Similarly, in Case 3 with $\Delta<0$, firm B operating on the less effective offline advertising market has an incentive to deviate to the type-collusion equilibrium where both outlets report online if

$$\frac{(1-\sigma_2)^3 k^2}{2h}-C<\frac{k}{2}-C \;\Leftrightarrow\; (1-\sigma_2)^2(1-\theta_2)<1.$$

Again we make use of Eq. (16) to substitute $(1-\sigma_2)=\frac{h}{k}(1-\theta_2)$. Recall also that for *Case 3* to occur $0<\sigma_2<1$ and $0<\theta_2<1$ has to be fulfilled such that for $k-\frac{|\Delta|}{3}<h<k+\frac{|\Delta|}{3}$ and $\Delta<0$ polarization represents no equilibrium either. For deviation from type-collusion to style-collusion to occur it must not be the case that condition (*DC*) is fulfilled. Yet, for homogeneous style and type preferences, $k>h-\frac{|\Delta|}{3}$ holds such that condition (*DC*) is always met. Lastly, if outlets collude on the less effective platform it follows from the profits in Eqs. (14) and (17) that firms have an incentive to deviate to the more effective platform type. Suppose $\Delta>0$ and firms collude in online platforms. With homogeneous style and type preferences B will shift to offline provision since $\Pi_{B,OFF}$ in Case 1 of Eq. (17) is greater than $\frac{k}{2}-C$. The best response of the other firm would be to shift to offline technology as well because $\Pi_{A,ON}$ in Case 1 of Eq. (17) is smaller than $\frac{k}{2}-C$.

If distance costs in the type and style dimensions are identical, it is evident from Eq. (18) that none of the polarization cases is defined. Hence, a collusion equilibrium has to apply. Inserting $k=h$ and $\Delta=0$ in Eqs. (13) and (14) shows immediately that type- and style-collusion yields the same level of profits. □

Whenever style and type preferences are sufficiently homogeneous the *principle of maximum–minimum differentiation* holds in our framework as well. However, due to the second market side outlets may face a trade-off between maximizing market power and advertising revenue. Hence, even for $h>k$ – where firms would generally prefer maximum differentiation in the type dimension – they collude in the type with the higher ad effectiveness.

5.5. Equilibria with heterogeneous style and type preferences

For heterogeneous style and type preferences, polarization Cases 2 and 4 represent equilibrium candidates. Case 2 refers to a configuration where the style preference is greater than the type preference $k>h$ and Case 4 requires the type preference to exceed the style preference $h>k$. The following two propositions look at these two cases separately in more detail and compare them to type- and style-collusion.

Proposition 4. *Given that preferences for the two attributes are sufficiently heterogeneous and the continuous attribute (style) dominates the discrete attribute (type), i.e.* $k>h+\frac{|\Delta|}{3}$, *we obtain the following specialization equilibria:*

- *Symmetric advertising markets* ($\Delta=0$) *yield either type-collusion or polarization.*
- *Asymmetric advertising markets* ($\Delta\neq 0$) *yield type-collusion.*

Proof. From Eq. (18) follows that only Case 2 represents a potential polarization equilibrium for $k>h+\frac{|\Delta|}{3}$ and $\Delta\gtreqless 0$. If $\Delta\neq 0$ holds true, profits in Case 2 are asymmetric. The firm specializing in the type with the lower ad effectiveness makes less revenues and may find it profitable to deviate from the polarization constellation. Suppose for now, $\Delta>0$, then firm A providing an online platform has an incentive to deviate to the offline type-collusion equilibrium as can be shown using the profits from Eq. (17):

$$\frac{(3k-\Delta)^2}{18k}-C<\frac{k}{2}-C\Leftrightarrow\Delta<6k. \tag{20}$$

Analogous reasoning applies for the parameter constellation with $\Delta<0$. Under polarization and $k>h+\frac{|\Delta|}{3}$, there is an incentive for the platform with the less effective advertising side to deviate to the type-collusion equilibrium. Only if $\Delta=0$, polarization can represent a Nash equilibrium as this implies for both firms under type-collusion as well as under polarization profits of $\Pi_{i,j}=\frac{k}{2}-C$ (see Eqs. (17) and (14)). Since $k>h+\frac{|\Delta|}{3}$ implies that condition (*DC*) is satisfied, style-collusion does not represent an equilibrium. □

If the style of coverage is the dominant attribute, firms' objective is to differentiate and capitalize on the style dimension. With regard to the less important type dimension, they would prefer a central location to maximize market access. Due to the discrete nature of the alternative technologies, a central location on the type dimension is ruled out and media outlets are indifferent between locating at the diagonally opposite corners of the unit square and choosing maximally differentiated styles of the same type. Both location constellations yield the same average consumer distance. Hence, if $k>h$ and $\Delta=0$, four alternative Nash equilibria arise: two symmetric type-collusion equilibria and two symmetric polarization equilibria as illustrated in Fig. 5 in columns 2 and 3. This shows that accounting for a discrete attribute which receives less weight in the utility function than the continuous attribute invalidates the *principle of maximum–minimum differentiation*. A further factor enters the location decision when advertising markets are asymmetric. Besides maximizing market power and market access, firms seek to maximize advertising revenues. Therefore, if $\Delta\lessgtr 0$ and $k>h$, a media outlet providing the less effective platform can increase its advertising revenues by shifting to type-collusion in the more effective technology without losing market power or market access. This way asymmetric advertising markets restore maximum–minimum differentiation.

Proposition 5. *Given that preferences for the two attributes are sufficiently heterogeneous and the discrete attribute (type) dominates the continuous attribute (style), i.e.* $h>k+\frac{|\Delta|}{3}$, *we obtain the following specialization equilibria:*

- *Symmetric advertising markets* ($\Delta=0$) *yield style-collusion.*
- *If advertising markets are asymmetric* ($\Delta\neq 0$) *and condition* (*DC*) *is violated, style-collusion or polarization occurs.*
- *If advertising markets are asymmetric* ($\Delta\neq 0$) *and condition* (*DC*) *is satisfied, type-collusion occurs.*

Proof. If the type preference exceeds the style preference by at least one third times the absolute difference in ad effectiveness, Case 4 is the polarization candidate. As is evident from Eqs. (13) and (17), the profits for the polarization case are identical to the profits for style-collusion. Hence, either both or none of them represent a Nash equilibrium. Accordingly, it remains to be determined whether there is an incentive to deviate from the polarization candidate – or alternatively from style-collusion – towards type-collusion. For the latter we have already derived the condition in Section 5.2: If the style preference is sufficiently small and the type preference is sufficiently large such that condition (*DC*) is not satisfied, type-collusion does not represent an equilibrium. Note that this condition is not necessarily violated by the heterogeneity in style and type preferences as defined above. Hence, the dominance condition (*DC*) is decisive for the equilibria emerging in a situation with asymmetric advertising markets $\Delta \neq 0$: If the dominance condition (*DC*) is satisfied, type-collusion has to apply. If the dominance condition is violated, either polarization or style-collusion will emerge in equilibrium. For symmetric advertising markets with $\Delta = 0$, Case 4 does not represent an equilibrium since condition (*DC*) is always satisfied for the parameter configuration $h > k$ underlying Case 4. □

It is intuitive that the equilibria are characterized by a provision of both media types if the type preference exceeds the style preference. In combination with symmetric advertising markets this yields the traditional max–min equilibrium because the continuous style dimension allows for a central location with maximum market access. For asymmetric advertising markets, media outlets do not collude in the platform type offering the higher advertising prices if the gains from capitalizing on the type preference compensate the losses from operating on the less effective advertising market i.e. h is sufficiently large. Remarkably, in this case media outlets are indifferent between polarization and style-collusion.[23] On the one hand, polarization has the disadvantage of a less central location compared to style-collusion. On the other hand, polarization results in a greater distance between competitors which mitigates price competition. Without asymmetric two-sided markets, the disadvantage would dominate and polarization would not constitute an equilibrium. The existence of an asymmetric second market side intensifies price competition and renders the distance between competitors more important such that polarization becomes an equilibrium. Hence, if the discrete attribute dominates, the *principle of maximum–minimum differentiation* is only valid as long as there is no second market side which features an asymmetry with regard to the discrete attribute.

6. Summary and conclusions

In this paper we have developed a model incorporating two-dimensional horizontal competition and two-sided markets. This framework allows us to analyze how alternative platform technologies in the sense of online and offline media interact with the traditional differentiation along the style of media content. We account for the fact that the advent of online technologies has reshaped the consumer as well as the advertising side of media markets. On the one hand, online platforms offer new ways of targeted advertising which is reflected by a platform-type specific ad effectiveness in our model. On the other hand, consumers and their requests for information are characterized by heterogeneous preferences regarding the style of coverage and the type of media technology. For this reason we consider a two-dimensional continuous distribution of consumers where the distance costs may vary across the type and the style dimension.

We show that the introduction of online media gives rise to two alternative scenarios: In the integration scenario, both media outlets enter the online market but eventually lose part of their profits. Online technologies may lead to a prisoner's dilemma in this scenario. The specialization scenario applies when platform fixed costs are sufficiently high such that none of the two firms finds it profitable to unilaterally enter the online market. The discrete nature of the technological type dimension, heterogeneous type and style preferences, and asymmetric advertising markets have important implications for the equilibrium locations of firms. Our analysis reveals that these three characteristics of the media market amend the traditional result of maximum–minimum differentiation as maximum differentiation in both dimension (polarization) may emerge in equilibrium. A discrete attribute and heterogeneous type and style preferences are necessary conditions for polarization to apply while asymmetric advertising markets can have ambiguous effects depending on whether the discrete or the continuous attribute dominates. Comparing the domination of style preferences to the domination of type preferences, we find that dominant style preferences only allow for polarization if advertising markets are symmetric. In contrast, dominant type preferences require asymmetric media markets for polarization to occur. As long as style preferences are equally strong and advertising markets are asymmetric, the traditional result of maximum–minimum differentiation applies with maximum differentiation in the type dimension.[24]

Acknowledgments

We would like to thank two anonymous referees, the editors Pai-Ling Yin and Tobias Kretschmer, Hanna Halaburda, Andreas Haufler, and Sergey Nigai for many helpful comments.

Appendix A. Derivation of the equilibrium in the integration scenario

Proof. Using the demands from Eq. (6) jointly with Eq. (1) we can state profits for firms A and B as:

$$\begin{aligned}
\Pi_A =& \frac{\left(p_{A,OFF}+\beta_{OFF}\right)\left(h+p_{A,ON}-p_{A,OFF}\right)\left[k\left(\sigma_A^2-\sigma_B^2\right)+p_{A,OFF}-p_{B,OFF}\right]}{4hk(\sigma_A-\sigma_B)} \\
&+\frac{\left(p_{A,ON}+\beta_{ON}\right)\left(h+p_{A,OFF}-p_{A,ON}\right)\left[k\left(\sigma_A^2-\sigma_B^2\right)+p_{A,ON}-p_{B,ON}\right]}{4hk(\sigma_A-\sigma_B)}-2C \\
\Pi_B =& \frac{\left(p_{B,OFF}+\beta_{OFF}\right)\left(h+p_{B,ON}-p_{B,OFF}\right)\left[k(\sigma_A-\sigma_B)(\sigma_A+\sigma_B-2)+p_{A,OFF}-p_{B,OFF}\right]}{4hk(\sigma_B-\sigma_A)} \\
&+\frac{\left(p_{B,ON}+\beta_{ON}\right)\left(h+p_{B,OFF}-p_{B,ON}\right)\left[k(\sigma_A-\sigma_B)(\sigma_A+\sigma_B-2)+p_{A,ON}-p_{B,ON}\right]}{4hk(\sigma_B-\sigma_A)}-2C.
\end{aligned} \tag{A.1}$$

The partial derivatives of Π_A and Π_B with respect to the four different prices yield the reaction functions. These have one interior intersection at prices:

$$p_{A,j}=\frac{k}{3}(\sigma_B-\sigma_A)(2+\sigma_A+\sigma_B)-\beta_j, \quad p_{B,j}=\frac{k}{3}(\sigma_B-\sigma_A)(4-\sigma_A-\sigma_B)-\beta_j \tag{A.2}$$

[23] Equilibrium prices, demand, and profits are identical for polarization and for style-collusion in a situation with $\Delta \neq 0$ and condition (*DC*) being violated.

[24] It is unambiguous on which dimension firms maximally differentiate because a central location which maximizes market access is only possible on the style dimension.

Inserting these prices in the second derivatives of the profit functions shows that the price vector $\mathbf{P}^* = (p_{i,j})$ from Eq. (A.2) represents mutually optimal prices:

$$\left.\frac{\partial^2 \Pi_A}{\partial p_{A,ON}^2}\right|_{P*} = \frac{h+\beta_{ON}-\beta_{OFF}}{2hk(\sigma_A-\sigma_B)} < 0 \quad \left.\frac{\partial^2 \Pi_A}{\partial p_{A,OFF}^2}\right|_{P*} = \frac{h+\beta_{ON}-\beta_{OFF}}{2hk(\sigma_A-\sigma_B)} < 0 \tag{A.3}$$
$$\left.\frac{\partial^2 \Pi_B}{\partial p_{B,ON}^2}\right|_{P*} = \frac{h-\beta_{ON}+\beta_{OFF}}{2hk(\sigma_A-\sigma_B)} < 0 \quad \left.\frac{\partial^2 \Pi_B}{\partial p_{B,OFF}^2}\right|_{P*} = \frac{h-\beta_{ON}+\beta_{OFF}}{2hk(\sigma_A-\sigma_B)} < 0$$

for $h, k > 1 \ \wedge \ 0 < \beta_j < 1 \ \wedge \ \sigma_B > \sigma_A$.

With the optimal prices we can establish the resulting prices market shares and profits:

$$n_{A,j} = \frac{(2+\sigma_A+\sigma_B)\left(h+\beta_j-\beta_{-j}\right)}{12h}, \qquad n_{B,j} = \frac{(4-\sigma_A-\sigma_B)\left(h+\beta_j-\beta_{-j}\right)}{12h}$$
$$\Pi_A = \frac{k}{18}(\sigma_B-\sigma_A)(2+\sigma_A+\sigma_B)^2-2C, \quad \Pi_B = \frac{k}{18}(\sigma_B-\sigma_A)(4-\sigma_A-\sigma_B)^2-2C. \tag{A.4}$$

In the first stage media outlets choose their location. We derive the reaction functions $\Pi_A(\sigma_B)$ and $\Pi_B(\sigma_A)$ corresponding to Eq. (A.4) and obtain three intersections of which only one $(\sigma_B = -\frac{1}{4}, \sigma_B = \frac{5}{4})$ satisfies the second-order conditions. This implies that there exists no interior location of mutual best responses and a corner solution has to occur in equilibrium. Since $\sigma_B > \sigma_A$, the only candidate to be considered is $\sigma_B = 1, \sigma_A = 0$. From the profits in Eq. (A.4) it is evident that deviations from $\sigma_B = 1, \sigma_A = 0$ are neither for firm A nor for firm B profitable because $\frac{\partial \Pi_B}{\partial \sigma_B}|_{\sigma_A=0} > 0$ and $\frac{\partial \Pi_A}{\partial \sigma_A}|_{\sigma_B=1} < 0$ for the full characteristics space. Inserting $\sigma_B = 1, \sigma_A = 0$ in Eqs. (A.2) and (A.4) immediately yields the equilibrium for integrated provision as stated in (7). □

Appendix B. Derivation of the equilibrium without online platforms

Without online platforms consumers select into style σ_A and σ_B. The pivotal consumers lie on the market-split line which is characterized by:

$$U_{A,OFF} = U_{B,OFF} \iff \hat{\sigma} = \frac{k\left(\sigma_A^2-\sigma_B^2\right)+p_{A,OFF}-p_{B,OFF}}{2k(\sigma_A-\sigma_B)}. \tag{B.5}$$

Hence, demand for media outlet A is $\hat{\sigma}$ and demand for B is $1-\hat{\sigma}$. Maximizing the profit functions with respect to the prices yields:

$$p_{A,OFF} = \frac{k}{3}(\sigma_B-\sigma_A)(\sigma_A+\sigma_B+2)-\beta_{OFF},$$
$$p_{B,OFF} = \frac{k}{3}(\sigma_A-\sigma_B)(\sigma_A+\sigma_B-4)-\beta_{OFF}. \tag{B.6}$$

Note that the second-order conditions are satisfied because the second-order partial derivatives of the profits at the above prices are $\frac{\partial^2 \Pi_A}{\partial p_{A,OFF}^2} = \frac{\partial^2 \Pi_B}{\partial p_{B,OFF}^2} = \frac{1}{k(\sigma_A-\sigma_B)} < 0$. We can employ the prices from Eq. (B.6) to reformulate profits:

$$\Pi_A = \frac{k}{18}(\sigma_B-3\sigma_A-2)(2+\sigma_A+\sigma_B),$$
$$\Pi_A = \frac{k}{18}(3\sigma_B-\sigma_A-4)(\sigma_A+\sigma_B-4). \tag{B.7}$$

Following the same procedure as in Appendix A we obtain the equilibrium locations of firms at $\sigma_A = 0$, $\sigma_B = 1$. The corresponding prices, demands, and profits are stated in Eq. (8).

Appendix C. Derivation of the equilibrium with unilateral provision of an online platform

For unilateral provision of an online platform, the market areas are determined by:

$$\hat{\theta} = \frac{h+p_{A,OFF}-p_{A,ON}}{2h}, \qquad \hat{\sigma} = \frac{k\left(\sigma_A^2-\sigma_B^2\right)+p_{A,OFF}-p_{B,OFF}}{2k(\sigma_A-\sigma_B)}. \tag{C.8}$$

This implies the following demands for the three platforms:

$$n_{A,ON} = \hat{\theta}\,\hat{\sigma}, \qquad n_{A,OFF} = \left(1-\hat{\theta}\right)\hat{\sigma}, \qquad n_{B,OFF} = 1-\hat{\sigma}. \tag{C.9}$$

Accordingly, the profits of the two media outlets can be stated as:

$$\Pi_A = \frac{\left(p_{A,OFF}+\beta_{OFF}\right)\left(h+p_{A,ON}-p_{A,OFF}\right)\left[k\left(\sigma_A^2-\sigma_B^2\right)+p_{A,OFF}-p_{B,OFF}\right]}{4hk(\sigma_A-\sigma_B)}$$
$$+\frac{\left(p_{A,ON}+\beta_{ON}\right)\left(h+p_{A,OFF}-p_{A,ON}\right)\left[k\left(\sigma_A^2-\sigma_B^2\right)+p_{A,OFF}-p_{B,OFF}\right]}{4hk(\sigma_A-\sigma_B)}-2C$$
$$\Pi_B = \frac{\left[(\sigma_B-\sigma_A)(\sigma_A+\sigma_B-2)k-p_{A,OFF}+p_{B,OFF}\right]\left(p_{B,OFF}+\beta_{OFF}\right)}{2k(\sigma_A-\sigma_B)}-C. \tag{C.10}$$

From the corresponding reaction functions we get three sets of equilibrium prices. However, from the second-order conditions we can show that only one set of prices represents a joint profit-maximum. This set of optimal prices is:

$$p_{A,ON} = \frac{h[4k(\sigma_B-\sigma_A)(2+\sigma_A+\sigma_B)+5h]+2\beta_{ON}(\beta_{OFF}-4h)-\beta_{OFF}(4h+\beta_{OFF})-\beta_{ON}^2}{12h}$$
$$p_{A,OFF} = \frac{h[4k(\sigma_B-\sigma_A)(2+\sigma_A+\sigma_B)-h]+2\beta_{ON}(\beta_{OFF}-h)-\beta_{OFF}(10h+\beta_{OFF})-\beta_{ON}^2}{12h}$$
$$p_{B,OFF} = \frac{h[8k(\sigma_B-\sigma_A)(\sigma_A+\sigma_B-4)-h]+2\beta_{ON}(\beta_{OFF}-h)-\beta_{OFF}(22h+\beta_{OFF})-\beta_{ON}^2}{24h}. \tag{C.11}$$

Inserting these prices into the profit functions yields:

$$\Pi_A^{\text{deviate}} = \frac{\left[(h-\Delta)^2+8(\sigma_B-\sigma_A)(2+\sigma_A+\sigma_B)hk\right]^2}{1152(\sigma_B-\sigma_A)h^2k}-2C$$
$$\Pi_B^{\text{comply}} = \frac{\left[(h-\Delta)^2-8(\sigma_B-\sigma_A)(4-\sigma_A-\sigma_B)hk\right]^2}{1152(\sigma_B-\sigma_A)h^2k}-C. \tag{C.12}$$

Outlets choose their locations in the style dimension by maximizing these profits with respect to σ_A and σ_B. It can be shown that the reaction functions corresponding to Eq. (C.12) yield no interior equilibrium that represents a profit maximum for both firms at the same time and ensures positive demand for A and B. Accordingly, the only remaining candidate for an equilibrium in pure strategies is a corner solution with $\sigma_A = 0$ and $\sigma_B = 1$. Inspecting the partial derivatives of the profits in Eq. (C.12) shows that $\Pi_A^{\text{deviate}}(\sigma_A = 0, \sigma_B = 1)$ is strictly decreasing in σ_A while $\Pi_B^{\text{comply}}(\sigma_A = 0, \sigma_B = 1)$ is strictly increasing in σ_B. Thus, neither for A nor for B it is profitable to deviate from the above mentioned corner solution. Any reduction of distance in the style dimension between the two firms is not stable which – in conjunction with the absence of interior equilibria – implies that $\sigma_A = 0, \sigma_B = 1$ represents a unique Nash Equilibrium as long as Π_A^{deviate} and Π_A^{comply} are both positive. Inserting $\sigma_A = 0, \sigma_B = 1$ in Eqs. (C.9), (C.11), and (C.12) we obtain the equilibrium values displayed in Eq. (10).

Appendix D. Derivation of the polarization equilibria

With the intercepts from Eq. (16) demands in the four cases can be calculated as:

$$\begin{aligned}
&\text{Case 1}: && \text{Case 2}: \\
&n_{A,ON}=\frac{\left(h+k-p_{A,ON}+p_{B,OFF}\right)^2}{8hk}, && n_{A,ON}=\frac{k-p_{A,ON}+p_{B,OFF}}{2k} \\
&\text{Case 3}: && \text{Case 4}: \\
&n_{A,ON}=\frac{\left(h+k+p_{A,ON}-p_{B,OFF}\right)^2}{8hk}, && n_{A,ON}=\frac{h-p_{A,ON}+p_{B,OFF}}{2h},
\end{aligned} \tag{D.13}$$

where $n_{B,OFF}=1-n_{A,ON}$ holds true in each case. Using the profit functions jointly with the above demands the optimal prices can be derived from the partial derivatives and the corresponding reaction functions for each separate case:

$$\begin{aligned}
&\text{Case 1}: \\
&p_{A,ON}=\frac{h+k-\beta_{OFF}-7\beta_{ON}+\Psi_1}{8}, \qquad p_{B,OFF}=\frac{5(h+k)-3(\beta_{OFF}+\beta_{ON})+3\Psi_1}{8} \\
&\text{Case 2}: \\
&p_{A,ON}=k-\frac{\beta_{OFF}+2\beta_{ON}}{3}, \qquad p_{B,OFF}=k-\frac{2\beta_{OFF}+\beta_{ON}}{3} \\
&\text{Case 3}: \\
&p_{A,ON}=\frac{3\Psi_2-5(h+k+\beta_{OFF})-3\beta_{ON}}{8}, \qquad p_{B,OFF}=\frac{h+k-\beta_{ON}-7\beta_{OFF}+\Psi_2}{8} \\
&\text{Case 4}: \\
&p_{A,ON}=h-\frac{\beta_{OFF}+2\beta_{ON}}{3}, \qquad p_{B,OFF}=h-\frac{2\beta_{OFF}+\beta_{ON}}{3} \\
&\text{where } \Psi_1\equiv\sqrt{(h-\Delta)^2+2(17h-\Delta)k+k^2},\ \ \Psi_2\equiv\sqrt{(h+\Delta)^2+2(17h+\Delta)k+k^2}.
\end{aligned} \tag{D.14}$$

A. Homogeneous style and type preferences:

B \ A	Online	Offline	IntegratedProvision
Online	$\frac{k}{2}-C$, $\frac{k}{2}-C$		$\hat{\Pi}_A^{deviate}$, $\hat{\Pi}_B^{comply}$
Offline		$\frac{k}{2}-C$, $\frac{k}{2}-C$	$\Pi_A^{deviate}$, Π_B^{comply}
Integrated Provision	$\hat{\Pi}_A^{comply}$, $\hat{\Pi}_B^{deviate}$	Π_A^{comply}, $\Pi_B^{deviate}$	$\frac{k}{2}-2C$, $\frac{k}{2}-2C$

B. Heterogeneous style and type preferences:

Style preference dominates:

B \ A	Online	Offline	IntegratedProvision
Online	$\frac{k}{2}-C$, $\frac{k}{2}-C$	$\frac{k}{2}-C$, $\frac{k}{2}-C$ *Only for $\Delta=0$	$\hat{\Pi}_A^{deviate}$, $\hat{\Pi}_B^{comply}$
Offline	$\frac{k}{2}-C$, $\frac{k}{2}-C$ *Only for $\Delta=0$	$\frac{k}{2}-C$, $\frac{k}{2}-C$	$\Pi_A^{deviate}$, Π_B^{comply}
Integrated Provision	$\hat{\Pi}_A^{comply}$, $\hat{\Pi}_B^{deviate}$	Π_A^{comply}, $\Pi_B^{deviate}$	$\frac{k}{2}-2C$, $\frac{k}{2}-2C$

Type preference dominates:

B \ A	Online	Offline	IntegratedProvision
Online		$\frac{(3h+\Delta)^2}{18h}-C$, $\frac{(3h-\Delta)^2}{18h}-C$	$\hat{\Pi}_A^{deviate}$, $\hat{\Pi}_B^{comply}$
Offline	$\frac{(3h-\Delta)^2}{18h}-C$, $\frac{(3h+\Delta)^2}{18h}-C$		$\Pi_A^{deviate}$, Π_B^{comply}
Integrated Provision	$\hat{\Pi}_A^{comply}$, $\hat{\Pi}_B^{deviate}$	Π_A^{comply}, $\Pi_B^{deviate}$	$\frac{k}{2}-2C$, $\frac{k}{2}-2C$

Fig. 7. Integration vs. Specialization and the level of fixed costs.
Note: If style preference dominates condition (*DC*) is satisfied, if type preference dominates condition (*DC*) is violated. Panel A refers to homogeneous type and style preferences $k-\frac{|\Delta|}{3}<h<k+\frac{|\Delta|}{3}$. Panel B refers to heterogeneous type and style preferences $k>h+\frac{|\Delta|}{3}$ or $h>k+\frac{|\Delta|}{3}$ and distinguishes between cases with style and type preference being dominant, respectively. In each figure we report profits only for those strategy combinations that represent potential equilibria for the respective set of type and style preferences. As is shown in Section 5.4 neither style-collusion nor polarization represents equilibria in panel A. In panel B, with type preference being dominant, type-collusion does not represent an equilibrium (see Section 5.5). A dominant style preference with heterogeneous preference parameters rules out equilibria with style-collusion and polarization may only occur for $\Delta=0$.

Note that we obtain two sets of prices satisfying the first-order conditions in Case 1 as well as in Case 3. Yet, for the parameter constraints h, $k > 1$ and $-1 < \Delta < 1$ we can show that only one set of prices satisfies the second-order condition in each case.

Appendix E. Integration vs. specialization equilibria

In addition to the offline type-collusion equilibrium – which represents the most relevant case as virtually all news outlets operating offline and online platforms started with an offline platform – specialization can yield three other configurations that are compared with the integration equilibria. First, firms may initially provide only online platforms. In this case the equilibrium is characterized by Eq. (14). Second, style-collusion as described in Eq. (13) might prevail. Third, specialization may yield a polarization equilibrium which gives rise to profits in Eq. (17). As opposed to the set of potential specialization equilibria firms may either both choose integrated provision (for the profits cf. Eq. (7)) or one firm unilaterally opts for integrated provision. With regard to the latter Eq. (10) describes the equilibrium if the other firm sticks to offline provision while the equilibrium is characterized by the following profits if the complying firm sticks to online provision:

$$\hat{\Pi}_A^{\text{deviate}} = \frac{\left[(h+\Delta)^2 + 24hk\right]^2}{1152h^2k} - 2C, \hat{\Pi}_B^{\text{comply}} = \frac{\left[(h+\Delta)^2 - 24hk\right]^2}{1152h^2k} - C. \quad \text{(E.15)}$$

Fig. 7 illustrates the set of strategy combinations that may – for some level of fixed costs – represent equilibria given the underlying set of preference parameters k, h. In Section 4.1 we have derived the critical fixed costs levels that animate firms to deviate from a offline type-collusion equilibrium to integrated provision. Following the same reasoning we can derive the critical values for fixed costs that make firms deviate from the online type-collusion equilibrium:

$$\begin{aligned} \hat{\Pi}_A^{\text{deviate}} &> \frac{k}{2} - C \iff C < \hat{C}^{**} = \frac{48hk(h+\Delta)^2 + (h+\Delta)^4}{1152h^2k} \\ \hat{\Pi}_B^{\text{comply}} &< \frac{k}{2} - 2C \iff C < \hat{C}^{*} = \frac{48hk(h+\Delta)^2 - (h+\Delta)^4}{1152h^2k} \end{aligned} \quad \text{(E.16)}$$

Again, the critical fixed costs for the first firm to deviate $\hat{C}^{**}$ are strictly greater than the critical fixed costs that make the other firm respond with an integration strategy $\hat{C}^*$. Hence, starting with an online type-collusion equilibrium the critical level of fixed costs that yields a prisoner's dilemma is $\hat{C}^*$ while the sum of media profits decreases due to one firm's choice of integrated provision already once fixed costs fall below $\hat{C}^{**}$.[25]

In Section 5.2 we have shown that type-collusion always occurs on the technology type with the higher ad effectiveness i.e. offline (online) type-collusion for $\Delta > 0$ ($\Delta < 0$). Accordingly, we can restrict the specialization configurations that may arise initially and we can state the critical levels of fixed costs in general terms as:

$$C^* = \frac{48hk(h-|\Delta|)^2 - (h-|\Delta|)^4}{1152h^2k} \quad C^{**} = \frac{48hk(h-|\Delta|)^2 + (h-|\Delta|)^4}{1152h^2k}. \quad \text{(E.17)}$$

The potential specialization and integration equilibria that may occur for heterogeneous style and type preferences with style of coverage being dominant (see Fig. 7, panel B) have already been compared above. Just as in the scenario with homogeneous preferences a prisoner's dilemma arises if $C < C^*$ and uncoordinated behavior makes media firm worse of in terms of their sum of profits already for $C < C^{**}$.

Finally, for heterogeneous type and style preferences and the type of coverage being dominant it follows from Section 5.5 that style-collusion as well as polarization represent specialization equilibria. For the comparison with the integration equilibria it does not matter whether one or the other applies since they yield the same equilibrium profits for the relevant set of preference parameters. The first to deviate from such an equilibrium is the one operating on the technology with the lower ad effectiveness. Comparing the profits shows that unilateral deviation is profitable once:

$$C < C^{**} + \Lambda \text{ where } \Lambda = \frac{1}{2}(k-h) + \frac{|\Delta|}{3} - \frac{\Delta^2}{18h}. \quad \text{(E.18)}$$

It can be shown that $\Lambda < 0$ as long as condition (*DC*) is met. The critical level of fixed costs for the prisoner's dilemma to arise remains C^* as is evident from Fig. 7. Hence, due to $\Lambda < 0$ the threshold fixed costs for uncoordinated behavior harming media outlets in terms of the sum of profits and the threshold for the prisoner's dilemma converge. For sufficiently small Λ an intermediate level of fixed costs implying that only one firm deviates towards integration does not exist.

[25] $2\tilde{\Pi}_i > \hat{\Pi}_A^{\text{deviate}} + \hat{\Pi}_B^{\text{comply}}$ can be reformulated as $C > \frac{2(h+\Delta)^4}{1152h^2k}$. Unilateral deviation represents an equilibrium only if $C \in \,]\hat{C}^*, \hat{C}^{**}[$ where the lower bound is strictly greater than $\frac{2(h+\Delta)^4}{1152h^2k}$ as long as prices are non-negative.

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