The Market for News

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We investigate the market for news under two assumptions: that readers hold beliefs which they like to see confirmed, and that newspapers can slant stories toward these beliefs. We show that, on the topics where readers share common beliefs, one should not expect accuracy even from competitive media: competition results in lower prices, but common slanting toward reader biases. On topics where reader beliefs diverge (such as politically divisive issues), however, newspapers segment the market and slant toward extreme positions. Yet in the aggregate, a reader with access to all news sources could get an unbiased perspective. Generally speaking, reader heterogeneity is more important for accuracy in media than competition per se. (*JEL* D23, L82)

Several recent books have accused mainline media outlets of reporting news with a heavy political bias. Bernard Goldberg (2002) and Ann Coulter (2003) argue that the bias is on the left, and provide numerous illustrations of their argument, while Eric Alterman (2003) and Al Franken (2003) argue that the bias is on the right, with equally numerous illustrations. In principle, media bias can come from the supply side, and reflect the preferences of journalists (David Baron, 2004), editors, or owners (Besley and Andrea Prat, 2004; Simeon Djankov et al., 2003). Alternatively, it can come from the demand side, and reflect the news providers' profit-maximizing choice to cater to the preferences of the consumers. We examine, theoretically, the determinants of media accuracy in such a demand-side model, focusing specifically on the effects of reader beliefs, reader heterogeneity, and competition on media bias. We argue that the analysis of media accuracy relies crucially on how one conceptualizes the demand for news.

In the traditional conception of the demand for news, consumers read, watch, and listen to the news in order to get information. The quality of this information is its accuracy. The more accurate the news, the more valuable is its source to the consumer. Pressure from audiences and rivals forces news outlets to seek and deliver more accurate information, just as market forces motivate auto-makers to produce better cars.[1]

This conception of the news as a source of pure information is dramatically different from that of noneconomists studying the media. According to these scholars, private media want to sell newspapers and television programs, as well as advertising space. To do that, they provide a great deal of pure entertainment. But even with news, audiences want their sources not only to inform but also to explain, interpret, persuade, and entertain. To meet this demand, media outlets do not provide unadulterated information, but rather tell stories that hang together and have a point of view, what is referred to in the business as "the narrative imperative."[2]

[1] Ronald Coase (1974), Besley and Robin Burgess (2002), Besley and Prat (2002), Djankov et al. (2003), David Stromberg (2001), and Alexander Dyck and Luigi Zingales (2002) all advance this view of competition in the media as delivering greater accuracy.

[2] H. L. Mencken (1920), Walter Lippmann (1922), Samuel Hayakawa (1940), Michael Jensen (1979), Doris Graber (1984), James Hamilton (2003), and the standard

In this view, news provision can be analyzed in the same way as entertainment broadcasting.[3]

In this paper, we examine these two conceptions of what the consumers want and what the media deliver, and evaluate media accuracy under different scenarios. We show, in particular, that these two conceptions have radically different implications for the accuracy of news in the competitive media, and more specifically on the question of which news issues will be reported more accurately.

Our model of rational readers seeking information shows that, indeed, consistent with economists' priors, media reporting is unbiased. We compare this to a specific behavioral model (of which the rational consumers are a special case), which relies on two assumptions, one about reader preferences and one about the technology of delivering news.[4] We assume that readers hold biased beliefs, which might come from their general knowledge and education, from previous news, from prejudices and stereotypes, or from the views of politicians or political parties they trust. With respect to preferences, we assume that readers prefer to hear or read news that is more consistent with their beliefs. Such biased readers might believe, for example, that corporate executives are cheats and crooks, and these readers prefer news about their indictments to news about their accomplishments. They might think that China is up to no good with respect to the United States, and appreciate stories about Chinese spies. Some readers might like President Bill Clinton and prefer to read about partisan Republicans persecuting the hard-working president; others might dislike Clinton and look for stories explaining, in salacious detail, the impeachability of his offenses.

The idea that people appreciate, find credible, enjoy, and remember stories consistent with their beliefs is standard in the communications literature (Graber, 1984; Severin and Tankard, 1992). Basic research in psychology strongly supports it. Research on memory suggests that people tend to remember information consistent with their beliefs better than information inconsistent with their beliefs (Frederic Bartlett, 1932). Research on information processing shows people find data inconsistent with their beliefs to be less credible and update less as a result (Charles Lord et al., 1979; John Zaller, 1992; Matthew Rabin and Joel Schrag, 1999). According to Graber (1984, p. 130), "stories about economic failures in third world countries were processed more readily than stories about economic successes." People seek information that confirms their beliefs (Josh Klayman, 1995). When people categorize, they tend to ignore category-inconsistent information unless it is large enough to induce category change (Susan Fiske, 1995; Mullainathan, 2002). Severin and Tankard (1992) see the demand for cognitive consistency as crucially shaping which news people listen to, and which they ignore.

Our second assumption is that newspapers can slant the presentation of the news to cater to the preferences of their audiences. The term "slanting" was introduced by Hayakawa (1940), and defined as "the process of selecting details that are favorable or unfavorable to the subject being described." Slanting is easily illustrated in a simple example. Suppose that the Bureau of Labor Statistics (BLS) releases data that show the rate of unemployment rising from 6.1 percent to 6.3 percent. What are the different ways a paper can report this number? One is a single sentence report that simply presents the above fact. But there are alternatives. Consider just two.

(a) *Headline: Recession Fears Grow.* New data suggest the economy is slipping into a recession. The BLS reports that the number of unemployed grew by 200,000 in the last quarter, reaching 6.3 percent. John Kenneth Galbraith, the distinguished Harvard economist, sees this as an ominous sign of the failure of the administration's policies. "Not since Herbert Hoover has a president ignored economic realities so blatantly. This news is only the beginning of more to come," he said. (Accompanying picture: a

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communications textbook (Werner Severin and James Tankard, Jr., 1992) all advance this view of news.

[3] Entertainment broadcasting is analyzed by Peter Steiner (1952), Michael Spence and Bruce Owen (1977), Ronald Goettler and Ron Shachar (2001), and Esther Gal-Or and Anthony Dukes (2003). Jean Gabszewicz et al. (2001) take the approach closest to ours by conceptualizing news provision in a Hotelling framework. They examine how advertisers have an impact on content, whereas we focus on media accuracy.

[4] For concreteness, we talk about newspapers, although our argument applies equally well to television and radio.

long line for unemployment benefits in Detroit, Michigan.)

(b) *Headline: Turnaround in Sight.* Is the economy poised for an imminent turnaround? Data from the BLS suggest that it might be. Newly released figures show unemployment inching up just 0.2 percent last quarter. Abbie Joseph Cohen, the chief stock market strategist at Goldman Sachs, sees the news as highly encouraging. "This is a good time to increase exposure to stocks," she says, "both because of the strong underlying fundamentals and because the softness in the labor market bodes well for corporate profitability." (Accompanying picture: smiling Abbie Joseph Cohen.)

Each of these stories could easily have been written by a major U.S. newspaper. In fact, stories like these, in light of public disclosure of identical facts, are written every day. Neither story says anything false, yet they give radically different impressions. Each cites an authority, without acknowledging that a comparably respectable authority might have exactly the opposite interpretation of the news. Each omits some aspect of the data: the first by neglecting to mention the starting point of the unemployment rate, the second by ignoring unemployment levels. Each uses a headline, and a picture, to persuade readers who do not focus on the details. Each, in other words, slants the news by not telling the whole truth, but the articles are slanted in opposite directions.[5]

Our model of the market for news combines the assumption of readers preferring stories consistent with their beliefs with the assumption that newspapers can slant stories toward specific beliefs. We examine two crucial aspects of this environment. First, we consider two alternative assumptions about the nature of competition: monopoly versus duopoly. Our model of media competition is analogous to a Hotelling model of product placement (Jean Tirole, 1988, ch. 7). Newspapers locate themselves in the product space through their reporting strategies (i.e., how they slant). Readers' beliefs determine their "transportation" costs, since they face psy-

chic costs of reading papers whose reporting does not cater to their beliefs. We ask whether competition by itself eliminates or reduces the slanting of news, as economists often argue. We show that the answer for biased readers is clearly *no*. Competition generally reduces newspaper prices, but does not reduce, and might even exaggerate, media bias.

Second, we study heterogeneity of reader beliefs. What effect does such heterogeneity have on the nature of slanting and the overall accuracy in media? What is the impact of competition on media accuracy when reader beliefs are heterogeneous, as in the case of beliefs about President Clinton? To answer this question, it is crucial to distinguish between an average reader, who reads one source of news, and a hypothetical conscientious reader, who reads multiple sources. In general, competition with heterogeneous readers increases the slanting by individual media sources. But with heterogeneous readers, the biases of individual media sources tend to offset each other, so the beliefs of the conscientious reader become more accurate than they are with homogeneous readers. Our central finding is that reader heterogeneity plays a more important role for accuracy in media than does competition.

At a broader level, this paper contributes to one of the central issues in economics, namely whether the presence of rational, profit-maximizing firms eliminates any effect of irrational participants on market "efficiency." In the context of financial markets, Milton Friedman (1953) argued long ago that it does, and that rational arbitrageurs keep financial markets efficient. Subsequent research, however, has proved him wrong, both theoretically and empirically (Shleifer, 2000; Markus Brunnermeier and Stefan Nagel, 2004). One finding of this research is that, in some situations, such as stock market bubbles, it might pay profit-maximizing firms to pump up the tulips rather than eliminate irrationality (Brad DeLong et al., 1990). Subsequent research has considered the interaction between biased individuals and rational entrepreneurs in other contexts, such as the incitement of hatred (Glaeser, 2005), political competition (Kevin Murphy and Shleifer, 2004), and product design (Xavier Gabaix and Laibson, 2004). Here we ask a closely related question for the market for news: does competition among profit-maximizing news providers

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[5] Persuasion can also work through outright fabrication of news, as was done routinely by the Communist press, and occasionally even in Western newspapers (e.g., Jason Blair's reporting for the *New York Times*.)

eliminate media bias? We find that the answer, in both financial and political markets, is *no*. Powerful forces motivate news providers to slant and increase bias rather than clear up confusion. The crucial determinant of accuracy is not competition, per se, but consumer heterogeneity.

I. Model Setup

Readers are interested in some underlying variable t, such as the state of the economy, which is distributed $N(0, v_t)$. Let $p = 1/v_t$ denote the precision. Readers hold a belief about t that may be biased; beliefs are distributed $N(b, v_t)$. Thus, readers are potentially biased about the expected value of t, but have the correct variance.

Newspapers are in the business of reporting news about t. They receive some data $d = t + \varepsilon$, where $\varepsilon \sim N(0, v_\varepsilon)$. In the example from the introduction, these data might be an unemployment rate release. We assume that the papers then report the data with a slant s, so the reported news is $n = d + s$. For most of the paper, the exact technology of slanting is not important, but in Section V we study a specific one.

A. *Reader Utility*

Suppose readers are rational and unbiased. All they want is information. They dislike slanting because it is costly both in effort and the time it takes to read slanted news and figure out the "truth." In the BLS example, the report of the first newspaper does not tell the reader how much the unemployment rate changed, while that of the second newspaper does not contain the unemployment rate. To get a full picture, the reader needs more information. We assume that a rational reader's utility is decreasing in the amount of slanting. So, if he reads a newspaper, his utility is:

$$(1) \qquad U_r = \bar{u} - \chi s^2 - P$$

where P is the paper's price. If he does not read the newspaper, he receives utility 0.

Biased readers, on the other hand, get disutility from reading news inconsistent with their beliefs. We model consistency as the distance between the news and the reader's beliefs, b, measured as $(n - b)^2$. In the BLS example, a

reader optimistic about the economy experiences disutility when reading stories that suggest a recession. At the same time, even biased readers dislike blatant and extreme slanting, at least in the long run. Holding constant the consistency with beliefs, they prefer less slanted news.[6] So, if he reads the newspaper, the overall utility of a biased reader is:

$$(2) \qquad U_b = \bar{u} - \chi s^2 - \phi(n - b)^2 - P$$

where $\phi > 0$ calibrates his preference for hearing confirming news.

B. *Newspaper Strategy*

Before seeing the data d, a newspaper announces its slanting strategy $s(d)$ and the price P it charges. Potential readers buy the paper if the price P is lower than the expected utility associated with reading the paper, $E_d[U(s(d))]$. To form expected utility, expectations are taken over d and are assumed to be the true expectations ($d \sim N(t, v_d)$) rather than the biased ones. This approach crudely captures the idea that this is a long-run game. Readers get a general sense of how much pleasure the paper provides them and make their purchasing decisions accordingly. It then makes more sense to think of expected utility using the empirical distributions. Practically, in the model both assumptions about expectations produce the same results.

Once readers decide whether to buy the paper, the paper observes its signal d and reports $n = d + s(d)$. Readers read the news and receive their utility. Timing of the full game is as follows:

(a) The newspaper announces a strategy $s(d)$ for how to report the news. When there are two papers, both announce strategies simultaneously.

(b) Price P is announced. When there are two papers, both announce prices simultaneously, after the other paper has revealed its strategy.

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[6] This assumption is immaterial to our results. All we require is that newspapers face some quadratic cost of slanting. This cost could just as easily arise on the supply side, with firms facing a technological or private reputational cost of slanting, and the results would be the same. The necessary feature is that firms cannot slant freely.

(c) Individuals decide whether to buy the paper based on average utility associated with its strategy $s(d)$ and price P.
(d) Newspaper receives data d and reports news $d + s(d)$. If there are two papers, they receive the same data d and report $d + s_j(d)$ where $j = 1, 2$.
(e) If individuals buy the paper, they read the news and receive utility.

C. Cases Considered

We consider two different distributions of reader beliefs: homogeneous and heterogeneous. Homogeneity means that all readers hold the same beliefs b with precision p. For example, all or nearly all readers in the United States might believe that the Russians are corrupt or that the French are anti-American. Heterogeneity means that there is a distribution of reader beliefs. Such heterogeneity could come from political ideology. For example, opinions about U.S. presidents often divide along party lines. We assume that heterogeneous beliefs are distributed uniformly between b_1 and b_2 where $b_1 < b_2$ and $b_2 > 0$. Readers in this uniform distribution are indexed by $i \in [1, 2]$ so that reader i holds belief b_i. All readers hold their beliefs with precision p. We denote by $\bar{b}$ the average of b_1 and b_2. We also denote reader i's utility function as $u_i(d)$ or $u_{b_i}(d)$, depending on context. The homogeneous and heterogeneous cases are designed to capture two different types of issues: ones on which there is consensus in the population and ones where there is substantial disagreement.

We also examine two cases of industry structure. In the first case, there is a single monopolistic newspaper. In the second, there are two newspapers, indexed by $j = 1, 2$, each seeing the same data d. For a monopolist, s^*_{hom} and s^*_{het} denote the optimal slanting strategy for the homogeneous and heterogeneous case. Similarly, P^*_{hom} and P^*_{het} denote optimal price in these cases. For duopolists, $s^*_{j,\text{hom}}$ and $s^*_{j,\text{het}}$ denote the optimal strategy of paper $j = 1, 2$ in the homogeneous and heterogeneous cases, respectively. Similarly, $P^*_{j,\text{hom}}$ and $P^*_{j,\text{het}}$ denote each duopolist's optimal price in these two cases.

This formalism of industry structure is similar in spirit to a Hotelling model. Readers' beliefs resemble consumers' preferred locations. Their dislike of inconsistent news resembles transportation costs. Firms' choice of a slanting rule resembles their choice of location. In this context, our utility function implies quadratic transportation costs and our distribution of reader beliefs in the heterogeneous case corresponds to a uniform distribution of consumers. Consequently, many of our proofs resemble the proofs for the Hotelling models in this case (Claude d'Aspremont et al., 1979).[7]

D. Defining Bias

We are interested in the extent of newspaper bias in the market. We measure this by the average bias of the newspapers in the market, weighted by their market share. In the homogeneous case, where there is only one kind of reader, we simply define bias as

$$(3) \qquad \text{ARB}_{\text{hom}} = E_d[(n - d)^2]$$

where n is the news read by these readers. So bias is defined as the average amount by which the news read deviates from the data for the average reader.

In the heterogeneous case, let n_i be the news read by reader $i \in [1, 2]$. Bias is then defined as:

$$(4) \qquad \text{ARB}_{\text{het}} = \int_i E_d[(n_i - d)^2].$$

This measures the average bias that readers encounter.

II. Rational Readers

When readers are rational, newspapers face only a disincentive to slant. The following proposition summarizes the outcomes for different cases.

PROPOSITION 1: *Suppose readers are rational. Then, whether readers are homogeneous or*

heterogeneous, the monopolist does not slant and charges the same price:

$$(5) \qquad s_{hom}^* = s_{het}^* = 0$$

and

$$(6) \qquad P_{hom}^* = P_{het}^* = \bar{u}.$$

In the duopolist case as well, papers do not slant and once again charge the same price:

$$(7) \qquad s_{j,hom}^* = s_{j.het}^* = 0$$

and

$$(8) \qquad P_{j,hom}^* = P_{j.het}^* = 0$$

for all j on the equilibrium path. The only effect of competition is to lower prices.

PROOF:
   See Appendix for all proofs.

   Proposition 1 illustrates the normal logic of economists' thinking about the media. When readers seek accuracy in news, newspapers pass on, without slant, the information they receive. Since perfect quality is achieved even without competition, the effect of competition is to reduce the price that readers pay. With both monopoly and duopoly, consumers get what they want and there is no media bias.[8] In the rest of the paper, we focus on the case of biased readers.

III. Homogeneous Biased Readers

   The following proposition summarizes the monopolist's behavior with homogeneous readers.

PROPOSITION 2: A monopolist facing a homogeneous audience chooses:

$$(9) \qquad s_{hom}^*(d) = \frac{\phi}{\chi + \phi}(b - d)$$

$$(10) \qquad P_{hom}^* = \bar{u} - \frac{\chi\phi}{\chi + \phi}[b^2 + v_d]$$

if $\bar{u} > [\chi\phi/(\chi + \phi)][b^2 + v_d]$. If not, there exists no slanting strategy that results in the news being read.

   Because the monopolist can capture all surplus through the price he charges, to maximize profits he merely maximizes expected utility. The news he reports is:

$$(11) \qquad n = \frac{\phi}{\chi + \phi}b + \frac{\chi}{\chi + \phi}d.$$

The reported news is a convex combination of bias and data, with weights given by utility parameters. In this case, we say the monopolist "slants toward b." Since this linear slanting strategy will reappear throughout the paper, we define:

$$(12) \qquad s_B(d) \equiv \frac{\phi}{\chi + \phi}(B - d).$$

With this notation, the proposition above can be rewritten as $s_{hom}^*(d) = s_b(d)$. The monopolist chooses this linear form because expected utility functions are separable in the value of d. The monopolist maximizes utility for every given value of d, which leads him to slant toward a biased reader's beliefs.[9]

   The following corollary derives comparative statics for the magnitude of slanting.

COROLLARY 1: In the homogeneous reader case, slanting increases with the reader preference for hearing confirmatory news and declines with the cost of slanting:

$$(13) \qquad \frac{\partial|s_{hom}^*(d)|}{\partial\phi} > 0$$

$$(14) \qquad \frac{\partial|s_{hom}^*(d)|}{\partial\chi} < 0.$$

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[8] As is clear from the proof of the proposition, this result generalizes trivially to $J > 2$ newspapers.

[9] Even when $b = 0$, there is slanting. This is because even a reader who has zero bias ex ante does not want to change his mind ex post. Consequently, the monopolist slants news toward the reader's bias, 0.

Proposition 2 suggests a theory of spin. Suppose that a politician, or some other figure of authority, has a first mover advantage, i.e., can choose which data d gets presented to the media first. The papers slant the data toward reader beliefs, but by Proposition 2, d will have significant influence on what papers report as compared to their getting data from an unbiased source. For example, by preemptively disclosing that a Chinese spy has been found in Los Alamos, a politician can focus the discussion on the risk to U.S. security from Chinese espionage, rather than on the administrative incompetence in the Department of Energy. This effect becomes even more powerful in a more general model of sequential reporting. In this case, the initial spin may shape reader priors, which future papers face and consequently slant news toward. The initial spin would then be reinforced even by ideologically neutral papers.

The condition $\bar{u} > [\chi\phi/(\chi + \phi)][b^2 + v_d]$ guarantees that this reader's reservation utility $\bar{u}$ is high enough that he prefers reading the optimally biased news to no news. From now on, we assume that this condition holds.

ASSUMPTION 1: *Reader utility from news is high enough that readers prefer the equilibrium news to no news:*

$$(15) \qquad \bar{u} > \frac{\chi\phi}{\chi + \phi}[b^2 + v_d].$$

With this assumption in place, we now turn to competition. How does competition between two newspapers affect the results above?

PROPOSITION 3: *Suppose duopolists face a homogeneous audience. Then there is an equilibrium in which duopolists choose on the equilibrium path:*

$$(16) \qquad s^*_{j,\text{hom}}(d) = \frac{\phi}{\chi + \phi}(b - d)$$

and prices

$$(17) \qquad P^*_{j,\text{hom}} = 0$$

for both $j = 1, 2$. Readers are indifferent between the two papers.

With a homogeneous audience, competition is Bertrand-like: it simply drives prices down to zero.[10] Each duopolist's slant is exactly equal to the monopolist's slant, and they split the readers between them. The following corollary summarizes the impact of competition on bias in the homogeneous case.[11]

COROLLARY 2: *For a homogeneous audience, both monopoly and duopoly produce the same amount of average reader bias:*

$$(18) \qquad \text{ARB}_{\text{mon}}(v_d) = \text{ARB}_{\text{duo}}(v_d).$$

Propositions 2 and 3 are the first critical results of the paper. They show that when readers have homogeneous biases, competition does not eliminate them—it only leads to price reductions. Both monopolists and duopolists cater to reader prejudices. These propositions basically say that one cannot expect accuracy—even in the competitive media—on issues where the readers share beliefs. One example of such uniformity might be foreign affairs, where there may be a great deal of commonality of views toward a particular foreign country, such as Russia, China, or France. Another example is law enforcement, where most readers might sympathize with efforts by the government to prosecute members of a disliked group (e.g., the Arabs or the rich).

IV. Heterogeneous Biased Readers

What happens when readers differ in their beliefs? Newspapers must now decide which one of the heterogeneous reader groups is its target audience.

PROPOSITION 4: *Suppose a monopolist faces a heterogeneous audience with $\bar{b} = 0$. There exists a C_m, which depends on the parameters of the model, that determines the monopolist's strategy. If $b_2 - b_1 < C_m$, the monopolist maximizes profits by choosing:*

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[10] For this same reason, and as is clear from the proof of the proposition, this result holds for any number of newspapers $J \geq 2$.

[11] The stated equilibrium for the duopolists is not unique because any strategy profile that differs on a set of measure zero would also be an equilibrium.

$$(19) \quad s^*_{\text{het}} = s_{\bar{b}}(d) = \frac{\phi}{\chi + \phi}(\bar{b} - d) = -\frac{\phi}{\chi + \phi}d$$

$$(20) \quad P^*_{\text{het}} = \bar{u} - \frac{\phi\chi}{\chi + \phi}v_d - \phi^2 b_2^2.$$

If $b_2 - b_1 > C_m$ the monopolist chooses not to cover the market, i.e., not all readers read the paper.

According to Proposition 4, the monopolist covers the market if the dispersion of reader beliefs is small enough. If beliefs are too far apart, readers on either extreme will not read the paper.[12]

Duopolists, in contrast, respond completely differently to heterogeneity. For tractability, we now consider only the situation where duopolists choose linear strategies.

PROPOSITION 5: *Suppose duopolists choose linear strategies of the form $s_B(d) = [\phi/(\chi + \phi)](B - d)$ and that $\bar{b} = 0$. Then there exists a constant*

$$(21) \quad C_d = \sqrt{\frac{4}{33}\left[\frac{\phi + \chi}{\phi^2}\bar{u} - \frac{\chi}{\phi}v_d\right]}$$

such that if $b_2 < C_d$ duopolists choose:

$$(22) \quad s^*_{1,\text{het}}(d) = \frac{\phi}{\chi + \phi}\left(\frac{3}{2}b_1 - d_1\right)$$

$$(23) \quad s^*_{2,\text{het}}(d) = \frac{\phi}{\chi + \phi}\left(\frac{3}{2}b_2 - d_2\right)$$

$$(24) \quad P^*_{j,\text{het}} = \frac{6\phi^2}{\chi + \phi}b_2^2$$

where we assume, without loss of generality,

that firm 1 slants toward the left and firm 2 slants toward the right. All readers read the newspaper.

Each duopolist positions himself as far away from the other as possible. The reported news in this case equals

$$(25) \quad n_j = d + s^*_{j,\text{het}}(d) = \frac{\phi}{\chi + \phi}\frac{3}{2}b_j + \frac{\chi}{\chi + \phi}d_j.$$

The reported news is a weighted average of the actual data d and $\tfrac{3}{2}b_j$, where b_j is the endpoint of the reader bias distribution. So duopolists are slanting news toward $\tfrac{3}{2}b_j$, points that are *more extreme* than the most extreme readers in the population.

This is analogous to the standard Hotelling result with uniform distributions and quadratic transportation costs (Tirole, 1988; d'Aspremont et al., 1979). As in the standard Hotelling model, the monopolist caters to both audiences unless they are too far apart, while duopolists maximally differentiate. But in the standard Hotelling model, firms are constrained to choose within the preference distribution. In our model, they can choose positions outside the distribution of reader bias, and in equilibrium choose very extreme positions.[13]

To see why this occurs, consider a simple case where $\phi = 1$, $\chi = 1$, $b_2 = 1$ and $b_1 = -1$. With these parameters, suppose the firms locate at $z_1 \le z_2$.[14] Equilibrium prices then equal (see the proof of Proposition 5):

$$(26) \quad P_1^*(z_1, z_2) = \Delta z\left(1 + \frac{\bar{z}}{3}\right)$$

$$(27) \quad P_2^*(z_1, z_2) = \Delta z\left(1 - \frac{\bar{z}}{3}\right)$$

where $\Delta z = z_2 - z_1$ and $\bar{z} = (z_1 + z_2)/2$. The more differentiated the duopolists (the greater is

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[12] If $\bar{b} = 0$, but $b_2 - b_1 > C_m$, the monopolist would use the same slanting strategy as in Proposition 4, but would charge a high enough price that not all people read the paper. The case where $\bar{b} \ne 0$ is more complicated. The monopolist would not slant toward $\bar{b}$ anymore. Instead, he would slant toward a point between $\bar{b}$ and 0. This is because readers closer to the origin enjoy higher overall surplus from reading the paper (see Lemma (A1)). Consequently, the monopolist would prefer a distribution of readers closer to the origin so as to be able to charge higher prices.

[13] If $\bar{b} = 0$ but $b_2 > C_d$, the duopolists differentiate less than stated in Proposition 5. The participation constraint of the reader with bias 0 begins to bind and the duopolists locate closer together than in the proposition. If b_2 is sufficiently large, the duopolists would even end up inside the distribution of reader beliefs so that $|z_j| < |b_j|$.

[14] Recall that "located at z" means the paper biases according to the rule $s_z(d) = [\phi/(\chi + \phi)](z - d)$.

Δz), the higher the prices they can charge. Differentiation softens price competition because the temptation to undercut each other diminishes as the firms move farther away from the marginal consumer (who is located between them).

Now consider firm 1's choice of where to locate. When biasing toward z_1, firm 1 captures all readers between -1 and $x^*(z_1, z_2) = \bar{z}/3$. Hence its profits equal $P_1^*(1 + \bar{z}/3)$. Differentiating with respect to z_1 gives the first-order condition

$$(28) \quad \frac{\partial P_1^*}{\partial z_1}(x^*(z_1, z_2)) + P_1^*\left(\frac{\partial x^*}{\partial z_1}\right) = 0$$

$$(29) \quad \frac{\partial P_1^*}{z_1}\left(1 + \frac{\bar{z}}{3}\right) + P_1^*\left(\frac{1}{3}\right) = 0.$$

Increasing z_1 (that is, moving closer to the origin) has two effects on profits. The first is a price effect; there is a change in profits because changing position affects the equilibrium prices. The second is a market share effect; there is a change in profits because moving closer to the origin raises market share.

Papers slant toward positions well beyond the extreme consumers because the price effect dominates the market share effect until firms are very far apart. Focusing on the symmetric case with $\bar{z} = 0$, the price effect is $\partial P_1^*/\partial z_1 = \Delta z/6 - 1$. The price effect is negative as long as $\Delta z < 6$, in other words, until the difference in firm locations is three times as high as the difference in most extreme readers ($3(b_2 - b_1) = 6$). The market share effect, on the other hand, is $P_1^*/3 = \Delta z/6$. These two effects offset each other to produce an optimum when $\Delta z/6 - 1 + \Delta z/6 = 0$ or $\Delta z = 3$. At the symmetric equilibrium, the optimum is reached at $\Delta z = -2z_1 = 3$ or $z_1 = -\frac{3}{2}$. The distance between the newspapers ($z_2 - z_1 = 3$) is greater than the distance between the most extreme readers ($b_2 - b_1 = 2$).

In short, when choosing how to slant, duopolists maximally differentiate themselves.[15] Practically, this means that news

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[15] This analysis also illustrates why Proposition 5 is about competition, per se, and not about variety alone. A monopolist who could start two newspapers does not need to differentiate to increase market power. He would differentiate simply to cater to reader tastes, but would not go beyond the most extreme readers as duopolists would.

sources can be even more extreme than their most biased readers. One cannot, therefore, infer reader beliefs directly from media bias.

Another point is worth noting:

$$(30) \quad E[|(s_{j,\text{het}}^*(d))|] \geq E[|(s_{\text{het}}^*(d))|].$$

Duopolists always slant more than the monopolist when readers are heterogeneous. In this sense, competition tends to polarize the news. The following corollary summarizes the impact of competition on bias.

COROLLARY 3: *Suppose $b_1 - b_2 < C_m$. In the heterogeneous reader case, competition increases the bias of the average reader:*

$$(31) \quad \text{ARB}_{\text{mon,het}}(v_d) < \text{ARB}_{\text{duo,het}}(v_d).$$

Corollary 3 shows that, with heterogeneous readers, competition by itself polarizes readership and, if anything, raises the average reader bias. Entry of a left-wing newspaper or a TV station into a local market previously dominated by a moderate or slightly right-wing monopolist might cause this monopolist to shift his reporting to the right.

Corollary 3 might shed light on the growing controversy in the United States about media bias. Several recent books have angrily attacked media outlets for having a left-wing bias (e.g., Goldberg, 2002; Coulter, 2003). Several equally angry books have responded that other media outlets have an even stronger right-wing bias (Alterman, 2003; Franken, 2003). We suspect that there is a grain of truth in all these books, and that the growing partisanship of alternative media sources is a response to the growth in competition, and market segmentation, in the media. Changes in media technology have led to significant entry, especially in television. If these media sources divide the market along ideological lines, we expect them to become *more* biased than they were in the regime of moderate competition. This is perhaps what the various commentators are recognizing.

Corollary 3 may also have implications for the effects of entry of new media outlets on the nature of reporting. In a provocative recent study, Gentzkow and Shapiro (2004) examine the responses to a Gallup poll by residents of nine Muslim countries about such topics as the

United States, terrorism, responsibility for 9/11, and so on. The authors document a striking pattern of factually inaccurate beliefs, but also suggest that the media have a strong effect on these beliefs. In particular, those who watch al-Jazeera (Arab television) are much more likely to hold factually false beliefs (as well as anti-American ones) than those watching CNN.[16] In concluding their paper, Gentzkow and Shapiro appear to endorse recent proposals favoring an expansion of Western news in the Arab world, because such news is likely to moderate opinions and beliefs.

Our model suggests that caution is appropriate. The people who watch or listen to Western news are already sympathetic to its perspective and might already watch CNN, so they are unlikely to be strongly affected. Additional entry might cause al-Jazeera and similar networks to further differentiate their product by advancing yet more extreme views. The effect might be to radicalize, rather than moderate, their audience.

V. Reader Heterogeneity and Accuracy in Media

Our results so far focus on how an average reader in the population is affected. We can also look at the impact of reporting on a *conscientious* reader, a hypothetical reader who reads all the news available but is too small to affect what is reported. The interesting insights arise in the duopoly case where the hypothetical conscientious reader reads both papers. Since both papers are reporting on the same event, the conscientious reader might in principle be able to use the two to undo the slanting. To understand this process we need a precise model of slanting.

A. *Technology of Slanting*

Following Hayakawa (1940), we assume that newspapers slant by selectively omitting specific bits of news, i.e., not reporting the whole truth.[17] To formalize this idea, suppose that, rather than simply receiving a composite $d = t + \varepsilon$, the newspaper receives a sequence of positive and negative "bits" or facts. In the example from the introduction, these facts could be the unemployment rate, the unemployment rate in the past, expert opinions, other relevant economic indicators, and so on. These bits or facts are modeled as a length L string f consisting of positive ($+1$), negative (-1), or nonexistent ($\varnothing$) pieces of news. At each position, the probability of each of these values is a function of d, so now instead of simply seeing the composite d, the paper sees all the bits of facts that constitute it. The probability that the piece of news in position i, denoted f_i, is positive, negative, or nonexistent is given by the distribution function:

$$(32) \qquad \Pr(f_i) = \begin{cases} +1 = qg(d) \\ -1 = q(1 - g(d)) \\ \varnothing = (1 - q) \end{cases}$$

where $g(\cdot)$ is a continuous and increasing function that is bounded between 0 and 1, and $0 < q \leq 1$. With probability $1 - q$, there is no news at position i. If there is news, it is positive with probability $g(d)$ and negative otherwise. Conditional on d, these probabilities are iid across different bits on a string. With multiple papers, we assume that they all see the same string f.

A newspaper that does not slant at all would simply report the string f without alteration. A reader who sees the string f can draw inferences from the number of $+1$'s and -1's, which we define as $N_+(f)$ and $N_-(f)$, respectively. By the Law of Large Numbers:

$$(33) \quad \frac{N_+(f)}{N_-(f) + N_+(f)} = g(d) + \eta \rightarrow g(d)$$

where η is a noise term that converges to zero as the length of the string $L \rightarrow \infty$. Consequently, for large L, the information the reader receives

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[16] These results are not unique to the Muslim world. Steven Kull et al. (2003) document significant confusion among large percentages of U.S. respondents on such questions as Saddam Hussein's culpability in 9/11 and the discovery of weapons of mass destruction in Iraq. The study also finds that those who get their news from Fox News are less well informed about these issues than those who get their news from PBS and NPR.

[17] Importantly, newspapers do not slant by simply manufacturing evidence.

is well approximated by the case in which he simply observes d since $g^{-1}[N_+(f)/(N_-(f) + N_+(f))] \to d$.

In this formalism, a newspaper slants the signal by selectively omitting positive or negative bits of information. To slant upward, for example, a newspaper drops negative bits. Instead of reporting $+1, -1, -1, \varnothing, +1, -1, \ldots$ it reports $+1, \varnothing, \varnothing, \varnothing, +1, -1 \ldots$, for example. A paper that wishes to slant upward by $s > 0$ produces a string f' by dropping enough negative bits to guarantee

$$(34) \quad g^{-1}\left(\frac{N_+(f')}{N_-(f') + N_+(f')}\right) \approx d + s.$$

Likewise, a paper that wishes to slant negatively by $s < 0$ simply drops enough positive bits. As $L \to \infty$, the paper can choose to drop bits to approximate better and better any given slant s.

For simplicity, assume that newspapers omit facts in fixed ways. To slant positively, a paper omits the lowest indexed negative bits until it approximates the desired fraction. To slant negatively, a paper omits the lowest indexed positive bits until it reaches the desired fraction. This assumption is simply one way of formalizing the idea that two papers wishing to slant in a particular direction do so similarly.

B. Cross-Checking

By cross-checking the facts in the two newspapers, a conscientious reader may be able to reduce the effect of slanting. Suppose each paper receives string f, which can be thought of as implying data $d = t + \varepsilon$, and paper j reports string f_j. There are now several cases. If the implied slants for both papers are positive and $s_1 > s_2 > 0$, then *every fact* that paper 1 reports, paper 2 also reports. Moreover, because paper 2 is slanting less, it reports some facts that paper 1 does not. Consequently, a conscientious reader would interpret the news as if she had read only paper 2. The case where $0 > s_2 > s_1$ is similar. On the other hand, if the two papers are on opposite sides of the issue so that $s_1 > 0 > s_2$, paper 1 omits some negative details to slant upward and paper 2 omits some positive details to slant downward. The conscientious reader, however, can cross-check both papers. Paper 1 reports the positive facts, which paper 2 omits, and paper 2 reports the negative facts,

which paper 1 omits. By cross-checking, the conscientious reader gets all the facts, as if she were able to read an unslanted newspaper. Define $xc(\cdot)$ to be the cross-checking function:

$$(35) \quad xc(s_1, s_2) = \begin{cases} \min\{s_1, s_2\} & \text{if } s_1 > 0, s_2 > 0 \\ \max\{s_1, s_2\} & \text{if } s_1 < 0, s_2 < 0 \\ 0 & \text{otherwise.} \end{cases}$$

This function summarizes how the conscientious reader can cross-check the two papers.[18]

Define n_c to be the news the conscientious reader is effectively exposed to:

$$(36) \quad n_c = \begin{cases} n & \text{if one newspaper} \\ d + xc(s_1, s_2) & \text{if two newspapers.} \end{cases}$$

We then define conscientious reader bias analogously to the average reader bias:

$$(37) \quad \mathrm{CRB} = E_d[(n_c - d)^2].$$

This definition of conscientious reader bias is independent of heterogeneity of reader beliefs. However, CRB does depend on the equilibrium news reporting, which in turn may depend on the heterogeneity of reader beliefs.

As the discussion on cross-checking suggests, reader heterogeneity can help the conscientious reader quite a bit. To formalize this, let us compare the case of homogeneous readers with bias b to the case of heterogeneous readers with beliefs distributed uniformly on $[b - \delta, b + \delta]$. The following corollary summarizes our principal finding:

COROLLARY 4: *The interaction of reader heterogeneity and duopoly lowers conscientious reader bias. When readers are heterogeneous, conscientious reader bias is lower under duopoly than monopoly:*

$$(38) \quad \mathrm{CRB}_{\text{het,duo}} < \mathrm{CRB}_{\text{het,mon}}.$$

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[18] The extreme cross-checking depends on the two papers slanting stories using the same rule. It is necessary for our results only that the papers use similar rules. Suppose that when one paper omits a fact, it appears in a oppositely slanted paper only with probability z. In this case, the cross-checking function becomes $(1 - z)s_1 + (1 - z)s_2 + z\,xc(s_1, s_2)$. Thus, the qualitative statements we make are preserved.

Under duopoly, conscientious reader bias is lower under heterogeneity than homogeneity:

$$(39) \qquad CRB_{het,duo} < CRB_{hom,duo}.$$

Corollary 4 is the final result of our paper and its bottom line. It points to the absolutely central role that heterogeneity of reader beliefs plays in assuring accuracy in media. We have shown that when readers are homogeneous, competition results in lower prices, but not in accurate news reporting. When readers are heterogeneous, the news received by the average reader might become even more biased as competitive media outlets segment the market. Such market segmentation, however, benefits a conscientious reader, who can then aggregate the news from different sources to synthesize a more accurate picture of reality. When newspapers are at different sides of the political spectrum, the conscientious reader gets all the facts. While individual news sources slant even more when faced with a heterogeneous public, the aggregate picture becomes more clear. In this respect, reader heterogeneity is the crucial antidote to media bias.

This analysis indicates which issues are more likely to receive accurate media coverage, at least for the conscientious reader. Almost surely, the most likely domain of reader heterogeneity is domestic politics, where readers have diverse beliefs and media coverage is correspondingly diverse. Such dispersion of reader beliefs could come from their self-interested economic and social preferences, what used to be called "class differences." But, as Glaeser (2005) argues, such differences are reinforced by political entrepreneurs, who have an incentive to create particular beliefs that would bring them support, especially if these beliefs distinguish them from the incumbent. Newspapers would then follow these entrepreneurs in mirroring and reinforcing the beliefs of their supporters. In fact, in many countries today, and in the United States 100 years ago, newspapers were affiliated with political parties (Hamilton, 2003). Reader diversity, and newspaper diversity, are partly a reflection of underlying political competition. In other areas of competition, such as sports, we likewise expect local papers to support local teams, thereby creating diversity of reporting across cities reflecting the diversity of reader beliefs.

Perhaps the clearest illustration of this corollary is the coverage of the Monica Lewinsky affair during the Clinton presidency. The left-wing press presented an enormous amount of information designed to expiate the president's sins, while the right-wing press dug out as many details pointing to his culpability. In the end, however, as Posner (1999) remarks in his book, much of the truth has come out and a conscientious reader could get a fairly complete picture of reality.

VI. Conclusion

We have examined the roles of two forces in promoting accuracy in media: competition and reader diversity. We have found that competition by itself is not a powerful force toward accuracy. Competition forces newspapers to cater to the prejudices of their readers, and greater competition typically results in more aggressive catering to such prejudices as competitors strive to divide the market. On the other hand, we found that reader diversity is a powerful force toward accuracy, as long as accuracy is interpreted as some aggregate measure of revelation of information to a reader who takes in all the news. Greater partisanship and bias of individual media outlets may result in a more accurate picture being presented to a conscientious reader.

Reader heterogeneity comes in part from underlying political competition, whereby political parties, movements, and individual entrepreneurs attempt to generate support by presenting their points of view. If they can generate enough interest, media outlets will try to cater to the very same audiences that the political entrepreneurs attract, and diversity in media coverage will arise endogenously. In contrast, when potential audiences share similar beliefs, and when there is no advantage from political entry, such as the coverage of foreign countries or crime, we do not expect to see diversity of media reports or accuracy in media.

Political competition is only one source of underlying reader diversity. We can also imagine entrepreneurs starting newspapers on their own and, as long as they have deep enough pockets, creating enough demand for unorthodox views to broaden the range of opinions (and slants) that are being covered. Ideological diversity of entrepreneurs themselves may be the source of diversity of media coverage.

We have studied competitive persuasion in the market for news. Our principal finding is that, when competitors can create or reinforce differences of opinion, they will do so in order to divide the market and reap higher profits. There will be no convergence in reporting to the median reader (as in a Downsian median voter framework). We believe that this consequence of competitive persuasion is more general, and that attempts to differentiate competitively by moving toward extreme positions will arise in both political (Murphy and Shleifer, 2004) and product (Gabaix and Laibson, 2004) markets. In these and other domains, the influence of audience heterogeneity and competition on the content of persuasive messages remains to be fully explored.

APPENDIX A: LEMMAS

LEMMA A1: *Define*

(A1) $$s_B(d) = \frac{\phi}{\chi + \phi} (B - d)$$

to be the strategy where a newspaper biases around point B. The reader's expected utility (gross of price) of reading such a newspaper is:

(A2) $$E_d[U(s_B(d))] = \bar{u} - \frac{\chi\phi}{\chi + \phi} [v_d + b^2] - \frac{\phi^2}{\chi + \phi} [B - b]^2.$$

Consequently when $B = 0$:

(A3) $$E_d[U(s_0(d))] = \bar{u} - \frac{\chi\phi}{\chi + \phi} v_d - \phi b^2.$$

And when $B = b$:

(A4) $$E_d[U(s_b(d))] = \bar{u} - \frac{\chi\phi}{\chi + \phi} (v_d + b^2).$$

PROOF:
Expected utility for $s_B(d)$ is:

(A5) $$\bar{u} - \chi \int_d \left(\frac{\phi}{\chi + \phi} (B - d) \right)^2 - \phi \int_d \left(d + \frac{\phi}{\chi + \phi} (B - d) - b \right)^2.$$

The first integral is:

(A6) $$-\chi \left(\frac{\phi}{\chi + \phi} \right)^2 [B^2 + v_d]$$

because $E[d] = 0$ and $E[d^2] = v_d$. The second integral is:

(A7) $$-\phi \left[\left(\frac{\chi}{\chi + \phi} \right)^2 v_d + \left(\frac{\phi}{\chi + \phi} \right)^2 B^2 + b^2 - 2\frac{\phi}{\chi + \phi} Bb \right]$$

again because $E[d] = 0$ and $E[d^2] = v_d$. Collecting terms produces

(A8)
$$\bar{u} - \frac{\phi\chi}{\chi + \phi} v_d - \phi b^2 - \frac{\phi^2}{\chi + \phi} B^2 + 2 \frac{\phi^2}{\chi + \phi} Bb =$$

(A9)
$$\bar{u} - \frac{\phi\chi}{\chi + \phi} [v_d + b^2] - \phi b^2 + \frac{\phi\chi}{\chi + \phi} b^2 - \frac{\phi^2}{\chi + \phi} B^2 + 2 \frac{\phi^2}{\chi + \phi} Bb =$$

(A10)
$$\bar{u} - \frac{\phi\chi}{\chi + \phi} [v_d + b^2] - \frac{\phi^2}{\chi + \phi} b^2 - \frac{\phi^2}{\chi + \phi} B^2 + 2 \frac{\phi^2}{\chi + \phi} Bb =$$

(A11)
$$\bar{u} - \frac{\phi\chi}{\chi + \phi} [v_d + b^2] - \frac{\phi^2}{\chi + \phi} [b^2 + B^2 - 2Bb]$$

and hence the result.

LEMMA A2: *Let $x_1 \leq x_2$ be the biases of two readers. For any $1 \geq c \geq 0$, the strategy*

(A12)
$$s_{\bar{x}}(d) = \frac{\phi}{\chi + \phi} (\bar{x} - d)$$

maximizes weighted average reader utility $c E_d u_{x_1}(s(d)) + (1 - c) E_d u_{x_2}(s(d))$, where $\bar{x} = c x_1 + (1 - c) x_2$.
Moreover, for some $x_1 \leq z \leq x_2$, the strategy $s_z(d) = [\phi/(\chi + \phi)](z - d)$ maximizes $\min\{Eu_{x_1}(s(d)), Eu_{x_2}(s(d))\}$.

PROOF:
Consider total utility $c E_d u_{x_1}(s(d)) + (1 - c) E_d u_{x_2}(s(d))$, which equals

(A13)
$$\int_d [\bar{u} - \chi s(d)^2 - c\phi(d + s(d) - x_1)^2 + (1 - c)\phi(d + s(d) - x_2)^2].$$

Since the right-hand side shows no interdependency in d, maximizing this integral is equivalent to maximizing for every single d, the term

(A14)
$$\bar{u} - \chi s(d)^2 - c\phi(d + s(d) - x_1)^2 + (1 - c)\phi(d + s(d) - x_2)^2.$$

Taking derivatives with respect to s then produces the first-order condition

(A15)
$$-2\chi s - 2\phi(d + s - \bar{x}) = 0,$$

which implies that the optimal slanting is:

(A16)
$$\frac{\phi}{\chi + \phi} (\bar{x} - d).$$

For the second part, let $s(d)$ be a candidate slanting strategy that maximizes $\min\{Eu_{x_1}(s(d)), Eu_{x_2}(s(d))\}$. Define u_1 and u_2 to be the expected utilities for $s(d)$. Note that s_{x_1} and s_{x_2} maximize reader 1 and reader 2 utilities, respectively. Consequently, there must be a c such that for $\bar{x} = c x_1 + (1 - c) x_2$ the strategy $s_{\bar{x}}$ yields the same ratio of reader 1 and 2 utilities as the candidate strategy does: u_1/u_2. But by the first part of the Lemma, $Eu_i(s_{\bar{x}}(d)) \geq u_i$ for $i = 1, 2$. Otherwise, the candidate strategy $s(d)$ would yield higher weighted average utility. But this shows $s_{\bar{x}}$ maximizes the min and hence $s = s_{\bar{x}}$.

APPENDIX B: PROOFS OF PROPOSITIONS

PROOF OF PROPOSITION 1:

Consider the monopolist's maximization problem. Reader utility is

$$(B1) \qquad\qquad U_r = \max\{\bar{u} - \chi s^2 - P, 0\}.$$

Since readers only dislike slanting, a newspaper gets no benefit from slanting and only pays costs. The optimal strategy for both the homogeneous and heterogeneous case is therefore $s^*(d) = 0$. Since the reader's gross utility in this case is $\bar{u}$, the monopolist can extract all surplus and charge P, so that the reader's net utility is 0.

Consider now the duopoly case. Begin with the homogeneous reader case and proceed by backward induction. Consider the price setting stage. Define V_j to be the utility the reader associates with reading newspaper j. There are two cases here: equal and unequal utilities. For the case of unequal utilities, suppose without loss of generality that $V_1 > V_2$. The price equilibrium is for paper 1 to charge $V_1 - V_2$ and capture the full market. If $V_1 = V_2$, then both papers charge zero.

In the strategy-setting stage, holding constant the other's strategy, both papers' profit functions are increasing in the reader utility from the strategies they choose. Consequently, it is a weakly dominant strategy for each paper to maximize reader utility. From the monopoly case, we know these strategies are $s(d) = 0$. It is an equilibrium, therefore, to have both prices and slanting equal to zero.

In the heterogeneous reader case, the logic remains the same because reader utility functions are the same as in the homogeneous case, since utility is independent of beliefs for rational readers. The homogeneous and heterogeneous cases produce the same incentives for the firm.

PROOF OF PROPOSITION 2:

Since the monopolist can extract all surplus, he maximizes expected utility,

$$(B2) \qquad\qquad \max_{s^*(d)} \bar{u} - \chi \int_d (s^*(d))^2 - \phi \int_d (d + s^*(d) - b)^2.$$

There are no interdependencies in this utility maximization across d's. Because the maximand is separable in d, choosing the optimal $s^*(d)$ is equivalent to choosing the optimal s^* for each d or

$$(B3) \qquad\qquad s^*(d) = \text{argmax}_s \bar{u} - \chi s^2 - \phi(d + s - b)^2.$$

For a given d, differentiating with respect to s produces the first-order condition

$$(B4) \qquad\qquad \chi s + \phi(d + s - b) = 0,$$

which implies

$$(B5) \qquad\qquad s^*_{\text{hom}}(d) = \frac{\phi}{\chi + \phi}(b - d).$$

Prices then are equal to the expected utility under this strategy. From Lemma (A1), we know the expected utility and hence price is

$$(B6) \qquad\qquad P^*_{\text{hom}} = \bar{u} - \frac{\chi\phi}{\chi + \phi}[b^2 + v_d].$$

PROOF OF PROPOSITION 3:

We proceed by backward induction. Consider the price-setting stage. Let V_j be the reader's utility associated with reading paper j. There are two cases here: equal and unequal utilities. For the case of unequal utilities, suppose without loss of generality that $V_1 > V_2$. The price equilibrium is for paper 1 to charge $V_1 - V_2$ and capture the full market. If $V_1 = V_2$, then both papers charge zero.

In the stage where the slanting strategy is set, maximizing reader utility is, as before, a weakly dominant strategy. Holding constant the other firm's strategy, each firm's profit is increasing in the reader utility associated with its strategy. We know from Proposition 2 that the utility-maximizing strategy is to slant $[\phi/(\chi + \phi)](b - d)$. Therefore, it is an equilibrium for duopolists to choose this strategy. Since this means both papers provide equal utility, prices equal zero. This shows that this is an equilibrium. Moreover, this logic directly implies that the only equilibrium involves both papers choosing a slanting strategy that maximizes utility and prices equal to zero on the equilibrium path.[19]

PROOF OF PROPOSITION 4:

We proceed in three steps:

(1) First, we show that a linear strategy is an optimal one.
(2) Second, we show that of the linear strategies, the strategy with zero bias produces maximum profit.
(3) Third, we compute the prices the monopolists would charge.

Step 1: Linearity of monopolist's strategy. The first step is to show that the linear strategy of the type $s_B(d) = [\phi/(\chi + \phi)](B - d)$ is optimal. To show this, suppose $s(d)$ and P form an optimal strategy for the monopolist. Let $X = \{b_i | Eu_i(s(d)) - P \geq 0\}$ be the biases of the readers who read the paper in this case.[20]

Since $X \subset [b_1, b_2]$ is non-empty, it must have a well-defined inf and sup. Let x_1 and x_2 be the inf and sup of this set and u_1 and u_2 be the utility of these readers. Lemma (A2) shows that a linear strategy of the form $s_z(d) = [\phi/(\chi + \phi)](z - d)$, where $z = cx_1 + (1 - c)x_2$, maximizes min$\{u_1, u_2\}$. So, s_z yields the maximum payoffs for x_1 and x_2. But by Lemma (A1), all readers with bias between x_1 and x_2 have even greater utility from this strategy. Define the price P_z to be min$\{u_1, u_2\}$. Since x_1 and x_2 are the inf and sup of the set X, by the formula in Lemma (A1), it is easy to see that the strategy s_z, with price P_z, satisfies the participation constraint of all readers in X.

Let us now contrast the supposed optimum strategy (s, P) with this strategy (s_z, P_z). By construction, s_z has at least as large a market share as s since it spans all readers between the inf and sup of the set X. Moreover, since s satisfies the participation constraint of x_1 and x_2 we know that it cannot yield higher gross utility for readers at x_1 and x_2 than s_z does. Hence, we know that $P \leq P_z$. Thus, the linear strategy $s_z(d)$ yields at least as much profit as the supposed optimum. This shows that we can work with a linear strategy as an optimum.

Step 2: Optimal bias is zero. The second step is to show that a monopolist would choose a linear strategy of $s_B(d)$ with $B = 0$. To do this, we proceed by contradiction. Let (B, P) be a linear strategy B and price P set by a monopolist that we suppose is an optimum strategy. Lemma (A1) shows that for a reader with bias b receives utility

(B7)
$$\bar{u} - \frac{\chi\phi}{\chi + \phi}[v_d + b^2] - \frac{\phi^2}{\chi + \phi}[B - b]^2 - P.$$

---

[19] Any slanting strategy that deviates on measure zero from the optimal one also forms an equilibrium since expected utility is the same.

[20] This set must be non-empty since the strategy stated in the proposition earns positive profits and an empty readership would earn zero profits.

All readers for whom this term is positive will read the paper. Since this is a quadratic equation, we can define the indifferent readers from this equation. By the quadratic formula, the zeros of this equation are at $z_+(P, B) = (2B\phi + \sqrt{-4\phi\chi B^2 + 4(K/\phi)(\chi + \phi)^2})/2(\chi + \phi)$ and $z_-(P, B) = (2B\phi - \sqrt{-4\phi\chi B^2 + 4(K/\phi)(\chi + \phi)^2}/2(\chi + \phi)$, where K is defined to be $\bar{u} - [\phi\chi/(\phi + \chi)]v_d - P$. Of course, these zero points may lie outside the range of reader biases, so define $b_+(P) \doteq \max(z_-(P, B), b_1)$ and $b_-(P) = \min(z_+(P, B), b_2)$. By definition, therefore, all individuals within this interval have weakly positive utility and therefore will purchase the paper.

With these definitions in hand, suppose now the monopolist chooses a $B \neq 0$. We will consider three different cases: (a) the case where b_+ and b_- are both interior (i.e., equal to z_+ and z_-); (b) the case where they are both at the boundary (i.e., equal to b_2 and b_1); and (c) the case where one is at the boundary and the other is at the interior. First, consider the case where $b_+(B, P) = z_+(B, P)$ and $b_-(B, P) = z_-(B, P)$ so that the end points are defined by the quadratic equation and not by the boundaries of the reader bias distribution. The size of the interval in this case then equals

$$(B8) \qquad z_+(P) - z_-(P) = \frac{\sqrt{-4\phi\chi B^2 + 4\dfrac{K}{\phi}(\chi + \phi)^2}}{\chi + \phi}.$$

But, since the constant K does not depend on B, this is strictly decreasing in B^2. Hence, a $B \neq 0$ strategy cannot be optimal. If $B > 0$, reducing it and keeping prices the same would increase profits, and similarly for $B < 0$.

Second, consider the case where both endpoints are defined by the boundary so that $b_+ = b_2 < z_+$ and $b_- = b_1 > z_-$. Let U_1 be the gross utility of the reader at the left boundary (i.e., with bias b_1) and U_2 be the corresponding utility for the reader at the right boundary. Prices in this case are defined by $P = \min\{U_1, U_2\}$. A price smaller than this could be increased marginally without violating the participation constraint and raising profits. A price higher than this would violate the participation constraint of the boundary readers and would be inconsistent with the definition of the boundary. Yet this price implies a violation of optimality. Lemma (A2) shows that for some c, choosing $B = cb_1 + (1 - c)b_2$ would maximize $\min\{U_1, U_2\}$. Moreover, by the symmetry of the formula in Lemma (A1) it is clear that $c = \frac{1}{2}$. So a strategy of $B = \bar{b} = 0$ would still satisfy the participation constraint since it is maximizing the minimum utility. Moreover, by switching to this strategy, the monopolist could increase the price he could charge since $\min\{U_1, U_2\}$ rises. Profits also rise because he continues to cover the whole market. Hence, by switching to this strategy, the monopolist could raise profits and this contradicts $B \neq 0$ as an optimal strategy.

Third, consider the case where (without loss of generality) $b_- = z_- > b_1$ but $b_+ = b_2 < z_+$. By definition of the roots z_- and z_+, the reader at b_2 earns greater utility than the reader at z_- who is indifferent between buying the paper and not. But in this case, consider a deviation that leaves prices fixed but changes strategies to $B' = B - \varepsilon$. For small enough $\varepsilon > 0$, this continues to give strictly positive utility to the reader at b_2 and hence he will continue to read. This will increase market share, however, because some readers with $b < z_-$ now earn positive utility from reading. Since this deviation increases market share without decreasing price, the original B could not be an optimum.

As this includes all the cases, we have now shown that profits are maximized by a linear strategy with $B = 0$. What should optimal prices look like? For $B = 0$, the monopolists profits equal $P * 2\sqrt{\phi K}$ where $K = \bar{u} - [\phi\chi/(\phi + \chi)]v_d - P$. Let P^m be the global maximum of this function. At this maximum $b_+ - b_- = 2\sqrt{\phi/[\bar{u} - (\chi\phi/(\chi + \phi)) - P^m]}$. Define this to be C_m. So if $b_2 - b_1 < C_m$, the monopolist will cover the whole market. He can then set a price equal to the utility of the boundary reader's utility, which by Lemma (A1) equals $\bar{u} - [\chi\phi/(\phi + \chi)]v_d - \phi^2 b_2^2$.

PROOF OF PROPOSITION 5:

We proceed by backward induction in several steps:

(1) We calculate $x(P_1, P_2, z_1, z_2)$, the bias of the reader who is indifferent between reading the two papers if paper j charges P_j and has bias z_j (chosen in the first stage of the game and taken as given in this stage). This allows us to determine the market share of each firm for that location and price pair.
(2) We then calculate $P_1^R(P_2; z_1, z_2)$ and $P_2^R(P_1; z_1, z_2)$, the best response functions for firms 1 and 2, respectively. These are the best price responses of each firm to the other's price (given the biases z_j which are chosen in the first stage and taken as given in the second stage).
(3) Using these prices, we calculate the equilibrium prices $P_1^*(z_1, z_2)$ and $P_2^*(z_1, z_2)$ and market share $x^*(z_1, z_2)$ that result from the choice of bias in the first stage.
(4) We then use these equilibrium prices to show that in the first stage, firms will want to differentiate as long as $z_2 \leq 3b_2$. We show that at $z_2 = 3b_2$ and $z_1 = 3b_1 = -3b_2$, the firms are indifferent between lowering and raising z_j and thus in equilibrium.
(5) Finally, we show that all participation constraints for the consumer are satisfied at the equilibrium.

Step 1: Calculating $x(P_1, P_2; z_1, z_2)$. A reader with bias x receives utility:

(B9)
$$\bar{u} - \frac{\chi\phi}{\chi + \phi}[v_d + x^2] - \frac{\phi^2}{\chi + \phi}[z_j - x]^2 - P_j$$

from reading paper j (Lemma (A1)). If the reader with bias x is indifferent between these two papers, then the utilities from reading the two papers are equal:

(B10)

$$\bar{u} - \frac{\chi\phi}{\chi + \phi}[v_d + x^2] - \frac{\phi^2}{\chi + \phi}[z_2 - x]^2 - P_2 = \bar{u} - \frac{\chi\phi}{\chi + \phi}[v_d + x^2] - \frac{\phi^2}{\chi + \phi}[z_1 - x]^2 - P_1.$$

This equality can in turn be simplified to

(B11)
$$\frac{\phi^2}{\chi + \phi}[(z_1 - x)^2 - (z_2 - x)^2] = P_2 - P_1$$

(B12)
$$\frac{\phi^2}{\chi + \phi}(z_2 - z_1)[2x - (z_2 + z_1)] = P_2 - P_1$$

(B13)
$$\frac{2\phi^2}{\chi + \phi}\Delta z[x - \bar{z}] = \Delta P$$

(B14)
$$x(P_1, P_2; z_1, z_2) = \bar{z} + \frac{\Delta P}{\Delta z}\frac{\chi + \phi}{2\phi^2}$$

where $\bar{z} = (z_1 + z_2)/2$, $\Delta P = P_2 - P_1$, and $\Delta z = z_2 - z_1$.

Step 2: Calculation price best response functions $P_j^R(P_{-j})$. Since the indifferent reader is located at x, firm profits are given by

(B15)
$$\Pi_1(P_1, P_2; z_1, z_2) = \frac{P_1}{b_2 - b_1}(x - b_1)$$

$$(B16) \qquad \Pi_2(P_1, P_2; z_1, z_2) = \frac{P_1}{b_2 - b_1}(b_2 - x).$$

The firm's best price response can be derived by differentiating profits with respect to own price. For firm 1, this first-order condition is

$$(B17) \qquad \frac{1}{b_2 - b_1}\left[x - b_1 + P_1 \frac{\partial x_1}{\partial P_1}\right] = 0$$

$$(B18) \qquad x - b_1 + P_1 \frac{\partial x_1}{\partial P_1} = 0$$

$$(B19) \qquad \bar{z} + \frac{\Delta P}{\Delta z}\frac{\chi + \phi}{2\phi^2} - b_1 + P_1\left(-\frac{\chi + \phi}{2\phi^2\Delta z}\right) = 0$$

$$(B20) \qquad \bar{z} + \frac{P_2}{\Delta z}\frac{\chi + \phi}{2\phi^2} - b_1 = P_1 \frac{\chi + \phi}{\phi^2\Delta z}$$

$$(B21) \qquad (\bar{z} - b_1)\frac{\Delta z\phi^2}{\chi + \phi} + \frac{P_2}{2} = P_1.$$

So the best response function is

$$(B22) \qquad P_1^R(P_2; z_1, z_2) = \frac{P_2}{2} + (b_2 + \bar{z})\frac{\Delta z\phi^2}{\chi + \phi}$$

where we've used the fact that $b_2 = -b_1$ by assumption. Similarly, the best response function for firm 2 is

$$(B23) \qquad P_2^R(P_1; z_1, z_2) = \frac{P_1}{2} + (b_2 - \bar{z})\frac{\Delta z\phi^2}{\chi + \phi}.$$

Step 3: Calculating equilibrium prices and market share. The Nash equilibrium of prices can be calculated from the best response functions by solving

$$(B24) \qquad P_1^* = P_1^R(P_2^R(P_1^*; z_1, z_2))$$

$$(B25) \qquad P_2^* = P_2^R(P_1^R(P_2^*; z_1, z_2)).$$

The first equation can be calculated as follows:

$$(B26) \qquad P_1^* = P_1^R(P_2^R(P_1^*; z_1, z_2))$$

$$(B27) \qquad P_1^* = \frac{P_2^R(P_1^*; z_1, z_2)}{2} + (b_2 + \bar{z})\frac{\Delta z\phi^2}{\chi + \phi}$$

$$(B28) \qquad P_1^* = \frac{1}{2}\left(\frac{P_1}{2} + (b_2 + \bar{z})\frac{\Delta z\phi^2}{\chi + \phi}\right) + (b_2 + \bar{z})\frac{\Delta z\phi^2}{\chi + \phi}$$

(B29)
$$\frac{3}{4} P_1^* = \frac{\phi^2 \Delta z}{\chi + \phi} \left[\frac{b_2}{2} - \frac{\bar{z}}{2} + \bar{z} + b_2 \right]$$

(B30)
$$P_1^* = \frac{\phi^2 \Delta z}{\chi + \phi} \left[2b_2 + \frac{2\bar{z}}{3} \right].$$

By a similar calculation

(B31)
$$P_2^* = \frac{\phi^2 \Delta z}{\chi + \phi} \left[2b_2 - \frac{2\bar{z}}{3} \right].$$

Using these equilibrium prices, we can also calculate equilibrium market share as

(B32)
$$x^*(z_1, z_2) = \bar{z} + \Delta P \frac{\chi + \phi}{2\phi^2 \Delta z}$$

(B33)
$$x^*(z_1, z_2) = \bar{z} + \left[-\frac{4\bar{z}}{3} \frac{\phi^2 \Delta z}{\chi + \phi} \right] \frac{\chi + \phi}{2\phi^2 \Delta z}$$

(B34)
$$x^*(z_1, z_2) = \bar{z} - \bar{z} \frac{2}{3}$$

(B35)
$$x^*(z_1, z_2) = \frac{\bar{z}}{3}.$$

Step 4: Differentiation in choosing bias (the first stage). These prices and market share allow us to backward induct and examine the firm's decision in stage 1. Taking the other firm's bias as given, they can be used to calculate each firm's profits for each bias chosen. Specifically profits in stage 1 are

(B36)
$$\Pi_1(z_1, z_2) = P_1^*(z_1, z_2)[x^*(z_1, z_2) - b_1]$$

(B37)
$$\Pi_2(z_1, z_2) = P_2^*(z_1, z_2)[b_2 - x^*(z_1, z_2)].$$

The first-order condition for this problem is instructive. Focusing on firm 1, we can write profits as

(B38)
$$P_1^*(z_1, z_2) \left[\frac{\bar{z}}{3} - b_1 \right].$$

Differentiating with respect to z_1 gives

(B39)
$$\frac{\partial \Pi_1}{\partial z_1} = \frac{P_1^*(z_1, z_2)}{6} + \frac{\partial P_1^*(z_1, z_2)}{\partial z_1} \left[\frac{\bar{z}}{3} - b_1 \right]$$

(B40)
$$\frac{\partial \Pi_1}{\partial z_1} = \left(b_2 + \frac{\bar{z}}{3} \right) \frac{2\phi^2 \Delta z}{6(\chi + \phi)} + \left(b_2 + \frac{\bar{z}}{3} \right) \frac{2\phi^2}{\chi + \phi} \left[\frac{\Delta z}{6} - b_2 - \frac{\bar{z}}{3} \right].$$

Now we are interested in the sign of this derivative. Define $sign(x)$ to be the function that equals $+1$ if $x > 0$ and -1 if $x < 0$. We can then write

(B41)
$$sign\left(\frac{\partial \Pi_1}{\partial z_1}\right) = sign\left(\left(b_2 + \frac{\bar{z}}{3}\right)\Delta z + \left(b_2 + \frac{\bar{z}}{3}\right) * [\Delta z - 6b_2 - 2\bar{z}]\right)$$

(B42)
$$sign\left(\frac{\partial \Pi_1}{\partial z_1}\right) = sign\left(\left[b_2 + \frac{\bar{z}}{3}\right] * (\Delta z + \Delta z - 6b_2 - 2\bar{z})\right).$$

Now suppose that we are in a symmetric case where $z_1 = -z_2$ so that $\bar{z} = 0$. In this case,

(B43)
$$sign\left(\frac{\partial \Pi_1}{\partial z_1}\bigg|_{\bar{z}=0}\right) = sign(b_2 * (2\Delta z - 6b_2))$$

(B44)
$$sign\left(\frac{\partial \Pi_1}{\partial z_1}\bigg|_{\bar{z}=0}\right) = sign(2\Delta z - 6b_2))$$

(B45)
$$sign\left(\frac{\partial \Pi_1}{\partial z_1}\bigg|_{\bar{z}=0}\right) = sign(-4z_1 - 6b_2)).$$

So $(\partial \Pi_1 / \partial z_1)|_{\bar{z}=0} < 0$ if and only if $-2z_1 < 3b_2$. In other words, if $-z_1 < \frac{3}{2}b_2$, firm 1 always has an incentive to further lower z_1. If $-z_1 > \frac{3}{2}b_2$, firm 1 has an incentive to raise z_1. A similar derivation shows that $(\partial \Pi_2 / \partial z_2)|_{\bar{z}=0} > 0$ only if $z_2 < \frac{3}{2}b_2$. This, therefore, shows that at $z_2^* = \frac{3}{2}b_2$ and $z_1^* = -\frac{3}{2}b_2$, the firms are at a Nash equilibrium for the first stage game. Substitution shows that for this choice of z_j^*, prices must be equal to $[\phi^2/(\chi + \phi)]6b_2^2$.

Step 5: Boundary conditions. Finally, we must verify that in equilibrium, the participation constraints of the consumer are satisfied. It suffices to show that the consumer located at zero receives non-zero utility from buying either paper. That is, we must show (by Lemma (1)) that:

(B46)
$$\bar{u} - \frac{\chi\phi}{\phi + \chi}v_d - \frac{\phi^2}{\chi + \phi}\frac{9}{4}b_2^2 - 6\frac{\phi^2}{\chi + \phi}b_2^2 > 0$$

where the first three terms are the gross utility of reading the paper and the last term is the price. This is equivalent to:

(B47)
$$\frac{33}{4}b_2^2\frac{\phi^2}{\chi + \phi} < \bar{u} - \frac{\phi\chi}{\chi + \phi}v_d,$$

which is equivalent to

(B48)
$$b_2 < \sqrt{\frac{4}{33}\left[\frac{\phi + \chi}{\phi^2}\bar{u} - \frac{\chi}{\phi}v_d\right]},$$

which is what was assumed in the statement of the proposition.

PROOF OF COROLLARY 4:

Consider the first comparison: $CRB_{het,duo} < CRB_{het,mon}$. From Propositions 5 and 4, we know that duopolists report more diverse news than the monopolist when readers are heterogeneous. But from the functional form of $xc(\cdot, \cdot)$, we know that this diversity allows the conscientious reader to cross-check and thus produces less bias for her overall.

Consider the second comparison $CRB_{het,duo} < CRB_{hom,duo}$. By Propositions 5 and 3, we know that reporting in the heterogeneous case is more diverse. So, once again, the increased diversity means lower conscientious reader bias.

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