What Do the Papers Sell?*

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Abstract

We model the market for news as a two-sided market where newspapers sell news to readers who value accuracy and sell space to advertisers who value advert-receptive readers. We show that monopolistic newspapers under-report or bias news that sufficiently reduces advertiser profits. Newspaper competition generally reduces the impact of advertising. In fact, as the size of advertising grows, newspapers may paradoxically reduce advertiser bias, due to increasing competition for readers. However, advertisers can counter this effect of competition by committing to news-sensitive cut-off strategies, potentially inducing as much under-reporting as in the monopoly case.

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> "[French TV channel] TF1's job is to help a company like Coca-Cola sell its products. For a TV commercial's message to get through, the viewer's brain must be receptive. Our programs are there to make it receptive, that is to say to divert and relax viewers between two commercials. What we are selling to Coca-Cola is human brain time."
>
> Patrick Le Lay, President of TF1 (James, 2004)

1 Introduction

A free and independent press is crucial to the effective working of society and democratic government. According to the ideal market view, uncensored newspapers compete to attract readers by selling the most accurate news they can produce. Mullainathan and Shleifer (2005) point out that newspapers will bias news if readers prefer bias (e.g., confirming personal ideologies) and they show that newspaper competition cannot prevent such bias. In this paper, we identify a very different source of bias – advertising – and we derive a clear, positive role for competition.

We model the market for news as a two-sided market with readers who value accuracy on one side and advertisers who value access to advert-receptive readers on the other.[1] We develop two main ideas. First, we derive why advertisers might dislike accurate or in-depth reporting on certain topics; these preferences then lead to inaccuracy in monopolistic markets, but we prove that newspaper competition can resolve this problem. Paradoxically, we find that increased advertising can even improve accuracy by increasing competition. Second, we show how advertisers can thwart this competitive effect if able to credibly threaten to withdraw their contracts from papers

[1] See Rochet and Tirole (2003, 2005) and Armstrong (2005) for general treatments of competition in two-sided markets.

that report too accurately on sensitive topics.

Advertising is numerically important. Mainstream U.S. newspapers generally earn over 50 and up to 80% of their revenue from advertising, and in Europe, this percentage lies between 40 and 50% (see e.g., Baker, 1994, and Gabszewicz et al., 2001). In the rosiest view, advertising revenue simply enables newspapers to spend more on producing well-written and accurate news,[2] but several media scholars are skeptical (see e.g., Baker, 1994, Bagdikian, 2000, McChesney, 2000, and Hamilton, 2004). They suggest that heavy dependence on advertising leads papers to bend news to the interests of advertisers, generating misrepresentation on some topics and possibly even a "dumbing-down" of general coverage (as suggested by the above quotation of Le Lay). To investigate their conjecture, we need to identify advertiser interests and analyze how they interact with reader interests, in competitive and monopolistic environments.

In Subsection 2.5 we sketch a microfoundation for advertiser preferences for under-reporting or bias on sensitive news topics such as the health costs of smoking. The underlying message (backed by psychological and empirical evidence) is that news reporting can change the receptiveness of readers to advertising. There are two channels: first, reporting affects mood and salient concerns while reading; second, ongoing reporting can change beliefs and attitudes. In either case, an advertiser's surplus from reaching a given reader increases with dumbing-down, under-reporting or bias of the sensitive topics that reduce reader receptiveness to adverts.

One might hope that advertiser pressures would cancel each other out as advertisers of competing products try to encourage news criticizing competing products, but competing products are in competition precisely because they are similar. So many news stories affect competing producers in a similar way. For instance, a health report that puts people off smoking harms tobacco companies altogether.[3] Furthermore, advertisers from different mar-

[2]Advertising also allows readers to learn about consumer products and may even be enjoyable (see e.g., Baker, 1994, Gabszewicz et al., 2003), but most papers assume a "nuisance cost" (e.g., Anderson and Coate, 2005).

[3]Bad publicity for one company can have repercussions for its competitors. For example, reports on child labor in Nike sports apparel led to the presumption or discovery that

kets often share news sensitivities: news on global warming can harm both energy and car companies; news on famine and deprivation can discourage thoughts on all personal consumption; news on corporate dishonesty can make people suspicious of advertising in general;[4] critical analysis, in general, may make readers more alert and less susceptible to a broad range of persuasive advertising strategies.

To isolate the role of advertising, we assume that all readers dislike bias and strictly prefer more accuracy on all topics. Absent advertising, a monopoly newspaper therefore reports all news accurately (to maximize revenue from readers). Advertising induces under-reporting on any topic that is sufficiently disliked by enough advertisers and occurs whenever the news sensitivity of advertiser surplus (whether from a single or many advertisers) exceeds that of reader surplus.

By contrast, absent advertising, competing newspapers may under-report, since they seek to soften price competition by segmenting the market for readers. However, advertising raises the intensity of competition for readers and this eventually precludes market segmentation: newspapers cannot please advertisers by cutting accuracy, because advertisers care about readership and (when competition is intense) the only way to attract readers is by maximizing accuracy and minimizing price.[5]

With competing newspapers, even a single advertiser eventually suffers (from increased reporting accuracy) as its importance increases, but this advertiser "weakness" is overturned if advertisers can influence reporting strategies directly. For instance, Chrysler corporation wrote to the editors of one hundred papers and magazines where they were advertising:

> "In an effort to avoid potential conflicts, it is required that Chrysler corporation be alerted in advance of any and all editorial content

its competitors acted similarly.

[4]Indeed, Baker (1994) and media monitors (e.g., Media Watch and Fair) claim that most advertisers shun newspapers that consistently contravene generic norms of "business-friendliness."

[5]In Section 6 we analyze the possibility of negative pricing. This neatly complements and elucidates the logic of our two main results.

> that encompasses sexual, political, social issues or any editorial content that could be construed as provocative or offensive."
>
> *Wall Street Journal* (April 30, 1997)

Implicitly, Chrysler threatens to withdraw its ad contracts from media that report too much sensitive news. We model this in Section 5 by allowing each advertiser to commit to withhold ads from any newspaper that reports above a chosen threshold or cut-off. Examples of such practices are relatively abundant and well documented.[6,7] Even though we continue to rule out collusion among advertisers, we find that advertisers with common news sensitivities optimally commit to the same thresholds. Furthermore, as advertisers grow in number or size, they increase the stringency of these demands, eventually forcing all newspapers to under-report or bias as heavily as in the monopolistic case. This result extends to any actor (e.g., a firm, government or bank) able to threaten withdrawal of significant revenue from the paper (whether by canceling ad contracts, subsidies, group subscriptions or finance).

Our paper is part of a rapidly growing literature. As noted above, Mullainathan and Shleifer (2005) show how (even competing) newspapers bias news if readers are ideological. Gabszewicz et al. (2001) show how advertising increases the intensity of competition for readers. They also assume ideological readers, so advertising leads the two papers to converge on news with a centrist ideology (which they call the "pensée unique").[8] None of the

[6] For example, NBC lost its corporate contracts with Coca-Cola in 1970 after airing a documentary critical of Coca-Cola worker conditions in Florida. As a result, NBC stopped producing documentaries on "controversial domestic issue[s] involving an important advertiser" (Brown, 1979). Baker (1994) and Bagdikian (2000) contain further examples. Baker also points out that actual intervention by advertisers is rare compared to media self-censorship; this is consistent with our analysis where intervention occurs only out of equilibrium.

[7] A recent survey by the Annenberg Center for Public Policy reports that "79% of the public said they believed a media company that receives substantial advertising revenue from a company would hesitate to report negative stories about that company" (as cited in Anderson and McLaren, 2005) and that "33% (of journalists) said that to either a great extent or a moderate extent, media organizations either intentionally or unintentionally avoid news stories that are potentially unfavorable to major advertisers."

[8] Convergence on the centrist ideology prevents conscientious readers from comparing information from different papers – see Mullainathan and Shleifer (2005) for a notion of aggregate bias.

papers in this literature allow for news-sensitive advertisers.[9] This is why we find a much stronger (reader) benefit from newspaper competition.

Recent analyses extend in other directions. Dyck and Zingales (2003) suggest that journalists bias news as a way to "thank" their sources for privileged access to news; Patterson and Donbasch (1996) study journalists' own biases; Balan et al. (2003) study media mergers when newspaper owners want to influence reader ideology; Anderson and McLaren (2005) analyze the same issue in a model where readers are fully Bayes rational – both their microfoundation for why readers value news and their model of bias by selective news suppression fit well with the leading interpretation of our model of reporting; Baron (2006) considers journalists who seek to have influence; Strömberg (2001 and 2004) and Besley and Prat (2001) integrate the media into models of electoral competition (complementing our results on how governments can affect reporting); finally, our results also provide theoretical support for Reuter and Zitzewitz's (2006) empirical evidence.

The paper is organized as follows. Section 2 sets out the general model. Sections 3, 4, 5 and 6 present the main results on monopoly, duopoly, the impact of cut-off strategies and negative pricing, in the one topic case. Section 7 generalizes to multiple topics and advertiser types, and Section 8 concludes. All proofs are in the Appendix.

2 The Model

We study competition between profit-maximizing newspapers in a two-sided market: newspapers sell news to readers and space to advertisers. We focus on the content and accuracy of news. To characterize news reporting, we classify news stories into K topics (e.g., the stock market, the environment, sports, and health). Each paper chooses how accurately to report news on each topic: $r \in [0,1]^K$ with $r_k = 1$ if the paper reports fully on topic k and $r_k = 0$ if it makes no report (or reports uninformatively) on k; see

[9] This also extends the two-sided markets literature, since we let "platform" design (newspaper reporting) affect the surplus from a *given* "transaction" between the two sides (a given ad message to a given reader).

Subsection 2.5 for background and further interpretation.

2.1 Newspapers

There are N competing newspapers. A typical paper, n, selects its reporting strategy $r_n \in [0,1]^K$, its copy price charged to readers, p_n, and its prices q_n^j for advertising by each type of advertiser, j (i.e., we assume newspapers can price discriminate among advertisers but not readers). Throughout most of the paper, we assume copy prices are nonnegative ($p_n \geq 0$), reflecting the perception that it is difficult for newspapers to force people to read newspapers and hence ads. However, in Section 6, we briefly consider the case where newspapers can set negative copy prices.

2.2 Readers

Readers are interested in news, but vary in their degree of "interest" in each topic k. There are I reader types, each characterized by a taste vector $s^i \in [0,1]^K$ where s_k^i represents i's marginal value of news or increased accuracy on topic k (e.g., a value from useful information, or a value for knowledge or entertainment) and a reservation value $b^i \geq 0$. We assume that readers buy at most one newspaper. So a reader of type i buys any paper n that maximizes utility,

$$\sum_{k=1}^{K} s_k^i r_{n,k} - p_n$$

provided this maximized value exceeds b^i; $b^i \geq 0$ since we assume no reader is willing to pay a positive price for a paper with $r_n = 0$. To avoid the degenerate case where newspapers cannot attract any readers even with zero prices and full accuracy ($p_n = 0, r_n = 1$), we assume $b^i \leq \sum_{k=1}^{K} s_k^i$ for some $i \in I$. There is an equal number (measure 1) of readers of each type, so denoting reader decisions by the probability $x_n^i \in [0,1]$ that reader i buys or reads newspaper n, we can write paper n's readership as $\sum_{i \in I} x_n^i$.

2.3 Advertisers

Advertisers are interested in reaching ad-receptive readers. They care about how many people read the papers where they advertise. They also care about the news reporting strategy in these papers, because news affects how readers respond to ads and hence the return to advertising. In 2.5 below, we present a microeconomic foundation for the following reduced-form utility of advertisers with an induced distaste for reporting on topics that reduce readers' ad-receptiveness. Each of J advertiser types is characterized by a distaste vector $t^j \in [0,1]^K$ defining its utility from advertising in paper n,

$$\sum_{i \in I} x_n^i \left(1 - \sum_{k=1}^{K} t_k^j r_{n,k}\right) - q_n^j, \tag{1}$$

(see 2.5 for the case ($t < 0$) where advertisers instead value accuracy). We assume that these utilities are additively separable across newspapers, so advertiser j chooses to advertise in paper n (denoted $y_n^j = 1$) if it gives non-negative utility, and otherwise j chooses not to advertise there ($y_n^j = 0$). To study variation in the numerical importance of advertising relative to readers, we assume that there are α^j advertisers of type j. Below we also study an advertiser size parameter, a^j.

We can now state the objective function for newspaper n,

$$\sum_{i=1}^{I} p_n x_n^i + \sum_{j=1}^{J} \alpha^j q_n^j y_n^j. \tag{2}$$

This implicitly assumes a trivial marginal cost of reporting and printing for a newspaper paying the fixed costs of maintaining its network of reporters, editors and news sources; see Baron (2006).[10]

2.4 Timing

We study the following four stage game (motivated below): In **stage 1** newspapers set their reporting strategies; In **stage 2**, newspapers set the copy

[10]For instance, a paper buying access to the bundle of news stories from Reuters or Associated Press then selects which stories to include and which to exclude. Marginal costs of increased reporting and accuracy have little substantive impact on our results.

price charged to readers; In **stage 3**, readers buy newspapers; In **stage 4**, newspapers and advertisers negotiate over advertising prices and quantities. In each case, all players observe the outcomes of all previous stages before acting.[11] We solve for subgame perfect equilibria. To simplify the exposition, we assume $1 - \sum_{k=1}^{K} t_k^j \geq 0$, $\forall j \in J$; this implies that it is always attractive to advertise in a paper n, even if it reports fully accurately on all topics ($r_{n,k} = 1, \forall k$). We also assume that efficient bargaining leads to sharing in a ratio $\rho : 1 - \rho$ between newspapers and advertisers, where $\rho \in (0,1)$.[12] So $y_n^j = 1, \forall n, j$, and the advertising price is a fraction ρ of the surplus, as captured in the following lemma.

Lemma 1 *Newspapers charge advertising prices given by*

$$q_n^j = \rho \sum_{i \in I} x_n^i \left(1 - \sum_{k=1}^{K} t_k^j r_{n,k} \right)$$

and all advertisers buy ads in all papers, $y_n^j = 1, \forall j \in J, n \in N$.

2.5 Interpretation

Reporting strategies (r) are best understood as measures of how newspapers report on average over an extended period of time. So newspapers take time to build up a reputation for reporting in a certain way. This is why newspapers set r at stage 1 in the above time ordering (each paper n sets its reporting strategy r_n). One interpretation of r is based on "accuracy". Newspapers can select stories and adjust news presentation to generate bias (see e.g., Mullainathan and Shleifer, 2005, for a micromodel in which newspapers "slant" their reports by selectively suppressing certain types of facts). For instance, a newspaper might report on the environment whenever a scientist makes statements suggesting that global warming is minimal, and omit news

[11] This time ordering is standard. It is only important that r is set in advance - see motivation below; simultaneity of stages 2, 3 and 4 would slightly complicate the derivations, but not change our results.

[12] This sharing rule can readily be derived as the outcome of standard non-cooperative bargaining. Notice that newspapers compete for readers (who by construction seek at most one paper), but that advertiser preferences are additively separable across newspapers.

suggesting global warming is a serious risk. Newspapers can thereby choose how much to bias reporting in a particular direction (e.g., towards under- or over- estimation of the risk of global warming). Our model generalizes this to the multi-dimensional case: we interpret $1 - r_k$ as the degree of bias on topic k in a particular direction. For instance, with global warming as topic k, $1 - r_k$ represents the degree to which a paper under-estimates the global warming risk.[13] A second, related, interpretation of r is based on "intensity". Newspapers select the frequency, length, prominence (e.g., frontpage headline), and persistence with which they report on given topics.

The nature of advertisers' induced preferences is an empirical question. Here, we sketch a foundation for the above preferences. Advertisers do not care about news reporting *per se*, but they do care about the impact of news on reader behavior. Consider the intensity interpretation of r. Reporting intensity can affect reader behavior in two ways, one temporary, the other more permanent. First, news reporting can affect readers' moods and attitudes *while* reading the paper and coming across its ads;[14] for instance, a newspaper report on animal rights can activate anti-cosmetics attitudes, so that readers are unreceptive to ads of cosmetics companies (if believed to practice animal testing); Baker (1994) and Bagdikian (2000) give consistent evidence that advertisers often choose to avoid advertising alongside depressing reports. Second, newspapers play a significant role in shaping their readers' *long-term* attitudes and beliefs; for instance, when a newspaper frequently reports on animal rights, pro-animal attitudes become chronically accessible to its readers, again possibly reducing the effectiveness of advertising cosmetics in that paper (see Chaiken et al., 1996); Cialdini (1993) directly emphasizes the influential power of message repetition; Baker (1994) reports how Estée Lauder declined to advertise in the magazine *Ms.*, arguing that *Ms.* was not

[13] Allowing the opposite bias ($r_k > 1$) makes no difference, as papers never want to go against the tastes of both readers and advertisers. To study biased readers, $r_k = 1$ could instead represent readers' preferred bias. Note that if advertisers valued accuracy ($t < 0$), they would then help de-bias news.

[14] We refer to Isen et al. (1978) and Forgas (1995) for psychological work on mood and Petty and Cacioppo (1986) on attitude change, but the introductory quotation of Le Lay provides a good caricature of the idea.

portraying the sort of "kept-woman mentality" (Lauder's words) that Lauder was trying to sell.

More specifically, we assume advertisers make profits m per unit sold, where m is the markup over unit cost. Let $z^{i,j}$ denote the expected quantity of goods purchased by reader type i from advertiser j. Since reader i comes across j's ad through paper n only if $y_n^j = 1$, we can write

$$z^{i,j} = \bar{z}^{i,j} + \sum_{n \in N} x_n^i \left(1 - \sum_{k=1}^{K} t_k^j r_{n,k}\right) y_n^j,$$

where $\bar{z}^{i,j}$ is an ad-independent component. The key assumption is that advertising raises consumption, but to a lesser extent if the paper carrying the ad contains a lot of reporting on sensitive topics.[15] Notice that no consumer reads the same ad twice (since each reader buys at most one paper), and that we assume reporting intensity affects responsiveness to the ad in a linear fashion. Advertisers get revenue from selling goods (whose prices we assume to be fixed). Their production costs are implicit in the markup m, a fixed cost F, and the advertising costs $q_n^j y_n^j$. We can thus write advertiser j's overall profit function as

$$\begin{aligned}
&\sum_{i \in I} \bar{z}^{i,j} + \sum_{i \in I} \sum_{n \in N} x_n^i \left(1 - \sum_{k=1}^{K} t_k^j r_{n,k}\right) y_n^j - \sum_{n \in N} q_n^j y_n^j - F \\
&= \bar{z}^{j} + \sum_{n \in N} \left(\sum_{i \in I} x_n^i \left(1 - \sum_{k=1}^{K} t_k^j r_{n,k}\right) - q_n^j \right) y_n^j - F
\end{aligned}$$

where $\bar{z}^{\cdot j}$ is the aggregated ad-independent component and we normalize the markup m to 1. This implies the reduced form of Equation (1).

The accuracy interpretation of r has similar implications for advertiser news preferences. For instance, when a newspaper's biased reporting induces readers to under-estimate the risk of global warming,[16] advertisers know that

[15] This assumption is also vindicated in an extension of Anderson and McLaren's (2005) model with Bayes rational readers, provided readers do not know how much hard information is available to the advertisers and newspapers.

[16] See DeMarzo, Vayanos and Zwiebel (2003) for a formal model analyzing how biased reporting distorts people's beliefs when some readers are boundedly rational. Repetition is key; see also Hawkins and Hoch (1992) on the "truth effect" in psychology.

these readers are less likely to develop beliefs that cars are harmful; so biased reporting can make readers more receptive to ads for cars, while accurate (or unbiased) reporting reduces the advertising payoff of car manufacturers.

A third possible interpretation is that r represents the "complexity" or "depth" of reporting. As suggested in the introductory quotation of Le Lay, critical thinking may distract people from advertisements and therefore make them less receptive to ads; see also Neisser (1979) for psychological evidence. This view suggests that t would be positive on a very broad range of topics, so we can use it to explain the general "dumbing down" of coverage mentioned in the introduction. It could also generate a trend towards more entertainment and superficial programming, but we suspect this factor is more relevant in other media outlets, such as television.

The durable effects of news reporting on people's beliefs and attitudes can explain why firms and governments might also care about a newspaper's reporting strategy independently of whether they advertise there. The news strategy affects how readers respond to ads and opportunities encountered elsewhere. In particular, it can affect how people vote and whether they pressure for regulation of an industry or a monopolistic company. We analyze these advertising-independent effects in Section 5.

3 Monopoly

In this section, we present the benchmark case of a monopoly newspaper market ($N = 1$).[17] Until the more general analysis of Section 7, we focus on the case with one type of advertiser and one topic ($J = K = 1$) which is of interest to all readers ($s^i > 0 \ \forall i \in I$), but to which advertisers are sensitive ($t > 0$). Our goal is to understand how the newspaper's equilibrium reporting level varies with the importance (α) of advertising. Substituting the advertising prices from Lemma 1 into the monopolist's objective function,

[17] An alternative benchmark for the case of two competing newspapers is that of a monopolist controlling two papers; we discuss this case below, but the single paper monopolist proves to be the most relevant for our analysis in Section 5.

Expression (2), gives the monopolist's reduced-form profit function:

$$\pi(p,r) = \sum_{i=1}^{I} px^i(p,r) + \rho\alpha \sum_{i=1}^{I} x^i(p,r)(1-tr) \tag{3}$$

The first term represents reader revenue (from selling copies) and the second term represents advertising revenue (from selling ad space). The tradeoff in choosing r is straightforward: the paper pleases readers by raising r and pleases advertisers (for a fixed readership) by lowering r; the only complication is that advertisers want the paper to have a high readership. It helps to define,

$$r^i_{min} = \frac{b^i}{s^i}, \tag{4}$$

the minimal level of accuracy that enables a newspaper to retain type i readers at $p = 0$.[18]

When $\alpha = 0$, the monopolist maximizes accuracy to please readers, but when α becomes large, the advertising revenue term dominates and the monopolist focuses on pleasing the advertiser; this drives accuracy downwards. In the following simple example (repeated for the competitive context below), the monopolist ends up lowering r to the minimal level that attracts all readers. Note that in all the examples, we assume a 50:50 sharing rule between newspaper(s) and advertisers, that is, $\rho = \frac{1}{2}$.

Example 1 There are two reader types, $(s^1, b^1) = (1, \frac{3}{8})$, $(s^2, b^2) = (\frac{1}{8}, 0)$, and α advertisers of type $t = \frac{1}{2}$. When α is small ($\alpha < 0.97$), readers determine accuracy; the paper selects maximal accuracy ($r = 1$) and sets a copy price of $p = \frac{5}{8}$. This extracts the full surplus from type 1 readers, while type 2 readers are priced out of the market. As α increases, the monopolist starts to earn more from advertising and is increasingly tempted to please advertisers by reducing r while increasing readership. When α reaches 0.97, the newspaper cuts r from 1 to $\frac{3}{7}$ and simultaneously cuts p to $\frac{3}{56}$ so that all readers buy the paper. When α reaches 4, the newspaper further reduces

[18] Recall that, except for Section 6, copy prices are always assumed to be nonnegative.

accuracy to $r = \frac{3}{8}(= r^1_{\min})$ and price to $p = 0$; again all readers buy. Since it is impossible to further reduce accuracy without losing readers, this is the equilibrium outcome for all α large ($\alpha \geq 4$). See Figure 1. $\square$

The general case is similar. First, accuracy is always full when $\alpha = 0$, since the monopolist then has no opportunity cost (lost advertising revenue) of increasing accuracy and can extract at least part of the increased reader surplus. Second, accuracy always falls, for sufficiently large α, to the minimal level $r^i_{\min}$ needed to attract some reader i at $p = 0$, since the monopolist eventually focuses on maximizing advertiser surplus, minimizing r subject to retaining a sufficient audience for advertisers.[19]

Proposition 1 *For α sufficiently small, a monopolist reports fully accurately, $r = 1$. For α sufficiently large, it sets $p = 0$ and reduces accuracy to the minimal level, $r = r^{\hat{\imath}}_{min} < 1$, sufficient to attract reader type $\hat{\imath}$, where $\hat{\imath} = \arg\max_{i \in I} \pi(0, r^i_{min})$.*

An immediate corollary is that if all readers have zero reservation values ($b^i = 0 \ \forall i \in I$), sufficiently large α leads the monopolist to reduce accuracy to zero. In general, however, it faces a tradeoff between reducing r to raise advertiser surplus per reader, and increasing r to increase readership. For instance, if advertising from car and energy companies are sufficiently important to a monopoly newspaper, the paper may under-report on global warming or bias its environmental reports to suggest that risks are minimal. Omitting this topic altogether, or biasing all reports to claim a zero risk, is rare because such a paper would lose credibility. We capture this credibility factor in the model through positive reservation values b_i.

Of course, if people have no way to judge or detect the degree of bias, papers can distort news arbitrarily and readers cannot reward papers for accuracy. The model would then predict extreme bias $r = 0$ for any $\alpha > 0$,

[19] The alternative benchmark of a two paper monopolist is slightly different: when α is low, such a monopolist may differentiate its papers to price discriminate, so even $\alpha = 0$ does not guarantee full accuracy for all readers; when α is high, it may differentiate its papers to lower the average of the accuracy levels accepted by readers, so advertising no longer drives all prices to zero.

but that is an extreme case. Readers usually have access to some external sources of information. So, over time, they get at least some idea of the degree to which newspapers under-report. Our assumption that readers observe r perfectly captures this in an extreme way. Since advertisers have more at stake, they will often learn to observe r more effectively than do (most) readers. Introducing such a difference in observation of r would increase the impact of advertising beyond that suggested by advertising's fraction of newspaper revenue.

The simple lesson from Proposition 1 is that advertisers affect news content through a market price mechanism. There is no free-riding problem among advertisers: they do *not* undersupply pressure for reducing r in the hope that other advertisers will apply that pressure in their place. To see this note that were advertisers able to agree on their strategies cooperatively in stage 5, they would behave as a single advertiser of size $a = \alpha$, whose utility from advertising in paper n is given by $a\left[\sum_{i\in I} x_n^i \left(1 - \sum_{k=1}^{K} t_k r_{n,k}\right)\right] - q_n$. Lemma 1 is then trivially adjusted: the paper would charge this advertiser a price of $q_n = \rho a\left[\sum_{i\in I} x_n^i \left(1 - \sum_{k=1}^{K} t_k r_{n,k}\right)\right]$. Substituting $a = \alpha$ reveals that the monopolist's profit function and hence reporting choice are exactly as before.[20]

4 Duopoly

In this section we analyze duopoly newspaper markets ($N = 2$). (We retain the above parametric assumptions.) We begin with the case of homogeneous readers where competition for readers is so direct that papers give full accuracy regardless of α. We then analyze how reader heterogeneity may permit vertical differentiation (see the multi-topic case of Section 7 for horizontal differentiation). In this setting, we derive our paradoxical result that increasing the number or size of advertisers may actually improve the reporting accuracy

[20] Advertisers get a selective benefit from advertising in newspapers that under-reports, so newspapers can implicitly charge advertisers for under-reporting. Reporting outcomes would only change if collusion or size increased advertisers bargaining or commitment power – see Section 5.

of competing newspapers.

4.1 Homogeneous Readers

Reader homogeneity precludes market segmentation. Bertrand price-setting generates perfect competition for readers, who therefore get what they want, namely full accuracy at zero prices.

Proposition 2 *For any $\alpha > 0$, in a duopoly with only one reader type, the unique subgame perfect equilibrium has full accuracy and zero prices, $r_n = 1$ and $p_n = 0$ for $n = 1, 2$.*

This full accuracy result is important because it shows how effective competition can be in preventing bias. It follows from the following lemma.

Lemma 2 *Under the assumptions of Proposition 2, the unique subgame perfect equilibrium of any subgame starting at a profile of reporting strategies (r_1, r_2), where $r_1 \neq r_2$, has all readers going to the newspaper with the higher level of accuracy.*

Both the lemma and the proposition do depend on the homogeneity assumption for small and intermediate values of α, however, when α is sufficiently large, this Bertrand-type competition and the lemma hold more generally as we now show.

4.2 Heterogeneous Readers

With heterogeneous readers, advertising can have a non-monotonic effect on accuracy in a duopoly. When α is small, the newspapers differentiate their reporting strategies to soften the price competition for readers. So increasing α initially leads to lower accuracy as a monopolistic reaction by at least one of the papers. However, when α becomes sufficiently large, the value to each paper of winning an additional reader is so high that market segmentation is no longer possible. Intense competition for readers forces the papers to raise accuracy to its maximal level (and set minimal copy price). We illustrate this non-monotonicity in the case with vertical differentiation by adding a competing newspaper to Example 1. Then we generalize the example.

Example 2 This is identical to Example 1, except that now $N = 2$ instead of 1 (i.e., add one paper, so $I = 2$, $J = K = 1$; $(s^1, b^1) = (1, \frac{3}{8})$, $(s^2, b^2) = (\frac{1}{8}, 0)$; $t = \frac{1}{2}$). For α small ($\alpha < 0.97$), the newspapers vertically differentiate their reporting strategies to soften competition for readers. The high accuracy newspaper is fully accurate and charges a higher price than its competitor. Figure 2 shows how increasing α initially leads the low accuracy paper to reduce its accuracy to maintain market segmentation, and then, when α exceeds 0.5 to reduce its accuracy to zero to raise advertiser profits (the local monopoly response). Then when α gets too large ($\alpha \geq 0.97$), market segmentation becomes impossible. (The accurate paper has an incentive to compete for the low quality paper's readers.) In the intense competition for readers that follows, the unique subgame perfect equilibrium has newspapers setting full accuracy and zero copy prices. $\square$

To generalize this example with vertical differentiation, we introduce a notion of reader diversity.

Definition 1 *Two reader types $(s^i, b^i) \in [0, 1]^2$, $i = 1, 2$, are* **diverse** *if the indifference curves yielding their respective reservation utility levels (b^1 and b^2) intersect in (r, p) space at some $r \in (0, 1]$ and $p > 0$. Two reader types are* **strongly diverse** *if they are diverse and $s^i - b^i > 2(s^{-i} - b^{-i})$ holds either for $i = 1, -i = 2$ or $i = 2, -i = 1$.*

The strong diversity condition (which is satisfied in Example 2) is sufficient to ensure that papers can segment the market for small α.

Proposition 3 *In a duopoly:* **(a)** *if there are two reader types and they are strongly diverse, then for sufficiently small α, subgame perfect equilibria involve vertical differentiation, with at least one newspaper providing less than full accuracy;* **(b)** *sufficiently large α always leads to full accuracy and zero prices in both papers.*

This result does not depend on the number of advertisers – the effect is identical for the case with a single advertiser that gets very large; that is, one can replace α with a. So the result is somewhat paradoxical: increasing the advertiser's size eventually leads to full accuracy even though the advertiser prefers minimal accuracy. The competition intensity effect of advertising that drives the result is straightforward and intuitive.[21] Nonetheless, we now show that the result is overturned when advertisers have sufficient commitment power.

5 Advertisers Revisited

Many advertisers are sufficiently long-lived to build up reputations for withdrawing their custom from "unfriendly" media outlets; see for instance, footnote 6 on Coca-Cola's rejection of NBC after NBC aired a critical documentary. To ensure that the wasteful punishments (foregone advertising) only occur out of equilibrium, advertisers usually get in contact with newspaper editors during the editorial process; such contacts are usually informal but see page 4 for the explicit Chrysler case. Advertisers may even tacitly coordinate on a general business norm of avoiding media that are insufficiently business-friendly.

In this section, we analyze how advertisers can use such commitment power to influence newspaper reporting. We motivate a simple model of this commitment mechanism that captures in reduced-form the dynamic process by which advertisers build commitment reputations (alongside newspapers building reporting reputations). We then derive its implications and extend the results to explain how any actor that represents a significant source of media revenue (not just from advertising custom) can influence the media.

[21]The result is fundamentally about competition and not the number of papers: a monopolist owning two newspapers would minimize accuracy on both papers when advertising gets sufficiently large (as in Section 3).

5.1 Adding Stage 0: Advertisers with Commitment

We now add a stage 0 (just before newspapers fix their reporting strategies) at which advertisers can commit to withhold advertising custom from newspapers that breach a given level of accuracy on a sensitive topic. This is the natural threat strategy: at stage 0, each advertiser announces a cut-off level of accuracy $\bar{r}^j$, for $j \in J$, which commits them to set $y_n^j = 0$ if $r_n > \bar{r}^j$. We refer to this as the **model with commitment**.[22] Our goal is to investigate whether commitment can allow large advertisers to escape the competition logic that led to full accuracy as α or $a \to \infty$ in the duopoly case.

Consider first a single advertiser of size a that sets $\bar{r} < 1$. Lemma 1 is slightly adjusted, because now $y_n^j = 0$ if $r_n^j > \bar{r}^j$. For large a, there is a subgame perfect equilibrium of the continuation game with $r_n = \bar{r}$ and $p_n = 0$ for $n = 1, 2$, because competition is intense for r_n restricted to $[0, \bar{r}]$, and deviating outside this range is dominated for large a, since it generates zero advertising revenue.[23] So, how will the advertiser set $\bar{r}$? For a fixed readership, the advertiser surplus is decreasing in $\bar{r}$, hence the advertiser minimizes $\bar{r}$ subject to the problem of satisfying $r_{\min}^i$ for enough readers. In the limit as a becomes large, reader profits become relatively insignificant, so the advertiser's tradeoff approaches that of the monopolist in Proposition 1.

When instead there is a large number (α) of advertisers of the same type, advertisers face a minor coordination problem. If enough advertisers set the optimal level of $\bar{r}$, then the papers will accept this restriction and setting $r = \bar{r}$ is optimal. However, if all other advertisers make weaker threats, the papers will set $r > \bar{r}$ and the advertiser setting $r = \bar{r}$ will not advertise at all. The advertisers effectively play an "assurance game" at stage 0. It is

[22] Alternative commitment models – e.g., direct negotiation with newspapers over r and commitments that raise $1 - \rho$ – also generate our key results. Newspaper-specific cut-offs ($\bar{r}_n^j$) *do* imply subtle changes, but are less plausible: advertisers often build (cut-off) reputations ($\bar{r}^j$) relevant to the widest group (all newspapers) or even follow a norm ($\bar{r}$) of avoiding all newspapers that contravene a generic "business-friendly" standard.

[23] There is also a subgame perfect equilibrium with $r_n = 1$ and $p_n = 0$ for $n = 1, 2$, but this is Pareto dominated for the newspapers (and for advertisers); so the outcome with $r_n = \bar{r}$ and $p_n = 0$ is more plausible.

Pareto optimal for them to all set $r = \bar{r}$.

Proposition 4 *For sufficiently large α or a, in a duopoly with commitment, there exists a subgame perfect equilibrium with accuracy restricted as in the monopoly case, $r_n = \bar{r} = r^{\hat{\iota}}_{min}$, $n = 1, 2$, as in Proposition 1.*

We find that advertisers' optimal cut-offs gradually become more extreme as the importance of advertising (α and a) grows. Our ongoing example provides a useful illustration.

Example 3 Adding stage 0 to Example 2 generally has a negative impact on accuracy. As α increases, advertisers can make increasingly stringent demands on newspapers. In particular, for low and intermediate α, accuracy on the high quality newspaper 1 is set at the optimal cut-off level $r = \bar{r} = \frac{2(2-\alpha)}{4-\alpha}$, which may even fall below the monopoly level without cut-offs. Market segmentation now becomes impossible already at $\alpha = 0.63$, (again newspaper 1 has an incentive to deviate by charging lower prices), but instead of jumping up to 1, r now goes to $\bar{r} = 0.81$, and prices fall to zero. Accuracy on both papers is now determined by $r = \bar{r} = \frac{2(2-\alpha)}{4-\alpha}$, (which coincides with the expression for the segmented case), until it hits the limiting monopoly value, $r^{\hat{\iota}}_{min} = r^1_{\min} = \frac{3}{8}$, and stays there for all $\alpha \geq 1.54$; newspaper prices stay at zero. See Figure 3. □

5.2 Other Channels of Influence

As motivated at the end of Subsection 2.5, businesses and governments may care about news reporting even when they are not advertising in a given newspaper. To capture this possibility, we add a utility term of

$$\sum_{i \in I} x^i_n \left(1 - \sum_{k=1}^{K} T^j_k r_{n,k}\right)$$

for each actor of type j, *independent* of whether it advertises ($y^j_n = 1$) in paper n (hence the absence of the price term q^j_n). The advertising-independent distaste vector $T^j \in [0,1]^K$ captures concerns such as politicians wanting to have news biased in their favor and large companies wanting to avoid criticism that might generate regulatory pressure or damage their reputations. Even if $t^j = 0$, we find that actors of type j can influence news content if they are sufficiently important.

The recent case of the largest Spanish electricity company, Endesa, is illustrative. After a recent spate of reports in the Spanish newspaper, La Vanguardia, criticizing Endesa's service quality and price, Endesa began paying for a costly supplement in La Vanguardia. Observers claim that, while ostensibly a form of advertising, this is actually a hidden subsidy and it came accompanied by a threat of withdrawal had La Vanguardia continued its negative reporting. Our model captures their argument as follows: Endesa subsidizes a supplement worth A to La Vanguardia (n) provided $r_n \leq \bar{r}$ – i.e., Endesa commits to set $Y_n = 0$ if $r_n > \bar{r}$. Endesa's threat is as effective as that of an advertiser with surplus worth $\frac{A}{\rho}$ ($2A$ for the 50:50 case) in Proposition 4.

There are many ways to generate the subsidy A. The recent scandal of a government report candidly discussing media influence by politicians in Spain and Catalonia offers a useful case study. First, central and regional governments make *explicit subsidies* (e.g., several major dailies receive very large subsidies from the Treasury and Social Security). Second, *mass subscriptions* generate an additional, hidden subsidy. For instance, the Catalan News Agency that supplies news stories to TV and other media gets 40% of its subscriptions from public institutions (compared to only 27% for clients other than the Catalan Television Corporation). *Cheap credit* from public (and private) institutions is the third main channel for effective subsidy.

Ownership, control rights (e.g., to appoint directors), and censorship are more direct mechanisms of influence, but the subtlest forms of influence are particularly problematic since they may go unnoticed. Our theoretical result (Proposition 4) applies to this case and suggests that large media subsidies may need to be regulated to prevent interference with the provision of accurate news. Two further mechanisms that restrict news reporting are "flak" (newspapers are threatened by legal costs when sued) and the power of news sources (such as businesses, governments and officials) to control access to information; see Dyck and Zingales (2003). In all cases, the downward pressure on reporting is particularly problematic when readers' willingness to pay for news is less than its social value, as is common when readers have difficulty assessing news quality and when information has a strong public good aspect (e.g., in public elections, stock market decisions, stakeholder activism).

6 Negative Prices

For the sake of completeness, we here address the case where negative pricing is feasible.[24] By allowing newspapers to compete on a broader range of prices, this averts the need to use accuracy when the competition for readers becomes extreme. When advertisers are sufficiently important, newspapers focus on pleasing advertisers by minimizing accuracy; their advertising revenue allows them to set a negative price that "bribes" readers to buy their paper in place of a more accurate rival one.

6.1 Monopoly

The possibility of negative pricing requires only a slight change in Proposition 1: increasing the importance of advertising now *always* leads a monopolist to reduce accuracy to zero; even when readers have positive reservation values, it is profit-maximizing to offer them a negative price, rather than raise accuracy.

Proposition 5 *If a monopoly newspaper is able to offer negative prices, then when α is sufficiently large, accuracy falls to zero and prices are just low enough to attract all readers, $r = 0$ and $p = \min\{-b_1, \ldots, -b_I\} \leq 0$.*

6.2 Duopoly

Allowing duopolists to charge unbounded negative prices, overturns the competition paradox identified in Section 4. Competition for readers is just as

[24] Negative prices should not be taken literally; for example, they capture the effect of bundling the newspaper with a valuable coupon.

intense, but newspapers now can, and for sufficiently significant advertising always will, compete for readers by lowering copy price instead of raising accuracy. The reason is that the increase in advertising surplus from lowering accuracy (used to subsidize the payments to readers) eventually dominates the reader disutility from reduced accuracy. The newspaper with lower accuracy therefore ends up winning all the readers. So Lemma 2 is inverted.

Lemma 3 *For sufficiently large α, in a duopoly with negative pricing, the unique subgame perfect equilibrium of any subgame starting at a profile of reporting strategies (r_1, r_2), where $r_1 \neq r_2$, has all readers going to the newspaper with the lower level of accuracy.*

As a result, intense competition now leads papers to minimize accuracy at $r = 0$ and set (negative) prices that pass on advertising surplus to readers.

Proposition 6 *For sufficiently large α, in a duopoly with negative pricing, all subgame perfect equilibria have zero accuracy and readers are subsidized, $r_n = 0$ and $p_n = -\rho\alpha < 0$, for $n = 1, 2$.*

The newspapers just break even in equilibrium, but accuracy is minimized instead of maximized, so advertisers are much better off than in the case with bounded pricing. However, notice a major caveat: if using coupons to attract readers involves distortions (in the sense that coupons cost more to the paper than they are worth to the readers), it may become optimal to compete on accuracy as well as negative prices. Indeed, the results of Section 4 are reestablished if readers' values from coupon expenditures are sufficiently concave.[25]

7 Multiple Topics and Advertiser Types

In this section we consider the cases of monopoly and duopoly in a market with two reader types and two or more advertiser types and topics. To

[25] On the other hand, if attractive coupons induce readers to buy (*and* read) both newspapers, each newspaper eventually acts monopolistically (and minimizes accuracy).

simplify the boundary case analysis, we assume $b^i = 0$, $s_k^i > 0$ and $t_k^j < 1$ for all $i \in I, k \in K, j \in J$. It is then easy to prove that all our results generalize to the case with multiple topics and advertiser types except that heterogeneity of large advertiser types could potentially weaken the power of cut-off strategies.

7.1 Monopoly

The only difference here is a slight increase in realism in that, with multiple topics, monopolists can charge a positive copy price at arbitrarily large α, provided important advertisers do not dislike all the topics. Proposition 1 generalizes to:

Proposition 7 *If α^j is sufficiently small for all $j \in J$, a monopolist reports fully accurately on all topics, $r_k = 1$ for all $k \in K$. Since $r_{\min}^i = 0$ for all i, the level of accuracy is zero on any topic disliked by sufficiently many advertisers, $r_k = 0$ if $t_k^j > 0$ for any $j \in J$ with α^j sufficiently large.*

7.2 Duopoly

The multiple topic case permits horizontal as well as vertical differentiation; market segmentation becomes even easier. However, it is unsustainable when advertisers are large.

Example 4 Consider the case with three topics, two reader types with $((s_1^1, s_2^1, s_3^1), b^1) = \left(\left(\frac{2}{3}, \frac{1}{4}, \frac{1}{4}\right), 0\right)$ and $((s_1^2, s_2^2, s_3^2), b^2) = \left(\left(\frac{1}{4}, \frac{1}{4}, \frac{2}{3}\right), 0\right)$, and one advertiser type with $(t^1, t^2, t^3) = (0, \frac{3}{4}, 0)$. Horizontal differentiation occurs for any $\alpha < 0.83$. Each paper specializes in reporting fully accurately on one of the two topics (1 and 3) that particularly interest readers. In addition, they also both report fully accurately on topic 2 (charging a monopolistic price of $\frac{11}{12}$) until α reaches 0.5, and at $\alpha = 0.5$, they both cut accuracy on topic 2 to zero (and cut p to $\frac{2}{3}$) to raise advertising profits. When α is large ($\alpha \geq 0.83$), product differentiation is impossible and the papers report with full accuracy on all topics and set zero prices.

Adding stage 0, commitment by advertisers again permits them to gradually force reporting on topic 2 down to zero while the market is segmented. When it is no longer possible to sustain product differentiation, accuracy (and the cut-off levels set by the advertisers) jump up to $\bar{r}_2 = 0.44$ and again gradually drop down to zero. Figure 4 presents the accuracy levels on topic 2 in both cases; accuracy on topic 2 is generally below the level in the no-commitment case. □

Lemma 2 and Propositions 3 and 4 all extend.

Proposition 8 *In a duopoly, if α^j is sufficiently large for some $j \in J$, then the unique subgame perfect equilibrium has $r_n = 1$ and $p_n = 0$ for $n = 1, 2$.*

Any sufficiently important advertiser provokes a fully accurate subgame perfect equilibrium, until we introduce advertiser commitment power.[26] Sufficient importance of advertising then takes us back to the monopoly case provided that the large advertisers share a common concern.

Proposition 9 *In a duopoly with commitment, if there is one large advertiser type, say j, (i.e., where α^j and $\frac{\alpha^j}{\alpha^{j'}}, j' \neq j$, are all sufficiently large), then there is a subgame perfect equilibrium where all papers set zero accuracy on any topic disliked by the large advertiser, $r_k = 0$ if $t_k^j > 0$.*

In summary, the commonalities of large advertisers combine additively in the results based on ad space pricing, but advertiser differences can inhibit coordinated use of cut-off threats.

[26]This result relies on the assumption that both readers have a single ideal point in terms of reporting strategy, i.e., all readers prefer (possibly weakly) $r = 1$ to anything else. For the more general, symmetric preferences, $s^i, t^j \in [-1, 1]^K, i \in I, j \in J$, our full accuracy equilibrium may not be subgame perfect and market segmentation may be sustainable even with large α. Similarly, one can escape Gabszewicz et al.'s (2001) pensée unique convergence result. So, except for the fact that our model is linear rather than quadratic, this framework generalizes both Gabszewicz et al. (2001) and Mullainathan and Shleifer (2005). We leave a fuller analysis to future research.

8 Concluding Remarks

Under the assumption of an unbiased readership, we developed two main ideas. First, we saw how, even without commitment power, advertisers can affect news reporting, because monopolistic newspapers appropriate a share of advertising surplus and therefore internalize advertiser concerns; competitive newspapers nonetheless report accurately in this setting. Second, we saw how any actor generating substantial income for the newspaper can affect news reporting if able to commit to withhold its custom or funding, contingent on undesirable reporting.

Our theory has clear policy implications. First and foremost, it shows how media competition can prevent harmful effects of advertising on news reporting, thus contributing to the debate on optimal merger policy in the media market (see e.g., Anderson and McLaren, 2005).[27] Second, it indicates that allowing governments and businesses to pay direct or indirect subsidies to newspapers generates a serious risk of news bias.[28] Third, it suggests that regulators should be concerned by the growing prevalence of newspapers that bundle their papers with coupons and gifts; bundling permits a form of negative pricing that softens competition on reporting and therefore reduces reporting quality in equilibrium. Finally, the analysis is relevant for the debate on funding of public television, such as the BBC. Publicly-funded stations do not need (and are often not allowed) revenues from advertising; this would avoid the type of content distortions analyzed here. Future work should extend and complete the model to tie down precise welfare implications from a consumer or electoral perspective.[29]

[27] This competitive market objective requires particular attention when newspapers need advertising to cover their fixed costs; see Ferrando et al. (2004) and also Baker (1994), Bagdikian (2000) and McChesney (2000) on how advertising may then lead to a concentrated media market.

[28] Those who argue that businesses should not be able to make financial contributions to political parties (to avoid political influence) would support bans on newspaper subsidies by a parallel logic.

[29] The notion that, from a welfare perspective, readers do not demand enough information in a market setting is based on the standard view that an informed citizenry is a public good. Anderson and McLaren (2005) offer a formalization of this idea. Strömberg's (2001 and 2004) theoretical and empirical analysis is also pertinent: politicians are more respon-

As Glaeser (2004) points out, "Psychology...tells us that people are very susceptible to influence...[but] it doesn't tell us what people will be told." Our framework analyzes what papers will say to their readers. We show that the answer depends on what the papers are selling beyond news: if primarily selling ad space, they will supply ad-friendly news content, unless competition for readers forces them to supply accurate news.

Clearly, the preferences of the agents and their actual impact on media content are an empirical matter. Our results are consistent with the empirical study of Reuter and Zitzewitz (2006), but more precise tests are feasible. Advertisers' induced news preferences are central to the first set of results (where advertising generates bias in a pure market context with unbiased readers and profit-maximizing newspapers), so our framework suggests that empirical work should estimate the sensitivity (and correlation) of advertisers' preferences over the news that is bundled with their ads as well as the financial value of ad contracts and the competitiveness of the newspaper market. Our second set of results (those based on advertisers' cut-off commitments) indicate the further need to measure all types of newspaper "subsidy". Thanks to the growing empirical literature on the estimation of media bias,[30] we are optimistic that it will soon be possible to test our specific predictions and better evaluate the impact of advertising (and other non-reader revenues) on actual media content.

Appendix

Proof of Lemma 1. This follows immediately from our assumptions. □

Proof of Example 1. Given any level of accuracy, r, the monopoly newspaper has essentially three possible pricing strategies, namely, to charge the highest price that attracts both readers, one reader, or no reader. One way to compute the values of the example is to compute the optimal r for each

sive to voters with better access to news; newspapers cater most to the news interests of the readers most valued by advertisers; see also Baker (1994) and Hamilton (2004).

[30]See Groseclose and Milyo (2005) and Reuter and Zitzewitz (2006) for two recent examples.

of the three cases as a function of α, and then to see which level of r (with corresponding price) maximizes profits, again as a function of α. $\square$

Proof of Proposition 1. Reporting strategy r and copy price p are chosen at stages 1 and 2 to maximize the continuation payoff $\pi(p, r)$ defined in Equation (3). When $\alpha = 0$, we get full accuracy ($r = 1$), because marginally raising r permits to raise p at a rate of at least $\min_{i \in I} s_i > 0$ and has no cost. As α increases, raising r begins to have a cost, but as long as α is small, the benefits from raising p dominate.

For large α, we first prove that $r = r^i_{\min}$ for some $i \in I$. Suppose to the contrary that $r \in \left(r^{i_1}_{\min}, r^{i_2}_{\min}\right)$ for some pair of reader types, i_1 and i_2 with consecutive values of $r_{\min}$. By reducing r towards $r^{i_1}_{\min}$ and reducing p by $\max_{i \in I} s^i$ times the reduction in r, the paper avoids losing any readers and it increases its advertising revenue at the rate $\rho \alpha t \sum_{i=1}^{I} x^i(p, r)$, while only decreasing reader revenue at the rate $\max_{i \in I} s^i \sum_{i=1}^{I} x^i(p, r)$. Since $\rho, t > 0$, for sufficiently large α, the gain in advertising revenue dominates the lost reader revenue. This contradicts the optimality of the above r. The same argument applies for $r > \max_{i \in I}\{r^i_{\min}\}$. Moreover, clearly $r < \min_{i \in I}\{r^i_{\min}\}$ cannot be optimal since it would lead to zero profits, when positive profits are possible. This proves the claim.

Now, given $r = r^i_{\min}$, if $p > 0$, reducing p to 0, strictly increases readership by at least 1 (by definition, the readers i with $r^i_{\min} = r$ start buying when $p = 0$) and this raises advertising revenue by at least $\rho\alpha(1 - tr)$ which again dominates the loss in reader revenue of $\sum_{i=1}^{I} p x^i(p, r)$ for sufficiently large α (notice that $1 - tr > 0$ by the assumption in Subsection 2.4). The monopolist's profits are therefore given by $\pi(0, r^i_{min})$ and i is chosen to maximize this. Hence $i = \hat{\imath}$ as stated. $\square$

Proof of Lemma 2. Without loss of generality, assume that at stage 1, newspaper 2 sets $r_2 < r_1$, and $sr_1 > sr_2 \geq b$ (otherwise, if $sr_2 < b$, there is no demand for newspaper 2 in any continuation game, and the claim is trivially true). We show that there is a unique SPE of this continuation game and that newspaper 1 wins all the readers. Essentially, this follows as in standard Bertrand competition, where both newspapers seek to undercut each other. Here, since $r_2 < r_1$, for any price $p_2 \geq 0$, 1 can always win all readers by offering a price marginally below $p_2+s(r_1-r_2)$ (the price at which the readers are indifferent between buying from 1 rather than buying from 2 at p_2). In particular, for any $p_2 \geq 0$, 1 can always find a price at which it wins all the readers. This is not true for player 2: since prices are assumed nonnegative, the lowest price 2 can charge is $p_2 = 0$ and so, unless $p_1 > s(r_1-r_2)$, 2 cannot undercut 1. Hence 1 will set $p_1 \leq s(r_1-r_2)$. Moreover, from $sr_2 \geq b$, we have $sr_1-b \geq s(r_1-r_2)$, which guarantees that buying at p_1 is individually rational for readers. Hence, if the inequality is strict and $p_1 < s(r_1-r_2)$, 1 can always increase profits by raising p_1 marginally. It follows that $p_1 = s(r_1 - r_2)$ and $p_2 = 0$ is the unique continuation SPE. Also, $x_1 = 1$ here, because otherwise 1 would marginally reduce p_1 to win over the $1 - x_1$ remaining readers. □

Proof of Proposition 2. If newspapers set $r_1 = r_2$, then Bertrand price competition generates zero prices. If one paper sets a positive price, the other paper can either set a higher price and get no readers, set the same price and get some fraction of the readers, or win all the readers by setting a lower price. Since a paper without readers makes no profits, and at least one paper can sharply increase its readership and profits by setting a marginally lower price than its competitor's, competition drives prices down to zero.

Using Lemma 2, given any pure strategy of, say, paper 1 with $r_1 < 1$, the other paper's response is to set r_2 marginally higher, thus taking all the readers and leaving 1 with no profits: if 2 sets $r_2 < r_1$, it gets no profits whereas it is guaranteed positive profits if it sets $r_2 > r_1$. Furthermore, $r_2 = r_1 < 1$ cannot be an equilibrium, because at least one paper could marginally raise r and sharply increase its readership (and advertising profits if $\alpha > 0$) and marginally increase reader revenue. The equilibrium with $r_1 = r_2 = 1$ and zero prices is the only possible one, since given $\alpha > 0$ both papers make profits (a positive number of readers leads to positive advertising profits – we assume readers randomize when the papers are identical) and so neither is willing to set a lower value of r since it would lead to zero readers and zero overall profits. □

Proof of Example 2. The proof closely follows that of Proposition 3 below. For α small, papers set accuracy levels $(r_1, r_2) = (1, \frac{6-2\alpha}{7})$; the decreasing level of r_2 reflects the fact that it is increasingly tempting for paper 1 to compete with paper 2 and segmentation can only be sustained at a lower level of accuracy of the low quality paper 2. As α continues to increase, it becomes increasingly attractive for paper 2 to decrease accuracy until at $\alpha = 0.5$ it is better off setting $r_2 = 0$ and $p_2 = 0$, and deriving all profits from advertising while still attracting type 2 readers. Since $r_2 = 0$ now, a segmentation equilibrium is easier to sustain and paper 1 can extract the full surplus from high type readers. However, as α continues to increase, 1 is further tempted to decrease accuracy in order to capture higher revenues from advertising. Going through all the possible deviations of paper 1, it can be verified that, from $\alpha = 0.97$ on, segmentation is no longer sustainable, and the only SPE is the fully competitive one (with full accuracy and zero prices). $\Box$

Proof of Proposition 3. Part **(a)**. Suppose $\alpha = 0$ and readers are strongly diverse with, say, $(*)$ $s^1 - b^1 > 2\,(s^2 - b^2)$. We will refer to type 1 readers as the high types and type 2 readers as the low types. The general idea of the segmentation equilibrium is that one of the newspapers targets the high reader types with higher accuracy and higher prices, while the other paper mostly targets low reader types with lower accuracy and lower prices. More specifically, we claim that there exists $\hat{r} < 1$ such that $(r_1, r_2) = (1, \hat{r})$ and conversely $(r_1, r_2) = (\hat{r}, 1)$, are the only pure SPE reporting outcomes. To show this, we first characterize the SPE of the continuation game given such a profile $(1, \hat{r})$ or $(\hat{r}, 1)$, and then prove that none of the papers have an incentive to deviate in the first stage. (It is easy to see that if both papers set $r < 1$, the one with higher r always has an incentive to raise r.) Without loss, we consider $(1, \hat{r})$ and refer to paper 1 as the high quality paper and to paper 2 as the low quality paper.

Recall that $s_i r - b_i - p = 0$ defines reader i's indifference curve at which i is indifferent between buying a paper of accuracy r at price p and not buying any paper; $s_i r - b_i$ is also the highest (individually rational) price at which i is still willing to buy a paper of accuracy r, $i = 1, 2$. By linearity, the diversity condition implies that these two indifference curves intersect in (r, p)-space at some $(r^0, p^0) \in (0, 1)^2$. Suppose now that the low quality paper sets accuracy r^0 while the other sets accuracy 1. By $(*)$ if the low quality paper charges

p^0, then the high quality paper is not interested in competing for low reader types, moreover, the low quality paper's subgame perfect continuation payoff is $p^0 = s_2 r^0 - b_2$, since it exactly wins all the low types when it charges p^0. (Notice that, at such a profile $(1, r^0)$, the continuation SPE involves a mixed strategy pricing equilibrium, where paper 2 charges prices on the interval $[\frac{p^0}{2}, p^0]$, while paper 1 charges prices on the interval $[s_1 - b_1 - \frac{p^0}{2}, s_1 - b_1]$.) It follows that in the first stage, while the high quality paper will set accuracy equal to 1, the low quality paper will want to increase its accuracy level above r^0 up to the point where the high type paper starts to compete for low type readers. This occurs at $r_2 = \hat{r}$. We characterize $\hat{r}$ and the continuation SPE and then show that paper 2 does not want to increase r_2 beyond this level.

To define $\hat{r}$, consider the high type reader indifference curve through the point $(1, 2(s_2 - b_2)) \in [1] \times (0, 1)$; by assumption this curve is to the south-east of the curve $s_1 r - b_1 - p = 0$, and any point on it is strictly better (for the high type readers). Let $(\hat{r}, \hat{p})$ denote the point in (r, p)-space at which this curve intersects the low type readers' curve $s_2 r - b_2 - p = 0$. Again, by assumption, we have $(\hat{r}, \hat{p}) \in (0, 1)^2$ and $\hat{r} > r^0$. (It is easy to check that $\hat{p} = s_2 \hat{r} - b_2$ and $\hat{r} = \frac{s_1 - 2s_2 + b_2}{s_1 - s_2}$.) The point $(\hat{r}, \hat{p})$ has the characteristic that it involves the highest level of accuracy of the low quality paper such that if it charges the price $\hat{p} = s_2 \hat{r} - b_2$ the other (high quality) paper is exactly indifferent between charging $2(s_2 - b_2)$ and serving type 1 readers alone or charging $s_2 - b_2$ and serving both types of readers. (Notice that the points $(1, 2(s_2 - b_2))$ and $(1, s_2 - b_2)$ lie on the indifference curves of respectively type 1 and 2 readers through $(\hat{r}, \hat{p})$.)

We now characterize continuation SPE following $(1, \hat{r})$. By construction, paper 2 will not set a price higher than $\hat{p}$ since it would lose the low type readers; consequently paper 1 will not set a price above $2(s_2 - b_2)$ since it will lose the high type readers. Furthermore, paper 2 will not set a price below $\hat{p}/2$ since it can make at most $2(\hat{p}/2) = \hat{p}$ if it gets all readers at $\hat{p}/2$, while it can guarantee the same amount by serving only low type readers at that $\hat{p}$ (notice that, again by construction, paper 1 is not interested in competing with paper 2 for low type readers); consequently paper 1 will not set a price below $2(s_2 - b_2) - \hat{p}/2$. The supports of the continuation equilibrium are thus contained in $[2(s_2-b_2)-\frac{\hat{p}}{2}, 2(s_2-b_2)]$ and $[\frac{\hat{p}}{2}, \hat{p}]$ for papers 1 and 2 respectively. Since paper 1 is competing to retain high reader types and is never competing for low reader types, while paper 2 is competing for high reader types while always serving low reader types, the expected payoffs are $2(s_2-b_2)-\hat{p}/2$ for paper 1 and $\hat{p}$ for paper 2. The mixed strategy equilibrium is defined (and uniquely determined) by the following two equations

$$\hat{p} = \int_{2(s_2-b_2)-\frac{\hat{p}}{2}}^{p_2+s_1(1-\hat{r})} p_2 dF_1(p_1) + \int_{p_2+s_1(1-\hat{r})}^{2(s_2-b_2)} 2p_2 dF_1(p_1)$$

$$2(s_2-b_2)-\frac{\hat{p}}{2} = 0 + \int_{p_1-s_1(1-\hat{r})}^{\hat{p}} p_1 dF_2(p_2),$$

which must hold for all (p_1, p_2) in the intervals mentioned and can in turn be unambiguously solved for paper 1 and 2's respective distribution functions over prices, F_1 and F_2. (Using $\hat{p} = s_2\hat{r} - b_2$, the above equations lead to

$$F_1(p_1) = 2 - \frac{s_2\hat{r} - b_2}{p_1 - s_1(1-\hat{r})} \quad \text{and} \quad F_2(p_2) = 1 - \frac{s_2(4-\hat{r}) - 3b_2}{2(p_2 + s_1(1-\hat{r}))},$$

holding for (p_1, p_2) on the interior of the intervals defined above, which using $\hat{r} = \frac{s_1-2s_2+b_2}{s_1-s_2}$ can be further solved to obtain overall distribution functions and which may contain mass points at the boundary of the intervals.) In summary, the profile $(1, \hat{r})$ leads to a continuation equilibrium with payoffs of $2(s_2-b_2)-\frac{\hat{p}}{2}$ and $\hat{p}$ to papers 1 and 2 respectively.

It remains to show that paper 2 has no incentive to increase its level of accuracy. Suppose it does, then a new type of mixed strategy pricing equilibrium follows, where paper 1 competes for the low reader types (this follows from the construction of $\hat{r}$). This is turn leads to decreasing payoffs for paper 2, since it can no longer guarantee the low type readers at $s_2r_2-b_2$, and instead only obtains a payoff of $x(r_2) < \hat{p}$ (whenever $r_2 > \hat{r}$), obtained as the value of x which solves the following equation

$$s_1r_2 - \left(1 - \frac{2(x + s_2(1-r_2))}{s_1}\right) = s_2r_2 - \left(1 - \frac{x + s_2(1-r_2)}{s_2}\right).$$

The point $(r_2, x(r_2))$ plays an analogous role to $(\hat{r}, \hat{p})$ in that, when paper 2 charges $x(r_2)$ at r_2, paper 1 is indifferent between serving high reader types or competing for both reader types at half the price and a related mixed strategy pricing equilibrium can be constructed. (Notice however that now the mixed equilibrium involves paper 1 mixing on two disjoint intervals, namely, around a high price that only attracts high reader types and around a lower price attracting both reader types.)

Finally, for $\alpha > 0$ sufficiently small, the same logic goes through due to the continuity of the papers' payoffs in α.

Part **(b)**. As α increases further, the incentive to capture all readers increases. The segmentation equilibrium in (a) eventually becomes unsustainable, because for sufficiently large α, the paper with higher r would want to compete to take all the readers. Once segmentation is ruled out, there is no equilibrium with $r_1 \neq r_2$, because in such equilibria the low r paper makes zero profits by the same logic as in Lemma 2. Furthermore, because all elements in the support of the equilibrium distribution over levels of accuracy must have equal expected payoff, there are no mixed strategy equilibria involving positive mass on levels of accuracy below 1. Hence, the unique SPE has $r_1 = r_2 = 1$ and zero prices as in Proposition 2. □

Proof of Proposition 4. Given any $\bar{r} \in [0, 1]$ and α sufficiently large, there is a SPE with $r_n = \bar{r}$, $n = 1, 2$ and zero prices. By setting $r > \bar{r}$, a paper gets all the readers, but even the full reader surplus is less than the $\frac{\varrho}{2}$ of the advertising surplus guaranteed from getting half the readers at $\bar{r}$. This is the unique continuation equilibrium given $\bar{r}$, because lower r_n's are ruled out by the logic of Lemma lemma:bert. With α sufficiently large, the advertisers choose $\bar{r}$ to maximize their surplus $((1-\rho)\sum_{i \in I} x_n^i(0, \bar{r})(1-t\bar{r}))$ at $r_{min}^{\hat{\iota}}$, since the monopolist's objective at $(\bar{r}, 0)$ only differs by $\frac{\rho\alpha}{1-\rho}$ times the advertiser surplus . Notice that in the limit, the equilibrium of this proposition Pareto dominates all the other ones for both advertisers and newspapers. □

Proof of Example 3. The proof is as with Example 2, except now optimal cut-offs need to be computed. At $\alpha = 0$ we have the same situation as in Example 2, but this changes as soon as α is positive. The advertiser can choose to bound the level of accuracy and computes the lowest level of accuracy $\overline{r}$ that makes paper 1 indifferent between choosing r_1 with the corresponding continuation SPE with no revenues from advertising, and a strategy $\overline{r}$ with corresponding continuation SPE and revenues from advertising. This gives the downward sloping curve $\overline{r} = \frac{2(\alpha-2)}{\alpha-4}$ which is also the level of accuracy paper 1 chooses; paper 2 chooses a similar strategy as in Example 2. Further, as α increases, paper 1 is increasingly tempted to lower its level of accuracy to capture more advertising revenues, and, already at $\alpha = 0.63$, the segmentation equilibrium is no longer sustainable. From here, the only equilibrium is again the fully competitive one, where now the level of accuracy is bound by the cut-off level set by the advertiser. That bound is determined by the condition that none of the papers have an incentive to set accuracy to 1 to capture all readers and make revenues from readers alone through high accuracy. This gives the same downward sloping curve $\overline{r} = \frac{2(\alpha-2)}{\alpha-4}$ as above. Finally, as this bound reaches $\overline{r} = \frac{3}{8}$ (at $\alpha = 1.54$), it can no longer decrease, since type 1 readers would otherwise be lost. Hence, from $\alpha = 1.54$ on, the competitive equilibrium entails $r_n = \frac{3}{8}$, $n = 1, 2$, which is the same level of accuracy set by the monopolist (for large α) but here at zero prices. □

Proof of Proposition 5. The proof is similar to the case of Proposition 1 with the difference that now a monopolist can set negative prices. It is now possible to lower r to 0 and retain all the readers by setting a price of $p = \min\{-b_1, \dots, -b_I\} \leq 0$. For large α, the bounded cost $(-p)$ of attracting readers in this way is worth paying, because the advertising surplus even on just one reader is so high. Furthermore, the marginal reduction in reader subsidy permitted by a marginal increase in r is dominated by the loss in advertising surplus. Thus, for α sufficiently large, the paper will set $r = 0$ and set $p = \min\{-b_1, \dots, -b_I\} \leq 0$ so as to capture all readers. At this price all readers either strictly or weakly prefer to read the newspaper and newspaper profits are given by $(\rho\alpha + p)I \gg 0$ $\forall$ large α.□

Proof of Lemma 3. Without loss of generality, assume that at stage 1, newspapers set $r_2 < r_1$, and $sr_1 > sr_2 \geq b$ as before. In stark contrast to Lemma 2, we show that newspaper 2 now wins all the readers. This follows by Bertrand competition with the important difference that now prices are not bounded from below. Newspapers continue to undercut each other as long as they can make positive profits. Since $s > 0$, the newspaper with the lower level of accuracy (here paper 2) is the one that can win the readers, because its greater advertising "subsidy" dominates the reader disutility from its accuracy deficit. More precisely, let $\underline{p}_n(r_n)$ denote the lowest price paper n with accuracy r_n can charge (as monopolist) and break even. (Notice that $\underline{p}_n(r_n) = -\rho\alpha(1-tr_n)$.) Clearly, neither paper will ever charge a lower price, and, since $r_2 < r_1$, we have $\underline{p}_2(r_2) < \underline{p}_1(r_1)(< 0)$. Moreover, for α sufficiently large, for any $p_1 \geq \underline{p}_1(r_1)$, paper 2 can always gain by undercutting paper 1 by just enough to take the entire market. This is not the case for newspaper 1. In the unique continuation SPE, newspaper1 competes as far as it can by setting $p_1 = \underline{p}_1(r_1)$ and newspaper 2 wins the whole market $x_2 = 1$, by setting $p_2 = p_1 - s(r_1 - r_2) - x_2$ must equal 1, otherwise paper 2 would marginally reduce p_2 to win over the $1 - x_2$ remaining readers.□

Proof of Proposition 6. If newspapers both set $r = r_1 = r_2$, then Bertrand price competition will lead to zero profits and to all papers being sold at the lowest sustainable price, namely, $\underline{p}(r)$ equals the lowest price a newspaper with $r = r_1 = r_2$ can charge and break even (this coincides with $\underline{p}_1$, $\underline{p}_2$ of Lemma 3 where now $\underline{p}(r) = \underline{p}_1(r) = \underline{p}_2(r) = -\rho\alpha(1 - tr)$). This is true regardless of how demand is split between two papers that charge the same price. A paper selling at a price higher than $\underline{p}(r)$ can be profitably undercut.

Using Lemma 3, (and parallel to Proposition 3(b)), given any pure strategy of, say, paper 1 with $r_1 > 0$, the other paper's response is to set r_2 marginally lower, thus taking all the readers and leaving 1 with no profits. Furthermore, $r_2 = r_1 > 0$ cannot be an equilibrium, because either paper could marginally decrease its accuracy and sharply increase readership and revenues (since α large). Again, because all elements in the support of the distribution must have the same expected payoff, there are no mixed equilibria with positive mass on accuracy levels $r_n > 0$, $n = 1, 2$. Hence the equilibrium with $r_1 = r_2 = 0$ and prices $p_1 = p_2 = \underline{p}(0) = -\rho\alpha$ is the only possible one. □

Proof of Proposition 7. The proof is almost exactly as in Proposition 1, because we can study variations in r_k for a single topic at a time. The multiple advertiser types pose no problem for the results about large α^j because reducing r_k weakly raises revenue from all advertiser types. However, the zero price result would no longer hold if we allowed there to be some topics k that are not disliked by any large advertisers (i.e., $t_k^j = 0$ for all the advertisers j with $\alpha^j \to \infty$). $\square$

Proof of Example 4. The proof follows from analogous computations to the ones of Examples 2 and 3. (Detailed proofs are available from the authors upon request.) $\square$

Proof of Proposition 8. This result extends Proposition 3(b). The idea of the proof is very similar. Take a stage 1 profile $(r_1, r_2) \leq 1$ with $r_1, r_2 \neq 1$, (r_1 and r_2 are now vectors), and suppose without loss that the subgame perfect continuation payoff for newspaper 1 is greater or equal to that of newspaper 2. We show that 2 then has an optimal deviation to set $r_2' \geq r_1$ with $r_2' \neq r_1$ (for any $\alpha > 0$). So the two papers drive accuracy up to $r_n = 1$ in any subgame perfect equilibrium. To see this, fix $r_1 \leq 1$ with $r_1 \neq 1$ and consider the payoff function of newspaper 2,

$$\sum_{i \in I} p_2 x_2^i + \sum_{j \in J} \rho \alpha^j \left(\sum_{i \in I} x_2^i \left(p_2, r_2\right) \sum_{k \in K} \left(1 - t_k^j r_{2,k}\right) \right)$$

since $\bar{r}^j = 1$ and $t^j \in [0,1)^K$, $j \in J$. The numbers of readers are characterized by the following lemma, which extends Lemma 2.

Lemma 4 *If, under the assumptions of Proposition 8, we have $r_2' \geq r_1$ and $r_2' \neq r_1$, then newspaper 2 captures all the readers, (i.e., $\sum_{i \in I} x_2^i(p, r_1, r_2') = 2$ and $\sum_{i \in I} x_1^i(p, r_1, r_2') = 0$).*

> To see this, notice that because there are no reservation values for readers and $s_k^i > 0$ for all $k \in K, i \in I$, newspaper 2 can attract all the readers by charging sufficiently low prices. Since α^j is large for at least one advertiser, it will be in newspaper 2's interest to charge a lower price to capture all the readers. $\square$

Now, given r_1, if newspaper 2's continuation payoff at r_2 is less than or equal to newspaper 1's payoff, 2 would gain by deviating to some r_2' sufficiently close to r_1 with $r_2' \geq r_1$ and $r_2' \neq r_1$. This gives almost the same advertising profits as paper 1 scaled up by the total number of readers divided by the original number of readers of paper 1; the scale factor exceeds unity and advertising revenues dominate reader revenues; paper 2 would be getting more than paper 1 had. Hence there is no subgame perfect equilibrium with either $r_n \leq 1$ and $r_n \neq 1$. To see that the profile $(r_n, p_n) = (1, 0)$, $n = 1, 2$, is part of a subgame perfect equilibrium, notice that by Lemma 4, newspapers cannot have a profitable deviation by changing the level of accuracy since they would get zero readers and hence zero profits. At $r_1 = r_2 = 1$, prices charged in stage 2 will again be zero, as the argument of the proof of Proposition 2 (see second paragraph) applies here as well. □

Proof of Proposition 9. Under the stated assumptions, one can effectively neglect all but one advertiser. This result immediately extends Proposition 4. The proof uses Proposition 8 (in place of Proposition 3) to verify that $r = \bar{r}^j$ and zero pricing constitutes the unique SPE for sufficiently large α^j. □

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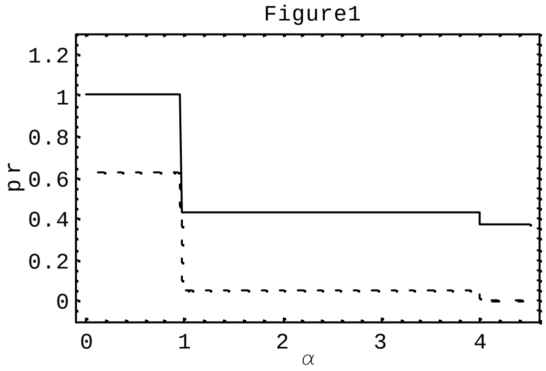
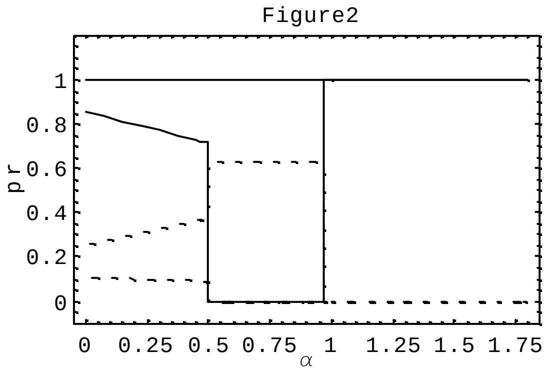
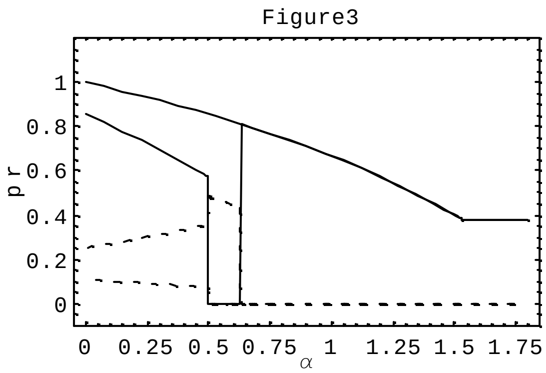
Example 1 : Monopoly accuracy (solid line) and reader prices (dashed line)



Example 2 : Duopoly accuracy (solid lines) and reader prices (dashed lines)



Example 3 : Duopoly accuracy (solid lines) and reader prices (dashed lines) with cutoffs



Example 4 : Duopoly accuracy on topic 2 without cutoffs (solid line)
and with cutoffs (dashed line)