# Cross-Checking the Media

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**Abstract**
A characteristic of the news market is that consumers often cross-check information, i.e. observe several news outlets. At the same time, data on political media suggest that more partisan consumers are more likely to cross-check. We explore these phenomena by building a model of horizontal competition in newspaper endorsements. Without cross-checking, outlets are unbiased and minimally differentiated. When cross-checking is allowed, we show that cross-checkers are indeed more partisan than those who only acquire one report. Furthermore, cross-checking induces outlets to differentiate, and the degree of differentiation is increasing in the dispersion of consumer beliefs. Differentiation is detrimental to consumer welfare, and a single monopoly outlet may provide higher consumer welfare than a competitive duopoly.

**Keywords**
News markets, media bias, cross-checking, Hotelling.

**JEL Codes**: D82, D83, L81.

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# 1. Introduction

News is often consumed multiple times throughout the day and from various sources. Apart from the entertainment aspect, media consumers cross-check news (observe various news outlets) to learn omitted information and to be exposed to different points of view. One of the stylized facts of media markets is that people prefer news sources that share their political bias (e.g Gentzkow and Shapiro (2010); Puglisi and Snyder (2011)), but cross-checking often involves sources of different partisanship. For instance, according to Pew Research Center's "2012 Media Consumption Survey", of the people who regularly read either the New York Times or the Wall Street Journal, 18 percent regularly read both, and of the people who regularly watch Fox News, 28 percent also regularly watch CNN or MSNBC. Furthermore, Gentzkow and Shapiro (2011) show that visitors to Internet sites with "extreme" political bias have a higher than average propensity to visit sites that are of the opposite bias. Cross-checking thus challenges stylized views of news consumption, yet no analysis exists of how it affects media bias.[1] To address this question, we develop a model of horizontal competition in newspaper endorsements, and show that cross-checking augments media bias to the detriment of consumers.

In our model, consumers face a choice between two options, for instance which political candidate to vote for, and get utility from choosing the correct one.[2] News outlets have noisy private information, and publish a report that endorses one of the two options. Their profits are proportional to their demand. An outlet must choose how much information it requires to endorse one option over the other, and this choice is interpreted as *media bias*. Bias is therefore not associated with lying, but rather with the weighting of evidence. Consumers are heterogeneous in their prior about which option is correct, and we associate this prior with *partisanship*. Because the informativeness of a report is decreasing with the distance between outlet and consumer bias, the model

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[1] Previous work has either focused on advertising (Anderson et al. (2011); Ambrus et al. (2012)) or quality and pricing (Anderson et al. (2010)).

[2] Notice however that this is not a voting model. Consumer utility depends *only* on choosing the correct option, and not on how many choose it.

has a *spatial dimension* akin to the Hotelling model.[3]

We consider two cases. When cross-checking is *sequential*, consumers can read the reports already acquired before deciding whether to continue acquisition. This can be thought of as online news or television, where the cost of switching from one outlet to another is very low. When cross-checking is *simultaneous*, reports can only be acquired at a given time, and therefore the acquisition decision must be taken prior to reading any report. This is an approximation to the newspaper market, where consumers often subscribe, and therefore pre-commit, or must decide how many papers to buy in the morning, knowing that buying the paper later will be more difficult.

First, consumer behavior is analyzed. In line with the aforementioned data, we show that cross-checkers are often more partisan than consumers who acquire only one report. The reason for this is that moderates have the weakest priors, and therefore they are more susceptible to any new information they receive. Thus, a moderate will almost always become more confident after observing a report, and may not want to acquire more information. A partisan consumer, on the other hand, gains confidence when his prior is confirmed, but loses confidence when his prior is contradicted. In the latter case, he wants to acquire more information to cross-check the first information.

Second, we look at market outcomes. The main result is that cross-checking leads to more media bias, and in particular we show that (i) in the benchmark case, where at most one report can be acquired, outlets are unbiased and minimally differentiated;[4] (ii) when cross-checking is allowed, outlets may be biased and differentiated. To see the intuition for this, consider the benchmark case. When outlets increase their bias, they gain partisan consumers, but lose moderate consumers. However, partisans are hard to attract since they are very confident in their prior, and therefore increasing bias leads to a net loss of demand. As a result, outlets prefer to compete for the moderate consumers. Consider then the cross-checking case. Increasing bias still entails a gain of partisan consumers, but now it need not imply a loss of moderate consumers, since it is possible

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3. However, the horizontal structure is derived from the primitives of the model, and does not resemble any standard type of Hotelling.

4. By unbiased, we mean that they require the same amount of information to endorse either option, and by minimally differentiated, we mean that they choose the same bias.

that they cross-check. Therefore, cross-checking "softens" competition. This effect is stronger in the simultaneous case than in the sequential case. The reason is that cross-checkers are more fickle when they can condition acquisition on previous information, than when they must decide a priori. We therefore expect more differentiation when cross-checking is simultaneous than when it is sequential. This is in line with Gentzkow and Shapiro (2011), who show that the ideological segregation of national newspapers is greater than that of cable news and the Internet in the United States.

Third, we analyze welfare and compare different competition structures. We find that differentiation increases outlet profits, but is detrimental to consumer welfare. In some cases, outlets differentiate so much that they become virtually uninformative, and consumer welfare approaches the no-information level. We then compare duopoly competition to other market structures, and find that if the outlets have a joint owner, they are always at least as biased and differentiated as the competitive duopolists. A single monopoly outlet, on the other hand, is unbiased, which implies that consumer welfare may be higher under monopoly than under duopoly. In conclusion, although cross-checking improves consumer welfare if we hold media bias constant, it may also soften competition so much that it defeats its purpose and leads to lower welfare in equilibrium.

## 1.1   Related Literature

The literature on news markets is often divided into two strands: supply-driven bias and demand-driven bias (see Gentzkow and Shapiro (2008) for a comprehensive review). This paper pertains to the latter. In models of supply-driven bias, competition often diminishes market bias since "hiding" information becomes more difficult the more competitors exist (e.g. Milgrom and Roberts (1986); Baron (2006); Besley and Prat (2006)). In models of demand-driven bias, consumers demand slant and therefore it is not clear that competition will reduce bias. The literature has largely focused on models where consumers observe at most a single outlet (e.g. Chan and Suen (2008); Sobbrio (2011); Germano and Meier (2012)), and it is found that competition often augments bias.

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The main difference between our paper and the existing literature on cross-checking, is that we focus on horizontal competition. Mullainathan and Shleifer (2005) analyze a Hotelling model without cross-checking, but consider how the news reports could be combined ex-post by a cross-checker. Thus, they do not model how cross-checking affects the supply of media bias, which is the focus of our paper. Furthermore, in their model, a news story consists of a string of verifiable bits, and slanting is done by omitting specific bits. A cross-checker can then "piece together" the correct news by comparing reports. This technology is very different to ours, where outlets have independent data and reports cannot be combined to retrieve the original information. In Gentzkow and Shapiro (2006), consumers are assumed to always cross-check. Outlets try to gain a reputation for being high quality and may "garble" their reports to achieve this. Our paper, in contrast, analyzes horizontal competition and endogenizes consumers' information acquisition. Anderson et al. (2010) analyze cross-checking in a model where consumers have an intrinsic preference for slant, and outlets are horizontally and vertically differentiated. However, horizontal differentiation is exogenous in their model, whereas we look at horizontal competition between outlets. Anderson et al. (2011) and Ambrus et al. (2012) analyze cross-checking and advertising, and show that exclusive consumers are more attractive to outlets. The reason is that advertisers pay to access consumers, and whereas an exclusive consumer can be charged at the monopoly price, outlets compete to sell access to cross-checkers. In neither of these models do outlets compete horizontally.

The horizontal dimension of our paper can be related to Mullainathan and Shleifer (2005) and Anderson et al. (2010), who analyze pure Hotelling models in which consumers have a preference for slant. Anderson et al. (2010) assume linear transport costs, but, as mentioned above, do not allow for horizontal competition. Mullainathan and Shleifer (2005) assume quadratic transport costs, which is known to lead to horizontal differentiation. In our paper, we derive the transport costs and reservation utilities from the primitives rather than assuming a particular functional form. Our setup is most related to Chan and Suen (2008), who also derive a horizontal competition structure from the primitives of their model. However, our paper differs from theirs in two ways. First,

we consider cross-checking, whereas in their paper at most one report is acquired. Second, we assume that consumers are heterogeneous in priors, whereas their consumers are heterogeneous in preferences, and the resulting spatial competition structures are very different. In particular, heterogeneous priors affect the reservation utility of consumers whereas heterogeneous preferences (in Chan and Suen's formulation) do not.

The remainder of the paper is organized as follows. Section 2 presents the model and establishes the benchmark case where at most one report can be acquired. Section 3 analyzes consumer behavior. Section 4 derives the market outcome and looks at media bias. Section 5 analyzes monopoly and joint ownership, derives welfare implications and considers a different profit structure. Section 6 concludes. Appendices A and B contain extra details from the analysis of consumer behavior. All proofs are relegated to Appendix C.

## 2.   A Media Market

In this section we present a model of a media market. Although we will keep the language general, it is perhaps easiest to think of it as a model of newspaper endorsements and "expressive voting". Newspapers have private information about the quality of two political candidates and endorse one of them. Readers all vote, and get a positive payoff if they vote for the correct candidate, regardless of whether he is elected. We first present the model, and then analyze the benchmark case where cross-checking is not allowed.

### 2.1   The Model

There is an unobserved binary state of the world, $\theta \in \{L, R\}$, and a continuum of readers[5]. Each reader chooses an action $y \in \{L, R\}$, which yields payoff $u(y, \theta)$ equal to one if $y = \theta$ and zero otherwise. We let $p$ denote the prior probability assigned by readers to the true state being $R$, and assume that $p$ is uniformly distributed on $[\delta, 1-\delta]$,

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5. We refer to "consumers" as readers to use a word that can both be used to describe newspaper and online consumers, but the conclusions are equally applicable to other media.

where $\delta \in (0, 1/2)$. Thus, readers are heterogeneous in their beliefs and we refer to the prior as the type of the reader.

Before taking their action, readers may acquire information about $\theta$ through the media. There are two news outlets, indexed by $n \in \{1, 2\}$. Outlets assign equal prior probability to the states, and receive private information about $\theta$ in the form of a signal, $x_n \in [0, 1]$. Signals are drawn independently across $n$ from the distribution $F_\theta$, with density function

$$f_\theta(x) \equiv \begin{cases} 2(1-x) & \text{if } \theta = L, \\ 2x & \text{if } \theta = R. \end{cases}$$

Hence, outlets conduct independent investigations, but the results are correlated through the true state of the world. After observing $x_n$, outlet $n$ costlessly produces a report $r_n \in \{L, R\}$ that endorses one of the actions. Apart from simplifying the model, we focus on endorsements because of their empirical relevance (endorsements of political candidates, stocks, consumer products, etc.).

Readers can acquire reports at cost $c$, such that if they acquire $k$ reports, their final utility is $u(y, \theta) - kc$. For the moment we make no assumptions on $c$, but later we simplify the analysis by assuming that it is "small", in a sense that we will make clear. For each outlet $n$, we let $\Pi_n(a_1, a_2)$ denote expected profits and $D_n(a_1, a_2)$ denote expected demand. Outlet profits are assumed to be proportional to demand, such that

$$\Pi_n(a_1, a_2) = D_n(a_1, a_2).$$

The profit function corresponds to a situation in which revenues are derived from advertising and are proportional to the number of readers.[6] In Section 5.3 we extend the model to allow for different revenues from single-readers and cross-checkers.

The timing of the game is as follows.

**t=0:** Outlets choose their strategy, observe their signal and prepare reports.

**t=1,2:** Reports are acquired and read.

6. Similar assumptions on news outlet profits are made in Chan and Suen (2008) and Gentzkow and Shapiro (2006), whereas Baron (2006) and Mullainathan and Shleifer (2005) model price competition.

**t=3:** Readers choose their action and realize their payoff.

Notice that information has no instrumental value to readers: they only acquire reports in order to make better decisions. Therefore, if a report is not sufficiently informative to influence the reader's action, it should not be acquired. If a reader is indifferent between two reports, we assume that he acquires either one with equal probability.

**Outlet Strategy.** Since reports take the form of endorsements, a *reporting strategy* $\rho_n : [0,1] \to \{L, R\}$ is completely characterized by a cut-off $a_n$, such that for $n = 1, 2$

$$\rho_n(x_n) = \begin{cases} L \text{ if } x_n < a_n, \\ R \text{ if } x_n \geq a_n. \end{cases}$$

We can interpret $a_n$ as outlet $n$'s *bias*, in the sense that as $a_n$ increases, outlet $n$ requires stronger evidence to report $R$, but less strong evidence to report $L$. Therefore, we say that the higher (resp. lower) $a_n$ is, the more biased outlet $n$ is toward $L$ (resp. $R$). From now on we use $a_n$ to refer to reporting strategies. Furthermore, we use $\rho_n$ to refer to the random variable generated by the reporting strategy and the signal, and $r_n$ to refer to a specific realization of this variable, i.e. $r_n = \rho_n(x_n)$.

**Reader Strategy.** The reader chooses an *acquisition strategy*, $\sigma_p \equiv (\sigma_p^1, \sigma_p^2)$, where $\sigma_p^t$ specifies the report acquired in stage $t$. We consider two cases. In the *simultaneous case*, reading can only take place after all reports have been acquired. In the *sequential case*, a reader can read the first report he acquires before he decides whether to acquire the second report. We can formalize this as follows. Let $\emptyset$ denote the event that no report is acquired, and write $H^1 \equiv \{\emptyset\}$ and $H^2 \equiv \{\emptyset, L, R\}$ for the possible histories at

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$t = 1, 2$. Then[7]

$$\sigma_p^t : H^1 \rightarrow \{\emptyset, \rho_1, \rho_2\}.$$

Simultaneous case:

Sequential case:

$$\sigma_p^t : H^t \rightarrow \{\emptyset, \rho_1, \rho_2\}.$$

We will be analyzing subgame-perfect equilibria, and therefore it is convenient to work directly with the *optimal action strategy*. Let $\pi_p(r)$ be a type-$p$ reader's posterior after observing $r \subset \{r_1, r_2\}$, and let $E_p[\cdot]$ be his expectations operator. The optimal action $y_p(r)$ maximizes $E_p[u(y, \theta)|r]$. Then

$$y_p(r) = \begin{cases} R \text{ if } \pi_p(r) \geq 1/2, \\ L \text{ if } \pi_p(r) < 1/2. \end{cases}$$

Since the posterior is always defined, $y_p(\cdot)$ is always defined. Conditional on the optimal action strategy and on an acquisition strategy $\sigma$, both the action taken and (in the sequential case) the number of reports acquired depend on the signals, and can therefore be seen as random variables. We denote these by $y_p(\sigma)$ and $k_p(\sigma)$, respectively.

**Equilibrium.** Recall that reporting strategies are defined entirely by their cut-off and we have assumed that actions are always chosen optimally. Then the strategies $(\sigma_p^*, a_n^*)$, $p \in [\delta, 1 - \delta]$, $n = 1, 2$, constitute a *Perfect Bayesian Equilibrium* if

- For each $p$, $\sigma_p^*$ maximizes $E_p[u(y_p(\sigma), \theta) - k_p(\sigma)c]$ with respect to $\sigma$, given $a_n^*$.

- For each $n = 1, 2$, $a_n^*$ maximizes $\Pi_n(a_n, a_m^*)$ with respect to $a_n$, given $\sigma_p^*$.

- Readers' beliefs about $\theta$ are updated using Bayes' rule, whenever possible.[8]

Let the set of equilibrium cut-offs $(a_1^*, a_2^*)$ be denoted $\mathcal{A}$ and suppose without loss of generality that $a_1^* \leq a_2^*$. Before beginning the analysis, we introduce the following

7. We use $\rho_n$ in the image of the acquisition strategy function, since, ex ante, the reports are random variables from the point of view of the reader.

8. Since we have restricted the reporting strategy of the outlets, there are no "out-of-equilibrium" messages and Bayes' rule always applies.

taxonomy. We say that the outlet whose cut-off is closest to either zero or one is the *most biased outlet*. If a reader does not expect to acquire any reports, we refer to him as *uninformed*; if he expects to acquire exactly one report, we refer to him as a *single-reader*; and if he expects to acquire more than one report, we refer to him as a *cross-checker*. Loosely speaking, we will refer to readers with prior close to zero or one as *partisans* and readers with prior close to a half as *moderates*. Lastly, we will use the notational convention that $m \neq n$, such that $n$ and $m$ refer to different outlets.

## 2.2 A Benchmark: Single-Reader Equilibrium

To understand how the model works in the absence of cross-checking, we first restrict readers to acquiring at most one report. Apart from establishing a benchmark, this also illustrates how the horizontal competition of the model works. Let $a_1 \leq a_2$ and assume that $0 < c < 1/4$ to avoid uninteresting equilibrium multiplicity.

Suppose first that the consumer does not acquire any report, and denote by $V_p \equiv E_p[u(y_p(\emptyset), \theta)]$ the no-information payoff. In this case, the posterior equals the prior, and therefore $y_p(\emptyset)$ is $R$ if $p$ is greater than a half and $L$ otherwise. Then

$$V_p = \begin{cases} p & \text{if } p \geq 1/2, \\ 1 - p & \text{otherwise.} \end{cases}$$

Thus, before learning any information, partisans have higher expected utility than moderates, since they are more convinced that they know the true state. This implies that readers are heterogeneous in their reservation utility. The dotted line in Figure I illustrates this. Suppose now that the reader acquires outlet $n$'s report. Since the report is always informative, either $y_p(r_n) = r_n$ or $y_p(r_n) = y_p(\emptyset)$ for all $r_n$. Denote by $V_p(a_n) \equiv E_p[u(y_p(\rho_n), \theta)]$ the reader's expected payoff from acquiring outlet $n$'s report. Then

$$V_p(a) = \max\{p(1 - a^2) + (1 - p)(2a - a^2), V_p\}.$$

The first term inside the brackets is the expected payoff from following the report, which

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is just the probability that the report is correct. The second term is the no-information payoff, which acts as a lower bound, since the reader can always ignore the report. This is represented by the solid line in Figure I. Maximizing the expected payoff with respect to $a$, we find that the optimal outlet type for a type-$p$ reader is $a^*(p) = 1 - p$. Therefore, readers prefer media that are biased in the same direction as themselves,[9] but they do so because they believe that these outlets are more informative.

[Figure I about here]

Acquiring $\rho_n$ is preferred to not acquiring any report if $V_p(a_n) - c > V_p$. Solving for $p$, we obtain an interval $(\phi_l^n, \phi_u^n)$ with

$$\phi_u^n = \frac{2 - a_n}{2} - \frac{c}{2a_n},$$
$$\phi_l^n = \frac{1 - a_n}{2} + \frac{c}{2(1 - a_n)}.$$

This interval indicates the potential readers of outlet $n$'s report. The actual readers will be the potential readers who prefer outlet $n$ over outlet $m$, i.e. the types for which $V_p(a_n) > V_p(a_m)$. Since $a_1 \leq a_2$ and $V_p(\cdot)$ is monotone in $p$, there exists a threshold $\bar{\phi}$ such that outlet 1 is preferred for $p > \bar{\phi}$ and outlet 2 preferred for $p < \bar{\phi}$. The threshold is found to be

$$\bar{\phi} = 1 - \frac{a_1 + a_2}{2}.$$

Outlet 1's market is then going to be all the types above $\bar{\phi}$ but below $\phi_u^1$, whereas outlet 2's market is the types below $\bar{\phi}$ and above $\phi_l^2$. When an outlet moves toward the center it loses partisan readers, but "steals" moderate readers from the other outlet. Taking derivatives of the thresholds, we notice that the rate at which the outlet steals moderates is always greater than the rate at which it loses partisans. The reason is that it is harder to attract partisans, since they gain less from acquiring information (see Figure I). This effect drives the first result.

9. Recall that high values of $a$ are associated with bias toward $L$, and vice versa.

**Proposition 1** *When readers can acquire at most one report, there exists a unique equilibrium with*

$$\mathcal{A} = (1/2, 1/2).$$

Both duopolists place themselves at the center, which we refer to as a *centrist equilibrium*. This looks like the classic Hotelling equilibrium with minimum differentiation, but the mechanism behind it is different. Eaton and Lipsey (1975) demonstrate that in Hotelling's formulation, the minimum differentiation result depends on a variety of factors, including inelastic demand and linear transport costs, and d'Aspremont et al. (1979) show that when transportation costs are quadratic, there is a tendency for outlets to maximize differentiation. We have elastic demand and $V_p(a)$ is quadratic in $a$, which would suggest that outlets have an incentive to separate. However, minimum differentiation ensues in our model because partisan readers have higher reservation utility, and are therefore harder to attract.

## 3.  Readers

We begin the main analysis by investigating the demand side of the market. We proceed backward by first identifying the optimal action function, and then establishing the optimal acquisition strategy. As stated earlier, we want to analyze market outcomes when costs are small. Our interest is in analyzing the incentives to cross-check and how media bias responds to this, so we will make the problem as tractable as possible. In particular, we let costs be zero and assume that readers only acquire information they expect to use.

**Assumption 1** *Suppose $\sigma^*$ is an equilibrium strategy for $p$. Then there exists no strategy $\sigma'$ such that $E_p[u(y_p(\sigma'), \theta)] = E_p[u(y_p(\sigma^*), \theta)]$ and $E_p[k_p(\sigma')] < E_p[k_p(\sigma^*)]$.*

The assumption simply says that if two strategies provide the same expected utility, the reader never chooses the one with which he expects to acquire more reports. If costs are strictly positive, this is of course always true. Suppose from now on that $c = 0$ and Assumption 1 is satisfied. As before, let $a_1 \leq a_2$. Lastly, to avoid tedious cases with a

large multiplicity of similar equilibria, suppose $\delta < 1/10$. The analysis in this section will apply to both the simultaneous and the sequential cases. In the next section where we determine the equilibrium, we will distinguish between the two cases.

## 3.1 Optimal Actions

In this section we discuss the optimal action function. The details of its derivation have been relegated to Appendix A. To build intuition, consider Figure II, which maps posteriors in a particular case for each possible realization of the reports.

[Figure II about here]

Since the optimal action is $R$ when the posterior is greater than a half and $L$ otherwise, the thresholds $(\psi_l, \psi_u, \varphi_1, \varphi_2)$ completely identify the optimal action function. They are found by setting the relevant posteriors equal to a half and solving for $p$.

$$\varphi_n = \frac{1}{2}\frac{(1-a_n)(2-a_m)}{1-a_n+a_na_m}, \quad \psi_l = \frac{1}{2}\frac{(1-a_1)(1-a_2)}{1+a_1a_2}, \quad \psi_u = \frac{1}{2}\frac{(2-a_1)(2-a_2)}{2-a_1-a_2+a_1a_2}.$$

In the figure, whenever the reports disagree, the posterior is greater when outlet 1 reports $R$, and smaller when outlet 1 reports $L$. We show in the appendix that this is true when outlet 1 is the most biased outlet, and is reversed when outlet 2 is the most biased outlet. The intuition is that the most biased outlet is more informative, because it sends a very strong signal when its reports goes against its bias. Therefore, whenever the outlets disagree, the report of the most biased outlet is given more weight. Let $\varphi_u$ (resp. $\varphi_l$) maximize (resp. minimize) $\varphi_n$ with respect to $n$. Then the optimal action function is given by

$$
\begin{cases}
p < \psi_l : & y_p(r_1, r_2) = L \text{ for all } r_1, r_2, \\
\psi_l < p < \varphi_l : & y_p(R, R) = R \text{ and } y_p(r_1, r_2) = L \text{ otherwise,} \\
\varphi_l < p < \varphi_u : & y_p(r_1, r_2) = r_1 \text{ if } a_1 < 1 - a_2 \text{ and } y_p(r_1, r_2) = r_2 \text{ if } a_1 > 1 - a_2, \\
\varphi_u < p < \psi_u : & y_p(L, L) = L \text{ and } y_p(r_1, r_2) = R \text{ otherwise,} \\
p > \psi_u : & y_p(r_1, r_2) = R \text{ for all } r_1, r_2.
\end{cases}
$$

Cross-checkers effectively use the second report as a check on the first report in the following manner. Suppose a reader satisfies $\varphi_u < p < \psi_u$. Notice that $\varphi_u$ may be less than a half, so the reader may not be a priori biased toward $R$. But, given the reporting strategies, he is inclined toward $R$ in the sense that he will choose action $R$ if at least one report recommends it. We can think of the optimal strategy in terms of this "inclination". If the first report confirms his inclination, the reader feels confident and chooses $R$ without reading the second report. On the other hand, if the first report goes against his inclination, the reader is surprised and cross-checks. If the second report also goes against his inclination, this is a strong signal and he chooses $L$, whereas if it confirms his inclination, he concludes that the first report was probably wrong and chooses $R$.

The expected payoff for a cross-checker, $V_p(a_1, a_2) \equiv E_p[u(y_p(\rho_1, \rho_2), \theta)]$, is derived in Appendix A. Appendix B discusses optimal outlet types. In particular, whereas in the benchmark case a reader always prefers an outlet which shares his bias, in the cross-checking case he may prefer both outlets to be more biased than he is. Furthermore, he may prefer that they are both biased in the same direction.

## 3.2 Optimal Acquisition

A reader will not acquire a report if he does not expect to follow its advice. We can formalize this in the following way. Say that $\rho_n \in \sigma$ if $\sigma^t(h) = \rho_n$ for some $h$ and $t$. Let $\sigma_{-n}$ denote $\sigma$ where $\rho_n$ is replaced by $\emptyset$ if $\rho_n \in \sigma$. Furthermore, we write $y_p(\sigma) = y_p(\sigma')$ if $y_p(\sigma)$ and $y_p(\sigma')$ generate the same outcome for all $(x_1, x_2)$. It follows from the definition of the optimal action strategy that

$$y_p(\sigma) \neq y_p(\sigma_{-n}) \Leftrightarrow E_p[u(y_p(\sigma), \theta)] > E_p[u(y_p(\sigma_{-n}), \theta)]. \tag{1}$$

This condition says that if the reader acts differently when we take information away from him, it must be that this information is valuable. Suppose $\rho_1, \rho_2 \in \sigma$. We will say outlet $n$'s report is *influential* if $y_p(\sigma) \neq y_p(\sigma_{-n})$ and both reports are influential if this holds for $n = 1, 2$. In other words, a report is influential if it can change the reader's

optimal action. Suppose $\sigma^*$ is an equilibrium strategy for reader type $p$. Then (1) and Assumption 1 imply that

$$\rho_n \in \sigma^* \Leftrightarrow y_p(\sigma^*) \neq y_p(\sigma^*_{-n}). \tag{2}$$

Hence, if a report is acquired in equilibrium, then it must be influential. This is a useful condition, since it allows us to focus on the action function. If none of the reports are influential to a reader, he should remain uninformed. If only one of the reports is influential, he should be a single-reader of that report, and if both are influential, he should be a cross-checker. Let $\mathcal{S}_U \equiv (\delta, \psi_l) \cup (\psi_u, 1 - \delta)$, $\mathcal{S}_S \equiv (\varphi_l, \varphi_u)$ and $\mathcal{S}_C \equiv (\psi_l, \varphi_l) \cup (\varphi_u, \psi_u)$. We can then prove the following proposition.

**Proposition 2** *Fix an equilibrium $(a_1^*, a_2^*, \sigma_p^*)$. Then types in $\mathcal{S}_U$ are uninformed and types in $\mathcal{S}_C$ are cross-checkers. Types in $\mathcal{S}_S$ are single-readers and for $p \in \mathcal{S}_S$,*

$$\rho_1 \in \sigma_p^* \text{ if } a_1 < 1 - a_2,$$
$$\rho_2 \in \sigma_p^* \text{ if } a_1 > 1 - a_2.$$

*If $a_1 = 1 - a_2$, then $\mathcal{S}_S$ is empty, and there are no single-readers.*

Figure III gives an overview of the different reader types. Whenever the outlets are equally biased ($a_1 = 1 - a_2$), the reports provide exactly the same amount of information (but with different bias) and therefore if one report is influential to a reader so are both of them.[10] In this case, if a reader acquires information, he always acquires both reports.

[Figure III about here]

It should be clear from the discussion of the benchmark case why some readers remain uninformed: they are sufficiently confident in their prior that no report is influential. The result that single-readers are moderate (or, at least, more moderate than the most partisan cross-checkers) is in accordance with Gentzkow and Shapiro (2011). The

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10. Effectively, when the outlets are equally biased, then $\pi_p(R, L) = \pi_p(L, R) = p$. Therefore, if one outlet is influential, so is the other, since it can cancel the effect of the first outlet's report.

intuition is the following. Suppose as an example that a reader is very biased toward $R$. This reader chooses $L$ only if he observes a strong signal contradicting his prior. If both outlets are moderately biased, then either report by itself does not provide him with a very strong signal. But if both reports say $L$, this is very convincing to him. Therefore, he benefits from cross-checking. A moderate reader, on the other hand, may find all the information needed for his decision in a single report, as illustrated by Figure II.

# 4.  Media Bias

In this section we analyze the market equilibrium, and in particular how the outlets strategically choose their bias. Suppose that the assumptions in Section 3 are satisfied. Notice that if an outlet chooses either $a_n = 0$ or $a_n = 1$, it is completely uninformative (always sends the same report), and it follows directly from Assumption 1 that no reader will ever acquire its report. Therefore, this will not occur in equilibrium, and to ease the exposition we assume henceforth that $0 < a_n < 1$, unless otherwise stated.

## 4.1  Simultaneous Case

In the simultaneous case, readers cannot condition their acquisition decisions on the content of any of the reports. Hence, outlets know that whomever expects ex ante to gain from cross-checking will acquire both reports. This is important, since it implies that outlets are indifferent between getting their demand from cross-checkers or single-readers. Contrast this with the sequential case, in which cross-checkers are more fickle than single-readers, since they condition their stage 2 choice on what they observe in stage 1. The fact that both types of readers are the same to outlets, makes it straightforward to calculate demand, using the discussion of the previous section. Suppose $\psi_l, \psi_u \in [\delta, 1 - \delta]$ and $a_1 < a_2$ (recall that when $a_1 = a_2$ consumers choose either report with equal probability, so outlets share total demand). Then the demand

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functions are given by

$$D_1(a_1, a_2) = \begin{cases} \psi_u - \varphi_1 + \varphi_2 - \psi_l & \text{if } a_1 > 1 - a_2; \\ \psi_u - \psi_l & \text{if } a_1 \le 1 - a_2, \end{cases}$$

$$D_2(a_1, a_2) = \begin{cases} \psi_u - \psi_l & \text{if } a_2 \ge 1 - a_1; \\ \psi_u - \varphi_2 + \varphi_1 - \psi_l & \text{if } a_2 < 1 - a_1. \end{cases}$$

We refer to $\psi_u - \psi_l$ as the *active market*. The key insight from the demand functions is that cross-checking changes the incentives to compete at the center. In the single-reading case, outlets would steal demand from each other by moving closer to the center. When cross-checking is allowed, this motive is less clear. For instance, when outlets are equally biased, demand-stealing is impossible since both outlets already have demand from the entire active market. Therefore, competition at the center tends to be softer when cross-checking is allowed.

We now analyze the equilibrium of the market. It turns out that this is not unique, and in particular there is both a centrist equilibrium and a continuum of *differentiated equilibria*, in which the outlets position themselves symmetrically around the center. In the differentiated equilibria, outlets capture the entire market. The level of bias in the differentiated equilibria depends monotonically on $\delta$ through the following threshold

$$a_\delta^* \equiv \frac{1}{2 - 4\delta} \left( 1 - 2\delta - \sqrt{1 - 12\delta + 20\delta^2} \right) < \frac{1}{2}.$$

The inequality holds for $\delta < 1/10$. The smaller $a_\delta^*$, the more outlets differentiate. Furthermore, $a_\delta^*$ is increasing with $\delta$. Hence, the more disperse the reader beliefs (the smaller $\delta$ is), the more outlets tend to differentiate.

**Proposition 3** *In the simultaneous case, $\mathcal{A} = \mathcal{A}_C \cup \mathcal{A}_D$, where $\mathcal{A}_C$ is the centrist equilibrium, $\mathcal{A}_C = \{(1/2, 1/2)\}$, and $\mathcal{A}_D$ is a non-empty set of symmetric, differentiated equilibria*

$$\mathcal{A}_D = \{(a, 1 - a)\}_{a \in \mathbf{A}}, \quad \mathbf{A} = (0, a_\delta^*].$$

The intuition for the differentiated equilibria is the following. There are two effects at

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play. First, the most biased outlet always has demand from the entire active market, whereas the least biased outlet does not have any single-reader demand. Therefore, holding the active market constant, the least biased outlet gains from deviating to a position that is at least as biased as the other outlet. Second, the least biased outlet can increase the active market size by becoming more biased. The reason is that there is a great deal of complementarity between the bias of the two reports. Most readers prefer their news diet to be somewhat balanced,[11] and therefore the least biased outlet can always expand the active market by becoming equally biased to the other outlet. Thus, the least biased outlet always gains from becoming more biased. As a consequence, if one outlet moves away from the center, the other outlet will have an incentive to move away too, but in the other direction. When the outlets are sufficiently differentiated, they capture the entire market, and they are in equilibrium.

Given the multiplicity of equilibria, we would like to say something about selection. There is no Pareto-dominant equilibrium, but as we next show, the equilibrium $(a_\delta^*, 1 - a_\delta^*)$ has some prominence in that it maximizes reader welfare within the class of equilibria that maximize profits. The corollary is a direct consequence of Proposition 6 below, and the fact that in the differentiated equilibria outlets capture the entire market. Reader welfare is measured as the total utility of readers.

**Corollary 1** *In the simultaneous case: (i) The equilibria in $\mathcal{A}_D$ are profit-maximizing, and (ii) the centralized equilibrium $\mathcal{A}_C$ maximizes reader welfare in $\mathcal{A}$. Furthermore, within $\mathcal{A}_D$, the equilibrium $(a_\delta^*, 1 - a_\delta^*)$ maximizes reader welfare.*

In light of this corollary, we choose to focus on the equilibrium $(a_\delta^*, 1 - a_\delta^*)$. The overall welfare effect of moving from the benchmark case to simultaneous cross-checking is ambiguous. Reader welfare is initially improved by the possibility of acquiring extra information, but the news market also becomes more segregated, and we show later that such segregation is detrimental to reader welfare. Take two extreme cases. First, consider what happens when reader beliefs are very dispersed. As $\delta$ goes to zero, $a_\delta^*$ goes to zero as well and outlets become uninformative, since they (almost) always send

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11. In the sense that the more biased toward $R$ one outlet is, the more biased toward $L$ they want the other to be. We discuss this in Appendix B.

the same report. As a consequence, reader welfare approaches the no-information level, which is clearly worse than the benchmark case. Second, consider the situation in which reader beliefs are very homogeneous. As $\delta$ goes to $1/10$, then $a_\delta^*$ goes to $1/2$. In this case, welfare is higher under cross-checking than in the benchmark, since outlet strategies are the same in the two cases and readers benefit from the possibility of cross-checking. Hence, simultaneous cross-checking may improve or diminish reader welfare compared to the benchmark case, depending on the dispersion of beliefs.

## 4.2 Sequential Case

In the sequential case, the order in which cross-checkers acquire information matters. Which report should be acquired first? Consider the case of $\varphi_u < p < \psi_u$. Readers choose action $R$ unless $r_1 = r_2 = L$. Therefore, if the first report says $R$, the reader should choose $R$ and not acquire the second report. If the first report says $L$, the reader should acquire the second report and follow its advice. This leads to the same action regardless of which report is acquired first, and thus the expected payoff is independent of the order of acquisition. Instead we must use Assumption 1, which implies that readers should choose the order of acquisition that minimizes the expected number of acquired reports. This leads us to the following lemma.

**Lemma 1** *In the sequential case, cross-checkers choose their strategies as follows.*

$$\varphi_u < p < \psi_u : \quad \sigma_p^1(\emptyset) = \rho_1, \sigma_p^2(R) = \emptyset, \sigma_p^2(L) = \rho_2,$$
$$\psi_l < p < \varphi_l : \quad \sigma_p^1(\emptyset) = \rho_2, \sigma_p^2(L) = \emptyset, \sigma_p^2(R) = \rho_1.$$

The lemma has the interpretation that readers first read the report that is closest to their own bias, and then if they are "surprised" they acquire the second report. Since we can precisely identify in which stage consumers acquire which report, we can split demand into a well-defined stage 1 and stage 2 demand. Denote the stage $t$ demand for

outlet $n$ by $D_n^t(a_1, a_2)$. If $a_1 < a_2$, then

$$D_1^1(a_1, a_2) = \psi_u - \varphi_1, \qquad D_1^2(a_1, a_2) = \begin{cases} \varphi_2 - \psi_l \text{ if } a_1 > 1 - a_2; \\ \varphi_1 - \psi_l \text{ if } a_1 \leq 1 - a_2, \end{cases}$$

$$D_2^1(a_1, a_2) = \varphi_1 - \psi_l, \qquad D_2^2(a_1, a_2) = \begin{cases} \psi_u - \varphi_1 \text{ if } a_2 \geq 1 - a_1; \\ \psi_u - \varphi_2 \text{ if } a_2 < 1 - a_1. \end{cases}$$

The difference to the simultaneous case is that now stage 2 demand is not certain. Therefore, outlet $n$ must weigh stage 2 demand by the probability that outlet $m$'s report leads readers to cross-check. Lemma 1 implies that outlet 1 has positive demand in stage 2 only if $r_2 = R$ and outlet 2 only if $r_1 = L$. Denote the probability that outlet $n$ has positive stage 2 demand by $P_n(a_m)$. Since outlets have uniform beliefs, then $P_1(a_2) = 1 - a_2$ and $P_2(a_1) = a_1$. We can then write outlet $n$'s total demand in the sequential case as

$$D_n(a_1, a_2) = D_n^1(a_1, a_2) + P_n(a_m)D_n^2(a_1, a_2).$$

In the simultaneous case, demand is exactly $D_n^1(a_1, a_2) + D_n^2(a_1, a_2)$, so outlets are indifferent between demand from different stages. In the sequential case, stage 1 demand is more valuable than stage 2 demand, because it materializes with higher probability. This creates an incentive to compete toward the center to steal stage 1 demand from the other outlet, just as in the benchmark case. In equilibrium, this demand-stealing incentive dominates, as shown in the next proposition.

**Proposition 4** *In the sequential case the unique equilibrium is the centrist equilibrium. I.e.,*

$$\mathcal{A} = \{(1/2, 1/2)\}.$$

When cross-checking is sequential the equilibrium is identical to the benchmark case. We show in Section 5.1 that this is also the pair of strategies that maximizes total demand, unlike in the benchmark and simultaneous cases, where total demand is maximized by choosing extreme positions. The reason is that in the sequential case, making

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one outlet more extreme diminishes the expected stage 2 demand for the other outlet. Therefore, although the number of potential cross-checkers is maximized by choosing extreme positions, the expected number of actual cross-checkers is maximized at the center. Furthermore, the centrist equilibrium maximizes reader welfare.

Gentzkow and Shapiro (2011) show empirically that the level of segregation in the American media market is greater among newspapers than online. This is consistent with our results if we interpret the simultaneous case as characterizing a market in which acquisition must be planned, such as the newspaper market, and the sequential case as characterizing a market in which acquisition is flexible, such as the online market. Arguably, our media market only captures a fraction of what goes on in a real media market, but it does expose some mechanisms that are worth noting. First, when actions are discrete, it is better to receive a strong signal sometimes than it is to receive a weak signal all the time, since the weak signal may not contain enough information to influence actions. This provides an incentive for outlets to be biased. Second, in the benchmark case it is easier to steal demand from the other outlet, than it is to increase the total market size. This provides an incentive for outlets to differentiate minimally. Third, cross-checking weakens the second mechanism, since cross-checkers are not worth "stealing". The mode of cross-checking determines how much the demand-stealing effect is weakened. The difference between the simultaneous and sequential case in our model comes about from the third mechanism.

## 5.   Competition, Welfare and Advertising

This section discusses the results of the previous section by (i) comparing the competitive duopoly case to that of a single owner, (ii) analyzing welfare and the social planner's perspective, and (iii) allowing revenues to differ for single-readers and cross-checkers.

## 5.1 Monopoly and Joint Ownership

By *monopoly* we refer to the case of a single outlet and by *joint ownership* we refer to the case of two outlets with a joint owner. We suppose that the joint owner chooses a symmetric strategy, $a_1 = 1 - a_2 = a \leq 1/2$, in order to simplify the analysis. Since we are interested in comparing outcomes with the cross-checking case, we analyze monopoly and joint ownership in the case where $c$ is small. In particular, we will assume that $c < \delta^2$. In the cross-checking case, we use the assumptions of Sections 3 and 4.

**Proposition 5** *The unique monopoly equilibrium has $a_M^* = 1/2$. Now assume $a_1 = 1 - a_2$ and let $\bar{\mathbf{A}} \equiv (\delta - \sqrt{\delta^2 - c}, \delta + \sqrt{\delta^2 - c})$. Under joint ownership, we have the following cases.*

*1. Benchmark: Suppose $c < \delta^2$. The set of equilibria is $\mathcal{A} = \{(a, 1 - a)\}_{a \in \bar{\mathbf{A}}}$.*

*2. Sequential case: The unique equilibrium is $\mathcal{A} = \{(1/2, 1/2)\}$.*

*3. Simultaneous case: The set of equilibria is $\mathcal{A} = \{(a, 1 - a)\}_{a \in \mathbf{A}}$.*

Thus, the monopolist is always unbiased, whereas the joint ownership is at least as biased as the competitive duopoly. In the sequential cross-checking case, the joint ownership remains unbiased, since increasing the bias of one outlet creates a negative externality, in the form of lower expected demand for the other outlet. In the benchmark case and in the simultaneous cross-checking cases, there is no negative externality from increasing bias, and therefore the joint ownership is as biased as possible.

## 5.2 Reader Welfare

As a measure of reader welfare we choose total reader utility. Unlike, for instance, Mullainathan and Shleifer (2005) and Gentzkow and Shapiro (2006), not all readers will necessarily acquire a report in the present model. Therefore, a social planner who wishes to maximize reader welfare must balance between maximizing the reader base and maximizing the informational content of reports. The total utility when costs are

zero is given by[12]

$$W(a_1, a_2) = \sum_{n \in \{1,2\}} \int_{\mathcal{S}_C^n} V_p(a_1, a_2)\, dp + \sum_{n \in \{1,2\}} \int_{\mathcal{S}_S^n} V_p(a_n)\, dp + \int_{\mathcal{S}_U} V_p\, dp,$$

where $\mathcal{S}_C^n$ is the set of cross-checkers who first read report $n$, $\mathcal{S}_S^n$ is the set of single-readers of $n$, and $\mathcal{S}_U$ is the set of uninformed consumers. As a benchmark, we use the no-information level of welfare (no media), $W_0$. Let $W_M$, $W_J$ and $W_D$ denote welfare under monopoly, joint ownership and duopoly, respectively. Furthermore, let $W_*$ denote the optimal welfare level. We summarize our findings as follows.

**Proposition 6** *In the benchmark case, as $c \to 0$ we have*

$$W_* > W_M = W_D > W_J$$

*In the sequential cross-checking case,*

$$W_* = W_J = W_D > W_M.$$

*In the simultaneous cross-checking case, there exists $\delta^* > 0$ such that*

$$W_* > W_M > W_J = W_D \ if \ \delta < \delta^*,$$
$$W_* \geq W_J = W_D \geq W_M \ if \ \delta \geq \delta^*.$$

When cross-checking is simultaneous, competition may lead to the worst possible outcome, in particular when consumer beliefs are very dispersed. Therefore, monopoly may actually be preferred. When cross-checking is sequential, the social optimum results both under competition and joint ownership.

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12. Notice that we have normalized the total utility by multiplying by $1 - 2\delta$.

## 5.3   Advertising

Several papers (Ambrus et al. (2012); Anderson et al. (2011); Gentzkow et al. (2012)) consider cross-checking and advertising. One of the key findings of these authors is that in terms of advertising, cross-checkers are worth less to outlets than single-readers. The reason is that outlets can only charge advertisers the marginal gain from accessing cross-checkers, whereas single-readers can be charged at the monopoly price.

To analyze how this affects our model, we follow Gentzkow et al. (2012) and use a simple reduced-form model of advertising. In particular, we normalize the value of a cross-checker to one and let the value of a single-reader be given by $\gamma > 1$. We will just look at the simultaneous case here. Whenever $\psi_u, \psi_l \in [\delta, 1-\delta]$ and $a_1 < a_2$, profits are as follows.

$$\Pi_1(a_1, a_2) = \begin{cases} \psi_u - \varphi_1 + \varphi_2 - \psi_l & \text{if } a_1 > 1 - a_2; \\ \psi_u - \psi_l & \text{if } a_1 = 1 - a_2; \\ \psi_u - \varphi_2 + \varphi_1 - \psi_l + \gamma(\varphi_2 - \varphi_1) & \text{if } a_1 < 1 - a_2, \end{cases}$$

$$\Pi_2(a_1, a_2) = \begin{cases} \psi_u - \varphi_1 + \varphi_2 - \psi_l + \gamma(\varphi_1 - \varphi_2) & \text{if } a_2 > 1 - a_1; \\ \psi_u - \psi_l & \text{if } a_2 = 1 - a_1; \\ \psi_u - \varphi_2 + \varphi_1 - \psi_l & \text{if } a_2 < 1 - a_1. \end{cases}$$

The greater $\gamma$ is, the greater is the incentive to deviate for the least-biased outlet, since this creates valuable single-reader demand. Therefore, when strategies are not symmetric, the least-biased outlet has even more incentive to differentiate than before. Hence, the set of equilibria must be a subset of the set of equilibria we obtained in Section 4.1. Paradoxically, there is no differentiated equilibrium because outlets always want to be *even more differentiated*, but when they become maximally differentiated they are also uninformative. It seems reasonable that there are many situations in which there exists some maximum level of bias which is still informative, so we make the restriction $a_1, a_2 \in [\bar{a}, 1 - \bar{a}]$, for some $\bar{a} \in (0, a_\delta^*]$. We can then show the following proposition.

**Proposition 7** *Suppose $a_1$ and $a_2$ are restricted to the interval $[\bar{a}, 1 - \bar{a}]$ where $\bar{a} \in (0, a_\delta^*]$. Furthermore, suppose cross-checking is simultaneous and that advertising revenues are differentiated such that demand is given as above. Then*

$$
\mathcal{A} = \begin{cases} \{(1/2, 1/2), (\bar{a}, 1 - \bar{a})\} & \text{for } \gamma \leq 6/5, \\ \{(\bar{a}, 1 - \bar{a})\} & \text{for } \gamma > 6/5. \end{cases}
$$

The introduction of differentiated advertising revenues increases incentives to deviate toward extreme positions, which may lead to the disappearance of the centrist equilibrium.

# 6. Conclusion

Cross-checking is an important aspect of nearly any media market. This paper has sought to derive its implications for horizontal competition when readers are heterogeneous in their beliefs and actions, states and reports are binary. Casual intuition may suggest that when readers can cross-check, outlets have more incentive to be moderate, so as to appeal to the entire spectrum of the market. It has been demonstrated that this is not so. On the contrary, cross-checking generates an incentive to be more partisan. In equilibrium this incentive may be dominated by the intrinsic moderating forces of the model, but as shown, differentiated equilibria are possible. Differentiation is detrimental to reader welfare, which is maximized when outlets are centrist. From a social planner perspective, competition seems to always be preferable to joint ownership, but monopoly may outperform a differentiated equilibrium and so there is no monotone relationship between competition and welfare.

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# Appendix

## A.   Deriving the Optimal Action Strategy

Since the action strategy is entirely determined by the posteriors, we first generalize the intuition from Figure II. As in the main text, let $a_1 \leq a_2$ such that outlet 1 is biased toward $R$ and outlet 2 is biased toward $L$. Observe that if $r_1 \neq r_2$, and $a_R$ is the cut-off of the report that says $R$ and $a_L$ the cut-off of the report that says $L$, then the posterior can be written as

$$\left[ 1 + \frac{1-p}{p} \cdot \alpha(a_R, a_L) \right]^{-1}, \quad \text{where } \alpha(a_R, a_L) \equiv \frac{1 - a_R}{a_L} \cdot \frac{2 - a_L}{2 - (1 - a_R)}.$$

Hence, $\pi_p(R, L) > \pi_p(L, R)$ if and only if $\alpha(a_1, a_2) < \alpha(a_2, a_1)$. Rearranging we find

$$\alpha(a_1, a_2) - \alpha(a_2, a_1) = -2 \frac{(a_2 - a_1)(1 - a_1 - a_2)}{a_1 a_2 (1 + a_1)(1 + a_2)}.$$

Therefore, $\pi_p(R, L) > \pi_p(L, R)$ if and only if $a_1 < 1 - a_2$. Combining this with the fact that the posterior is greatest (resp. smallest) when both reports are $R$ (resp. $L$) we obtain the following set of inequalities.

$$\begin{aligned} \pi_p(R, R) \geq \pi_p(L, R) \geq \pi_p(R, L) \geq \pi_p(L, L) \text{ if } a_1 \geq 1 - a_2, \\ \pi_p(R, R) \geq \pi_p(R, L) \geq \pi_p(L, R) \geq \pi_p(L, L) \text{ if } a_1 \leq 1 - a_2. \end{aligned} \tag{3}$$

When the reports disagree, the posterior follows the most biased outlet's report, in the sense that it is greater when the most biased outlet says $R$, and smaller when it says $L$. The reason for this is that when there is disagreement, the strongest possible signal is that the report of the most biased outlet goes against the bias. To see this, take the case in which outlet 1 is most biased. Then $a_1 + a_2 < 1$, which we can interpret as saying that the overall bias of the two outlets is toward $R$. This implies that $L$ signals are more informative than $R$ signals, and therefore readers revise their posterior *downward* when the reports disagree. When is this revision greatest? It is more informative

when both outlets report against their bias, than when they both report according to their bias. Hence, the posterior will move most in the former case, which implies that $\pi_p(L, R) < \pi_p(R, L)$. The posterior thus follows outlet 1's report. When $a_1 + a_2 > 1$, this is reversed. We then define the thresholds $(\psi_l, \psi_u, \varphi_1, \varphi_2)$ implicitly by

$$
\begin{aligned}
\pi_{\psi_l}(R, R) = 1/2, \quad \pi_{\psi_u}(L, L) = 1/2 \\
\pi_{\varphi_1}(L, R) = 1/2, \quad \pi_{\varphi_2}(R, L) = 1/2.
\end{aligned}
\tag{4}
$$

Since the posterior is strictly increasing in $p$, the thresholds are well-defined and will allow us to identify a set of intervals as in Figure II. These intervals then determine the action function. Solving the equations we find that

$$
\begin{aligned}
\varphi_n &= \frac{1}{2} \frac{(1 - a_n)(2 - a_m)}{1 - a_n + a_n a_m}, \\
\psi_l &= \frac{1}{2} \frac{(1 - a_1)(1 - a_2)}{1 + a_1 a_2}, \\
\psi_u &= \frac{1}{2} \frac{(2 - a_1)(2 - a_2)}{2 - a_1 - a_2 + a_1 a_2}.
\end{aligned}
$$

From the ranking of the posteriors, we can deduce that $\varphi_1 < \varphi_2$ when outlet 1 is most biased and vice versa when outlet 2 is most biased. Let $\varphi_l$ (resp. $\varphi_u$) be the smallest (resp. largest) $\varphi_n$ with respect to $n$. Combining (3) and (4) and the fact that $\pi_p$ is strictly increasing in $p$, we derive the action function $y_p(r_1, r_2)$.

$$
\begin{cases}
p < \psi_l : & y_p(r_1, r_2) = L \text{ for all } r_1, r_2, \\
\psi_l < p < \varphi_l : & y_p(R, R) = R \text{ and } y_p(r_1, r_2) = L \text{ otherwise}, \\
\varphi_l < p < \varphi_u : & y_p(r_1, r_2) = r_1 \text{ if } a_1 < 1 - a_2 \text{ and } y_p(r_1, r_2) = r_2 \text{ if } a_1 > 1 - a_2, \\
\varphi_u < p < \psi_u : & y_p(L, L) = L \text{ and } y_p(r_1, r_2) = R \text{ otherwise}, \\
p > \psi_u : & y_p(r_1, r_2) = R \text{ for all } r_1, r_2.
\end{cases}
$$

Lastly, we calculate the readers' expected payoff, $V_p(a_1, a_2) \equiv E_p[u(y_p(\rho_1, \rho_2), \theta)]$. Using the optimal action strategy, this becomes

$$
V_p(a_1, a_2) = \begin{cases}
p\left(1 - a_1^2\right)\left(1 - a_2^2\right) + (1 - p)\left(1 - (1 - a_1)^2(1 - a_2)^2\right) & \text{if } p \in [\psi_l, \varphi_l), \\
p\left(1 - a_1^2 a_2^2\right) + (1 - p)\left(2a_1 - a_1^2\right)\left(2a_2 - a_2^2\right) & \text{if } p \in [\varphi_u, \psi_u), \\
\max\{V_p(a_1), V_p(a_2)\} & \text{if } p \in [\varphi_l, \varphi_u), \\
V_p & \text{otherwise.}
\end{cases}
$$

Take the case where $p \in [\varphi_u, \psi_u)$. Readers in this interval will only choose $L$ if $r_1 = r_2 = L$. The first term in the expected payoff is the probability that the reader chooses the correct action when the state is $R$, which is equal to one less the probability that both reports are $L$. The second term is the probability that the reader chooses correctly when the state is $L$, which is equal to the probability that both reports are $L$. The case where $p \in [\varphi_u, \psi_u)$ is calculated similarly.


## B.   Optimal Outlets

Recall that in the benchmark case, the optimal outlet type for a type-$p$ reader was given by $a^*(p) = 1 - p$. In the cross-checking case, the expression is a great deal more complicated. Conditional on $a_m$, denote the $a_n$ that maximizes expected payoffs by $a_n^*(a_m, p)$. This can be found to be

$$
a_n^*(a_m, p) = \frac{(1-p)(2 - a_m)}{(1-p)(2 - a_m) + p a_m} \qquad \text{if } y_p(L, R) = R,
$$

$$
a_n^*(a_m, p) = \frac{(1-p)(1 - a_m)}{(1-p)(1 - a_m) + p(1 + a_m)} \qquad \text{if } y_p(L, R) = L.
$$

We can show that $a_n^*(\cdot)$ is decreasing in $a_m$. Putting this in words, the more biased outlet $m$ is toward $R$, the more biased the optimal outlet $n$ type is toward $L$. The intuition is the following. Suppose $y_p(L, R) = R$. In this case the reader will read the second report only if the first report is equal to $L$. Suppose $r_m$ is read first and $r_n$ potentially

afterwards. The closer $a_m$ is to zero, the greater will be the downward revision of beliefs after observing $r_m = L$. This in turn leads to a larger upward revision of the preferred outlet $n$ type, since a higher type is associated with more bias toward $L$.

The preferred pair of outlets is then given by $(a_1^*, a_2^*)$ such that $a_n^* = a_n^*(a_m^*, p)$. Rather than analyzing this generally we look at an example. The pair of outlet types that maximize the expected utility of a type-$1/2$ reader is either $(1/3, 1/3)$ or $(2/3, 2/3)$. This contrasts with the benchmark case, where the optimal outlet type is given by $a^*(1/2) = 1/2$. That is, in the benchmark the unbiased reader prefers an unbiased outlet. Why, then, does he not prefer two unbiased outlets when he cross-checks? The reason is that the reader has to pick an action when the reports disagree, and therefore the "symmetry" of the problem is broken. Suppose the reader chooses two outlets both with bias one half. If the reports disagree, the reader's posterior is exactly one half, but he must choose either $L$ or $R$, although he does not feel very convinced about either of them. The reports are not very helpful in this case. It would be better for him to choose the outlets such that the reports either give a strong signal about $R$ or a strong signal about $L$. If, for instance, the reader chooses outlet types $(1/3, 1/3)$, this provides a strong signal for $L$ whenever either of the reports says $L$, and a strong signal for $R$ whenever both reports say $R$. Thus, the reader obtains a strong signal no matter what the outcome of the reports is.

This is in contrast with Krishna and Morgan (2001), who study sequential consultation of experts and find that when two experts are biased in the same direction, it is never optimal to consult both. We find that readers may prefer both experts (outlets) to be biased in the same direction. There are two differences between our model and theirs. First, in their model both experts observe the same information, hence it is possible to learn everything necessary from the first expert. Second, in their model the decision maker has to make a continuous decision, whereas in our model actions are binary.

## C.  Proofs

*Proof of Proposition 1.* Suppose $a_1 < a_2$. The demand functions are $D_1(a_1, a_2) =$

$\frac{1}{2}\left[a_2 - c/(a_1)\right]$ and $D_2(a_1, a_2) = \frac{1}{2}\left[1 - a_1 - c/(1 - a_2)\right]$. Since $D_1(\cdot)$ is increasing in $a_1$ and $D_2(\cdot)$ is decreasing in $a_2$, any equilibrium must be symmetric: $a_1 = a_2 = a$. In this case, readers acquire each report with equal probability, so outlets expect to split demand. This is an equilibrium if and only if there is no discontinuity at $a$, i.e. if $\lim_{a_1 \uparrow a} D_1(a_1, a) = \lim_{a_2 \downarrow a} D_2(a, a_2)$. Otherwise, there exists a profitable deviation around $a$. The condition is only satisfied for $a = 1/2$. $\blacksquare$

*Proof of Proposition 2.* First, suppose $p \in \mathcal{S}_U$. Then $y_p(r_1, r_2) = y_p(r_n) = y_p(\emptyset)$ for all $n$ and $p$. Therefore, the only way to satisfy (2) is by not acquiring any report, i.e. $E_p[k_p(\sigma_p^*)] = 0$. For $p \in \mathcal{S}_C$, it follows from $y_p(\cdot)$ that (2) is always satisfied for $n = 1, 2$. Therefore, $\rho_1, \rho_2 \in \sigma_p^*$ and $E_p[k_p(\sigma_p^*)] > 1$. Lastly, suppose $p \in \mathcal{S}_S$. Take the case where $a_1 < 1 - a_2$. Since $y_p(r_1, r_2) = r_1$ for all $r_1$ and $r_2$ and $\rho_1 \neq \rho_2$, it follows from the optimality of $y_p(\cdot)$ that $E_p[u(y_p(\rho_1), \theta)] > E_p[u(y_p(\rho_2), \theta)] \geq E_p[u(y_p(\emptyset), \theta)]$. Therefore, $\rho_1 \in \sigma_p^*$. Furthermore, since $E_p[u(y_p(\rho_1, \rho_2), \theta)] = E_p[u(y_p(\rho_1), \theta)]$, then $\rho_2 \notin \sigma_p^*$. Similarly for $a_1 > 1 - a_2$. $\blacksquare$

*Proof of Proposition 3.* Write the thresholds as $\psi_u(a_1, a_2)$ and $\psi_l(a_1, a_2)$ to make explicit the dependence on cut-offs. First we calculate the following derivative.

$$\frac{\partial(\psi_u(a_1, a_2) - \psi_l(a_1, a_2))}{\partial a_1} = \frac{1}{2}\left[\frac{1 - a_2^2}{(1 + a_1 a_2)^2} - \frac{(2 - a_2)a_2}{(2 - a_1 - a_2 + a_1 a_2)^2}\right]. \quad (5)$$

*Case 1: Centrist equilibrium.* We want to check if $(1/2, 1/2)$ is an equilibrium. Consider a deviation by outlet 1 to $a_1 < 1/2$. Since $\delta < 1/10$ by assumption and $\psi_l(1/2, 1/2) = 1 - \psi_u(1/2, 1/2) = 1/10$, then $\psi_l(1/2, 1/2), \psi_u(1/2, 1/2) \in (\delta, 1 - \delta)$. Furthermore, both $\psi_l(a_1, 1/2)$ and $\psi_u(a_1, 1/2)$ are decreasing in $a_1$. Hence, $\psi_l(a_1, 1/2) > \delta$ and therefore

$$D_1(a_1, 1/2) = \min\{\psi_u(a_1, 1/2) - \psi_l(a_1, 1/2), 1 - \delta - \psi_l(a_1, 1/2)\}.$$

Substituting $a_2 = 1/2$ into (5) we obtain $(15 - 30a_1)/(3 - a_1)^3(2 + a_1)^2 > 0$. Hence, the

first term in the minimum operator is increasing in $a_1$. And since $\psi_l(a_1, 1/2)$ is strictly decreasing in $a_1$, the second term in the minimum operator is also strictly increasing in $a_1$ for $a_1 < 1/2$. It follows that $D_1(a_1, 1/2)$ is strictly increasing for all $a_1 < 1/2$. Therefore, outlet 1 has no profitable downward deviation. Since the case is symmetric for an upward deviation and for outlet 2, $(a_1, a_2) = (1/2, 1/2)$ is an equilibrium.

*Case 2: Differentiated equilibrium.* The proof will demonstrate that if the outlets are not in a centrist equilibrium, then they will seek extreme positions. We show this in three steps.

Step 1. There is no differentiated equilibrium with $\psi_u(a_1, a_2), \psi_l(a_1, a_2) \in (\delta, 1 - \delta)$. First take the case where $a_1 \geq 1 - a_2$, $a_2 > 1/2$ and $\psi_u(a_1, a_2), \psi_l(a_1, a_2) \in (\delta, 1 - \delta)$. First, rewrite the right-hand side of (5) to obtain

$$\frac{1}{2} \left[ \frac{1 - a_2^2}{(1 + a_1 a_2)^2} - \frac{(2 - a_2)a_2}{(2 - a_1 - a_2 + a_1 a_2)^2} \right] \leq \frac{1}{2} \frac{1 - 2a_2}{(1 + a_1 a_2)^2} < 0. \tag{6}$$

The first inequality holds because $a_1 + a_2 \geq 1$ and the second because $a_2 > 1/2$. Then, the following inequalities hold since $a_1 \geq 1 - a_2$, $\psi_l(\cdot)$ is decreasing in $a_1$ and $\psi_l(a_1, a_2) \in (\delta, 1 - \delta)$.

$$\delta < \psi_l(a_1, a_2) \leq \psi_l(1 - a_2, a_2).$$

It follows from this and $\psi_u(1 - a_2, a_2) = 1 - \psi_l(1 - a_2, a_2)$ that $\psi_u(1 - a_2, a_2), \psi_l(1 - a_2, a_2) \in (\delta, 1 - \delta)$. Therefore, by continuity of the thresholds, there exists $a_1' < 1 - a_2$ with $\psi_u(a_1', a_2), \psi_l(a_1', a_2) \in (\delta, 1 - \delta)$. Conditions (5) and (6) then imply

$$D_1(a_1', a_2) = \psi_u(a_1', a_2) - \psi_l(a_1', a_2) > \psi_u(a_1, a_2) - \psi_l(a_1, a_2) \geq D_1(a_1, a_2).$$

Therefore, a profitable deviation exists. If $a_2 > 1/2$ and $a_1 < 1 - a_2 < 1/2$, just relabel the axis such that $\tilde{a}_n = 1 - a_n$, which gives $\tilde{a}_2 > 1 - \tilde{a}_1$ and $\tilde{a}_1 > 1/2$. Then repeat the analysis to show that outlet 2 has a profitable deviation. If $a_2 < 1/2$, then since $a_1 \leq a_2$ we must have $a_1 < 1 - a_2$ and $a_1 < 1/2$. We can then repeat the relabeling argument. Hence, there can be no equilibrium with $\psi_u(a_1, a_2), \psi_l(a_1, a_2) \in (\delta, 1 - \delta)$.

Step 2. Consider now $(a_1, a_2)$ such that exactly one of $\psi_u(a_1, a_2), \psi_l(a_1, a_2)$ is outside $(\delta, 1 - \delta)$. This can only be true if $a_1 \neq 1 - a_2$ (otherwise either both or neither of the thresholds are outside the interval). Suppose that $\delta < \psi_u(a_1, a_2) < 1 - \delta$ but $\psi_l(a_1, a_2) \leq \delta$. Checking the thresholds, we find that this implies $a_1 > 1 - a_2$. First, take the case where $\psi_l(a_1, a_2) < \delta$. Consider a small deviation $a_1' < a_1$ such that $\psi_l(a_1', a_2) < \delta$ and $\psi_u(a_1', a_2) < 1 - \delta$. Then

$$D_1(a_1', a_2) - D_1(a_1, a_2) = [\psi_u(a_1', a_2) - \delta] - [\psi_u(a_1, a_2) - \delta] > 0.$$

The inequality holds since the thresholds are decreasing in both arguments. Hence a profitable deviation exists. Suppose then $\psi_l(a_1, a_2) = \delta$. In this case, we can apply the arguments of Step 1 to show that a profitable deviation exists. We can repeat the arguments for $\psi_u(a_1, a_2) \geq 1 - \delta$ and $\psi_l(a_1, a_2) > \delta$. Hence, there can be no equilibrium with exactly one of the two thresholds outside $(\delta, 1 - \delta)$.

Step 3. Lastly, consider $(a_1, a_2)$ such that $\psi_u(a_1, a_2), \psi_l(a_1, a_2) \notin (\delta, 1 - \delta)$. If $a_1 = 1 - a_2$, then both outlets have demand 1 and there is no profitable deviation. This is clearly an equilibrium. Suppose instead that $a_1 < 1 - a_2$. Clearly $D_1(a_1, a_2) = 1$, but possibly $D_2(a_1, a_2) < 1$, in which case outlet 2 has a profitable deviation to $a_2' = 1 - a_1$. The inequality $D_2(a_1, a_2) < 1$ holds true whenever there are single-readers, i.e. whenever

$$(\varphi_1(a_1, a_2), \varphi_2(a_1, a_2)) \cap (\delta, 1 - \delta) \neq \emptyset. \tag{7}$$

Since $a_1 < 1 - a_2$ implies $1/2 < \varphi_1(a_1, a_2) < \varphi_2(a_1, a_2)$, then (7) corresponds to $\varphi_1(a_1, a_2) < 1 - \delta$. As $\varphi_1(\cdot)$ is decreasing in both arguments we have $\varphi_1(a_1, a_2) \leq \varphi_1(0, 1/2) = 3/4$. Hence, if $\delta < 1/4$, then $D_2(a_1, a_2) < 1$ and $a_1 < 1 - a_2$ cannot be an equilibrium. Since $\delta < 1/10$ by assumption, this is always true. The case of $a_2 > 1 - a_1$ can be analyzed similarly. In conclusion, differentiated equilibria exist and are given by $a_1 = 1 - a_2$ and $\psi_l, \psi_u \notin (\delta, 1 - \delta)$. It can be checked that this implies $a_1 \leq a_\delta$. ∎

*Proof of Lemma 1.* The optimal action function implies that if $\rho_1, \rho_2 \in \sigma$, the expected payoff $E_p[u(y_p(\sigma))]$ is the same no matter the order of acquisition. Then, by

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Assumption 1, the order of acquisition should be chosen so as to minimize $E_p[k_p(\sigma)]$. Suppose $\varphi_u < p < \psi_u$ and suppose $\rho_n$ is acquired in stage 1. If $r_n = R$, then $y_p(R, r_m) = R$ regardless of $r_m$. Therefore, Assumption 1 tells us that the reader should not acquire any report in stage 2. On the other hand, if $r_n = L$, then $y_p(L, r_m) = r_m$, and the reader should acquire $\rho_m$ in stage 2. It follows that the equilibrium strategy must be of the type $\sigma_p^1 = \rho_n$, $\sigma_p^2(L) = \rho_m$ and $\sigma_p^2(R) = \emptyset$. Thus $E_p[k_p(\sigma)] = 1 + pa_n^2 + (1-p)(2a_n - a_n^2)$. This is the probability of acquiring $\rho_n$ (which is one) plus the probability of acquiring $\rho_m$ (which is the probability that $r_n = L$). Since $E_p[k_p(\sigma)]$ is increasing in $a_n$ and $a_1 \leq a_2$, then the reader should acquire $\rho_1$ first. A similar analysis shows that cross-checkers with $\psi_l < p < \varphi_l$ should acquire $\rho_2$ first. ∎

*Proof of Proposition 4.* We prove the proposition in four steps. Step 1 demonstrates the existence of the centrist equilibrium. Step 2 shows that the only candidates for differentiated equilibria are $a_1 = 1 - a_2$ and $a_1 = a_2$. Steps 3 and 4 rule out these candidates whenever $a_2 \neq 1/2$, which leaves the centrist equilibrium as the unique equilibrium.

Step 1. We first calculate the derivative of outlet 1's demand when $a_1 < a_2 \leq 1/2$.

$$
\begin{aligned}
\frac{\partial D_1(a_1, a_2)}{\partial a_1} &= a_2 \frac{(2 - a_2)}{2} \left[ \frac{1}{(1 - a_1 - a_1 a_2)^2} - \frac{1}{(2 - a_1 - a_2 + a_1 a_2)^2} \right] \\
&\quad + \frac{1 - a_2}{2} \left[ \frac{1 - a_2^2}{(1 + a_1 a_2)^2} - \frac{a_2(2 - a_2)}{(1 - a_1 + a_1 a_2)^2} \right] \\
&= \frac{1}{2} \left[ \frac{(1 - a_2)(1 - a_2^2)}{(1 + a_1 a_2)^2} + \frac{a_2^2(2 - a_2)}{(1 - a_1 + a_1 a_2)^2} - \frac{a_2(2 - a_2)}{(2 - a_1 - a_2 + a_1 a_2)^2} \right] \\
&\geq \frac{1}{2} \left[ \frac{(1 - a_2)(1 - a_2^2)}{(1 + a_1 a_2)^2} + \frac{a_2^2(2 - a_2)}{(1 + a_1 a_2)^2} - \frac{a_2(2 - a_2)}{(2 - a_1 - a_2 + a_1 a_2)^2} \right] \\
&> \frac{1}{2} \left[ \frac{(1 - a_2)(1 - a_2^2)}{(1 + a_1 a_2)^2} + \frac{a_2^2(2 - a_2)}{(1 + a_1 a_2)^2} - \frac{a_2(2 - a_2)}{(1 + a_1 a_2)^2} \right] \quad (8) \\
&= \frac{1}{2} \frac{1 - 3a_2 + 2a_2^2}{(1 + a_1 a_2)^2} \quad (9) \\
&\geq 0. \quad (10)
\end{aligned}
$$

The first lines should be obvious. The inequality in (8) follows from $a_1 + a_2 < 1$. The equality in (9) follows from collecting terms and the inequality in (10) since $a_2 \leq 1/2$. This immediately implies that there is no profitable deviation from $a_1 = a_2 = 1/2$, since upward and downward deviations can be treated symmetrically. Thus, $a_1 = a_2 = 1/2$ is an equilibrium. It also implies that no equilibrium can have $a_1 < a_2 \leq 1/2$. Then, by the symmetry of the problem, no equilibrium can have $1/2 \leq a_1 < a_2$. Hence, in the next steps we can focus on potential equilibria of the type $a_1 = a_2$ and $a_1 \leq 1/2 \leq a_2$.

Step 2. We calculate the second derivative of outlet 1's first and second stage demand when $a_2 > a_1 > 1 - a_2$.

$$\frac{\partial^2 D_1^1(a_1, a_2)}{(\partial a_1)^2} = a_2(2 - 3a_2 + a_2^2)\left[\frac{1}{(1 - a_1 + a_1 a_2)^3} - \frac{1}{(2 - a_1 - a_2 + a_1 a_2)^3}\right] > 0,$$

$$\frac{\partial^2 D_1^2(a_1, a_2)}{(\partial a_1)^2} = a_2(1 - a_2^2)\left[\frac{1}{(1 - a_2 + a_1 a_2)^3} - \frac{1}{(1 + a_1 a_2)^3}\right] > 0.$$

Both derivatives are strictly positive since we have assumed that $0 < a_n < 1$. This implies that

$$\frac{\partial^2 D_1(a_1, a_2)}{(\partial a_1)^2} > 0.$$

The strict convexity of demand implies that there is no equilibrium with $1 - a_2 < a_1 < a_2$. Repeating the argument for outlet 2, there can be no equilibrium with $1 - a_1 > a_2 > a_1$. So the only possibilities are $a_1 = 1 - a_2$ and $a_1 = a_2$.

Step 3. Suppose that $a_1 = 1 - a_2 \neq 1/2$. We show that this is not an equilibrium by calculating the gain to outlet 1 from deviating to some $a_1'$ close to $a_2$. First, calculate the demands. Since we have shown the convexity of the demand function when $1 - a_2 < a_1' < a_2$, then either demand is decreasing over the interval, in which case there is no profitable deviation, or the upper bound of the gain from a deviation is achieved by

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letting $a_1'$ approach $a_2$ from below. We therefore calculate

$$D_1(1 - a_2, a_2) = \frac{1}{2} \frac{2 - a_2}{1 + a_2 - a_2^2},$$

$$\lim_{a_1 \uparrow a_2} D_1(a_1, a_2) = \frac{1}{2} \frac{2 - 2a_2 + 5a_2^3 - 4a_2^4 + a_2^5}{(1 + a_2^2)(1 - a_2 + a_2^2)(2 - 2a_2 + a_2^2)}.$$

Thus, there is a profitable deviation from $a_1 = 1 - a_2$ if the following is positive.

$$\lim_{a_1 \uparrow a_2} D_1(a_1, a_2) - D_1(1 - a_2, a_2) = -\frac{(1 - a_2)(1 - 2a_2)(a_2 + (1 - a_2)^3)}{(1 + a_2^2)(1 - a_2 + a_2^2)(2 - 2a_2 + a_2^2)(1 + a_2 - a_2^2)}.$$

Notice that $a_1 = 1 - a_2 \neq 1/2$ and $a_1 \leq a_2$ imply $a_2 > 1/2$. This again implies that $1 - 2a_2 < 0$. All other terms are positive. Hence, the difference is positive, and $a_1 = 1 - a_2 \neq 1/2$ cannot be an equilibrium since there always exists a profitable deviation close to $a_2$.

Step 4. We show that $a_1 = a_2 \neq 1/2$ is not an equilibrium. Outlets share demand when $a_1 = a_2$, which implies that $D_n(a, a) = (\lim_{a_1 \uparrow a} D_1(a_1, a) + \lim_{a_2 \downarrow a} D_2(a, a_2))/2$. This can only be an equilibrium if $\lim_{a_2 \downarrow a} D_2(a, a_2) - \lim_{a_1 \uparrow a} D_1(a_1, a) = 0$. Otherwise, continuity implies that there is a profitable deviation. Calculate this difference when $a > 1/2$.

$$\lim_{a_2 \downarrow a} D_2(a, a_2) - \lim_{a_1 \uparrow a} D_1(a_1, a) = -\frac{1}{2} \frac{a^2 (1 - a)^2 (1 - 2a)}{(1 + a^2)(1 - a + a^2)(2 - 2a + a^2)} > 0.$$

Hence, a profitable upward deviation exists. A similar calculation for $a < 1/2$ shows that this is not an equilibrium either. Thus, $a_1 = a_2 \neq 1/2$ can never be an equilibrium. ∎

*Proof of Proposition 5.* In the monopoly case, cross-checking is clearly not possible since there is only one outlet. Using the thresholds of Section 2.2 it is straightforward to show that the equilibrium strategy of a monopolist is $a_M^* = 1/2$. Consider now two outlets under joint ownership.

*Benchmark.* If $\phi_u^1, \phi_l^2 \in [\delta, 1-\delta]$ then the demand of the joint ownership will be

$$D_J(a) = \phi_u^1 - \phi_l^2 = 1 - a - \frac{c}{a}.$$

Maximizing this, we get $a^* = \sqrt{c}$. Since we have assumed $c < \delta^2$, this implies that the joint owner captures the entire market. In fact, since $\phi_l^2 = 1 - \phi_u^1 = a/2 + c/(2a)$, then for all $a \in (\delta - \sqrt{\delta^2 - c}, \delta + \sqrt{\delta^2 - c}) \equiv \bar{\mathbf{A}}$, the joint owner captures the entire market.[13]

*Cross-Checking.* Consider instead joint ownership. Suppose first that $\psi_l, \psi_u \in [\delta, 1-\delta]$. In the sequential case, demand is given by $D_J^{SE}(a) = D_J^1(a) + a D_J^2(a)$. When outlets are equally biased, all active readers cross-check, which implies that

$$D_J^1(a) = D_J^2(a) = \psi_u - \psi_l.$$

Whenever the outlets become more extreme ($a$ lower), demand is higher in stage 1 and potential demand is higher in stage 2. But also, the probability that stage 2 demand materializes is lower. We can calculate the joint owner's demand as

$$D_J^{SE}(a) = \frac{1+a}{1+a-a^2}.$$

This is maximized at $a = 1/2$, and hence the joint owner chooses cut-offs $(1/2, 1/2)$, just like the duopolists. Given $\delta < 1/10$, then $\psi_l, \psi_u \in [\delta, 1-\delta]$ and this is an equilibrium. On the other hand, in the simultaneous case, demand is given by $D_J^{SI}(a) = D_J^1(a) + D_J^2(a)$. It is straightforward to check that $D_J^{SI}(a) = 2$ (i.e. everybody cross-checks) for any $a$ such that $\psi_l \le \delta$ and $\psi_u \ge 1 - \delta$. Hence, the joint owner will choose one of the differentiated equilibria of Proposition 3. ∎

*Proof of Proposition 6.* First, notice that $W_0 = \delta^2 - 2\delta + 3/4$.

*Benchmark case.* Consider the social planner's problem with two symmetric outlets,

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13. Solve $\phi_l = a/2 + c/(2a) < \delta$ for $a$ to get $\bar{\mathbf{A}}$.

i.e. $a_1 = 1 - a_2 = a$ and $a \le 1/2$. When costs are zero, we can then calculate welfare as

$$W_S(a) = 2 \left[ \int_{1/2}^{1-\frac{a}{2}} \left[ p\left(1 - a^2\right) + (1-p)\left(2a - a^2\right) \right] dp + \int_{1-\frac{a}{2}}^{1-\delta} p \, dp \right].$$

The derivative with respect to $a$ is $(3a^2 - 4a + 1)/2$ and the welfare optimizing strategy in this case can be solved for $a = 1/3$. This yields $W_* = W_S(1/3) = \delta^2 - 2\delta + 89/108$. Hence, no form of competition delivers the social optimum. Monopoly and duopoly yield the same welfare, since the duopolists both play the monopolist strategy. Hence, $W_M = W_D = W_S(1/2) = \delta^2 - 2\delta + 13/16$. In the joint ownership case, as $c$ goes to zero the equilibrium strategies go to $(0, 1)$, which implies that $W_J \to W_0$.

*Cross-Checking.* Notice that the welfare function is the same in the sequential and simultaneous cases. For a symmetric equilibrium, we can write it as follows.

$$W_C(a) = 2 \left[ \int_{\delta}^{\psi_l} V_p \, dp + \int_{\psi_l}^{1/2} V_p(a, 1-a) \, dp \right].$$

We can check that $W_C'(a) > 0$ for $a < 1/2$.[14] Hence, the social optimum is achieved at $a = 1/2$. In the sequential case, the optimum is achieved by duopoly and joint ownership, which yield welfare $W_J = W_D = W_C(1/2) = \delta^2 - 2\delta + 17/20$. Both are thus preferred to monopoly. In the simultaneous case, both the competitive duopoly and the joint owner have equilibrium strategies $(a_\delta^*, 1 - a_\delta^*)$.[15] Since $a_\delta^*$ is increasing in $\delta$ for $\delta < 1/10$, then $W_D$ and $W_J$ are increasing in $\delta$ and go toward the social optimum (resp. the no-information welfare) as beliefs become less (resp. more) disperse. Therefore, there exists $\delta^* < 1/10$ such that the differentiated equilibrium is better than monopoly

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14. In particular

$$W_C'(a) = \frac{d\psi_l}{da}[V(\psi_l) - V(\psi_l, 1 - \psi_l)] + \int_{\psi_l}^{1/2} [U_1(a, 1 - a, p) - U_2(a, 1 - a, p)] \, dp$$

$$= \frac{(1 - 2a)(1 + a - 5a^2 + 6a^3 + 2a^4 - 6a^5 + 2a^6)}{4(1 + a - a^2)^3}.$$

This is positive for all $a < 1/2$ and zero for $a = 1/2$.

15. Recall that there are multiple equilibria, but we focus on this one in particular.

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when $\delta > \delta^*$ and worse otherwise. As $\delta \to 1/10$, the strategies of the competitive duopolists as well as of the joint owner go toward $(1/2, 1/2)$. Therefore, $W_J, W_D \to W_*$. ∎

*Proof of Proposition 7.* Consider the centrist equilibrium. Profits for both outlets are $\psi_u(1/2, 1/2) - \psi_l(1/2, 1/2)$, where we have augmented the notation to emphasize the dependence of thresholds on strategies. If outlet 1 deviates to $a_1 < 1/2$, it will have profits $\psi_u(a_1, 1/2) - \psi_l(a_1, 1/2) + (\gamma - 1)[\varphi_u(a_1, 1/2) - \varphi_l(a_1, 1/2)]$. Rearranging, we find that outlet 1 has a profitable deviation whenever

$$\gamma > 1 + \inf_{a_1 < 1/2} \left\{ \frac{\psi_u(1/2, 1/2) - \psi_l(1/2, 1/2) - (\psi_u(a_1, 1/2) - \psi_l(a_1, 1/2))}{\varphi_u(a_1, 1/2) - \varphi_l(a_1, 1/2))} \right\}.$$

The expression inside the infimum-operator reduces to $3/5$ times $(1 + a_1)(2 - a_1)/((2 + a_1)(3 - a_1))$, which is increasing in $a_1$ and equal to $1/5$ when evaluated at $a_1 = 0$. Hence, for $\gamma > 6/5$ there is no centrist equilibrium.

For strategies in $\mathcal{A}_D$, i.e. the set of differentiated equilibria, profits are 1 for both outlets, but a deviation toward the extreme yields profits $1 + (\gamma - 1)(\varphi_u - \varphi_l) > 1$.[16] Outlets will therefore deviate toward $(\bar{a}, 1 - \bar{a})$. Since at this point outlets can differentiate no more, this is an equilibrium. ∎

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16. Recall that outlets are equally biased in all equilibria of $\mathcal{A}_D$, and that in this case $\varphi_u = \varphi_l = 1/2$. By the symmetry of the thresholds, there exists some small deviation for outlet 1 such that the new thresholds satisfy $\varphi'_u - \varphi'_l > 0$ and $\varphi'_u, \varphi'_l \in [\delta, 1 - \delta]$.

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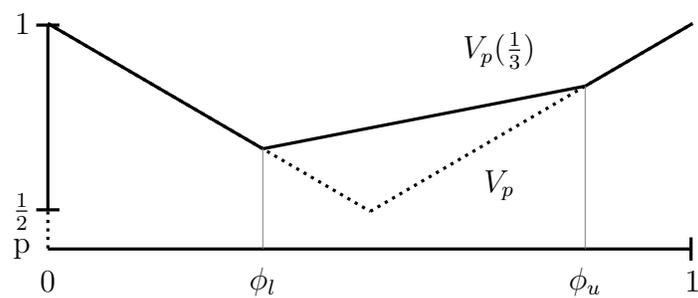Sobbrio, F., 2011. A Citizen-editors Model of News Media. Mimeo.

# Figures



FIGURE I:
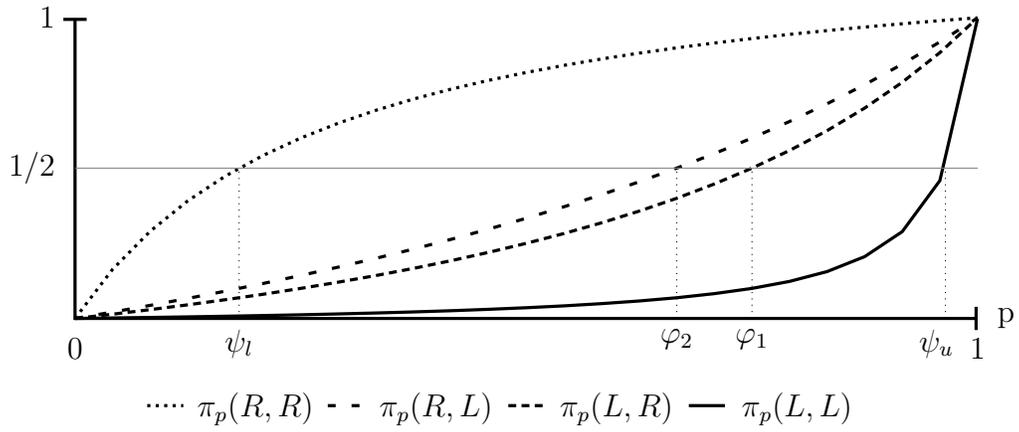READER EXPECTED PAYOFF IN THE BENCHMARK CASE

FIGURE II:
POSTERIORS. DRAWN FOR $a_1 = 1/5$ AND $a_2 = 1/2$.

(a)

| don't read | cross-check | single | cross-check | don't read |

0         $\psi_l$               $\varphi_l$    $\varphi_u$        $\psi_u$          1

(b)

| don't read | cross-check | don't read |

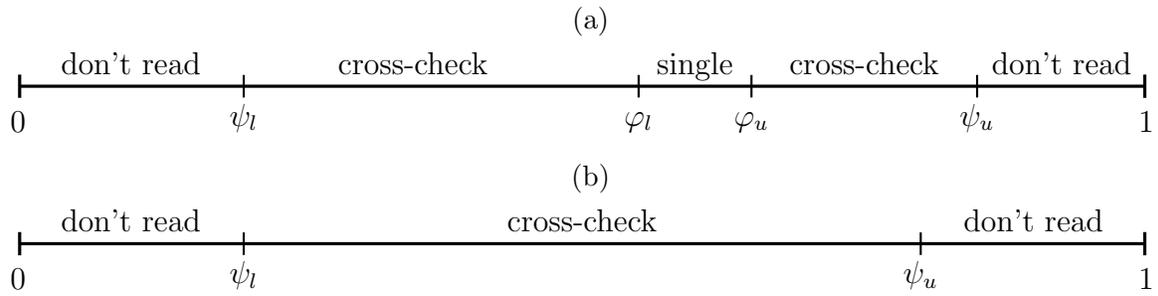0         $\psi_l$                         $\psi_u$       1

FIGURE III:
EQUILIBRIUM ACQUISITION STRATEGIES

Figure IIIa shows outlet 1 being most biased; Figure IIIb shows the outlets being equally biased.