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Does foreign media entry discipline or provoke local media bias?

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Abstract

This paper extends the Gehlbach and Sonin (2009) *voter mobilization framework* to analyze the effect of foreign media on bias in government-controlled media. Without foreign media, government biases local media report to influence public action that benefits the government. We show that the presence of foreign media reduces the effectiveness of media control as an avenue to influence public action. Although foreign media tends to reduce bias in local government controlled media, it could also have the opposite effect of increasing the bias of government-controlled media to an extreme level. We show that this increase in bias occurs when local citizens from countries with very low quality of governance, gain access to relatively accurate information from foreign media. Therefore the presence of foreign media could potentially harm the welfare of local citizens, if the welfare loss from increased bias in government-controlled media, exceeds the welfare benefit from additional information provided by foreign media. Finally, we consider government suppression of foreign media and find it strongest in countries with moderate quality of government.

1 Introduction

In the information age where Internet access is widely available, citizens in nondemocratic countries can now receive news reports from foreign media other than government-controlled media. Even if the government is successful in preventing most of its citizen from access to foreign media reports on the Internet, the availability of mobile phones allows information to spread from those who manage to breach through firewalls. Therefore it is prohibitively difficult for a government to control all information outlets, especially media outlets owned by foreign international outlets. Nevertheless, very little is known about bias in government-controlled media when its citizen have access to information outlets that is out of government control. Standard assumptions of government control of media assumes that all information outlets can be controlled, provided that the cost of doing so is not prohibitively high. This essentially ignores the possibility that citizens obtain sources of information other than government-controlled media. Furthermore literature that analyzes the effect of foreign media on local government policies fail to take into account its effect on local media bias. Even though reports from local media is biased, citizens may rely on local media if the information is only known to the government. In addition, information content from foreign media may not be accurate, especially when foreign media reports rely on local government officials that are reluctant to disclose information. Therefore the presence of foreign media not only affects government's decision in manipulating local media, but also affects welfare of its citizen through changes in local media bias.

This paper provides a theoretical framework that characterizes conditions in which foreign media entry increases bias in local media, as well as conditions when the presence of foreign media lowers welfare of its citizen. The theoretical framework is closely related to the "voter mobilization framework " used in Gehlbach and Sonin (2009) in two similar respects. First, both papers provide a theoretical foundation that highlights the conflict of interest between the government and its local citizen, in which media report is biased to influence public actions that benefits the government but may harm its citizen. In doing so we represent a government's utility by a program in which the public could invest, and the investment could be potentially beneficial or harmful to investors. Second, the framework assumes that citizens are rational and revise their beliefs using Bayesian updating in response to quality of information provided in both media outlets. This framework departs from Gehlbach and Sonin (2009) by incorporating foreign media reports that cannot be controlled by the government. In addition, Gehlbach and Sonin (2009) focus on the importance of advertising revenue with government's mobilization effort, while we focus on the effect of foreign media on local media bias and welfare of its citizens. We are also able to endogenize the degree of government suppression of foreign media's access to information[1]. We found that government suppression towards foreign media tends to be highest in countries of moderate quality of governance.

This paper builds upon existing literature that focuses on distortion of media reports by a government to influence the decision of listeners[2]. Besley and Pratt (2006) demonstrate the role of media in influencing political outcomes, as well as positive correlation between the number of independent news outlets with government's cost of suppressing information. They assume that all media outlets can be potentially captured, however we take into account that some media outlets cannot be captured. Gehlbach and Sonin (2009) demonstrate that increasing importance of advertising revenue relative to value of government mobilization induces greater likelihood of government ownership of local media outlets [3]. Even though our paper shares many similar features with the framework used in Gehlbach and Sonin (2009) our focus here is different: that is to analyze the presence of foreign media on the government effectiveness in mobilizing its citizen through media bias. Last but not the least, even though our paper is closely related to a significant amount of literature that links media freedom to better quality of governance [4], our focus is quite the opposite: we demonstrate how differences in quality of governance affect bias in media content in the presence of foreign media.

This paper proceeds as follows. Section 2 provides details and outlines assumptions regarding a simple theoretical framework that involves government-controlled media, its citizens and foreign media. For a benchmark analysis, section 3 studies how government-controlled media chooses to influence public in absence of foreign media. Section 4 introduces foreign media and characterizes conditions under which the presence of foreign media may increase or decrease bias in government-controlled media. Section 5 extends the results from section 4 to study the effects of the presence of foreign media on the welfare of citizens and highlight cases in which its presence could potentially

[1] In an attempt to control news, government rewards inside scoops to media that reports favorably about the government, while preventing access of foreign media that strives to provide accurate information that maximize advertising revenue from its audience. See "D: Bribing as Access" from Besley and Pratt (2006) for a brief discussion.

[2] This branch of literature is also known as "supply side bias". Another branch that studies the bias in media content that was referred to as the *demand-side bias*, analyzes bias in media content that caters to audience of certain prior beliefs. Representative paper in 'demand-side bias' includes Gentzkow and Shapiro (2006) that examines the tendency of inaccurate media outlet to bias report that conform with consumer's prior belief to signal themselves as high quality media outlets. Shleifer and Mullainathan (2005) discusses media outlets incentives to bias report in order to segment consumers with different prior beliefs. Papers by Groseclose and Mylio (2005) and Gentzkow and Shapiro (2010) demonstrates a relation between media bias and audience's political beliefs in United States's newspaper market.

[3] In a different institutional settings, Gentzkow, Glaeser and Goldin (2004) attribute the increase in informative in United States' newspapers from 1870 to 1920 to increasing importance in advertising revenue.

[4] Representative papers includes Brunetti and Weder (2003) on media freedom and corruption, Ravallion (1997) on presence of international news outlet on the incidence of famine, Snyder and Strömberg (2004) and Strömberg (2004) on impact of media on citizen's responsiveness to political issue.

reduce this welfare. To analyze government suppression toward foreign media, section 6 modifies the basic framework of section 2, allowing the foreign media to choose its accuracy level, as well as endogenizing government's choice to suppress foreign media. Section 7 summarizes the discussion and concludes.

2 Basic Framework

In this framework we will consider two players: a government and a continuum of individual (public) citizens with population normalized to one and two media outlets: local (mainstream) media (M) and foreign media (F). We shall focus first on the relationship between government and its public. Government's utility is represented by a program in which the individual public could invest. The conflict of interest between the government and public is such that the government receives one utility for every individual's investment in the program, but individuals that invest incur an initial cost, and the return from its investment is state dependent. This framework also assumes that the government possesses full information on whether the program will benefit individual public, or not; while the individual public only knows the probability that the program will benefit them. Denote two possible state: the *high* state H, which occurs with probability θ, when the program is successful and all individuals who invest receives positive return from the program; and *low* state L, which occurs with probability $1 - \theta$, when the program fails and all individuals who invest receives no return from the program. For simplicity, we shall assume that all individuals that invest incur the same initial cost normalized to 1; and in state H, the returns to individuals X_i, is distributed uniformly in the range of $[0, 2b]$, where b is the average return to all individuals when the program is successful [5]. I shall assume that $b > 1$, which implies that more than half of the population will choose to invest in the program if it succeeds with certainty[6]. Since the conflict of interest between the government and its public is less severe at higher program success rate θ and at higher average benefit b, higher values of θ and b will be used as indicators of higher quality of governance.

[5] For compactness, we shall henceforth refer to b as average benefit. The difference in return could also be interpreted as different cost in investing in the program. Suppose the government requires support from individual public before implementing an income redistribution program that could potentially reduce crime rate through lower inequality. Assuming that the public receives the same benefits from reduction in crime through lower inequality, a person with higher income may be subjected to a higher tax rate compare to a person with lower income, and thus face a higher cost of participation.

[6] One could also consider a more general case in which initial investment cost c such that $b > c$. Since the key conditions in the analysis will involve benefit relative to cost, little is lost by normalizing cost c to 1.

We shall now focus on two media outlets. First denote $\hat{h}$ and $\hat{l}$ as media reports for state H and L respectively. Government-controlled mainstream media is assumed to truthfully report state H since the government wants individual public to invest in state H[7]. Bias in mainstream media report occurs in state L when $\hat{h}$ is observed with probability σ. We assume that bias σ, as well as any changes in bias, is observable by the public [8].

In addition to mainstream media, individual public also receives reports from foreign media [9]. We assume that the government cannot alter information content of foreign media report, however it could restrict information regarding the nature of the program, making foreign report potentially inaccurate. We characterize the accuracy of foreign media such that foreign media's signal $s \in \{h, l\}$ correctly matches the true state $S \in \{H, L\}$ with probability π. This implies that with probability $1 - \pi$, foreign media's signal does not match with the true state. We assume that $\pi > \frac{1}{2}$, and that the value of π is common knowledge. The foreign media truthfully reports its signal, thereby minimizing its probability of making incorrect reports. Finally, we assume that both mainstream media and foreign media *simultaneously* make their reports to the public.

To summarize the framework discussed in chronological order:

1. State $S \in \{H, L\}$ is revealed to the government/mainstream media only. Foreign media receives signal $s \in \{h, l\}$ such that with probability π, its signal s matches true state S.

2. Foreign media reports its signal truthfully while mainstream media reports according to government's editorial policy. Public observes bias, σ.

3. Upon receiving reports from all media outlets, public decides whether to invest in program or do nothing. Government receives a unit of utility for every public investment.

4. Returns are realized at the end of period.

[7] This assumption is similar to assumption used in Gehlbach and Sonin (2009) that report from state controlled media has "natural" meaning.

[8] This assumption is also used in Gehlbach and Sonin (2009). If individual public could not observe bias σ, then we may need some mechanism that provides sufficient incentives for government controlled media to follow a particular editorial policy. Otherwise the only Nash equilibrium is that mainstream media always reports $\hat{h}$ ($\sigma = 1$).

[9] Even though foreign media may be barred from broadcasting in local media market, some of the individual public may have access to reports from foreign media, and this information is spread among local public through Internet or mobile phones. Therefore we assume that the public has full access to foreign media report as if foreign media is broadcasting in the local foreign market. See Parry (2008) on the role of mobile phones in spreading news about food crisis.

3 Mainstream Media Bias in Absence of Foreign Media

To understand the presence of foreign media on government's mobilization effort through mainstream media control, it would be instructive to consider a benchmark case where public only receives report from government-controlled mainstream media [10]. Assuming that mainstream media truthfully reports state H, but reports $\hat{h}$ in state L with probability σ; public posterior belief of state H conditional on mainstream media report $\hat{h}$ is:

$$P(H|\hat{h}) = \frac{P(\hat{h}|H)P(H)}{P(\hat{h})} = \frac{\theta}{\theta + (1-\theta)\sigma}, \tag{1}$$

which is increasing in the program success rate θ and decreasing in bias σ. When bias σ equal 1, public posterior belief remains at θ as government controlled media cease to be informative as it reports $\hat{h}$ all the time.

Denote X_0 as the benefit level at which an individual would be indifferent between investing in the program and doing nothing upon receiving report $\hat{h}$. X_0 satisfies:

$$\begin{aligned} X_0 \Pr(H|\hat{h}) + 0 \Pr(L|\hat{h}) = 1 \Rightarrow X_0 \frac{\theta}{\theta + (1-\theta)\sigma} &= 1 \\ \Rightarrow X_0 = 1 + \left(\frac{1-\theta}{\theta}\right)\sigma & \end{aligned} \tag{2}$$

Given the uniform distribution of benefits, the fraction of total population that invest upon observing mainstream media report $\hat{h}$ is $\max\left\{\frac{2b-X_0}{2b}, 0\right\}$. Since no individual will invest in the program whenever mainstream media reports $\hat{l}$, the (expected) public investment is derived by multiplying the fraction of the total population that invest upon observing mainstream media report $\hat{h}$, with the probability of observing $\hat{h}$ from mainstream media. The government sets bias σ that maximizes the following public investment[11]:

$$\max_{\sigma \in [0,1]} \frac{1}{2b}\left[2b - 1 - \left(\frac{1-\theta}{\theta}\right)\sigma\right]\left[\theta + (1-\theta)\sigma\right], \tag{3}$$

Denote bias σ_n^* that maximizes public investment of equation (3). Given that σ_n^* is bounded by

[10] Alternatively one could assume that the foreign media that is perfectly inaccurate $\left(\pi = \frac{1}{2}\right)$.

[11] This assumes $X_0 \leq 2b$, which will always be the case at the optimum.

one, σ_n^* takes the following expression:

$$\sigma_n^* = \begin{cases} (b-1)\left(\frac{\theta}{1-\theta}\right) & \theta b \leq 1 \\ 1 & \theta b \geq 1 \end{cases} \tag{4}$$

With bias σ_n^* derived, denote V_n as maximal public investment, which follows from bias σ_n^*. Substituting σ_n^* into public investment (equation (3)), we obtain the following expression of V_n:

$$V_n = \begin{cases} V_n^i = \frac{\theta b}{2} & \text{for } \theta b \leq 1 \\ \bar{V}_n = 1 - \frac{1}{2b\theta} & \text{for } \theta b \geq 1 \end{cases} \tag{5}$$

Basic comparative statics on maximal public investment V_n demonstrates that:

$$\frac{\partial \sigma_n^*}{\partial(\theta b)} \geq 0 \qquad \frac{\partial V_n^i}{\partial(\theta b)} > 0 \qquad \frac{\partial \bar{V}_n}{\partial(\theta b)} > 0$$

bias σ_n^* and maximal public investment V_n is strictly increasing in expected average benefit θb. At higher level of expected average benefit θb, bias σ plays a smaller role in influencing public investment. Since the cost of biasing mainstream media content is lower, media content becomes more biased to increase likelihood of public investment.

Proposition 1 *Gehlbach and Sonin (2009): When government controls mainstream media in absence of foreign media, bias σ_n^*, and maximal public investment V_n, is increasing in expected average benefit θb. Probability of lying $(1-\theta)\sigma_n^*$, is increasing in expected average benefit θb, for $\theta b < 1$ and decreasing in expected average benefit θb for $\theta b \geq 1$, when government controlled media ceases to be informative.*

4 Presence of Foreign Media on Mainstream Media Bias

In the previous section, we focus only on analysis where public receives information through government controlled mainstream media. In this section, public receives an additional source of unbiased information through foreign media with a predetermined level of accuracy π. The availability of the foreign media report reduces government's effectiveness of using mainstream media to mobilize public investment because individuals investment decisions now depend on foreign media reports. Assuming that mainstream media maintains truthful reporting of state H, then public places zero probability on state H whenever $\hat{l}$ is observed from mainstream media. Assuming that both media simultaneously make their reports to the public, then whenever $\hat{h}$ is observed from both media outlets, i.e. $\{M = \hat{h},\ F = \hat{h}\}$, public's posterior belief of state H is:

$$\Pr(H|M = \hat{h}, F = \hat{h}) = \frac{\pi\theta}{\pi\theta + (1-\pi)(1-\theta)\sigma} \tag{6}$$

which is increasing in foreign media accuracy, π. This is derived from the observation that there are two paths to observing $\{M = \hat{h}, F = \hat{h}\}$. First, the true state may be H (probability θ) in which case the mainstream media reports $\hat{h}$ for sure and the foreign media reports $\hat{h}$ with probability π. Second, the true state may be L (probability $1-\theta$), in which case the mainstream media reports $\hat{h}$ with probability σ and the foreign media errs and reports $\hat{h}$ with probability $1-\pi$. Denote X_1 as the benefit level at which an individual would be indifferent between investing in the program and doing nothing upon observing report $\hat{h}$ from both media outlets. Mathematically, X_1 satisfies $X_1 Pr(H|M = \hat{h}, F = \hat{h}) + 0Pr(L : |M = \hat{h}, F = \hat{h}) = 1$. Therefore, the fraction of total population that invest is $\max\left\{\frac{2b-X_1}{2b}, 0\right\}$ where:

$$X_1 = 1 + \left(\frac{1-\pi}{\pi}\right)\left(\frac{1-\theta}{\theta}\right)\sigma \tag{7}$$

Whenever the public observe mainstream media report $\hat{h}$ and foreign media report $\hat{l}$, i.e. $\{M = \hat{h}, F = \hat{l}\}$, public's posterior belief of state H is:

$$\Pr(H|M = \hat{h}, F = \hat{l}) = \frac{\theta(1-\pi)}{\theta(1-\pi) + \pi(1-\theta)\sigma} \tag{8}$$

which is decreasing in foreign media accuracy π. This is derived from the observation that there are two paths to observing $\{M = \hat{h}, F = \hat{l}\}$. First, the true state may be H (probability θ) in which case the mainstream media reports $\hat{h}$ for sure and foreign media errs and reports $\hat{l}$ with probability $1-\pi$. Second, the true state may be L (probability $1-\theta$), in which case the mainstream media reports $\hat{h}$ with probability σ and foreign reports $\hat{l}$ with probability π. Denote X_2 as the benefit level at which an individual would be indifferent between investing in the program and doing nothing after observing mainstream media report of $\hat{h}$ and foreign media report of $\hat{l}$. Mathematically, X_2 satisfies $X_2 Pr(H|M = \hat{h}, F = \hat{l}) + 0Pr(H|M = \hat{h}, F = \hat{l}) = 1$. Therefore the fraction of total population that invest is $\max\left\{\frac{2b-X_2}{2b}, 0\right\}$ where:

$$X_2 = 1 + \left(\frac{\pi}{1-\pi}\right)\left(\frac{1-\theta}{\theta}\right)\sigma \tag{9}$$

Note that $X_2 > X_1$, since $\pi > \frac{1}{2}$. Thus fewer citizens invest when hearing $\{M = \hat{h}, F = \hat{l}\}$, than when hearing $\{M = \hat{h}, F = \hat{h}\}$. Of course no one invest when $M = \hat{l}$ since mainstream media does not lie in that direction. Denote $\bar{\sigma} = (2b-1)\left(\frac{\theta(1-\pi)}{(1-\theta)\pi}\right)$ as the upper bound for bias such that for $\sigma \leq \bar{\sigma}$, $X_2 \leq 2b$; that is if $\sigma \leq \bar{\sigma}$, someone at least weakly prefers investing when mainstream media reports $\hat{h}$ and when foreign reports $\hat{l}$. If $\sigma \geq \bar{\sigma}$, no one invests when either media reports $\hat{l}$. Therefore in the presence of foreign media, the government chooses σ that maximizes the following public investment[12]:

$$\max_{\sigma\in[0,1]} \begin{cases} \frac{1}{2b}\left[2b-1-\left(\frac{1-\pi}{\pi}\right)\left(\frac{1-\theta}{\theta}\right)\sigma\right][\theta\pi + (1-\theta)(1-\pi)\sigma] & \\ \quad +\frac{1}{2b}\left[2b-1-\left(\frac{\pi}{1-\pi}\right)\left(\frac{1-\theta}{\theta}\right)\sigma\right][\theta(1-\pi) + (1-\theta)\pi\sigma] & \text{if } \sigma \leq \bar{\sigma} \\ \\ \frac{1}{2b}\left[2b-1-\left(\frac{1-\pi}{\pi}\right)\left(\frac{1-\theta}{\theta}\right)\sigma\right][\theta\pi + (1-\theta)(1-\pi)\sigma] & \text{if } \sigma \geq \bar{\sigma} \end{cases} \tag{10}$$

Focusing on bias below $\bar{\sigma}$, public investment (equation (10)) consists of two expression: the first expression corresponds to public investment when public hear $\{M = \hat{h}, F = \hat{h}\}$; while the second expression corresponds to public investment when public hears $\{M = \hat{h}, F = \hat{l}\}$. When bias σ exceeds $\bar{\sigma}$, the second expression is zero, indicating that public investment only occurs when public observes $\hat{h}$ from both mainstream media and foreign media. This give rise to two potential local public investment optima that corresponds to two levels of bias. We characterize first the two local optima, then derive the global optimum.

[12]The expression assumes $X_1 \leq 2b$, which will always be the case at the optimum.

4.1 Low Bias

Denote low bias σ_l as the bias below $\bar{\sigma}$ that maximizes public investment (equation (10)). In other words, bias is restricted to be sufficiently *small* that someone at least weakly prefers investing whenever the mainstream media reports $\hat{h}$, even if foreign media reports $\hat{l}$. Denote $k(\pi) = \frac{\pi(1-\pi)}{1-3\pi+3\pi^2}$, the expression of σ_l simplifies to:

$$\sigma_l = \min\left[(b-1)\left(\frac{\theta}{1-\theta}\right)k(\pi), 1\right] \tag{11}$$

With assumptions $b > 1$ and $\pi \in \left(\frac{1}{2}, 1\right)$, one could show that low bias σ_l lies in the interior of $[0, \bar{\sigma}]$[13]. Thus whenever bias follows σ_l, public investment is strictly positive whenever $\hat{h}$ is observed from mainstream media. Note that the expression $k(\pi)$ is decreasing in foreign media accuracy π, reaching its upper bound of 1 at $\pi = \frac{1}{2}$, and reaching its lower bound of 0 at $\pi = 1$. Therefore bias that follows σ_l is weakly decreasing in foreign media accuracy π. In this region of the objective function, then, the foreign media essentially provides greater discipline for the local media. It alters the cost-benefit bias calculation in such a way that bias becomes less attractive as an avenue for gaining support. A more accurate foreign media implies lower mainstream media bias, whereby bias approaches zero as accuracy gets closer to perfect.

For $\theta b \geq 1$, bias σ_l reaches its upper bound of one at low levels of foreign media accuracy π. Denote $\hat{\pi}_l = \frac{1}{2}\left(1 + \sqrt{\frac{\theta b - 1}{3-(4-b)\theta}}\right)$; one can show that for $\theta b \geq 1$ and $\pi \leq \hat{\pi}_1$, $\sigma_l = 1$. Denote maximal public investment, V_l when bias follows σ_l. Substituting bias σ_l (equation (11)) into public investment (equation (10)), we obtain:

$$V_l = \begin{cases} V_l^i = \frac{\theta}{2b}\left[(2b-1) + k(\pi)(b-1)^2\right] & \text{for } \theta b \leq 1, \text{ or } \pi \geq \hat{\pi}_l \\ \bar{V}_l = 1 - \frac{(2-\theta)}{2b} - \frac{1}{2b}\left(\frac{(1-\theta)^2}{\theta}\right)\left(\frac{1-3\pi+3\pi^2}{\pi(1-\pi)}\right) & \text{for } \theta b \geq 1 \text{ and } \pi \leq \hat{\pi}_l \end{cases} \tag{12}$$

[13] The inequality $\overline{\sigma} > \sigma_l$ is equivalent to $\overline{\sigma} - \sigma_l = \left(\frac{\theta(1-\pi)}{(1-\theta)\pi}\right)\left(2b - 1 - (b-1)\frac{\pi^2}{1-3\pi+3\pi^2}\right) > 0$. This is equivalent to $\left(\frac{1-3\pi+3\pi^2}{\pi^2} > \frac{b-1}{2b-1}\right)$ for $b > 1$ and $\frac{1}{2} < \pi < 1$. To show that this is true, note that $\frac{b-1}{2b}$ is increasing in b, and reaches its upper bound of $\frac{1}{2}$ as b approaches ∞. On the other hand the expression $\frac{1-3\pi+3\pi^2}{\pi^2}$ is a convex function of π that reaches its minimum of $\frac{3}{4}$ at $\pi = \frac{2}{3}$, therefore the inequality $\left(\frac{1-3\pi+3\pi^2}{\pi^2} > \frac{b-1}{2b-1}\right)$ holds for $b > 1$ and $\frac{1}{2} < \pi < 1$.

Basic comparative statics on maximal public investment V_l demonstrates that

$$\frac{\partial V_l^i}{\partial \pi} < 0 \qquad \frac{\partial \bar{V}_l}{\partial \pi} < 0$$

maximal public investment V_l is decreasing in foreign media accuracy π. The cross partial derivatives for V_l demonstrates that

$$\begin{array}{ll} \frac{\partial^2 V_l^i}{\partial \pi \partial \theta} < 0 & \frac{\partial^2 V_l^i}{\partial \pi \partial b} < 0 \\ \frac{\partial^2 \bar{V}_l}{\partial \pi \partial \theta} > 0 & \frac{\partial^2 \bar{V}_l}{\partial \pi \partial b} > 0 \end{array} \tag{13}$$

For bias σ_l below 1, higher program success rate θ or average benefit b causes greater reduction in maximal public investment from an increase in foreign media accuracy π. Since higher θ and b indicate higher quality of governance, this implies that higher quality governments have greater desire to suppress foreign media, compare to lower quality governments. We shall observe this result section 6 when we analyze government's decision to suppress foreign media. In the case of $\sigma_l = 1$ where mainstream media remains uninformative despite the presence of foreign media, higher θ or b causes smaller reduction in maximal public investment from an increase in π. This implies that higher quality of governments have lesser desire to suppress foreign media, compare to lower quality governments. To understand the signs on the cross partial derivatives, one could observe from equation (7) and equation (9) that as long as bias σ_l equals 1, higher values of θ or b reduces the role of foreign media accuracy π in influencing public investment. In contrast when bias equals $\sigma_l < 1$, higher values of θ or b implies higher bias σ_l. The increase in bias σ_l increases the role of foreign media accuracy π in influencing public investment because citizens rely less on more biased mainstream media report.

4.2 High Bias

As long as $\bar{\sigma}$ remains less than one, there exist another local bias in the range of $[\bar{\sigma}, 1]$. Denote high bias σ_h as the locally optimal bias between $[\bar{\sigma}, 1]$ that maximizes public investment. Therefore public investment occurs only when both media outlets report $\hat{h}$. Solving for bias σ_h, we obtain:

$$\sigma_h = \min\left\{(b-1)\left(\frac{\theta}{1-\theta}\right)\left(\frac{\pi}{1-\pi}\right), 1\right\} \tag{14}$$

Note that bias in this region, σ_h, is increasing in foreign media accuracy π. This reverses the common sense result of the previous section, where a more accurate foreign media provides greater discipline on local bias. Here, greater foreign accuracy provokes local bias. The intuition is as follows. Given that $\sigma_h \geq \bar{\sigma}$, investment only occurs when both media sources report $\hat{h}$. With greater foreign accuracy, the public put more stock in the foreign report, so the decline in investment due to increased local bias is lessened. This lowers the cost of bias, and outweighs the decreased benefit of bias (coming from its smaller influence) to push the local media toward a more biased policy.

Since bias σ_h reaches its upper bound of one when accuracy of foreign media π approaches perfect, denote $\hat{\pi}_h = \frac{1-\theta}{\theta(b-1)+(1-\theta)}$ such that for $\pi \geq \hat{\pi}_h$, $\sigma_h = 1$. When bias follows σ_h, maximal public investment V_h takes the following expression:

$$V_h = \begin{cases} V_h^i = \frac{\theta\pi b}{2} & \text{for } \pi \leq \hat{\pi}_h \\ \bar{V}_h = \frac{1}{2b}\left[2b-1-\left(\frac{(1-\theta)(1-\pi)}{\theta\pi}\right)\right](\theta\pi+(1-\theta)(1-\pi)) & \text{for } \pi \geq \hat{\pi}_h \end{cases} \tag{15}$$

Assuming bias follows σ_h, comparative statics demonstrates that:

$$\begin{aligned} &\frac{\partial V_h^i}{\partial \pi} > 0 \qquad \frac{\partial^2 V_h^i}{\partial \pi \partial \theta} > 0 \qquad \frac{\partial^2 V_h^i}{\partial \pi \partial b} > 0 \\ &\frac{\partial \bar{V}_h}{\partial \pi} < 0 \quad \text{for } \theta \leq \frac{1}{2} \qquad \frac{\partial^2 \bar{V}_h}{\partial \pi \partial \theta} \geq 0 \quad \text{for } \theta \geq \sqrt{\frac{1-\pi^2}{4\pi^2(b-1)+1}} \\ &\frac{\partial^2 \bar{V}_h}{\partial \pi \partial b} \geq 0 \quad \text{for } \theta \geq \frac{1+\pi}{2\pi+1} \end{aligned} \tag{16}$$

For $\sigma_h < 1$, maximal public investment not only increase in π, but further increase in b and θ positively reinforces this effect. For $\sigma_h = 1$, when government controlled media becomes uninformative, public investment only increases in π when $\theta \geq \frac{1}{2}$. We shall demonstrate later that when bias equals $\sigma_h = 1$, $\theta < \frac{1}{2}$, which implies that maximal public investment $\bar{V}_h$ is decreasing in π.

We have established that the presence of foreign media reduces the efficiency of government-controlled media in mobilizing public investment. We can make a stronger statement using maximal public investment without foreign media V_n (equation (5)), and maximal public investment with presence of foreign media $V \in \{V_l, V_h\}$ (equation (12) and equation (15)) to show the following proposition:

Proposition 2 *Maximal public investment in absence of foreign media V_n is greater than maximal public investment with presence of foreign media V.*

This implies that the presence of foreign media is undesirable to the government because it reduces public investment in the program.

4.3 Globally Optimal Bias

In previous section 4.1 and section 4.2, we have characterize the behavior of two local optimal bias: low bias σ_l and high bias σ_h; as well as changes in maximal public investment V_l and V_h, in response to a predetermined accuracy level of foreign media π. Here, we specify the conditions under which bias follows σ_l or σ_h. Since mainstream will adopt bias that yields the highest public investment, bias that follows σ_l, or σ_h, is outlined in the following proposition:

Proposition 3 *In the case of a mainstream media and a single foreign media:*
For $\theta \geq \frac{2(b-1)}{b^2+2(b-1)}$, bias σ^* follows σ_l and therefore decreases in π for $\pi \in \left(\frac{1}{2}, 1\right)$ and approaches 0 as π approaches 1.
For $\theta < \frac{2(b-1)}{b^2+2(b-1)}$, there exists a critical level of $\pi' \in \left(\frac{1}{2}, 1\right)$ such that: 1) For $\pi \in \left(\frac{1}{2}, \pi'\right)$, bias σ^* follows σ_l and therefore decreases in π. Some people invest in the program whenever the mainstream media reports $\hat{h}$. 2) For $\pi \in (\pi', 1)$ bias follows σ_h and therefore increases in π and reaches $\sigma = 1$ for $\pi < 1$ high enough. No one invests whenever the foreign media reports $\hat{l}$.

For illustrative purposes, figure 1 (also in appendix section 3) maps the combination of program success rate θ (vertical axis) and average benefit b (horizontal axis) that determines the direction of bias σ^* in response to presence of foreign media. In particular, denote areas A and A', which lies above line 1 of $\theta = \frac{2(b-1)}{b^2+2(b-1)}$, where bias follows σ_l, and is decreasing in foreign media accuracy π. Denote areas B, B' and C, which lies below line 1 of $\theta = \frac{2(b-1)}{b^2+2(b-1)}$, in which bias follows σ_l and is decreasing in π when π is below some critical threshold π', but follows bias σ_h for $\pi > \pi'$

and bias is weakly increasing in foreign media accuracy π[14]. To illustrate the direction on bias σ^*

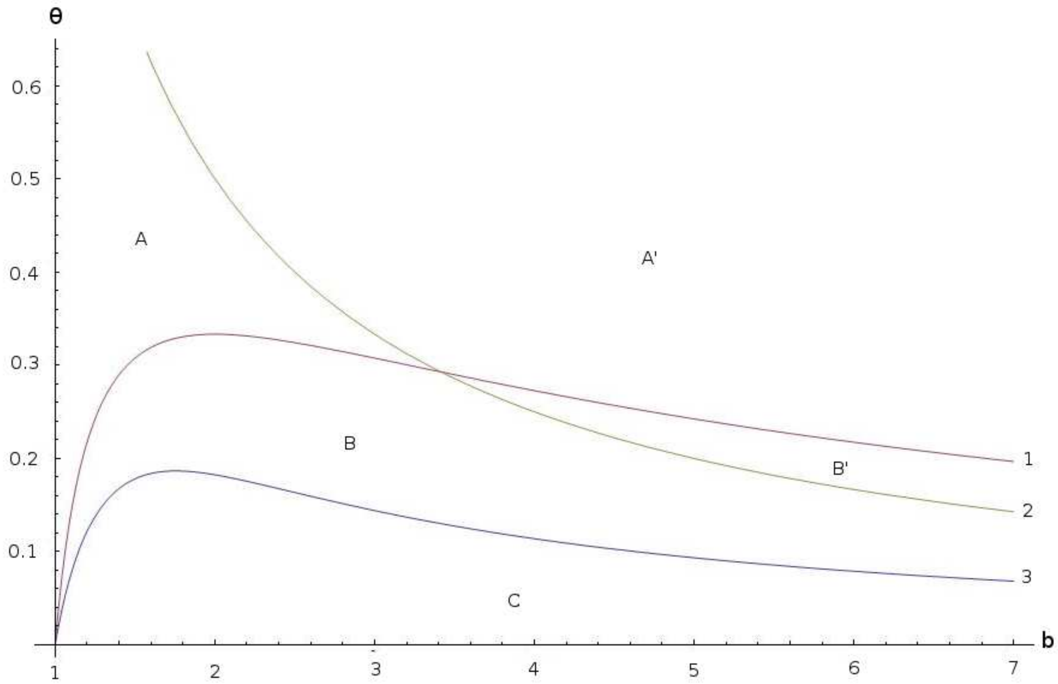


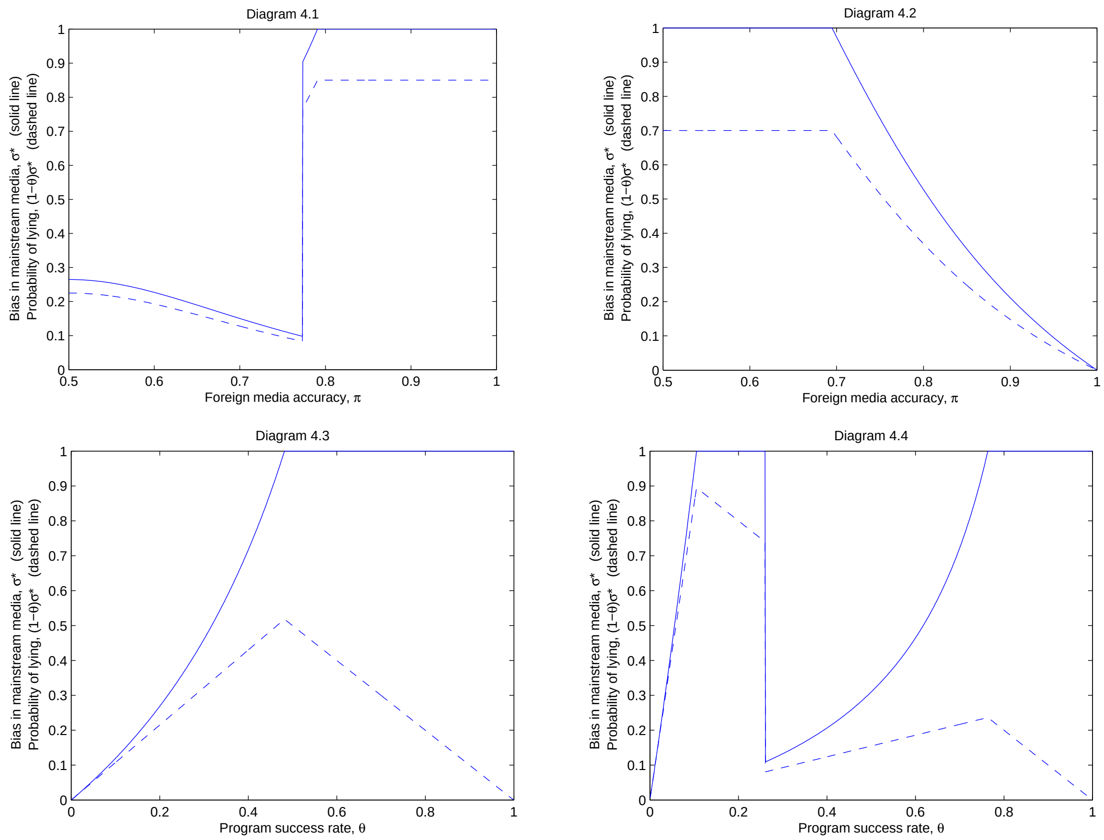
Figure 1: Mapping of bias in mainstream media σ^*

in response to foreign media, diagrams 4.1 and diagram 4.2 compute bias in mainstream media σ^* (solid line), and probability of lying $(1-\theta)\sigma^*$ (dashed line), with respect to foreign media accuracy π. In particular, diagram 4.1 sets program success rate at $\theta = 0.15$ and average benefit at $b = 2.5$, which satisfy $\theta < \frac{2(b-1)}{b^2+2(b-1)}$ and is located in area C. For low values of foreign media accuracy π, bias follows σ_l, and is strictly decreasing in π. Once π exceeds 0.774[15], bias discontinuously increases from $\sigma^* = \sigma_l = 0.098$ to $\sigma^* = \sigma_h = 0.905$, and is weakly increasing in foreign media accuracy π. Diagram 4.2 on the other hand fixed program success rate at $\theta = 0.30$ and average benefit at $b = 5$, which satisfy $\theta \geq \frac{2(b-1)}{b^2+2(b-1)}$. Located in area A' bias σ^* equals $\sigma_l = 1$ for $\pi \leq \hat{\pi}_l = 0.695$, is strictly decreasing in π for $\pi > 0.695$, and approaches zero when π is close to 1.

This result is important because it demonstrates that while foreign media typically disciplines local bias, it can have the opposite effect, pushing local media to extreme level of bias. It also suggests

[14]The difference between areas B, B' and area C is as follows: In areas B or B', bias increases from $\sigma_l < 1$ for $\pi < \pi'$ to $\sigma_h = 1$ for $\pi > \pi'$ where π' solves $V_l^i = \bar{V}_h$. In area C, bias increases from $\sigma_l < 1$ for $\pi < \pi''$ to $\sigma_h < 1$ for $\pi'' < \pi < \hat{\pi}_h$ where π'' solves $V_l^i = V_h^i$, and remains at $\sigma_h = 1$ for $\pi > \hat{\pi}_h$.

[15]The simulated figures used in diagram 4.1 to diagram 4.4 are significant to three digits.



the increase in bias tends to occur in countries with low quality of governance (low θ and low b); while the presence of foreign media on countries with high quality of governance tends to reduce bias in mainstream media. Proposition 3 suggests that even with very low quality of governance, as long as foreign media accuracy π is sufficiently low, the presence of foreign media disciplines local media bias. Diagram 4.3 and diagram 4.4 above illustrate bias in mainstream media σ^* (solid line), and probability of lying ($(1-\theta)\sigma^*$) (dotted line) with respect to program success rate θ. In particular, diagram 4.3 sets average benefit at $b = 2.5$ but with relatively low accuracy of $\pi = 0.65$. Since foreign media accuracy is below the critical threshold, bias σ^* equals σ_l for all values of $\theta \in (0, 1)$. Since bias $\sigma^* = \sigma_l$ is below bias without foreign media (equation (4)), the presence of foreign media reduces bias in mainstream media. Diagram 4.4 on the other hand, sets similar average benefit at $b = 2.5$, but with higher foreign media accuracy of $\pi = 0.85$ that exceeds critical threshold π'. For θ in the range of $(0, 0.261)$), bias σ^* follows high bias σ_h, in which bias equals $\sigma_h < 1$ for $\theta < 0.105$, and equals $\sigma_h = 1$ for $\theta \in [0.105, 0.261)$. Bias discontinuously decreases from $\sigma_h = 1$, $\sigma_l = 0.109$ at

$\theta = 0.261$ and continues to follow σ_l for $\theta \geq 0.261$. For average benefit $b = 2.5$ and program success rate θ in the range of $(0.261, 0.763)$ the presence of foreign media of accuracy $\pi = 0.85$ reduces bias relative to the case without foreign media[16]; while bias with foreign media is higher than the case without foreign media for θ in the range of $(0, 0.261)$.

5 Public Welfare

So far we have remained silent on the issue on the effects of foreign media on the welfare of the public. In previous section for very low program success rate θ and high foreign media accuracy π, bias in mainstream content increases to extreme level and is undesirable to the public that uses its report to make investment decision and now relies on foreign media report. Does the presence of foreign media as a new source of information make up for a more biased mainstream media content? In order to quantify public welfare, recall the basic framework of section 2 where individuals that invest in the program incur initial investment cost of 1, and receives benefit X_i in state H, where individual benefit X_i is uniformly distributed between $[0, 2b]$. Therefore public welfare can be quantified as the total surplus from public investment in state H after subtracting losses from public investment in state L.

5.1 Public Welfare in Absence of Foreign Media

The *first best* outcome requires government commitment to allow mainstream media to truthfully report its signal. If this is possible, then whenever government announces $\hat{h}$, those with benefit X_i greater than investment cost of 1 will invest in the program. Denote first best public welfare as W_{FB}. Mathematically:

$$W_{FB} = \theta \int_1^{2b} (X - 1) \frac{dX}{2b} = \theta b \left(1 - \frac{1}{2b}\right)^2 \tag{17}$$

aggregates net public benefit, $(X - 1)$, for those who invest in government's program at state H (which occurs with probability θ).

In a case where government controls mainstream media to maximize expected level of public

[16]Foreign media could potentially reduce bias σ_l for $\theta > 0.763$, if its accuracy level π exceeds 0.85.

investment, denote W_n as public welfare without foreign media that takes the following expression:

$$W_n = \theta \int_{X_0}^{2b} (X-1)\,\frac{dX}{2b} - (1-\theta)\sigma_n^* \int_{X_0}^{2b} \frac{dX}{2b}$$

where X_0 (from equation (2)) is the benefit level at which an individual is indifferent between investing in program and doing nothing upon observing mainstream media report $\hat{h}$, and σ_n^* (from equation (4)) is bias without foreign media. The first expression of W_n is total surplus from public investment in state H (which occurs with probability θ) upon observing mainstream media report $\hat{h}$. The second expression of W_n represents expected public loss from investing in state L. Recall that in state L, mainstream media report $\hat{h}$ with probability σ_n^*. This induces $\left(\frac{2b-X_0}{2b}\right)$ fraction of total population to invest in the program, receiving zero benefit in return. Recall from equation (4) for $\theta b \geq 1$, σ_n^* reaches its upper bound of 1 . Thus the expression W_n could be further simplified to:

$$W_n = \begin{cases} W_n^i = \frac{\theta b}{4} & \text{for } \theta b \leq 1 \\ \overline{W}_n = \theta b\left(1 - \frac{1}{2b\theta}\right)^2 & \text{for } \theta b \geq 1 \end{cases} \tag{18}$$

Note that public welfare in absence of foreign media W_n, is lower than first best public welfare W_{FB}, for two reasons. First, some of the public that receive positive net benefit from investment in state H (namely $X \in [1, X_0)$), chooses not to do so because of the expectation that mainstream media may be manipulating its news. Second, there are public losses from investment in program in state L when mainstream reports $\hat{h}$.

5.2 Public Welfare with Presence of Foreign Media

Focusing first on public welfare when mainstream media adopts low bias σ_l, denote W_l as the corresponding public welfare. W_l takes the following expression:

$$W_l = \theta\left[\pi \int_{X_1}^{2b} (X-1)\,\frac{dX}{2b} + (1-\pi)\int_{X_2}^{2b} (X-1)\,\frac{dX}{2b}\right] - (1-\theta)\left[(1-\pi)\sigma_l \int_{X_1}^{2b} \frac{dX}{2b} + \pi\sigma_l \int_{X_2}^{2b} \frac{dX}{2b}\right]$$

where X_1 (from equation (7)) is the benefit level at which an individual would be indifferent between investing in the program and doing nothing upon observing report $\hat{h}$ from both media outlets; X_2 (from equation (9)) is the benefit level at which an individual is indifferent between investing in the program and doing nothing when mainstream media report of $\hat{h}$ and foreign media report of $\hat{l}$; and low bias σ_l (from equation (11)) is the probability of mainstream media report $\hat{h}$ in state L. The first two expressions of W_l is the total surplus from public investment at state H. In state H, foreign media correctly reports $\hat{h}$ with probability π, but errs in reporting $\hat{l}$ with probability $(1-\pi)$. This in turn induces public investment of $\left(\frac{2b-X_1}{2b}\right)$ and $\left(\frac{2b-X_2}{2b}\right)$ respectively. The last two expressions of W_l represent public losses from public investment in state L. Recall that when bias follows σ_l, mainstream report of $\hat{h}$ is observed in state L with probability σ_l. Foreign media in turn, correctly reports $\hat{l}$ with probability π and errs in reporting $\hat{h}$ with probability $1-\pi$. Therefore in state L, public investment of $\left(\frac{2b-X_1}{2b}\right)$ and $\left(\frac{2b-X_2}{2b}\right)$ occurs when public hears $\{M = \hat{h}, F = \hat{h}\}$ and hears $\{M = \hat{h}, F = \hat{l}\}$ respectively. For $\theta b \geq 1$, since bias equals $\sigma_l = 1$ for $\pi < \hat{\pi}_l$, public welfare W_l can be simplified to:

$$W_l = \begin{cases} W_l^i = \theta b \left[\left(1 - \frac{1}{2b}\right)^2 - \frac{(3b-1)(b-1)}{4b^2} \left(\frac{\pi(1-\pi)}{1-3\pi+3\pi^2} \right) \right] & \text{for } \theta b \leq 1 \text{ or } \pi \geq \hat{\pi}_l \\ \overline{W}_l = \theta b \Big\{ \pi \left[1 - \frac{1}{2b}\left(1 + \frac{(1-\theta)(1-\pi)}{\theta\pi}\right)\right]^2 & \\ \qquad + (1-\pi)\left[1 - \frac{1}{2b}\left(1 + \frac{(1-\theta)\pi}{\theta(1-\pi)}\right)\right]^2 \Big\} & \text{for } \theta b \geq 1 \text{ and } \pi \leq \hat{\pi}_l \end{cases} \tag{19}$$

Note that for low bias σ_l, public welfare W_l^i equals W_n when foreign media accuracy is at $\pi = \frac{1}{2}$, which is equivalent to its nonexistence. Also note that as foreign media accuracy π approaches perfect accuracy of $\pi = 1$, public welfare W_l^i approaches first best welfare W_{FB}. Furthermore, public welfare W_l is strictly increasing in foreign media accuracy π for two reasons. First, public benefits when the quality of foreign media reports improves. Second, the increases in foreign media accuracy also improves quality of mainstream report when foreign media disciplines local mainstream media by reducing bias.

When bias σ^* follows, σ_h, public investment only occurs when report $\hat{h}$ is observed from both mainstream media and foreign media. Denote the corresponding public welfare as W_h where:

$$W_h = \theta\pi \int_{X_1}^{2b} (X-1)\frac{dX}{2b} - (1-\theta)(1-\pi)\sigma_h \int_{X_1}^{2b} \frac{dX}{2b}$$

where σ_h (from equation (14)) is probability of mainstream media report of $\hat{h}$ in state L. The first expression of W_h is the is the total surplus from public investment at state H, which occurs when foreign media correctly reports $\hat{h}$ with probability π. The second expression is the expected public losses from investment in state L, which occurs when foreign media errs in reporting $\hat{h}$ with probability $1-\pi$, and bias mainstream report of $\hat{h}$ with probability σ_h. Since high bias σ_h reaches the upper bound of one when foreign media accuracy π exceeds $\hat{\pi}_h$, the expression of public welfare W_h simplifies to:

$$W_h = \begin{cases} W_h^i = \frac{\pi\theta b}{4} & \text{for } \pi \leq \hat{\pi}_h \\ \overline{W}_h = \pi\theta b \left[1 - \frac{1}{2b}\left(1 + \frac{(1-\theta)(1-\pi)}{\theta\pi}\right)\right]^2 & \text{for } \pi \geq \hat{\pi}_h \end{cases} \tag{20}$$

When bias follows σ_h, note that for foreign media accuracy π exceeds some critical threshold π'[17] and lies between $(\pi', \hat{\pi}_h]$, public welfare W_h^i *is less than* W_n. In this region, public welfare loss from more biased mainstream media content, exceeds the benefit from having additional information from foreign media. Furthermore public welfare in absence of foreign media is higher than public welfare with foreign media ($\bar{W}_h < W_n$) in a neighborhood of $\hat{\pi}_h$ in area C. Nevertheless even if mainstream bias follows σ_h, public welfare W_h, is strictly increasing in π, and approaches first best level W_{FB} when foreign media approaches perfect accuracy.

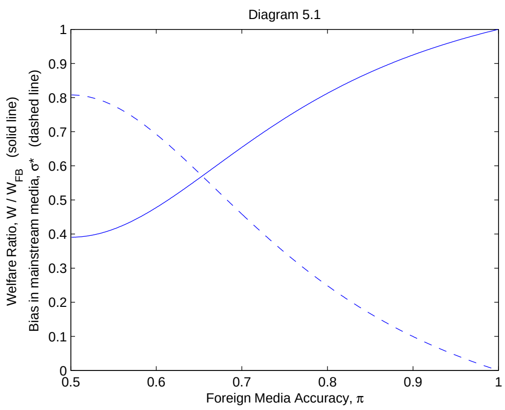
5.3 The Effect of Foreign Media on Public Welfare

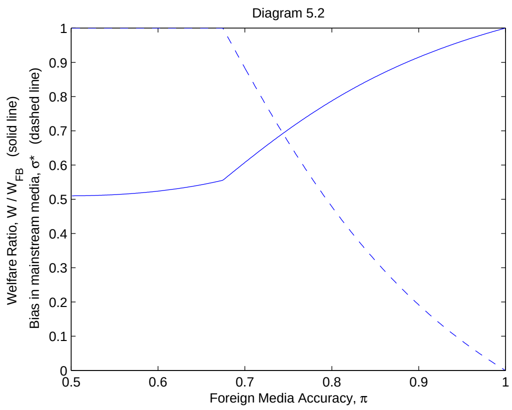
Using the expression of public welfare above and proposition 3 that characterize the behavior of bias in response to foreign media accuracy, we arrive to the following proposition:

Proposition 4 *In a case of single media and single foreign media:*
For $\theta \geq \frac{2(b-1)}{b^2+2(b-1)}$*, public welfare strictly increases in* π*.*
For $\theta < \frac{2(b-1)}{b^2+2(b-1)}$*, there exist a critical level of* π' *where public welfare is strictly increases in* $\left(\frac{1}{2}, \pi'\right)$*, falls to lower level at* π'*, and monotonically increases in* π *for* $\pi \in (\pi', 1)$*. For* θ *low enough, i.e, below some strictly positive function* $f(b)$*, welfare is lower with a foreign media of accuracy* π *in a right neighborhood of* π' *than without a foreign media.*

[17] Recall that the critical threshold π' in section 4.3 where bias follows σ_l for $\pi < \pi'$ and bias follows σ_h for $\pi > \pi'$.

To demonstrate the first part of proposition 4 we shall focus first on public welfare in cases where presence of foreign media reduces bias of mainstream media report. First denote W as public welfare with the presence of foreign media. Diagram 5.1 and 5.2 below compute public welfare relative to first best, $\frac{W}{W_{FB}}$ [18] (solid line), bias in mainstream media, σ^* (dashed lines) with respect to foreign media accuracy π. In diagram 5.1, we set program success rate at $\theta = 0.35$ and average benefit at $b = 2.5$; while in diagram 5.2 we set program success rate at $\theta = 0.28$ and average benefit at $b = 5$. Both cases satisfy the $\theta \geq \frac{2(b-1)}{b^2+2(b-1)}$ inequality, except that the former is located in area A of figure 1, while the latter is located in area A'. Note that in diagram 5.1, public welfare $\frac{W}{W_{FB}}$, is strictly increasing in foreign media accuracy π, which is driven by improvement in foreign media content, as well as improvement in mainstream report from bias decreasing in π. In diagram 5.2, bias σ^* remains unchanged at $\sigma_l = 1$ for $\pi \leq 0.674$ and welfare improvement in this region is driven only by increase in π. Therefore when foreign media accuracy π exceeds 0.674, the pace of welfare improvement in this region is faster from improvements in mainstream media report as bias σ_l is strictly decreasing in π.

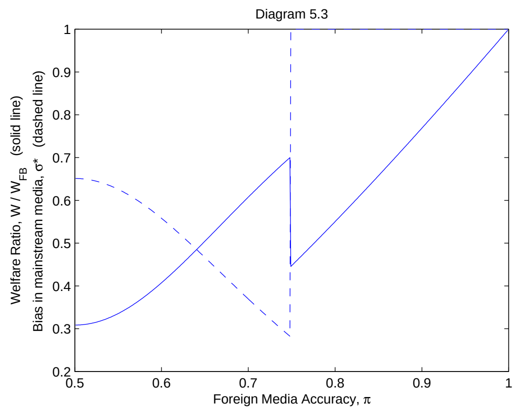


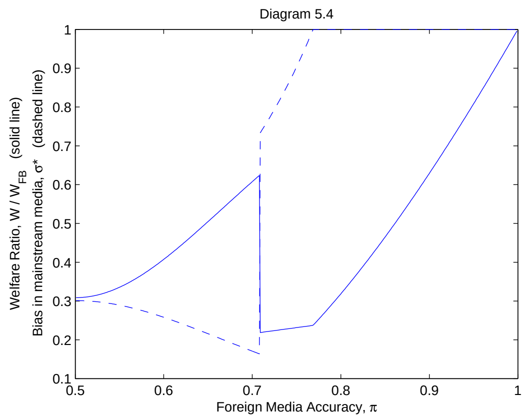


However the second part of proposition 4 states that for low values of program success rate θ, public welfare is not monotonically increasing in foreign media accuracy π because mainstream bias σ^* discontinuously increase to extreme level when foreign media accuracy π exceeds some threshold π. Diagram 5.3 and diagram 5.4 below compute public welfare relative to first best $\frac{W}{W_{FB}}$ (solid line) and bias σ^* (dotted line) with respect to foreign media accuracy π. In particular, diagram

[18]Public welfare W relative to first best public welfare W_{FB} is used so that the range lies between $[0, 1]$. Note too that W_{FB} does not depend on foreign media accuracy π. Therefore any change in $\frac{W}{W_{FB}}$ from changes in foreign media accuracy π attributed to effects of π on W.

5.3 sets program success rate at $\theta = 0.14$ and and average benefit at $b = 5$. Note that public welfare is piecewise increasing in foreign media accuracy π, with a drop in public welfare when bias discontinuously increases from $\sigma_l = 0.283$ to $\sigma_h = 1$. Nevertheless public welfare in this region remains higher compared to a case without foreign media (W at $\pi = \frac{1}{2}$), despite large increase in bias in mainstream media. However this may not be true for smaller program success rate θ. As an example, diagram 5.4 sets average benefit at $b = 5$ but at very low program success rate of $\theta = 0.07$. Located in the interior of area C, even though public welfare is piecewise increasing in foreign media accuracy π, for π between the range of $(0.709, 0.796)$, public welfare is below public welfare without independent media (W for $\pi = \frac{1}{2}$). Note further that within this region, public welfare is increasing in π at slower rate, because the increase in bias σ^* that follows σ_h dampens improvement in public welfare through increase in foreign media accuracy π. Nevertheless public welfare approaches first best case W_{FB} as π approaches perfect accuracy.





Proposition 4, with the help of diagram 5.1 to diagram 5.4, outlines the cases where presence of foreign media improves public welfare (areas A, A', B' and upper portions of area B of Figure 1), as well as cases in which the presence of foreign media could potentially reduce public welfare (area C, as well as area B in the neighborhood of area C). In cases where public welfare is monotonically increasing in foreign media accuracy (areas A and A'), welfare improvement comes from two distinct sources: first, public benefits from additional information source provided by foreign media, and second, quality of mainstream report is higher from lower bias. This implies that welfare improvement occurs when foreign media is present in countries with sufficiently high quality of governance (high θ and b). In countries with moderate level of governance (area B' and upper portion of area B), public welfare with foreign media is unambiguously better than the case without foreign media even though mainstream media remains uninformative (bias $\sigma^* = 1$), because public replace uninformative mainstream media with information provided by foreign media. In cases with very low quality of governance (area C, as well as area B in the neighborhood of area C), the presence of foreign media on public welfare depends on the magnitude of foreign media accuracy π. In particular, when foreign media report is moderately accurate [19], then public welfare incurs losses from presence of foreign media because the loss in quality of mainstream media outweighs the gain in having relatively unbiased but semi-accurate foreign media report. Nevertheless it is important to note that regardless of the quality of governance, the presence of foreign media with accuracy close to perfect always improve public welfare even though mainstream media becomes uninformative because individual public will substitute mainstream media report for the less biased news source.

So far we have assumed that foreign media accuracy is taken as given. We have yet to address how foreign media arrive to a particular level of accuracy π. This may depend on two factors. First, foreign media relies on advertising revenue derived from maintaining an audience that values accuracy in foreign media report. Second, foreign media accuracy depends on government's willingness and cost to suppressing private information of the program from reaching foreign media. In the next section, we introduce a simple framework that allows foreign media accuracy π to be a choice variable that maximizes advertising revenue, subject to government suppression. In turn the government faces costs from suppressing foreign media. The analysis will focus government suppression towards foreign media based on predetermined level of governance (θ and b).

6 Endogenous Foreign Media Accuracy and Government Suppression

In this section we assume that foreign media revenue depends on viewership, which is monotonically increasing in its accuracy π. As such we use the Cobb-Douglas advertising revenue $R(\pi) = A\left(\pi - \frac{1}{2}\right)^{\alpha}$, where $A > 0$ and $\alpha < 1$ are assumed to be constant parameters. On the other hand, higher foreign media accuracy π, comes with higher cost, as greater resources is spent to

[19] This only occurs when program success rate θ is low, and when foreign media accuracy π, is is not too far from π', where π' is minimum value of foreign media accuracy that causes bias to increase to extreme level.

ensure greater accuracy and to comply with restriction imposed by the government. Denote foreign's cost function $C(\pi) = \delta\left(\pi - \frac{1}{2}\right)^2$ where parameter δ is determined by the government. Therefore optimal foreign media accuracy $\pi^* \in \left(\frac{1}{2}, 1\right)$ maximizes net revenue $A\left(\pi - \frac{1}{2}\right)^\alpha - \delta\left(\pi - \frac{1}{2}\right)^2$. Solving for optimal foreign media accuracy, π^* equals $\min\left\{\frac{1}{2} + \left(\frac{\alpha A}{2\delta}\right)^{\frac{1}{2-\alpha}}, 1\right\}$.[20]. Since we have established that in proposition 2, the presence of foreign media reduces maximal public investment V; higher government suppression δ increases public investment by reducing foreign media accuracy π [21] However higher government suppression comes at a price in terms of enforcement cost and political cost. For simplicity, we assume that government cost in suppressing foreign media take the form of $\alpha\delta^2$, which is increasing in δ and α is a fixed parameter.

To model the interaction between foreign media and the government, existing framework of section 2 is modified into a sequential game between government and foreign media. First the government chooses suppression δ^* that maximizes *government profit* $V - \alpha\delta^2$ where V is maximal public investment and $\alpha\delta^2$ is government cost for imposing suppression δ. We assume that government suppression δ^* is observable to the public and foreign media. Upon observing δ^*, foreign media enters into the market with accuracy π^* that maximizes net advertising revenue, where π^* is assumed to be observable to the public and government[22]. Upon choosing accuracy π^* foreign media is able to correctly identify a given true state S with probability π^*. Upon receiving its signal, foreign media reports its signal truthfully; while government controlled mainstream media reports $\hat{h}$ truthfully, but reports $\hat{h}$ in state L with probability σ^*. The public then choose to invest based on mainstream media and foreign media report. Returns to individual public, government and foreign media are realized at the end of the period.

Observing the value of optimal foreign media accuracy π^*, government chooses bias σ^* and

[20] On the other hand if the audience of foreign media consists primarily of local public, then changes in bias in mainstream media affect advertising revenue as local demand for foreign news is increasing in bias σ. Notationally, assume that revenue is directly proportional to $\frac{X_2 - X_1}{2b}$, which is the fraction of people whose investment decision depends on whether foreign media reports $\hat{h}$ or $\hat{l}$. Specifically for $\theta \geq \frac{2(b-1)}{b^2+2(b-1)}$ and assuming zero cost faced by foreign media ($C(\pi) = 0$), optimal foreign media accuracy solves $\pi^* = \text{argmax}\ \frac{1-\theta}{2b\theta}\left(\frac{\pi}{1-\pi} - \frac{1-\pi}{\pi}\right)\sigma_l$. One could show that $\pi^* = \max\{\hat{\pi}_l, \frac{3+\sqrt{3}}{6}\}$, which is strictly less than one despite facing no cost to higher accuracy π. The reason is that when foreign media accuracy π increases, it improves quality of mainstream media by reducing its bias σ. This reduces local public reliance on foreign media report, which reduces revenue of foreign media. One could observe that when foreign media accuracy approaches perfect ($\pi = 1$), its advertising revenue approaches zero since mainstream report is free from bias and individuals no longer rely on foreign media report.

[21] Marginal decrease in foreign media accuracy π increases maximal public investment V, except in the case where bias equals $\sigma_h < 1$ (from equation (16)).

[22] The assumption that government and public knows π is not too far off from reality. One justification is that given government suppression δ^*, the government and public could predict the amount of accuracy π^*. Secondly it may be prohibitively expensive for foreign media to change π^* in the short run after entering into the media industry.

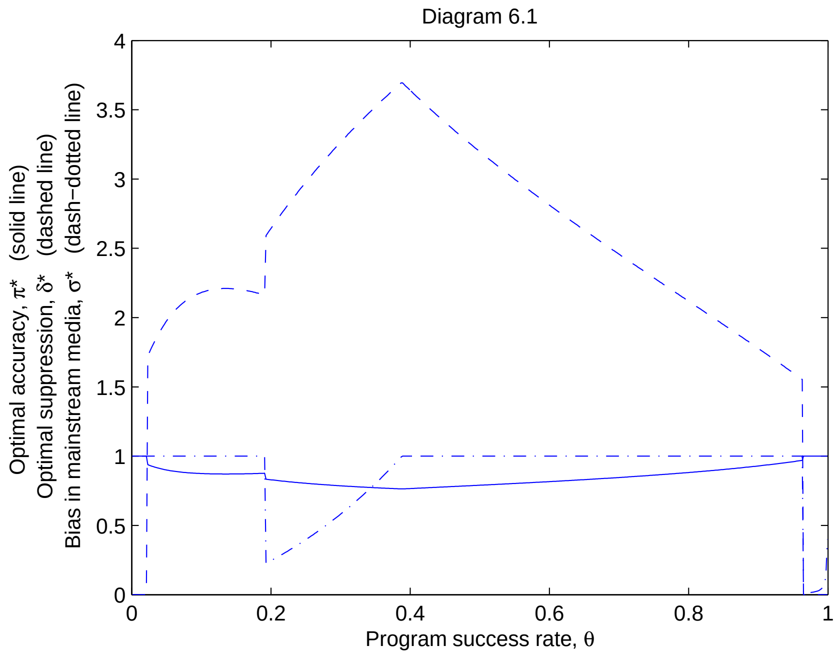
optimal suppression δ^* that maximizes government profit [23] $V - \alpha\delta^2$. To analyze optimal government suppression δ^* based on its quality of governance (θ and b), we could start by observing the direction of cross partial derivative on public investment $\frac{\partial^2 V}{\partial\pi\partial\theta}$ and $\frac{\partial^2 V}{\partial\pi\partial b}$ from equation (13) and equation (16). A negative cross partial derivative implies that marginal *decrease* in foreign media accuracy π, yields higher gain to public investment for higher levels of θ or b. Therefore an increase in program success rate θ, or average benefit b, induces greater government suppression δ^*. Likewise a positive cross partial derive implies that marginal decrease in foreign media accuracy π, yields lower marginal gain in public investment $\bar{V}_l$, for higher values of θ or b. Therefore higher program success rate θ, or higher average benefit b, induces smaller government suppression δ^*. Since the direction of cross partial derivatives, $\frac{\partial^2 V}{\partial\pi\partial\theta}$ and $\frac{\partial^2 V}{\partial\pi\partial b}$, are quite similar to each other, little is loss by focusing only on changes in government suppression δ^* for a given level of program success rate θ.

To demonstrate optimal decision of government and foreign media for given level of program success rate θ, or b we shall resort to computation. Diagram 6.1 simulates three curves on the vertical axis: optimal foreign media accuracy π^* (solid line), government choice of suppression δ^* (dashed line), and bias in mainstream media σ^* (dash-dotted line), with program success rate (θ) on the horizontal axis holding fixed $b = 5$, $A = 2$ and $\alpha = 0.01$. One could show that foreign media maximizes revenue by choosing $\pi^* = \min\left\{\frac{1}{2} + \left(\frac{1}{2\delta^*}\right)^{\frac{2}{3}}, 1\right\}$. In diagram 6.1 for θ between $(0, 0.193)$ bias equals $\sigma_h = 1$. Suppression δ^* within this region is weakly increasing from $\theta \in (0, 0.135)$ and decreasing from $\theta \in (0.135, 0.193)$, as predicted by the sign of $\frac{\partial^2 \bar{V}_h}{\partial\pi\partial\theta}$ (equation (16)). For $\theta \in (0.193, 1)$, bias σ^* equals σ_l, which is less than one for $\theta \in (.0193, 0.388)$ and equals one for $\theta \in (0.388, 1)$. This coincides with the increase in suppression from $\theta \in (.0193, 0.388)$ and a decrease in suppression δ^* for $\theta > 0.388$ as predicted by the positive cross partial derivative $\frac{\partial^2 V_l}{\partial\pi\partial\theta}$. Notice the overall trend in which suppression δ^* is increasing in θ for low values of θ, is decreasing in θ for high values of θ and peaks at moderate values of θ[24].

To understand the link between optimal government suppression δ^* and quality of governance (θ and b), recall that government suppression δ is higher when foreign media accuracy π has the greater

[23] In order to analytically solve for $V - \alpha\delta^2$, one could employ backward induction by choosing bias σ^* that maximizes public investment $V(\pi^*)$ (of equation (10)) as a function optimal foreign media accuracy, π^*. With bias σ^* and optimal foreign media accuracy π^* known, government chooses δ^* that maximizes net public investment $\tilde{V}(\sigma^*, \pi^*) - \alpha\delta^2$ where $\tilde{V}(\pi^*, \sigma^*)$ is public investment. Since the analytical procedure is quite involved, we have decided to omit it and instead present the computational result in diagram 6.1.

[24] This result does not hold for sufficiently small average benefit b. For fixed parameter $a = 0.01$ and $A = 2$, one could show that for $b \in (1, 2.2507)$ optimal government suppression δ^* remains at 0 for any values of θ in the range of (0,1).



(negative) impact on public investment V. From diagram 6.1, for θ close to 0 or 1, foreign media plays a minimal role in influencing public prior beliefs regarding the outcome of the program and therefore will have little impact on public investment. Therefore government suppression δ^* in both of these region is close to zero. From diagram 6.1, note the two distinct regions separated by peak government suppression at $\theta = 0.388$. For low values of θ, since the cross partial derivative tends negative, this implies that further improvements in θ in this region increases government suppression δ^*. This confirms the common sense notion that when quality of governance is increasing, the incentive for government to suppress foreign media tends to be higher because the greater negative impact from presence of foreign media. However this result does not hold in regions of very large θ where cross partial derivative is positive, which implies that further increase quality of governance actually *reduces* government suppression δ^* towards foreign media.

7 Conclusion

In summary, although the presence of foreign media reduces government's effectiveness in using media as an avenue to influence public action, the direction of bias in mainstream media depends on the quality of governance. For a country with relatively high quality of governance, the presence of foreign media reduces bias in government-controlled media, improving public welfare from higher quality mainstream report, as well as providing additional news source from foreign media. However for a country with very low quality of governance, the presence of foreign media could potentially increase bias to extreme level. In cases where foreign media is semi-accurate, the fall in quality of information from state controlled media outweighs the gains in information through foreign media outlets, causing public welfare to fall below the case without foreign media. On the analysis of government suppression that reduces foreign media's accuracy, this paper demonstrates that government suppression is not monotonically increasing in quality of governance. If any, the analysis suggests that government suppression of foreign media is highest in country with moderate level of governance.

Continuing the analysis of impact of foreign media on government controlled media, there are at least two possible topics one could explore. First, the relationship between government's value of mobilizing citizen's action and the importance of advertising revenue is ignored in this analysis. In the spirit of Gehlbach and Sonin (2009), one could extend their model to analyze government's incentive to directly control media outlets in response to presence of foreign media outlet. Second, little is known about the link between government reputation and its citizen. Oftentimes government invokes paternalistic reasons to control media outlets and to impose regulations that protects the interest of its individuals. If individual citizen believe that their government is benevolent, they will put more trust in reports from government-controlled media. On the other hand, an opportunistic government could masquerade as a benevolent government to mobilize public action using government-controlled media. As such the "voter mobilization framework" could be extended in a multi period setting with more than one type of government, to analyze the government's trade-off between its reputation and its value of mobilizing public action, as well as the presence of foreign media in undermining its mobilization effort.

8 Appendix

8.1 Proof of Proposition 2

To demonstrate that maximal public investment without foreign media V_n, exceeds public investment with foreign media V. We first rewrite the expression of V_n, V_h and V_l from equation (5), equation (15) and equation (12) respectively:

$$V_n^i = \frac{\theta b}{2} \quad \bar{V}_n = 1 - \frac{1}{2b\theta}$$

$$V_h^i = \frac{b\theta\pi}{2} \quad \bar{V}_h = \left(\frac{(1-\theta)(1-\pi)+\theta\pi}{2b\theta\pi}\right)[2b\theta\pi - ((1-\theta)(1-\pi)+\theta\pi)]$$

$$V_l^i = \theta\left[\left(1-\frac{1}{2b}\right)(1-k(\pi)) + \frac{bk(\pi)}{2}\right] \quad \bar{V}_l = 1 - \frac{(2-\theta)}{2b} - \frac{1}{2b}\left(\frac{(1-\theta)^2}{\theta}\right)\left(\frac{1-3\pi+3\pi^2}{\pi(1-\pi)}\right)$$

We shall first show that $V_n \geq V_h$, followed by $V_n \geq V_l$.

In order to show that $V_n - V_h \geq 0$, recall from equation (4) for bias $\sigma_n^* \leq 1$ for $\theta b \leq 1$ and $\sigma_n^* = 1$ for $\theta b \geq 1$. In cases where bias equals σ_h, recall that $\sigma_h \leq 1$ for $\pi \leq \hat{\pi}_h$ and $\sigma_h = 1$ for $\pi \geq \hat{\pi}_h$. Therefore we need to show that $V_n - V_h \geq 0$ holds under the following conditions:

1. For $\pi \leq \hat{\pi}_h$, show that $V_n^i - V_h^i \geq 0$
2. For $\pi \leq \hat{\pi}_h$
   (a) If $\theta b \leq 1$, show that $V_n^i - \bar{V}_h \geq 0$
   (b) If $\theta b \geq 1$, show that $\bar{V}_n - \bar{V}_h \geq 0$

For case (1), the expression of $V_n^i - V_h^i$ simplifies to $\frac{b\theta(1-\pi)}{2} \geq 0$.

For case (2a), the expression of $V_n^i - \bar{V}_h$ simplifies to $\frac{b(1-\theta)}{2} + \frac{(b\theta\pi - [\theta\pi+(1-\theta)(1-\pi)])^2}{2b\theta\pi} \geq 0$.

We are left with case (2b). To show that $\bar{V}_n - \bar{V}_h \geq 0$ holds for $\theta b \geq 1$ and for $\pi \geq \hat{\pi}_h$, recall that the inequality $\pi \geq \hat{\pi}_h$ can be rewritten as $(b-1)\left(\frac{\theta\pi}{(1-\theta)(1-\pi)}\right) \geq 1$. First, restrict θ to take only values between $\left[\frac{1}{b}, \frac{(1-3\pi+3\pi^2)}{(2\pi-1)^2+b(1-\pi)\pi}\right]$. For $\theta = \frac{1}{b}$, the expression of $\bar{V}_n - \bar{V}_h$ simplifies to $\frac{(b\pi-2(2\pi-1))^2}{2b^2} \geq 0$; while for $\theta = \frac{(1-3\pi+3\pi^2)}{(2\pi-1)^2+b(1-\pi)\pi}$, the expression of $\bar{V}_n - \bar{V}_h$ simplifies to $\frac{(b-1)^2(1-\pi)(2\pi-1)^2((2\pi-1)+\pi(1-\pi))+b^2(1-3\pi+3\pi^2)^2}{2b(1-3\pi+3\pi^2)((2\pi-1)^2+b(1-\pi)\pi)} \geq 0$. Lastly the expression of $\frac{\partial^2 \bar{V}_n - \bar{V}_h}{\partial\theta^2}$ simplifies to $-\frac{((2\pi-1)+\pi(1-\pi))}{b\theta^3\pi}$, which is negative. Since the expression $\bar{V}_n - \bar{V}_h \geq 0$ at both endpoints for permissible values of θ and $\frac{\partial^2 \bar{V}_n - \bar{V}_h}{\partial\theta^2} < 0$, it follows then by concavity that $\bar{V}_n - \bar{V}_h \geq 0$ for $\theta \in \left[\frac{1}{b}, \frac{(1-3\pi+3\pi^2)}{(2\pi-1)^2+b(1-\pi)\pi}\right]$. This concludes the proof that $V_n \geq V_h$ under the appropriate conditions.

Next, we will show that $V_n \geq V_l$. Recall from equation (11) bias follows σ_l note that in a case of $\theta b \geq 1$, bias $\sigma_l \leq 1$ for $\pi > \hat{\pi}_l$ and $\sigma_l = 1$ for $\pi < \hat{\pi}_l$. As mentioned earlier, bias $\sigma_n^* \leq 1$ for $\theta b \leq 1$ and $\sigma_n^* = 1$ for $\theta b \geq 1$. Therefore the comparison between V_n and V_l is as follows:

1. For $\theta b \leq 1$, show that $V_n^i - V_l^i \geq 0$
2. For $\theta b \geq 1$
   (a) If $\pi \geq \hat{\pi}_l$, show that $\bar{V}_n - V_l^i \geq 0$
   (b) If $\pi \leq \hat{\pi}_l$, show that $\bar{V}_n - \bar{V}_l \geq 0$

Recall from section 4.1 that $k(\pi) = \frac{\pi(1-\pi)}{1-3\pi+3\pi^2}$. For case (1), the expression of $V_n^i - V_l^i$ simplifies to $\theta(1-k(\pi))\left(\frac{(b-1)^2}{2b}\right) \geq 0$.

For case 2(b), the expression of $\bar{V}_n - \bar{V}_l$ simplifies to $\frac{1}{2b\theta}\left[(1-\theta)^2\left(1 - \frac{1-3\pi+3\pi^2}{\pi(1-\pi)}\right)\right] \geq 0$.

To show that case 2(a) holds for $\theta b \geq 0$ and $\pi \geq \hat{\pi}_l$, note that the restriction $\pi \geq \hat{\pi}_l$ can be expressed by $(b-1)\left(\frac{\theta}{1-\theta}\right)\left(\frac{\pi(1-\pi)}{1-3\pi+3\pi^2}\right) \leq 1$. First we impose restrictions on θ to take values between $\left[\frac{1}{b}, \frac{1}{bk(\pi)+(1-k(\pi))}\right]$. For $\theta = \frac{1}{b}$, the expression of $\bar{V}_n - V_l^i$ simplifies to $\frac{(b-1)^2}{b}(1-k(\pi)) \geq 0$; while for $\theta = \frac{1}{bk(\pi)+(1-k(\pi))}$, the expression of $\bar{V}_n - V_l^i$ simplifies to $\frac{(1-k(\pi))k(\pi)(b-1)^2}{2b(bk(\pi)+(1-k)} \geq 0$. Lastly the expression of $\frac{\partial^2 \bar{V}_n - V_l^i}{\partial\theta^2}$ simplifies to $-\frac{1}{b\theta^3} < 0$. Since the expression of $\bar{V}_n - V_l^i \geq 0$ at both endpoints for permissible values of θ and $\frac{\partial^2 \bar{V}_n - V_l^i}{\partial\theta^2} < 0$, it follows by concavity that $\bar{V}_n - V_l^i \geq 0$ for $\theta \in \left[\frac{1}{b}, \frac{1}{bk(\pi)+(1-k(\pi))}\right]$. This concludes the proof that $V_n \geq V_l$.

8.2 Proof of Proposition 3

Define parameter $\breve{\pi}$, $\breve{\theta}$ and $\breve{b}$ and s such that:

$$\breve{\pi} = \left(\frac{\pi}{1-\pi}\right) \qquad \breve{\theta} = \left(\frac{\theta}{1-\theta}\right) \qquad \breve{b} = 2b - 1 \qquad s = \left(\frac{\sigma}{\breve{\theta}}\right)$$

The purpose of redefining parameters of π, b, θ, and σ to $\breve{\pi}$, $\breve{b}$, $\breve{\theta}$ and s respectively is to allow easier comparison between expected level of investment V_l, V_h and $\bar{V}_h$. Note that each is a strictly monotonic transformation. Also, note that $\pi \in \left(\frac{1}{2}, 1\right) \Rightarrow \breve{\pi} \in (1, \infty)$, $b > 1 \Rightarrow \breve{b} > 1$, and $\theta \in (0,1) \Rightarrow \breve{\theta} \in (0, \infty)$. Parameter s takes on values in $[0, \frac{1}{\breve{\theta}}]$, since bias σ must lie in $[0,1]$. Let $\bar{s} = \frac{\breve{b}}{\breve{\pi}}$; $\bar{s}$ corresponds to $\overline{\sigma}$, giving the level of bias above which no one invests when the foreign media reports $\hat{l}$. Then the expected level of investment (equation (10)) can be re-written in terms of $\breve{\pi}$, $\breve{b}$, $\breve{\theta}$ and s as:

$$E[I] = \begin{cases} V_1 \equiv \frac{\theta(1-\pi)}{\breve{b}+1}\left[\left(\breve{b} - \frac{s}{\breve{\pi}}\right)(\breve{\pi}+s) + \left(\breve{b} - \breve{\pi}s\right)(1+\breve{\pi}s)\right] & \text{if } s \leq \overline{s} \\ V_2 \equiv \frac{\theta(1-\pi)}{\breve{b}+1}\left(\breve{b} - \frac{s}{\breve{\pi}}\right)(\breve{\pi}+s) & \text{if } \overline{s} \leq s \leq \breve{\pi}\breve{b} \\ 0 & \text{if } \breve{\pi}\breve{b} \leq s \end{cases} \tag{21}$$

Define s_l and s_h as

$$s_l = \underset{s}{\text{argmax}} \frac{\theta(1-\pi)}{\breve{b}+1}\left[\left(\breve{b} - \frac{s}{\breve{\pi}}\right)(\breve{\pi}+s) + \left(\breve{b} - \breve{\pi}s\right)(1+\breve{\pi}s)\right] = \frac{(\breve{b}-1)(\breve{\pi}(\breve{\pi}+1))}{(1+\breve{\pi}^3)}$$
$$s_h = \underset{s}{\text{argmax}} \frac{\theta(1-\pi)}{\breve{b}+1}\left(\breve{b} - \frac{s}{\breve{\pi}}\right)(\breve{\pi}+s) = \frac{(\breve{b}-1)\breve{\pi}}{2}$$

It is straightforward to show that $s_l < \overline{s}$ and $s_h < \breve{\pi}\breve{b}$. Next define V_l, V_h, and $\bar{V}_h$ as $V_1(s_l)$, $V_2(s_h)$, and $V_2(\frac{1}{\breve{\theta}})$, respectively.

$$V_l^i = \frac{\theta(1-\pi)}{\breve{b}+1}(\breve{\pi}+1)\left[\breve{b} + \frac{\breve{\pi}(\breve{\pi}+1)}{1+\breve{\pi}^3}\left(\frac{\breve{b}-1}{2}\right)^2\right]$$
$$V_h^i = \frac{\theta(1-\pi)}{\breve{b}+1}\breve{\pi}\left(\frac{\breve{b}+1}{2}\right)^2$$
$$\bar{V}_h = \frac{\theta(1-\pi)}{\breve{b}+1}\left(\breve{b} - \frac{1}{\breve{\pi}\breve{\theta}}\right)\left(\breve{\pi} + \frac{1}{\breve{\theta}}\right)$$

Note that the government's objective function (equation (21)) is continuous and piecewise quadratic in s – with one or two pieces, in the latter case meeting at $s = \overline{s}$. Maximizing the function then requires finding up to two local peaks, corresponding to functions V_1 and V_2, and comparing the two values of the objective function to find the global maximum.

We proceed by analyzing potential second quadratic piece, defined by V_2. First, note that if $\overline{s} \geq \frac{1}{\breve{\theta}}$, this piece does not exist; that is, since s must lie in $[0, \frac{1}{\breve{\theta}}]$, V_1 is the only relevant piece. One can show that $\overline{s} \geq \frac{1}{\breve{\theta}}$ is equivalent to $\breve{\pi} \leq \breve{b}\breve{\theta} \equiv Q_1$. Next, given the quadratic shape of V_2, if s_h (the unconstrained argmax of V_2) is lower than $\overline{s}$, then V_2 is maximized in the relevant range at $s = \overline{s}$. Similarly, if s_h is higher than $\frac{1}{\breve{\theta}}$, then V_2 is maximized in the relevant range at $s = \frac{1}{\breve{\theta}}$ (Recall that $s_h < \breve{\pi}\breve{b}$.). One can show that $s_h \leq \overline{s}$ is equivalent to $\breve{\pi} \leq \sqrt{\frac{2\breve{b}}{\breve{b}-1}} \equiv Q_2$. Also, $s_h \geq \frac{1}{\breve{\theta}}$ is equivalent to $\breve{\pi} \geq \frac{2}{\breve{\theta}(\breve{b}-1)} \equiv Q_3$. Finally, one can show that if $\breve{\theta}\sqrt{\breve{b}(\breve{b}-1)} \geq \sqrt{2}$, then $Q_1 \geq Q_2 \geq Q_3$, and $\breve{\theta}\sqrt{\breve{b}(\breve{b}-1)} < \sqrt{2}$ implies $Q_1 < Q_2 < Q_3$.

The shape of the objective function thus breaks into several cases.

1. $\breve{\theta}\sqrt{\breve{b}(\breve{b}-1)} \geq \sqrt{2}$.

   (a) $\breve{\pi} \leq Q_1$. $\quad s^* = \min\left\{s_l\,, \frac{1}{\breve{\theta}}\right\}$

   Here V_1 applies for all $s \in [0, \frac{1}{\breve{\theta}}]$, so the objective function is single-peaked and maximized at $\min\{s_l, \frac{1}{\breve{\theta}}\}$.

   (b) $Q_1 < \breve{\pi}$. $\quad s^* = s_l$ or $\frac{1}{\breve{\theta}}$

   Here the objective function has two local maxima, one each above and below $\overline{s}$. Since $\breve{\theta}\sqrt{\breve{b}(\breve{b}-1)} \geq \sqrt{2}$, we know $Q_3 \leq Q_2 \leq Q_1$. Thus, $Q_3 < \breve{\pi}$, so the second peak is maximized at $s = \frac{1}{\breve{\theta}}$. One can also show that $Q_1 < \breve{\pi}$ ensures $s_l \leq \frac{1}{\breve{\theta}}$; also recall that $s_l \leq \bar{s}$. Thus the unconstrained maximum of V_1, V_l, is the constrained maximum. Thus, the global maximum is found by comparing V_l^i with $\bar{V}_h$.

2. For $\breve{\theta}\sqrt{\breve{b}(\breve{b}-1)} < \sqrt{2}$;

   (a) $\breve{\pi} \leq Q_2$. $\quad s^* = \min\left\{s_l\,, \frac{1}{\breve{\theta}}\right\}$

   Here, either V_1 applies for all $s \in [0, \frac{1}{\breve{\theta}}]$, or the V_1 peak is globally maximal because V_2 is maximized below $\overline{s}$ and thus decreasing in the relevant range. Thus the objective function is single-peaked and maximized at $\min\{s_l, \frac{1}{\breve{\theta}}\}$.

   (b) $Q_2 < \breve{\pi} < Q_3$. $\quad s^* = s_l$ or s_h

   Here the objective function has two local maxima, one each above and below $\overline{s}$. Since $\breve{\theta}\sqrt{\breve{b}(\breve{b}-1)} < \sqrt{2}$, we know $Q_3 > Q_2 > Q_1$. $\breve{\pi} > Q_1$ ensures the first peak maximizes at $s_l < \frac{1}{\breve{\theta}}$. For the second peak, $Q_2 < \breve{\pi} < Q_3$ ensures $\bar{s} < s_h < \frac{1}{\breve{\theta}}$. Thus V_2 is maximized in the interior of the relevant range of s_h, and the global maximum is found by comparing V_l^i with V_h^i.

   (c) $Q_3 \leq \breve{\pi}$. $\quad s^* = s_l$ or $\frac{1}{\breve{\theta}}$

   Here the objective function has two local maxima, one each above and below $\overline{s}$. Since $\breve{\pi} > Q_3 > Q_1$, the first peak maximizes at $s_l < \frac{1}{\breve{\theta}}$, while $Q_3 \leq \breve{\pi}$ ensures the second peak is maximized at $s = \frac{1}{\breve{\theta}}$. The global maximum is found by comparing V_l^i with $\bar{V}_h$.

Next we compare V_l^i and $\bar{V}_h$. Observe that:

$$\begin{aligned} V_l^i > \bar{V}_h \Leftrightarrow & \frac{\theta(1-\pi)}{\breve{b}+1}(\breve{\pi}+1)\left[\breve{b}+\frac{\breve{\pi}(\breve{\pi}+1)}{1+\breve{\pi}^3}\left(\frac{\breve{b}-1}{2}\right)^2\right] > \frac{\theta(1-\pi)}{\breve{b}+1}\left(\breve{b}-\frac{1}{\breve{\pi}\breve{\theta}}\right)\left(\breve{\pi}+\frac{1}{\breve{\theta}}\right) \\ \Leftrightarrow & \frac{\breve{\pi}(\breve{\pi}+1)^2}{1+\breve{\pi}^3}\left(\frac{\breve{b}-1}{2}\right)^2 + \frac{1}{\breve{\pi}\breve{\theta}^2} > \frac{\breve{b}-1}{\breve{\theta}} - \breve{b} \end{aligned} \tag{22}$$

We next show that the LHS expression reaches its lower bound as $\breve{\pi}$ approaches ∞. The first term in the LHS is single-peaked in $\breve{\pi}$, reaching its maximum at $\breve{\pi} = \frac{1+\sqrt{3}}{2}$ and decreasing beyond that. It suffices then to compare endpoints ($\breve{\pi} = 1$ and $\breve{\pi} \to \infty$) to establish that the first term approaches its lower bound at $\breve{\pi} \to \infty$. The second term $\frac{1}{\breve{\pi}\breve{\theta}^2}$ strictly decreases in $\breve{\pi}$, and so also reaches its lower bound at $\breve{\pi} \to \infty$.

Since the LHS expression of equation 20 is bounded below by its value as $\breve{\pi} \to \infty$, a sufficient condition to ensure $V_l^i > \bar{V}_h$ for all $\pi \in \left(\frac{1}{2}, 1\right)$ is:

$$\left(\frac{\breve{b}-1}{2}\right)^2 \geq \frac{\breve{b}-1}{\breve{\theta}} - \breve{b} \quad \Leftrightarrow \breve{\theta} \geq \frac{4(\breve{b}-1)}{(\breve{b}+1)^2} \tag{23}$$

The expression $\breve{\theta} \geq \frac{4(\breve{b}-1)}{(\breve{b}+1)^2}$ can be rewritten in terms of b and θ as $\theta \geq \frac{2(b-1)}{b^2+2(b-1)}$.

Assume the reverse, i.e. $\breve{\theta} < \frac{4(\breve{b}-1)}{(\breve{b}+1)^2}$, so that $\left(\frac{\breve{b}-1}{2}\right)^2 < \frac{\breve{b}-1}{\breve{\theta}} - \breve{b}$. First note that for $\breve{\pi} \in [1,2]$, LHS>RHS of equation (22), since LHS expression is minimized over $[1,2]$ at $\breve{\pi} = 2$ and LHS>RHS when $\breve{\pi} = 2$. Note that the LHS expression of equation (22) is strictly decreasing in $\breve{\pi}$ for $\breve{\pi} > 2$ and LHS < RHS when $\breve{\pi} \to \infty$. Therefore there exist a critical value of $\breve{\pi}^* \in [2, \infty)$ such that for $\breve{\pi} \in (1, \breve{\pi}^*)$, $V_l^i > \bar{V}_h$ and for $\breve{\pi} > \breve{\pi}^*$, $V_l^i < \bar{V}_h$.

At this point we have established that given restriction $\breve{\theta} \geq \frac{4(\breve{b}-1)}{(\breve{b}+1)^2}$, $V_l^i > \bar{V}_h$. What is left is to derive restriction that ensures $V_l^i > V_h^i$ for $\breve{\theta}\sqrt{\breve{b}(\breve{b}-1)} < \sqrt{2}$ and $Q_2 < \breve{\pi} < Q_3$. It turns out that the restriction $\breve{\theta} \geq \frac{4(\breve{b}-1)}{(\breve{b}+1)^2}$ is sufficient to ensure that $V_l^i > V_h^i$ for $Q_2 < \breve{\pi} < Q_3$. To see why this is true, observe the difference of $V_l^i - V_h^i$, in terms of θ, π and b:

$$V_l^i - V_h^i = \frac{\theta}{2b}\left[2b - 1 + \frac{(1-\pi)\pi}{1-3\pi+3\pi^2}(b-1)^2\right] - \frac{\theta\pi b}{2},$$

is strictly decreasing in π. Hence it is sufficient to show $V_l^i > V_h^i$ for π ($\breve{\pi}$) at the upper end of the range, i.e $\breve{\pi} = Q_3$. Under restriction $\breve{\theta} \geq \frac{4(\breve{b}-1)}{(\breve{b}+1)^2}$, we have established that $V_l^i > \bar{V}_h$. Of course when $\breve{\theta}\sqrt{\breve{b}(\breve{b}-1)} < \sqrt{2}$, at $\breve{\pi} = Q_3$, $V_h^i = \bar{V}_h$ since $\breve{\pi} = Q_3 \Rightarrow s_h = \frac{1}{\breve{\theta}}$; thus $V_l^i > V_h^i$ at $\breve{\pi} = Q_3$. This concludes the proof that for $\breve{\theta}\sqrt{\breve{b}(\breve{b}-1)} < \sqrt{2}$, $V_l > V_h$ for $Q_2 < \breve{\pi} < Q_3$, under restriction $\breve{\theta} \geq \frac{4(\breve{b}-1)}{(\breve{b}+1)^2}$.

Even though the inequality $\left(\breve{\theta} \geq \frac{4(\breve{b}-1)}{(\breve{b}+1)^2}\right)$ is sufficient for V_l^i to be greater than V_h^i, it would be interesting to derive a necessary and sufficient condition for $V_l^i \geq V_h^i$ for $\breve{\theta}\sqrt{\breve{b}(\breve{b}-1)} < \sqrt{2}$ and $Q_2 < \breve{\pi} < Q_3$. The expression of $V_l^i \geq V_h^i$ can be simplified as follows:

$$
\begin{aligned}
V_l^i \geq V_h^i \Leftrightarrow (\breve{\pi}+1)\left[\breve{b} + \frac{\breve{\pi}(\breve{\pi}+1)}{1+\breve{\pi}^3}\left(\frac{\breve{b}-1}{2}\right)^2\right] &\geq \breve{\pi}\left(\frac{\breve{b}+1}{2}\right)^2 \\
\Leftrightarrow \frac{4\breve{b}}{(\breve{b}+1)^2} &\geq \frac{\breve{\pi}^2(\breve{\pi}-2)}{(\breve{\pi}+1)(\breve{\pi}-1)^2}
\end{aligned} \tag{24}
$$

One can show that this holds with strict inequality at $\breve{\pi} = Q_2$. It is also straightforward to show that the RHS of (equation (24)) is strictly increasing in $\breve{\pi}$ (since $\breve{\pi} > 1$). Thus if the inequality holds at $\breve{\pi} = Q_3$, it holds for all $\breve{\pi}$ in the range; if not $V_l^i > V_h^i$ for $\breve{\pi} < \breve{\pi}''$ and $V_l^i < V_h^i$ for $\breve{\pi} > \breve{\pi}''$, for some $\breve{\pi}'' \in (Q_2, Q_3)$. Substitute $\breve{\pi} = Q_3$ to the above inequality to obtain:

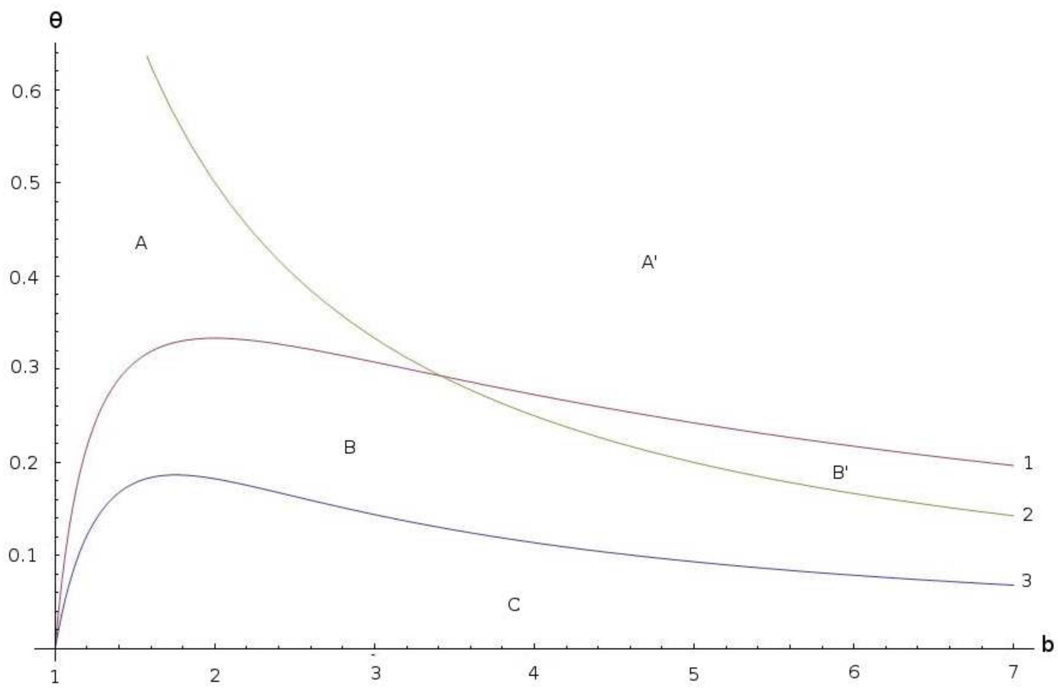
$$
\begin{aligned}
\frac{4\breve{b}}{(\breve{b}+1)^2} &\geq \frac{\left(\frac{2}{\breve{\theta}(\breve{b}-1)}\right)^2\left[\left(\frac{2}{\breve{\theta}(\breve{b}-1)}\right)-2\right]}{\left[\left(\frac{2}{\breve{\theta}(\breve{b}-1)}\right)+1\right]\left[\left(\frac{2}{\breve{\theta}(\breve{b}-1)}\right)-1\right]^2} \\
\Leftrightarrow \frac{4\breve{b}}{(\breve{b}+1)^2} &\geq \frac{8-8(\breve{b}-1)\breve{\theta}}{[2+(\breve{b}-1)\breve{\theta}][2-(\breve{b}-1)\breve{\theta}]^2}
\end{aligned} \tag{25}
$$

For a given $\breve{b}$ denote $\breve{\theta}_0$ such that equation (25) holds with equality. Since RHS of (equation (25)) is strictly decreasing in $\breve{\theta}$ for $\breve{\theta} < \sqrt{\frac{2}{\breve{b}(\breve{b}-1)}}$, $\breve{\theta} > \breve{\theta}_0$ implies that $V_l^i > V_h^i$ for $\breve{\pi} \in (Q_2, Q_3)$. Conversely for $\breve{\theta}$ such that $\breve{\theta} < \breve{\theta}_0$, there exist a $\breve{\pi}''$ in (Q_2, Q_3) such that $V_l > V_h$ for $\breve{\pi} < \breve{\pi}''$ and $V_l^i < V_h^i$ for $\breve{\pi} > \breve{\pi}''$.

Taking into account the restrictions in section 8.3 which ensure σ_l is the global solution, the diagram below plots three curves: $\theta = \frac{2(b-1)}{b^2+2(b-1)}$ (curve (1)), $\theta = \frac{1}{b}$ (curve (2)), and $\frac{2b-1}{b^2} = \frac{(1-\theta)^2(1-\theta(2b-1))}{(1+\theta(b-2))(1-\theta b)^2}$ (curve (3)) with θ on the vertical axis and b on the horizontal axis [25]. The area

[25] The three curves corresponds to $\breve{\theta} = \frac{4(\breve{b}-1)}{(\breve{b}+1)^2}$ (equation 20), $\breve{\theta} = \frac{1}{\breve{b}}$ and $\frac{4\breve{b}}{(\breve{b}+1)^2} = \frac{8-8(\breve{b}-1)\breve{\theta}}{[2+(\breve{b}-1)\breve{\theta}][2-(\breve{b}-1)\breve{\theta}]^2}$ (equation 21) respectively

below curve (2) ensures that $\sigma_l < 1$ for $\pi \in \left(\frac{1}{2}, 1\right)$. This is derived from equation (11), noting that $k(\pi)$ strictly decreases from 1 as π increases from $\frac{1}{2}$. Three areas of interest, namely A (A'), B (B'), and C are labeled in the diagram below. Area A (A'), which lies above the $\theta = \frac{2(b-1)}{b^2+2(b-1)}$ curve, corresponds to a combination of θ and b where σ_l is the global solution for $\pi \in \left(\frac{1}{2}, 1\right)$ since we have establish earlier that $\theta \geq \frac{2(b-1)}{b^2+2(b-1)}$ is a necessary and sufficient condition for $V_l^i > V_h$ in the relevant ranges of $\breve{\pi}$. The difference between A and A' is that in A, bias $\sigma_l < 1$ is decreasing in π for $\pi \in \left(\frac{1}{2}, 1\right)$, while in A', bias remains at $\sigma_l = 1$ for low values of π and strictly decreasing in π for $\pi \geq k^{-1}\left(\frac{1-\theta}{\theta(b-1)}\right)$[26]. Since σ_l declines in π, this establishes the first part of proposition 3.



Area B (B'), which lies below curve (1), indicates that $\bar{V}_h > V_l^i$ given sufficiently high π. It lies above curve (3), indicating that the V_h^i will never be larger than V_l^i. More specifically, area B corresponds to a combination of θ and b such that there exist $\pi' \in \left(\frac{1}{2}, 1\right)$ such that σ_l is the global solution for $\pi \in \left(\frac{1}{2}, \pi'\right)$. For $\pi \in (\pi', 1)$, $\bar{V}_h > V_l^i$ and $\sigma_h = 1$ is the global solution. This is true as we have established earlier that for $\theta < \frac{2(b-1)}{b^2+2(b-1)}$, there exist a critical $\breve{\pi}' \in (2, \infty)$ such that $V_l^i > \bar{V}_h$ for $\breve{\pi} < \breve{\pi}'$, and $\bar{V}_h > V_l^i$ for $\breve{\pi} > \breve{\pi}'$. We have also demonstrated that since RHS of equation (25) is

[26] $k(\pi) = \frac{(1-\pi)\pi}{1-3\pi+3\pi^2}$ as defined before equation (11).

strictly decreasing in $\breve{\theta}$ (θ) in the relevant range; any point that lies above curve 3 implies $V_l^i > V_h^i$ for $\breve{\pi} \in (Q_2, Q_3)$. The difference between area B and area B' is that in the interior of area B, $\sigma_l < 1$ for $\pi \in \left(\frac{1}{2}, \pi'\right)$, and is strictly decreasing in π. In the interior of area B', bias remains at $\sigma_l = 1$ for $\pi \in \left(\frac{1}{2}, k^{-1}\left(\frac{1-\theta}{\theta(b-1)}\right)\right]$. Bias equals $\sigma_l < 1$ for $\pi \in \left(k^{-1}\left(\frac{1-\theta}{\theta(b-1)}\right), \pi'\right)$ and is strictly decreasing in π before switching to $\sigma_h = 1$ for $\pi \in (\pi', 1)$. Furthermore since $\breve{\pi} \geq Q_1$ ensures $s_l < \frac{1}{\theta}$ for the interior of area B' (which involves case 1, since $\theta > \frac{1}{b}$ implies $\breve{\theta}\sqrt{\breve{b}(\breve{b}-1)} \geq \sqrt{2}$), one could show that the range of $\pi \in \left[k^{-1}\left(\frac{1-\theta}{\theta(b-1)}\right), \pi'\right]$ (the range where bias is strictly decreasing in π), is non-empty.

The interior of area C, which lies below curve (3), corresponds to parameters b and θ such that there exists $\breve{\pi}'' \in (Q_2, Q_3)$, such that for $\breve{\pi} < \breve{\pi}''$, $V_l^i > V_h^i$ and bias equals $\sigma_l < 1$, strictly decreasing in π, while for $\breve{\pi} \in (\breve{\pi}'', Q_3)$, $V_l^i < V_h^i$ and bias equals $\sigma_h < 1$, strictly increasing in π. For $\breve{\pi} \in [Q_3, \infty)$, $\bar{V}_h > V_l$ and bias $\sigma = 1$. To show that this is true, note that at $\breve{\pi} = Q_3$, $V_h^i = \bar{V}_h$. Since $V_l^i < V_h^i$ at Q_3, thus $V_l^i < \bar{V}_h$ at Q_3. We have shown that below curve (2), there exist $\breve{\pi} \in (2, \infty)$ such that $\bar{V}_h > V_l^i$ for $\breve{\pi} > \breve{\pi}'$ and $V_l^i > \bar{V}_h$ for $\breve{\pi} < \breve{\pi}'$. Evidently, $\breve{\pi}' < Q_3$, so $\bar{V}_h > V_l$ for $\breve{\pi} > Q_3$.

8.3 Proof of Proposition 4

To show that public welfare W_l falls to a lower level at W_h at π', note first that in a case of $\theta b \geq 1$ $\pi \leq \hat{\pi}_l$, public welfare $\overline{W}_l$ is strictly increasing in π. For $\pi \geq \hat{\pi}_l$ and $\pi < \hat{\pi}_h$, one needs to show that $W_l^i > W_h$ for given values of θ and b. Since $W_n^i > W_h^i$ and $W_l^i > W_n^i$[27], it follows that $W_l^i > W_h^i$.

For $\pi > \hat{\pi}_h$ we need to demonstrate that $W_l^i > \overline{W}_h$. The restriction $\pi > \hat{\pi}_l$ and $\pi > \hat{\pi}_h$ also implies that θ can only take values between $\left[\frac{(1-\pi)}{(b-1)\pi+(1-\pi)}, \frac{(1-3\pi+3\pi^2)}{b\pi(1-\pi)+(2\pi-1)^2}\right]$ for $b > 1$ and $\pi \in \left(\frac{1}{2}, 1\right)$. At $\theta = \frac{(1-\pi)}{(b-1)\pi+(1-\pi)}$, $W_l^i - \overline{W}_h$ simplifies to $\left[\frac{(2b-1)^2(2\pi-1)^2+b^2(\pi^2(2\pi-3))}{4b(1-3\pi+3\pi^2)^2}\right]\left(\frac{(1-\pi)}{b\pi+(2\pi-1)}\right) \geq 0$. For $\theta = \frac{(1-3\pi+3\pi^2)}{b\pi(1-\pi)+(2\pi-1)^2}$, $W_l^i - \overline{W}_h$ simplifies to $\left(\frac{(1-3\pi+3\pi^2)}{b(1-\pi)\pi+(2\pi-1)^2}\right)\left[\frac{(1-\pi)\left(2b(-2+6\pi-5\pi^2)+(2-6\pi+4\pi^2)\right)^2}{16b(1-3\pi+3\pi^2))^2}\right] \geq 0$. Finally, one could show that $\frac{\partial^2\left(W_l^i-\overline{W}_h\right)}{\partial\theta^2} = -\frac{(1-\pi)^2}{2b\theta^3\pi} < 0$. Given that $W_l^i \geq \overline{W}_h$ at end points for permissible values of θ, as well as $\frac{\partial^2\left(W_l^i-\overline{W}_h\right)}{\partial\theta^2} < 0$ it follows by concavity that $W_l^i - \overline{W}_h \geq 0$ for $\theta \in \left(\frac{(1-\pi)}{(b-1)\pi+(1-\pi)}, \frac{(1-3\pi+3\pi^2)}{(b-1)(1-\pi)\pi+(1-3\pi+3\pi^2)}\right)$ and thus $W_l^i \geq \overline{W}_h$ holds for $\pi > \hat{\pi}_l$ and $\pi > \hat{\pi}_h$. Since the critical threshold π', lies in similar range, it follows then that $W_l^i \geq \overline{W}_h$ holds at critical value π'.

To demonstrate that for a given level of average benefit $b > 1$, there exist a positive function $\theta = f(b)$ such that for $\theta \leq f(b)$, public welfare without foreign media W_n, is higher than welfare

[27]Since W_l^i is strictly increasing in π and $\lim_{x\to\frac{1}{2}} W_l^i = W_n^i$.

with foreign media W in a right neighborhood of π'. Recall from section 3 that for any points in area C, the presence of foreign media induces bias $\sigma_h < 1$ in a right neighborhood of π' inducing public welfare W_h^i which is *strictly smaller than public welfare without foreign media* W_n^i (by inspection see equation (17) and equation (19)). Denote $g(b)$ as the boundary between area B and C (curve 3); computation of section 3 shows that $\theta = g(b)$ is defined implicitly by $\frac{2b-1}{b^2} = \frac{(1-\theta)^2(1-\theta(2b-1))}{(1+\theta(b-2))(1-\theta b)^2}$. One can show $g(b) > 0$ for (b, ∞). We have established that for $\theta \leq g(b)$, $W_n^i < W_h^i$ in the right neighborhood of π'. Therefore $f(b) > g(b)$ for $b \in (1, \infty)$, which proves the second part of proposition 4.

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