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Abstract

Bias in the market for news is well documented. Recent research in economics explains the phenomenon by assuming that consumers want to read (watch) news that is consistent with their tastes or prior beliefs rather than the truth. The present paper builds on this idea but recognizes that (i) besides 'biased' consumers there are also 'conscientious' consumers whose sole interest is in discovering the truth, and (ii) consistent with reality, media bias is constrained by the truth. These two factors were expected to limit media bias in a competitive setting. Our results reveal the opposite. We find that media bias may increase when there are more conscientious consumers. However, this increased media bias does not necessarily hurt conscientious consumers who may be able to recover more information from multiple media outlets, the more these are biased. We discuss the practical implications of these findings for media positioning, media pricing, media planning and the targeting of advertising.

Keywords: information goods, complements, media competition, media positioning.

1 Introduction

"The largest opinion is what we leave out."— CBS reporter Betsy Aaron.

In September, 2004, during the US presidential campaign, the Texans for Truth group began airing television ads questioning whether President Bush fulfilled his military obligations in the National Guard. Fox News reported:

Fox News, Tuesday, September 14, 2004— *President Bush's National Guard record is now under assault by a group calling itself Texans for Truth. The group is a branch of DriveDemocracy, an Austin-based organization that has received seed money from the liberal-leaning anti-Bush group, MoveOn.org. …The group this week is releasing an ad in which a former lieutenant in the Alabama Air National Guard says neither he nor his friends saw Bush when he supposedly was with their unit in 1972. The president served as a pilot with the Texas Air National Guard and sought a transfer in 1972 to work on a political campaign.*

On the same day, CNN's report said:

CNN, Tuesday, September 14, 2004— *The founder of the group Texans for Truth said Tuesday that he is offering $50,000 to anyone who can prove President Bush fulfilled his service requirements, including required duties and drills, in the Alabama Air National Guard in 1972. …the Texans for Truth group began airing television ads questioning whether Bush fulfilled his military obligations. Its name is a takeoff on Swift Boat Veterans for Truth, which has been airing ads questioning the military record of Democratic nominee Sen. John Kerry. That group's allegations are at odds with the official Navy records and Kerry's former crew mates.*

Examples like the above abound and cover a variety of topics. Gentzkow and Shapriro (2004), for instance, report a similar case in the context of the Iraqi war, comparing reports on the same event by Fox News, The New York Times and Al Jazeera. A common feature among these alternative reports is that, while they are factually correct they convey very different messages and stimulate radically different impressions about the events. This is achieved by selective omissions and differing emphasis. The different impressions created from an objective event by *slanting* information is what we call media bias, which is the subject of the present paper. In particular, we study media bias in the context of news provided by *competing* media outlets.

Media bias in the context of news is well-documented. In the domain of U.S. politics, Goldberg (2002) and Coulter (2003) document media bias on the left, while Alterman (2003) and Franken (2003) argue that the US media is biased towards the right. Apart from political news, media bias is also present in other domains. Sport game commentaries, for example, vary greatly across hosting cities.

The strong and visible existence of media bias is a challenge for marketing. The media - including news - constitute the central 'infrastructure' for advertising, representing billions of dollars of business in the US alone. It is also the main vehicle for the marketing of political candidates and PR activities. Besides marketing, the media (especially news) are the key source of information for society and, as such, are critical for a well functioning democracy. In this context, the existence of media bias raises several important questions. What consumer behavior drives media bias? How can it persist under media competition in a free society? What determines the extent of media bias and what are its social costs? These are the broad questions addressed in this paper. Beyond being of general interest, the answers have important implications for media firms and advertisers as well. In the context of news, media bias is closely related to media positioning, which in turn affects decisions related to media pricing, the targeting of audiences for advertising as well as media planning.

We are not the first to ask these and similar questions. Media bias in the context of news has received increasing attention in recent years. In particular, Gabszewicz et al. (2001) and Mullainathan and Shleifer (2005) provide a simple explanation for its persistence. They point out that a great deal of news is describing events that are of little relevance to the audiences' daily decision making. Rather, their role is more to provide entertainment to the public. Furthermore, audiences spend little effort processing the information in the news. In this context, news providers can slant the news to attract audiences with preferences towards certain news content. That news needs to be embellished in a "story" and needs to be explained and interpreted for the audience is broadly accepted and practiced by the media. It is commonly called the "narrative imperative" by the news industry (Hayakawa 1990, Jensen 1979, Graber 1984, Hamilton 2003, Severin and Tankard 1992).

If consumers look for entertainment in the news and their tastes vary for certain stories, then the narrative imperative results in media bias even under free media competition. In this framework, media bias is conceptually identical to media positioning. Under competition and heterogeneous consumer preferences for certain news, the outcome is media differentiation: each competing medium satisfies the preferences of different consumer segments. Anecdotal evidence is consistent with this view. Figure 1, for example, is adopted from a survey conducted by Pollingpoint in 2004, using online interviews with 73,969 US adults, aged 18 or older. It roughly describes the relationship between consumers' political identity (democrat vs. republican) and their valuations of different TV networks. Nine in ten Republicans say Fox News offers the best news coverage among television networks. Democrats divide their loyalty among PBS and CNN, with nearly 70% naming one of the two as the best news source. The chart suggests that different consumers prefer different news, i.e. there clearly seems to be demand for certain news by different segments of consumers. Media firms then slant and provide biased news to cater to this demand.[1]

While the above interpretation of media bias is consistent with anecdotal evidence it neglects two important factors. First, it does not consider the cost of slanting. In a free democracy however, such costs are not negligible. Media cannot outright lie about events to please its audiences. As such, media may not be able to always achieve the positioning desired by its target

[1]According to former Fox News producer, Charlie Reina, "The roots of Fox News Channel's day-to-day on-air bias are actual and direct. They come in the form of an executive memo distributed electronically each morning, addressing what stories will be covered and, often, suggesting how they should be covered" (see PoynterOnline: www.poynter.org).

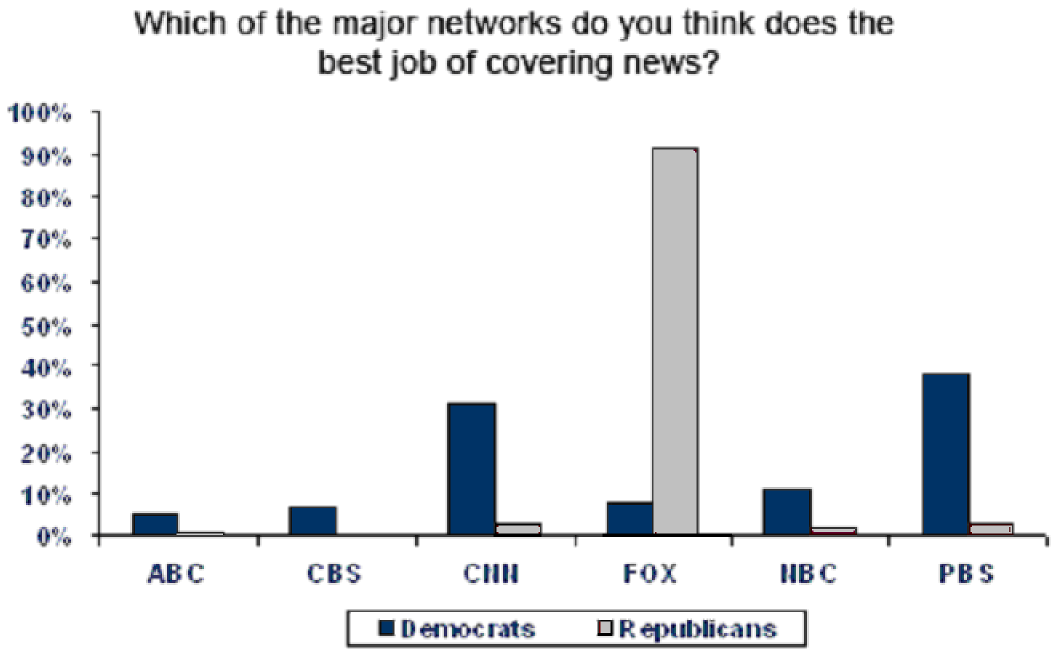

Figure 1: Consumer self-identity and liking of TV networks.

segment. Similarly, even if a biased view can be conveyed by appropriate slanting of the news, such bias should come at a cost to the media outlet. These costs should limit the extent of media bias.

Second, and more importantly, the above view on media bias assumes that *all* people consume news for 'entertainment'. Empirical evidence clearly shows that this is not the case. In a careful study, for example, Vigna and Kaplan (2005) point out that the conservative Fox News has limited impact on its audience's voting decisions. This suggests that at least some people correct for media bias when it comes to decision making. There is also evidence that a substantial proportion - up to 20% - of consumers cross-check media with opposite political orientation.[2] One would assume that in the presence of these 'conscientious' consumers, the media has less incentive to slant in a competitive setting. One of our key findings is that this is not necessarily the case. In fact, under

[2]This is confirmed by surveys from the Pew Research Center for People and Press, which regularly measures people's media consumption behavior as well as their attitudes towards the main media outlets in the US. Data source: Pew Media Consumption Survey 2000, 2002, 2004.

some conditions, higher proportion of conscientious consumers may actually *increase* media bias.

In sum, the concrete research questions asked in this paper are the following. What happens to media bias under competition if (i) slanting is costly and constrained by the truth and (ii) news represents information for some consumers but entertainment for others? How will the relative proportions of these consumers affect the extent of bias in the news market and media prices? Finally, how does media bias affect conscientious consumers' ability to recover the truth from the available news?

To answer these questions we develop a model with two competing media outlets, selling news to a dual market with two kinds of consumers. The first kind of consumer has heterogenous beliefs about the world and wants to read/watch news that is consistent with these beliefs. The second kind of consumer is conscientious and simply wants to know the truth. Media outlets are modeled as firms who package the available information about exogenous events in a news report that has finite length. Specifically, pieces of unbiased, independent (albeit noisy) information about events reach the media outlets at a constant rate. Media firms can choose how much of this information they want to acquire with more information being more costly. Subsequently, and only if they have enough information available, media outlets can strategically omit certain pieces of information to fill the news report. Biased consumers choose media outlets based on prices and the media's advertised media stances (i.e. the positions that the media aspire to fulfill with slanting). Conscientious consumers also consider prices and media stances albeit they will use the latter to infer the truth from the slanted news.

Consistently with Mullainathan and Shleifer (2005), we find that media bias can be a result of biased consumers' heterogeneity in beliefs. However, we find that this consumer heterogeneity can increase media bias depending on the proportion of conscientious consumers and the media firms' cost of acquiring more information. Interestingly, we find that media bias increases when there are more conscientious consumers. However, it turns out that even with higher media bias, conscientious consumers may actually recover more information about the truth than with less biased media. Consequently, media bias may actually increase information efficiency although it may also increase media prices. These findings have important implications for marketing practice. In particular, we discuss their impact on media positioning, advertising planning and targeting and the marketing of political candidates.

The paper is organized as follows. In the next section, we briefly review the relevant literature. Then, we present the model followed by its analysis. We explore three cases: a monopolist medium, a competitive setting with a symmetric equilibrium where both media slant and an asymmetric equilibrium with only one biased medium. The paper ends with a discussion of the key results and concluding remarks. To ease the exposition, most mathematical details have been relegated to appendices.

2 Relevant Literature

The traditional view on news consumption is that people seek accurate and unbiased information. Historians, sociologists and economists traditionally view the consumption of news as satisfying a basic human impulse. Being aware of what is happening beyond people's direct experience engenders a sense of security, control, and confidence. Mass media, having emerged from satisfying this intrinsic human need, serves as the major channel for informing citizens. For example, journalists agree that "the central purpose of journalism is to provide citizens with accurate and reliable information they need to function in a free society."[3] Within this paradigm, media bias shouldn't exist in a free and competitive environment. Indeed, if accurate and reliable information is what consumers want from and what journalists provide in news, then the media will compete on these relevant dimensions (Coase 1974, Besley and Burgess 2004, Stromberg 2001, Dyck and Zingales 2002). Since any biased news will decrease information accuracy and consumers' capacity to estimate the underlying truth, classic economic theory suggests that media competition will eliminate biases in the news if media is free and not influenced by outside forces.[4]

[3] See "A Statement of Shared Purpose" on www.journalism.org.

[4] Of course, government influence or control is also an important source of media bias (Gentzkow et al. 2004) as is media ownership (Besley and Prat 2006, Djankov et al. 2003).

Recently, media bias has been revisited by the economics literature.[5] In an earlier paper Gabszewicz et al. (2001) consider the demand for advertising in the press and study the political opinions of competing newspapers in a Hotelling setting.[6] More recent papers continued along this line by examining media bias under the core assumption that heterogenous consumer preferences are at the origin of the phenomenon. The most prominent among these is Mullainathan and Shleifer (2005) who assume that biased news is solely produced by slanting, i.e., the selective omission of certain information. Media bias then emerges from the optimal slanting strategies of news providers because consumers want certain (albeit different) degree and direction of slant. Thus, Mullainathan and Shleifer (2005) argue that the *extent* of media bias is mainly driven by consumer heterogeneity. This is intuitive. After all, if there is a need and demand for biased news, privately owned media will have an incentive to satisfy that need/demand. Their core result is that under media competition, while increased consumer heterogeneity may lead to increased media bias as compared to a monopoly, a hypothetical conscientious reader may be better off under media competition because by cross-checking the news s/he can obtain more accurate information. Apart from Mullainathan and Shleifer (2005), Gentzkow and Shapriro (2004) also argue that media bias may emerge from competing media catering to biased consumer beliefs but in their paper the mechanism is slightly different. In their model, consumers consider that news consistent with their prior expectations is of higher quality. In response, news providers slant news to earn a reputation for high quality.

Our work is closest to Mullainathan and Shleifer (2005) with two important differences. First, as opposed to their paper, where slanting is costless and the available information is unlimited, in our model, media doesn't have unlimited ability to slant in order to deliver news that exactly fits the preferences of certain consumers. While a medium may aspire to position news in certain

[5]Despite being an important topic, media bias has been largely neglected by marketing. In the relatively narrow domain of political marketing, the literature has mostly focused on issues related to the effectiveness/efficiency of campaign advertising (Sheinkopf et al. 1972, Rothschild 1978, Chapman and Palda 1984) and voter behavior (Newman and Sheth 1985). In a recent article, Crockett and Wallendorf (2004) study the impact of political ideology on consumer behavior.

[6]Media positioning is also modeled this way in Dukes and Gal-Or (2003) but there, positioning is exogenous.

ways, the truth about the underlying events may prevent an extreme positioning. For example, if losses are high in a war, then a medium can downplay them in the news but cannot claim them to be minimal. Furthermore, we assume that the more a medium is willing to support a position that is inconsistent with the truth the higher costs it has to incur to find supporting evidence. Second, and more importantly, our model considers the conscientious consumers as active economic agents in the marketplace. As we have argued above, data shows that this segment is not negligible and may exert an important externality on media outlets competing for biased consumers. Our model therefore explicitly takes into account the dual nature of the news market by considering two segments: biased and conscientious consumers.

3 The Model

The model consists of three building blocks. First, we describe the data structure that relates to the events that the public wants to hear about and media report. Next, we describe how media outlets construct news from this data, possibly by slanting some of the data. Finally, we describe how different consumers value the news and how media respond to their demand.

3.1 Data About Events

Assume that for an event the true state of the world is an underlying random variable θ, uniformly distributed over $[0, 1]$. For example, θ can be the benefit of a healthcare program; e.g. $\theta = 1$ means the program is excellent from every aspect while $\theta = 0$ means it doesn't do anything good.

The true state of the world is not directly observable, only data about θ is. These data are generated through an exogenous process. Specifically, in line with Hayakawa (1990) and Mullainathan and Shleifer (2005), we model the data as a string D consisting of '1's and '0's. This data string is a series of *i.i.d.* random draws from a Bernoulli process with Prob($D_i = 1$)=θ. In other words, a datapoint in position i of the string D is 1 with probability θ and 0 with probability $1 - \theta$. These '1's and '0's can be thought of as positive and negative signals about the truth. In the example of the health care program, a '1' could be the opinion of a retired worker suggesting that the program is excellent, while a '0' could be the opinion of an economist who argues that the program is a financial disaster. Therefore, '1's will push the inferred truth towards the right end of the continuum $[0, 1]$, while '0's will push it towards the left end. Assume that the data a media firm obtains looks like $d = \{1, 0, 0, 1, 1, 1, 0, 0, 1, 1\}$. There are six '1's and four '0's in d; then θ can be inferred from the string: $\hat{\theta} = \frac{6}{6+4} = 0.6$. More generally, if the string d contains n_1 of '1's and n_0 of '0's, the unbiased estimate of the truth is $\frac{n_1}{n_1 + n_0}$.

3.2 News, Data Collection and Slanting

The news reported by a media outlet comes from the string D and it conveys a message about the state of the world, denoted m. If a news report contains n_1 and n_0 of '1's and '0's respectively, then $m = \frac{n_1}{n_1 + n_0}$. We assume that the length of the news, i.e., the total number of '1's and '0's in a reported piece of news is N, which can be thought of as the word limit of a news story, or the minute limit of a TV news program.

Collecting data is costly. For simplicity, we assume two cost levels and, without loss of generality, we normalize the low cost level to 0 while the high cost level is denoted C. More precisely, a medium can either spend 0 to collect N bits of information to satisfy the required word limit of the news or spend C to collect $2N$ bits of data. In the former case, the media outlet has to report its data integrally. If it spends C however, it can select what to report as it has more information available than what is needed for the news. Stated in another way, with low effort of collecting data a media outlet has to be honest, but with high effort it can slant the news.[7] At first sight, this seems to be inconsistent with reality as one could argue that media outlets can send reporters to collect biased data (e.g. interview a partisan witness). Our model is consistent with this setup, however. If we assume that the reporter randomly samples the witnesses until it finds the one with the desired point of view, then this setup is identical to our model's. Notice that we assume that media outlets can not manufacture data.

[7] This assumption is consistent with Dewatripont and Tirole (1999) who consider data collection under advocacy.

With $2N$ data a media outlet can slant the news but such slanting is constrained by the truth. At cost C, a media outlet can expectedly get $n_1 = 2N\theta$ and $n_0 = 2N(1-\theta)$ '1's and '0's respectively. However, if a media outlet slants with the objective to convey a message m, then its news should contains $n_1 = mN$ '1's and $n_0 = (1-m)N$ '0's. But even with $2N$ data points, the medium may not have sufficient numbers of '1's or '0's to be able to report m. Specifically, m is constrained by the truth θ the following way:

$$\begin{cases} mN \leq 2N\theta & \text{(news contains no more '1's than in the data)}, \\ (1-m)N \leq 2N(1-\theta) & \text{(news contains no more '0's than in the data)}. \end{cases} \quad (1)$$

(1) determines the possible range of slanting by a media outlet: $2\theta - 1 \leq m \leq 2\theta$.[8]

3.3 Consumers

There are two kinds of consumers: "biased" and "conscientious". Biased consumers want to read/watch news that is consistent with their prior beliefs. One can consider that for these consumers, news essentially represents entertainment. We assume that biased consumers are heterogenous in their beliefs. More specifically, they are uniformly distributed over $[a, b]$ in their prior beliefs ($0 \leq a \leq b = 1 - a$) with their total number normalized to 1. Denote by x a biased consumer's belief location. Then, his/her utility from consuming a news report is:

$$u^b = R - t(x-m)^2 - p, \quad (2)$$

where R is the reservation price, t calibrates the biased consumer's disutility from consuming news different from x, $x - m$ measures the inconsistency between the news and the consumer's

[8] We assume that N is finite but large. While the truth is a continuous variable like the red liquid in a thermometer, the length N resembles the temperature scale. This means that consumers are satisfied with the amount of data reported in a news story and it also allows us to approximate m as on a continuum. The finiteness of N forbids a media outlet from limitless slanting and utilizing such reporting strategies as $m = m_b + \epsilon(\theta - m_b)$, where m_b is catered to biased consumers and ϵ is a very small scalar used to signal the truth to conscientious consumers.

prior belief, and p is the price of the news. The term price here is used to crudely capture a rather wide range of revenue models (unit price, annual subscription fees or even consumers' willingness to read/watch ads). Distinction between these revenue models is outside the scope of the present paper. For simplicity, we assume that every biased consumer will buy and consume at least one piece of news, i.e. that their reservation price R is sufficiently high.[9]

In contrast to biased consumers, conscientious consumers consume the news to gain information about the truth. Thus, after the realization of the truth, a conscientious consumer's utility for the news consumed is:

$$\begin{cases} u_i^c = R - k(\theta - E(\theta \mid m_i))^2 - p_i & \text{if she only consumes news } i, \\ \\ u_{1,2}^c = R - k(\theta - E(\theta \mid m_1,\ m_2))^2 - p_1 - p_2 & \text{if she consumes news 1 and 2,} \end{cases} \tag{3}$$

where $\theta - E(\theta \mid m_i)$ is the deviation from the truth by news report i, k measures the disutility of this deviation, and p_i is the price of news i. Notice that consumers don't know the content of the news story until they finish consuming it. They have to make a purchase decision before the consumption, i.e., before knowing the message m from a news report (and, of course, before the realization of θ). Therefore, their purchase decisions are based on their expected utility, $E(u)$.[10] We assume that the total number of conscientious consumers is $\alpha > 0$.

3.4 Media Reporting Stances

A media outlet can claim that its news is an unslanted reflection of its data and hence an unbiased estimate of the truth, $m = E(\theta \mid D)$. Since the total number of data points, N is large, $E(\theta \mid D) \approx \theta$.[11] Therefore we will assume that when a media outlet reports honestly,

[9] We give detailed proof about the existence of such a reservation price in the technical appendix.

[10] Also, (3) assumes that conscientious consumers incur no cost when they combine multiple pieces of news. Under this assumption, one could argue that, instead of using m_1 and m_2 they should cross-check the news bit-by-bit. While this is not possible in our model (as the position of bits is not recorded), introducing this feature would actually make our results stronger because cross-checking news reports would provide even more information.

[11] The assumption of a large N allows us to focus on the bias issue neglecting the statistical inference issues.

$E(\theta \mid D) = \theta$, i.e., $m = \theta$. The media outlets can also influence consumers' expected utility by announcing their reporting stances, denoted s ($s \in [0,1]$). The reporting stance is a claim about the numbers of '1's and '0's in the news that the medium will *aspire* to report. This reporting stance is used to crudely capture the long-term reputation of a media outlet (say for example, in terms of political orientation). If the data allow, a media outlet will fulfill its reporting stance, i.e. it will slant the data till $m = s$. Since slanting is limited by the available data, a medium will not always be able to fulfill its reporting stance. If the data don't allow, a media outlet will slant the news so that m is closest to its reporting stance, s. This means that $m = 2\theta$ for a media outlet on the left and $m = 2\theta - 1$ for a media outlet on the right. Put more formally:

$$m(s) = \begin{cases} 2\theta & \text{if } s > 2\theta, \\ s & \text{if } s \leq 2\theta \text{ and } (1-s) \leq 2(1-\theta), \\ 2\theta - 1 & \text{if } (1-s) > 2(1-\theta). \end{cases} \tag{4}$$

Consider the following example. Assume that the data collected with high effort (i.e. representing $2N$ data points) is the following: $\{1,0,0,1,1,1,0,0,1,1\}$.[12] Clearly, $E(\theta \mid D) = 0.6$. Notice that for no cost a media outlet would have received the first half of the data (N observations): $\{1,0,0,1,1\}$, which also leads to $E(\theta) = 0.6$. If a media outlet incurs low effort, it then has to report honestly: $m = E(\theta) = 0.6$. However, if it incurs high effort, it can slant its news story to cater to some consumers. Suppose the medium's reporting stance is $s = 0.4$. With a bigger data set, it can drop some '1's from the data string, and its news report will look like $\{1,0,0,0,1\}$, leading to $m = s = 0.4$. However, if its reporting stance were $s = 0$, then at most it could report a news story of $\{1,0,0,0,0\}$, hence, in this case $m = 0.2 \neq s$. Notice that we allow media outlets to choose reporting stances outside the range of consumer preferences, $[a,b]$ as long as $0 < a < b < 1$.

After the decision on reporting stance, media outlets announce their prices and consumers decide how much and which news to buy. Notice that consumers' purchase decision depends on two factors: reporting stances and prices. We will consider two cases: (i) a monopolist media

[12] For the sake of the example, we use a small N.

outlet and, (ii) two competing media outlets, 1 and 2. Without loss of generality, we assume that media outlet 1 is positioned to the left of outlet 2, that is $s_1 < s_2$. The timing of the game is the following. The two media outlets simultaneously choose their effort for data collection (high or low). Next, they decide their reporting stances simultaneously, which become public knowledge.[13] Next, prices are simultaneously announced. Finally, consumers (both biased and conscientious) make their purchase decisions.

3.5 Media Bias and Information Efficiency

We are interested in the level of media bias and the information efficiency of the industry. We define media bias in terms of the sum of expected differences between the truth and the message delivered by the media:

Definition 1 $MB = \sum_{i=1}^{2} E(|m_i(s_i) - \theta|)$.

Notice that MB is a function of the media outlets' choices of reporting stances. The more extreme those stances are, the more slanting is likely to be needed to meet each medium's reporting stance.

We are also interested in the efficiency of the media (as an industry) in recovering the truth from the data. We call this information efficiency. Obviously, this only concerns conscientious consumers as they are the only ones interested in the truth. Thus, information efficiency is:

Definition 2 $IE = -E[(\theta - E(\theta \mid m_1, m_2))^2]$.

The measure of information efficiency is basically a conscientious consumer's expected loss when reading/watching both pieces of news. With these definitions, we can examine how the media performs on these measures in equilibrium, the computation of which is presented next.

4 Analysis

The game is solved by backward induction. In the fourth stage, consumers make their purchase decision before consuming the news, i.e., before knowing the message m from a news story.

[13] The order of these first two steps could be reversed without changing the results.

Therefore, we first calculate consumers' expected utility of consuming different news (slanted or unslanted). We then analyze media outlets' strategic variables, including prices, reporting stances and data collection effort. Before claiming their reporting stances, media outlets first have to decide their effort level in collecting data. With a high effort, a media outlet can either claim a reporting stance at a fixed number ($s \in [0,1]$) or claim its honesty ($m = \theta$). With a low effort, however, it can only claim its unbiasedness and consequently its reporting stance is just the truth ($m = \theta$). Therefore, different effort levels will result in different strategic action sets in the subsequent stages.

4.1 Consumers' Expected Utility

Let us start with consumers consuming unslanted news. If a media outlet chooses to report the unslanted reflection of whatever data it gets, then the media outlet doesn't have a fixed reporting stance so its message m is always an unbiased estimate of the truth (i.e., $m = \theta$ since N is large). Before a biased consumer reads/watches this unslanted news, his/her expected utility is:

$$\begin{aligned} E(u_i^b) &= R - tE\left[(x - m_i)^2\right] - p_i \\ &= R - t\left[x^2 - 2xE(m_i) + E(m_i^2)\right] - p_i \\ &= R - t(x^2 - x + \frac{1}{3}) - p_i. \end{aligned} \tag{5}$$

Obviously, a conscientious consumer will have an expected utility of $E(u^c) = R - p_i$.

Next, let us take the case when consumers consume slanted news. Before their purchase, consumers know that the fulfillment of a reporting stance is constrained by the data and the underlying truth. From (4), the fulfillment requires $2\theta - 1 \le s \le 2\theta$, i.e. $\frac{s}{2} \le \theta \le \frac{s+1}{2}$. The expected utility of a biased consumer then becomes:

$$E(u_i^b) = R - tE[(x - m_i)^2] - p_i = R - t[x^2 - 2xE(m_i) + E(m_i^2)] - p_i, \tag{6}$$

where

$$E(m_i) = \int_0^{s_i/2} 2\theta f(\theta)d\theta + \int_{s_i/2}^{(s_i+1)/2} s_i f(\theta)d\theta + \int_{(s_i+1)/2}^{1} (2\theta - 1)f(\theta)d\theta = \frac{2s_i + 1}{4} \tag{7}$$

and

$$E(m_i^2) = \int_0^{s_i/2} (2\theta)^2 f(\theta) d\theta + \int_{s_i/2}^{(s_i+1)/2} s_i^2 f(\theta) d\theta + \int_{(s_i+1)/2}^{1} (2\theta - 1)^2 f(\theta) d\theta = \frac{3s_i^2 + 1}{6}. \tag{8}$$

Therefore,

$$E(u_i^b) = R - t \left[\left(x - \frac{2s_i + 1}{4} \right)^2 + \left(\frac{2s_i - 1}{4} \right)^2 + \frac{1}{24} \right] - p_i. \tag{9}$$

A conscientious consumer is not interested in message m but rather the underlying truth, $E(\theta \mid m)$, that s/he can estimate from s and m. Specifically, when $m \neq s$, s/he knows that the media outlet can not fulfill its reporting stance because the data is not enough to support it. From this, s/he knows that the truth is on the left of the message if $m < s$ and on the right of the message if $m > s$. Understanding that the slanted news comes from $2N$ bits of data, a conscientious consumer knows $E(\theta \mid m_i) = m_i/2$ if $m_i < s_i$, and $E(\theta \mid m_i) = (m_i + 1)/2$ if $m_i > s_i$. However, when $m = s$, the conscientious consumer only knows that the data allow the fulfillment of the reporting stance, hence the truth is uniformly distributed between $\left[\frac{s_i}{2}, \frac{s_i+1}{2}\right]$ and his/her best estimate of the truth is the mean of this reduced uniform distribution: $\frac{2s_i+1}{4}$. Therefore,

$$E(\theta \mid m_i) = \begin{cases} \frac{m_i}{2} & \text{if } m_i < s_i, \\ \frac{2s_i + 1}{4} & \text{if } m_i = s_i, \\ \frac{m_i + 1}{2} & \text{if } m_i > s_i. \end{cases} \tag{10}$$

Substituting (4) into (10), we have:

$$\begin{aligned} E[(\theta - E(\theta \mid m_i))^2] &= \int_0^{s_i/2} 0 f(\theta) d\theta + \int_{s_i/2}^{(s_i+1)/2} (\theta - \frac{2s_i + 1}{4})^2 f(\theta) d\theta + \int_{(s_i+1)/2}^{1} 0 f(\theta) d\theta \\ &= 1/96. \end{aligned} \tag{11}$$

As a result, a conscientious consumer's expected utility from consuming a biased news is:

$$E(u_i^c) = R - kE[(\theta - E(\theta \mid m_i))^2] - p_i = R - k/96 - p_i. \tag{12}$$

When the conscientious consumer consumes news from two biased media outlets, 1 and 2, with reporting stances $s_1 < s_2$, s/he knows that $m_1 < m_2$ since the two media outlets have the same data. Therefore,

$$E(\theta \mid m_1, m_2) = \begin{cases} \dfrac{m_2}{2} & \text{if } m_2 < s_2, \\ \dfrac{s_1 + s_2 + 1}{4} & \text{if } m_1 = s_1 \text{ and } m_2 = s_2, \\ \dfrac{m_1 + 1}{2} & \text{if } m_1 > s_1. \end{cases} \tag{13}$$

His/her expected utility can be calculated using the same logic as before. After some algebra, we obtain:

$$E(u^c_{1,2}) = R - k\frac{(1 + s_1 - s_2)^3}{96} - p_1 - p_2.$$

Clearly, the conscientious consumers' utility is higher, the higher is information efficiency. The intuition is explained on Figure 2. When consuming only one slanted news, say news 1, a conscientious consumer can precisely figure out the truth when $\theta < \frac{s_1}{2}$ or $\theta > \frac{s_1+1}{2}$. When $\frac{s_1}{2} < \theta < \frac{s_1+1}{2}$, the conscientious consumer only knows that the truth is between $\left[\frac{s_1}{2}, \frac{s_1+1}{2}\right]$. Notice that the size of this area doesn't change with s_1. The same applies to consuming news 2 alone. However, when consuming both slanted news, the conscientious consumer can precisely figure out the truth when $\theta < \frac{s_2}{2}$ or when $\theta > \frac{s_1+1}{2}$. When $\frac{s_2}{2} < \theta < \frac{s_1+1}{2}$, the conscientious consumers only know that the truth is between $\left[\frac{s_2}{2}, \frac{s_1+1}{2}\right]$. In other words, $\left[\frac{s_2}{2}, \frac{s_1+1}{2}\right]$ is the area where the conscientious consumer can not figure out the truth. Obviously, this area decreases as s_1 decreases or s_2 increases.

Notice that, when the conscientious consumer buys from two media, the more the two media are biased (the more their reporting stances are extreme), the better off the conscientious consumer is from the perspective of information efficiency (the middle term in $E(u^c_{1,2})$ is a negative number with lower absolute value). However, we can expect that in this case, media prices are also going to be higher because the media are more differentiated (reporting stances are further apart), which hurts the conscientious consumer.

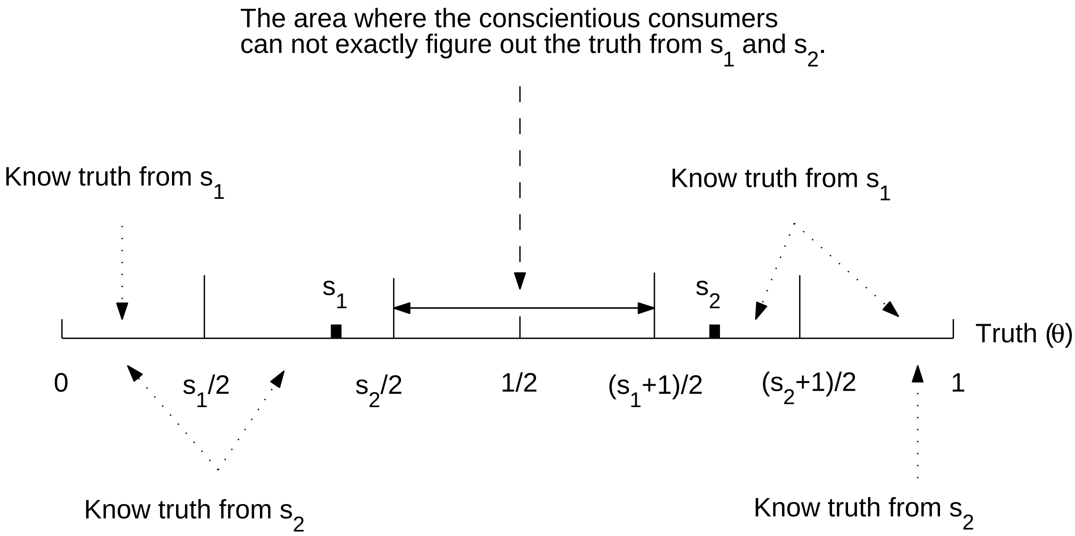

Figure 2: Conscientious consumers' truth revealing as a function of reporting stances.

4.2 Monopolist Media Outlet

To set a benchmark, let us first look at a monopolist media outlet. The following Lemma summarizes the analysis for this case.

Lemma 1 *Let $\underline{s_m}$ and $\overline{s_m}$ be as defined in the Appendix. There exists an $\underline{R_m}$ such that, when $R > \underline{R_m}$, a monopolist media outlet will cover both the biased and conscientious markets, and its equilibrium data collection effort and reporting stance is:*

$$\begin{cases} \textit{High effort} \quad s_m = \frac{1}{2} & \textit{if } k \leq 96t\left[(\frac{1}{2}-a)^2 + \frac{1}{24}\right] \textit{ and } \frac{t(1+\alpha)}{12} > C, \\ \textit{High effort} \quad s_m \in [\underline{s_m}, \overline{s_m}] & \textit{if } k > 96t\left[(\frac{1}{2}-a)^2 + \frac{1}{24}\right] \\ & \quad \textit{and } (1+\alpha)\left[t(a-\frac{1}{2})^2 + \frac{t}{12} - \frac{k}{96}\right] > C, \\ \textit{Low effort} \quad \textit{honest reporting} & \textit{if } \frac{t(1+\alpha)}{12} < C \textit{ or,} \\ & \frac{t(1+\alpha)}{12} > C > (1+\alpha)\left[t(a-\frac{1}{2})^2 + \frac{t}{12} - \frac{k}{96}\right] \\ & \quad \textit{and } k > 96t\left[(\frac{1}{2}-a)^2 + \frac{1}{24}\right]. \end{cases} \tag{14}$$

Proof: See appendix.

Lemma 1 basically says that when the conscientious consumers' disutility for bias (k) is low, the monopolist will incur high effort in data collection so that it can slant its news to cater to the biased consumers. However, when the monopolist slants, its reporting stance will be in the middle of the biased consumers' preference continuum.[14] In contrast, when the conscientious consumers' disutility for bias (k) is high, the monopolist will incur low effort in data collection and report the truth so that the conscientious consumers buy the news. In sum, under a monopoly setting, as expected, the medium caters to the conscientious consumers when these become more relevant. We will see that this is not necessarily the case under competition.

4.3 Duopolist Media Outlets

Recall that media outlets first have to decide their effort levels in collecting data. With a high effort, a media outlet can claim its reporting stance at a fixed number between $[0, 1]$. With a low effort, however, it can only claim its unbiasedness and consequently its reporting stance is just the truth θ. Therefore, different effort levels will introduce different strategic action sets in the subsequent stages. To determine the full equilibrium, we need to calculate the equilibrium profits in three sub-games: (i) each media outlet incurs low effort (π_{LL}), (ii) one media outlet incurs low effort and the other incurs high effort (π_{LH} and π_{HL}) and, (iii) both outlets incur high effort, (π_{HH}). With these equilibrium profits we can calculate the equilibrium effort levels according to the game represented by Table 1.

Obviously, when both media outlets incur low effort in collecting data, both have to report honestly and their news reports convey the same message that is an unbiased estimate of the truth θ. In other words, the two pieces of news are perfect substitutes[15] and consequently Bertrand

[14] Under the second case of the Lemma, the monopolist media outlet is indifferent between the points of a segment that is centered on $1/2$, i.e. the first two cases in the Lemma are qualitatively equivalent.

[15] Since the bias level in the news is the major focus of this paper, we do not consider the benefit of decreased variance in the estimate of truth when consuming news from both media outlets. Furthermore, considering decreased

competition will drive prices down to 0. Therefore $\pi_{LL} = 0$.

		Media outlet 2	
		Low	High
Media	Low	π_{LL} , π_{LL}	π_{LH} , π_{HL}
outlet 1	High	π_{HL} , π_{LH}	π_{HH} , π_{HH}

Table 1: Media outlets' equilibrium profits under different effort levels

Detailed calculations of π_{HL}, π_{LH}, and π_{HH} are available in the appendices. Obviously, when the cost of collecting data is very high, no media outlet will ever collect data and therefore, they will not slant either. To avoid this uninteresting case, in the following analysis, we will assume that the cost of collecting data (C) is not very high, such that when one media outlet chooses low effort, the other will choose high effort. In other words, slanting is always considered by at least one media outlet. To ensure this we assume the following:

Assumption 1

$$C < \frac{t(1-3\psi\omega)^2}{648\psi}, \quad \textit{where} \quad \psi = 1-2a \textit{ and } \omega = 3+2\alpha.$$

Under Assumption 1, $\pi_{HL} > \pi_{LL}$.[16] Consequently, depending on π_{HH} and π_{LH}, there are two possible equilibria:

$$\begin{cases} (H,H) & \text{if } \pi_{HH} \geq \pi_{LH}, \\ (H,L) \textit{ or } (L,H) & \text{if } \pi_{HH} < \pi_{LH}. \end{cases} \tag{15}$$

In the first equilibrium, both media outlets incur high efforts in collecting data so as to cater to the biased consumers (albeit to different ones). In the second equilibrium, only one medium collects extra data, the other collects just enough data to report honestly. These two equilibria are analyzed in detail next.

variance would actually strengthen our results.

[16]When $\pi_{HL} \leq \pi_{LL}$, there may exist mixed strategy equilibria where media outlets incur high effort or exit the market with some probability.

4.3.1 Both Media Slant

The following proposition describes the equilibrium in which both media outlets slant the news.

Proposition 1 *Assume that the conscientious consumers' disutility for bias is large ($k > 16t$). There exist $\underline{C}$ and $\overline{\alpha}$ such that, when the cost of collecting extra data is low ($C < \underline{C}$), or when the cost is high ($\underline{C} < C$) and the number of conscientious consumers is high ($\alpha > \overline{\alpha}$), there exists a unique sub-game perfect equilibrium where both media outlets incur high effort in collecting data and provide slanted news to fulfill the following reporting stances (assuming $s_1 < s_2$):*

$$\begin{cases} s_1^* & = \max\left\{\frac{1}{2} - \frac{3\psi(\omega-2)}{4}, 0\right\}, \\ \\ s_2^* & = \min\left\{\frac{1}{2} + \frac{3\psi(\omega-2)}{4}, 1\right\}, \end{cases} \tag{16}$$

where $\psi = 1 - 2a$ and $\omega = 3 + 2\alpha$. In equilibrium, conscientious consumers buy both pieces of news.

Proof: See appendix.

The equilibrium described in Proposition 1 has several interesting characteristics. The first one concerns the cost of data collection. Intuitively, when this cost is low, slanting is cheap and media outlets are willing to collect extra data to slant irrespective of α. In particular, if C and α are both 0, we get the simple Hotelling game.

The second characteristic concerns media outlets' reporting stances. It can be easily checked that $s_1^* < a < 1-a < s_2^*$. This means that when both media outlets slant, they will claim reporting stances that are more extreme than the position of the most extreme biased consumers in the population. While this is intriguing, it is consistent with Mullainathan and Shleifer (2005) and relates to the standard Hotelling model. Zhang (2006) shows that in Hotelling, price competition drives competitors away from each other and this can lead to positions beyond extreme consumer preferences. She also shows that as a decreases (consumer bias has a larger range) firms' positions (media stances) will be more extreme too. However, with the presence of conscientious consumers, media stances become *even* more extreme. This is intriguing and requires an explanation.

The third characteristic of the equilibrium concerns the impact of conscientious consumers on media bias, which is our major focus in this paper. Surprisingly, Proposition 1 suggests (see detailed analysis in section 4.3.3) that with more conscientious consumers, media outlets are more inclined to collect extra data and slant. This is related to the extreme reporting stances that they claim: the more these positions are extreme the more pressure news providers have to slant.

The intuition behind Proposition 1 is the following. When the disutility for bias of conscientious consumers is high ($k > 16t$), they might buy both pieces of news. Then the media outlets only compete on price for the biased consumers. When the number of conscientious consumers increases, the biased consumer market becomes less important and media outlets are more willing to increase prices to exploit the captive conscientious consumer segment. To achieve this they claim extreme reporting stances (well beyond the most biased consumers' preferences), which in turn forces them to slant more. In sum, when the number of conscientious consumers is high and their disutility for bias is also high, media bias is high and there is little price competition between media outlets.

An interesting particular case to consider is when $\alpha = \infty$, i.e. there are only conscientious consumers. Naive reasoning would say that in this case, both media would be always unbiased in equilibrium. This is not necessarily the case. Two unbiased media face harsh price competition. As we will see below, this is also the case when only one medium is biased. On the other hand, if conscientious consumers' disutility for bias is large, then two biased media would face little price competition because both sell to each consumer. Therefore, media firms prefer to be biased.

4.3.2 Only One Medium Slants

We next explore an equilibrium where one of the media outlets reports honestly. The following proposition summarizes the conditions for such an equilibrium.

Proposition 2 *Assume that the conscientious consumers' disutility for bias is large ($k > 16t$).*

There exist $\underline{C}$ and $\underline{\alpha}$ such that, when the cost of information collection is high ($C > \underline{C}$) and the number of conscientious consumers is small ($\alpha < \underline{\alpha}$), there exists a unique sub-game perfect equilibrium where one media outlet incurs high effort in collecting data and provides biased news while the other incurs low effort and reports honestly. The equilibrium reporting stance of the slanting medium is:

$$s_H^* = \max\left\{\frac{1}{6}(3 - \psi\omega - \sqrt{\psi^2\omega^2 - 1}),\, 0\right\}, \qquad \text{where } \psi = 1 - 2a \text{ and } \omega = 3 + 2\alpha. \tag{17}$$

All consumers buy one piece of news with conscientious consumers buying from the honest medium.

Proof: See appendix.

As expected, when the cost of collecting extra data is high, slanting becomes less profitable than honest reporting. Then it may become interesting to choose this strategy. By choosing low effort, i.e. honest reporting, the media outlet also positions itself in the center of the biased market.[17] This is similar to strategic commitment in positioning. In reaction, the media outlet with high effort has to position itself far away from the center of the biased market to decrease price competition. Thus, the honest media outlet gains an advantage of being close to demand. Here, however, the number of conscientious consumers has qualitatively different impact on the price competition between media outlets. Now, buying the honest news only always dominates buying both pieces of news for a conscientious consumer. This is because when the conscientious consumer buys the unslanted news, his/her disutility for media bias is minimized to zero and the slanted news adds no utility, while representing extra cost. The two media outlets then compete in both biased and conscientious markets. More specifically, a conscientious consumer's expected utility from the honest news is: $R - p_L$ and her utility from the slanted news is: $R - \dfrac{k}{96} - p_H$. Thus, the maximal price an honest media outlet can charge to the conscientious consumers is

[17] This is different from claiming a reporting stance $s = \frac{1}{2}$. A reporting stance $s = \frac{1}{2}$ gives a biased consumer an expected utility of $R - t\left[(x - \frac{1}{2})^2 + \frac{1}{24}\right] - p$, while honest reporting gives the biased consumer an expected utility of $R - t\left[(x - \frac{1}{2})^2 + \frac{1}{12}\right] - p$.

$p_L = p_H + \dfrac{k}{96}$. Therefore, the two media outlets are in harsh price competition. Understandably, this price competition increases with the number of conscientious consumers, which is in sharp contrast with the symmetric equilibrium.

An interesting special case to consider is when $\alpha = 0$, i.e. there are only biased consumers. Again, naive reasoning would argue for a standard Hotelling game in this case. However, when C is high then being unbiased means covering the middle of the marker *and*, at the same time lowering costs as there is no need to collect extra data. In other words, if the cost of collecting extra data is large (as stated in Proposition 2) then even with only biased consumers, we may end-up in an asymmetric equilibrium.

4.3.3 Comparative Statics

In this section, we summarize the key results from the comparative statics.

Result 1 *When biased consumers' heterogeneity increases, media have more incentives to slant.*

Proof (sketch): The detailed proof is in the appendix. In the game described in Table 1, if $\pi_{HH} > \pi_{LH}$, then both media outlets will collect extra data to slant, while only one media outlet will collect extra data if $\pi_{HH} < \pi_{LH}$. Simplification yields that (i) if $t > \underline{t}$ then $\pi_{HH} > \pi_{LH}$ and if $t < \underline{t}$ then $\pi_{HH} < \pi_{LH}$.

The parameter t captures the biased consumers' disutility of reading/watching news that is inconsistent with their beliefs. Thus t measures those consumers' preference for bias. It is then clear that when these consumers' preference for bias is high $t > \underline{t}$, both media outlets collect extra data and slant. When these consumers' preference for bias is low $t < \underline{t}$, only one media outlet collects extra data to slant, the other reports honestly. However, it can be easily checked in Propositions 1 and 2 that all reporting stances are independent of the parameter t. $\square$

Result 2 *When there are more conscientious consumers, media bias is higher (reporting stances are more extreme) and thus, the media slant more.*

Proof: We need to show that more media outlets will slant and their reporting stances become more extreme as the number of conscientious consumers increases. In the technical appendix, we show that $\underline{\alpha} \leq \overline{\alpha}$. This means that, when there are more conscientious consumers, media outlets' slanting strategies move from Equilibrium 2 to Equilibrium 1. Thus, more media outlets will slant when there are more conscientious consumers.

When both media outlets slant (Equilibrium 1), taking the derivative of the equilibrium reporting stances with respect to α (i.e. the number of conscientious consumers) we obtain (for the case when media outlets are not at the extreme, i.e., their reporting stances are not 0 or 1):

$$\begin{cases} \dfrac{\partial s_1^*}{\partial \alpha} & = \dfrac{3(2a-1)}{2} < 0, \\ \\ \dfrac{\partial s_2^*}{\partial \alpha} & = \dfrac{3(1-2a)}{2} > 0. \end{cases} \tag{18}$$

The above inequalities show that, as α increases, s_1^* will become smaller and s_2^* larger. Thus both media outlets will have reporting stances further away from the mean of the truth. Also, the total media bias in the industry is $MB = \dfrac{13}{16} + \dfrac{9}{4}[\alpha(1+\alpha) - a(1+2\alpha)^2 + a^2(1+2\alpha)^2]$. Consistently with the above discussion, one can see that MB is increasing in α, as $\dfrac{\partial MB}{\partial \alpha} = \dfrac{9}{4}(1-2a)^2(1+2\alpha) > 0$.

Similarly, when only one media outlet slants, only this media outlet claims a reporting stance s_H. It can also be checked that in this case $\dfrac{\partial s_H^*}{\partial \alpha} < 0$. Since $s_H < \dfrac{1}{2}$, the slanting media outlet's reporting stance also becomes more extreme when there are more conscientious consumers. The total media bias in the industry is

$$MB = \frac{4 + \psi\omega(\psi\omega + \sqrt{\psi^2\omega^2 - 1})}{36}, \tag{19}$$

where $\psi = 1 - 2a$ and $\omega = 3 + \alpha$. It is easily checked that

$$\frac{\partial MB}{\partial \alpha} = \frac{\partial MB}{\partial \omega} \cdot \frac{\partial \omega}{\partial \alpha} = \frac{\psi(2\psi^2\omega^2 - 1 + 2\psi^2\omega^2\sqrt{\psi^2\omega^2 - 1})}{36\sqrt{\psi^2\omega^2 - 1}} > 0. \ \square \tag{20}$$

Figure 3 shows the two pure-strategy equilibria in the parameter space of $\{a, \alpha\}$ at ($t = 1, C = 0.2$). It is obvious that given any a, t, C, Equilibrium 1 happens only when α is high, and

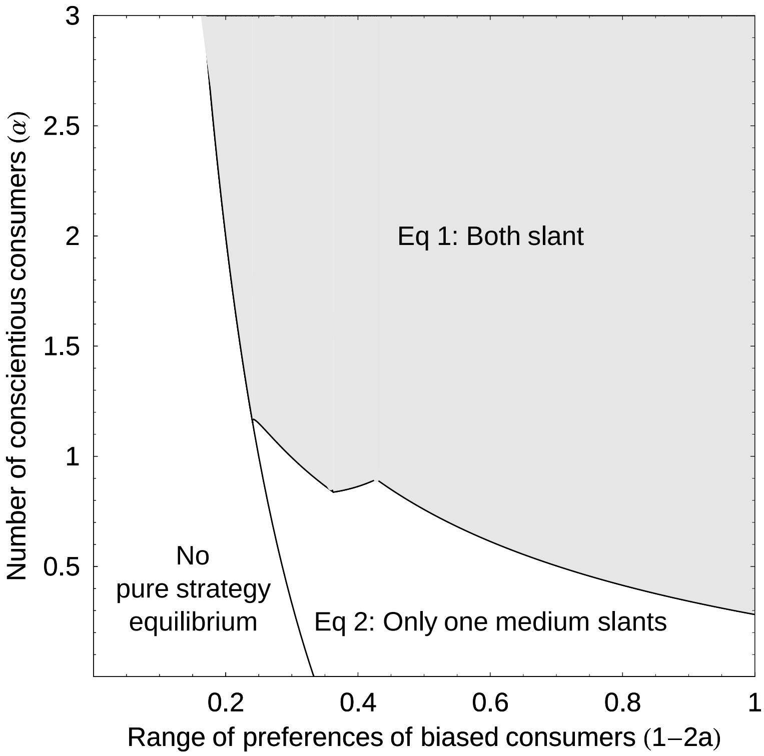

Figure 3: Equilibria in the parameter space of $\{a, \alpha\}$, $(t = 1, C = 0.2)$.

Equilibrium 2 only happens when α is low. Thus, in equilibrium more media outlets will slant when there are more conscientious consumers.

With respect to prices, we have already seen that:

Result 3 *In the symmetric equilibrium (Proposition 1), more conscientious consumers leads to less price competition. In the asymmetric equilibrium (Proposition 2), more conscientious consumers leads to more price competition.*

The conscientious market's qualitatively different impact on price competition sheds some light on the consequences of entry. It is well known that the introduction of Fox News in 1996 caused CNN to shift to the left. Based on the standard Hotelling model, one would expect that this move results in less demand. This is not what happened. While Fox News' audience increased substantially after the entry, this did not significantly decrease CNN's audience size.

Our analysis of the Pew data shows that 21.1% of the population regularly watched CNN in early 1997, and in 2004, this actually increased to 22%. Note also, that 30% of Fox News audience (8% of population) regularly watches CNN. This indicates that a substantial part of consumers cross-checks the two competing news outlets. CNN's shift to the left also indicates that here, the symmetric equilibrium where price competition is mild was preferred to the asymmetric one.

Result 4 *Given high effort levels of media outlets, when media bias is higher, information efficiency is also higher, i.e. conscientious consumers can better recover the truth from the biased news.*

Proof: Recall from Section 3 that in the symmetric equilibrium, information efficiency is:

$$IE = -E[(\theta - E(\theta \mid m_1, m_2))^2] = -\frac{(1 + s_1 - s_2)^3}{96}, \tag{21}$$

which represents the conscientious consumers' expected error of consuming both pieces of news. It is then straightforward to see that when media bias increases (s_1 decreases or s_2 increases), information efficiency becomes higher. □

Figure 4 shows information efficiency as a function of media bias when both media slant. The underlying intuition is again illustrated in Figure 2. We saw that in a symmetric equilibrium conscientious consumers buy both reports. Therefore, when the media outlets' reporting stances are more extreme, the conscientious consumers can better figure out the truth. This increased information efficiency with higher media bias underlines a very basic phenomenon in our model related to the assumption that media outlets do not have an unlimited capacity to slant.[18] If a media outlet wants to slant its news, it has to collect more information. When the available information is limited (high effort in data collection gives a media outlet only $2N$ data points in our model), a media outlet can no longer freely report its reporting stance. The bounded reports when combined, then enable the conscientious consumers to calibrate the underlying truth.

[18] This result is also consistent with Dewatripont and Tirole (1999). In the context of advocacy, they show that biased advocates may generate more information about an uncertain event than a single unbiased judge.

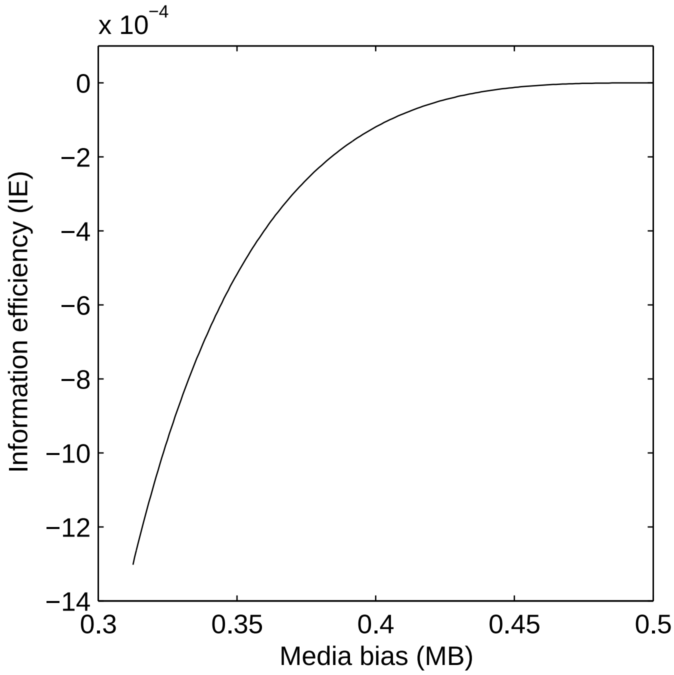

Figure 4: Information efficiency as a function of media bias when both media slant ($a = 1/3$, $t = 1, C = 0.1$).

5 Discussion and Conclusion

Recent explanations for the visible and persistent phenomenon of media bias consider that it is primarily driven by demand from consumers who seek confirmation of their beliefs in the news (e.g. Mullainathan and Shleifer (2005)). We have challenged this perspective by studying competing media under two key conditions. First, we assumed that slanting news is costly for media and it has limits. Second, we have assumed that a significant number of consumers are conscientious, in the sense that they are solely interested in finding out the truth. We thought that these two assumptions will eliminate or at least mitigate media bias in a competitive setting. Surprisingly, we found the opposite. Media bias may well increase when there are more conscientious consumers and if these consumers' dislike for bias is large. Our results are based on the fact that conscientious consumers purchase multiple news to combine their content to recover the truth. In response, media outlets who essentially hold this segment captive, will try to increase their prices by avoiding competition on the biased consumer market. This leads to extreme positions in a Hotelling sense, which translates to increased media bias. However, we also showed that this increased media bias does not necessarily mean information inefficiency for the media industry as a whole. Conscientious consumers may actually recover more information from multiple, increasingly biased news than from a single non-partisan news provider. We also examined media prices, which generally increase with more conscientious consumers.

Marketing implications

The results concerning the mechanisms underlying the existence and extent of media bias have interesting implications for marketing practice.[19] First, they highlight that media positioning does not trivially reflect the composition of media viewers, which is likely to pose a challenge for targeting. Recent research in marketing highlights the importance of targeting for advertisers (Iyer et al. 2005), which in turn requires a clear understanding of the population of media consumers. Our results show that an extreme media positioning does not necessarily reflect that the population of media viewers adheres to extreme views. In contrast, it may indicate that the market contains many conscientious consumers who cross-check multiple biased media outlets. Similarly, this heterogeneity in the viewership base may also represent an increased challenge for forecasting the success of new broadcast programs considered by the media outlet.

Media bias may represent a particular problem for political advertising and PR activities where the consistency of media positioning with that of the political candidate (or PR representative) is especially important. In a political campaign, for example, the competition is often for the 'middle', which becomes increasingly difficult if media firms have an incentive to claim extreme media stances. Our results show however, that extreme media positions may just represent a market with many conscientious consumers mitigating the inconsistency between media positioning and the candidate's preferred position.

Finally, our results with respect to price competition between biased media is also interesting.

[19] We would like to thank the Editor for highlighting some of these issues.

We find that increased media bias typically leads to less price competition or - under an advertising revenue model - more opportunity for the medium to sell advertising space. As such, the finding suggests that changes in media positioning should be followed by a careful reconsideration of subscription policies and/or media scheduling.

Our theoretical results also represent a number of interesting hypotheses for more empirical work on media bias in the news industry. As stated above, there is evidence that a significant number of news consumers cross-check media with opposite orientations. The interesting question for empirical research however, is what relationship exists between the proportion of these consumers and the extent of media bias. While answering this question is not easy given the extensive data requirements and measurement challenges, our analysis of the data set from the Pew Research Center supports a positive relationship between the proportion of conscientious consumers and the extent of media bias. For example, between 2000 and 2004 there is a significant increase (roughly 2.5%) in consumers who cross-check CNN and Fox News. In the same time period, the data indicate that both news outlets became more extreme when measured by the political orientation of viewers who state that they "only believe that medium".[20] More empirical research in this area is certainly warranted.

Limitations and Future Research

One of the 'strange' characteristics of our model is that slanted news is more costly to produce than neutral news. This is contrary to the usual setup studied when a decision maker (e.g. a judge) finds it more difficult to find unbiased information. Notice however, that in our model, the media are not decision makers. Rather they are the information providers whose objective is to sell the information generated from the data. In this case, it is natural to assume that information produced with a specific 'positioning' be more costly to produce than information simply summarizing the available data (Dewatripont and Tirole 1999). Notice also, that conscientious consumers resemble traditional decision makers in our model who are confronted with the usual

[20]Data source: Pew Media Consumption Survey and Pew Media Believability Survey 2000, 2002, and 2004. See Xiang (2006) for detailed statistical evidence.

problem of gathering information from potentially biased sources. As is the case in a classical setup, their cost for unbiased information is higher than the cost of biased information as they need to obtain both opposing views.

Our stylized model may be limited in other ways. For example, we assume that media can communicate a clear and exact positioning that conscientious consumers can utilize to recover the truth. This, and the fact that competing media outlets have an incentive to choose opposing positions lead to the counterintuitive result that more media bias results in more information efficiency. In other situations, when media stances are not clear or media bias is driven by different incentives (e.g. media ownership by a political constituency) bias clearly decreases information efficiency. We have also assumed, as is quite common in free democracies, that news is abundant (N is high) and is available for media outlets at some cost. However, we did not allow N to be infinity to make sure that media are constrained in slanting the news. With small amount of data, our model would be much more complicated and media outlets could choose more complex strategies to communicate with consumers. Such complex signaling is typically not observed in free media markets, however. Finally, while we assumed slanting to be costly, it is important to realize that with no cost for slanting, our results still hold.

Another limitation of our model may come from the fact that we have only considered two competitors. One could ask what would happen if a third media firm would enter the market. It is easy to see that our results would hold even stronger if this new competitor were a biased media outlet. In this case, the incumbent outlets could have even more incentive to slant to further decrease price competition and exploit the conscientious consumers. The situation is much more complex if an unbiased medium enters the duopoly as this medium could attract all the conscientious consumers while still competing for biased consumers in the middle. However, Proposition 2 combined with Result 2 provides good insight on what might happen under this scenario. Qualitatively, this case is similar to the case of the asymmetric equilibrium where one biased firm competes with an unbiased one. Result 2 shows that even in this equilibrium, with more conscientious consumers, the biased firm may have an incentive to increase slanting to successfully compete with the unbiased medium (even though, in this case, media outlets face harsh price competition as shown in Result 3). This effect is even stronger when there are two slanting firms. In sum, our results seem to hold even under a market structure with three firms.

Finally, all along, we have assumed that consumer heterogeneity in preferences for the biased segment are exogenous and given. Other research in political science and communication (e.g., Ansolabehere and Iyengar (1995), George and Waldfogel (2002), Kull et al. (2003), Lazarsfeld et al. (1944), Zaller (1996)) explores how media may change consumers' beliefs and preferences. In a recent paper, for instance, Glaeser (2005), builds a model where political entrepreneurs exploit the demand for hatred by creating biased stories about certain events. While he doesn't mention media bias per se, he allows for media to influence (as opposed to simply inform) consumers. It would be interesting to investigate how these two phenomena (media bias and political entrepreneurship) interact in the news market. In sum, there are multiple opportunities to further explore media bias both from a theoretical as well as from an empirical perspective.

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Appendix

A Proof of Lemma 1: Monopolist Media Outlet

The monopolist has three strategic variables: effort in data collection L/H, reporting stance denoted by s_m, and price denoted by p_m. By managing these three variables, it can reach five different scenarios in terms of market coverage: (i) full market coverage, i.e., both the biased and conscientious market are covered resulting in a total demand of $D_m = 1+\alpha$, (ii) the whole conscientious market and part of the biased market are covered resulting in a demand of $D_m = D^b + \alpha$, where D^b is the demand from the biased market and $0 < D^b < 1$, (iii) only the conscientious market is covered, which yields a demand of $D_m = \alpha$, (iv) only the whole biased market is covered, resulting in a demand of $D_m = 1$ and (v) only part of the biased market is covered, and consequently $D_m = D^b$.

We calculate the optimal strategies by the monopolist under full market coverage, i.e. under scenario (i). In the technical appendix available on the *Marketing Science* website, in a more detailed proof, we show the existence of $\underline{R_m}$ such that when $R > \underline{R_m}$, the monopolist's profit maximizing behavior will indeed lead to full market coverage.

Under full market coverage, the monopolist can either choose to incur a high effort or a low effort in data collection. If the monopolist incurs a high effort in data collection, it will claim its reporting stance, denoted s_m, after data collection. A biased consumer will buy the news if his expected utility is positive. To make the biased consumers at either end of the [a, b] continuum willing to buy, the monopolist will charge a price of

$$p_m = R - t\left[\max\left\{\left(a - \frac{2s_m+1}{4}\right)^2 + \left(\frac{2s_m-1}{4}\right)^2, \left(b - \frac{2s_m+1}{4}\right)^2 + \left(\frac{2s_m-1}{4}\right)^2\right\} + \frac{1}{24}\right].$$

Since $b = 1-a$, this price reaches its maximum when $s_m = 1/2$. Thus, the monopolist will claim a reporting stance $s_m = \frac{1}{2}$. Consequently, the maximum price becomes $p_m = R - t[(a - \frac{1}{2})^2 + \frac{1}{24}]$. Notice that when the monopolist incurs a high effort, no matter what reporting stance it claims, the conscientious consumers' expected utility will be: $R - \frac{k}{96} - p_m$. There are two cases: When

$\frac{k}{96} \leq t\left[(\frac{1}{2}-a)^2+\frac{1}{24}\right]$, it is easily checked that the conscientious consumers will buy the news. When $\frac{k}{96} > t\left[(\frac{1}{2}-a)^2+\frac{1}{24}\right]$, the conscientious consumers will not buy. Then, the monopolist has to lower its price if it wants to cover the conscientious market. If it does so, the maximum price it can charge is $p_m = R - \frac{k}{96} < R - t\left[(\frac{1}{2}-a)^2+\frac{1}{24}\right]$. The latter inequality means that if the monopolist covers the conscientious market, the biased market will also be covered.

Notice that, when $p_m = R - \frac{k}{96}$, the biased consumers who are at the extremes will have an expected utility of: $E(u) = \frac{k}{96} - t\left[(\frac{2s_m+1}{4}-a)^2+\left(\frac{2s_m-1}{4}\right)^2+\frac{1}{24}\right]$. When $s_m = \frac{1}{2}$, $E(u) > 0$. This means that, even if the monopolist's reporting stance, s_m is a little bit different from $\frac{1}{2}$, these extreme consumers will still buy. Since $p_m = R - \frac{k}{96}$ is the optimal price for the monopolist, it will be indifferent in reporting stances between $[\underline{s_m}, \overline{s_m}]$, where $\underline{s_m}$ and $\overline{s_m}$ are roots of equation: $\frac{k}{96} - t\left[(\frac{2s_m+1}{4}-a)^2+\left(\frac{2s_m-1}{4}\right)^2+\frac{1}{24}\right] = 0$.

In summary, when the monopolist incurs a high effort in data collection, it will cover both the biased and the conscientious market. Its optimal reporting stance and price are:

$$\begin{cases} s_m \in [\underline{s_m}, \overline{s_m}] & p_m = R - \frac{k}{96} \qquad \text{if } \frac{k}{96} > t\left[(\frac{1}{2}-a)^2+\frac{1}{24}\right], \\ s_m = 1/2, & p_m = R - t[(\frac{1}{2}-a)^2+\frac{1}{24}] \qquad \text{if } \frac{k}{96} \leq t\left[(\frac{1}{2}-a)^2+\frac{1}{24}\right]. \end{cases} \tag{A.1}$$

The monopolist's profit is:

$$\pi_m = \begin{cases} (1+\alpha)(R-\frac{k}{96}) - C & \text{if } \frac{k}{96} > t\left[(\frac{1}{2}-a)^2+\frac{1}{24}\right], \\ (1+\alpha)\left[R - t[(\frac{1}{2}-a)^2+\frac{1}{24}]\right] - C & \text{if } \frac{k}{96} \leq t\left[(\frac{1}{2}-a)^2+\frac{1}{24}\right]. \end{cases} \tag{A.2}$$

If the monopolist incurs a low effort in data collection, the conscientious consumers will buy as long as $p_m < R$. Under full market coverage, the monopolist's maximum price becomes: $p_m = R - t[(a-\frac{1}{2})^2+\frac{1}{12}]$. The corresponding profit is $\pi_m = (1+\alpha)\left[R - t\left(\frac{1}{2}-a\right)^2 - \frac{t}{12}\right]$. When choosing its effort level in data collection, the monopolist then compares this π_m to that in (A.2). Simplification gives us (14). □

B Calculations of Duopoly Media Profits

B.1 Calculation of π_{HH} (Both Media Outlets Incur High Effort)

Lemma B.1 *When both media outlets incur high effort in data collection, and $k \geq 16t$, there exists an $\underline{R}$ such that, when $R > \underline{R}$ there is a unique sub-game perfect equilibrium in reporting stances where conscientious consumers buy both pieces of news, and the equilibrium reporting stances are:*

$$\begin{cases} s_1^* &= \max\left\{\frac{1}{2} - \frac{3\psi(\omega-2)}{4}, 0\right\} \\ s_2^* &= \min\left\{\frac{1}{2} + \frac{3\psi(\omega-2)}{4}, 1\right\} \end{cases} \tag{B.1}$$

and the corresponding equilibrium profits are:

$$\pi_{HH} = \begin{cases} \frac{3t\psi^2(\omega-2)^3}{8} - C & \text{if } \frac{3\psi(\omega-2)}{4} < \frac{1}{2}, \\ \frac{t\psi(\omega-2)^2}{4} - C & \text{if } \frac{3\psi(\omega-2)}{4} \geq \frac{1}{2}, \end{cases} \tag{B.2}$$

where $\psi = 1 - 2a$, and $\omega = 3 + 2\alpha$.

Proof: When both media outlets spend high effort in collecting data, both will slant and report only half of their data. In this case, each media outlet will claim a reporting stance so as to satisfy the biased consumers. Without loss of generality, we assume media outlet 1's reporting stance is to the left of media outlet 2's ($s_1 \leq s_2$). Notice that when both media outlets slant, a conscientious consumer's expected utility of consuming news i, $E(u_i^c)$, is $R - k/96 - p_i$, which is independent of the media outlet's reporting stance. However, when the conscientious consumer consumes both news items, her expected utility, $E(u_{1,2}^c)$, becomes $R - k\frac{(1+s_1-s_2)^3}{96} - p_1 - p_2$, which is a function of the two media outlets' reporting stances. Therefore, a conscientious consumer may buy from both media outlets if $u_{1,2}^c \geq \max\{u_1^c, u_2^c\}$. When $u_{1,2}^c < \max\{u_1^c, u_2^c\}$, the conscientious consumers will buy only one news item, the one with a lower price. To compute the demand from the biased consumers, notice that the biased consumer who is indifferent between the two news items is located at $x_I = \frac{s_1+s_2}{2} + \frac{p_2-p_1}{t(s_2-s_1)}$. Thus, the *total* demand for media outlet 1, denoted

D_1, is:

$$D_1 = \begin{cases} \dfrac{x_I - a}{b-a} & \text{if } p_1 \geq p_2 \text{ and } u^c_{1,2} < u^c_2, \\ \dfrac{x_I - a}{b-a} + \alpha & \text{otherwise.} \end{cases} \tag{B.3}$$

Decompose $u^c_{1,2} < u^c_2$, we have:

$$p_1 > \frac{k - k(1 + s_1 - s_2)^3}{96}. \tag{B.4}$$

Notice that this demand function holds for both media outlets. Figure 5 describes these demands as a function of prices.

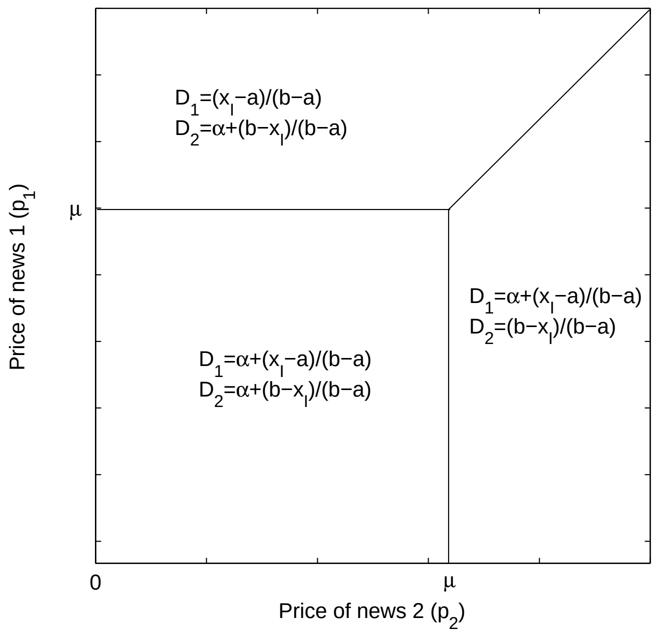

Figure 5: Demand as a function of news prices ($\mu = \dfrac{k - k(1 + s_1 - s_2)^3}{96}$).

We now show that the price equilibrium is unique under the conditions of markets being covered and $k \geq 16t$. We will focus on the case of $\psi\omega \geq 1$, and we show in the technical appendix that when $\psi\omega < 1$ there is no solution in $\mathbb{R}$.

Given any price p_2, media outlet 1 may have different demand depending on its price response p_1 as detailed in (B.3) and (B.4). If media outlet 1's demand is $D_1 = \dfrac{x_I - a}{b - a}$, its best response in price should satisfy the first order condition $\dfrac{\partial D_1 p_1}{\partial p_1} = 0$. Denote this price by p_1^{foc}, and we have

$p_1^{foc} = \dfrac{p_2}{2} + \dfrac{t(s_2 - s_1)(s_1 + s_2 - 2a)}{4}$. Similarly, if $D_1 = \alpha + \dfrac{x_I - a}{b - a}$, then the first order condition yields a price $p_1^{foc'} = \dfrac{p_2}{2} + \dfrac{t(s_2 - s_1)(s_1 + s_2 - 2a + 2\alpha(b - a))}{4}$.

Since $b > a$, it is then obvious that $p_1^{foc'} > p_1^{foc}$. Because $\alpha + \dfrac{x_I - a}{b - a} > \dfrac{x_I - a}{b - a}$, $p_1^{foc'}$ yields higher profit as long as it satisfies the demand constraints in (B.3) and (B.4). In other words, $p_1^{foc'}$ is the best response in price whenever it satisfies the demand constraints. From (B.3) and (B.4), we know that when $p_1 < \dfrac{k - k(1 + s_1 - s_2)^3}{96}$ or $p_1 < p_2$, $D_1 = \alpha + \dfrac{x_I - a}{b - a}$. Thus, when $p_1^{foc'} < \dfrac{k - k(1 + s_1 - s_2)^3}{96}$ or $p_1^{foc'} < p_2$, $p_1^{foc'}$ always results in a demand of $D_1 = \alpha + \dfrac{x_I - a}{b - a}$, i.e., $p_1^{foc'}$ is optimal.

Denote $\mu = \dfrac{k - k(1 + s_1 - s_2)^3}{96}$ as in figure 5, and $\eta = \dfrac{t(s_2 - s_1)(s_1 + s_2 - 2a + 2\alpha(b - a))}{4}$. Then, $p_1^{foc'} = \dfrac{p_2}{2} + \eta$. When $\dfrac{\mu}{2} > \eta$, $p_1^{foc'}$ always satisfies the demand constraints. This is because: 1) if $p_2 \leq \mu$, $p_1^{foc'} = \dfrac{p_2}{2} + \eta \leq \dfrac{\mu}{2} + \eta < \mu$; 2) if $p_2 > \mu$, $p_1^{foc'} = \dfrac{p_2}{2} + \eta < \dfrac{p_2}{2} + \dfrac{\mu}{2} < p_2$.

Therefore, when $\dfrac{\mu}{2} > \eta$, media outlet 1's best response is $p_1^{foc'}$. The same holds for media outlet 2. The price equilibrium exists and is unique as long as $\eta > 0$. It can be checked that when $k \geq 16t$, $\dfrac{\mu}{2} > \eta$ always holds for all s_1 and s_2 ($0 \leq s_1 < s_2 \leq 1$). Solving the first order conditions, $p_1 = p_1^{foc'}$ and $p_2 = p_2^{foc'}$, for both media outlets, we have the price equilibrium:

$$\begin{cases} p_1^* &= \dfrac{t(s_2 - s_1)}{6}[s_1 + s_2 - 2a(2 + 3\alpha) + b(2 + 6\alpha)], \\ p_2^* &= \dfrac{t(s_1 - s_2)}{6}[s_1 + s_2 - 2b(2 + 3\alpha) + a(2 + 6\alpha)]. \end{cases} \tag{B.5}$$

Given the equilibrium prices, obviously, we can always find an $\underline{R}$ such that when $R > \underline{R}$, the biased consumers will buy one piece of news and the conscientious consumers will buy both. Under these prices, the media outlets' demands are: $D_1 = \dfrac{x_I - a}{b - a} + \alpha$ and $D_2 = \dfrac{b - x_I}{b - a} + \alpha$. Substituting p_i^* into the profit function $\pi_i = D_i(p_i^*) \cdot p_i^* - C$ ($i = 1, 2$), we have:

$$\begin{cases} \pi_1 &= \dfrac{t(s_2 - s_1)}{36(b - a)}[s_1 + s_2 - 2a(2 + 3\alpha) + b(2 + 6\alpha)]^2 - C, \\ \pi_2 &= \dfrac{t(s_2 - s_1)}{36(b - a)}[s_1 + s_2 - 2b(2 + 3\alpha) + a(2 + 6\alpha)]^2 - C. \end{cases} \tag{B.6}$$

The second order condition for π_1 gives us:

$$\frac{\partial^2 \pi_1}{\partial s_1^2} = \frac{t[3s_1 + s_2 + 4(b - a)(1 + 3\alpha) - 4a]}{18(a - b)} = \frac{-t[3s_1 + s_2 + 2(\psi\omega - 1) + 4\psi(\omega - 3)}{18\psi}. \tag{B.7}$$

Since $\psi\omega \geq 1$ and $\omega \geq 3$, we have $\dfrac{\partial^2 \pi_1}{\partial s_1^2} < 0$. Similarly, for the second order condition for π_2:

$$\frac{\partial^2 \pi_2}{\partial s_2^2} = \frac{t[s_1 + 3s_2 - 4(b-a)(1+3\alpha) - 4b]}{18(b-a)} = \frac{t[-2(1+\psi\omega) + (s_1 + 3s_2) + 4\psi(3-\omega)]}{18\psi}. \quad \text{(B.8)}$$

Since $\psi\omega \geq 1$ and $0 < s_1 < s_2 < 1$, we have $2(1+\psi\omega) \geq 4 > (s_1 + 3s_2)$. Meanwhile, $3 - \omega < 0$ obviously. Thus, $\dfrac{\partial^2 \pi_2}{\partial s_2^2} < 0$. Therefore, the equilibrium in reporting stances s_1 and s_2 is the solution of the first order conditions for the two media outlets. Standard calculation gives us (B.1). Substituting (B.1) into (B.6), we have (B.2). □

B.2 Calculation of π_{LH} (Only One Media Outlet Incurs High Effort)

The calculation of π_{LH} is similar to that of π_{HH}. Here we only state the result in Lemma B.2, the proof of which is available online at the *Marketing Science* website.

Lemma B.2 *When only one media outlet incurs high effort in data collection , and $k \geq 16t$, there exists $\underline{R}$ such that when $R > \underline{R}$, there is a unique equilibrium in reporting stances, where the unslanting media outlet reports honestly ($m = \theta$) and the slanting media outlet claims a reporting stance $s_H^* = \max\left\{\frac{1}{6}(3 - \psi\omega - \sqrt{\psi^2\omega^2 - 1}),\, 0\right\}$, where $\psi = 1 - 2a$, and $\omega = 3 + 2\alpha$. The equilibrium profits are:*

$$\begin{cases} \pi_{LH} = \begin{cases} \dfrac{t[\psi(7\omega - 9)(\psi\omega + \sqrt{\psi^2\omega^2 - 1}) - 2]^2}{1944\psi(\psi\omega + \sqrt{\psi^2\omega^2 - 1})} & \text{if } \frac{1}{6}(3 - \psi\omega - \sqrt{\psi^2\omega^2 - 1}) > 0, \\ \dfrac{t[\psi(6\omega - 9) + 1]^2}{648\psi} & \text{if } \frac{1}{6}(3 - \psi\omega - \sqrt{\psi^2\omega^2 - 1}) \leq 0, \end{cases} \\ \\ \pi_{HL} = \begin{cases} \dfrac{t[\psi\omega(\psi\omega + \sqrt{\psi^2\omega^2 - 1}) + 1]^2}{486\psi(\psi\omega + \sqrt{\psi^2\omega^2 - 1})} - C & \text{if } \frac{1}{6}(3 - \psi\omega - \sqrt{\psi^2\omega^2 - 1}) > 0, \\ \dfrac{t(1 - 3\psi\omega)^2}{648\psi} - C & \text{if } \frac{1}{6}(3 - \psi\omega - \sqrt{\psi^2\omega^2 - 1}) \leq 0, \end{cases} \end{cases} \quad \text{(B.9)}$$

Proof: See technical appendix online.

C Proof of Propositions

Proof of Proposition 1: As (15) indicates, this equilibrium will emerge if and only if $\pi_{HH} \geq \pi_{LH}$. To compare π_{HH} and π_{LH} in (B.2) and (B.9) respectively, we need to consider four cases:

1. $\frac{1}{6}(3 - \psi\omega - \sqrt{\psi^2\omega^2 - 1}) \leq 0$ and $\frac{3\psi(\omega - 2)}{4} \geq \frac{1}{2}$
2. $\frac{1}{6}(3 - \psi\omega - \sqrt{\psi^2\omega^2 - 1}) \leq 0$ and $\frac{3\psi(\omega - 2)}{4} < \frac{1}{2}$
3. $\frac{1}{6}(3 - \psi\omega - \sqrt{\psi^2\omega^2 - 1}) > 0$ and $\frac{3\psi(\omega - 2)}{4} \geq \frac{1}{2}$
4. $\frac{1}{6}(3 - \psi\omega - \sqrt{\psi^2\omega^2 - 1}) > 0$ and $\frac{3\psi(\omega - 2)}{4} < \frac{1}{2}$

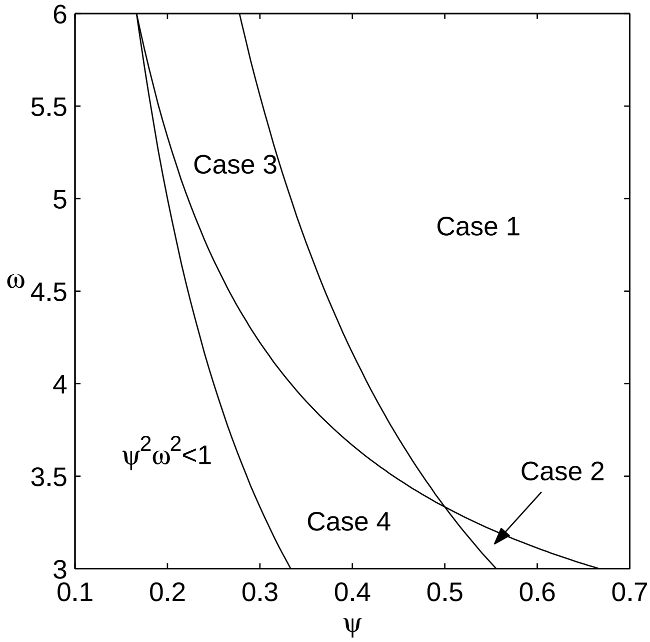

Figure 6: Parameter space $\{\psi, \omega\}$ and the four cases.

The four cases divide the parameter space (ψ, ω) in four regions as shown in Figure 6. We show the proof for the first case, and in the technical appendix, we show the proofs for the remaining cases. Notice that $\psi = 1 - 2a$ and $0 \leq a < 1/2$, and this gives $0 < \psi \leq 1$. Also notice that $\omega = 3 + 2\alpha$ and $\alpha > 0$, therefore $\omega > 3$.

In Case 1 $\quad \frac{1}{6}(3-\psi\omega-\sqrt{\psi^2\omega^2-1}) \leq 0$ and $\frac{3\psi(\omega-2)}{4} \geq \frac{1}{2}$.

Then, $\pi_{HH} - \pi_{LH} = \frac{t[126\psi^2\omega^2 - (12\psi + 540\psi^2)\omega + (567\psi^2 + 18\psi - 1)]}{648\psi} - C$. To find $\underline{C}$, we minimize the above expression with respect to ψ and ω. This yields: $\min\{\pi_{HH} - \pi_{LH}\} = \frac{23t}{432} - C$, when $\psi \to \frac{2}{3}$ and $\omega \to 3$. Let $\underline{C_1} \equiv \frac{23t}{432}$. Thus, when $0 < C \leq \underline{C_1}$, $\pi_{HH} > \pi_{LH}$ always. Meanwhile, $\frac{\partial(\pi_{HH} - \pi_{LH})}{\partial\omega} = \frac{t[(21\omega-45)\psi-1]}{54}$. Notice that $\frac{3\psi(\omega-2)}{4} \geq \frac{1}{2} \Rightarrow \psi(3\omega-6) \geq 2 \Rightarrow \psi(21\omega-45) + 3\psi - 14 \geq 0 \Rightarrow \frac{\partial(\pi_{HH} - \pi_{LH})}{\partial\omega} > 0$. Therefore, for any given ψ and $C > \underline{C_1}$, we can always find a $\underline{\omega_1}$ such that when $\omega > \underline{\omega_1}$, $\pi_{HH} - \pi_{LH} > 0$ and $\omega < \underline{\omega_1}$, $\pi_{HH} - \pi_{LH} < 0$.

In the technical appendix, we show the existence of $\underline{C_i}$, $\underline{\omega_i}$ and $\overline{\omega_i}$ $(i = 2, 3, 4)$ in the other three cases. Let $\underline{C} = \underline{C_1}$, $\underline{C_2}$, $\underline{C_3}$, $\underline{C_4}$ in each corresponding region. Then for any $C < \underline{C}$, $\pi_{HH} > \pi_{LH}$. Furthermore, since in every case, there exist an $\underline{\omega_i}$ and an $\overline{\omega_i}$ (in the first case, $\underline{\omega_1} = \overline{\omega_1}$), thus for any given $\psi \in (0, 1]$ and $C > \underline{C}$ we can find an $\underline{\omega}$ and an $\overline{\omega}$ ($\underline{\omega} \leq \overline{\omega}$) such that: when $\omega > \overline{\omega}$, $\pi_{HH} > \pi_{LH}$ and when $\omega < \underline{\omega}$, $\pi_{HH} < \pi_{LH}$. Because $\omega = 3 + \alpha$, the existences of $\underline{\alpha}$ and $\overline{\alpha}$ are obvious.

When (H, H) is the equilibrium data collection effort, the subsequent equilibrium reporting stances and consumer behaviors are the sub-game equilibria described in Lemma B.1. The uniqueness of the equilibrium follows from the uniqueness of the sub-game equilibria. □

Proof of Proposition 2: As (15) indicates, this equilibrium will emerge if and only if $\pi_{HH} < \pi_{LH}$. The proof is already shown in the proof of Proposition 1. When (H, L) or (L, H) is the equilibrium data collection effort, the subsequent equilibrium reporting stances and consumer behaviors are the sub-game equilibria described in Lemma B.2. The uniqueness of the equilibrium follows from the uniqueness of the sub-game equilibria. □

D Proof of Results

Proof of Result 1: In the game described in Table 1, if $\pi_{HH} > \pi_{LH}$, then both media outlets will collect extra data to slant, while if $\pi_{HH} < \pi_{LH}$ only one media outlet will collect extra data.

From the proof of Proposition 1, we know that $\underline{C} > 0$. Thus, $\pi_{HH} + C > \pi_{LH}$ always holds. This means, $\frac{\partial(\pi_{HH} - \pi_{LH})}{\partial t} > 0$ always holds. Therefore, for any given ψ, ω, C, we can always find a $\underline{t}$ such that (i)if $t > \underline{t}$ then $\pi_{HH} > \pi_{LH}$ and (ii) if $t < \underline{t}$ then $\pi_{HH} < \pi_{LH}$. It can be easily checked in Propositions 1 and 2 that all reporting stances are independent of the parameter t. □

Proof of Result 4: From Section 3, in the symmetric equilibrium, information efficiency is:

$$IE = -E_\theta[(\theta - E(\theta \mid \hat{s}_1, \hat{s}_2))^2] = -\frac{(1 + s_1 - s_2)^3}{96}, \tag{D.1}$$

which represents the conscientious consumers' expected error of reading both pieces of news. It is then straightforward to see that when media bias increases (s_1 decreases or s_2 increases), information efficiency becomes higher. □

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