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Essays in Applied Theory

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To my husband, Yun

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Abstract of the Dissertation

Essays in Applied Theory

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This dissertation contains three theoretical essays analyzing the incentives for reporting and acquiring information.

The first chapter explores how anonymity as a policy can be useful to induce information revelation when commitment problems exist. I present a stylized model of police soliciting crime tips from the general population, who are either criminals or non-criminals. The police can implement one of two systems: (1) anonymity and (2) non-anonymity. If the police can credibly commit to tracing only a small fraction of the calls, then the system of non-anonymity yields the best outcome for the police. However, if the police's commitment is not credible, then criminals correctly anticipate the police breaking their word and do not call. Hence, given the existence of a commitment problem, the police are better off implementing a system of anonymity. The second chapter argues that consumers

are better off with biased media firms rather than unbiased ones. To make such an argument, I use a simple communication game between potentially biased experts (media firms) and a decision maker (news consumers). In the game, information is costly for experts to acquire, all parameters are common knowledge, and reported information is verifiable. Upon characterizing the informative equilibria, in which reports are fully revealing, I show that biased experts have a higher willingness to pay for information than unbiased ones. In addition, competition among experts further improves the welfare of the decision maker, and the size of those improvements does not depend on having asymmetrically biased experts. The third chapter explores whether the presence of multiple experts increases truthful reporting through the framework of a repeated communication game between informed experts and an uninformed decision maker. A strategic expert may lie to influence the decision maker towards her own preferences. On the other hand, she may report truthfully to maintain a reputation for being honest. Within certain parameter ranges, there exists a unique symmetric, non-babbling, equilibrium, in which all strategic experts randomize between reporting truthfully and lying. Increasing the number of experts has two effects: (i) it increases the probability of truthful reporting, and (ii) it decreases the amount of patience required for the existence of this mixed strategy equilibrium. As the number of experts approaches infinity, the probability of truthful reporting converges to a value less than one.

CHAPTER 1

Anonymity as Commitment

1.1 Introduction

People act differently when others are not watching. In particular, anonymity affects human behavior. Much of the economics literature suggests that anonymity would be socially damaging. A large literature has amassed based on the problems society faces precisely due to the fact that people behave differently when no one is watching. Employees will shirk and people will behave opportunistically if they are not monitored (Alchian and Demsetz 1972). Uncertainty about what type of person (or firm) you are facing typically leads to less efficient outcomes than if you were certain.[1] The welfare theorems depend on full information and it has been shown that the lack of full information can invalidate those welfare theorems (Stiglitz 2000). Furthermore, much of the literature on repeated games informs us that having long-run players with histories allows the economy to

[1]A notable exception is Goldin and Rouse (2000). They show that employing blind orchestra auditions increased the proportion of women orchestras. Here, when the directors' preconceived notions about types were wrong, concealing types improved the overall quality of the orchestra.

achieve Pareto improving outcomes (Fudenberg, Levine, and Maskin 1990). Cooperative behavior is sustainable when you know who did what. Future treatment of others, cooperation or punishment, can be conditioned on how one is currently being treated.

Despite the fact that anonymity is typically viewed as socially damaging, it can also lead to desirable outcomes that otherwise would not occur. Consider the situations in which anonymity is employed. Voting is often anonymous. Anonymity is guaranteed to subjects who participate in experiments and surveys. Teaching evaluations and similar critiques are often submitted anonymously. Anonymous H.I.V. testing is offered by many health clinics. Police often ask for anonymous tips from the general public to help solve crimes. The common link in these examples is that granting anonymity actually induces truthful information revelation.

In this paper, I argue that anonymity can be used as a mechanism to induce information revelation when commitment problems exist. An individual with a regard for her future may not reveal private information if doing so leads to negative consequences. For instance, an illegal immigrant may not call the police with information about a serious crime in fear of being deported[2]. Moreover,

[2]One way the Los Angeles Police Department has dealt with this issue is Special Order 40, "which prohibits officers from initiating contact with individuals for the sole purpose of determining whether they are illegal immigrants.

The 29-year-old policy was designed to encourage illegal immigrants to cooperate with police without fear of being deported." (*Los Angeles Times*, April 17, 2008) this illegal immigrant may fear retaliation from the criminals for being a snitch. The commitment problem is on the part of the police. They are unable to fully ensure that negative consequences from providing the information will not befall the informant. Anonymity provides a resolution to this type of commitment problem.

The model presented in this paper will focus on when citizens derive a personal benefit from calling and not be concerned about problems associated with the lack of accountability. In the police example it is clear how a lack of accountability is potentially problematic, however, it is not so clear in other examples. For instance, anonymous H.I.V. testing does not suffer from the problem of lack of accountability. Here, the patients personally benefit from the knowledge about whether or not they have contracted H.I.V., so that they can make better decisions in their life. Relaxing this assumption is left for future research projects. The personal benefit is crucial, because with anonymity comes a lack of accountability. Implementing a system of anonymity may inadvertently invite criminals to phone in erroneous tips. If the police are busy investigating false leads, then they have less resources to devote to investigating the correct leads.

In order to develop my main point, I use a stylized example of police who solicit crime tips from the general population. To solicit these crime tips, the police may implement one of two systems: (1) anonymity and (2) non-anonymity.

The system of anonymity does not allow the police to trace phone calls, while the one of non-anonymity does.

The system of non-anonymity yields the best outcome for the police, but only if the police can credibly commit to tracing a small fraction of the calls. With credible commitment, the risk of being identified is sufficiently low so that a criminal won't be deterred from calling. However, if the police's commitment is not credible, then the criminals correctly anticipate the police breaking their word and do not call. Given the existence of a commitment problem, the police are better off implementing a system of anonymity.

1.2 The Model

The players in this model are a single police player and a continuum of citizens with mass m. There are two types of citizens: non-criminals (NC) and criminals (CR). Let the total mass of non-criminals be m_{NC} and the total mass of criminals be m_{CR}. Each citizen has private information about her own type. At the beginning of the game, all citizens interact in a public place where they can observe the actions of others. After the observation in a public place, each citizen obtains imperfect knowledge about the identity of a criminal. Each citizen then has the opportunity to call the police with a crime tip. It is necessary to have two types of citizens in this model because there needs be some uncertainty about the identity of the caller. If all citizens were of the criminal type, then the police would believe that all callers were criminals.

Let μ_{NC} and μ_{CR} be the respective probabilities that a non-criminal's tip and a criminal's tip lead to a conviction of a criminal. Assume that $0 \leq \mu_{NC} < \mu_{CR} \leq 1$. In other words, criminals have better information than non-criminals[3]. The total number of non-criminal and criminal callers is determined endogenously in the game and is notated as n_{NC} and n_{CR} respectively. Furthermore, assume that $\mu_{NC}m_{NC} + \mu_{CR}m_{CR} \leq m_{CR}$; if every citizen calls, the number of criminal convictions has to be less than or equal to the total mass of criminals.

Assume that both non-criminals and criminals derive strictly positive net benefits b_{NC} and b_{CR} from helping the police.[4] This assumption states that all citizens care about helping the police, but not necessarily by the same amount. In order for anonymity as a policy to be socially beneficial, it is necessary to assume that individuals personally benefit from revealing truthful information. Otherwise, there is no incentive to call.

If a criminal is convicted of a crime, then she is punished and receives a utility of $-\phi$, where ϕ is randomly drawn from a continuous probability distribution $F(\phi)$ with support $[0, \overline{\phi}]$.

[3]While this assumption is reasonable, it is not necessary for obtaining the results. All that is necessary is for μ_{NC} and μ_{CR} to be proper probabilities.

[4]While there may exist a cost associated with calling, this cost is already incorporated into the parameters b_{NC} and b_{CR}, since b_{NC} and b_{CR} are *net* benefits.

There are two ways in which the police can use phone calls to identify criminals. The first way is from citizens calling in tips, and the second way is from the police tracing phone calls to obtain further convictions. The police do not incur costs from receiving phone calls, but do incur a constant cost t from tracing a phone call, where $t \in [0, 1)$. The probability of convicting a criminal based on a traced call is ν. The police do not make mistakes in determining a citizens' type. In other words, non-criminals do not face a risk of being incorrectly convicted.

As the mechanism designers, the police can implement two possible systems: one of anonymity and one of non-anonymity. Under anonymity, the police are unable to trace calls back to their caller, while under non-anonymity, the police are able to trace calls. Let n_P be the number of calls the police trace. Whatever system the police decide to implement, the citizens become fully informed about what system is in place and also fully believe in it.

1.2.1 The System of Anonymity

Under the system of anonymity, all citizens will call the police with their crime tips. Being unable to trace calls, the police rely entirely on the information provided by the citizens to identify criminals.

The expected utility of a non-criminal is

$$EU_{NC} = \begin{cases} b_{NC} & \text{if call} \\ 0 & \text{if not call} \end{cases}$$

Hence, all non-criminals call since $b_{NC} > 0$.

$$n_{NC} = m_{NC}$$

The expected utility of a criminal is

$$EU_{CR} = \begin{cases} b_{CR} - (\frac{\mu_{NC} n_{NC} + \mu_{CR} n_{CR}}{m_{CR}}) * \phi & \text{if call} \\ -(\frac{\mu_{NC} n_{NC} + \mu_{CR} n_{CR}}{m_{CR}}) * \phi & \text{if not call} \end{cases}$$

Regardless of a criminal's calling decision, she faces the possibility of being punished from the information provided by other callers. Here, $\frac{\mu_{NC} n_{NC} + \mu_{CR} n_{CR}}{m_{CR}}$ is the probability of that occurrence.

All criminals call since $b_{CR} > 0$.

$$n_{CR} = m_{CR}$$

Under the system of anonymity, the police are unable to trace calls, hence $n_P = 0$.

The expected utility of the police is

$$EU_P = \mu_{NC} m_{NC} + \mu_{CR} m_{CR}$$

1.2.2 The System of Non-Anonymity

Under the system of non-anonymity, all non-criminals will call the police, but the behavior of criminals will differ depending on whether or not the police are able to credibly commit to limiting the number of traced calls.

The expected utility of a non-criminal is

$$EU_{NC} = \begin{cases} b_{NC} & \text{if call} \\ 0 & \text{if not call} \end{cases}$$

Again, all non-criminals call since $b_{NC} > 0$.

$$n_{NC} = m_{NC}$$

The expected utility of a criminal is

$$EU_{CR} = \begin{cases} b_{CR} - (\frac{n_P}{n_{NC}+n_{CR}} * \nu + \frac{\mu_{NC}n_{NC}+\mu_{CR}n_{CR}}{m_{CR}}) * \phi & \text{if call} \\ -(\frac{\mu_{NC}n_{NC}+\mu_{CR}n_{CR}}{m_{CR}}) * \phi & \text{if not call} \end{cases}$$

Regardless of a criminal's calling decision, she faces the possibility of being punished from the information provided by other callers. Here, $\frac{\mu_{NC}n_{NC}+\mu_{CR}n_{CR}}{m_{CR}}$ is the probability of that occurrence. In addition, if a criminal calls, her call may be traced back to her with probability $\frac{n_P}{n_{NC}+n_{CR}}$. If the police traces the call back to her, there is a probability ν of conviction.

Criminals call only when the expected utility from calling exceeds the expected utility from not calling.

$$
\begin{aligned}
\underbrace{\begin{bmatrix} b_{CR} - (\frac{n_P}{n_{NC}+n_{CR}} * \nu \\ + \frac{\mu_{NC}n_{NC}+\mu_{CR}n_{CR}}{m_{CR}}) * \phi \end{bmatrix}}_{EU_{CR} \text{ if call}} &> \underbrace{-(\frac{\mu_{NC}n_{NC}+\mu_{CR}n_{CR}}{m_{CR}}) * \phi}_{EU_{CR} \text{ if not call}} \\
b_{CR} - \phi\nu\left(\frac{n_P}{n_{NC}+n_{CR}}\right) &> 0 \\
b_{CR} &> \phi\nu\left(\frac{n_P}{n_{NC}+n_{CR}}\right) \qquad (1.1)
\end{aligned}
$$

Inequality (1.1) shows that the number of criminal callers n^*_{CR} depends on whether the benefit of calling b_{CR} exceeds the risk of having the call traced.

If inequality (1.1) holds true with all non-criminals calling and the maximum penalty $\overline{\phi}$, then all criminals will call. That is, if

$$
b_{CR}\left(\frac{m_{NC}+n^*_{CR}}{\nu n_P}\right) \geq \overline{\phi} \qquad (1.2)
$$

then

$$
F\left[b_{CR}\left(\frac{m_{NC}+n^*_{CR}}{\nu n_P}\right)\right] = 1 \qquad (1.3)
$$

and therefore, all criminals will call.

$$
n^*_{CR} = m_{CR}
$$

However, if inequality (1.1) does not hold true with the maximum penalty $\overline{\phi}$, that is,

$$b_{CR}\left(\frac{n_{NC}+n_{CR}^{*}}{\nu n_{P}}\right)<\overline{\phi} \tag{1.4}$$

then only a portion of criminals call depending on the probability distribution of ϕ. Those with lower penalties call.

$$n_{CR}^{*}=F\left[b_{CR}\left(\frac{n_{NC}+n_{CR}^{*}}{\nu n_{P}}\right)\right]m_{CR} \tag{1.5}$$

From this point on, the analysis differs depending on whether or not the police are able to commit to tracing a certain number of calls. What follows is first, an analysis with commitment, and second, an analysis without commitment.

1.2.2.1 With Commitment

In the commitment case, the police are able to credibly commit to tracing only $\widetilde{n}_P$ calls. Since commitment is possible, the timing of the game is sequential. The police first announce that they will only trace $\widetilde{n}_P$ calls and then the citizens make their calling decisions based on the announced value of $\widetilde{n}_P$. The game is solved using backwards induction. In deciding whether or not to call, the citizens treat $\widetilde{n}_P$ as exogenous. As was determined earlier, all non-criminals will call ($n_{NC}=m_{NC}$). Combining that information with equation (1.5), the number of criminals who call is characterized by the following equation.

$$n_{CR}^{*} = F\left[b_{CR}\left(\frac{m_{NC} + n_{CR}^{*}}{\nu\widetilde{n}_{P}}\right)\right]m_{CR} \tag{1.6}$$

The expected utility of the police is

$$EU_{P} = (\mu_{NC}m_{NC} + \mu_{CR}n_{CR}^{*}) + \left(\frac{n_{CR}^{*}}{m_{NC} + n_{CR}^{*}}\right)\nu n_{P} - tn_{P} \tag{1.7}$$

Knowing the best response of the criminals and how the choice of n_P will affect n_{CR}^{*}, the police will select n_P, so as to maximize their utility.

$$n_{P}^{*} = \arg\max_{n_P} EU_{P}$$

Let the maximized expected utility of the police be denoted as V_P.

It is possible for the police to select $\widetilde{n}_P > 0$ sufficiently small such that all criminals will call. To achieve this the police must select $\widetilde{n}_P > 0$ such that condition (1.2) holds. In this case, equation (1.3) holds and thus $n_{CR}^{*} = m_{CR}$. The expected utility of the police becomes

$$EU_{P} = (\mu_{NC}m_{NC} + \mu_{CR}m_{CR}) + \left(\frac{m_{CR}}{m_{NC} + m_{CR}}\right)\nu\widetilde{n}_{P} - t\widetilde{n}_{P} \tag{1.8}$$

The expected utility of the police given in (1.8) must be either equal to or less than V_P, since V_P is the maximum expected utility of the police.

1.2.2.2 Without Commitment

After the citizens have already completed their phone calls to the police, the police have no reason to trace only $\widetilde{n}_P$ calls because this is a one-shot game. In this case, all citizens are aware that the police are unable to commit to tracing only $\widetilde{n}_P$ calls. Since commitment is not possible, the timing of this game is simultaneous.

Because non-criminals are unaffected by the police's lack of commitment, all non-criminals call ($n_{NC} = m_{NC}$).

The expected utility of the police is

$$EU_P = (\mu_{NC} n_{NC} + \mu_{CR} n_{CR}) + \left(\frac{n_{CR}}{n_{NC} + n_{CR}}\right) \nu n_P - t n_P$$

In the case without commitment, the police will maximize their utility treating n_{CR} as exogenous. The number of calls that the police trace will be such that the marginal benefit of tracing will be equal to the marginal cost of tracing.

$$\underbrace{\left(\frac{n_{CR}}{n_{NC} + n_{CR}}\right)}_{\text{marginal benefit}} \nu = \underbrace{t}_{\text{marginal cost}} \tag{1.9}$$

Assume that the marginal cost of tracing a call is not too high. Even if all non-criminals and criminals call, the police still have an incentive to trace calls. That is, assume

$$\left(\frac{m_{CR}}{m_{NC}+m_{CR}}\right)\nu > t$$

The number of criminal callers can be identified by substituting $n_{NC} = m_{NC}$ into (1.9).

$$\begin{aligned}
\left(\frac{n_{CR}}{m_{NC}+n_{CR}}\right)\nu &= t \\
n_{CR} &= \frac{t}{\nu - t} m_{NC}
\end{aligned}$$

The number of traced calls can be found by substituting this above equation into (1.5).

$$\begin{aligned}
n_{CR} &= F\left[b_{CR}\left(\frac{n_{NC}+n_{CR}}{\nu n_P}\right)\right] m_{CR} \\
\frac{t}{\nu - t} m_{NC} &= F\left[b_{CR}\left(\frac{m_{NC}+\left(\frac{t}{\nu-t}m_{NC}\right)}{\nu n_P}\right)\right] m_{CR} \\
n_P &= \frac{b_{CR} m_{NC}}{(\nu - t)\, F^{-1}\left[\left(\frac{t}{\nu-t}\right)\left(\frac{m_{NC}}{m_{CR}}\right)\right]}
\end{aligned}$$

The expected utility of the police becomes the following. Notice that because the marginal benefit of tracing equals the marginal cost, the last two terms of (1.7) becomes zero.

$$
\begin{aligned}
EU_P &= \mu_{NC} n_{NC} + \mu_{CR} n_{CR} \\
&= \mu_{NC} m_{NC} + \mu_{CR} \left(\frac{t}{\nu - t} m_{NC} \right) \\
&= \left[\mu_{NC} + \mu_{CR} \left(\frac{t}{\nu - t} \right) \right] m_{NC}
\end{aligned}
$$

1.3 Implications

Proposition 1 *The expected utility of the police under non-anonymity with commitment is greater than the expected utility of the police under anonymity.*

If the police are able to commit to tracing only a very small number of calls, then it is possible to still induce all criminals to call. Hence, under non-anonymity with commitment, the police can induce all citizens to call in their crime tips. In addition, the police are able to trace that very small number of calls, and achieve an additional positive utility from tracing that very small number of calls. Under the system of anonymity, the best that the police can achieve is to induce all citizens to call in crime tips. Under anonymity, the police cannot trace any calls and cannot achieve any more utility. Thus, the first best system is one of non-anonymity with commitment.

Proof. The expected utility of the police under non-anonymity with commitment is at least as large as

$$EU_P = (\mu_{NC} m_{NC} + \mu_{CR} m_{CR}) + \left(\frac{m_{CR}}{m_{NC} + m_{CR}} \right) \nu \widetilde{n}_P - t \widetilde{n}_P$$

where $\widetilde{n}_P > 0$ and condition (1.2) holds.

The expected utility of the police under anonymity is

$$EU_P = \mu_{NC} m_{NC} + \mu_{CR} m_{CR}$$

Hence, this proposition states that

$$\begin{aligned} (\mu_{NC} m_{NC} + \mu_{CR} m_{CR}) + \left(\frac{m_{CR}}{m_{NC} + m_{CR}} \right) \nu \widetilde{n}_P - t \widetilde{n}_P &> \mu_{NC} m_{NC} + \mu_{CR} m_{CR} \\ \left(\frac{m_{CR}}{m_{NC} + m_{CR}} \right) \nu \widetilde{n}_P - t \widetilde{n}_P &> 0 \\ \left(\frac{m_{CR}}{m_{NC} + m_{CR}} \right) (\nu - t) \widetilde{n}_P &> 0 \qquad (1.10) \end{aligned}$$

Since $m_{CR} > 0$, $(\nu - t) > 0$, and $\widetilde{n}_P > 0$, inequality (1.10) holds true. ■

Proposition 2 *If the police have an incentive to trace calls, then the expected utility of the police under anonymity is greater than the expected utility of the police under non-anonymity without commitment.*

Proof. The expected utility of the police under anonymity is

$$EU_P = \mu_{NC} m_{NC} + \mu_{CR} m_{CR}$$

The expected utility of the police under non-anonymity without commitment is

$$EU_P = \mu_{NC} m_{NC} + \mu_{CR} \frac{t}{\nu - t} m_{NC}$$

Hence, this proposition states that

$$\begin{aligned} \mu_{NC} m_{NC} + \mu_{CR} m_{CR} &> \mu_N m_{NC} + \mu_{CR} \frac{t}{\nu - t} m_{NC} \\ m_{CR} &> \frac{t}{\nu - t} m_{NC} \end{aligned}$$

■

This inequality is the same condition for the police to have any incentive to trace calls. In other words, as long as the police have an incentive to trace calls, the police would have a higher utility implementing a system of anonymity.

1.4 Discussion

The stylized model presented in this paper highlights the benefits of anonymity in inducing truthful information revelation. In keeping with that focus, certain assumptions were made. For instance, implementing a system of anonymity was assumed to be costless. Once implemented, it was assumed that all citizens fully believed it. Additionally, all citizens in the model, criminals and non-criminals alike, cared about reducing crime. The first part of this section addresses possible concerns about those assumptions. The second part of this section then broadens our understanding of anonymity by relating it to other commitment devices, specifically, reputation and privacy.

1.4.1 Discussion of Assumptions

In the model, the cost of implementing a system of anonymity was ignored and hence implicitly assumed to be zero. Relaxing this assumption changes the cost and benefit scale, but does not significantly alter the essence of the model. Given the existence of a commitment problem, the relevant comparison is between the expected utility of the police under anonymity and the expected utility under non-anonymity without commitment.

Recall that the expected utility of the police under anonymity was

$$EU_P = \mu_{NC} m_{NC} + \mu_{CR} m_{CR}$$

while the expected utility of the police under non-anonymity without commitment was

$$EU_P = \mu_{NC} m_{NC} + \mu_{CR} \frac{t}{\nu - t} m_{NC}$$

As long as the police actually have an incentive to trace calls (that is, $m_{CR} > \frac{t}{\nu-t} m_{NC}$), the police would be willing to pay up to the difference between the two expected utilities in order to implement the system of anonymity (that value is, $m_{CR} - \frac{t}{\nu-t} m_{NC}$). If the police did not have an incentive to trace calls, then there is no commitment problem.

Part of the implementation cost is making the system believable to the citizens. Even if the police announce that they have a system that does not allow them to trace calls, the public may not believe it. The believability of true anonymity is absolutely crucial in its effectiveness. Given the prevalence of Caller ID technology, it might not be possible for the police to convince the public that phoned tips are completely anonymous. If the burden of convincing the public that a system is anonymous is put on the police, then the cost of implementing a system of anonymity may be prohibitively high. Instead, citizens may take it upon themselves to ensure anonymity. They may call from a pay phone or send anonymous tips through the postal system.

In other examples, such as voting and teaching evaluations, it is reasonably easy to construct a believable system of anonymity. A common system of anonymity is to have individuals fill in bubbles on a form that is then shuffled with all other forms. Using electronic devices for communication tends to be less believable as an anonymous scheme than using paper.

1.4.2 Relationship to Reputation and Privacy

A useful way to understand anonymity is to compare and contrast it with reputation. The two can be regarded as similar because they both resolve commitment problems. Reputation serves as a commitment device in the face of short-run incentive problems. In the classic chain store example, establishing a reputation for being tough can deter potential entrants, despite the fact that it may be cheaper to accommodate each new entrant in the short-run. Similarly, in the stylized model of this paper, the police could resolve its commitment problem by establishing a reputation for always keeping its word. As long as the police care enough about future payoffs, reputation effectively becomes equivalent to non-anonymity with commitment. Therefore, as long as reputation can adequately serve as a commitment device, it yields a better outcome than anonymity.

Reputation depends on the long-run incentives being more attractive relative to the short-run gains. Reputation may not suffice as a commitment device for several reasons. First, it requires repeated game play. Often times a citizen's interaction with the police is infrequent. Moreover, given the vast number of police jurisdictions, a citizen's interaction with the *same* police force is even less frequent. Second, it requires individuals to observe past behavior. Assessing the police's reputation may require costly investigation through public records or through asking fellow citizens about their past experiences with the police. Moreover, a citizen who recently moved into a neighborhood may not know of the police's reputation. Third, citizens may not know the exact preferences of the police and may not be able to infer whether or not the long-run incentives of the police are sufficient for them to keep their word. Fourth, the party interested in maintaining a reputation may in fact be comprised of multiple people who have incentive to individually deviate. For instance, the Police Department as a whole may want to maintain a reputation for keeping its word, but an individual policeman with career concerns may deviate by secretly tracing more phone calls. While reputation may yield an outcome superior to anonymity, sometimes reputation cannot work for the reasons explored above and implementing a system of anonymity overcomes these obstacles.

From a different perspective, anonymity can also be regarded as the opposite of reputation. In the previous paragraphs, we discussed the police's reputational concerns. By turning our attention to the citizen's reputational concerns, we can see how anonymity can be regarded as the opposite of reputation. Establishing reputation requires repeated game play with an observable history. By stripping away identity, anonymity effectively makes all citizens short-run players with no history. Criminals do not want to reveal themselves to be of the criminal type to the police and they also do not want a reputation of being a snitch to other criminals. Without anonymity, their reputational concern prevents information dissemination. However, with anonymity, there is no regard for future consequences, thus, allowing private information to be revealed.

A nice feature of both reputation and anonymity is that they resolve commitment problems without a contractual agreement. An alternative resolution to the commitment problem is an enforceable privacy contract[5]. Privacy and anonymity are closely related; they both withhold information from others. For

[5]There are many names for this type of contractual agreement including privacy policy, non-disclosure agreement, and confidentiality agreement.

instance, a doctor agrees to a legally binding contract to keep patient records private. Since a patient without privacy may fear loss of employment, being denied insurance, or social discrimination, this contract allows the patient to seek counsel and treatment and commits the doctor to keep records safe from outside interested parties.

If a contractual agreement is unsustainable or unenforceable, then anonymity may help to resolve the commitment problem in place of the contract. One obvious example of an unsustainable contractual agreement is any illegal transaction. Surely, all illegal drug transactions are made with an anonymous form of payment – cash. Another example is when the punishment for breaking the contract is an insufficient deterrent. For instance, when a customer reveals her credit card number to a merchant, all of its employees have access to that information. Disgruntled, dishonest, or disregardful workers can easily breach the privacy contract. A customer can avoid all such risk by paying anonymously with cash.

1.5 Conclusion

This paper argues that anonymity is useful as a policy because it may help to resolve a commitment problem. The commitment problem lies with the mechanism designer, that is, the police of the stylized model. The police need the citizens' information in order to solve crimes, but they may be unable to prevent negative consequences from befalling the informant. In particular, they may be unable to keep their own word in tracing only a small fraction of the phoned crime tips. After the calls come in, the police could convict more criminals by tracing more calls than previously promised. When such commitment problems exist, anonymity helps by inducing information revelation.

References

[1] Ely, Jeffrey C., and Juuso Valimaki. 2003. "Bad Reputation." *The Quarterly Journal of Economics*, 118(3): 785-814.

[2] Fudenberg, Drew, David K. Levine, and Eric Maskin. 1994. "The Folk Theorem with Imperfect Public Information." *Econometrica*, 62(5): 997-1039.

[3] Goldin, Claudia and Cecilia Rouse. 2000. "Orchestrating Impartiality: The Impact of "Blind" Auditions on Female Musicians." *American Economic Review*, 90(4): 715-741.

[4] Hoffman, Elizabeth, Kevin McCabe, Keith Shachat, and Vernon Smith. 1994. "Preferences, Property Rights, and Anonymity in Bargaining Games." *Games and Economic Behavior*, 7: 346-380.

[5] Kreps, David M., and Robert Wilson. 1982. "Reputation and Imperfect Information." *Journal of Economic Theory*, 27(2): 253-279.

[6] Milgrom, Paul, and John Roberts. 1982. "Predation, Reputation, and Entry Deterrence." *Journal of Economic Theory*, 27(2): 280-312.

[7] Stiglitz, Joseph E. 2000. "The Contributions of the Economics of Information to Twentieth Century Economics." *The Quarterly Journal of Economics*, 115(4): 1441-1478.

[8] Winton, Charles. 2008. "LAPD chief vows to clarify policy on immigrants." *Los Angeles Times*. April 17.

CHAPTER 2

Is Media Bias Bad?

2.1 Introduction

A common sentiment is that society is better off with unbiased experts than biased ones. Much of the economics literature, notably starting with Crawford and Sobel (1982), conclude that the conflict of interests between experts and decision makers leads to information loss. I explore this topic of biased experts in the context of the media market with the media firms as potentially biased experts and news consumers as decision makers.

The American Society of Newspaper Editors (ASNE) has identified at least three different interpretations of bias in a public poll.

> "not being open-minded and neutral about the facts" : 30%
>
> "having an agenda, and shaping the news report to fit it" : 29%
>
> "favoritism to a particular social or political group" : 29%

The meaning of bias in this paper encompasses the latter two interpretations.

Bias is the media firm's preference for a particular side. For example, *The New York Times* is accused of having a liberal bias, meaning that it has a left preference, while *Fox News Channel* is accused of having a conservative bias, meaning that it has a right preference. Moreover, the strength of the sided preference can vary, so that *The New York Times* may be more left biased than *The Los Angeles Times*.

In this paper, I argue that consumers are better off with a biased media firm rather than an unbiased one. Using a simple communication game between a potentially biased media firm and unbiased consumers, I explore the incentives for information acquisition in the media market. When information is costly, bias provides an additional incentive for a firm to acquire it in the first place. I also show that competition among firms improves the welfare of consumers, and those improvements do not depend on a diversity of biases. In other words, having two firms of opposite bias does not improve the welfare of consumers any more than having two firms of the same bias.

The framework of my model is best illustrated by a simple story. A mass of voters is about to vote on a policy. Of two proposed alternatives, one of them is better than the other. No one knows for sure which is better, but voters want to select the best one. Before the election, voters can read a news report about the two proposed alternatives. Meanwhile, the media firm can hire reporters to investigate the alternatives and then publish a report. The firm then generates revenue from advertisements. Additionally, the firm also cares about having the best policy in effect, but may be biased toward one of the alternatives.

Five key assumptions are made in this model.

1. *Information is costly for the expert to acquire.* A cursory observation of reality confirms such an assumption. Media firms incur costs in hiring journalists, photographers, and sending them to various parts of the world to collect information. Many previous models of media bias[1] and communication games[2] assume information is costless and exogenously given to the expert. An author who does endogenize costly information acquisition is Austen-Smith (1993 & 1994); however, he neither examines the consequences of bias nor of competition. Dewatripont and Tirole (1999) also have costly information, and I discuss their paper in the related literature section.

2. *People read news reports because they are informative, but reading is costly in terms of time and effort.* With numerous alternative uses for a person's time and attention, consuming news cannot be costless. If it were costless, then people might as well consume an infinite amount of news.

[1] Gentzkow and Shapiro (2006), Mullainathan and Shleifer (2005), Baron (2006)

[2] Milgrom (1981), Crawford and Sobel (1982), Milgrom and Roberts (1986), Shin (1994), Glazer and Rubinstein (2001), Krishna and Morgan (2001), Battaglini (2002), Glazer and Rubinstein (2004), and Dziuda (2007)

3. *Reports are not priced by the firm.*[3] In reality, news reported through the radio, Internet, and television are almost never priced. The revenue of most media firms is generated through advertisements, and not from directly selling its reports. Reflecting such a fact is the recent demise of *TimesSelect*, a paid subscription program of *The New York Times* online. Exceptions to the non-pricing of reports include the *Wall Street Journal* online and portions of the *Financial Times* online, but there are recent speculations about the *Wall Street Journal* removing its subscription fees upon its acquisition by News Corporation.

4. *All parameters are common knowledge.* There is no uncertainty about the firms' bias level, the cost of information, and the effort cost of reading. Here, common knowledge is a simplifying assumption used to separate out the acquisition incentives from the effects of uncertainty.

5. *The media firms can withhold acquired information in their reports, but cannot lie.*[4] Firms are generally accused of creating biased by selectively omitting certain facts rather than outright fabrication, since being caught lying results in large penalties. One example is the infamous *New York Times* reporter Jayson Blair, who plagiarized and created fraudulent re-

[3]Previous models of media bias, such as Mullainathan and Shleifer (2005) and Baron (2006), include a pricing strategy for the firm.

[4]Milgrom and Roberts (1986), Mullainathan and Shleifer (2006) and Dziuda (2007) make a similar assumption, but Gentzkow and Shapiro (2006) allow lying.

ports. To minimize damage to the newspaper's credibility, not only was Jayson Blair forced to resign, but two top editors as well. In the long run, a media firm that continuously deceives the public cannot survive in the industry, for no one would waste time reading lies. Alternatively, this assumption is justified if information is verifiable. The consumer may be able to verify facts on his own or ask the firm for the source of information. It is not necessary for every news consumer to be able to verify the information, just so long as someone is able to verify the information and expose any fabrications.

The main result of this paper is striking – consumers are better off with a biased media firm than an unbiased one. Informative equilibria exist when the firm's cost of acquiring information is sufficiently low and the consumers' effort cost of reading is sufficiently low. Reports are fully revealing in informative equilibria and this is not inconsistent with reality, as the ASNE cites:

> More than two-thirds of adults say their perception of bias in newspapers does not represent a "major obstacle" to being able to trust newspapers as a source of news - perhaps because they believe they've built sufficient filtering mechanisms to identify and neutralize it when they think they see it.

Moreover, as the firm's bias level increases, its willingness to pay for information also increases. Since a biased media firm would never withhold favorable information, withheld information must be unfavorable. If a biased media firm does not acquire information, then consumers would believe the firm acquired unfavorable information and was simply not reporting it. The certainty of an unfavorable outcome by not acquiring information provides the incentive for a biased media firm to acquire it. Therefore, a more biased media firm has a higher willingness to pay for information than a less biased one.

The second result is that competition, modeled as a duopoly, improves the welfare of the consumers. Having two firms rather than one improves the welfare of the consumers because it allows for the possibility of two informative reports.

The third and final result is that having two asymmetrically biased firms does not offer any more welfare improvements in addition to what was already present with two identical experts. In the informative equilibria, reports are fully revealing. The decision of a firm to acquire information depends on whether its competitor is acquiring information. The bias level is relevant only in determining whether or not a competitor will acquire information. Other than that purpose, a competitor's bias level does not affect a firm's decision to acquire information. Therefore, the welfare improvements from competition do not depend on whether the experts are identically biased or asymmetrically biased.

2.1.1 Related Literature

This paper contributes to the communication game literature, which includes the classic paper by Crawford and Sobel (1982). In their paper, when the preferences of the expert and decision maker are not perfectly aligned, information loss occurs due to the strategic incentives of the expert to distort her message to the decision maker. Numerous subsequent papers have explored different possible ways of attaining full information despite the conflict of interests. For instance, Milgrom and Roberts (1986) as well as Krishna and Morgan (2001) consider competition among experts. Battaglini (2002) considers bias across many dimensions. Chakraborty and Harbaugh (2007) consider transparency of the expert's bias to the decision maker. They all share the common assumption that information is costless and the expert is exogenously informed. Indeed, given that the expert is informed, there is an incentive to distort the information. However, my paper addresses the question, will the expert acquire that information in the first place. When information is costly for the expert to acquire, the conclusions are different because the incentives of the expert have changed.

Topically, this paper also contributes to the literature on media bias. Three notable models of media bias are Gentzkow and Shapiro (2006), Mullainathan and Shleifer (2005), and Baron (2006). Because interpretations of media bias greatly differ, the models also greatly differ. Gentzkow and Shapiro (2006) do not have any biased players in their model and interpret media bias as the presence of information loss. Mullainathan and Shleifer (2005) model the news consumers as the biased players. Baron (2006) assumes that journalists are biased. All of these papers on media bias assume information is costless and exogenously given to the firm. As a result, they all focus on the information loss created by a conflict of interests. In contrast, my paper shows benefits in having biased media firms.

The most closely related paper is Dewatripont and Tirole (1999), who include costly information. Our conclusions are similar in that we both provide arguments in favor of biased experts, however our approaches are different. Dewatripont and Tirole compare an unbiased expert with two oppositely biased experts. Their argument in favor of biased experts depends on having two oppositely biased experts, while my argument does not. In my model, the decision maker is better off even in the case of a single biased expert. Furthermore, I show that having two experts of opposite biases does not improve the welfare of the decision maker any more than having two experts of the same bias.

2.2 Model Environment

The story of the media market told in the introduction is now formally modeled as a communication game between a potentially biased expert (the media firm) and a decision maker (the news consumers[5]).

There is a binary state of the world, $S \in \{R, L\}$, unknown to all players. All players hold common prior beliefs about the state, $\Pr(R) = \theta$ and $\Pr(L) = 1 - \theta$. The expert can either acquire information or not acquire one piece of information about the state. The cost of acquiring information c is strictly positive. If an expert acquires information, then she gets an imperfect signal $s \in \{r, l\}$. The accuracy of the signals is $\Pr(r|R) = \pi_R$ and $\Pr(l|L) = \pi_L$. After receiving a signal, the expert publishes a report $\widehat{s} \in \{\widehat{0}, \widehat{r}, \widehat{l}\}$. In her report, the expert can either reveal the true signal or withhold information, but not lie. For instance, if the expert acquired information and received signal l, then the report can be either $\widehat{l}$ or $\widehat{0}$, but not $\widehat{r}$. If the expert did not acquire any information, then she must report $\widehat{0}$. Simultaneous with the expert's acquisition decision, the decision maker decides whether or not to read the expert's report. Because reading a report takes time and effort, let e denote the effort cost of reading one report. After reading the report, if any, the decision maker selects an action $A \in \{L, R\}$. Finally, the game ends, and all players receive their respective payoffs.

[5] The decision maker can be interpreted in two ways. He can represent a single consumer or he can represent a mass of identical consumers.

2.2.1 Strategies

The expert's strategy is comprised of two decisions: acquiring information (α^E) and reporting information (ρ^E). The expert decides on whether or not to acquire information, α^E, where α^E is the probability of the expert acquiring information. Also, the expert decides on what to report given the signal she received. If she received signal r, then $\rho^E(\widehat{r}|r)$ is the probability of reporting $\widehat{r}$, while $\rho^E(\widehat{0}|r)$ is the probability of reporting $\widehat{0}$. If she received signal l, then $\rho^E(\widehat{l}|l)$ is the probability of reporting $\widehat{l}$, while $\rho^E(\widehat{0}|l)$ is the probability of reporting $\widehat{0}$. If the expert did not acquire a signal, then she has no reporting decision; the expert must report $\widehat{0}$.

The decision maker's strategy is also comprised of two decisions: what report to read, if any, (ρ^{DM}) and what action to take (α^{DM}). The decision maker's reading strategy ρ^{DM} is the probability of reading the expert's report. Here, a mixed strategy of $\rho^{DM} = 0.5$ means that with 50% probability the expert reads and with 50% probability the expert does not read.

Lastly, the decision maker decides on an action strategy depending on the report read, if any. Let $\alpha^{DM}(R|\widehat{r})$ be the probability that the decision maker takes action R after reading report $\widehat{r}$ from the expert. Let $\alpha^{DM}(R|\widehat{l})$ be the probability that the decision maker takes action R after reading report $\widehat{l}$ from the expert.[6] Let $\alpha^{DM}(R|\widehat{0})$ be the probability that the decision maker takes action R after reading report $\widehat{0}$ from the expert. If the decision maker does not read any report, then $\alpha^{DM}(R|0)$ denotes the probability that the decision maker takes action R after not reading anything. Notice that $\widehat{0}$ represents no report when the decision maker chooses to read a report while 0 represents the lack of a report when the decision maker chooses *not* to read a report.

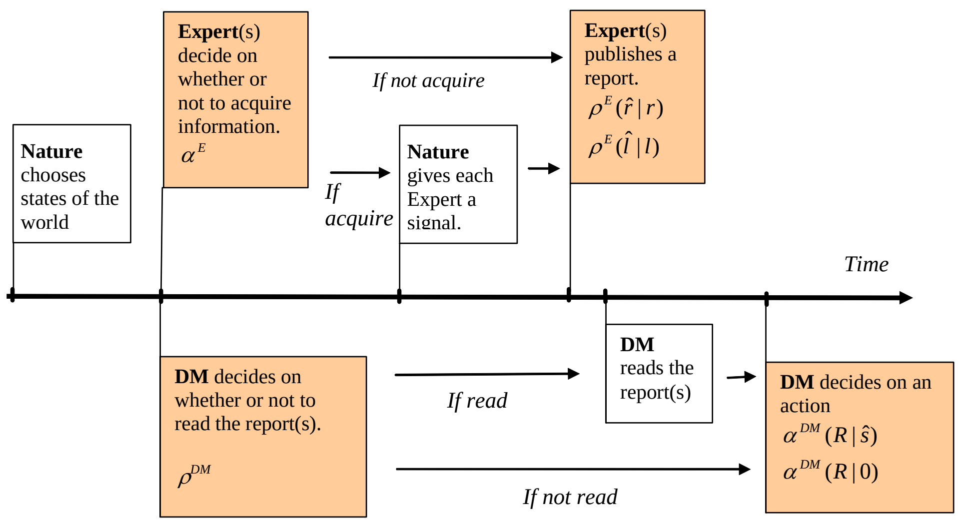

Figure 2.1: Timing of the Game

2.2.2 Payoffs

The expert receives advertising revenue, $Rev(\rho^{DM})$, which depends on the probability of the decision maker reading the expert's report. In particular, $Rev(\rho^{DM})$

[6] Notice that $\alpha^{DM}(R|\widehat{l}) = 1 - \alpha^{DM}(L|\widehat{l})$.

is a strictly increasing function in ρ^{DM}. If the decision maker does not read the expert's report, then $Rev(0) = 0$. If the decision maker does read the expert's report, then the expert receives the maximum amount of advertising revenue: $Rev(1)$. In addition to advertising revenue, the expert cares about the truth and may be biased toward one action. In particular, the expert receives a payoff of 1 if the decision maker's action matches the true state. Additionally, the expert receives a payoff of b if the decision maker takes action R regardless of the state. If $b = 0$, then the expert is unbiased and only cares about having the decision maker correctly match the state. If $b > 0$, then the expert is right-biased. If $b < 0$, then the expert is left-biased. Receiving a negative payoff when action R is chosen is equivalent to receiving a positive payoff when action L is chosen.

$$U^E = Rev(\rho^{DM}) - \alpha^E c + \begin{array}{|c|c|cc|} \cline{3-4} \multicolumn{2}{c|}{} & \multicolumn{2}{c|}{\text{state}} \\ \cline{3-4} \multicolumn{2}{c|}{} & L & R \\ \hline \text{action} & L & 1 & 0 \\ & R & b & 1+b \\ \hline \end{array}$$

The decision maker receives a payoff of 1 when the action he selects matches the state. Furthermore, the decision maker incurs an effort cost e for each report read.

$$U^{DM} = \begin{array}{cc|cc} & & \multicolumn{2}{c}{\text{state}} \\ & & L & R \\ \hline \text{action} & L & 1 & 0 \\ & R & 0 & 1 \end{array} - e\rho^{DM}$$

2.3 Equilibrium Analysis

In this section, I present and discuss three variations of the model: (i) monopoly model, (ii) duopoly model with identical experts, (iii) duopoly model with asymmetrically biased experts. The equilibrium concept is sequential equilibrium.

I focus on equilibria in pure acquisition and pure reading strategies, and later discuss why the equilibria in mixed acquisition and mixed reading strategies are uninteresting. There are only two kinds of equilibria in pure acquisition and pure reading strategies: informative and uninformative.

Definition 1 *An informative equilibrium in the monopoly game is one in which the expert acquires information and the decision maker reads the report.*

Definition 2 *An uninformative equilibrium is one in which no information is acquired and no report is read.*

I make two innocuous parameter assumptions throughout the paper.

Assume $\theta < \frac{1}{2}$ without loss of generality, because the game is symmetric to the prior beliefs.

Assume that a signal is informative, meaning that a signal is strong enough to change a player's beliefs about the true state. Without this assumption an informative equilibrium would never be possible. Call this the assumption of informative signals.

$$\underbrace{\Pr(R|r) > \Pr(L|r)}_{\theta\pi_R > (1-\theta)(1-\pi_L)}$$
$$\underbrace{\Pr(L|l) > \Pr(R|l)}_{(1-\theta)\pi_L > \theta(1-\pi_R)}$$

The pure acquisition strategies for the expert are to acquire information and to not acquire. The pure reading strategies for the decision maker are to read and to not read. If the expert does not acquire, then it is a best response for the decision maker to not read. Conversely, if the decision maker does not read, it is a best response for the expert to not acquire. Such behavior leads us to the uninformative equilibrium.

Proposition 3 *For all parameter values ($c \in \Re^+$, $e \in \Re^+$, and $b_i \in \Re$ for all $i = 1, 2, \ldots n$) and for any number of n experts, there exists an uninformative equilibrium.*

In this equilibrium, the expected utilities are

$$
\begin{aligned}
EU^{DM} &= 1 - \theta \\
EU_i^E &= Rev(1) + (1 - \theta)
\end{aligned}
$$

Having presented the uninformative equilibrium, the rest of the paper focuses on the informative ones.

2.3.1 Monopoly Model

Using a game with one biased expert, I show how it is possible for a decision maker to be better off with a biased expert than an unbiased one. The strategy that occurs last in the timing of the game is considered first: the decision maker's action strategy. If the decision maker reads either $\widehat{r}$ or $\widehat{l}$, the action decision is simple. He selects R given report $\widehat{r}$, and L given report $\widehat{l}$. The more complicated decision occurs when the decision maker reads report $\widehat{0}$.

When the decision maker reads a report of $\widehat{0}$, he can hold three different beliefs about the expert's actions: (i) the expert received an r signal and withheld information, (ii) the expert received an l signal and withheld information, or (iii) the expert didn't acquire any information at all. Whatever reporting strategy the expert selects, the decision maker's beliefs about $\widehat{0}$ will be consistent with the expert's strategies in equilibrium. In informative equilibria, reports of $\widehat{0}$ represent either an r signal or an l signal. Hence, define the following two types: Type R and Type L.

Type R: The decision maker's action upon reading $\widehat{0}$ is the same as if he read $\widehat{r}$. The expert reports $\widehat{l}$ given a left signal and is indifferent between reporting $\widehat{r}$ and $\widehat{0}$ given a right signal.

Type L: The decision maker's action upon reading $\widehat{0}$ is the same as if he read $\widehat{l}$. The expert reports $\widehat{r}$ given a right signal and is indifferent between reporting $\widehat{l}$ and $\widehat{0}$ given a left signal.

With the exception of the uninformative equilibrium, all equilibria of the monopoly game is either Type R or Type L. If the expert acquires information, then she will report informatively according to either Type R or Type L.[7] She will not adopt a mixed reporting strategy for both r and l signals. Why would the expert bother acquiring costly information to begin with, if she is planning on distorting the report so that it becomes useless to the decision maker? If she doesn't acquire information at all, she can still report $\widehat{0}$, which will yield the same expected utility as if she did acquire information save the cost of information.

Propositions 4 and 5 formally state the two informative equilibria[8]. The

[7] To be clear, there exist equilibria in which the expert adopts a mixed acquisition strategy. With probability α^E the expert acquires information. When the expert acquires information, she will report informatively according to either Type R or Type L.

[8] There exists multiple Type R informative equilibria and multiple Type L informative equilibria, but the multiplicity is irrelevant. To understand why the multiplicity is irrelevant, consider just the Type R informative equilibrium. The multiplicity arises because the expert is indifferent between reporting r signals as $\widehat{r}$ and as $\widehat{0}$. For instance, in one Type R informative

discussion of all the threshold values immediately follows.

Proposition 4 *There exists a Type R informative equilibrium when the effort cost is sufficiently low ($e \leq e^M$), the expert is not too right-biased ($b < b^{MR}$), and the cost is sufficiently low ($c \leq c^{MR}$).*

Proposition 5 *There exists a Type L informative equilibrium when the effort cost is sufficiently low ($e \leq e^M$), the expert is not too left-biased ($b > b^{ML}$), and the cost is sufficiently low ($c \leq c^{ML}$).*

In any informative equilibria, the decision maker reads the expert's report. He reads only when the effort cost is sufficiently low ($e \leq e^M$).

$$e^M = \underbrace{\theta\pi_R - (1-\theta)(1-\pi_L)}_{\Pr(R,r)-\Pr(L,r)}$$

If the decision maker does not read, he will rely on his priors and select action L. Reading a report is worthwhile when the information in the report leads to a *different* action in the decision maker. Thus, the effort cost threshold is equal to the probability of correctly choosing action R minus the probability of a mistake, that is, $[\Pr(R,r) - \Pr(L,r)]$.

In informative equilibria, the reporting strategy of the expert must be incentive compatible with her bias level. If the expert's bias level is sufficiently low

equilibrium the expert always reports r signals as $\widehat{0}$, while in another Type R informative equilibrium, the expert reports r signals as $\widehat{0}$ with 50% probability. The argument is the similar for the Type L informative equilibrium.

($b^{ML} < b < b^{MR}$), then reporting according to either Type is credible.

$$
\begin{aligned}
b^{ML} &= \underbrace{-\frac{\theta\pi_R - (1-\theta)(1-\pi_L)}{\theta\pi_R + (1-\theta)(1-\pi_L)}}_{-[\Pr(R|r)-\Pr(L|r)]} \\
b^{MR} &= \underbrace{\frac{(1-\theta)\,\pi_L - \theta\,(1-\pi_R)}{(1-\theta)\,\pi_L + \theta\,(1-\pi_R)}}_{\Pr(L|l)-\Pr(R|l)}
\end{aligned}
$$

If the expert is too right-biased ($b \geq b^{MR}$), then a Type R equilibrium cannot exist. Such an expert has an incentive to deviate by reporting an l signal as $\widehat{0}$, because in a Type R equilibrium, the decision maker believes $\widehat{0}$ represents an r signal. For instance, knowing that Ann Coulter strongly supports the right, a news consumer would never believe that her report of $\widehat{0}$ represents an r signal. A Type R equilibrium cannot exist for Ann Coulter. To understand why, suppose news consumers did believe that $\widehat{0}$ from Ann Coulter represented an r signal. Then she would have an incentive to withhold all information, thus leading consumers to vote right. Such behavior is sub-optimal for consumers.

Although the Type R equilibrium does not exist for an expert who is too right-biased ($b \geq b^{MR}$), the Type L one does. Type L is incentive compatible with such an expert. Here, the expert cannot gain by reporting an l signal as $\widehat{0}$, because the decision maker will correctly believe that it represents an l signal. A Type L equilibrium exists for Ann Coulter. News consumers believe that all the facts Ann Coulter reports support the right, while all her omitted facts support the left.

Conversely, if the expert is too left-biased ($b \leq b^{ML}$), then a Type L equilibrium does not exist and a Type R equilibrium does. The argument is similar to above.

In informative equilibria, the expert acquires information, which she does only when the cost is sufficiently low. To identify the cost threshold, compare the expert's expected utility of acquiring information to that when she does not.

For both Types of equilibria, the expert's expected utility of acquiring information is the same because full information is achieved. It consists of advertising revenue, the cost of information, the payoff when the decision maker's action matches the true state, and also the bias payoff when the decision maker selects action R.

$$\begin{aligned} EU^E &= Rev(1) - c \\ &\quad + [\theta\pi_R + (1-\theta)\pi_L] + b\,[\theta\pi_R + (1-\theta)(1-\pi_L)] \end{aligned} \tag{2.1}$$

If the expert does not acquire information, then her expected utility depends on what the decision maker's believes about $\widehat{0}$. In Type R, the decision maker believes $\widehat{0}$ represents an r signal, while in Type L, he believes $\widehat{0}$ represents an l signal.

$$\text{Type R:} \qquad EU^E = Rev(1) + \theta + b \tag{2.2}$$

$$\text{Type L:} \qquad EU^E = Rev(1) + (1-\theta) \tag{2.3}$$

Hence, the acquisition strategy depends on the Type. In Type R, the expert acquires information when $c \leq c^{MR}$, while in Type L, the expert acquires information when $c \leq c^{ML}$.

$$\text{Type R:} \qquad c^{MR} = \underbrace{[(1-\theta)\pi_L - \theta(1-\pi_R)]}_{\Pr(L,l)-\Pr(R,l)} - b\underbrace{[\theta(1-\pi_R) + (1-\theta)\pi_L]}_{\Pr(l)}$$

$$\text{Type L:} \qquad c^{ML} = \underbrace{[\theta\pi_R - (1-\theta)(1-\pi_L)]}_{\Pr(R,r)-\Pr(L,r)} + b\underbrace{[\theta\pi_R + (1-\theta)(1-\pi_L)]}_{\Pr(r)}$$

The two cost thresholds, c^{MR} and c^{ML}, are typically not equal,[9] because the different Types lead to different outcomes when information is not acquired as shown by (2.2) and (2.3). This difference affects the incentives for acquiring information.

Proposition 6 *In an informative equilibrium of the monopoly game, regardless of type, the decision maker's expected utility is*

$$EU^{DM} = [\theta\pi_R + (1-\theta)\,\pi_L] - e$$

and the expert's expected utility is

$$\begin{aligned} EU^{E} &= Rev(1) - c \\ &\quad + [\theta\pi_R + (1-\theta)\,\pi_L] + b\,[\theta\pi_R + (1-\theta)(1-\pi_L)] \end{aligned}$$

[9]Generally, if $(1-2\theta) > b$, then $c^{MR} > c^{ML}$. If $(1-2\theta) < b$, then $c^{MR} < c^{ML}$. And lastly, if $(1-2\theta) = b$, then $c^{MR} = c^{ML}$.

Since all informative equilibria are outcome equivalent, what matters is the existence of at least one of the informative equilibria and not which one. Hence, it is only the larger of the two cost thresholds that matters. To understand this point, suppose $0 < c^{MR} < c^{ML}$.[10] If $0 < c \leq c^{MR}$, then both Types of informative equilibria exist. However, if $c^{MR} < c \leq c^{ML}$, then only the Type L informative equilibrium exists. Thus, it is the larger of the two cost thresholds, c^{MR} and c^{ML}, that matters in determining the existence of at least one informative equilibrium. Denote $c^M = \max\{c^{MR}, c^{ML}\}$. The main result is stated in Theorem 1.

Theorem 1 *As the bias level increases, whether it be right or left, c^M increases.*

Proof. There are two cases to discuss: when the expert is increasingly left-biased and when the expert is increasingly left-biased.

When the bias level is increasingly left-biased (b becomes more negative), the cost threshold c^{MR} increases, while c^{ML} decreases until it hits the minimum of zero. In this case, $c^M = c^{MR}$. Hence, c^M increases as the bias level is increasingly left-biased.

When the bias level is increasingly right-bias (b becomes more positive), the cost threshold c^{ML} increases, while c^{MR} decreases until it hits the minimum of zero. In this case, $c^M = c^{ML}$. Hence, c^M increases as the bias level is increasingly

[10] The order, $0 < c^{MR} < c^{ML}$, holds true when $(1 - 2\theta) < b < b^{MR}$. There are many possible orderings depending on the parameters, and I have taken this particular order just as an example.

right-biased. ■

The interpretation of Theorem 1 is that a more biased expert has a larger willingness to pay for information than a less biased one. The driving force behind this result is what happens when the expert does not acquire information. When Ann Coulter does not acquire information, she must report $\widehat{0}$. Because the news consumers are aware of her extreme right bias level, they believe that she in fact acquired a left signal and chose not to report it. Thus, not acquiring information results in the left action; this is the exact opposite of Ann Coulter's preference. If she does acquire information, there is a chance for her to receive a right signal. Since she reports all right signals as $\widehat{r}$, a right signal allows her to convince the consumers to vote right. It is the certainty of the unfavorable outcome when she does not acquire information that provides the incentive for her to acquire it.

In addition to the two informative equilibria, there also exist two equilibria in mixed acquisition and mixed reading strategies: Type R and Type L. In both types of mixed strategy equilibria, the decision maker is indifferent between reading and not and the expert is indifferent between acquiring and not. Therefore, the equilibrium expected utilities of both players are the same as that in the uninformative equilibrium. For that reason, I do not pay much attention to these mixed equilibria.

Proposition 7 *There exist two equilibria in mixed acquisition and mixed reading* *strategies: one in Type R and one in Type L. In both of these equilibria, the decision maker's expected utility and the expert's expected utility is the same as that in the uninformative equilibrium.*

Below, I summarize the equilibrium expected utilities of the decision maker, since we are concerned with the welfare of news consumers. Figure 2 and Lemma 1 express the same information. One is graphical, while the other is verbal. They summarize the region in which the informative equilibria exist. As the bias level of an expert increases, that region increases.

Let $Z^{(i)}$ be the set of all the equilibrium expected utilities for the decision maker in a game with one expert.

Let $z_0 = 1 - \theta$, the expected utility of the decision maker in an uninformative equilibrium.

Let $z_1 = [\theta \pi_R + (1 - \theta) \pi_L] - e$, the expected utility of the decision maker in an informative equilibrium with one report.

Lemma 1 *For any $b \in \Re$, there exists a cost threshold $c^M > 0$ and an effort threshold $e^M > 0$, such that (i) if $c < c^M$ and $e < e^M$, then $Z^{(i)} = \{z_0, z_1\}$, and (ii) if either $c \geq c^M$ or $e \geq e^M$, then $Z^{(i)} = \{z_0\}$.*

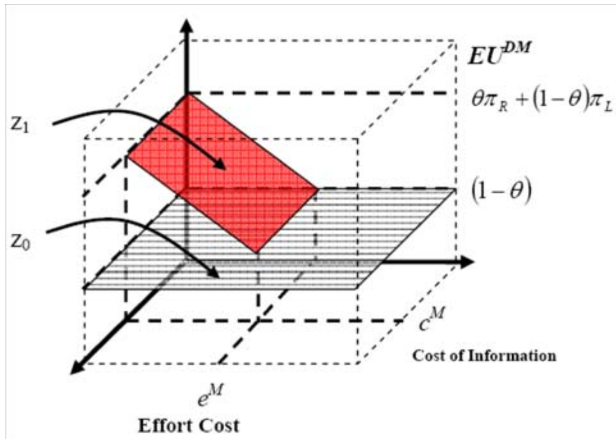

Figure 2.2: Equilibrium EU^{DM} in the monopoly model

2.3.2 Duopoly Model with Two Identical Experts

Using a duopoly model with two identical experts, I show that competition improves the welfare of the decision maker. Competition allows for the possibility of more information. In a duopoly model, two informative reports are possible, whereas in the monopoly model, only one informative report was possible. The decision maker is never worse off with two identical experts than with one expert.

Now that there are two experts, each expert has an acquisition strategy (α_i^E) and a reporting strategy (ρ_i^E), where $i = 1, 2$. If both experts acquire information, then the signals they receive are independent. The decision maker's reading strategy, $\rho^{DM} = [\rho_1^{DM}, \rho_2^{DM}]$, is now a vector, where ρ_i^{DM} is the probability of reading expert i's report[11] for all $i = 1, 2$. The decision maker's action strategy

[11] If the decision maker reads both reports, then $\rho^{DM} = [\rho_1^{DM}, \rho_2^{DM}] = [1, 1]$. If the decision maker does not read any report, then $\rho^{DM} = [\rho_1^{DM}, \rho_2^{DM}] = [0, 0]$. To be clear on the meaning of a mixed strategy, consider the strategy $\rho^{DM} = [0.5, 0.5]$. Here, $\rho^{DM} = [0.5, 0.5]$ means that

now depends on two possible reports if he chooses to read them. Lastly, if the decision maker reads both experts' reports, the total effort cost is $2e$.

In the duopoly model, there are two kinds of informative equilibria: one in which only one report is read and one in which two reports are read.

Definition 3 *An informative equilibrium with one (two) report(s) is an equilibrium in which one (two) expert(s) acquires (acquire) information and the decision maker reads that expert's (both) reports.*

The informative equilibria with one report in the duopoly game is very similar to that in the monopoly game. In the duopoly game, all informative equilibria with one report requires one of the two experts to be dormant (that is, to not acquire information and for the decision maker to not read that expert's report). With one of the two experts dormant, the remaining game between the non-dormant expert and decision maker is the same as the game with one expert. There are potentially four different informative equilibria with one report, because either expert could be the non-dormant one and there are two types of informative equilibria (Type R and Type L).

The remainder of this section examines the informative equilibria with two reports. The strategy that occurs last in the timing of the game is considered

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with 25% chance the decision maker reads both reports, with 50% chance the decision maker reads one and not the other, and with 25% chance the decision maker reads neither. It does not mean that the decision maker reads half of expert 1's report and half of expert 2's report.

first: the decision maker's action strategy. If the decision maker reads either $(\widehat{r},\widehat{r})$ or $\left(\widehat{l},\widehat{l}\right)$, then the decision is simple: R and L, respectively. If the decision maker reads $\left(\widehat{r},\widehat{l}\right)$ or $\left(\widehat{l},\widehat{r}\right)$, it is possible for either state R to be more likely or state L to be more likely. Since, it is uninteresting to read through both cases when they share so many similarities, I assume the first possibility $(\Pr(R|r,l) > \Pr(L|r,l))$ for the main discussion and relegate the second possibility $(\Pr(L|r,l) > \Pr(R|r,l))$ to the footnotes.

Similar to the monopoly model, when the decision maker reads a report of $\widehat{0}$ from expert i, he can hold three different beliefs about the actions of expert i. He could believe that expert i (i) received an r signal and withheld information, (ii) received an l signal and withheld information, or (iii) didn't acquire any information at all. In any informative equilibrium, a report of $\widehat{0}$ from expert i can mean either an r signal or an l signal.

The duopoly model is more complicated than the monopoly one, because each expert can adopt different reporting strategies. Thus, the decision maker can hold different beliefs about the meaning of $\widehat{0}$, depending on which expert reports $\widehat{0}$. Reading reports $\left(\widehat{0},\widehat{0}\right)$ can represent any one of the four possible sets of signals: (r,r), (l,l), (r,l), (l,r). Hence, define the following 4 types: Type RR, Type LL, Type RL, and Type LR.

Type RR: The decision maker's action upon reading $\left(\widehat{0},\widehat{0}\right)$ is the same as if he read $(\widehat{r}, \widehat{r})$. Each expert reports $\widehat{l}$ given a left signal and is indifferent between reporting $\widehat{r}$ and $\widehat{0}$ given a right signal.

Type LL: The decision maker's action upon reading $\left(\widehat{0}, \widehat{0}\right)$ is the same as if he read $\left(\widehat{l}, \widehat{l}\right)$. Each expert reports $\widehat{r}$ given a right signal and is indifferent between reporting $\widehat{l}$ and $\widehat{0}$ given a left signal.

Type RL: The decision maker's action upon reading $\left(\widehat{0}, \widehat{0}\right)$ is the same as if he read $\left(\widehat{r}, \widehat{l}\right)$. The first expert reports $\widehat{l}$ given a left signal and is indifferent between reporting $\widehat{r}$ and $\widehat{0}$ given a right signal. The second expert reports $\widehat{r}$ given a right signal and is indifferent between reporting $\widehat{l}$ and $\widehat{0}$ given a left signal.

Type LR: The decision maker's action upon reading $\left(\widehat{0}, \widehat{0}\right)$ is the same as if he read $\left(\widehat{l}, \widehat{r}\right)$. The first expert reports $\widehat{r}$ given a right signal and is indifferent between reporting $\widehat{l}$ and $\widehat{0}$ given a left signal. The second expert reports $\widehat{l}$ given a left signal and is indifferent between reporting $\widehat{r}$ and $\widehat{0}$ given a right signal.

For the same reason as was mentioned in the monopoly model, all equilibria of the duopoly game is of a defined Type except for the uninformative equilibrium. An expert will not adopt a mixed reporting strategy for both r and l signals.

I first focus on only Type RR and Type LL. Propositions 8 and 9 formally state those two types of informative equilibria with two reports. The Type RL and Type LR informative equilibria with two reports will be discussed later.

Proposition 8 *There exists a Type RR informative equilibrium with two reports when the effort cost is sufficiently low ($e \leq e^D$), the experts are not too right-biased ($b < b^{DR}$), and the cost is sufficiently low ($c \leq c^{DR}$).*

Proposition 9 *There exists a Type LL informative equilibrium with two reports when the effort cost is sufficiently low ($e \leq e^D$), the expert are not too left-biased ($b > b^{DL}$), and the cost is sufficiently low ($c \leq c^{DL}$).*

In informative equilibria with two reports, the effort cost of reading must be sufficiently low[12] ($e \leq e^D$).

$$e^D = \theta\pi_R(1-\pi_R) - (1-\theta)\pi_L(1-\pi_L)$$

The decision maker reads both experts' reports rather than just one if the additional information gained exceeds the effort cost of reading. The threshold is determined by comparing his expected utility from reading two informative reports[13]

$$\begin{aligned} EU^{DM} &= \theta\left[\pi_R^2 + 2\pi_R(1-\pi_R)\right] + (1-\theta)\pi_L^2 \\ &\quad -2e \end{aligned}$$

[12]Under the assumption $\Pr(L|r,l) > \Pr(R|r,l)$, the effort cost threshold is $e^D = (1-\theta)\pi_L(1-\pi_L) - \theta\pi_R(1-\pi_R)$.

[13]Under the assumption $\Pr(L|r,l) > \Pr(R|r,l)$, the expected utility from reading two informative reports is $EU^{DM} = \theta\pi_R^2 + (1-\theta)\left[\pi_L^2 + 2\pi_L(1-\pi_L)\right]$.

with that from reading only one informative report.

$$EU^{DM} = [\theta\pi_R + (1-\theta)\,\pi_L] - e$$

In informative equilibria with two reports, the reporting strategy of each expert must be incentive compatible with her bias level. If the expert's bias level is sufficiently low[14] ($b^{DL} < b < b^{DR}$), then reporting according to either Type is credible.

$$\begin{aligned} b^{DR} &= \frac{(1-\theta)\,\pi_L^2 - \theta\,(1-\pi_R)^2}{(1-\theta)\,\pi_L^2 + \theta\,(1-\pi_R)^2} \\ b^{DL} &= -\left[\frac{\theta\pi_R\,(1-\pi_R) - (1-\theta)\,\pi_L\,(1-\pi_L)}{\theta\pi_R\,(1-\pi_R) + (1-\theta)\,\pi_L\,(1-\pi_L)}\right] \end{aligned}$$

However, if the experts are too right-biased ($b \geq b^{DR}$), then the Type RR equilibrium cannot exist. The argument is similar to that in the monopoly model. Because the experts are so right-biased, they have an incentive to deviate and report l signals as $\widehat{0}$. If there were two Ann Coulters, the Type RR equilibrium cannot exist for them.

Although the Type RR equilibrium does not exist in this case, the Type LL one does. Type LL is incentive compatible with experts who are too right-biased ($b \geq b^{DR}$). Here, the experts cannot gain by reporting l signals as $\widehat{0}$, because the decision maker will correctly believe that $\widehat{0}$ represents an l signal. The Type LL equilibrium does exist for two Ann Coulters.

[14] Under the assumption $\Pr(L|r,l) > \Pr(R|r,l)$, the bias thresholds are $b^{DR} = \frac{(1-\theta)\pi_L(1-\pi_L)-\theta\pi_R(1-\pi_R)}{(1-\theta)\pi_L(1-\pi_L)+\theta\pi_R(1-\pi_R)}$ $b^{DL} = -\left[\frac{\theta\pi^2-(1-\theta)(1-\pi_L)^2}{\theta\pi^2+(1-\theta)(1-\pi_L)^2}\right]$

Conversely, if the experts are too left-biased ($b \leq b^{DL}$), then a Type LL equilibrium does not exist and a Type RR one does. The argument is similar to above.

In informative equilibria with two reports, both experts must acquire information, which they do only when the cost is sufficiently low. To identify the cost threshold, compare expert i's expected utility of acquiring information to that when she does not, assuming that expert j behaves according to equilibrium play. For all four Types of equilibria, expert i's expected utility of acquiring information is the same.[15]

$$\begin{aligned} EU_i^E &= Rev(1) - c \\ &+ \left[\theta\left[\pi_R^2 + 2\pi_R(1-\pi_R)\right] + (1-\theta)\,\pi_L^2\right] \\ &+ b\left[\theta\left[\pi_R^2 + 2\pi_R(1-\pi_R)\right] + (1-\theta)\left(1-\pi_L^2\right)\right] \end{aligned} \tag{2.4}$$

If expert i does not acquire information, then her expected utility depends on the Type.

$$\text{Type RR} \quad : \quad EU_i^E = Rev(1) + \theta + b \tag{2.5}$$

$$\text{Type LL} \quad : \quad EU_i^E = Rev(1) + \left[\theta\pi_R + \pi_L\left(1-\theta\right)\right] + b\left[\left(1-\theta\right)\left(1-\pi_L\right) + \theta\pi_R\right] \tag{2.6}$$

In Type RR, the decision maker believes $\widehat{0}$ from expert i represents an r signal. Because of the assumption $\Pr(R|r,l) > \Pr(L|r,l)$, in Type RR the only time the

[15] Under the assumption $\Pr(L|r,l) > \Pr(R|r,l)$, expert i's expected utility of acquiring information is $EU_i^E = Rev(1) - c + \left[\theta\pi_R^2 + (1-\theta)\left(2\pi_L\left(1-\pi_L\right) + \pi_L^2\right)\right] + b\left[\theta\pi_R^2 + (1-\theta)\left(1-\pi_L\right)^2\right]$

decision maker selects action L is after reading reports $\left(\widehat{l},\widehat{l}\right)$. If expert i does not acquire information, then the decision maker will never receive reports $\left(\widehat{l},\widehat{l}\right)$. Therefore, if expert i does not acquire information, the decision maker will always select R, regardless of expert j's report.[16]

By comparing the expected utilities, (2.4) and (2.5), I determine the Type RR cost threshold[17]. Below this threshold, expert i acquires information and above, she does not.

$$\text{Type RR: } c^{DR} = \left[\begin{array}{c} (1-\theta)\,\pi_L^2 - \theta\,(1-\pi_R)^2 \\ -b\left[\theta\,(1-\pi_R)^2 + (1-\theta)\,\pi_L^2\right] \end{array}\right]$$

In Type LL, the decision maker believes $\widehat{0}$ from expert i represents an l signal. Under the assumption that $\Pr(R|r,l) > \Pr(L|r,l)$, the decision maker selects R given reports $(\widehat{r},\widehat{l})$ and $(\widehat{l},\widehat{r})$. Because in Type LL the decision maker believes expert i's report of $\widehat{0}$ is an l signal, he selects R given reports $\left(\widehat{0},\widehat{r}\right)$ and L given reports $\left(\widehat{0},\widehat{l}\right)$. Therefore, if expert i does not acquire information, then the decision maker's action decision is determined entirely by expert j's informative reports.[18] In other words, expert i is able to free ride from the information

[16]Under the assumption $\Pr(L|r,l) > \Pr(L|r,l)$, if expert i does not acquire information, then the decision maker's action depends entirely on expert j's informative reports. Because the decision maker believes $\widehat{0}$ from expert i is an r signal, he selects R given reports $\left(\widehat{0},\widehat{r}\right)$ and L given reports $\left(\widehat{0},\widehat{l}\right)$.

[17]Under the assumption $\Pr(L|rl) > \Pr(R|rl)$, the cost threshold is $c^{DR} = [(1-\theta)\,\pi_L\,(1-\pi_L) - \theta\pi_R\,(1-\pi_R)] - b\,[(1-\theta)\,\pi_L\,(1-\pi_L) + \theta\pi_R\,(1-\pi_R)]$

[18]Under the assumption $\Pr(L|r,l) > \Pr(L|r,l)$, if expert i does not acquire information, then the decision maker's always selects action L. The only time the decision maker selects action R is after reading reports $(\widehat{r},\widehat{r})$. If expert i does not acquire information, then the decision maker will never receive reports $(\widehat{r},\widehat{r})$.

acquired by expert j.

By comparing the expected utilities, (2.4) and (2.6), I determine the Type LL cost threshold[19]. Below this threshold, expert i acquires information and above, she does not.

$$\text{Type LL: } c^{DL} = \begin{bmatrix} \theta\pi_R\left(1-\pi_R\right) - \left(1-\theta\right)\pi_L\left(1-\pi_L\right) \\ +b\left[\theta\pi_R\left(1-\pi_R\right) + \left(1-\theta\right)\pi_L\left(1-\pi_L\right)\right] \end{bmatrix}$$

The incentives for information acquisition greatly differ between the two Types, because of what occurs when an expert does not acquire. In Type RR, if an expert does not acquire information, the decision maker will choose R. In Type LL, an expert has an incentive to free ride off of the information provided by the other expert.[20]

Having fully discussed the Type RR and Type LL informative equilibria with two reports, I now examine equilibria in which the experts adopt asymmetric reporting strategies. There exists a Type RL informative equilibrium with two reports when the cost of information is lower than the minimum of c^{DR} and c^{DL}. If the cost lies above c^{DR}, then the first expert will no longer acquire information given that the second is acquiring information. Likewise, if the cost lies above c^{DL}, then the second expert will no longer acquire information given that first is

[19] In the second case, where $\Pr(L|rl) > \Pr(R|rl)$, the cost threshold is $c^{DL} = \left[\theta\pi^2 - \left(1-\theta\right)\left(1-\pi_L\right)^2\right] + b\left[\theta\pi^2 + \left(1-\theta\right)\left(1-\pi_L\right)^2\right]$

[20] In the second case, where $\Pr(L|rl) > \Pr(R|rl)$, Type RR would provide the incentive to free ride, while Type LL would provide the expert with complete power to convince the decision maker to choose L.

acquiring information. When the cost lies between c^{DR} and c^{DL}, one of the two experts will no longer find it in her best interests to acquire information. For the same reason, the Type LR informative equilibrium with two reports exists when the cost of information is lower than the minimum of c^{DR} and c^{DL}.

Proposition 10 *There exist Type RL and Type LR informative equilibria with two reports when the effort cost is sufficiently low ($e \leq e^D$), the experts are not too left- nor too right-biased ($b^{DL} < b < b^{DR}$), and the cost is sufficiently low ($c \leq \min\{c^{DR}, c^{DL}\}$).*

Equilibria with asymmetric reporting strategies are not particularly interesting. Their existence requires $c \leq \min\{c^{DR}, c^{DL}\}$. When the two experts adopt symmetric reporting strategies, an informative equilibrium with two reports exists when $c \leq \max\{c^{DR}, c^{DL}\}$. Therefore, whenever an informative equilibrium with asymmetric reporting strategies exists, so does an informative equilibrium with symmetric reporting strategies.

Since all informative equilibria with two reports are outcome equivalent, what matters is the existence of at least one of those equilibria and not which one. Hence, it is only the larger of the two cost thresholds that matters. Let $c^D = \max\{c^{DR}, c^{DL}\}$.

Proposition 11 *In any informative equilibrium with two reports, the decision* *maker's expected utility*[21] *is*

$$EU^{DM} = \left[\theta\left[\pi_R^2 + 2\pi_R(1-\pi_R)\right] + (1-\theta)\,\pi_L^2\right] - 2e$$

and the expected utility of each expert is

$$\begin{aligned} EU_i^E &= Rev(1) - c \\ &+ \left[\theta\left(\pi_R^2 + 2\pi_R(1-\pi_R)\right) + (1-\theta)\,\pi_L^2\right] \\ &+ b\left[\theta\left(\pi_R^2 + 2\pi_R(1-\pi_R)\right) + (1-\theta)\left(1-\pi_L^2\right)\right] \end{aligned}$$

Equilibria with mixed acquisition strategies and mixed reading strategies do exist in the duopoly model, but they are not particularly interesting. One set of mixed strategy equilibria occur when the decision maker is indifferent between not reading and reading one report. This set of mixed strategy equilibria is outcome equivalent to the uninformative equilibrium. Another set of mixed strategy equilibria occur when the decision maker is indifferent between reading one report and reading two reports. This set of mixed strategy equilibria is outcome equivalent to the informative equilibria with one report. The decision maker will never

[21] *Under the assumption* $\Pr(L|r,l) > \Pr(R|r,l)$,

$$EU^{DM} = \left[\theta\pi_R^2 + (1-\theta)\left[\pi_L^2 + 2\pi_L\left(1-\pi_L\right)\right]\right] - 2e$$

$$\begin{aligned} EU_i^E &= Rev(1) - c \\ &+ \theta\pi_R^2 + (1-\theta)\left[\pi_L^2 + 2\pi_L\left(1-\pi_L\right)\right] \\ &+ b\left[\theta\pi_R^2 + (1-\theta)\left(1-\pi_L\right)^2\right] \end{aligned}$$

be indifferent between reading no report and two reports, because the marginal cost of reading is constant, while the marginal benefit of reading decreases. A more formal discussion of the mixed strategy equilibria appears in the appendix.

Competition improves welfare because more information can be acquired. In the duopoly model, two signals can be acquired and reported, whereas, in the monopoly model, only one signal was possible. Below, I summarize the set of equilibrium expected utilities for the decision maker in the duopoly game.

Let $Z^{(i,i)}$ be the set of all the equilibrium expected utilities for the decision maker in a game with two identical experts.

Recall that $z_0 = 1 - \theta$, the expected utility of the decision maker in an uninformative equilibrium.

Recall that $z_1 = [\theta \pi_R + (1 - \theta) \pi_L] - e$, the expected utility of the decision maker in an informative equilibrium with one reports.

Let $z_2 = [\theta \pi_R^2 + 2\theta \pi_R (1 - \pi_R) + (1 - \theta) \pi_L^2] - 2e$, the expected utility of the decision maker in an informative equilibrium with two reports.

The following two lemmas and two graphs express the set $Z^{(i,i)}$, that is, the set of all the equilibrium expected utilities for the decision maker in a game with two identical experts.

Lemma 2 *If $e < e^M$ and $c < c^M$, then $z_1 \in Z^{(i,i)}$ and $z_1 \in Z^{(i)}$.*

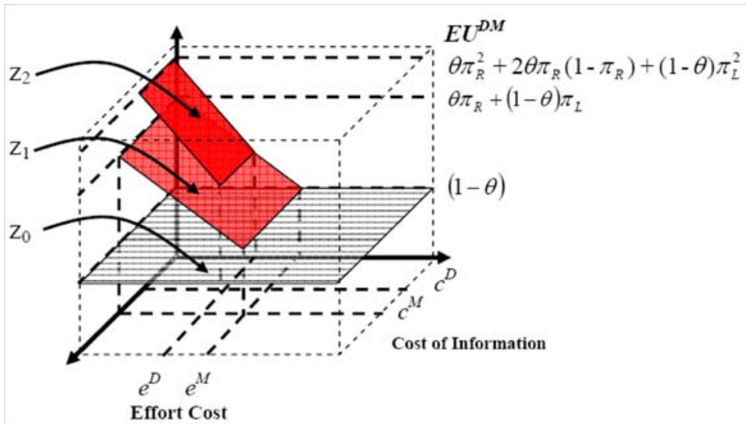

Figure 2.3: Equilibria EU^{DM} when $c^M > c^D$

Lemma 3 *If $e \leq e^D$ and $c \leq c^D$, then $z_2 \in Z^{(i,i)}$.*

Depending on the parameters, it is possible for either $c^M > c^D$ or $c^D > c^M$. Figure 3 depicts the case when $c^M > c^D$.

Figures 4 depicts the opposite case when $c^D > c^M$.

Informally speaking, the decision maker is better off in the game with two experts than the game with only one expert in the following sense. In the monopoly game, the figure consists of the shaded regions with z_0 and z_1, while in the duopoly game, the figure consists of the shaded regions z_0, z_1, and z_2. Thus, for all parameters, the set $Z^{(i,i)}$ is never "worse" than the set $Z^{(i)}$, while for other parameters, the set $Z^{(i,i)}$ is "better" than the set $Z^{(i)}$. Theorem 2 formally states how the decision maker is better off in the game with two experts than the game with only one expert.

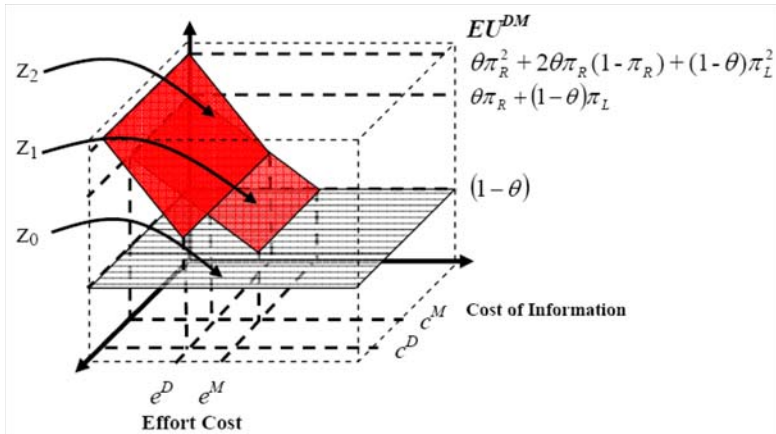

Figure 2.4: Equilibria EU^{DM} when $c^D > c^M$

Theorem 2

$$\begin{aligned} \textit{For any } c &\in \Re^+,\ b \in \Re,\ e \in \Re^+, \textit{ and for all } z^M \in Z^{(i)}, \\ &\textit{there exists } z^D \in Z^{(i,i)} \textit{ such that } z^D \geq z^M \\ \textit{For some } c &\in \Re^+,\ b \in \Re,\ e \in \Re^+, \textit{ and for all } z^M \in Z^{(i)}, \\ &\textit{there exists } z^D \in Z^{(i,i)} \textit{ such that } z^D > z^M \end{aligned}$$

2.3.3 Duopoly Model with Two Asymmetrically Biased Experts

There is a notion that having two equally biased experts may not improve the welfare of the population as much as having two oppositely biased experts. I explore this notion using the game with two asymmetrically biased experts and show that additional welfare improvements do not emerge.

Let one expert be more right-biased than another ($b_j < b_i$). There are three possible cases. (i) Both of them could be right-biased with expert i being more right-biased ($0 < b_j < b_i$). (ii) Both of them could be left-biased with expert j being more left-biased ($b_j < b_i < 0$). (iii) Lastly, the two experts could be oppositely biased ($b_j < 0 < b_i$). It is not necessary to consider each case individually for the analysis. All that is necessary is $b_j < b_i$. Without loss of generality, let the first expert be expert i, and the second be expert j. I first examine the informative equilibria with one report and then that with two reports.

For the informative equilibria with one report, the asymmetric bias levels do not change the decision maker's effort condition. Similar to the previous games, the decision maker reads one report when $e \leq e^M$. However, the asymmetric bias levels do change the experts' acquisition decisions. The different bias levels leads to different cost thresholds.

$$
\begin{aligned}
c_i^{MR} &= [(1-\theta)\pi_L - \theta(1-\pi_R)] - b_i\left[\theta(1-\pi_R) + (1-\theta)\pi_L\right] \\
c_j^{MR} &= [(1-\theta)\pi_L - \theta(1-\pi_R)] - b_j\left[\theta(1-\pi_R) + (1-\theta)\pi_L\right] \\
c_i^{ML} &= [\theta\pi_R - (1-\theta)(1-\pi_L)] + b_i\left[\theta\pi_R + (1-\theta)(1-\pi_L)\right] \\
c_j^{ML} &= [\theta\pi_R - (1-\theta)(1-\pi_L)] + b_j\left[\theta\pi_R + (1-\theta)(1-\pi_L)\right]
\end{aligned}
$$

Let $c^{M_A} = \max\{c_i^{MR}, c_j^{MR}, c_i^{ML}, c_j^{ML}\} = \max\{c_j^{MR}, c_i^{ML}\}$. The more left-biased expert (that is, expert j) has a higher cost threshold than expert i under Type R, while the more right-biased expert (that is, expert i) has a higher cost threshold than expert j under Type L.

$$\begin{aligned} \text{Type R :} \qquad & c_j^{MR} > c_i^{MR} \\ \text{Type L :} \qquad & c_i^{ML} > c_j^{ML} \end{aligned}$$

Let $Z^{(i,j)}$ = the set of equilibrium EU^{DM} in the duopoly game with asymmetrically biased experts, $b_i > b_j$.

Lemma 4 summarizes when an informative equilibrium with one report exists.

Lemma 4 *If $e \leq e^M$ and $c \leq c^{M_A}$, then $z_1 \in Z^{(i,j)}$.*

Now consider informative equilibria with two reports. Again, the different bias levels do not change the decision maker's effort condition. The decision maker reds two reports when $e \leq e^D$. However, the asymmetric bias levels do change the experts' acquisition decisions. The different bias levels lead to different cost thresholds.

$$\begin{aligned} c_i^{DR} &= \left[\begin{array}{c} (1-\theta)\,\pi_L^2 - \theta\,(1-\pi_R)^2 \\ -b_i\left[\theta\,(1-\pi_R)^2 + (1-\theta)\,\pi_L^2\right] \end{array} \right] \\ c_j^{DR} &= \left[\begin{array}{c} (1-\theta)\,\pi_L^2 - \theta\,(1-\pi_R)^2 \\ -b_j\left[\theta\,(1-\pi_R)^2 + (1-\theta)\,\pi_L^2\right] \end{array} \right] \end{aligned}$$

$$c_i^{DL} = \left[\begin{array}{c} \theta\pi_R(1-\pi_R) - (1-\theta)\pi_L(1-\pi_L) \\ +b_i\left[\theta\pi_R(1-\pi_R) + (1-\theta)\pi_L(1-\pi_L)\right] \end{array} \right]$$

$$c_j^{DL} = \left[\begin{array}{c} \theta\pi_R(1-\pi_R) - (1-\theta)\pi_L(1-\pi_L) \\ +b_j\left[\theta\pi_R(1-\pi_R) + (1-\theta)\pi_L(1-\pi_L)\right] \end{array} \right]$$

The more left-biased expert (that is, expert j) has a higher cost threshold than expert i under Type RR, while the more right-biased expert (that is, expert i) has a higher cost threshold than expert j under Type LL.

$$\text{Type RR}: \quad c_j^{DR} > c_i^{DR}$$
$$\text{Type LL}: \quad c_i^{DL} > c_j^{DL}$$

Proposition 12 *A Type RR informative equilibrium with two reports exists when the effort cost is sufficiently low ($e \leq e^D$), the experts are not too too right-biased ($b_i < b^{DR}$, $b_j < b^{DR}$), and the cost is sufficiently low ($c \leq c_i^{DR}$).*

Proposition 13 *A Type LL informative equilibrium with two reports exists when the effort cost is sufficiently low ($e \leq e^D$), the experts are not too too left-biased ($b_i > b^{DL}$, $b_j > b^{DL}$), and the cost is sufficiently low ($c \leq c_j^{DL}$).*

Proposition 14 *A Type RL informative equilibrium with two reports exists when the effort cost is sufficiently low ($e \leq e^D$), the first expert is not too right-biased*

($b_i < b^{DR}$), the second is not too left-biased ($b_j > b^{DL}$), and the cost is sufficiently low ($c \leq \min\{c_i^{DR}, c_j^{DL}\}$).

Proposition 15 *A Type LR informative equilibrium with two reports exists when the effort cost is sufficiently low ($e \leq e^D$), the first expert is not too left-biased ($b_i > b^{DL}$), the second is not too right-biased ($b_j < b^{DR}$), and the cost is sufficiently low ($c \leq \min\{c_i^{DL}, c_j^{DR}\}$).*

The cost thresholds are constructed based on the assumption that the other expert is acquiring information and reporting informatively. To understand what is going on in this game, let's momentarily restrict attention to Type RR. Given that expert j is acquiring and reporting informatively, expert i will acquire information when $c \leq c_i^{DR}$. Similarly, given that expert i is acquiring and reporting information, expert j will acquire information when $c \leq c_j^{DR}$. However, since $c_j^{DR} > c_i^{DR}$, the equilibrium with two informative reports only exists when the cost of information is less than the smaller of the two thresholds ($c \leq c_i^{DR}$). When $c \in (c_i^{DR}, c_j^{DR}]$, expert i no longer acquires information even though expert j would acquire.

Let

$$\begin{aligned} c^{D_A} &= \max\{c_i^{DR}, c_j^{DL}, \min\{c_i^{DR}, c_j^{DL}\}, \min\{c_i^{DL}, c_j^{DR}\}\} \\ &= \max\{c_i^{DR}, c_j^{DL}, \min\{c_i^{DL}, c_j^{DR}\}\} \end{aligned}$$

Lemma 5 *If $e \leq e^D$ and $c \leq c^{D_A}$, then $z_2 \in Z^{(i,j)}$.*

Let $Z^{(i,i)}$ = the set of equilibrium EU^{DM} in the duopoly game with identical experts with bias level of b_i.

Let $Z^{(j,j)}$ = the set of equilibrium EU^{DM} in the duopoly game with identical experts with bias level of b_j.

The duopoly model with asymmetrically biased experts does not offer any welfare improvements in addition to what was already present in a duopoly model with identical experts. For every equilibrium in the duopoly model with asymmetrically biased experts, there exists a corresponding outcome equivalent game with identically biased experts.

Theorem 3 *For any fixed set of parameters ($c \in \Re^+$, $e \in \Re^+$, $b_i \in \Re$, $b_j \in \Re$ with $b_j < b_i$) and for any $z^A \in Z^{(i,j)}$, there exists $z \in \left(Z^{(i,i)} \cup Z^{(j,j)}\right)$ such that $z \geq z^A$.*

For some parameters, ($c \in \Re^+$, $e \in \Re^+$, $b_i \in \Re$, $b_j \in \Re$ with $b_j < b_i$) and for any $z^A \in Z^{(i,j)}$, there exists $z \in \left(Z^{(i,i)} \cup Z^{(j,j)}\right)$ such that $z > z^A$.

Proof. In the duopoly game with asymmetric experts, the highest duopoly cost threshold (that is, $c^{D_A} = \max\{c_i^{DR}, c_j^{DL}, \min\{c_i^{DL}, c_j^{DR}\}\}$) can be any one of four values, and the highest monopoly cost threshold (that is, $c^{M_A} = \max\{c_j^{MR}, c_i^{ML}\}$) can be any one of two values. Initially, it appears that there are eight cases to consider. In fact, there are only four cases to consider, because some cases can be considered together.

1. **Case 1**: Suppose $c_i^{DL} < c_j^{DR}$, then $c^{D_A} = \max\{c_i^{DR}, c_j^{DL}, c_i^{DL}\}$

   $= \max\{c_i^{DR}, c_i^{DL}\}$.

   (a) **Sub-case 1.1**: $c^{M_A} = c_j^{MR}$

   In this case, having two expert j's is better than having one expert i and one expert j.

   If $e \leq e^M$ and $c \leq c^{M_A}$, then $z_1 \in Z^{(j,j)}$ and $z_1 \in Z^{(i,j)}$.

   If $e \leq e^M$ and $c \leq c^{D_A}$, then in the interval $c \in (c^{D_A}, c_j^{DR}]$, $z_2 \in Z^{(j,j)}$ but $z_2 \notin Z^{(i,j)}$. This means a higher equilibrium EU^{DM} can be achieved in the interval $c \in (c^{D_A}, c_j^{DR}]$ in a game with two expert j's than in a game with one expert i and one expert j.

   (b) **Sub-case: 1.2**: $c^{M_A} = c_i^{ML}$

   In this case, having two expert i's is the same as having one expert i and one expert j.

   If $e \leq e^M$ and $c \leq c^{M_A}$, then $z_1 \in Z^{(i,i)}$ and $z_1 \in Z^{(i,j)}$.

   If $e \leq e^M$ and $c \leq c^{D_A}$, then $z_2 \in Z^{(i,i)}$ and $z_2 \in Z^{(i,j)}$.

2. **Case 2**: Suppose $c_i^{DL} > c_j^{DR}$, then $c^{D_A} = \max\{c_i^{DR}, c_j^{DL}, c_j^{DR}\}$

   $= \max\{c_j^{DL}, c_j^{DR}\}$.

(a) **Sub-case 2.1**: $c^{M_A} = c_j^{MR}$

In this case, having two expert j's is the same as having one expert i and one expert j.

If $e \leq e^M$ and $c \leq c^{M_A}$, then $z_1 \in Z^{(j,j)}$ and $z_1 \in Z^{(i,j)}$.

If $e \leq e^M$ and $c \leq c^{D_A}$, then $z_2 \in Z^{(j,j)}$ and $z_2 \in Z^{(i,j)}$.

(b) **Sub-case: 2.2**: $c^{M_A} = c_i^{ML}$

In this case, having two expert i's is better than having one expert i and one expert j.

If $e \leq e^M$ and $c \leq c^{M_A}$, then $z_1 \in Z^{(i,i)}$ and $z_1 \in Z^{(i,j)}$.

If $e \leq e^M$ and $c \leq c^{D_A}$, then in the interval $c \in (c^{D_A}, c_i^{DL}]$, $z_2 \in Z^{(i,i)}$ but $z_2 \notin Z^{(i,j)}$. This means a higher equilibrium EU^{DM} can be achieved in the interval $c \in (c^{D_A}, c_i^{DL}]$ in a game with two expert i's than in a game with one expert i and one expert j.

■

Aside from shifting some cost thresholds, having asymmetrically biased experts does not alter the model with identical duopolists by much. The basic results remain the same. Since full information is already achieved in this model, having asymmetrically biased experts does not yield any further welfare improvements. In other words, there are no additional incentives for experts to acquire information if they are of opposite bias levels or of the same bias level.

2.4 Conclusion

This paper shines a spotlight on an often neglected aspect of the media market: information is costly. The assumption that it is both free and exogenous is common in the economics community. Agents in numerous models receive signals; some signals are public and some are private, but almost all fall freely from the sky. While the assumption is reasonable in some applications, it is not in others. In a model about the media market, it definitely is not.

Given that information is costly, bias provides an incentive for firms to acquire information. With the model presented in this paper, I have shown that a more biased firm has a larger willingness to pay for information than an unbiased firm. The incentive for a more biased firm to acquire information arises from what occurs when the firm does not acquire information. By not acquiring information, the consumers believe the firm did acquire information and is merely withholding it. Thus, the unfavorable action occurs with certainty. It is the threat of punishment rather than a reward that drives the result.

The results of this paper caution against policies and regulations that attempt to eliminate or alter the biases of firms, because there is a benefit in having biased firms. Instead, the social goal should focus on ensuring no information loss, possibly through the following three suggestions.

1. *Published reports may be one-sided, but cannot contain fabrications.* Market

forces alone appear to be sufficient in achieving this goal. While fabricated news can emerge in the short-run, it cannot last in the long-run. Firms that present fabricated information are severely punished with reduced credibility among its audience. No one would waste valuable time consuming lies. Both firms as well as consumers can expose the lies. While competing firms may have stronger incentives than consumers in exposing lies, the Internet offers such a low cost publication method for everyone that consumers often expose lies. For instance, average bloggers were the ones who first pointed out that Reuters published a digitally manipulated photograph of smoke in Beirut, Lebanon.

2. *The bias level should be publicly known.* With the model presented in this paper, reports are fully revealing in the informative equilibria. The result of fully informative reports depends on the structure of the game. In particular, fully informative reports may not be achievable with a richer signal space even when bias levels are known. Recent work by Chakraborty and Harbaugh (2007) explore the extent to which reports are informative when the biases are publicly known. They conclude that while the transparency of the expert's bias level positively impacts communication, full revelation is not generally attained.

3. *Competition among asymmetrically biased firms may help.* Since fully infor-

mative reports were achievable in this paper, having asymmetrically biased firms was not necessary for welfare improvements from competition. There was no benefit in having asymmetrically biased firms in terms of information acquisition. However, if full information is not achievable, then perhaps asymmetrically biased firms helps in reducing information loss. Milgrom and Roberts (1986) suggest that having firms with opposing biases helps to achieve full information when the population is unable to make the correct inferences.

I conclude that media bias may not be bad. In fact, having biased media firms may be good, so long as their bias is known and information is not lost.

2.5 Appendix

Proof of Proposition 3:

Let n be the number of experts. For all parameter values, $c \in \Re^+$, $e \in \Re^+$, $b_i \in \Re$ for $i = 1, 2, ...n$, there exists an equilibrium for all n experts to not acquire any information ($\alpha_i^E = 0$ for all $i = 1, 2, ...n$) and for the decision maker to not read any reports ($\rho_i^{DM} = 0$ for all $i = 1, 2, ...n$). Given that all experts do not acquire any information, the decision maker's best response is to not read reports. Conversely, given that the decision maker does not read any reports, each expert's best response is to not acquire information. Thus, the decision maker will select an action based on his prior beliefs. If the common prior beliefs are $\theta < \frac{1}{2}$, then he will select L. The equilibrium expected utilities are $EU^{DM} = 1 - \theta$ and $EU^E = Rev(1) + (1 - \theta)$.

Proof of Propositions 4, 5, and 7

The game with one biased expert is solved backwards by identifying the best responses of the expert and decision maker. The four strategies are analyzed in the following order: (1) the decision maker's action strategy, (2) the decision maker's reading strategy, (3) the expert's reporting strategy, and (4) the expert's acquisition strategy.

Step 1: The Decision Maker's Action Strategy

There are four components to the decision maker's action strategy: $\alpha^{DM}(R|0)$, $\alpha^{DM}(R|\widehat{r})$, $\alpha^{DM}(L|\widehat{l})$, and $\alpha^{DM}(R|\widehat{0})$. The first three are simple, while the fourth is more complicated. The first, $\alpha^{DM}(R|0)$, deals with the decision maker's best response given that he does not read a report. Since $\theta < \frac{1}{2}$, $\alpha^{DM}(R|0) = 0$ (which is the same as $\alpha^{DM}(L|0) = 1$). Next, from the assumption of informative signals, the decision maker follows the advice of truthful reports, that is, $\alpha^{DM}(R|\widehat{r}) = 1$ and $\alpha^{DM}(L|\widehat{l}) = 1$. The last, $\alpha^{DM}(R|\widehat{0})$, is more complicated.

Suppose the decision maker has reached the information set where the decision maker reads report $\widehat{0}$. When the decision maker reads a report of $\widehat{0}$, he can hold three different beliefs about the expert's actions. He could believe that the expert (i) didn't acquire any information at all, (ii) received an l signal and withheld information, or (iii) received an r signal and withheld information.

$$\begin{aligned}\Pr(\widehat{0}) &= (1-\theta)\left[\left(1-\alpha^{E}\right) + \alpha^{E}\pi_{L}\rho^{E}(\widehat{0}|l) + \alpha^{E}(1-\pi_{L})\rho^{E}(\widehat{0}|r)\right] \\ &\quad +\theta\left[\left(1-\alpha^{E}\right) + \alpha^{E}(1-\pi_{R})\rho^{E}(\widehat{0}|l) + \alpha^{E}\pi_{R}\rho^{E}(\widehat{0}|r)\right]\end{aligned}$$

The decision maker's expected utilities are

$$\begin{aligned}EU^{DM}\left[\alpha^{DM}(L|\widehat{0}) = 1\right] &= \frac{\left[\begin{array}{c}(1-\theta)\left(1-\alpha^{E}\right) + (1-\theta)\alpha^{E}\pi_{L}\rho^{E}(\widehat{0}|l) \\ +(1-\theta)\alpha^{E}(1-\pi_{L})\rho^{E}(\widehat{0}|r)\end{array}\right]}{\Pr(\widehat{0})} \\ EU^{DM}\left[\alpha^{DM}(R|\widehat{0}) = 1\right] &= \frac{\theta\left(1-\alpha^{E}\right) + \theta\alpha^{E}(1-\pi_{R})\rho^{E}(\widehat{0}|l) + \theta\alpha^{E}\pi_{R}\rho^{E}(\widehat{0}|r)}{\Pr(\widehat{0})}\end{aligned}$$

The decision maker's best response is as follows:

$$\text{select action } L \text{ if } EU^{DM}\left[\alpha^{DM}(L|\widehat{0})=1\right] > EU^{DM}\left[\alpha^{DM}(R|\widehat{0})=1\right]$$

$$\text{select action } R \text{ if } EU^{DM}\left[\alpha^{DM}(L|\widehat{0})=1\right] < EU^{DM}\left[\alpha^{DM}(R|\widehat{0})=1\right]$$

Be indifferent between L and R

$$\text{if } EU^{DM}\left[\alpha^{DM}(L|\widehat{0})=1\right] = EU^{DM}\left[\alpha^{DM}(R|\widehat{0})=1\right]$$

Step 2: The Expert's Reporting Strategy

If the expert receives a signal, then she must have purchased a signal. Take $\alpha^{E} = 1$ as given. The reporting strategy is analyzed in two steps. The first step identifies the best reporting strategy given an r signal, while the second step identified the best reporting strategy given an l signal.

Sub-Step 1: Suppose the expert receives an r signal. Compare her expected utility of reporting $\widehat{r}$ with that of reporting $\widehat{0}$.

$$\begin{aligned} EU^{E}\left[\rho^{E}(\widehat{r}|r)=1\right] &= Rev(\rho^{DM}) - c \\ &\quad +\rho^{DM}\left[\Pr(R|r)+b\right] \\ &\quad +(1-\rho^{DM})\left[\left[\begin{array}{c} \theta\alpha^{DM}(R|0) \\ +(1-\theta)\alpha^{DM}(L|0) \end{array}\right] + \alpha^{DM}(R|0)b\right] \end{aligned}$$

$$
\begin{aligned}
EU^E\left[\rho^E\left(\widehat{0}|r\right)=1\right] &= Rev(\rho^{DM})-c \\
&\quad +\rho^{DM}\left[\left[\begin{array}{c}\Pr(R|r)\alpha^{DM}(R|\widehat{0}) \\ +\Pr(L|r)\alpha^{DM}(L|\widehat{0})\end{array}\right]+\alpha^{DM}(R|\widehat{0})b\right] \\
&\quad +(1-\rho^{DM})\left[\left[\begin{array}{c}\theta\alpha^{DM}(R|0) \\ +(1-\theta)\alpha^{DM}(L|0)\end{array}\right]+\alpha^{DM}(R|0)b\right]
\end{aligned}
$$

The expert will prefer to report $\widehat{r}$ over $\widehat{0}$ when

$$
\begin{aligned}
EU^E\left[\rho^E\left(\widehat{r}|r\right)=1\right] &> EU^E\left[\rho^E\left(\widehat{0}|r\right)=1\right] \\
\rho^{DM}\left[\Pr(R|r)+b\right] &> \rho^{DM}\left[\left[\begin{array}{c}\Pr(R|r)\alpha^{DM}(R|\widehat{0}) \\ +\Pr(L|r)\alpha^{DM}(L|\widehat{0})\end{array}\right]+\alpha^{DM}(R|\widehat{0})b\right]
\end{aligned}
$$

If $\rho^{DM}=0$, then the expert will be indifferent between reporting $\widehat{r}$ and $\widehat{0}$.

If $\rho^{DM}>0$, the above inequality reduces to

$$
\begin{aligned}
\Pr(R|r)+b &> \left[\begin{array}{c}\Pr(R|r)\alpha^{DM}(R|\widehat{0}) \\ +\Pr(L|r)\alpha^{DM}(L|\widehat{0})\end{array}\right]+\alpha^{DM}(R|\widehat{0})b \\
\Pr(R|r)+b &> \left[\begin{array}{c}\left[\begin{array}{c}\Pr(R|r)\alpha^{DM}(R|\widehat{0}) \\ +\Pr(L|r)\left[1-\alpha^{DM}(R|\widehat{0})\right]\end{array}\right] \\ +\alpha^{DM}(R|\widehat{0})b\end{array}\right] \\
\left[\Pr(R|r)-\Pr(L|r)\right]\left[1-\alpha^{DM}(R|\widehat{0})\right] &> -\left[1-\alpha^{DM}(R|\widehat{0})\right]b
\end{aligned}
$$

If $\alpha^{DM}(R|\widehat{0})=1$, then the expert will be indifferent between reporting $\widehat{r}$ and

$\widehat{0}$ ($\rho^E(\widehat{r}|r) \in [0,1]$).

If $\alpha^{DM}(L|\widehat{0}) > 0$, the above inequality reduces to

$$-[\Pr(R|r) - \Pr(L|r)] < b$$

Denote the bias threshold as $b^{ML} = -[\Pr(R|r) - \Pr(L|r)]$. Notice that b^{ML} is a negative value. The expert will report r signals as $\widehat{r}$ if she is not too left-biased ($b > b^{ML}$). However, if she is too left-biased ($b < b^{ML}$), then she will report r signals as $\widehat{0}$. Lastly, if $b = b^{ML}$, then the expert will be indifferent between reporting $\widehat{r}$ and reporting $\widehat{0}$.

Sub-step 2: Suppose the expert receives an l signal. Compare her expected utility of reporting $\widehat{l}$ with that of reporting $\widehat{0}$.

$$\begin{aligned} EU^E\left[\rho^E\left(\widehat{l}|l\right) = 1\right] &= Rev(\rho^{DM}) - c \\ &\quad +\rho^{DM}\Pr(L|l) \\ &\quad +(1-\rho^{DM})\left[\begin{bmatrix} \theta\alpha^{DM}(R|0) \\ +(1-\theta)\alpha^{DM}(L|0) \end{bmatrix} + \alpha^{DM}(R|0)b\right] \end{aligned}$$

$$
\begin{aligned}
EU^E\left[\rho^E\left(\widehat{0}|l\right)=1\right] &= Rev(\rho^{DM})-c \\
&+\rho^{DM}\left[\left[\begin{array}{c}\Pr(R|l)\alpha^{DM}(R|\widehat{0}) \\ +\Pr(L|l)\alpha^{DM}(L|\widehat{0})\end{array}\right]+\alpha^{DM}(R|\widehat{0})b\right] \\
&+(1-\rho^{DM})\left[\left[\begin{array}{c}\theta\alpha^{DM}(R|0) \\ +(1-\theta)\alpha^{DM}(L|0)\end{array}\right]+\alpha^{DM}(R|0)b\right]
\end{aligned}
$$

The expert will prefer to report $\widehat{l}$ over $\widehat{0}$ when

$$
\begin{aligned}
EU^E\left[\rho^E\left(\widehat{l}|l\right)=1\right] &> EU^E\left[\rho^E\left(\widehat{0}|l\right)=1\right] \\
\rho^{DM}\Pr(L|l) &> \rho^{DM}\left[\left[\begin{array}{c}\Pr(R|l)\alpha^{DM}(R|\widehat{0}) \\ +\Pr(L|l)\alpha^{DM}(L|\widehat{0})\end{array}\right]+\alpha^{DM}(R|\widehat{0})b\right]
\end{aligned}
$$

If $\rho^{DM}=0$, then the expert will be indifferent between reporting $\widehat{l}$ and $\widehat{0}$.

If $\rho^{DM}>0$, the above inequality reduces to

$$
\begin{aligned}
\Pr(L|l) &> \left[\Pr(R|l)\alpha^{DM}(R|\widehat{0})+\Pr(L|l)\alpha^{DM}(L|\widehat{0})\right]+\alpha^{DM}(R|\widehat{0})b \\
\Pr(L|l) &> \left[\Pr(R|l)\alpha^{DM}(R|\widehat{0})+\Pr(L|l)\left[1-\alpha^{DM}(R|\widehat{0})\right]\right]+\alpha^{DM}(R|\widehat{0})b \\
0 &> \left[\Pr(R|l)-\Pr(L|l)\right]\alpha^{DM}(R|\widehat{0})+\alpha^{DM}(R|\widehat{0})b
\end{aligned}
$$

If $\alpha^{DM}(R|\widehat{0})=0$, then the expert is indifferent between reporting $\widehat{l}$ and $\widehat{0}$. Either reporting strategy will result in the decision maker selecting L.

If $\alpha^{DM}(R|\widehat{0})>0$, the above inequality reduces to

$$
\left[\Pr(L|l)-\Pr(R|l)\right]>b
$$

Denote the bias threshold $b^{MR} = [\Pr(L|l) - \Pr(R|l)]$.

Hence, if the expert is not too right-biased ($b < b^{MR}$), the expert will report l signals as $\widehat{l}$. However, if the expert is too right-biased ($b > b^{MR}$), then the expert will report l signals as $\widehat{0}$. Lastly, if $b = b^{MR}$, the expert will be indifferent between reporting $\widehat{l}$ and reporting $\widehat{0}$.

The best response is summarized below.

1. If $0 \leq \alpha^{DM}(R|\widehat{0}) < 1$ and $\rho^{DM} > 0$, then the expert's reporting strategy given an r signal depends on her bias level. The expert will report r signals as $\widehat{r}$ if she is not too left-biased ($b > b^{ML}$). If she is too left-biased ($b < b^{ML}$), then the expert reports $\widehat{0}$ given an r signal ($\rho^E(\widehat{0}|r) = 1$). Lastly, if the expert's bias level is equal to the threshold value ($b = b^{ML}$), then the expert is indifferent between reporting $\widehat{r}$ and reporting $\widehat{0}$ given an l signal ($\rho^E(\widehat{r}|r) \in [0, 1]$).

2. If $\alpha^{DM}(R|\widehat{0}) = 1$ and $\rho^{DM} > 0$, then the expert is indifferent between reporting $\widehat{r}$ and reporting $\widehat{0}$ given an r signal ($\rho^E(\widehat{r}|r) \in [0, 1]$).

3. If $0 < \alpha^{DM}(R|\widehat{0}) \leq 1$ and $\rho^{DM} > 0$, then the expert's reporting strategy for an l signal depends on her bias level. She reports $\widehat{l}$ given an l signal ($\rho^E(\widehat{l}|l) = 1$) when she is not too right-biased ($b < b^{MR}$). If she is too right-biased ($b > b^{MR}$), then the expert reports $\widehat{0}$ given an l signal ($\rho^E(\widehat{0}|l) = 1$).

Lastly, if the expert's bias level is equal to the threshold value ($b = b^{MR}$), then the expert is indifferent between reporting $\widehat{l}$ and reporting $\widehat{0}$ given an l signal ($\rho^E(\widehat{l}|l) \in [0,1]$).

4. If $\alpha^{DM}(R|\widehat{0}) = 0$ and $\rho^{DM} > 0$, then the expert is indifferent between reporting $\widehat{l}$ and reporting $\widehat{0}$ given an l signal ($\rho^E(\widehat{l}|l) \in [0,1]$).

5. If $\rho^{DM} = 0$, then the expert will be indifferent in reporting strategies ($\rho^E(\widehat{r}|r) \in [0,1]$ and $\rho^E(\widehat{l}|l) \in [0,1]$).

Step 3: The Decision Maker's Reading Strategy

To identify the best reading response, compare the expected utility of the decision maker when he does not read with that when he does read.

If the decision maker does not read a report, then he must select an action based on his prior beliefs. Since the prior beliefs are $\theta < \frac{1}{2}$, then $\alpha^{DM}(L|0) = 1$ and

$$EU^{DM}\left[\rho^{DM} = 0\right] = 1 - \theta$$

If the decision maker does read a report from the monopolist expert, then

$$
\begin{aligned}
EU^{DM}\left[\rho_i^{DM}=1\right] &= \alpha_i^E \left[\begin{array}{c}
\theta\pi_R\left[\rho_i^E(\widehat{r}|r)+\rho_i^E(\widehat{0}|r)\alpha^{DM}(R|\widehat{0})\right] \\
+\theta(1-\pi_R)\rho_i^E(\widehat{0}|l)\alpha^{DM}(R|\widehat{0}) \\
+(1-\theta)\pi_L\left[\rho_i^E(\widehat{l}|l)+\rho_i^E(\widehat{0}|l)\alpha^{DM}(L|\widehat{0})\right] \\
+(1-\theta)(1-\pi_L)\rho_i^E(\widehat{0}|r)\alpha^{DM}(L|\widehat{0})
\end{array}\right] \\
&\quad +(1-\alpha_i^E)\left[\theta\alpha^{DM}(R|\widehat{0})+(1-\theta)\alpha^{DM}(L|\widehat{0})\right] \\
&\quad -e
\end{aligned}
$$

With a monopolist expert, the decision maker must choose whether or not to read the expert's report. He will read the report when

$$EU^{DM}(\rho^{DM}=1) > EU^{DM}(\rho^{DM}=0)$$

The best response is summarized below.

1. In Type R, the best response is as follows.

$$
\begin{aligned}
\text{Read when } e &< \alpha^E\left[(1-\theta)\pi_L-\theta(1-\pi_R)\right]-(1-2\theta) \\
\text{Do not read when } e &> \alpha^E\left[(1-\theta)\pi_L-\theta(1-\pi_R)\right]-(1-2\theta) \\
\text{Be indifferent when } e &= \alpha^E\left[(1-\theta)\pi_L-\theta(1-\pi_R)\right]-(1-2\theta)
\end{aligned}
$$

2. In Type L, the best response is as follows.

$$
\begin{aligned}
\text{Read when } e &< \alpha^E\left[\theta\pi_R-(1-\theta)(1-\pi_L)\right] \\
\text{Do not read when } e &> \alpha^E\left[\theta\pi_R-(1-\theta)(1-\pi_L)\right] \\
\text{Be indifferent when } e &= \alpha^E\left[\theta\pi_R-(1-\theta)(1-\pi_L)\right]
\end{aligned}
$$

When $\alpha^E = 1$, the best response of the two Types converges to

$$\begin{aligned} \text{Read when } e &< e^M \\ \text{Do not read when } e &> e^M \\ \text{Be indifferent when } e &= e^M \end{aligned}$$

where $e^M = \theta\pi_R - (1-\theta)(1-\pi_L)$.

Step 4: The Expert's Acquisition Strategy

The acquisition strategy is analyzed in 3 steps.

1. Type R and $b < b^{MR}$
2. Type L and $b > b^{ML}$
3. All remaining cases.

Sub-step 1: Type R and $b < b^{MR}$.

Compare the expected utility of the expert when she acquires information to that when she does not.

$$
\begin{aligned}
EU^E\left[\alpha^E = 1\right] &= Rev(\rho^{DM}) - c + \rho^{DM}\left[\begin{array}{c} [\theta\pi_R + (1-\theta)\pi_L] \\ + [\theta\pi_R + (1-\theta)(1-\pi_L)]\, b \end{array}\right] \\
&\quad +(1-\rho^{DM})\left[\left[\begin{array}{c} \theta\alpha^{DM}(R|0) \\ +(1-\theta)\alpha^{DM}(L|0) \end{array}\right] + \alpha^{DM}(R|0)b\right]
\end{aligned}
$$

$$
\begin{aligned}
EU^E\left[\alpha^E = 0\right] &= Rev(\rho^{DM}) + \rho^{DM}\left[\theta + b\right] \\
&\quad +(1-\rho^{DM})\left[\left[\begin{array}{c} \theta\alpha^{DM}(R|0) \\ +(1-\theta)\alpha^{DM}(L|0) \end{array}\right] + \alpha^{DM}(R|0)b\right]
\end{aligned}
$$

The expert prefers to acquire information when

$$
\begin{aligned}
EU^E\left[\alpha^E = 1\right] &> EU^E\left[\alpha^E = 0\right] \\
-c + \rho^{DM}\left[[\theta\pi_R + (1-\theta)\pi_L] + [\theta\pi_R + (1-\theta)(1-\pi_L)]\, b\right] &> \rho^{DM}\left[\theta + b\right] \\
\rho^{DM}\left[[(1-\theta)\pi_L - \theta(1-\pi_R)] - b\left[\theta(1-\pi_R) + (1-\theta)\pi_L\right]\right] &> c \\
\rho^{DM} c^{MR} &> c
\end{aligned}
$$

where

$$
c^{MR} = [(1-\theta)\pi_L - \theta(1-\pi_R)] - b\left[\theta(1-\pi_R) + (1-\theta)\pi_L\right]
$$

Sub-step 2: Type L and $b < b^{ML}$.

Compare the expected utility of the expert when she acquires information to that when she does not.

$$
\begin{aligned}
EU^E\left[\alpha^E=1\right] &= Rev(\rho^{DM})-c+\rho^{DM}\left[\begin{array}{c}[\theta\pi_R+(1-\theta)\pi_L] \\ +\left[\theta\pi_R+(1-\theta)(1-\pi_L)\right]b\end{array}\right] \\
&\quad +(1-\rho^{DM})\left[\left[\begin{array}{c}\theta\alpha^{DM}(R|0) \\ +(1-\theta)\alpha^{DM}(L|0)\end{array}\right]+\alpha^{DM}(R|0)b\right]
\end{aligned}
$$

$$
\begin{aligned}
EU^E\left[\alpha^E=0\right] &= Rev(\rho^{DM})+\rho^{DM}(1-\theta) \\
&\quad +(1-\rho^{DM})\left[\left[\begin{array}{c}\theta\alpha^{DM}(R|0) \\ +(1-\theta)\alpha^{DM}(L|0)\end{array}\right]+\alpha^{DM}(R|0)b\right]
\end{aligned}
$$

The expert prefers to acquire information when

$$
\begin{aligned}
EU^E\left[\alpha^E=1\right] &> EU^E\left[\alpha^E=0\right] \\
-c+\rho^{DM}\left[[\theta\pi_R+(1-\theta)\pi_L]+\left[\theta\pi_R+(1-\theta)(1-\pi_L)\right]b\right] &> \rho^{DM}(1-\theta) \\
\rho^{DM}\left[[\theta\pi_R+(1-\theta)(1-\pi_L)]+\left[\theta\pi_R+(1-\theta)(1-\pi_L)\right]b\right] &> c \\
\rho^{DM}c^{ML} &> c
\end{aligned}
$$

Sub-step 3: The remaining cases include: (i) Type R and $b \geq b^{MR}$, and (ii) Type L and $b \leq b^{ML}$.

In these remaining cases, the expert does not strictly prefer to report truthfully for at least one of the two signals.

In these cases, the following two statements are true.

Given an l signal, $EU^E\left[\rho^E\left(\widehat{l}|l\right)\right] \leq EU^E\left[\rho^E\left(\widehat{0}|l\right)\right]$.

Given an r signal, $EU^E\left[\rho^E\left(\widehat{r}|r\right)\right] \leq EU^E\left[\rho^E\left(\widehat{0}|r\right)\right]$.

If the above two statements are true, then expert is better off not acquiring information at all. If she doesn't acquire information at all, she can still report $\widehat{0}$, which will yield the same expected utility as if she did acquire information save the cost of acquiring information.

The best response is summarized below.

1. If Type R and $b < b^{MR}$, then

$$\begin{aligned}\text{Acquire if } \rho^{DM}c^{MR} &> c\\ \text{Do not acquire if } \rho^{DM}c^{MR} &< c\\ \text{Be indifferent if } \rho^{DM}c^{MR} &= c\end{aligned}$$

2. If Type L and $b > b^{ML}$, then

$$\begin{aligned}\text{Acquire if } \rho^{DM}c^{ML} &> c\\ \text{Do not acquire if } \rho^{DM}c^{ML} &< c\\ \text{Be indifferent if } \rho^{DM}c^{ML} &= c\end{aligned}$$

3. If Type R and $b \geq b^{MR}$, then do not acquire information ($\alpha^E = 0$).

4. If Type L and $b \leq b^{ML}$, then do not acquire information ($\alpha^E = 0$).

From the results of Sub-step 3, it is clear that the only informative equilibria are of Type R or Type L. The expert would not bother acquiring costly information if she did not strictly prefer to report truthfully for at least one of the two signals.

Step 5: The equilibria in mixed acquisition and mixed reading strategies

1. There exists a Type R equilibrium in which the expert adopts a mixed acquisition strategy ($\alpha^E = \frac{e+(1-2\theta)}{[(1-\theta)\pi_L - \theta(1-\pi_R)]}$) and the decision maker adopts a mixed reading strategy ($\rho^{DM} = \frac{c}{c^{MR}}$) if the effort cost is sufficiently low ($e \leq e^M$), the expert is not too right-biased ($b < b^{MR}$), and the cost is sufficiently low ($c \leq c^{MR}$).

2. There exists a Type L equilibrium in which the expert adopts a mixed acquisition strategy ($\alpha^E = \frac{e}{[\theta\pi_R - (1-\theta)(1-\pi_L)]}$) and the decision maker adopts a mixed reading strategy ($\rho^{DM} = \frac{c}{c^{ML}}$) if the effort cost is sufficiently low ($e \leq e^M$), the expert is not too left-biased ($b > b^{ML}$), the cost is sufficiently low ($c \leq c^{ML}$).

3. In all of the equilibria with mixed acquisition and mixed reading strategies,

the equilibrium expected utilities are

$$
\begin{aligned}
EU^{DM} &= 1-\theta \\
EU^{E} &= Rev(1)+(1-\theta)
\end{aligned}
$$

If the expert adopts a mixed acquisition strategy, then her expected utility of acquiring is the same as if she did not. Similarly, if the decision maker adopts a mixed reading strategy, then his expected utility of reading is the same as if he did not. Therefore, the equilibrium expected utilities of these mixed strategy equilibria is the same as the uninformative equilibrium.

Proof of Proposition 6:

By definition of informative equilibria, the expert acquires information and the decision maker reads the report. If the expert acquires information, then the expert will report informatively (as shown in Step 4 of the Proof to Proposition 4, 5, and 7). The Type of equilibria is relevant only in determining what reporting strategy the expert adopts and what beliefs the decision maker holds about $\widehat{0}$. But the Type does not affect the equilibria expected utilities.

$$
\begin{aligned}
EU^{DM} &= [\theta\pi_R+(1-\theta)\,\pi_L]-e \\
EU^{E} &= Rev(1)-c+[\theta\pi_R+(1-\theta)\,\pi_L]+b\,[\theta\pi_R+(1-\theta)(1-\pi_L)]
\end{aligned}
$$

Proof of Lemma 1:

Step 1: There exists a cost threshold $c^M > 0$, where $c^M = \max\{c^{MR}, c^{ML}\}$. If $c^{MR} > 0$ and $c^{ML} > 0$, then there is no question about the existence of a cost threshold $c^M > 0$. The question remains: is it possible for $c^M = 0$?

It is possible for $c^{MR} = 0$ if the expert's bias level is too right-biased (that is, $b \geq b^{MR}$). However, if $b \geq b^{MR}$, then $c^{ML} > 0$.

It is possible for $c^{ML} = 0$ if the expert's bias level is too left-biased (that is, $b \leq b^{ML}$). However, if $b \leq b^{ML}$, then $c^{MR} > 0$.

Hence, it is not possible for $c^M = 0$.

Step 2: By the assumption of informative signals $e^M > 0$.

Step 3: By Proposition 4 and 5, if $c < c^M$ and $e < e^M$, then $z_1 \in Z^{(i)}$. By Proposition 3, for all $c > 0$ and $e > 0$, $z_0 \in Z^{(i)}$, Hence, if $c < c^M$ and $e < e^M$, then $Z^{(i)} = \{z_0, z_1\}$.

Step 4: By Proposition 7, if $c = c^M$ and $e = e^M$, then $z_0 \in Z^{(i)}$. Suppose $c^M = c^{ML}$. Furthermore, for all $c > 0$ and $e > 0$, $z_0 \in Z^{(i)}$ by Proposition 3. Hence, if either $c \geq c^M$ or $e \geq e^M$, then $Z^{(i)} = \{z_0\}$.

Proof of Proposition 8 and 9:

The game with two identical experts is solved backwards. Step 1 identifies the best responses of the decision maker when he reads a report, except for reports that involve $\widehat{0}$. Step 2 identifies that all equilibria, except for the uninformative one, is one of four possible Types. Step 3 identifies the decision maker's reading strategy. Step 4 identifies experts' acquisition strategy in Type RR, while Step 5 identifies the experts' acquisition strategy in Type LL.

Step 1: Decision maker's action strategy

With two experts the decision maker's action strategy is a plan involving 16 possible reports: 3^2 possible reports if he reads two reports, 2(3) possible reports if he reads one report, and 1 possibility if he doesn't read a report.

Based on the assumption of informative signals, the following best responses are obvious: $\alpha^{DM}(R|\widehat{r},\widehat{r}) = 1$, $\alpha^{DM}(L|\widehat{l},\widehat{l}) = 1$, $\alpha^{DM}(R|\widehat{r},0) = 1$, $\alpha^{DM}(R|0,\widehat{r}) = 1$, $\alpha^{DM}(L|\widehat{l},0) = 1$, $\alpha^{DM}(L|0,\widehat{l}) = 1$, $\alpha^{DM}(L|0,0) = 1$. Additionally, $\alpha^{DM}(R|\widehat{r},\widehat{l})$ and $\alpha^{DM}(R|\widehat{l},\widehat{r})$ is also obvious, but they depend on the parameters. Under the assumption $\Pr(R|r,l) > \Pr(L|r,l)$, $\alpha^{DM}(R|\widehat{r},\widehat{l}) = \alpha^{DM}(R|\widehat{l},\widehat{r}) = 1$. Under the assumption $\Pr(R|r,l) < \Pr(L|r,l)$, $\alpha^{DM}(R|\widehat{r},\widehat{l}) = \alpha^{DM}(R|\widehat{l},\widehat{r}) = 0$.

The more complicated best responses involve all reports with $\widehat{0}$: $\left(\widehat{r},\widehat{0}\right)$, $\left(\widehat{0},\widehat{r}\right)$, $\left(\widehat{l},\widehat{0}\right)$, $\left(\widehat{0},\widehat{l}\right)$, $\left(\widehat{0},\widehat{0}\right)$, $\left(0,\widehat{0}\right)$, and $\left(\widehat{0},0\right)$.

Step 2: Type RR, Type LL, Type RL, and Type LR

With the exception of the uninformative equilibria, all equilibria is of a type. If the expert acquires information with some positive probability, then the expert will report informatively (as shown in Step 4 of the Proof to Proposition 4, 5, and 7). The bias levels of the experts must be incentive compatible with the Types.

For Type R to exist (that is, one expert is dormant), the bias level cannot be too right ($b < b^{MR}$).

For Type L to exist (that is, one expert is dormant), the bias level cannot be too right ($b < b^{ML}$).

For Type RR to exist (that is, neither expert is dormant), both experts cannot be too right-biased ($b < b^{DR}$).

For Type LL to exist (that is, neither expert is dormant), both experts cannot be too left-biased ($b > b^{DL}$).

For either Type RL or Type LR to exist (whether in pure or mixed acquisition and reading strategies), both experts cannot be too right- nor too left-biased ($b^{DL} < b < b^{DR}$).

Step 3: Decision maker's reading strategy

Find the decision maker's best response by identifying his expected utility when he does not read, when he reads one report, and when he reads two reports. Then compare the expected utilities.

If the decision maker reads no report, then his expected utility is

$$EU^{DM}\left[\rho_1^{DM}=0,\rho_2^{DM}=0\right]=1-\theta$$

If the decision maker reads only expert 1's report, then his expected utility is

$$\begin{aligned}
& EU^{DM}\left[\rho_1^{DM}=1,\rho_2^{DM}=0\right] \\
= \quad & \alpha_1^E\begin{bmatrix} \theta\pi_R\left[\rho_1^E(\widehat{r}|r)+\rho_1^E(\widehat{0}|r)\alpha^{DM}(R|\widehat{0},0)\right] \\ +\theta(1-\pi_R)\rho_1^E(\widehat{0}|l)\alpha^{DM}(R|\widehat{0},0) \\ +(1-\theta)\pi_L\left[\rho_1^E(\widehat{l}|l)+\rho_1^E(\widehat{0}|l)\alpha^{DM}(L|\widehat{0},0)\right] \\ +(1-\theta)(1-\pi_L)\rho_1^E(\widehat{0}|r)\alpha^{DM}(L|\widehat{0},0) \end{bmatrix} \\
& +(1-\alpha_1^E)\left[\theta\alpha^{DM}(R|\widehat{0},0)+(1-\theta)\alpha^{DM}(L|\widehat{0},0)\right] \\
& -e
\end{aligned}$$

If the decision maker reads only expert 2's report, then his expected utility is

$$
\begin{aligned}
& EU^{DM}\left[\rho_1^{DM}=0,\rho_2^{DM}=1\right] \\
= \quad & \alpha_2^E \left[\begin{array}{c} \theta\pi_R\left[\rho_2^E(\widehat{r}|r)+\rho_2^E(\widehat{0}|r)\alpha^{DM}(R|0,\widehat{0})\right] \\ +\theta(1-\pi_R)\rho_2^E(\widehat{0}|l)\alpha^{DM}(R|0,\widehat{0}) \\ +(1-\theta)\pi_L\left[\rho_2^E(\widehat{l}|l)+\rho_2^E(\widehat{0}|l)\alpha^{DM}(L|0,\widehat{0})\right] \\ +(1-\theta)(1-\pi_L)\rho_2^E(\widehat{0}|r)\alpha^{DM}(L|0,\widehat{0}) \end{array} \right] \\
& +(1-\alpha_2^E)\left[\theta\alpha^{DM}(R|0,\widehat{0})+(1-\theta)\alpha^{DM}(L|0,\widehat{0})\right] \\
& -e
\end{aligned}
$$

If the decision maker reads both experts' reports, then his expected utility is

$$
EU^{DM}\left[\rho_1^{DM}=\rho_2^{DM}=1\right]=
$$

$$
\alpha_1^E\alpha_2^E[\theta
\left[\begin{array}{c}
\pi_R^2\left[\begin{array}{c}
\rho_1^E(\widehat{r}|r)\rho_2^E(\widehat{r}|r) \\
+\rho_1^E(\widehat{0}|r)\rho_2^E(\widehat{r}|r)\alpha^{DM}\left(R|\widehat{0},\widehat{r}\right) \\
+\rho_1^E(\widehat{r}|r)\rho_2^E(\widehat{0}|r)\alpha^{DM}\left(R|\widehat{r},\widehat{0}\right) \\
+\rho_1^E(\widehat{0}|r)\rho_2^E(\widehat{0}|r)\alpha^{DM}\left(R|\widehat{0},\widehat{0}\right)
\end{array}\right] \\
+\pi_R\left(1-\pi_R\right)\left[\begin{array}{c}
\rho_1^E(\widehat{r}|r)\rho_2^E(\widehat{l}|l)\alpha^{DM}\left(R|\widehat{r},\widehat{l}\right) \\
+\rho_1^E(\widehat{0}|r)\rho_2^E(\widehat{l}|l)\alpha^{DM}\left(R|\widehat{0},\widehat{l}\right) \\
+\rho_1^E(\widehat{r}|r)\rho_2^E(\widehat{0}|l)\alpha^{DM}\left(R|\widehat{r},\widehat{0}\right) \\
+\rho_1^E(\widehat{0}|r)\rho_2^E(\widehat{0}|l)\alpha^{DM}\left(R|\widehat{0},\widehat{0}\right)
\end{array}\right] \\
+\left(1-\pi_R\right)\pi_R\left[\begin{array}{c}
\rho_1^E(\widehat{l}|l)\rho_2^E(\widehat{r}|r)\alpha^{DM}\left(R|\widehat{l},\widehat{r}\right) \\
+\rho_1^E(\widehat{0}|l)\rho_2^E(\widehat{r}|r)\alpha^{DM}\left(R|\widehat{0},\widehat{r}\right) \\
+\rho_1^E(\widehat{l}|l)\rho_2^E(\widehat{0}|r)\alpha^{DM}\left(R|\widehat{l},\widehat{0}\right) \\
+\rho_1^E(\widehat{0}|l)\rho_2^E(\widehat{0}|r)\alpha^{DM}\left(R|\widehat{0},\widehat{0}\right)
\end{array}\right] \\
+\left(1-\pi_R\right)^2\left[\begin{array}{c}
\rho_1^E(\widehat{0}|l)\rho_2^E(\widehat{l}|l)\alpha^{DM}\left(R|\widehat{0},\widehat{l}\right) \\
+\rho_1^E(\widehat{l}|l)\rho_2^E(\widehat{0}|l)\alpha^{DM}\left(R|\widehat{l},\widehat{0}\right) \\
+\rho_1^E(\widehat{0}|l)\rho_2^E(\widehat{0}|l)\alpha^{DM}\left(R|\widehat{0},\widehat{0}\right)
\end{array}\right]
\end{array}\right]
$$

$$
+\left(1-\theta\right)\left[\begin{array}{c}
+\pi_L^2\left[\begin{array}{c}
\rho_1^E(\widehat{l}|l)\rho_2^E(\widehat{l}|l)\\
+\rho_1^E(\widehat{0}|l)\rho_2^E(\widehat{l}|l)\alpha^{DM}\left(L|\widehat{0},\widehat{l}\right)\\
+\rho_1^E(\widehat{l}|l)\rho_2^E(\widehat{0}|l)\alpha^{DM}\left(L|\widehat{l},\widehat{0}\right)\\
+\rho_1^E(\widehat{0}|l)\rho_2^E(\widehat{0}|l)\alpha^{DM}\left(L|\widehat{0},\widehat{0}\right)
\end{array}\right]\\
+\pi_L\left(1-\pi_L\right)\left[\begin{array}{c}
\rho_1^E(\widehat{r}|r)\rho_2^E(\widehat{l}|l)\alpha^{DM}\left(L|\widehat{r},\widehat{l}\right)\\
+\rho_1^E(\widehat{0}|r)\rho_2^E(\widehat{l}|l)\alpha^{DM}\left(L|\widehat{0},\widehat{l}\right)\\
+\rho_1^E(\widehat{r}|r)\rho_2^E(\widehat{0}|l)\alpha^{DM}\left(L|\widehat{r},\widehat{0}\right)\\
+\rho_1^E(\widehat{0}|r)\rho_2^E(\widehat{0}|l)\alpha^{DM}\left(L|\widehat{0},\widehat{0}\right)
\end{array}\right]\\
+\left(1-\pi_L\right)\pi_L\left[\begin{array}{c}
\rho_1^E(\widehat{l}|l)\rho_2^E(\widehat{r}|r)\alpha^{DM}\left(L|\widehat{l},\widehat{r}\right)\\
+\rho_1^E(\widehat{0}|l)\rho_2^E(\widehat{r}|r)\alpha^{DM}\left(L|\widehat{0},\widehat{r}\right)\\
+\rho_1^E(\widehat{l}|l)\rho_2^E(\widehat{0}|r)\alpha^{DM}\left(L|\widehat{l},\widehat{0}\right)\\
+\rho_1^E(\widehat{0}|l)\rho_2^E(\widehat{0}|r)\alpha^{DM}\left(L|\widehat{0},\widehat{0}\right)
\end{array}\right]\\
+\left(1-\pi_L\right)^2\left[\begin{array}{c}
\rho_1^E(\widehat{0}|r)\rho_2^E(\widehat{r}|r)\alpha^{DM}\left(L|\widehat{0},\widehat{r}\right)\\
+\rho_1^E(\widehat{r}|r)\rho_2^E(\widehat{0}|r)\alpha^{DM}\left(L|\widehat{r},\widehat{0}\right)\\
+\rho_1^E(\widehat{0}|r)\rho_2^E(\widehat{0}|r)\alpha^{DM}\left(L|\widehat{0},\widehat{0}\right)
\end{array}\right]
\end{array}\right]]
$$

$$
+\left(1-\alpha_1^E\right)\alpha_2^E
\begin{bmatrix}
\theta
\begin{bmatrix}
\pi_R
\begin{bmatrix}
\rho_2^E(\widehat{r}|r)\alpha^{DM}\left(R|\widehat{0},\widehat{r}\right) \\
+\rho_2^E(\widehat{0}|r)\alpha^{DM}\left(R|\widehat{0},\widehat{0}\right)
\end{bmatrix} \\
+\left(1-\pi_R\right)
\begin{bmatrix}
\rho_2^E(\widehat{l}|l)\alpha^{DM}\left(R|\widehat{0},\widehat{l}\right) \\
+\rho_2^E(\widehat{0}|l)\alpha^{DM}\left(R|\widehat{0},\widehat{0}\right)
\end{bmatrix}
\end{bmatrix} \\
+\left(1-\theta\right)
\begin{bmatrix}
+\pi_L
\begin{bmatrix}
\rho_2^E(\widehat{l}|l)\alpha^{DM}\left(L|\widehat{0},\widehat{l}\right) \\
+\rho_2^E(\widehat{0}|l)\alpha^{DM}\left(L|\widehat{0},\widehat{0}\right)
\end{bmatrix} \\
+\left(1-\pi_L\right)
\begin{bmatrix}
\rho_2^E(\widehat{r}|r)\alpha^{DM}\left(L|\widehat{0},\widehat{r}\right) \\
+\rho_2^E(\widehat{0}|r)\alpha^{DM}\left(L|\widehat{0},\widehat{0}\right)
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

$$
+\alpha_1^E\left(1-\alpha_2^E\right)
\begin{bmatrix}
\theta
\begin{bmatrix}
\pi_R
\begin{bmatrix}
\rho_1^E(\widehat{r}|r)\alpha^{DM}\left(R|\widehat{r},\widehat{0}\right) \\
+\rho_1^E(\widehat{0}|r)\alpha^{DM}\left(R|\widehat{0},\widehat{0}\right)
\end{bmatrix} \\
+\left(1-\pi_R\right)
\begin{bmatrix}
\rho_1^E(\widehat{l}|l)\alpha^{DM}\left(R|\widehat{l},\widehat{0}\right) \\
+\rho_1^E(\widehat{0}|l)\alpha^{DM}\left(R|\widehat{0},\widehat{0}\right)
\end{bmatrix}
\end{bmatrix} \\
+\left(1-\theta\right)
\begin{bmatrix}
+\pi_L
\begin{bmatrix}
\rho_1^E(\widehat{l}|l)\alpha^{DM}\left(L|\widehat{l},\widehat{0}\right) \\
+\rho_1^E(\widehat{0}|l)\alpha^{DM}\left(L|\widehat{0},\widehat{0}\right)
\end{bmatrix} \\
+\left(1-\pi_L\right)
\begin{bmatrix}
\rho_1^E(\widehat{r}|r)\alpha^{DM}\left(L|\widehat{r},\widehat{0}\right) \\
+\rho_1^E(\widehat{0}|r)\alpha^{DM}\left(L|\widehat{0},\widehat{0}\right)
\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

$$
+\left(1-\alpha_1^E\right)\left(1-\alpha_2^E\right)\left[\theta\alpha^{DM}(R|\widehat{0},\widehat{0})+(1-\theta)\alpha^{DM}(L|\widehat{0},\widehat{0})\right]
$$

$$
-2e
$$

The decision maker reads only expert 1's report over no report when

$$EU^{DM}\left[\rho_1^{DM}=1,\rho_2^{DM}=0\right] > EU^{DM}\left[\rho_1^{DM}=0,\rho_2^{DM}=0\right]$$

The decision maker reads only expert 2's report over no report when

$$EU^{DM}\left[\rho_1^{DM}=0,\rho_2^{DM}=1\right] > EU^{DM}\left[\rho_1^{DM}=0,\rho_2^{DM}=0\right]$$

The decision maker reads both experts' reports over reading only one report when

$$\begin{aligned}
EU^{DM}\left[\rho_1^{DM}=\rho_2^{DM}=1\right] &> EU^{DM}\left[\rho_1^{DM}=0,\rho_2^{DM}=1\right] \\
EU^{DM}\left[\rho_1^{DM}=\rho_2^{DM}=1\right] &> EU^{DM}\left[\rho_1^{DM}=1,\rho_2^{DM}=0\right]
\end{aligned}$$

The best response is summarized below.

For all types, the best response for reading only one expert's report is the same as the monopoly model. The difference here is that one expert is dormant, that is, she does not acquire information and is not read.

Given that the decision maker is already reading expert 2's report, the following is his best response.

$$\begin{aligned}
\text{Read both reports when} \quad & e < \alpha_1^E\left[\theta\pi_R\left(1-\pi_R\right)-\left(1-\theta\right)\pi_L\left(1-\pi_L\right)\right] \\
\text{Read only expert 2 when} \quad & \alpha_1^E\left[\theta\pi_R\left(1-\pi_R\right)-\left(1-\theta\right)\pi_L\left(1-\pi_L\right)\right] < e < e^M \\
\text{Be indifferent when} \quad & e = \alpha_1^E\left[\theta\pi_R\left(1-\pi_R\right)-\left(1-\theta\right)\pi_L\left(1-\pi_L\right)\right]
\end{aligned}$$

When $\alpha_1^E = 1$, then the best response is

$$\begin{aligned} \text{Read both reports when} \quad & e < e^D \\ \text{Read only expert 2 when} \quad & e^D < e < e^M \\ \text{Be indifferent when} \quad & e = e^D \end{aligned}$$

where $e^D = \theta\pi_R(1-\pi_R) - (1-\theta)\pi_L(1-\pi_L)$.

Step 4: Expert's acquisition strategy under Type RR

To find the expert's best response, compare the expected utilities from acquiring information and not acquiring information. Without loss of generality, consider the acquisition strategy for only expert 1.

Given an r signal in Type RR, her expected utility is

$$
\begin{aligned}
EU_1^E &= R\left(\rho_1^{DM}\right) - c \\
&+\rho_1^{DM}\left[\Pr(R|r) + b\right] \\
&+\left(1-\rho_1^{DM}\right)\rho_2^{DM}\left[\begin{array}{c} \alpha_2^E \left[\begin{array}{c} \Pr(R|r)\pi_R(1+b) \\ +\Pr(L|r)\pi_L\rho_2^E\left(\widehat{l}|l\right) \\ +\Pr(L|r)\pi_L\left(1-\rho_2^E\left(\widehat{l}|l\right)\right)b \\ +\Pr(L|r)(1-\pi_L)b \end{array}\right] \\ +(1-\alpha_2^E)\left(\Pr(R|r)+b\right) \end{array}\right] \\
&+\left(1-\rho_1^{DM}\right)\left(1-\rho_2^{DM}\right)(1-\theta)
\end{aligned}
$$

Given an l signal in Type RR, her expected utility is

$$
\begin{aligned}
\left[EU_1^E|l\right] &= Rev(\rho_1^{DM}) - c \\
&+\rho_1^{DM}\rho_2^{DM}\left[\begin{array}{c}
\alpha_2^E\left[\begin{array}{c}
\Pr(R|l)\pi_R(1+b) \\
+\Pr(R|l)(1-\pi_R)(1-\rho_2^E(\widehat{l}|l))\,(1+b) \\
+\Pr(L|l)(1-\pi_L)b \\
+\Pr(L|l)\pi_L\rho_2^E(\widehat{l}|l) \\
+\Pr(L|l)\pi_L(1-\rho_2^E(\widehat{l}|l))b
\end{array}\right] \\
+(1-\alpha_2^E)\,(\Pr(R|l)+b)
\end{array}\right] \\
&+\rho_1^{DM}\left(1-\rho_2^{DM}\right)\Pr(L|l) \\
&+\left(1-\rho_1^{DM}\right)\rho_2^{DM}\left[\begin{array}{c}
\alpha_2^E\left[\begin{array}{c}
\Pr(R|l)\pi_R(1+b) \\
+\Pr(L|l)\pi_L\rho_2^E\left(\widehat{l}|l\right) \\
+\Pr(L|l)\pi_L\left(1-\rho_2^E\left(\widehat{l}|l\right)\right)b \\
+\Pr(L|l)(1-\pi_L)b
\end{array}\right] \\
+(1-\alpha_2^E)\,(\Pr(R|l)+b)
\end{array}\right] \\
&+\left(1-\rho_1^{DM}\right)\left(1-\rho_2^{DM}\right)(1-\theta)
\end{aligned}
$$

$$
= Rev(\rho_1^{DM}) - c
$$

$$
\begin{aligned}
&+\rho_1^{MD}[\Pr(L|l) \\
&+\rho_2^{MD}\left[\begin{array}{c}
\Pr(R|l)-\Pr(L|l) \\
+\alpha_2^E\rho_2^E(\widehat{l}|l)\left[\begin{array}{c}\Pr(L|l)\pi_L \\ -\Pr(R|l)\left(1-\pi_R\right)\end{array}\right] \\
+b\left[\begin{array}{c}
\Pr(R|l) \\
+\alpha_2^E\left[\begin{array}{c}\Pr(L|l) \\ -\rho_2^E(\widehat{l}|l)\left[\begin{array}{c}\Pr(R|l)\left(1-\pi_R\right) \\ +\Pr(L|l)\pi_L\end{array}\right]\end{array}\right]
\end{array}\right]
\end{array}\right]] \\
&+\left(1-\rho_1^{DM}\right)\rho_2^{DM}\left[\begin{array}{c}
\alpha_2^E\left[\begin{array}{c}
\Pr(R|l)\pi_R(1+b) \\
+\Pr(L|l)\pi_L\rho_2^E\left(\widehat{l}|l\right) \\
+\Pr(L|l)\pi_L\left(1-\rho_2^E\left(\widehat{l}|l\right)\right)b \\
+\Pr(L|l)(1-\pi_L)b
\end{array}\right] \\
+(1-\alpha_2^E)\left(\Pr(R|l)+b\right)
\end{array}\right] \\
&+\left(1-\rho_1^{DM}\right)\left(1-\rho_2^{DM}\right)(1-\theta)
\end{aligned}
$$

If the expert acquires information, her expected utility is

$$EU_1^E\left[\alpha_1^E=1\right]=\Pr(r)\left[EU_1^E|r\right]+\Pr(l)\left[EU_1^E|l\right]$$

If the expert does not acquire information, her expected utility is

$$
\begin{aligned}
EU_1^E\left[\alpha_1^E=0\right] &= R\left(\rho_1^{DM}\right) \\
&+\rho_1^{DM}\left[\Pr(R)+b\right] \\
&+\left(1-\rho_1^{DM}\right)\rho_2^{DM}\left[\begin{array}{c} \alpha_2^E\left[\begin{array}{c} \Pr(R)\pi_R(1+b) \\ +\Pr(L)\pi_L\rho_2^E\left(\widehat{l}|l\right) \\ +\Pr(L)\pi_L\left(1-\rho_2^E\left(\widehat{l}|l\right)\right)b \\ +\Pr(L)(1-\pi_L)b \end{array}\right] \\ +\left(1-\alpha_2^E\right)\left(\Pr(R)+b\right) \end{array}\right] \\
&+\left(1-\rho_1^{DM}\right)\left(1-\rho_2^{DM}\right)(1-\theta)
\end{aligned}
$$

It is a best response for the expert to acquire information when

$$EU_1^E\left[\alpha_1^E=1\right] > EU_1^E\left[\alpha_1^E=0\right]$$

$$
\begin{aligned}
&-c+\rho_1^{DM}\left[\Pr(R\&r)+b\Pr(r)\right] \\
&+\rho_1^{DM}[\Pr(L\&l)+\rho_2^{DM}[\Pr(R\&l)-\Pr(L\&l) \\
&+\alpha_2^E\rho_2^E(\widehat{l}|l)\left[\begin{array}{c} \Pr(L\&l)\pi_L \\ -\Pr(R\&l)\left(1-\pi_R\right) \end{array}\right] \\
&+b\left[\Pr(R\&l)+\alpha_2^E\left[\begin{array}{c} \Pr(L\&l) \\ -\rho_2^E(\widehat{l}|l)\left[\Pr(R\&l)\left(1-\pi_R\right)+\Pr(L\&l)\pi_L\right] \end{array}\right]\right]]]
\end{aligned}
$$

$$> \rho_1^{DM}\left[\Pr(R)+b\right]$$

$$\rho_1^{DM}\begin{bmatrix} (1-\theta)\pi_L-\theta(1-\pi_R)-b\left(\theta\left(1-\pi_R\right)+\left(1-\theta\right)\pi_L\right) \\ +\rho_2^{DM}\begin{bmatrix} \theta\left(1-\pi_R\right)-\left(1-\theta\right)\pi_L+\theta\left(1-\pi_R\right)b \\ +\alpha_2^E\begin{bmatrix} \left(1-\theta\right)\pi_L b \\ -\rho_2^E(\widehat{l}|l)\begin{bmatrix} \theta\left(1-\pi_R\right)^2-\left(1-\theta\right)\pi_L^2 \\ +b\left(\left(1-\theta\right)\pi_L^2+\theta\left(1-\pi_R\right)^2\right) \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

$$> \quad c$$

In Type RR, assuming that expert 2 is acquiring and reporting informatively, the best response for expert 1 is

$$\begin{aligned} \text{Acquire if } \rho_1^{DM}c^{DR} &> c \\ \text{Do Not Acquire if } \rho_1^{DM}c^{DR} &< c \\ \text{Be indifferent if } \rho_1^{DM}c^{DR} &= c \end{aligned}$$

where

$$c^{DR}=\begin{bmatrix} \left(1-\theta\right)\pi_L^2-\theta\left(1-\pi_R\right)^2 \\ -b\left(\theta\left(1-\pi_R\right)^2+\left(1-\theta\right)\pi_L^2\right) \end{bmatrix}$$

In Type R, assuming that expert 2 is not acquiring information, the best response for expert 1 is

$$\begin{aligned} \text{Acquire if } \rho_1^{DM} c^{MR} &> c \\ \text{Do Not Acquire if } \rho_1^{DM} c^{MR} &< c \\ \text{Be indifferent if } \rho_1^{DM} c^{MR} &= c \end{aligned}$$

where

$$c^{MR} = \begin{bmatrix} (1-\theta)\pi_L - \theta(1-\pi_R) \\ -b\left((1-\theta)\pi_L + \theta\left(1-\pi_R\right)\right) \end{bmatrix}$$

Step 5: Expert's acquisition strategy under Type LL

To find the expert's best response, compare the expected utilities from acquiring information and not acquiring information. Without loss of generality, consider the acquisition strategy for only expert 1.

Given an r signal in Type LL, her expected utility is

$$
\begin{aligned}
\left[EU_1^E|r\right] &= R\left(\rho_1^{DM}\right)-c \\
&+\rho_1^{DM}\left[\Pr(R|r)+b\right] \\
&+\left(1-\rho_1^{DM}\right)\rho_2^{DM}\left[\begin{array}{c} \alpha_2^E\left[\begin{array}{c} \Pr(R|r)\pi_R(1+b) \\ +\Pr(L|r)\pi_L+\Pr(L|r)(1-\pi_L)b \end{array}\right] \\ (1-\alpha_2^E)\Pr(L|r) \end{array}\right] \\
&+\left(1-\rho_1^{DM}\right)\left(1-\rho_2^{DM}\right)(1-\theta)
\end{aligned}
$$

Given an l signal in Type LL, her expected utility is

$$
\begin{aligned}
\left[EU_1^E|l\right] &= Rev(\rho_1^{DM})-c \\
&+\rho_1^{DM}\rho_2^{DM}\left[\begin{array}{c} \alpha_2^E\left[\begin{array}{c} \Pr(R|l)\pi_R\rho_2^E(\widehat{r}|r)(1+b) \\ +\Pr(L|l)(1-\pi_L)\left(1-\rho_2^E(\widehat{r}|r)\right) \\ +\Pr(L|l)\pi_L\rho_2^E(\widehat{l}|l) \\ +\Pr(L|l)\pi_L(1-\rho_2^E(\widehat{l}|l)) \\ +\Pr(L|l)(1-\pi_L)\rho_2^E(\widehat{r}|r)b \end{array}\right] \\ +(1-\alpha_2^E)\Pr(L|l) \end{array}\right] \\
&+\rho_1^{DM}\left(1-\rho_2^{DM}\right)\Pr(L|l) \\
&+\left(1-\rho_1^{DM}\right)\rho_2^{DM}\left[\begin{array}{c} \alpha_2^E\left[\begin{array}{c} \Pr(R|l)\pi_R(1+b) \\ +\Pr(L|l)\pi_L+\Pr(L|l)(1-\pi_L)b \end{array}\right] \\ (1-\alpha_2^E)\Pr(L|l) \end{array}\right] \\
&+\left(1-\rho_1^{DM}\right)\left(1-\rho_2^{DM}\right)(1-\theta)
\end{aligned}
$$

$$
\begin{aligned}
&= Rev(\rho_1^{DM}) - c \\
&\quad +\rho_1^{DM} \left[\Pr(L|l) + \rho_2^{DM} \rho_2^E(\widehat{r}|r)\alpha_2^E \left[\begin{array}{c} \Pr(R|l)\pi_R - \Pr(L|l)\,(1-\pi_L) \\ +b\,(\Pr(L|l)\,(1-\pi_L) + \Pr(R|l)\pi_R) \end{array} \right] \right] \\
&\quad + \left(1-\rho_1^{DM}\right)\rho_2^{DM} \left[\begin{array}{c} \alpha_2^E \left[\begin{array}{c} \Pr(R|l)\pi_R(1+b) \\ +\Pr(L|l)\pi_L + \Pr(L|l)(1-\pi_L)b \end{array} \right] \\ (1-\alpha_2^E)\Pr(L|l) \end{array} \right] \\
&\quad + \left(1-\rho_1^{DM}\right)\left(1-\rho_2^{DM}\right)(1-\theta)
\end{aligned}
$$

The expected utility from acquiring is

$$
\begin{aligned}
EU_1^E \left[\alpha_1^E = 1\right] &= \Pr(r)\left[EU_1^E|r\right] + \Pr(l)\left[EU_1^E|l\right] \\
&= \rho_1^{DM}\left[\Pr(R\&r) + b\Pr(r)\right]
\end{aligned}
$$

The expected utility from not acquiring is

$$
\begin{aligned}
EU_1^E\left[\alpha_1^E=0\right] &= Rev(\rho_1^{DM}) \\
&+\rho_1^{DM}\rho_2^{DM}\left[\begin{array}{c}
\alpha_2^E\left[\begin{array}{c}
\Pr(R)\pi_R\rho_2^E(\widehat{r}|r)(1+b) \\
+\Pr(L)(1-\pi_L)\left(1-\rho_2^E(\widehat{r}|r)\right) \\
+\Pr(L)\pi_L\rho_2^E(\widehat{l}|l) \\
+\Pr(L)\pi_L(1-\rho_2^E(\widehat{l}|l)) \\
+\Pr(L)(1-\pi_L)\rho_2^E(\widehat{r}|r)b
\end{array}\right] \\
+(1-\alpha_2^E)\Pr(L)
\end{array}\right] \\
&+\rho_1^{DM}\left(1-\rho_2^{DM}\right)\Pr(L) \\
&+\left(1-\rho_1^{DM}\right)\rho_2^{DM}\left[\begin{array}{c}
\alpha_2^E\left[\begin{array}{c}
\Pr(R)\pi_R(1+b) \\
+\Pr(L)\pi_L+\Pr(L)(1-\pi_L)b
\end{array}\right] \\
(1-\alpha_2^E)\Pr(L)
\end{array}\right] \\
&+\left(1-\rho_1^{DM}\right)\left(1-\rho_2^{DM}\right)(1-\theta)
\end{aligned}
$$

$$
\begin{aligned}
&= Rev(\rho_1^{DM}) \\
&\quad+\rho_1^{DM}\left[\Pr(L)+\rho_2^{DM}\alpha_2^E\rho_2^E(\widehat{r}|r)\left[\begin{array}{c}
\Pr(R)\pi_R-\Pr(L)\left(1-\pi_L\right) \\
+b\left[\Pr(L)\left(1-\pi_L\right)+\Pr(R)\pi_R\right]
\end{array}\right]\right] \\
&\quad+\left(1-\rho_1^{DM}\right)\rho_2^{DM}\left[\begin{array}{c}
\alpha_2^E\left[\Pr(R)\pi_R(1+b)+\Pr(L)\pi_L+\Pr(L)(1-\pi_L)b\right] \\
(1-\alpha_2^E)\Pr(L)
\end{array}\right] \\
&\quad+\left(1-\rho_1^{DM}\right)\left(1-\rho_2^{DM}\right)(1-\theta)
\end{aligned}
$$

It is a best response for the expert to acquire information when

$$EU_1^E\left[\alpha_1^E=1\right] > EU_1^E\left[\alpha_1^E=0\right]$$

$$\left[\begin{array}{c} -c+\rho_1^{DM}\left[\Pr(R\&r)+b\Pr(r)\right] \\ +\rho_1^{DM}\left[\begin{array}{c} \Pr(L\&l) \\ +\rho_2^{DM}\rho_2^E(\widehat{r}|r)\alpha_2^E\left[\begin{array}{c} \Pr(R\&l)\pi_R-\Pr(L\&l)\left(1-\pi_L\right) \\ +b\left(\Pr(L\&l)\left(1-\pi_L\right)+\Pr(R\&l)\pi_R\right) \end{array}\right] \end{array}\right] \end{array}\right]$$

$$> \quad \rho_1^{DM}\left[\begin{array}{c} \Pr(L) \\ +\rho_2^{DM}\alpha_2^E\rho_2^E(\widehat{r}|r)\left[\begin{array}{c} \Pr(R)\pi_R-\Pr(L)\left(1-\pi_L\right) \\ +b\left[\Pr(L)\left(1-\pi_L\right)+\Pr(R)\pi_R\right] \end{array}\right] \end{array}\right]$$

$$\rho_1^{DM}\left[\begin{array}{c} \Pr(R\&r)+b\Pr(r)+\Pr(L\&l) \\ +\rho_2^{DM}\rho_2^E(\widehat{r}|r)\alpha_2^E\left[\begin{array}{c} \Pr(R\&l)\pi_R-\Pr(L\&l)\left(1-\pi_L\right) \\ +b\left(\Pr(L\&l)\left(1-\pi_L\right)+\Pr(R\&l)\pi_R\right) \end{array}\right] \\ -\left[\Pr(L)+\rho_2^{DM}\alpha_2^E\rho_2^E(\widehat{r}|r)\left[\begin{array}{c} \Pr(R)\pi_R-\Pr(L)\left(1-\pi_L\right) \\ +b\left[\Pr(L)\left(1-\pi_L\right)+\Pr(R)\pi_R\right] \end{array}\right]\right] \end{array}\right] > c$$

$$\rho_1^{DM}\left[\begin{array}{c} \theta\pi_R-(1-\theta)\left(1-\pi_L\right)+b\left(\theta\pi_R+(1-\theta)\left(1-\pi_L\right)\right) \\ -\rho_2^{DM}\alpha_2^E\rho_2^E(\widehat{r}|r)\left(\begin{array}{c} \theta\pi_R^2-(1-\theta)\left(1-\pi_L\right)^2 \\ +b\left((1-\theta)\left(1-\pi_L\right)^2+\theta\pi_R^2\right) \end{array}\right) \end{array}\right] > c$$

In Type LL, assuming that expert 2 is acquiring and reporting informatively, the best response for expert 1 is

$$\begin{aligned} \text{Acquire if } \rho_1^{DM} c^{DL} &> c \\ \text{Do Not Acquire if } \rho_1^{DM} c^{DL} &< c \\ \text{Be indifferent if } \rho_1^{DM} c^{DL} &= c \end{aligned}$$

$$c^{DL} = \left[\begin{array}{c} \theta\pi_R (1-\pi_R) - (1-\theta)\,\pi_L (1-\pi_L) \\ +b\left[\theta\pi_R (1-\pi_R) + (1-\theta)\,\pi_L (1-\pi_L)\right] \end{array} \right]$$

In Type LL, assuming that expert 2 is not acquiring, the best response for expert 1 is

$$\begin{aligned} \text{Acquire if } \rho_1^{DM} c^{ML} &> c \\ \text{Do Not Acquire if } \rho_1^{DM} c^{ML} &< c \\ \text{Be indifferent if } \rho_1^{DM} c^{ML} &= c \end{aligned}$$

$$c^{ML} = \left[\begin{array}{c} \left[\theta\pi_R - (1-\theta)(1-\pi_L)\right] \\ +b\left[\theta\pi_R + (1-\theta)(1-\pi_L)\right] \end{array} \right]$$

Proof of Proposition 10:

The Type RL and Type LR informative equilibria with two reports is very similar to the Type RR and Type LL ones. The difference arises with the bias level and the cost threshold. Step 1 examines the bias threshold. Steps 2 and 3 examine the cost threshold.

Step 1: For either Type RL or Type LR to exist, it is necessary that their bias levels are incentive compatible with their Types. For Type RL to exist, Expert 1 cannot be too right-biased ($b < b^{DR}$) and Expert 2 cannot be too left-biased ($b > b^{DL}$). Conversely, for Type LR to exist, Expert 1 cannot be too left-biased ($b > b^{DL}$) and Expert 2 cannot be too right-biased ($b < b^{DR}$). Since the experts are identical, they cannot be too right- nor too left-biased ($b^{DL} < b < b^{DR}$).

Step 2: For the Type RL informative equilibrium with two reports, assuming that Expert 2 is acquiring and reporting informatively, the best response for Expert 1 is

$$\begin{aligned}
\text{Acquire if } c^{DR} &> c \\
\text{Do Not Acquire if } c^{DR} &< c \\
\text{Be indifferent if } c^{DR} &= c
\end{aligned}$$

where

$$c^{DR} = \left[\begin{array}{c} (1-\theta)\,\pi_L^2 - \theta\,(1-\pi_R)^2 \\ \\ -b\left(\theta\,(1-\pi_R)^2 + (1-\theta)\,\pi_L^2\right) \end{array} \right]$$

Assuming that Expert 1 is acquiring and reporting informatively, the best response for Expert 2 is

$$\begin{aligned} \text{Acquire if } c^{DL} &> c \\ \text{Do Not Acquire if } c^{DL} &< c \\ \text{Be indifferent if } c^{DL} &= c \end{aligned}$$

$$c^{DL} = \left[\begin{array}{c} \theta\pi_R\,(1-\pi_R) - (1-\theta)\,\pi_L\,(1-\pi_L) \\ \\ +b\,[\theta\pi_R\,(1-\pi_R) + (1-\theta)\,\pi_L\,(1-\pi_L)] \end{array} \right]$$

Therefore, a Type RL informative equilibrium with two reports exists when the $c \leq \min\{c^{DR}, c^{DL}\}$. It is the minimum value that is relevant because in between c^{DR} and c^{DL}, one expert will not be willing to acquire information.

Step 3: For the Type LR informative equilibrium with two reports, the conditions are just the opposite of Step 2. A Type LR informative with two reports equilibrium exists when the $c \leq \min\{c^{DR}, c^{DL}\}$.

Proof of Proposition 11:

By definition of informative equilibria with two reports, both experts acquire information and the decision maker reads both report. If the expert acquires information, then the expert will report informatively (as shown in Step 4 of the Proof to Proposition 4, 5, and 7). The Type of equilibria is relevant only in determining what reporting strategy the experts adopt and what beliefs the decision maker holds about $\widehat{0}$, but the Type does not affect the equilibria expected utilities.

$$\begin{aligned} EU^{DM} &= \left[\theta\left[\pi_R^2 + 2\pi_R(1-\pi_R)\right] + (1-\theta)\,\pi_L^2\right] - 2e \\ EU^{E} &= Rev(1) - c \\ &\quad + \left[\theta\left(\pi_R^2 + 2\pi_R(1-\pi_R)\right) + (1-\theta)\,\pi_L^2\right] \\ &\quad + b\left[\theta\left(\pi_R^2 + 2\pi_R(1-\pi_R)\right) + (1-\theta)\left(1-\pi_L^2\right)\right] \end{aligned}$$

Equilibria in mixed acquisition and mixed reporting strategies

In the first four equilibria, the decision maker is indifferent between reading no reports and reading one report.

In the last four equilibria, the decision maker is indifferent between reading one report and reading two reports.

1. There exists a Type R equilibrium in which expert 1 adopts a mixed ac-

quisition strategy ($\alpha_1^E = \frac{e+(1-2\theta)}{e^M}$) and the decision maker adopts a mixed reading strategy ($\rho_1^{DM} = \frac{c}{c^{MR}}$) if the effort cost is sufficiently low ($e \leq e^M$), expert 1 is not too right-biased ($b_1 < b^{MR}$), and the cost is sufficiently low ($c \leq c^{MR}$). Expert 2 does not acquire information ($\alpha_2^E = 0$) and is not read by the decision maker ($\rho_2^{DM} = 0$).

2. There exists a Type R equilibrium in which expert 2 adopts a mixed acquisition strategy ($\alpha_2^E = \frac{e+(1-2\theta)}{e^M}$) and the decision maker adopts a mixed reading strategy ($\rho_2^{DM} = \frac{c}{c^{MR}}$) if the effort cost is sufficiently low ($e \leq e^M$), expert 2 is not too right-biased ($b_2 < b^{MR}$), and the cost is sufficiently low ($c \leq c^{MR}$). Expert 1 does not acquire information ($\alpha_1^E = 0$) and is not read by the decision maker ($\rho_1^{DM} = 0$).

3. There exists a Type L equilibrium in which expert 1 adopts a mixed acquisition strategy ($\alpha_1^E = \frac{e}{e^M}$) and the decision maker adopts a mixed reading strategy ($\rho_1^{DM} = \frac{c}{c^{ML}}$) if the effort cost is sufficiently low ($e \leq e^M$), expert 1 is not too left-biased ($b_1 > b^{ML}$), the cost is sufficiently low ($c \leq c^{ML}$). Expert 2 does not acquire information ($\alpha_2^E = 0$) and is not read by the decision maker ($\rho_2^{DM} = 0$).

4. There exists a Type L equilibrium in which expert 2 adopts a mixed acquisition strategy ($\alpha_2^E = \frac{e}{[\theta\pi_R-(1-\theta)(1-\pi_L)]}$) and the decision maker adopts a mixed reading strategy ($\rho_2^{DM} = \frac{c}{c^{ML}}$) if the effort cost is sufficiently low

($e \leq e^M$), expert 2 is not too left-biased ($b_2 > b^{ML}$), the cost is sufficiently low ($c \leq c^{ML}$). Expert 1 does not acquire information ($\alpha_1^E = 0$) and is not read by the decision maker ($\rho_1^{DM} = 0$).

5. There exists Type RR and Type RL equilibria in which expert 1 adopts a mixed acquisition strategy ($\alpha_1^E = \frac{e}{e^D}$) and the decision maker adopts a mixed reading strategy ($\rho_1^{DM} = \frac{c}{c^{DR}}$) if the effort cost is sufficiently low ($e \leq e^D$), expert 1 is not too right-biased ($b_1 < b^{DR}$), the cost is sufficiently low ($c \leq c^{DL}$). Expert 2 does acquire information ($\alpha_2^E = 1$) and is read by the decision maker ($\rho_2^{DM} = 1$).

6. There exists Type RR and Type LR equilibria in which expert 2 adopts a mixed acquisition strategy ($\alpha_2^E = \frac{e}{e^D}$) and the decision maker adopts a mixed reading strategy ($\rho_2^{DM} = \frac{c}{c^{DR}}$) if the effort cost is sufficiently low ($e \leq e^D$), expert 2 is not right-biased ($b_2 < b^{DR}$), the cost is sufficiently low ($c \leq c^{DL}$). Expert 1 does acquire information ($\alpha_1^E = 1$) and is read by the decision maker ($\rho_1^{DM} = 1$).

7. There exists Type LL and Type LR equilibria in which expert 1 adopts a mixed acquisition strategy ($\alpha_1^E = \frac{e}{e^D}$) and the decision maker adopts a mixed reading strategy ($\rho_1^{DM} = \frac{c}{c^{DL}}$) if the effort cost is sufficiently low ($e \leq e^D$), expert 1 is not too left-biased ($b_1 > b^{DL}$), the cost is sufficiently low ($c \leq c^{DL}$). Expert 2 does acquire information ($\alpha_2^E = 1$) and is read by

the decision maker ($\rho_2^{DM} = 1$).

8. There exists Type LL and Type RL equilibria in which expert 2 adopts a mixed acquisition strategy ($\alpha_2^E = \frac{e}{e^D}$) and the decision maker adopts a mixed reading strategy ($\rho_2^{DM} = \frac{c}{c^{DL}}$) if the effort cost is sufficiently low ($e \leq e^D$), expert 2 is not too left-biased ($b_2 > b^{DL}$), the cost is sufficiently low ($c \leq c^{DL}$). Expert 1 does acquire information ($\alpha_1^E = 1$) and is read by the decision maker ($\rho_1^{DM} = 1$).

Proof of Lemma 2:

The cost threshold c^M can take on two values: c^{MR} and c^{ML}. Consider both cases.

Case 1: If $c^M = c^{MR}$ and $e \leq e^M$, there exist two possible Type R equilibria with one informative report. In one Type R equilibrium, expert 1 acquires information and is read by the decision maker, while expert 2 is dormant. In the second Type R equilibrium, expert 2 acquires information and is read by the decision maker, while expert 1 is dormant.

Case 2: If $c^M = c^{ML}$ and $e \leq e^M$, there exist two possible Type L equilibria with one informative report. In one Type L equilibrium, expert 1 acquires information and is read by the decision maker, while expert 2 is dormant. In the second Type L equilibrium, expert 2 acquires information and is read by the decision maker, while expert 1 is dormant.

Proof of Lemma 3:

The cost threshold c^D can take on two values: c^{DR} and c^{DL}. Consider both cases.

Case 1: If $c^D = c^{DR}$ and $e \leq e^D$, then the equilibrium in which both experts adopt the reporting strategy of Type RR exists by Proposition 8.

Case 2: If $c^D = c^{DL}$ and $e \leq e^D$, then the equilibrium in which both experts adopt the reporting strategy of Type LL exists by Proposition 9.

Proof of Theorem 2:

Step 1: By Proposition 3, for all the parameter values, $z_0 \in Z^{(i)}$ and $z_0 \in Z^{(i,i)}$.

Step 2: Given a set of parameters, c^M of the game with one expert equals c^M of the game with two experts, and e^M of the game with one expert equals e^M of the game with two experts by Lemma **??**. Therefore, for $c < c^M$ and $e < e^M$, $z_1 \in Z^{(i)}$ and $z_1 \in Z^{(i,i)}$.

Step 3: For some parameter values (that is, $c \leq c^D$ and $e < e^D$), there exists an equilibrium expected utility for the decision maker in the duopoly game that is strictly greater than the highest equilibrium expected utility for the decision maker in the monopoly game. If $c \leq c^D$ and $e < e^D$, then $z_2 \notin Z^{(i)}$ and $z_2 \in Z^{(i,i)}$. The highest possible equilibrium expected utility for the decision maker in the monopoly game is z_1 and $z_2 > z_1$ when $e < e^D$.

Proof of Proposition 12, 13, 14, and 15:

The informative equilibria of the duopoly model with asymmetrically biased experts is very similar to that of the duopoly model with identical experts. The difference is the bias levels and the cost thresholds.

All of the bias levels for both experts must be incentive compatible with the Types. Otherwise, the expert would have an incentive to deviate and that equilibrium would no longer exist, as shown in Step 2 of the Proof of Propositions 4, 5, and 7.

1. For the Type RR informative equilibrium with two reports to exist, both experts cannot be too right-biased ($b_i < b^{DR}$ and $b_j < b^{DR}$).

2. For the Type LL informative equilibrium with two reports to exist, both experts cannot be too left-biased ($b_i > b^{DL}$ and $b_j > b^{DL}$).

3. For the Type RL informative equilibrium with two reports to exist, the first expert cannot be too right-biased and the second expert cannot be too left-biased ($b_i < b^{DR}$ and $b_j > b^{DL}$).

4. For the Type LR informative equilibrium with two reports to exist, the first expert cannot be too left-biased and the second expert cannot be too

left-biased ($b_i > b^{DL}$ and $b_j < b^{DR}$).

For each Type, the informative equilibrium with two reports exists when the cost of information is less than the smaller of the two thresholds.

1. Type RR. Given that expert j is acquiring and reporting informatively, expert i will acquire information when $c \leq c_i^{DR}$. Similarly, given that expert i is acquiring and reporting information, expert j will acquire information when $c \leq c_j^{DR}$. It was established that $c_j^{DR} > c_i^{DR}$. When $c \in (c_i^{DR}, c_j^{DR}]$, expert i no longer acquires information even though expert j would acquire. The equilibrium with two informative reports only exists when the cost of information is less than the smaller of the two thresholds ($c \leq c_i^{DR}$).

2. Type LL. Given that expert j is acquiring and reporting informatively, expert i will acquire information when $c \leq c_i^{DL}$. Similarly, given that expert i is acquiring and reporting information, expert j will acquire information when $c \leq c_j^{DL}$. It was established that $c_i^{DL} > c_j^{DL}$. When $c \in (c_j^{DL}, c_i^{DL}]$, expert j no longer acquires information even though expert i would acquire. The equilibrium with two informative reports only exists when the cost of information is less than the smaller of the two thresholds ($c \leq c_j^{DL}$).

3. Type RL. Given that expert j is acquiring and reporting informatively, expert i will acquire information when $c \leq c_i^{DR}$. Similarly, given that expert

i is acquiring and reporting information, expert j will acquire information when $c \leq c_j^{DL}$. However, in this case, either cost threshold could be the smaller one depending on the parameters. Therefore, the equilibrium with two informative reports only exists when the cost of information is less than the minimum of the two thresholds ($c \leq \min\{c_i^{DR}, c_j^{DL}\}$).

4. Type LR. Given that expert j is acquiring and reporting informatively, expert i will acquire information when $c \leq c_i^{DL}$. Similarly, given that expert i is acquiring and reporting information, expert j will acquire information when $c \leq c_j^{DR}$. However, in this case, either cost threshold could be the smaller one depending on the parameters. Therefore, the equilibrium with two informative reports only exists when the cost of information is less than the minimum of the two thresholds ($c \leq \min\{c_i^{DL}, c_j^{DR}\}$).

Proof of Lemma 4:

The cost threshold c^{M_A} can be either c_j^{MR} or c_i^{ML}, depending on the parameters. Consider both cases.

Case 1: Suppose $c^{M_A} = c_j^{MR}$. When $e \leq e^M$ and $c \leq c_j^{MR}$, the following Type R informative equilibrium with one report exists. Expert j acquires information, and the decision maker reads Expert j's report. Expert i is dormant, that is, she does not acquire information and her report is not read by the decision maker.

Case 2: Suppose $c^{M_A} = c_i^{ML}$. When $e \leq e^M$ and $c \leq c_i^{ML}$, the following Type L informative equilibrium with one report exists. Expert i acquires information, and the decision maker reads Expert i's report. Expert j is dormant, that is, she does not acquire information and her report is not read by the decision maker.

Proof of Lemma 5:

The cost threshold c^{D_A} can be either c_i^{DR} or c_j^{DL}, depending on the parameters. Consider both cases.

Case 1: Suppose $c^{D_A} = c_i^{DR}$. This is the Type RR equilibrium. Given that expert j is acquiring information and reporting informatively, expert i acquires information when $c \leq c_i^{DR}$. Given that expert i is acquiring information and reporting informatively, expert j also acquires information when $c \leq c_j^{DR}$. If $b_j < b_i$, then $c_i^{DR} < c_j^{DR}$. Thus if $c \leq c^{D_A}$ and $c^{D_A} = c_i^{DR}$, then certainly $c \leq c_j^{DR}$.

Case 2: Suppose $c^{D_A} = c_j^{DL}$. This is the Type LL equilibrium. Given that expert j is acquiring information and reporting informatively, expert i acquires information when $c \leq c_i^{DL}$. Given that expert i is acquiring information and reporting informatively, expert j also acquires information when $c \leq c_j^{DL}$. If $b_j < b_i$, then $c_j^{DL} < c_i^{DL}$. Thus if $c \leq c^{D_A}$ and $c^{D_A} = c_j^{DL}$, then certainly $c \leq c_i^{DR}$.

References

[1] American Society of Newspaper Editors. 1999. "Examining our Credibility: Perspectives of the Public and the Press." http://www.asne.org. (accessed August 5, 2007).

[2] Arce, Rose and Shannon Troetel. 2004. "Top New York Times editors quit." *CNN*. March 1. http://www2.cnn.com/2003/US/Northeast/06/05/nytimes.resigns.

[3] Austen-Smith, David. 1993. "Information and Influence: Lobbying for Agendas and Votes." *American Journal of Political Science*. 37(3): 799-833.

[4] —–. 1994. "Strategic Transmission of Costly Information." *Econometrica*. 62(4): 995-963.

[5] Battaglini, Marco. 2002. "Multiple Referrals and Multidimensional Cheap Talk." *Econometrica.* 70(4): 1379-1401.

[6] Baron, David P. 2006. "Persistent Media Bias." *Journal of Public Economics*. 90(1-2): 1-36.

[7] *BBC*. 2006. "Reuters Drops Beirut Photographer." August 8. http://news.bbc.co.uk/2/hi/middle_east/5254838.stm.

[8] Cabrales, Antonio and Piero Gottardi. 2007. "Markets for Information: Of Inefficient Firewalls and Efficient Monopolies." Working Paper.

[9] Chakraborty, Archishman and Rick Harbaugh. 2007. "Clearly Biased Experts." http://ssrn.com/abstract=889190.

[10] Crawford, Vincent P. and Joel Sobel. 1982. "Strategic Information Transmission." *Econometrica*. 50(6): 1431-1451.

[11] Dewatripont, Mathias and Jean Tirole. 1999. "Advocates." *Journal of Political Economy*. 107(1): 1-39.

[12] Dziuda, Wioletta. 2007. "Strategic Argumentation." Ph. D. Dissertation. Princeton University.

[13] Ellison, Sarah. 2007. "Murdoch's Choice: Paid or Free for WSJ.com?" *Wall Street Journal*. September 19.

[14] Gentzkow, Matthew and Jesse Shapiro. 2006. "Media Bias and Reputation." *The Journal of Political Economy*. 114(2): 280-316.

[15] Glazer, Jacob and Ariel Rubinstein. 2001. "Debates and Decisions: On a Rationale of Argumentation Rules." Games and Economic Behavior. 36(2): 158-173.

[16] ——. 2004. "On Optimal Rules of Persuasion." *Econometrica.* 72(6): 1715–1736.

[17] Krishna, Vijay and John Morgan. 2001. "A Model of Expertise." The Quarterly Journal of Economics. 116(2): 747-775.

[18] Kreps, David M. and Robert Wilson. 1982. "Sequential Equilibrium." *Econometrica*. 50(4): 863-894.

[19] Milgrom, Paul. 1981. "Good News and Bad News: Representation Theorems and Applications." *Bell Journal of Economics*. 12(2): 380-391.

[20] Milgrom, Paul and John Roberts. 1986. "Relying on the Information of Interested Parties." *The RAND Journal of Economics*. 17(1): 18-32.

[21] Mullainathan, Sendhil and Andrei Shleifer. 2006. "The Market for News." *American Economic Review*. 95(4):1031-1053.

[22] Perez-Pena, Richard. 2007. "Times to End Charges on Web Site." *The New York Times*. September 18.

[23] Shin, Hyun Song. "The Burden of Proof in a Game of Persuasion." *Journal of Economic Theory*. 64(1): 253-264.

[24] Stromberg, David. 2004. "Mass Media Competition, Political Competition, and Public Policy." *Review of Economic Studies*. 71(1): 265-284.

CHAPTER 3

Competition and Truthful Reporting

3.1 Introduction

In this paper, I investigate whether increasing the number of media firms increases truthful reporting. Answering this question has policy implications for the Federal Communications Commission (FCC) regulation on media ownership.

> "...we [the FCC] continue to have a public interest responsibility, distinct from our diversity and localism goals, to ensure that broadcasting markets remain competitive so that all the benefits of competition – including more innovation and improved service – are made available to the public." – FCC 2003

The FCC asserts that the media industry is sufficiently different from other industries to require special regulation. Of particular concern is the ability of media firms to slant their news reports or even lie in order to influence public opinion. It is often believed that promoting competition in media markets allows the public to uncover the truth.

The arguments supporting the notion, competition allows the public to uncover the truth, are based on two broad concepts. The first concept claims that each firm reports a part of the truth (or even a falsehood) and the consumers must collect all of the parts to form the whole truth (or at least more of the truth). The second concept claims the mere presence of multiple firms increases the incentives for each firm to be more truthful. It is important to distinguish these two concepts especially when one is investigating the effect of competition in the media market.

Although the two concepts are largely intertwined, most of the discourse on this topic has focused on the first concept more than the second. Proponents supporting this line of thought require decision makers to consult with sufficiently opposed parties and piece together the truth by themselves[1].

The second concept and the focus of this paper is that the mere presence of multiple experts increases truthfully reporting for each expert. Milgrom and Roberts (1986) follows this line of thought by concluding that all relevant information will be revealed with the presence of more experts if at least one expert prefers the information to be revealed. Even more in line with this second con-

[1] Austen-Smith (1993) examines this in the context of congressional hearings. Krishna and Morgan (2001) conclude that full revelation of information may be induced by an extended debate between two opposing parties with rebuttal. Glazer and Rubinstein (2001) investigate the optimal design of debate rules. Dewatripont and Tirole (1999) argue the benefits of having two opposing advocates rather than one unbiased party investigate.

cept is the model of competition in Gentzkow and Shapiro (2006). They present a sequential model in which a lead firm reports first and competing firms report second. Here, the competing secondary firms serve as a feedback mechanism which allows consumers to determine whether or not the lead firm reported truthfully. In their model, as the number of competing secondary firms increase, the probability of learning the lead firm's truthfulness also increases. Therefore, they conclude that increasing the number of firms increases the truth-telling incentives of the lead firm. However, their conclusion is not particularly surprising given the fact that the experts in their model are completely unbiased.

I explore whether competition increases truthful reporting for biased experts by modeling the media market as a repeated communication game (also known as a sender-receiver game) between multiple experts (who represent the media firms) and a single decision maker (who represents a mass of identical consumers). The firms are perfectly informed, and the uninformed consumers must rely on the firms' published reports to make a decision, such as a vote[2].

The consumers are unbiased in the sense that they only care about selecting the best policy or candidate. However, the media firms have political motives, that is, a preference for consumers to vote in favor of a particular political party. Although media outlets in the United States claim to be unbiased, many are often

[2]By modeling the decision maker as one player, I am assuming that the mass of consumers all agree on what is considered the better alternative.

accused of having a political bias. Newspapers in the United Kingdom, however, are much more candid and affiliate themselves openly with political parties.

In my model, firms seek a reputation for being honest. There are two potential types of firms (honest and strategic) and the type is unknown to the consumers. An honest firm is not a strategic player; she always reports the truth. A strategic firm is biased and can report the truth or lie.

The effect of reputation as an incentive for truthful reporting has been previously studied. Sobel (1985) explored the truthtelling incentives of an informed monopolist with reputational concerns. Further work by Sette (2006) analyzed duopolists with reputational concerns and concluded that the presence of a second expert had ambiguous effects on the incentives to report truthfully. Contributing to this literature, I ask whether increasing the number of experts increases the truth-telling incentives for a biased expert.

Given the availability of multiple news sources, I assume that consumers select one firm's report to read in each period. With increased competition, an individual firm has a very small chance of being selected; that is, her power to influence public opinion is very small. Thus, it is not obvious that competition among firms with reputational concerns leads to truthful reporting, because both the cost and benefit of truthful reporting depends on the probability of being selected.

The main result of this paper is that increasing the number of firms increases truthful reporting. Within a certain parameter range, there exists a mixed strategy equilibrium in which all strategic firms randomize between reporting truthfully and lying. In the complementary parameter range, all strategic firms lie. Increased competition has two effects. (i) In the mixed strategy equilibrium, the probability that a strategic firm reports truthfully increases as the number of firms increase. (ii) The parameter range for the existence of a mixed strategy equilibrium increases as the number of firms increase. In particular, the amount of patience necessary for existence decreases.

In order to intuitively understand the incentive for truthful reporting, consider a strategic firm's reporting decision given that all other strategic firms lie. With many firms, the probability of being selected today is small. Thus, this firm may report truthfully today in hopes of free riding off of a competitor's lie and still maintaining their reputation. Tomorrow, with all of the other strategic firms revealed to be liars, this firm will have a higher probability of being selected, thus, making it more worthwhile to lie at the later date.

Although competition does indeed increase the probability of truthful reporting, it is never equilibrium behavior for all strategic firms to report truthfully. As the number of firms tends to infinity, the probability of truthful reporting converges to a value less than one. In other words, consumers never learn the entire truth even with increased competition.

3.2 The Model

Multiple experts ($i = 1, 2, ...n$) play a repeated communication game with a decision maker (DM). The stage game proceeds as follows. At the beginning of each period, nature selects one of two possible states of the world, $\Omega \in \{R, L\}$. The two states are equally likely to occur; states do not persist over time. Next, each expert receives a perfect, private signal $\omega \in \{r, l\}$ about the true state. In other words, all experts are perfectly informed, while the decision maker remains uninformed. After observing her private signal, each expert publishes a report $\widehat{\omega} \in \{\widehat{r}, \widehat{l}\}$. The reports are made simultaneously in each period.[3] The decision maker selects one expert's report to read. After reading a report, the decision maker takes an action. Then payoffs are realized and the decision maker learns the true state of that period.

The model presented in this paper analyzes a repeated game that lasts for two periods, $t = 0, 1$. A two period game is the simplest model to demonstrate intertemporal trade-offs. It provides a sufficient framework to address whether reputational concerns and competition can discipline a strategic expert into re-

[3]Indeed the question may be analyzed with sequential reporting, but that is not my focus here. The scenario here corresponds to media firms simultaneously publishing their papers every morning.

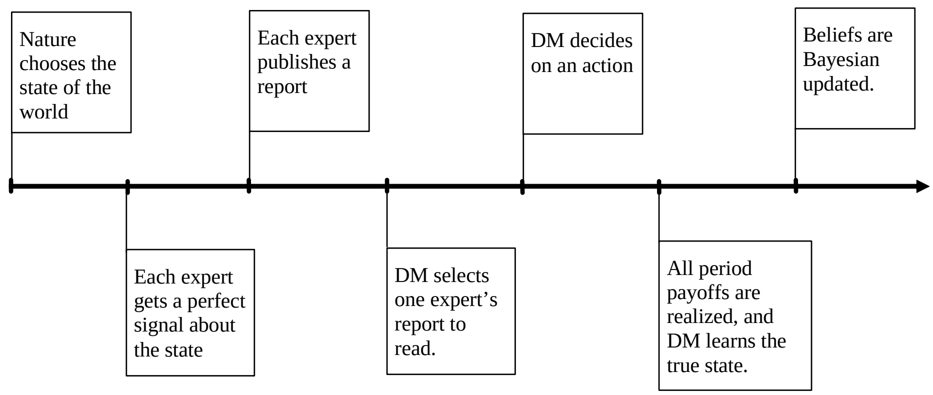

Figure 3.1: Timing of Game

porting the truth.

Each expert i decides on a sequence of reporting rules, $\{\sigma_0^i(\omega_0), \sigma_1^i(\omega_1)\}$. The strategy in each period consists of two components, $\sigma_t^i(\omega_t) = \{\sigma_{r,t}^i, \sigma_{l,t}^i\}$, where $\sigma_{\omega,t}^i$ is the probability of expert i reporting truthfully in period t given signal ω.

There are two types of experts: honest (H) and strategic (S). Honest types always report their signal truthfully, while strategic types are allowed to lie. An expert's type is private information. At the beginning of the game, the prior probability that an expert is honest $p_0 \in (0, 1)$.

Because the decision maker learns the true state at the conclusion of a period, when a strategic expert lies, her type is revealed at the conclusion of that period. Thus, with a repeated game, there can be at most two groups of experts: (i) experts who have been revealed to be of the strategic type and (ii) experts who have not been revealed to be of the strategic type. The first is named the "strategic for sure group" and the second is named the "potentially honest group". There is nothing that an honest type can do to distinguish herself from the strategic type. Only the strategic expert can reveal her type by reporting dishonestly.

Let h_t denote the number of experts in the potentially honest group in period t. When a strategic expert lies, her type is revealed at the conclusion of that period. Therefore, in the next period, she will be excluded from the potentially honest group. At $t = 0$, all experts belong to the potentially honest group.

$$h_0 = n$$

If a strategic expert reports truthfully in $t = 0$, then she remains in the potentially honest group in $t = 1$. However, if she lies in $t = 0$, then she is excluded from the potentially honest group in $t = 1$.

$$\begin{aligned} h_1 &= h_0 - s_0 \\ &= n - s_0 \end{aligned}$$

where s_0 is the number of experts who decide to lie in $t = 0$.

Let p_t^i denote the probability that expert i is honest; this represents an expert's reputation. Only in period $t = 0$ is the value $p_0^i = p_0$ exogenously given. All subsequent values of p_t^i are updated according to Bayes' Rule. Throughout the paper, I will slightly abuse this notation. When an expert has been revealed to be strategic, her reputation drops to zero ($p_t^i = 0$). There is no need to notate that case. Hence, I use p_t to denotes the probability that an expert in the potentially honest group is honest at time t. Furthermore, because all experts in the potentially honest group have the same probability of being honest, the i superscript is dropped from the notation.

At time $t = 1$, p_1 is the probability that an expert in the potentially honest group is actually honest.

$$p_1 = \begin{cases} \frac{p_0}{p_0+(1-p_0)\sigma^i_{r,0}} & \text{if } \omega_0 = r \\ \frac{p_0}{p_0+(1-p_0)\sigma^i_{l,0}} & \text{if } \omega_0 = l \end{cases}$$

To better understand the evolution of p_1, consider the following example. Suppose all strategic experts report r signals truthfully and lie about l signals in every period. If $\omega_0 = r$, then there is nothing learned about the experts' types and $p_1 = p_0$. If $\omega_0 = l$, then everything is learned about experts' types. If honest types exist, then $p_1 = 1$. If all experts happen to be strategic, then $p_1 = 0$.

While a strategic expert i knows her own type, she does not know her competitors' type. In period $t = 0$, expert i forms an expectation about the value of s_0.

$$E\left[s_0\right] = \begin{cases} E\left[s_0^{-i}\right] + \left(1 - \sigma_{r,0}^i\right) & \text{if } \omega_0 = r \\ E\left[s_0^{-i}\right] + \left(1 - \sigma_{l,0}^i\right) & \text{if } \omega_0 = l \end{cases}$$

where $E\left[s_0^{-i}\right]$ is an expert's expectation about the number of *other* experts who report dishonestly in $t = 0$.

$$E\left[s_0^{-i}\right] = \begin{cases} \sum_{j \neq i}^{n-1} \left(1 - p_0\right)\left(1 - \sigma_{r,0}^j\right) & \text{if } \omega_0 = r \\ \sum_{j \neq i}^{n-1} \left(1 - p_0\right)\left(1 - \sigma_{l,0}^j\right) & \text{if } \omega_0 = l \end{cases}$$

Because the decision maker selects only one expert's report to read, his action strategy in each period depends on only the selected expert's report, $\alpha_t(\widehat{\omega}_t^i) = \{\alpha_{\widehat{r},t}^i, \alpha_{\widehat{l},t}^i\}$, where $\alpha_{\widehat{\omega},t}^i$ is the probability of following expert i's recommendation. That is, $\alpha_{\widehat{r},t}^i = \Pr(A_t = R, \widehat{\omega}_t^i = \widehat{r})$ and $\alpha_{\widehat{l},t}^i = \Pr(A_t = L, \widehat{\omega}_t^i = \widehat{l})$. Although the decision maker only selects one expert's report to read in each period, assume that all expert's reputations get Bayesian updated at the conclusion of each period.

Without loss of generality, assume $\alpha_{\widehat{r},t}^i + \alpha_{\widehat{l},t}^i \geq 1$. When $\alpha_{\widehat{r},t}^i + \alpha_{\widehat{l},t}^i < 1$, the meaning of recommendations merely become switched[4].

The per-period utility of each strategic expert is:

[4] To see this point, consider the fact that there are two ways to represent the decision maker completely following the expert's report: $(\alpha_{\widehat{r},t}^i = \alpha_{\widehat{l},t}^i = 1)$ and $(\alpha_{\widehat{r},t}^i = \alpha_{\widehat{l},t}^i = 0)$. The first representation $(\alpha_{\widehat{r},t}^i = \alpha_{\widehat{l},t}^i = 1)$ says that given report $\widehat{r}$, the decision maker selects R, and given report $\widehat{l}$, the decision maker selects L. The second representation $(\alpha_{\widehat{r},t}^i = \alpha_{\widehat{l},t}^i = 0)$ says given report $\widehat{r}$, the decision maker selects L, and given report $\widehat{l}$, the decision maker selects R. Thus, the meaning of the report $\widehat{r}$ and $\widehat{l}$ are merely switched, but the expert's influence over the decision maker is the same.

$$
U_t^i = \begin{array}{|c|c|cc|}
\hline
 & & \multicolumn{2}{c|}{\text{state}} \\
\hline
 & & L & R \\
\hline
\text{DM's} & L & 1 & 0 \\
\text{action} & R & b & 1+b \\
\hline
\end{array}
$$

For the rest of the paper, assume that strategic experts are strongly right-biased, that is, $b > 1$. The analysis would be the same as restricting attention to strategic experts who are all left-biased ($b < -1$). Lastly, the case when strategic experts are relatively unbiased ($-1 \leq b \leq 1$) is uninteresting, because they have no incentive to lie in the first place.

In each period, the decision maker wants to select the action that matches the state. In this sense, the decision maker is unbiased.

$$
U_t^{DM} = \begin{array}{|c|c|cc|}
\hline
 & & \multicolumn{2}{c|}{\text{state}} \\
\hline
 & & L & R \\
\hline
\text{DM's} & L & 1 & 0 \\
\text{action} & R & 0 & 1 \\
\hline
\end{array}
$$

All players maximize the discounted sum of single period payoffs. Let the common discount factor be δ.

3.3 Equilibrium Analysis

In the discussion of the main results, it is necessary to first present some preliminary analysis. First lemma (6) characterizes the equilibrium behavior of the decision maker. Then I discuss the behavior in the last period subgame in order to figure out the continuation payoffs. After this preliminary analysis, I then present the main results, which focus on the equilibrium behavior in the first period of the game. Additionally, I restrict attention to equilibria in which strategic experts adopt symmetric strategies.

Since the decision maker only selects one expert's report to read in each period, he is always better off selecting an expert with some probability of being honest rather than an expert that has been revealed to be strategic for sure.

Lemma 6 *In each time period, the decision maker selects an expert from the potentially honest group and follows the advice of that expert ($\alpha_{\widehat{r},t} = \alpha_{\widehat{l},t} = 1$ for $t = 0, 1$).*

In $t = 0$, all experts face the same $\frac{1}{n}$ probability of being selected. As n increases, the probability of being selected decreases. In other words, as the number of experts increase, an individual expert's influence on the decision maker decreases.

If no experts lie ($s_0 = 0$), then an individual expert's influence over the decision maker remains the same over time. On the other hand, if some experts lie ($s_0 > 0$), then an expert who remains in the potentially honest group has a greater influence over the decision maker in $t = 1$ compared to in $t = 0$.

Because the game is solved backwards, first consider the last period of the game, $t = 1$. In the last period there are two subgames to consider: (i) the expert was truthful in the past and remains in the pool of potentially honest experts and (ii) the expert was dishonest in the past and belongs to the strategic for sure group.

Lemma 7 *In the last period subgame in which the expert belongs to the potentially honest group, the equilibrium behavior in pure strategies is all strategic experts report r truthfully ($\sigma_{r,1} = 1$) and lie about l signals ($\sigma_{l,1} = 0$).*

In the last period subgame in which the expert remains in the pool of potentially honest experts, she has a $\frac{1}{h_1}$ chance of being selected and influencing the decision maker. She has a complementary probability $(1 - \frac{1}{h_1})$ of not being selected and receiving a payoff that is determined by a competing expert.

Let $V_1^i\left(\sigma_1^j\right)$ be the expected utility of expert i in $t = 1$ when the decision maker selects expert j, who is not i.

$$V_1^i\left(\sigma_1^j\right) = \left[\begin{array}{c} \underbrace{\frac{1}{2}p_1\left(1+b\right)+\frac{1}{2}p_1}_{j\text{ is honest expert}} \\ +\underbrace{\frac{1}{2}\left(1-p_1\right)\sigma_{r,1}^j\left(1+b\right)+\frac{1}{2}\left(1-p_1\right)\sigma_{l,1}^j}_{j\text{ is a truthful, strategic expert}} \\ +\underbrace{\frac{1}{2}\left(1-p_1\right)\left(1-\sigma_{r,1}^j\right)(0)+\frac{1}{2}\left(1-p_1\right)\left(1-\sigma_{l,1}^j\right)b}_{j\text{ is a deceitful, strategic expert}} \end{array}\right]$$

Because all the strategic experts behave the same in the last period, $V_1^i\left(\sigma_1^j\right)$ can be further simplified.

$$\begin{aligned} V_1^i\left(\sigma_1^j\right) &= p_1\left(\frac{b}{2}+1\right)+\left(1-p_1\right)\left(b+\frac{1}{2}\right) \\ &= b+\frac{1}{2}-\frac{1}{2}p_1\left(b-1\right) \end{aligned}$$

The expected utility of strategic expert i, who has always reported truthfully in the past, is

$$EU_1^i = \underbrace{\frac{1}{h_1}\left[\frac{1}{2}\left(1+b\right)+\frac{1}{2}b\right]}_{\text{DM selects expert } i} + \underbrace{\sum_{j\neq i}^{h_1-1}\frac{1}{h_1}V_1^i\left(\sigma_1^j\right)}_{\text{DM selects an expert who is not } i}$$

By substituting $V_1^i\left(\sigma_1^j\right) = b+\frac{1}{2}-\frac{1}{2}p_1\left(b-1\right)$, the expert's expected utility can be further reduced to

$$
\begin{aligned}
EU_1^i &= \frac{1}{h_1}\left[b+\frac{1}{2}\right]+\sum_{j\neq i}^{h_1-1}\frac{1}{h_1}V_1^i\left(\sigma_1^j\right) \\
&= \frac{1}{h_1}\left[b+\frac{1}{2}\right]+\left(1-\frac{1}{h_1}\right)\left(b+\frac{1}{2}-\frac{1}{2}p_1\left(b-1\right)\right) \\
&= V_1^i\left(\sigma_1^j\right)+\frac{1}{h_1}\left[\frac{1}{2}p_1\left(b-1\right)\right] \qquad (3.1)
\end{aligned}
$$

Now consider the other subgame, in which the expert lied in the past and belongs to the strategic for sure group. Since she belongs to the strategic for sure group, the decision maker never consults her. Therefore, her reporting strategy has no affect on her payoff.

Lemma 8 *In the last period subgame, in which the expert belongs to strategic for sure group, the equilibrium behavior of strategic experts is being indifferent in their reporting strategy ($\sigma_{r,1}\in[0,1]$, $\sigma_{l,1}\in[0,1]$).*

If the expert belongs to the strategic for sure group, then she has no control over her last period payoff.

$$
EU_1^i = V_1^i\left(\sigma_1^j\right) \qquad (3.2)
$$

The expected utilities in (3.1) and (3.2) are the continuation payoffs. Clearly, the benefit of truthful reporting in the first period is being able to influence the decision maker in the last period.

Now that the preliminary analysis has been discussed, we can turn our attention to the first period problem, $t = 0$. Because the strategic expert is right-biased, it is not surprising that she reports r signals truthfully in the first period.

Lemma 9 *A strategic expert always reports r truthfully in the first period ($\sigma_{r,0}^{i} = 1$ for all for all $i = 1, 2, ...n$).*

The more interesting case is when a strategic expert receives an l signal, because she may have an incentive to lie. If she lies in the first period, then she gains today at the expense of forever being unable to influence the decision maker in the future. If the strategic expert tells the truth today, then she keeps her reputation.

Let $V_0^i\left(\sigma_0^j, \omega_0 = l\right)$ be the expected utility of expert i in $t = 0$ when the decision maker selects expert j, who is not i, and when $\omega_0 = l$.

$$V_0^i\left(\sigma_0^j, \omega_0 = l\right) = \begin{bmatrix} p_0\left[\alpha_{\widehat{l}}^j + b\left(1 - \alpha_{\widehat{l}}^j\right)\right] \\ +\left(1 - p_0\right)\sigma_l^j\left[\alpha_{\widehat{l}}^j + b\left(1 - \alpha_{\widehat{l}}^j\right)\right] \\ +\left(1 - p_0\right)\left(1 - \sigma_l^j\right)\left[b\alpha_{\widehat{r}}^j + \left(1 - \alpha_{\widehat{r}}^j\right)\right] \end{bmatrix}$$

Here, I present first, the expected payoffs of reporting truthfully and second, the expected payoffs of reporting dishonestly. Given $\omega_0 = l$, if expert i reports truthfully today ($\sigma_{l,0}^i = 1$), her payoff is

$$
\begin{aligned}
EU_0^i\left(\sigma_{l,0}^i=1,\omega_0=l\right) &= \underbrace{\frac{1}{h_0}\left[\alpha_{\hat{l},0}^i+b\left(1-\alpha_{\hat{l},0}^i\right)\right]}_{\text{DM selects expert } i} \\
&+ \underbrace{\sum_{j\neq i}^{h_0-1}\frac{1}{h_0}V_0^i\left(\sigma_0^j,\omega_0=l\right)}_{\text{DM selects an expert who is not } i} \\
&+\delta \underbrace{\left[V_1^i\left(\sigma_1^j\right)+\frac{1}{h_1}\left[\frac{1}{2}p_1\left(b-1\right)\right]\right]}_{\text{Next period's payoff if expert } i \text{ remains in potentially honest group}}
\end{aligned}
$$

Substituting in $h_0=n$, her payoff can be re-written as

$$
\begin{aligned}
EU_0^i\left(\sigma_{l,0}^i=1,\omega_0=l\right) &= \frac{1}{n}\left[\alpha_{\hat{l},0}^i+b\left(1-\alpha_{\hat{l},0}^i\right)\right] \\
&+\sum_{j\neq i}^{n-1}\frac{1}{n}V_0^i\left(\sigma_0^j,\omega_0=l\right) \\
&+\delta\left[V_1^i\left(\sigma_1^j\right)+\frac{1}{h_1}\left[\frac{1}{2}p_1\left(b-1\right)\right]\right]
\end{aligned}
$$

Given $\omega_0=l$, if the expert reports dishonestly today ($\sigma_{l,0}^i=0$), her payoff is

$$
\begin{aligned}
& EU_0^i\left(\sigma_{l,0}^i = 0, \omega_0 = l\right) \\
= \; & \underbrace{\frac{1}{h_0}\left[b\alpha_{\hat{r},0}^i + \left(1 - \alpha_{\hat{r},0}^i\right)\right]}_{\text{DM selects expert } i} \\
& + \underbrace{\sum_{j \neq i}^{h_0 - 1} \frac{1}{h_0} V_0^i\left(\sigma_0^j, \omega_0 = l\right)}_{\text{DM selects an expert who is not } i} \\
& + \delta \underbrace{V_1^i\left(\sigma_1^j\right)}_{\text{Next period's payoffs if expert } i \text{ is excluded from the potentially honest group}}
\end{aligned}
$$

Since, $h_0 = n$, her payoff can be re-written as

$$
\begin{aligned}
EU_0^i\left(\sigma_{l,0}^i = 0, \omega_0 = l\right) = \; & \frac{1}{n}\left[b\alpha_{\hat{r},0}^i + \left(1 - \alpha_{\hat{r},0}^i\right)\right] \\
& + \sum_{j \neq i}^{n-1} \frac{1}{n} V_0^i\left(\sigma_0^j, \omega_0 = l\right) \\
& + \delta V_1^i\left(\sigma_1^j\right)
\end{aligned}
$$

The main result is presented below in proposition (16). Given that experts are sufficiently patient, a mixed strategy equilibrium exists in which all strategic experts randomize between reporting truthfully and lying.

Define

$$
\delta^* = 2p_0 + \frac{2\left(1 - p_0\right)}{n}
$$

Proposition 16 *If $\delta \geq \delta^*$, then there exists an equilibrium in which all strategic experts randomize in their reporting of l signals*

$$\sigma_{l,0}^{i} = 1 - \frac{2n - 1 - \sqrt{2p_0 \delta n \left(n-1\right) + 1}}{2\left(n-1\right)\left(1-p_0\right)}$$

and report r signals truthfully ($\sigma_{r,0}^{i} = 1$) in $t = 0$. Then, in $t = 1$, all strategic experts lie about l signals ($\sigma_{l,1}^{i} = 0$), report r signals truthfully ($\sigma_{r,1}^{i} = 1$), and the decision maker follows the expert's recommendation ($\alpha_{\hat{l},0}^{i} = \alpha_{\hat{r},0}^{i} = \alpha_{\hat{l},1}^{i} = \alpha_{\hat{r},1}^{i} = 1$ for all $i = 1, 2, ...n$).

Increasing the number of experts, increases the probability of truthful reporting, as stated below in corollary (4). While competition does indeed improve truthful reporting, corollary (5) reveals that the benefit of competition is limited.

As an illustration of Proposition (16), consider the following example in which $p_0 = \frac{1}{4}$ and $\delta = 1$.

$$\sigma_{l,0} = 1 + \frac{1 - 2n + \sqrt{2\left(\frac{1}{4}\right) n \left(n-1\right) + 1}}{2\left(n-1\right)\left(1 - \frac{1}{4}\right)}$$

Corollary 4 *In the symmetric mixed strategy equilibrium, $\frac{\partial \sigma_{l,0}^{i}}{\partial n} > 0$.*

Corollary 5 *In the symmetric mixed strategy equilibrium, $\lim\limits_{n \to \infty} \sigma_{l,0} = \frac{-2p_0 + \sqrt{2p_0 \delta}}{2(1-p_0)}$, $\lim\limits_{p \to 0} \sigma_{l,0} = 0$, and $\lim\limits_{p \to 1} \sigma_{l,0} = 1$.*

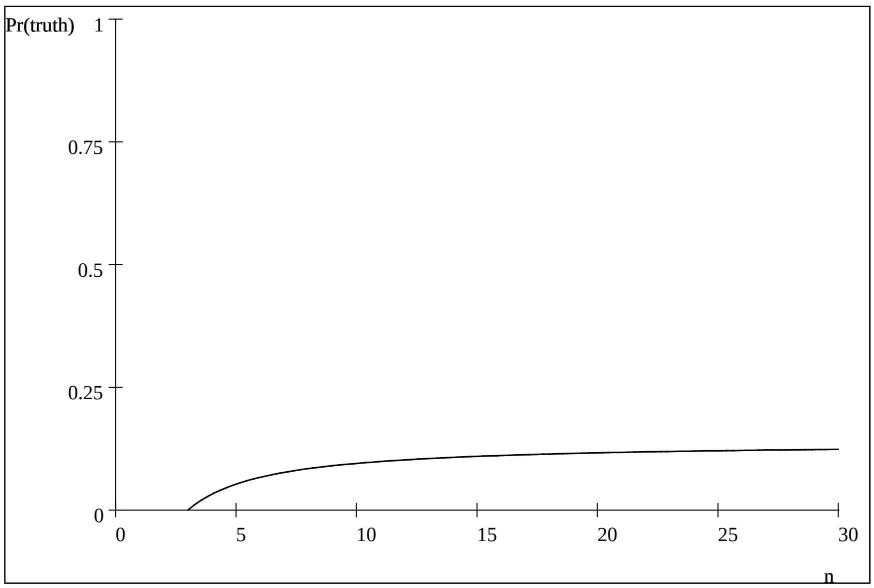

Figure 3.2: Relationship between $\sigma_{l,0}$ and n when $p_0 = \frac{1}{4}$

The decision maker's equilibrium expected utility in the first period is

$$\begin{aligned}
U^{DM} &= \left[\begin{array}{c}
\underbrace{\frac{1}{2}p_0}_{\Omega=R,\text{ Expert } i=H} + \underbrace{\frac{1}{2}p_0}_{\Omega=L,\text{ Expert } i=H} + \underbrace{\frac{1}{2}(1-p_0)}_{\Omega=R,\text{ Expert } i=S} \\
\underbrace{+\frac{1}{2}(1-p_0)\left(1+\frac{1-2n+\sqrt{2p_0\delta n(n-1)+1}}{2(n-1)(1-p_0)}\right)}_{\Omega=L,\text{ Expert } i=S}
\end{array}\right] \\
\lim_{n\to\infty} U^{DM} &= p_0 + \frac{1}{2}(1-p_0) + \frac{1}{2}(1-p_0)\left(\frac{-2p_0+\sqrt{2p_0\delta}}{2(1-p_0)}\right) \\
&= p_0 + \frac{1}{2}(1-p_0) + \frac{1}{4}\left(-2p_0+\sqrt{2p_0\delta}\right) \\
&= p_0 + \frac{1}{2} - p_0 + \frac{1}{4}\sqrt{2p_0\delta} \\
&= \frac{1}{2} + \frac{1}{4}\sqrt{2p_0\delta}
\end{aligned}$$

When experts are not sufficiently patient, then they all lie in the first period. The proof of proposition (17) is presented below in order to demonstrate the derivation of δ^*.

Proposition 17 *If $\delta \le \delta^*$, then there exists an equilibrium in pure strategies in which all strategic experts lie about l signals in both periods ($\sigma^i_{l,0} = \sigma^i_{l,1} = 0$ for all $i = 1, 2, ...n$), report r signals truthfully ($\sigma^i_{r,0} = \sigma^i_{r,1} = 1$ for all $i = 1, 2, ...n$), and the decision maker follows the expert's recommendation ($\alpha^i_{\widehat{l},0} = \alpha^i_{\widehat{r},0} = \alpha^i_{\widehat{l},1} = \alpha^i_{\widehat{r},1} = 1$ for all $i = 1, 2, ...n$).*

Proof. It is an equilibrium for all strategic experts to lie given $\omega_0 = l$ in $t = 0$

when

$$
\begin{aligned}
EU_0^i\left(\sigma_{l,0}^i = 1, \omega_0 = l\right) &< EU_0^i\left(\sigma_{l,0}^i = 0, \omega_0 = l\right) \\
\left[\begin{array}{c} \frac{1}{n}\left[\alpha_{\hat{l}}^i + b\left(1 - \alpha_{\hat{l},0}^i\right)\right] \\ +\delta\left[\frac{1}{n-E\left[s_0^{-i}\right]}\left[\frac{1}{2}p_1\left(b-1\right)\right]\right] \end{array}\right] &< \left[\frac{1}{n}\left[b\alpha_{\hat{r},0}^i + \left(1 - \alpha_{\hat{r},0}^i\right)\right]\right]
\end{aligned}
$$

If all strategic experts lie given $\omega_0 = l$ in $t = 0$, then $E\left[s_0^{-i}\right] = (n-1)(1-p_0)$, $p_1 = 1$.

$$
\begin{aligned}
\left[\begin{array}{c} \frac{1}{n}\left[\alpha_{\hat{l},0}^i + b\left(1 - \alpha_{\hat{l}}^i\right)\right] \\ +\delta\left[\frac{1}{n-(n-1)(1-p_0)}\left[\frac{1}{2}\left(b-1\right)\right]\right] \end{array}\right] &< \frac{1}{n}\left[b\alpha_{\hat{r},0}^i + \left(1 - \alpha_{\hat{r}}^i\right)\right] \\
\delta\left[\frac{1}{n-(n-1)(1-p_0)}\right]\left[\frac{1}{2}\left(b-1\right)\right] &< \frac{1}{n}\left(\alpha_{\hat{l},0}^i + \alpha_{\hat{r},0}^i - 1\right)(b-1) \\
\delta\left(\frac{1}{np_0 + 1 - p_0}\right) &< \frac{2}{n}\left(\alpha_{\hat{l},0}^i + \alpha_{\hat{r},0}^i - 1\right) \\
\delta &< \frac{2}{n}\left(\alpha_{\hat{l},0}^i + \alpha_{\hat{r},0}^i - 1\right)(np_0 + 1 - p_0)
\end{aligned}
$$

From Lemma (**??**), $\alpha_{\hat{l},0}^i = \alpha_{\hat{r},0}^i = 1$.

$$
\begin{aligned}
\delta &< \frac{2}{n}(np_0 + 1 - p_0) \\
\delta &< 2p_0 + \frac{2(1-p_0)}{n}
\end{aligned}
$$

When $\delta < \delta^*$, all strategic experts strictly prefer to lie. When $\delta = \delta^*$, they are indifferent between lying and not. ■

As an illustration of Proposition (17), consider the case when $p_0 = \frac{1}{4}$.

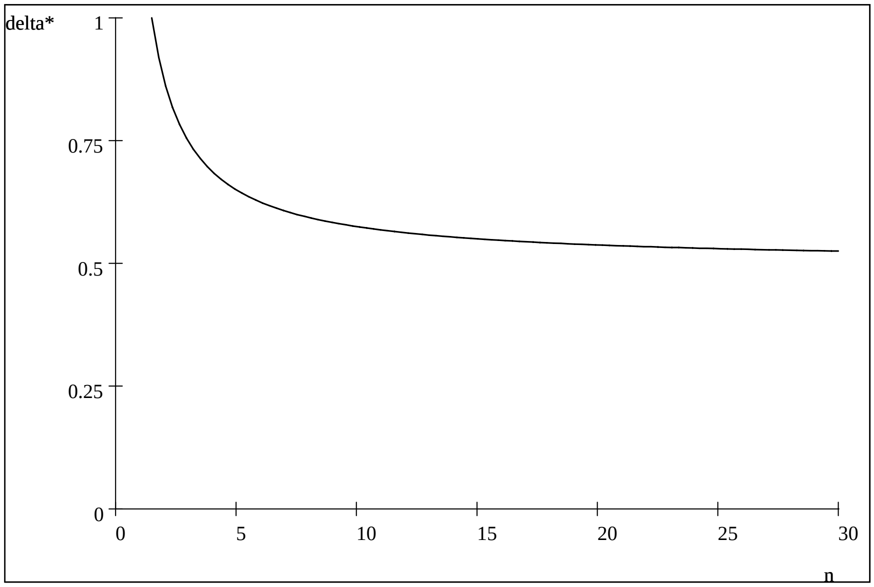

Figure 3.3: Relationship between δ^* and n when $p_0 = \frac{1}{4}$

$$\begin{aligned}\delta^* &= 2\left(\frac{1}{4}\right) + \frac{1 - \left(\frac{1}{4}\right)}{n} \\ &= \frac{1}{2} + \frac{3}{4n}\end{aligned}$$

Below the curve represents the area where the only equilibrium in pure strategies is for all strategic experts to lie. Above the curve represents the area where the mixed strategy equilibrium exists.

As the number of experts increases, δ^* decreases ($\frac{\partial \delta^*}{\partial n} = -\frac{(1-p_0)}{n^2} < 0$). The interpretation is that as the number of experts increase, the amount of patience necessary for some truthful reporting decreases.

Corollary 6 $\lim_{n\to\infty}\delta^* = 2p_0$, $\lim_{p_0\to 0}\delta^* = \frac{2}{n}$, *and* $\lim_{p_0\to 1}\delta^* = 2$

Proposition 18 *It is never equilibrium behavior for all strategic experts to report an l signal truthfully in the first period.*

When experts are sufficiently patient, truthful reporting does emerge from strategic experts. In particular, they randomize between truthful reporting and lying. However, when experts are not sufficiently patient, then all strategic experts lie. Increasing the number of experts has two effects. It increases the probability of truthful reporting in the mixed strategy equilibrium and it also decreases δ^*, so that the mixed strategy equilibrium exists for a larger range of parameters.

Lastly, while it is true that increasing the number of experts does increase truthful reporting, the effect of competition in providing such incentives is limited. In this model, the benefits of competition in terms of truthful reporting reaches a limit, which is less than one. The decision maker does not learn the entire truth no matter how many experts are added to the game.

3.4 Conclusion

The results of this paper confirm the conventional wisdom that competition increases truthful reporting. While there does not exist an equilibrium in which all biased media firms report truthfully, there does exist an incentive for some biased firms to report truthfully under certain parameters. Moreover, increasing the number of firms does indeed increase this incentive.

However, it is important to note that the benefits of competition in promoting truth-telling among biased media firms are limited. That is, as the number of firms tends toward infinity, the probability of truthful reporting from biased media firms reaches a limit that is less than one. No matter how many competing firms one adds to the market, it is not possible to achieve completely truthful reporting from all biased firms.

The policy implications of this paper support the FCC's current stance on media ownership regulation. In recent years, the FCC has reduced some of their restrictions on media ownership, allowing for the formation of larger media conglomerates. Their trend towards deregulation has generated many critics, such as Senator Bryon L. Dorgan.

> "We really do literally have five or six major corporations in this country that determine for the most part what Americans see, hear and read every day," said Sen. Byron L. Dorgan (D-N.D.), the lead spon-

sor of the resolution. "I don't think that's healthy for our country."

While this paper does not specify an optimal number of media firms, that is, it doesn't say whether five or six media firms is good or bad, it does demonstrate that competition is limited in its ability to induce biased firms to be more truthful. Therefore, it is not always worthwhile to restrict ownership in order to artificially increase the number of media firms, at least not from the perspective of achieving more truthful reporting. I do not deny other possible benefits of competition, such as diversity of information. I merely conclude that from the perspective of achieving more truthful reporting, strict ownership rules may not be the answer.

3.5 Appendix

Proof of Lemma 6, 7, and 8

Step 1: The decision maker's problem

The decision maker's problem is solved as follows. The decision maker selects expert i's report to read.

If the decision maker selects action R given an $\widehat{r}$ report ($\alpha^i_{\widehat{r}} = 1$), his payoff is

$$U^{DM} = \frac{p + (1-p)\,\sigma^i_r}{p + (1-p)\,\sigma^i_r + (1-p)\,(1-\sigma^i_l)}$$

If the decision maker selects action L given an $\widehat{r}$ report ($\alpha^i_{\widehat{r}} = 0$), his payoff is

$$U^{DM} = \frac{(1-p)\,(1-\sigma^i_l)}{p + (1-p)\,\sigma^i_r + (1-p)\,(1-\sigma^i_l)}$$

If the decision maker selects action L given an $\widehat{l}$ report, his payoff is

$$U^{DM} = \frac{p + (1-p)\,\sigma^i_l}{(1-p)\,(1-\sigma^i_r) + p + (1-p)\,\sigma^i_l}$$

If the decision maker selects action R given an $\widehat{l}$ report, his payoff is

$$U^{DM} = \frac{(1-p)\,(1-\sigma^i_r)}{(1-p)\,(1-\sigma^i_r) + p + (1-p)\,\sigma^i_l}$$

The decision maker's best response is summarized below:

$$\begin{cases} \text{If } p > \frac{1-\sigma^i_r-\sigma^i_l}{2-\sigma^i_r-\sigma^i_l} \text{ or if } [2-\sigma^i_l-\sigma^i_r] = 0, & \text{then } \alpha^i_{\widehat{r}} = 1,\ \alpha^i_{\widehat{l}} = 1 \\ \text{If } p < \frac{1-\sigma^i_r-\sigma^i_l}{2-\sigma^i_r-\sigma^i_l}, & \text{then } \alpha^i_{\widehat{r}} = 0,\ \alpha^i_{\widehat{l}} = 0 \\ \text{If } p = \frac{1-\sigma^i_r-\sigma^i_l}{2-\sigma^i_r-\sigma^i_l}, & \text{then } \alpha^i_{\widehat{r}} \in [0,1],\ \alpha^i_{\widehat{l}} \in [0,1] \end{cases}$$

Step 2: The strategic expert's problem if the expert has a chance of being selected by the decision maker

The expert's utility is comprised of two parts: (1) when the decision maker selects expert i's report to read, (2) when the decision maker selects a different expert's report to read.

Let $V^i(\sigma^j, \omega = r)$ and $V^i(\sigma^j, \omega = l)$ represent the expected utilities to expert i when the decision maker selects another expert's report to read given $\omega = r$ and $\omega = l$ respectively.

$$V^i(\sigma^j, \omega = r) = \begin{bmatrix} \underbrace{p\left[(1+b)\,\alpha^j_{\widehat{r}}\right]}_{\text{not } i \text{ is honest expert}} \\ + \underbrace{(1-p)\,\sigma^j_r\left[(1+b)\,\alpha^j_{\widehat{r}}\right]}_{\text{not } i \text{ is a truthful, strategic expert}} \\ + \underbrace{(1-p)\left(1-\sigma^j_r\right)\left[(1+b)\left(1-\alpha^j_{\widehat{l}}\right)\right]}_{\text{not } i \text{ is a deceitful, strategic expert}} \end{bmatrix}$$

$$V^i(\sigma^j, \omega = l) = \begin{bmatrix} p\left[\alpha^j_{\widehat{l}} + b\left(1-\alpha^j_{\widehat{l}}\right)\right] \\ + (1-p)\,\sigma^j_l\left[\alpha^j_{\widehat{l}} + b\left(1-\alpha^j_{\widehat{l}}\right)\right] \\ + (1-p)\left(1-\sigma^j_l\right)\left[b\alpha^j_{\widehat{r}} + \left(1-\alpha^j_{\widehat{r}}\right)\right] \end{bmatrix}$$

Suppose the strategic expert is receives an r signal. If she reports truthfully $(\sigma_r = 1)$, her payoff will be

$$EU^i\left(\sigma^i_r = 1, \omega = r\right) = \underbrace{\frac{1}{n}\left[(1+b)\,\alpha^i_{\widehat{r}}\right]}_{\text{DM selects expert } i} + \underbrace{\sum_{j\neq i}^{n-1}\frac{1}{n}V^i(\sigma^j, \omega = r)}_{\text{DM selects an expert who is not } i}$$

If she lies ($\sigma_r = 0$), her payoff will be

$$EU^i\left(\sigma_r^i = 0, \omega = r\right) = \frac{1}{n}\left[(1+b)\left(1-\alpha_{\hat{l}}^i\right)\right] + \sum_{j \neq i}^{n-1} \frac{1}{n} V^i(\sigma^j, \omega = r)$$

Since expert i cannot affect the outcome when the decision maker selects someone else's report to read, that part does not affect his decision to be truthful. The strategic expert's best response given R is summarized below:

$$\begin{cases} \text{If } (1+b)\,\alpha_{\hat{r}}^i > (1+b)\left(1-\alpha_{\hat{l}}^i\right), & \text{then } \sigma_r^i = 1 \\ \text{If } (1+b)\,\alpha_{\hat{r}}^i < (1+b)\left(1-\alpha_{\hat{l}}^i\right), & \text{then } \sigma_r^i = 0 \\ \text{If } (1+b)\,\alpha_{\hat{r}}^i = (1+b)\left(1-\alpha_{\hat{l}}^i\right), & \text{then } \sigma_r^i \in [0,1] \end{cases}$$

$$= \begin{cases} \text{If } -b\left(1-\alpha_{\hat{r}}^i-\alpha_{\hat{l}}^i\right) > 1-\alpha_{\hat{r}}^i-\alpha_{\hat{l}}^i, & \text{then } \sigma_r^i = 1 \\ \text{If } -b\left(1-\alpha_{\hat{r}}^i-\alpha_{\hat{l}}^i\right) < 1-\alpha_{\hat{r}}^i-\alpha_{\hat{l}}^i, & \text{then } \sigma_r^i = 0 \\ \text{If } -b\left(1-\alpha_{\hat{r}}^i-\alpha_{\hat{l}}^i\right) = 1-\alpha_{\hat{r}}^i-\alpha_{\hat{l}}^i, & \text{then } \sigma_r^i \in [0,1] \end{cases}$$

Recall that $1-\alpha_{\hat{r}}^i-\alpha_{\hat{l}}^i \leq 0$ is assumed. When $1-\alpha_{\hat{r}}^i-\alpha_{\hat{l}}^i < 0$, the best response given R can be reduced to

$$\begin{cases} \text{If } b > -1, & \text{then } \sigma_r^i = 1 \\ \text{If } b < -1, & \text{then } \sigma_r^i = 0 \\ \text{If } b = 1, & \text{then } \sigma_r^i \in [0,1] \end{cases}$$

Since $b > 1$ is assumed, the equilibrium behavior is $\sigma_r^i = 1$.

When $1-\alpha_{\hat{r}}^i-\alpha_{\hat{l}}^i = 0$, the best response given R can be reduced to

$$\begin{cases} \text{If } 0 > 0, & \text{then } \sigma_r^i = 1 \\ \text{If } 0 < 0, & \text{then } \sigma_r^i = 0 \\ \text{If } 0 = 0, & \text{then } \sigma_r^i \in [0,1] \end{cases}$$

In this case, the equilibrium behavior is $\sigma_r^i \in [0,1]$.

When expert i tells the truth by reporting $\widehat{l}$ given an l signal ($\sigma_l^i = 1$), her payoff is the following:

$$EU^i\left(\sigma_l^i = 1, \omega = l\right) = \frac{1}{n}\left[\alpha_{\widehat{l}}^i + b\left(1 - \alpha_{\widehat{l}}^i\right)\right] + \sum_{j \neq i}^{n-1} \frac{1}{n} V^i(\sigma^j, \omega = l)$$

The expert's utility when she lies by reporting $\widehat{r}$ given an l signal ($\sigma_l^i = 0$) is the following:

$$EU^i\left(\sigma_l^i = 0, \omega = l\right) = \frac{1}{n}\left[b\alpha_{\widehat{r}}^i + \left(1 - \alpha_{\widehat{r}}^i\right)\right] + \sum_{j \neq i}^{n-1} \frac{1}{n} V^i(\sigma^j, \omega = l)$$

Since expert i cannot affect the outcome when the decision maker selects someone else's report to read, that part does not affect his decision to be truthful. The expert's best response function given an l signal is

$$\begin{cases} \text{If } \alpha_{\widehat{l}}^i + b\left(1 - \alpha_{\widehat{l}}^i\right) > b\alpha_{\widehat{r}}^i + (1 - \alpha_{\widehat{r}}^i) & \text{then } \sigma_l^i = 1 \\ \text{If } \alpha_{\widehat{l}}^i + b\left(1 - \alpha_{\widehat{l}}^i\right) < b\alpha_{\widehat{r}}^i + (1 - \alpha_{\widehat{r}}^i) & \text{then } \sigma_l^i = 0 \\ \text{If } \alpha_{\widehat{l}}^i + b\left(1 - \alpha_{\widehat{l}}^i\right) = b\alpha_{\widehat{r}}^i + (1 - \alpha_{\widehat{r}}^i) & \text{then } \sigma_l^i \in [0,1] \end{cases}$$

$$= \begin{cases} \text{If } b\left(1 - \alpha_{\widehat{r}}^i - \alpha_{\widehat{l}}^i\right) > 1 - \alpha_{\widehat{r}}^i - \alpha_{\widehat{l}}^i & \text{then } \sigma_l^i = 1 \\ \text{If } b\left(1 - \alpha_{\widehat{r}}^i - \alpha_{\widehat{l}}^i\right) < 1 - \alpha_{\widehat{r}}^i - \alpha_{\widehat{l}}^i & \text{then } \sigma_l^i = 0 \\ \text{If } b\left(1 - \alpha_{\widehat{r}}^i - \alpha_{\widehat{l}}^i\right) = 1 - \alpha_{\widehat{r}}^i - \alpha_{\widehat{l}}^i & \text{then } \sigma_l^i \in [0,1] \end{cases}$$

Recall that $1-\alpha^i_{\hat{r}}-\alpha^i_{\hat{l}}\leq 0$ is assumed. When $1-\alpha^i_{\hat{r}}-\alpha^i_{\hat{l}}<0$, the best response given L can be reduced to

$$\begin{cases} \text{If } b<1 & \text{then } \sigma^i_l=1 \\ \text{If } b>1 & \text{then } \sigma^i_l=0 \\ \text{If } b=1 & \text{then } \sigma^i_l\in[0,1] \end{cases}$$

Since $b>1$ is assumed, the equilibrium behavior is $\sigma^i_l=0$.

When $1-\alpha^i_{\hat{r}}-\alpha^i_{\hat{l}}=0$, the best response given R can be reduced to

$$\begin{cases} \text{If } 0>0 & \text{then } \sigma^i_l=1 \\ \text{If } 0<0 & \text{then } \sigma^i_l=0 \\ \text{If } 0=0 & \text{then } \sigma^i_l\in[0,1] \end{cases}$$

In this case, the equilibrium behavior is $\sigma^i_l\in[0,1]$.

Step 3: The strategic expert's problem in which the expert has no chance of being selected

In the case when the strategic expert has no chance of being selected by the decision maker, she is completely indifferent in her reporting strategies. Since her reports are never read, she cannot affect her payoff.

Step 4: The DM selects from the potentially honest group

The decision maker's equilibrium utility is

$$
\begin{aligned}
U^{DM} &= \frac{1}{2}p + \frac{1}{2}p + \frac{1}{2}(1-p) \\
&= \frac{p+1}{2}
\end{aligned}
$$

In the potentially honest group $p > 0$, while in the strategic for sure group $p = 0$. Therefore, it is always better for the decision maker to select an expert from the potentially honest group.

Step 5: The equilibria

1. The equilibrium of the subgame in which the expert belongs to the potentially honest group is ($\sigma^i_r = 1$, $\sigma^i_l = 0$), ($\alpha^i_{\hat{r}} = 1, \alpha^i_{\hat{l}} = 1$) and the decision maker selects an expert from the potentially honest group.

2. The equilibrium of the subgame in which the expert belongs to the strategic for sure group is ($\sigma^i_r \in [0,1], \sigma^i_l \in [0,1]$), ($\alpha^i_{\hat{r}} = 1, \alpha^i_{\hat{l}} = 1$) and the decision maker selects an expert from the potentially honest group.

3. There exists a babbling equilibrium, ($\sigma^i_r \in [0,1], \sigma^i_l \in [0,1]$) and ($\alpha^i_{\hat{r}} \in [0,1], \alpha^i_{\hat{l}} \in [0,1]$), when $p = \frac{1-\sigma^i_r-\sigma^i_l}{2-\sigma^i_r-\sigma^i_l}$ and $1 - \alpha^i_{\hat{r}} - \alpha^i_{\hat{l}} = 0$.

Proof of Lemma 9

The strategic expert's problem in the first period, t = 0, given $\boldsymbol{\omega}_0$= r.

Let $V_0^i\left(\sigma_0^j, \omega_0 = r\right)$ be the expected utility that expert i receives when the decision maker selects expert j, who is not i, given $\omega_0 = r$.

$$V_0^i\left(\sigma_0^j, \omega_0 = r\right) = \left[\begin{array}{c} \underbrace{p_0 \left(1+b\right) \alpha_{\widehat{r}}^j}_{j \text{ is honest expert}} \\ + \underbrace{\left(1-p_0\right) \sigma_r^j \left(1+b\right) \alpha_{\widehat{r}}^j}_{j \text{ is truthful, strategic expert}} \\ + \underbrace{\left(1-p_0\right)\left(1-\sigma_r^j\right)\left(1+b\right)\left(1-\alpha_{\widehat{l}}^j\right)}_{j \text{ is deceitful, strategic expert}} \end{array} \right]$$

Given $\omega_0 = r$, if expert i reports truthfully today ($\sigma_{r,0}^i = 1$), her payoff is

$$\begin{aligned} & EU_0^i\left(\sigma_{r,0}^i = 1, \omega_0 = r\right) \\ = \; & \underbrace{\frac{1}{h_0}\left[\left(1+b\right)\alpha_{\widehat{r},0}\right]}_{\text{DM selects expert } i} \\ & + \underbrace{\sum_{j \neq i}^{h_0 - 1} \frac{1}{h_0} V_0^i\left(\sigma_0^j, \omega_0 = r\right)}_{\text{DM selects an expert who is not } i} \\ & + \delta \qquad \underbrace{\left[V_1^i\left(\sigma_1^j\right) + \frac{1}{n - s_0^{-i}}\left[\frac{1}{2} p_1 \left(b-1\right)\right]\right]}_{\text{Next period's payoff if expert } i \text{ remains in potentially honest group}} \end{aligned}$$

Substituting in $h_0 = n$, her payoff can be re-written as

$$\begin{aligned}
& EU_0^i\left(\sigma_{r,0}^i = 1, \omega_0 = r\right) \\
= \; & \frac{1}{n}\left[(1+b)\,\alpha_{\widehat{r},0}\right] \\
& + \sum_{j \neq i}^{n-1} \frac{1}{n} V_0^i\left(\sigma_0^j, \omega_0 = r\right) \\
& + \delta\left[V_1^i\left(\sigma_1^j\right) + \frac{1}{n - s_0^{-i}}\left[\frac{1}{2} p_1 (b-1)\right]\right]
\end{aligned}$$

Given $\omega_0 = r$, if the expert reports dishonestly today ($\sigma_{r,0}^i = 0$), her payoff is

$$\begin{aligned}
& EU_0^i\left(\sigma_{r,0}^i = 0, \omega_0 = r\right) \\
= \; & \underbrace{\frac{1}{h_0}\left[(1+b)\left(1 - \alpha_{\widehat{l},0}\right)\right]}_{\text{DM selects expert } i} \\
& + \underbrace{\sum_{j \neq i}^{h_0 - 1} \frac{1}{h_0} V_0^i\left(\sigma_0^j, \omega_0 = r\right)}_{\text{DM selects an expert who is not } i} \\
& + \delta \qquad \underbrace{V_1^i\left(\sigma_1^j\right)}_{\text{Next period's payoffs if expert } i \text{ is excluded from the potentially honest group}}
\end{aligned}$$

Since, $h_0 = n$, her payoff can be re-written as

$$\begin{aligned}
EU_0^i\left(\sigma_{r,0}^i = 0, \omega_0 = r\right) \;=\; & \frac{1}{n}\left[(1+b)\left(1 - \alpha_{\widehat{l},0}\right)\right] \\
& + \sum_{j \neq i}^{n-1} \frac{1}{n} V_0^i\left(\sigma_0^j, \omega_0 = r\right) \\
& + \delta\left[V_1^i\left(\sigma_1^j\right)\right]
\end{aligned}$$

The expert will report truthfully $\left(\sigma_{r,0}^{i}=1\right)$ when

$$
\begin{array}{ccc}
EU_0^i\left(\sigma_{r,0}^{i}=1,\omega_0=r\right) & > & EU_0^i\left(\sigma_{r,0}^{i}=0,\omega_0=r\right) \\
\left[\begin{array}{c} \frac{1}{n}\left[(1+b)\,\alpha_{\widehat{r},0}\right] \\ +\delta\left[\frac{1}{n-s_0^{-i}}\left[\frac{1}{2}p_1\,(b-1)\right]\right] \end{array}\right] & > & \left[\frac{1}{n}\left[(1+b)\left(1-\alpha_{\widehat{l},0}\right)\right]\right]
\end{array}
$$

Since the payoffs in the next period, $t=1$, is clearly better if you tell the truth in $t=0$, let's focus attention on the payoffs of the first period.

In $t=0$, the expert is comparing

$$
\begin{cases}
\text{If } -b\left(1-\alpha_{\widehat{r},1}-\alpha_{\widehat{l},1}\right)>1-\alpha_{\widehat{r},1}-\alpha_{\widehat{l},1}, & \text{then } \sigma_{r,1}=1 \\
\text{If } -b\left(1-\alpha_{\widehat{r},1}-\alpha_{\widehat{l},1}\right)<1-\alpha_{\widehat{r},1}-\alpha_{\widehat{l},1}, & \text{then } \sigma_{r,1}=0 \\
\text{If } -b\left(1-\alpha_{\widehat{r},1}-\alpha_{\widehat{l},1}\right)=1-\alpha_{\widehat{r},1}-\alpha_{\widehat{l},1}, & \text{then } \sigma_{r,1}\in[0,1]
\end{cases}
$$

When $b>1$, this reduces to

$$
\begin{cases}
\text{If } \left(1-\alpha_{\widehat{r},1}-\alpha_{\widehat{l},1}\right)<0, & \text{then } \sigma_{r,1}=1 \\
\text{If } \left(1-\alpha_{\widehat{r},1}-\alpha_{\widehat{l},1}\right)>0, & \text{then } \sigma_{r,1}=0 \\
\text{If } \left(1-\alpha_{\widehat{r},1}-\alpha_{\widehat{l},1}\right)=0, & \text{then } \sigma_{r,1}\in[0,1]
\end{cases}
$$

Since it is assumed that $\left(1-\alpha_{\widehat{r},1}-\alpha_{\widehat{l},1}\right)\leq 0$, the only equilibrium strategy in pure strategies is $\sigma_{r,1}=1$.

Suppose all strategic experts report r signals truthfully ($\sigma_{r,0} = 1$).

$$\begin{cases} \text{If } p_0 > \frac{-\sigma^i_{l,0}}{1-\sigma^i_{l,0}} \text{ or if } \left[1-\sigma^i_{l,0}\right] = 0, & \text{then } \alpha^i_{\widehat{r},0} = 1, \ \alpha^i_{\widehat{l},0} = 1 \\ \text{If } p_0 < \frac{-\sigma^i_{l,0}}{1-\sigma^i_{l,0}}, & \text{then } \alpha^i_{\widehat{r},0} = 0, \ \alpha^i_{\widehat{l},0} = 0 \\ \text{If } p_0 = \frac{-\sigma^i_{l,0}}{1-\sigma^i_{l,0}}, & \text{then } \alpha^i_{\widehat{r},0} \in [0,1], \ \alpha^i_{\widehat{l},0} \in [0,1] \end{cases}$$

Proof of Proposition 16

It is an equilibrium for all strategic experts to adopt a mixed strategy given $\omega_0 = l$ in $t = 0$ when she is indifferent between telling the truth and lying.

$$\begin{aligned} EU^i_0\left(\sigma^i_{l,0} = 1, \omega_0 = l\right) &= EU^i_0\left(\sigma^i_{l,0} = 0, \omega_0 = l\right) \\ \begin{bmatrix} \frac{1}{n}\left[\alpha^i_{\widehat{l},0} + b\left(1 - \alpha^i_{\widehat{l},0}\right)\right] \\ +\delta\left[\frac{1}{n-E\left[s_0^{-i}\right]}\left[\frac{1}{2}p^i_1(b-1)\right]\right] \end{bmatrix} &= \left[\frac{1}{n}\left[b\alpha^i_{\widehat{r},0} + \left(1-\alpha^i_{\widehat{r},0}\right)\right]\right] \end{aligned}$$

If all strategic experts play the same mixed strategy $\sigma^i_{l,0} \in [0,1]$, then $E\left[s_0^{-i}\right] = (n-1)(1-p_0)\left(1-\sigma^i_{l,0}\right)$, $p^i_1 = \frac{p_0}{p_0+(1-p_0)\sigma^i_{l,0}}$. Furthermore, from Lemma (6), $\alpha^i_{r,0} = \alpha^i_{l,0} = 1$.

$$\left[\begin{array}{c}\delta\left(\frac{1}{n-(n-1)(1-p_0)\left(1-\sigma_{l,0}^i\right)}\right)\\ *\left[\frac{1}{2}\left(\frac{p_0}{p_0+(1-p_0)\sigma_{l,0}^i}\right)(b-1)\right]\end{array}\right] = \frac{1}{n}(b-1)$$

$$\left[\begin{array}{c}\delta\frac{1}{2}\left(\frac{1}{n-(n-1)(1-p_0)\left(1-\sigma_{l,0}^i\right)}\right)\\ *\left(\frac{p_0}{p_0+(1-p_0)\sigma_{l,0}^i}\right)\end{array}\right] = \frac{1}{n}$$

$$\left[\begin{array}{c}\left(\frac{1}{np_0+1-p_0-\sigma_{l,0}^i(1-n)(1-p_0)}\right)\\ *\left(\frac{1}{p_0+(1-p_0)\sigma_{l,0}^i}\right)\end{array}\right] = 2\left(\frac{1}{\delta}\right)\left(\frac{1}{p_0}\right)\left(\frac{1}{n}\right)$$

$$\left[\begin{array}{c}(np_0+1-p_0)\\ +\sigma_{l,0}^i(n-1)(1-p_0)\end{array}\right]\left[p_0+(1-p_0)\sigma_{l,0}^i\right] = \frac{\delta p_0 n}{2}$$

$$\left[\begin{array}{c}p_0(np_0+1-p_0)\\ +\left[\begin{array}{c}(np_0+1-p_0)(1-p_0)\\ +p_0(n-1)(1-p_0)\end{array}\right]\sigma_{l,0}^i\\ +(n-1)(1-p_0)^2\left(\sigma_{l,0}^i\right)^2\end{array}\right] = \frac{\delta p_0 n}{2}$$

$$\left[\begin{array}{c}p_0(np_0+1-p_0)\\ +\left[(2p_0(n-1)+1)(1-p_0)\right]\sigma_{l,0}^i\\ +(n-1)(1-p_0)^2\left(\sigma_{l,0}^i\right)^2\end{array}\right] = \frac{\delta p_0 n}{2}$$

$$\left[\begin{array}{c}\underbrace{(n-1)(1-p_0)^2}_{a}\left(\sigma_{l,0}^i\right)^2\\ +\underbrace{\left[(2p_0(n-1)+1)(1-p_0)\right]}_{b}\sigma_{l,0}^i\\ \underbrace{+p_0(np_0+1-p_0)-\frac{\delta p_0 n}{2\left(\alpha_l^i+\alpha_r^i-1\right)}}_{c}\end{array}\right] = 0$$

$$\sigma_{l,0}^i = \frac{\left[\begin{array}{c} -\left[\left(2p_0\left(n-1\right)+1\right)\left(1-p_0\right)\right] \\ \pm\sqrt{\begin{array}{c}\left(\left(2p_0\left(n-1\right)+1\right)\left(1-p_0\right)\right)^2 \\ -4\left(n-1\right)\left(1-p_0\right)^2\left(p_0\left(np_0+1-p_0\right)-\frac{\delta p_0 n}{2}\right)\end{array}}\end{array}\right]}{2\left(n-1\right)\left(1-p_0\right)^2}$$

$$= \frac{-2p_0\left(n-1\right)-1\pm\sqrt{2p_0\delta n\left(n-1\right)+1}}{2\left(n-1\right)\left(1-p_0\right)}$$

$$= \frac{-2p_0\left(n-1\right)-2+2n+1-2n\pm\sqrt{2p_0\delta n\left(n-1\right)+1}}{2\left(n-1\right)\left(1-p_0\right)}$$

$$= \frac{2\left(n-1\right)\left(1-p_0\right)+1-2n\pm\sqrt{2p_0\delta n\left(n-1\right)+1}}{2\left(n-1\right)\left(1-p_0\right)}$$

$$= 1+\frac{1-2n\pm\sqrt{2p_0\delta n\left(n-1\right)+1}}{2\left(n-1\right)\left(1-p_0\right)}$$

In order to ensure that the square root term is real, let's double check to see that the value under the square root (that is, $(2p_0\delta n\left(n-1\right)+1)$) is non-negative. Notice that $(2p_0\delta n\left(n-1\right)+1) > 0$ for all of the parameter domains of the model, $p_0 \in [0,1]$, $\delta \in [0,1]$, $n \geq 1$. Additionally, it is necessary to select the $(+)$, rather than the $(-)$, in the $(\pm)$.

For $\sigma_{l,0}^i$ to be a proper mixed strategy, it must be the case that $0 \leq \sigma_{l,0}^i \leq 1$, which means

$$\begin{aligned} 0 &\leq 1+\frac{1-2n+\sqrt{2p_0\delta n\left(n-1\right)+1}}{2\left(n-1\right)\left(1-p_0\right)} \leq 1 \\ -1 &\leq \frac{1-2n+\sqrt{2p_0\delta n\left(n-1\right)+1}}{2\left(n-1\right)\left(1-p_0\right)} \leq 0 \end{aligned}$$

Case 1: Find the parameters for which $-1 \leq \frac{1-2n\pm\sqrt{2p_0\delta n(n-1)+1}}{2(n-1)(1-p_0)}$.

$$\begin{aligned}
-1 &\leq \frac{1-2n+\sqrt{2p_0\delta n\left(n-1\right)+1}}{2\left(n-1\right)\left(1-p_0\right)} \\
-2\left(n-1\right)\left(1-p_0\right) &\leq 1-2n+\sqrt{2p_0\delta n\left(n-1\right)+1} \\
\left(2np_0-2p_0+1\right)^2 &\leq 2p_0\delta n\left(n-1\right)+1 \\
\left[\begin{array}{c} 4np_0-4p_0+4p_0^2 \\ -8np_0^2+4n^2p_0^2+1 \end{array}\right] &\leq 2n^2\delta p_0-2n\delta p_0+1 \\
-n^2\delta+n\delta &\leq -2n+2-2p_0+4np_0-2n^2p_0 \\
-\delta n\left(n-1\right) &\leq \left(-2\right)\left(n-1\right)\left(p_0\left(n-1\right)+1\right) \\
-\delta n &\leq \left(-2\right)\left(p_0\left(n-1\right)+1\right) \\
\delta &\geq \frac{2}{n}\left(p_0\left(n-1\right)+1\right) \\
\delta &\geq 2p_0+\frac{2\left(1-p_0\right)}{n} \\
\delta &\geq \delta^*
\end{aligned}$$

If $\delta \geq \delta^*$, then $0 \leq \sigma_{l,0}^i$.

Case 2: Find the parameters for which $\frac{1-2n+\sqrt{2p_0\delta n(n-1)+1}}{2(n-1)(1-p_0)} \leq 0$. Since the denominator is strictly positive for $n > 1$ and $p_0 < 1$, only consider the numerator.

$$
\begin{aligned}
1 - 2n + \sqrt{2p_0\delta n\,(n-1)+1} &\leq 0 \\
\sqrt{2p_0\delta n\,(n-1)+1} &\leq 2n-1 \\
2p_0\delta n\,(n-1)+1 &\leq (2n-1)^2 \\
2p_0\delta n\,(n-1) &\leq 4n^2-4n \\
2p_0\delta n\,(n-1) &\leq 4n\,(n-1) \\
\delta &\leq \frac{2}{p_0}
\end{aligned}
$$

This condition is satisfied for all $p_0 \in (0,1]$ and all $\delta \in [0,1]$.

Proof of Corollary 4

$$\sigma^i_{l,0} = 1 + \frac{1-2n+\sqrt{2p_0\delta n\,(n-1)+1}}{2\,(n-1)\,(1-p_0)}$$

Find $\frac{\partial \sigma^i_{l,0}}{\partial n}$.

$$\frac{\partial \sigma^i_{l,0}}{\partial n} = \frac{\partial}{\partial n}\left(\frac{1-2n+\sqrt{2p_0\delta n\,(n-1)+1}}{2\,(n-1)\,(1-p_0)}\right)$$

Let $g = -2n+1+\sqrt{2p_0\delta n\,(n-1)+1}$ and $h = 2\,(n-1)\,(1-p_0)$

$$
\begin{aligned}
g &= -2n+1+\left[2p_0\delta n\left(n-1\right)+1\right]^{\frac{1}{2}} \\
\frac{\partial g}{\partial n} &= -2+\frac{1}{2}\left[2p_0\delta n\left(n-1\right)+1\right]^{\frac{-1}{2}}\left[4n\delta p_0-2\delta p_0\right] \\
&= -2+\frac{p_0\delta\left(2n-1\right)}{\sqrt{2p_0\delta n\left(n-1\right)+1}}
\end{aligned}
$$

$$
\begin{aligned}
h &= 2\left(n-1\right)\left(1-p_0\right) \\
\frac{\partial h}{\partial n} &= 2\left(1-p_0\right)
\end{aligned}
$$

$$
\begin{aligned}
\frac{\partial \sigma_{l,0}^{i}}{\partial n} &= \frac{\frac{\partial g}{\partial n}h-\frac{\partial h}{\partial n}g}{h^2} \\
&= \frac{\left[\begin{array}{c}\left[-2+\frac{p_0\delta(2n-1)}{\sqrt{2p_0\delta n(n-1)+1}}\right]2\left(n-1\right)\left(1-p_0\right) \\ -2\left(1-p_0\right)\left[-2n+1+\sqrt{2p_0\delta n\left(n-1\right)+1}\right]\end{array}\right]}{4\left(n-1\right)^2\left(1-p_0\right)^2} \\
&= \frac{\left[\begin{array}{c}-2\left(n-1\right)+\frac{p_0\delta(2n-1)}{\sqrt{2p_0\delta n(n-1)+1}}\left(n-1\right) \\ +2n-1-\sqrt{2p_0\delta n\left(n-1\right)+1}\end{array}\right]}{2\left(n-1\right)^2\left(1-p_0\right)} \\
&= \frac{1+\frac{p_0\delta(2n-1)(n-1)}{\sqrt{2p_0\delta n(n-1)+1}}-\sqrt{2p_0\delta n\left(n-1\right)+1}}{2\left(n-1\right)^2\left(1-p_0\right)} \\
&= \frac{\left[\begin{array}{c}\sqrt{2p_0\delta n\left(n-1\right)+1}+p_0\delta\left(2n-1\right)\left(n-1\right) \\ -2p_0\delta n\left(n-1\right)-1\end{array}\right]}{2\left(n-1\right)^2\left(1-p_0\right)\sqrt{2p_0\delta n\left(n-1\right)+1}} \\
&= \frac{-\left(p_0\delta\left(n-1\right)+1\right)+\sqrt{2p_0\delta n\left(n-1\right)+1}}{2\left(n-1\right)^2\left(1-p_0\right)\sqrt{2p_0\delta n\left(n-1\right)+1}}
\end{aligned}
$$

The denominator is a positive value. Now to show that $\frac{\partial \sigma_{l,0}^{i}}{\partial n} > 0$, I need to show that the numerator is positive.

It must be the case that

$$\begin{aligned}
\begin{bmatrix} -\left(p_0\delta\left(n-1\right)+1\right) \\ +\sqrt{2p_0\delta n\left(n-1\right)+1} \end{bmatrix} &> 0 \\
\sqrt{2p_0\delta n\left(n-1\right)+1} &> \left(p_0\delta\left(n-1\right)+1\right) \\
2p_0\delta n\left(n-1\right)+1 &> \left(p_0\delta\left(n-1\right)+1\right)^2 \\
2n^2\delta p_0 - 2n\delta p_0 + 1 &> \begin{bmatrix} 2n\delta p_0 - 2\delta p_0 + \delta^2 p_0^2 \\ -2n\delta^2 p_0^2 + n^2\delta^2 p_0^2 + 1 \end{bmatrix} \\
0 &> \begin{bmatrix} 2n\delta p_0 - 2\delta p_0 + \delta^2 p_0^2 - 2n\delta^2 p_0^2 \\ +n^2\delta^2 p_0^2 + 1 - 2n^2\delta p_0 + 2n\delta p_0 - 1 \end{bmatrix} \\
0 &> \begin{bmatrix} 4n\delta p_0 - 2\delta p_0 - 2n^2\delta p_0 \\ +\delta^2 p_0^2 - 2n\delta^2 p_0^2 + n^2\delta^2 p_0^2 \end{bmatrix} \\
0 &> \underbrace{p_0\delta\left(n-1\right)^2}_{>0}\underbrace{\left(\delta p_0 - 2\right)}_{<0}
\end{aligned}$$

The expression $p_0\delta\left(n-1\right)^2\left(\delta p_0-2\right)$ is negative, because $p_0\delta\left(n-1\right)^2 > 0$ and $\left(\delta p_0 - 2\right) < 0$ for the parameter values of the model ($p_0 > 0$, $\delta > 0$, and $n > 1$). The highest value that δp_0 can be is 1, so this means $\left(\delta p_0 - 2\right) < 0$. Therefore, $\frac{\partial \sigma_{l,0}^{i}}{\partial n} > 0$.

Proof of Corollary 5

$$
\begin{aligned}
& \lim_{n\to\infty} \sigma_{l,0}^{i} \\
= \quad & \lim_{n\to\infty} \left(1 + \frac{1-2n+\sqrt{2p_0\delta n\left(n-1\right)+1}}{2\left(n-1\right)\left(1-p_0\right)} \right) \\
= \quad & \lim_{n\to\infty} \left(\frac{2\left(n-1\right)\left(1-p_0\right)+1-2n+\sqrt{2p_0\delta n\left(n-1\right)+1}}{2\left(n-1\right)\left(1-p_0\right)} \right) \\
= \quad & \lim_{n\to\infty} \left[\begin{array}{c} \frac{-2p_0(n-1)}{2(n-1)(1-p_0)} - \frac{1}{2(n-1)(1-p_0)} \\ +\sqrt{\frac{2p_0\delta n(n-1)+1}{4(n-1)^2(1-p_0)^2}} \end{array} \right] \\
= \quad & \left[\begin{array}{c} \lim\limits_{n\to\infty} \left(\frac{-2p_0(n-1)}{2(n-1)(1-p_0)} \right) - \lim\limits_{n\to\infty} \left(\frac{1}{2(n-1)(1-p_0)} \right) \\ +\lim\limits_{n\to\infty} \sqrt{\frac{2p_0\delta n(n-1)+1}{4(n-1)^2(1-p_0)^2}} \end{array} \right] \\
= \quad & \lim_{n\to\infty} \left(\frac{-p_0}{\left(1-p_0\right)} \right) + \lim_{n\to\infty} \sqrt{\frac{2p_0\delta n\left(n-1\right)+1}{4\left(n-1\right)^2\left(1-p_0\right)^2}} \\
= \quad & \frac{-p_0}{\left(1-p_0\right)} + \sqrt{\lim_{n\to\infty} \left(\frac{2p_0\delta n\left(n-1\right)+1}{4\left(n-1\right)^2\left(1-p_0\right)^2} \right)} \\
= \quad & \frac{-p_0}{\left(1-p_0\right)} + \sqrt{ \begin{array}{c} \lim\limits_{n\to\infty} \left(\frac{2p_0\delta n(n-1)}{4(n-1)^2(1-p_0)^2} \right) \\ +\lim\limits_{n\to\infty} \left(\frac{1}{4(n-1)^2(1-p_0)^2} \right) \end{array} } \\
= \quad & \frac{-p_0}{\left(1-p_0\right)} + \sqrt{\lim_{n\to\infty} \left(\frac{2p_0\delta n}{4\left(n-1\right)\left(1-p_0\right)^2} \right)} \\
= \quad & \frac{-p_0}{\left(1-p_0\right)} + \sqrt{\left(\frac{2p_0\delta}{4\left(1-p_0\right)^2} \right)} \\
= \quad & \frac{-2p_0+\sqrt{2p_0\delta}}{2\left(1-p_0\right)}
\end{aligned}
$$

$$
\begin{aligned}
&\lim_{p_0 \to 0} \sigma_{l,0}^{i} \\
= \;& 1 - \frac{2n - 1 - \sqrt{2(0)\delta n\,(n-1) + 1}}{2\,(n-1)\,(1-0)} \\
= \;& 1 - \frac{2n - 1 - 1}{2\,(n-1)} \\
= \;& 1 - 1 \\
= \;& 0
\end{aligned}
$$

$$
\begin{aligned}
&\lim_{p_0 \to 1} \sigma_{l,0}^{i} \\
= \;& \lim_{p_0 \to 1} (1) - \lim_{p_0 \to 1} \left(\frac{2n - 1 - \sqrt{2(p_0)\delta n\,(n-1) + 1}}{2\,(n-1)\,(1-p_0)} \right) \\
= \;& 1 - 0 \\
= \;& 1
\end{aligned}
$$

Proof of Corollary 6

$$
\delta^* = 2p_0 + \frac{2\,(1-p_0)}{n}
$$

$$
\lim_{n \to \infty} \delta^* = \lim_{n \to \infty} 2p_0 + \lim_{n \to \infty} \frac{2\,(1-p_0)}{n} = 2p_0
$$

$$
\lim_{p_0 \to 0} \delta^* = 2\,(0) + \frac{2\,(1-0)}{n} = \frac{2}{n}
$$

$$\lim_{p_0 \to 1} \delta^* = 2(1) + \frac{2(1-1)}{n} = 2$$

Proof of Proposition 18

Suppose $\sigma^i_{l,0} = 1$ for all $i = 1, 2, ...n$ is equilibrium behavior.

If $\sigma^i_{l,0} = 1$ is equilibrium behavior for expert i, then

$$\begin{aligned} EU^i_0\left(\sigma^i_{l,0} = 1, \omega_0 = l\right) &> EU^i_0\left(\sigma^i_{l,0} = 0, \omega_0 = l\right) \\ \left[\begin{array}{c} \frac{1}{n}\left[\alpha^i_{\widehat{l},0} + b\left(1 - \alpha^i_{\widehat{l},0}\right)\right] \\ +\delta\left[\frac{1}{n - E\left[s_0^{-i}\right]}\left[\frac{1}{2}p_1(b-1)\right]\right] \end{array}\right] &> \left[\frac{1}{n}\left[b\alpha^i_{\widehat{r},0} + \left(1 - \alpha^i_{\widehat{r},0}\right)\right]\right] \end{aligned}$$

Furthermore if $\sigma^i_{l,0} = 1$ for all $i = 1, 2, ...n$ is equilibrium behavior, then $s_0^{-i} = 0$, $p_1 = p_0$.

$$\begin{aligned} \left[\begin{array}{c} \frac{1}{n}\left[\alpha^i_{\widehat{l},0} + b\left(1 - \alpha^i_{\widehat{l},0}\right)\right] \\ +\delta\left[\frac{1}{n}\left[\frac{1}{2}p_0(b-1)\right]\right] \end{array}\right] &> \frac{1}{n}\left[b\alpha^i_{\widehat{r},0} + \left(1 - \alpha^i_{\widehat{r},0}\right)\right] \\ \delta\left[\frac{1}{n}\left[\frac{1}{2}p_0(b-1)\right]\right] &> \frac{1}{n}\left(\alpha^i_{\widehat{l},0} + \alpha^i_{\widehat{r},0} - 1\right)(b-1) \\ \delta &> \frac{2}{p_0}\left(\alpha^i_{\widehat{l},0} + \alpha^i_{\widehat{r},0} - 1\right) \qquad (3.3) \end{aligned}$$

By Lemma (**??**), $\alpha^i_{\widehat{l},0} = \alpha^i_{\widehat{r},0} = 1$. Hence, condition (3.3) is reduced to

$$\delta > \frac{2}{p_0}$$

which can never be satisfied for any $p_0 \in (0, 1]$ and any $\delta \in [0, 1]$.

References

[1] Austen-Smith, David. 1993. "Information and Influence: Lobbying for Agendas and Votes." *American Journal of Political Science*. 37(3): 799-833.

[2] Dewatripont, Mathias and Jean Tirole. 1999. "Advocates." *Journal of Political Economy*. 107(1): 1-39.

[3] Federal Communications Commission. 2003. "Report and Order and Motive of Proposed Rulemaking." Washington, DC: Federal Communications Commission.

[4] Gentzkow, Matthew and Jesse Shapiro. 2006. "Media Bias and Reputation." *The Journal of Political Economy*. 114(2): 280-316.

[5] Glazer, Jacob and Ariel Rubinstein. 2001. "Debates and Decisions: On a Rationale of Argumentation Rules." Games and Economic Behavior. 36(2): 158-173.

[6] Krishna, Vijay and John Morgan. 2001. "A Model of Expertise." *The Quarterly Journal of Economics*. 116(2): 747-775.

[7] Milgrom, Paul and John Roberts. 1986. "Relying on the Information of Interested Parties." *The RAND Journal of Economics*. 17(1): 18-32.

[8] Puzzanghera, Jim. 2008. "Senate panel moves against FCC media-ownership rules." *Los Angeles Times*. April 25. (http://www.latimes.com/business/la-fi-ownership25apr25,1,4190979.story)

[9] Sette, Enrico. 2006. "Competing Influence." Ph.D. Dissertation. London School of Economics.

[10] Sobel, Joel. 1985. "A Theory of Credibility." *The Review of Economic Studies*. 52(4):557-573.