Party-influenced media, independent news and information traps*

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Abstract

Independent news is a cornerstone of liberal democracy. Among its many roles, free and fearless journalism keeps the voters informed and enables them to choose good leaders through elections. On the other hand, almost all major democracies are experiencing direct or indirect takeover of an increasing number of media outlets by political parties, enabling politicians to influence news and endanger press freedom. Despite the co-existence of party-influenced media alternatives where politicians undertake hidden but costly investments, which in combination with unobserved quality produce electorally favorable signals for them, we show, using a 'noisy signaling model', that any improvement in independent news continues to enhance voter welfare other than in situations which we call 'information traps'. When democracies fall in an information trap, stronger independent news asymmetrically affects media investments (and thereby media control) across high- and low-quality politicians, reduces the reliability of party-influenced media further, overpowers the direct benefits of independent news, and leads to an ultimate decline in the expected quality of the elected leader. While exiting from information traps requires large improvements in independent news, allowing for some degree of media influence may enhance voter welfare when policy changes for large improvements in independent news are hard to come by in the short run. Despite information traps, we then demonstrate that ex-ante voter favoritism towards any politician can increase equilibrium information, enhance expected leadership quality, and even curb information traps. The results obtained in this paper provide novel implications for talent-spotting in labor markets.

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1 Introduction

Political leaders or their close associates often own prominent media outlets.[1] Silvio Berlusconi, who served as the the Prime Minister of Italy for four terms between 1994 to 2013 is a prime example of a leading European politician with direct media ownership, having built a media empire that included television channels, newspapers, and other media outlets. Since its inception in 2021, the political connections and affiliations of GB News in the UK have been a contested topic of discussion in various political spheres. Influential individuals in this news channel like Andrew Neil and Dan Wootton are accused of having strong political ties while prominent party leaders (such as Nigel Farage who had his own program on the network) have also been accused of using the network for political campaigning.[2] In general, there is a rise in the number of private outlets that are typically being utilized by political parties to strategically publicize their respective political agendas.

As party-influenced media outlets are gradually populating political news, there is a growing call for protecting and improving independent news in order to crowd out biased and noisy information from private sources and enhance the overall ability of elections to improve the quality of elected leaders. On 19th April, 2025, The Guardian made the following despairing pledge to its online readers: "[...] forces around the globe are challenging journalists' ability to report. An independent press, one that those in power can't simply overrule, is crucial to democracy. [...] We are owned by an independent trust devoted only to protecting and defending our journalism. That means we don't have a billionaire owner dictating what our reporters can cover or what opinions our columnists can have, or shareholders demanding a quick return."

The purpose of the present paper is to provide rigorous foundation and support to fearless journalism amidst growing political capture of the media. We find that the value of independent news can get nuanced in the presence of party-influenced media. While improvements are generally beneficial to the voters, one needs to be cautious in certain situations: there are democracies where the initial level of informativeness of independent news falls in a specific interval, which we call an *information trap.* When democracies fall in information traps, improvements in the informativeness of independent news need to be substantial, and if it is not, then strengthening independent and unbiased media may actually bring down the expected quality of winning politicians. We therefore propose an argument similar in spirit to the Big-Push Theory which posits that a large, comprehensive surge in investment is required for economies to achieve development rather than gradual, piecemeal improvements. Our finding therefore emphasizes the need to bring about sweeping policy changes that will

[1] Djankov et al. (2003) examine the patterns of media ownership in 97 countries around the world and find that often the largest media firms are owned by private families and in a number of such cases, political leaders themselves have significant media ownership.

[2] There are many other examples. Before serving as Prime Minister of the Czech Republic from 2017 to 2021, Andrej Babiš was the owner of Agrofert, a conglomerate that included two major Czech newspapers, Mladá fronta DNES and Lidové Noviny. In one way or another, allegations against major political parties controlling private media is an old subject matter in all major democracies.

lead to a sizable rise in the informativeness of independent news within the electorate in order to help democracies emerge from information traps.

There is a large literature on the welfare effects of media capture and biased news (see for example Baron (2006), Andina-Diaz (2006), Genztkow and Shapiro (2006), Besley and Prat (2006), DellaVigna and Kaplan (2007), Duggan and Martinelli (2011), Gul and Pesendorfer (2012), Prat and Stromberg (2013), Gelbach and Sonin (2014), Enikolopov and Petrova (2015), Chakraborty and Ghosh (2016) and Bandyopadhyay et al. (2020) to mention only a few). Government control of media has been directly addressed in Gelbach and Sonin (2014) from a different perspective where the government in power uses media to manipulate information in order to mobilize citizens in ways that can be detrimental to welfare. There are other models of media control in authoritarian societies such as Edmond (2013) and Egorov et al. (2009). However, the political implications of the *co-existence* of independent versus strategically influenced party-controlled media in an electoral democracy have not received sufficient theoretical attention.

That public information can have detrimental effects on quality of aggregate decision-making is well known in the literature on jury theorems where the jurors receive private information whose precision is exogenously fixed (see Austen-Smith and Banks (1996)). However, in our model, we consider the quality of private information to be strategically controlled in a noisy signaling framework akin to a contest where politicians care about their relative reputation. These features make the present paper novel.

To demonstrate the perverse possibility of immiserizing independent news, we employ a noisy signaling model where two politicians with hidden governance quality (or valence) secretly invest in their respective party-influenced media to generate positive coverage about their leadership quality and gain electoral advantage. This investment is costly either due to institutional checks and balances or because it requires various corrupt activities. Such an environment comes naturally into play when parties have some strategic control over certain media outlets where such activities fall outside the purview of the legal system. Yet, due to non-verifiability of the act of media control through investments (which may amount to bribery), even if the practice of media control and the identities of media outlets that fall under such control are common knowledge – which we assume throughout – neither the parties nor the media outlets can be legally held accountable. The assumption of common knowledge of media identity has its foundations in the effort exerted by the outlets to signal their independence. With the rising prevalence of fake news particularly in the digital media, there is an increasing need for news agencies to convince their clients that the news disseminated by them is both credible, unbiased, and fearless. As a result there are a number of news agencies which specifically announce that their policy is to not accept donations from governments or corporate houses, and rely solely on donations and subscriptions. Although this announced position needs to ideally be investigated, the fact that if found to be untrue the reputation of the media house can get severely affected itself lends some credibility to such announcements.[3]

While utilizing private media is electorally beneficial, it comes with risks. For example, it requires active participation in events that are publicly televised where there is always room for unexpected mishaps that may not result in the intended increase in the reputation of the participating politician. In spite of this, it is natural to assume that more investment and/or higher intrinsic quality of the involved politician reduce the probability of such negative events for a party. It is important to note that in our model the control that parties have over private media is never complete; that is, irrespective of the innate quality of the politician or the amount of investments made by them, there is always a risk of failing to generate favorable news from their party-controlled media. This feature of the model is both natural and crucial for our results as it enables even the influenced media to preserve some degree of informative power.

In such a framework, a more efficient independent media discourages investments in party-influenced media outlets, as the politician's true quality is likelier to be revealed to the voters by independent media channels. In particular, higher quality politicians have stronger incentives to reduce expensive media investments. This in turn may have a negative impact on the overall quality of party-influenced media outlets. When the information from independent news is low and the difference in the qualities between good and bad leadership is high, this negative impact overrides the positive impact of independent media. Consequently, the expected quality of the elected leader goes down.

We then show that the quality of the elected leader is maximized when the cost of investment in private media is intermediate in value and this optimal influence cost falls as the quality of independent news rises. As a consequence, we conclude that when it comes to electing good quality leaders, allowing parties to influence some media outlets through private connections may indeed be welfare improving. Moreover, when independent news improves, democracies where it is easier for political parties to control some private media outlets tend to do even better. We generalize these findings objective functions in the class of power functions.

Another aspect of electoral democracy that can potentially distort the selection of good leadership is ex-ante favoritism that can arise due to biases pertaining to race, ethnicity, gender, education, social class (such as caste), or any other form of in- versus out-group majoritarian preferences (see for example Besco (2020) and Fisher et al. (2015) on favoritism based on immigration status, Sanbonmatsu (2002) on favoritism based on gender, Carnes et. al (2016) on class, and Griffin et al.(2020) on wealth). At a technical level, an interesting feature of the model is that if voters have no ex-ante favorite politician so that when infor-

[3]The recent pledge by The Guardian is a great example of this. See also https://www.trustworthymedia.org/list-of-independent-media/ for a list of self-declared news organizations in the United States and elsewhere. However, there may still be cases of manipulation by the media houses who claim to be 'independent'. The strength of independent news we consider in our model may therefore be interpreted to capture two aspects: (i) the efficacy of investigative agencies in verifying the independence of media houses, and (ii) the capacity of these independent media outlets to reveal information to the public.

mation – either from private or independent sources – cannot distinguish between the two politicians the voters vote for each politician with equal probability, the media investment game has a dominant strategy equilibrium. However, as soon as one allows for favoritism in its weakest form, so that whenever indifferent, voters vote for a particular politician with a higher probability, the dominant-strategy feature of the investment game is destroyed.

Favoritism challenges the fundamental virtue of political equality that lies at the heart of liberal democracies (see Dahl (2006)). We show that even though in some cases a completely unbiased electorate is needed, there are also cases where a rise in favoritism can enhance the expected quality of the elected politician provided the quality of independent news is high enough. Moreover, under certain circumstances, favoritism can reduce the curse of information traps. This curious possibility implies that democracies which are able to successfully promote independent news benefit further if one politician enjoys favoritism on the part of the voters.[4]

The rest of the paper is organized as follows. In Section 2 we describe the framework formally. In Section 3, the main results are presented along with generalizations to power functions. In Section 4 we study favoritism. Section 5 provides a short review of the related theoretical literature on signaling games and discusses an application on talent-spotting in labor markets. The paper concludes in Section 6. All proofs are moved to an appendix.

2 The model

Two parties, called 1 and 2, contest in a winner-take-all election and are led by two politicians with hidden quality (or valence) v_1 and v_2, where $v_i \in \{\bar{v}, \underline{v}\}$ with $0 < \underline{v} < \bar{v} \leq 1$, $i = 1, 2$. There is a common prior that v_i is i.i.d. and $v_i = \bar{v}$ with probability $0 < p < 1$. Winning the election yields an office-rent (that we normalize to 1) to the politician; losing yields 0.

Voters care only about the quality of the politician and vote for the politician who they expect to be of higher quality. Thus, voters vote for politician i if $\mathbb{E}[v_i] > \mathbb{E}[v_j]$ while votes are tied if $\mathbb{E}[v_i] = \mathbb{E}[v_j]$ in which case each politician wins with probability 1/2. Voters learn about the quality profile (v_1, v_2) from an independent and unbiased news source with probability μ while with probability $1 - \mu$ the source provides no information. Thus μ measures the informativeness of independent news in our model.

Foreseeing the role of independent news, each politician i invests an amount $m_i \in [0, 1]$ in its party-influenced media outlet at an influence cost cm_i^2 where $c > 0$. The outlet either generates a favorable signal $s_i = \bar{s}$ with probability $v_i m_i$ (to 'suggest' that $v_i = \bar{v}$) or no signal at all ($s_i = \emptyset$) with the remaining probability. The probability $1 - v_i m_i$ is a measure of airtime or print-space devoted to issues that are uncorrelated to politics.

[4]The model we study is essentially that of a contest where the instrument of participation is private media control. Drugov and Ryvkin (2017) study biased contest success functions that favor one particular player even when all players are ex-ante symmetric to show that under certain circumstances, biased contests perform better. See also Fu and Wu (2023) who find that optimal contests may require some ex-ante bias. Meyer (1991) also studies biased contests with career concerns.

Events and outcomes described above represents a dynamic game of incomplete information with a timeline depicted in Figure 1. We employ the notion of perfect Bayesian

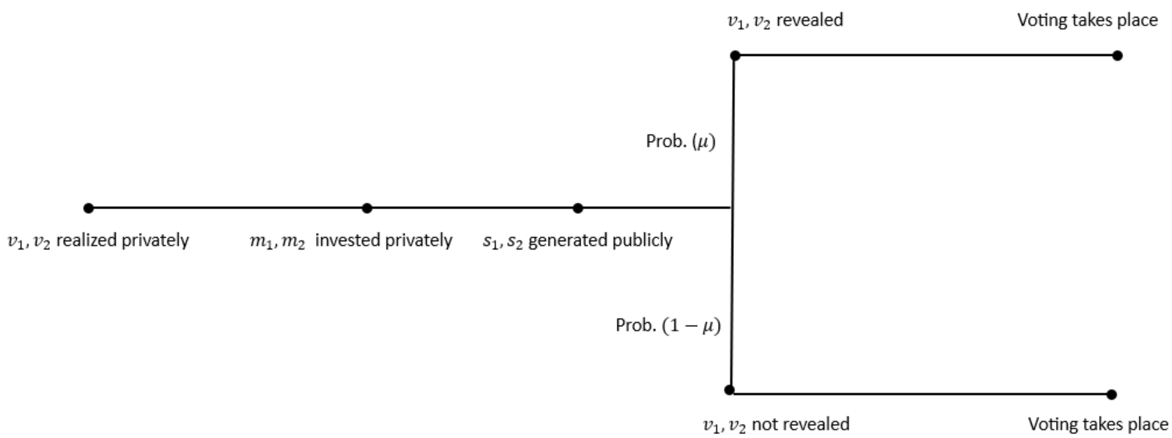

Figure 1: Timeline for events and decisions

equilibrium to study the effects of independent news and institutional checks and balances that affect c in the most informative equilibrium on the size of media influence and on the expected quality of the elected politician.

3 Equilibrium characterization of information traps

We say that a democracy features an *information trap* if there exists a non-empty interval of μ such that in the most informative equilibrium, a local rise in μ leads to a lower expected quality of the elected politician. Our first result directly addresses information traps and shows that their existence is largely endemic. We state this result by identifying two cutoffs for the informativeness of independent news, namely,

$$\hat{\mu} = 1 - \frac{2c}{(\bar{v}/2)} \text{ and } \bar{\mu} = 1 - \frac{2c}{\bar{v}^2 - \underline{v}^2}.$$

Note that $\hat{\mu} < \bar{\mu}$ holds if and only if $(\bar{v}^2 - \underline{v}^2)/2 > \bar{v}/4$. Also, $\bar{\mu} < 1$ while $0 < \bar{\mu}$ if and only if $(\bar{v}^2 - \underline{v}^2)/2 > 2$. Hence it follows that when $(\bar{v}^2 - \underline{v}^2)/2 > \max\{\frac{\bar{v}}{4}, c\}$, we have $\max\{0, \hat{\mu}\} < \bar{\mu}$.

Proposition 1. *An information trap exists if and only if* $(\bar{v}^2 - \underline{v}^2)/2 > \max\{\bar{v}/4, c\}$ *and is characterized as follows: (i) for all* $0 < c < \bar{v}/4$, *we have* $0 < \hat{\mu} < \bar{\mu} < 1$ *and the expected quality of the elected politician falls with a rise in* μ *if and only if* $\hat{\mu} < \mu < \bar{\mu}$, *(ii) for all* $\bar{v}/4 < c < (\bar{v}^2 - \underline{v}^2)/2$ *we have* $\hat{\mu} < 0 < \bar{\mu} < 1$ *and the expected quality of the elected politician falls with a rise in* μ *if and only if* $0 \leq \mu < \bar{\mu}$, *and (iii) for all* $c > (\bar{v}^2 - \underline{v}^2)/2$ *an information trap does not exist.*

The intuition for the main result is as follows. When the quality of independent news improves, the probability that voters will vote based on what independent news reveals goes up. We call this the Independent Information Effect. However, the presence of party-influenced media and the possibility that the independent media can sometimes fail to reveal the quality profile creates a Crowding Out Effect of independent news. When both types of media are present, party-influenced media becomes relevant only when independent news reveals no additional information. It is here that the votes are based only on party-influenced media signals. Foreseeing this, the politicians have an incentive to undertake costly investments to generate favorable signals. This incentive is dampened for both the high and low quality politicians when independent news quality improves. However, the impact is different across the two types of politicians.

When the quality of independent news is below some threshold $\tilde{\mu} = 1 - \frac{4c}{\underline{v}} < \hat{\mu}$ (as shown in the appendix), a rise in μ has no strategic impact as both types continue to undertake full investments in their respective party-influenced media. Therefore in that range, a rise in μ can only increase the expected quality of the winner. As μ rises further, it is the low quality politicians for whom the usefulness of private media gets diminished and only such politicians reduce their media investments. On the other hand in the intermediate range $\tilde{\mu} < \mu < \hat{\mu}$ the high quality politician continues to find it profitable to be fully invested in media influence as they still do not want to take chances on events where independent media remains uninformative. Hence, so long as $\mu < \hat{\mu}$, better independent news will always increase the welfare of the voter.

When μ crosses the threshold $\hat{\mu}$, both types of politicians find it optimal to cut back on costs from media influence, but for diametrically opposite reasons. Whilst the low quality politicians do so because they fear likely damning reports from independent news, the high quality politicians do so because they hope they will anyway be helped by favorable independent news. Of course, as the 'efficiency coefficient' of signal generation from party-influenced media is higher for high quality politicians, the cut back is sharper on the margin for high quality politicians. For this reason, a rise in the quality of independent news within this range reduces the role of private media. We show that this negative impact on private news dominates the positive Independent Information Effect, yielding a negative aggregate effect on ex-ante quality of the elected leadership. However, for extremely high quality independent news (viz. $\mu > \bar{\mu}$), a further improvement in independent news augments the ex-ante quality due to the dominance of the Independent Information Effect channel.

The proposition proves that the troublesome region $\max\{0, \hat{\mu}\} < \mu < \bar{\mu}$, which we have referred to as the information trap, is non-empty provided $\bar{v}^2 - \underline{v}^2 > \max\{\frac{\bar{v}}{2}, 2c\}$, a condition that qualitatively suggests that $\bar{v}$ needs to be sufficiently larger than $\underline{v}$, an environment where information is actually useful to the voters. Figure 2 depicts information traps in the (μ, c) plane (shaded region) and underscores that the perverse effect of independent news is robust in the parametric space.

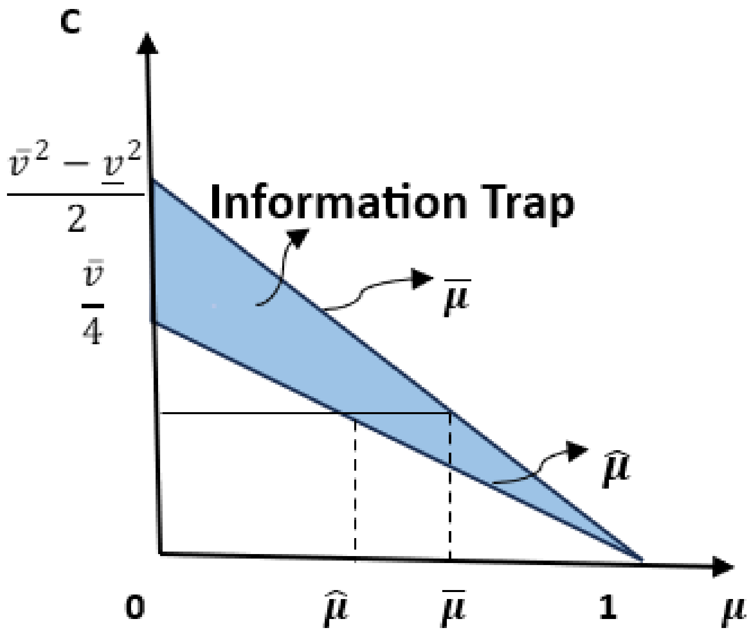

Figure 2: Information trap

3.1 Cost of influence

While Proposition 1 draws our attention towards the efficacy (or lack of it) of independent news as an instrument to improve voter welfare, the cost-of-influence parameter c reflects other aspects of the environment that can affect equilibrium behavior. For example, democracies with more autonomous private media outlets will have a higher c. A higher c can also reflect stricter institutional checks and balances on the control of political parties over vulnerable media outlets.

To understand the impact of this important parameter on the expected quality of elected politicians, we define two threshold values for c:

$$0 < c_1 = \frac{\underline{v}(1-\mu)}{4} < c_2 = \frac{\bar{v}(1-\mu)}{4} < 1.$$

The following proposition curiously implies that optimal institutions must allow for some degree of party-influenced media to operate.

Proposition 2. *The expected quality of the elected politician is unaffected by the cost of influence c if $c < c_1$, increases in c if $c_1 < c < c_2$, and decreases in c if $c > c_2$. Consequently, (i) voter welfare is maximized at $c = c_2$ and (ii) the welfare-maximizing influence cost falls as the quality of independent news rises.*

When the cost of influence is very low, both types of politicians engage in the maximal possible amount of investment in the media, which remains constant as long as the cost remains below the threshold c_1. Hence changes in c within this range has no effect on the expected quality of the winning politician. For an intermediate level of influence cost ($c_1 < c < c_2$), the high quality politician continues to expend maximal resources on influencing the media, while the low quality politician pulls back on such investments. This works as a mechanism to filter out high and low quality politicians and leads to a rise in the expected quality of the elected politician. When the cost of influence becomes excessively high ($c > c_2$), both high and low quality politicians cut down on their levels of media investments. As the cost of influencing c increases further, the high quality politicians cut down more on their media investments than their low quality counterparts. This leads to an eventual reduction in welfare.

To explore the generality of existence of information traps, we now consider a wider class of power functions where the signal generation function of the party influenced media is $v_i m_i^\beta$ with $\beta > 0$ and the influence cost is cm_i^α with $\alpha > \beta$. We show through this generalization that it is not necessary to have concave signal generation functions or convex cost functions in order for information traps to exist. To state the result formally we define:[5]

$$\zeta = \left(\frac{(\alpha - \beta)}{(\alpha - \beta + 1)\left(\bar{v}^{\frac{\alpha-\beta+1}{\alpha-\beta}} - \underline{v}^{\frac{\alpha-\beta+1}{\alpha-\beta}}\right)} \right)^{\alpha-\beta}, \mu_2 = 1 - \frac{2c\alpha}{\bar{v}\beta}, \text{and } \mu_3 = 1 - \frac{2c\alpha\zeta}{\beta}.$$

Proposition 3. *An information trap exists for $\mu_2 < \mu < \mu_3$ iff $1/\zeta > \max\{\frac{2c\alpha}{\beta}, \bar{v}\}$.*

4 Favoritism and information traps

As standard in the theoretical literature on electoral politics, our analysis so far has assumed that voters are ex-ante impartial: when indifferent between the two politicians, they vote for each with equal probability. We now extend our analysis beyond that assumption. While we are agnostic about the sources, breaking voter indifference by non-equiprobable draws can be applicable to many environments such as incumbency advantage at the margin or in-group cultural preferences of the majority as in Aragones and Palfrey (2002) and Ashworth and Bueno de Mesquita (2008). Tie-breaking can also disfavor incumbents as in Gersbach (2010) when voters acknowledge that incumbents enjoy advantages and therefore set higher hurdles for them to defeat entrants.

One feature of the media-investment 'subgame' under the assumption of no-favoritism is that the equilibrium investment levels of each politician to influence their party's media outlet are independent of the decisions of their political competitors (see Eqns. (7) and (8) in the appendix).

[5] When $\alpha = 2$, and $\beta = 1$, we have $\zeta = \frac{1}{2(\bar{v}^2 - \underline{v}^2)}$, $\mu_2 = \hat{\mu}$, $\mu_3 = \bar{\mu}$ and the condition $1/\zeta > \max\{\frac{2c\alpha}{\beta}, \bar{v}\}$ is equivalent to the condition $(\bar{v}^2 - \underline{v}^2)/2 > \max\{\bar{v}/4, c\}$ is in the statement of Proposition 1.

We first show in Proposition 4 that this dominant-strategy property of the media-influence game is not hostage to how one models the signal generating functions or the particular form of the cost function. Instead, it solely depends on the tie-breaking rule. While this is an interesting theoretical endeavor, it allows us to understand the consequences of favoritism in our model while remaining agnostic towards the source of favoritism.

In Proposition 3 we had considered a generalized case where the signal generation and influence cost were power functions. To study the effect of favoritism, we now consider further generalization by allowing the signal generation and cost of influence functions to be completely arbitrary. To accommodate such flexibility we only impose the restrictions that the signal generating function be concave and the cost function be convex. So suppose politician i's probabilities of generating the good and the null signals are given by $f(v_i, m_i)$ and $1 - f(v_i, m_i)$ respectively, where f is differentiable, concave and increasing in both arguments. Also, let the investment $m_i \in [0, 1]$ in his party-influenced media come with a convex influence cost $g(m_i)$ where $g' > 0$, $g'' > 0$.

When it comes to favoritism, we look at its weakest form: whenever indifferent between the two politicians, the voters vote for the politician with probability $\tau \geq 1/2$ while with probability $1 - \tau$ they vote for the unfavored politician. In this sense, there is no favoritism when $\tau = 1/2$.[6]

Proposition 4. *In the most informative equilibrium, the media-investment game has a dominant strategy equilibrium if and only if $\tau = 1/2$. If i is the favored politician, then the media-investment game induces strategic complementarity for i and strategic substitutability for j.*

To understand the intuition behind this curious result, consider politician i who is favored ($\tau > 1/2$). His optimal level of investment moves in the same direction as that of his disfavored rival j, and the intensity of the response increases in the degree of favoritism τ. To see this, suppose m_j has increased from both types, which implies that the probability of a favorable signal $\bar{s}_j$ is higher.[7] Given this, it is in the best interest for i of each type to raise m_i since this in turn increases the probability of $\bar{s}_i$, and therefore the profile ($\bar{s}_i$,$\bar{s}_j$) at which politician i reaps the benefits of favoritism despite the additional costs of investment.

In contrast, consider the disfavored politician j. His optimal level of investment moves in the opposite direction as that of his favored rival i, and the intensity of the response increases in the degree of favoritism τ. To see this, suppose m_i is raised by both types: this prompts a reduction in m_j from both types since in the event both politicians generate favorable signals, the voter's mandate will go against the disfavored politician. Hence the optimal response is to reduce investment and save costs.

[6] A more general model of ex-ante favoritism should map the utility difference between voting sincerely for the two politicians to the actual probability of voting in a continuous manner. The main insights obtained in this section are however robust to this generalization.

[7] As described in the proof, the arguments go through even for a stronger notion of strategic complementarity/substitutability where all that matters is that the net impact of changes in the other player's strategies is a higher success probability for that player.

The intensities of these contrasting 'best-responses' are higher for more extreme values of τ, while they are gradually muted as the degree of favoritism falls until they are completely counter-balanced at $\tau = 1/2$. For a completely unbiased electorate, we therefore have the phenomenon that the optimum investment of one politician is independent of that of the other.

Given Proposition 4, suppose the electorate has a favored politician. To keep things simple, we assume that the investment game always has an interior equilibrium.[8] We have the following proposition in this regard. The following proposition explores the relationship between the level of favoritism and expected quality of the elected politician.

Proposition 5. *There exists $\tilde{c} > 0$ such that for all $c > \tilde{c}$, there exists $\bar{v}, \underline{v}, p, \tau$ such that the expected quality of the elected politician is strictly increasing in τ if $\mu > 1 - \frac{2c}{p\bar{v}^2+(1-p)\underline{v}^2}$, and is strictly decreasing if $\mu < 1 - \frac{2c}{p\bar{v}^2+(1-p)\underline{v}^2}$.*

It follows from Proposition 5 that the optimal level of favoritism that corresponds to the highest expected quality of the elected politician is $\tau^* = 1$ if $\mu > 1 - \frac{2c}{p\bar{v}^2+(1-p)\underline{v}^2}$, and $\tau^* = 1/2$ if $\mu < 1 - \frac{2c}{p\bar{v}^2+(1-p)\underline{v}^2}$. In order to understand the intuition behind Proposition 5, note that being a favored politician provides no additional information about politician quality. With high quality independent news (viz. $\mu > 1 - \frac{2c}{p\bar{v}^2+(1-p)\underline{v}^2}$), the incentives to invest for all types of politicians are low, which in turn makes the probability of both politicians failing to generate a favorable signal from party-controlled media high. This is welcomed by the favored politician, as the voters are more likely to vote for him. Hence the favored politician (of both high or low quality) reduces his private investment as the level of favoritism rises.

On the other hand, the disfavored politician (of both high and low quality) would increase his private investment as he intends to avoid the particular profile where both the contesting politicians have failed to generate positive signals from their private media. However, the increase in investment by the disfavored high quality politician is more than the reduction in investment by the favored high quality politician. This is also true for low quality politicians. Thus, although the media investments of both the high and low quality politicians rise with favoritism, the increase is higher from the high quality politicians. Hence, the expected quality of the winning politician rises with the level of favoritism.

When independent news is poor (viz. $\mu < 1 - \frac{2c}{p\bar{v}^2+(1-p)\underline{v}^2}$), the incentives to invest for all types of politicians are high, which makes the probability of both politicians generating a favorable signal through private media outlets to be high. This event is to the advantage of the favored politician, as the voters are more likely to vote for him when they are unable to differentiate based on the profile of signals generated through private investments. Hence the favored politician (of both high or low quality) increases his private investment as the level of favoritism rises. On the other hand, the disfavored politician (of both high and low quality) would decrease his private investment as the incentive for him to generate

[8] Relaxing this assumption requires working out the details when at least one type of politician's equilibrium response yields a corner solution. As we have seen in the proof of Proposition 1, this leads to further calculations for cases that are not of interest in the present section.

a favorable signal decreases as the level of favoritism rises. In addition, the decrease in investment by the disfavored high quality politician is more than the increase in investment by the favored high quality politician. This is also true for low quality politicians. Thus, although the investments of both the high and low quality politicians who are disfavored falls with favoritism, the decrease in the investments made by the high quality politicians is more than that of the low quality ones. Hence, the expected quality of the winning politician falls with the level of favoritism.[9]

Existence of information traps: While Proposition 5 provides a stark characterization for the optimal level of favoritism, we return to the main theme of the paper: *How does favoritism affect the impact of independent news on the quality of the elected politician?* Although a fully general characterization of this remains analytically intractable, we provide numerical examples (see Figure 3) to demonstrate the following possibilities, when the investments for both high and low quality politicians are responsive to change in μ : (1) For high values of τ, the expected quality of the elected politician initially increases, then decreases and finally increases, and (2) for low values of τ (which includes 1/2), the expected quality initially decreases and then increases. Note that the intuition behind Proposition 5 relied on the following factors: *(i)* the response of the favored or disfavored politicians (of high or low quality) to a parametric change, *(ii)* the aggregate change in the level of investments of high and low politicians due to (i), and which of these were dominant. The exact same forces are at play under favoritism too.[10]

Can favoritism help democracies avoid information traps? We find that the answer is surprisingly yes. While a full characterization is again analytical intractable, we construct an example to suggest such a possibility. Let $\bar{v} = 1$, $\underline{v} = 0.1$, $c = 0.25$ and $p = 0.63$. Then $1 - \frac{2c}{p\bar{v}^2+(1-p)\underline{v}^2} = 0.211$. Now suppose $\mu > 0.211$. Then from Proposition 5 we know that the optimal value of τ is 1, that is the democracy requires full favoritism. Under this optimal τ, the information trap is the region $0.478 \leq \mu \leq 0.605$. Continue to assume $\mu > 0.211$ but choose the sub-optimal value of $\tau = 1/2$ where there is no favoritism. Then, the resulting information trap is the region $0.211 \leq \mu \leq 0.4949$. While the two regions of information trap are different (although they have a common intersection), the range of μ that keeps the democracy in the information trap rises without favoritism. Thus, favoritism not only can enhance overall efficacy of electoral democracy but can simultaneously reduce information traps.

[9]These observations are proved in the Appendix.

[10]Note in Figure 3 that there exists a unique value μ for which the expected quality of the elected politician is the same at different levels of τ. Its existence is implicitly given in Proposition 5 where we show that the expected quality of the winning politician is independent of τ if and only if $\mu = 1 - \frac{2c}{p\bar{v}^2+(1-p)\underline{v}^2}$ (= 0.0220 for the example plotted). If μ is lower than this cutoff, the expected leadership quality of the winner is decreasing in τ while when μ is larger, the quality is increasing in τ.

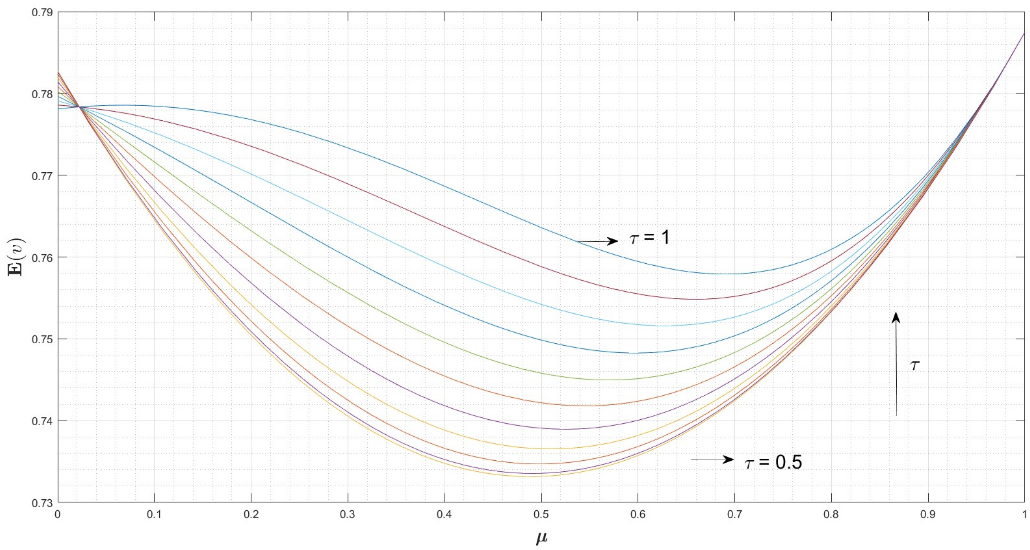

Figure 3: Efficacy of independent news and favoritism

5 Related literature on signaling games

We employed a noisy signaling model of political competition in which agents (viz. politicians) participate in a 'contest' where only relative performance matters. In addition, the contest allows for an exogenously pre-specified probabilistic 'switch' from a full-information regime where the private types of the agents are revealed to one where there is no such revelation.

Note that in our model, whilst m_1 and m_2 (that signify endogenous levels of influence over party-controlled media) are private information, the signals they produce stochastically are public. Thus, the channel of communication is indirect: the sender of information (the politicians in our case) can only control the probability of signals, but not the actual realization of observable signals. Moreover, even these signal-generating probabilities remain private information to the agents. This feature places our model in the family of "noisy signaling" models a la Matthews and Mirman (1983), Carlsson and Dasgupta (1997), Levy (2007), Daley and Green (2014) and Ghosh and Roy (2015).

In noisy signaling models, the receivers do not observe the sender's action (unlike in the class of signaling models as in Spence (1973)), but only a noisy signal which is endogenously influenced by the sender's action. The receivers of information (voters in our case) are therefore required to make Bayesian inferences regarding the sender's actions, and in turn proceed to make judgments about the private type of each sender to decide the winner of the contest.

Matthews and Mirman (1983) analyze a model where a potential entrant firm makes inferences about market conditions by observing the market price which depends on both the incumbent's actions as well as a stochastic market demand. In a reputational cheap talk setting, Ghosh and Roy (2015) consider an evaluator of hidden talents of committee members who vote secretly. The evaluator only observes the committee decision unless individual votes get 'leaked' with an exogenously specified probability. In Daley and Green (2014) receivers observe both the sender's costly signal as well as a noisy signal that is correlated with the sender's type. However, in all these works, the senders wish to maximize their absolute reputations in the eyes of the receiver, and their payoffs are independent of the what the receiver thinks about their competitors. Hence the element of contest is ultimately missing. To the best of our knowledge, our model is the first to investigate noisy signaling in a contest among multiple senders. In the model of political competition that we study, signaling his own superior type is not the goal of the sender, but maximizing the probability of winning the election by judiciously spending a scarce resource is. These two objectives are not the same under all circumstances, particularly in a contest like ours.

In addition to noisy signals received from party-influenced media, the availability of direct information regarding the quality profile from an impartial news source links this paper to others that study additional sources of information in signaling models as in Alós-Ferrer and Prat (2012) or Kurlat and Scheuer (2021). Bester and Ritzberger (2001), Mayzlin and Shin (2011) and Bester et al. (2019) consider settings in which the receiver, after observing the sender's action, strategically decides whether or not to acquire further information. A similar choice for the receiver in a Bayesian persuasion setting is considered in Bloedel and Segal (2018) and Matyskova and Montes (2021). In our framework, the additional source (and its informativeness) is exogenous.

Introducing biased voters in a world with exogenous information relates our work to Frankel and Kartik (2019) where, although not in the realm of direct contests, a signaling model is studied where the sender with two-dimensional private type can take an action that depends on the 'natural' type that is not motivated by signaling gains while the other is strategic that can help a high-talent sender. The favoritism bias along with the exogenous information source ingrain heterogeneity in the natural dimension. The media investment on the other hand is what they call the 'gaming' part of the action where we have heterogeneity as well. The difference is that in our case the 'market' cares about the gaming ability but can only observe noisy strategic signals.

5.1 Application to talent-spotting in labor markets

Although we study the proposed model in the context of elections, it can be readily applied to other areas such as talent-spotting in the job market.[11] Suppose we deviate from the canonical signaling model in Spence (1973) by assuming that in a job market the effort of a job-seeker (or candidate) with private quality-type is not observable directly by the employer. The candidate secretly exerts effort which affects the probability of obtaining an outstanding

[11] See, for instance, "The War for Talent" by Michaels et al. (2001), McDonnell (2011) and Inman (2014). In this regard, companies like Google and SAP International are increasingly adopting predictive talent analytics for effective recruitment.

versus an average academic degree. Suppose this probability of success remains unknown to the employer who just observes the obtained degree.

It is common knowledge that at the hiring stage, the employer conducts informative interviews which can reveal the true quality of a candidate with some probability. In this context, Fernandez-Araoz (2014) discusses an intuitively appealing talent-spotting strategy that involves "pushing [candidates] out of their comfort zones."

Our results imply that in case there are multiple candidates vying for a single position, this strategy may be counter-productive, as more incisive interview questions that are likelier to reveal the candidate types can correspond to a reduced expected quality of the job-seeker who is ultimately hired. Furthermore, depending on the level of informativeness of interview questions, an employer with a bias towards a particular candidate can expect a higher quality of hired worker in some cases, while in others a completely impartial employer does better.

6 Conclusion

We employ a noisy signaling model of electoral competition with exogenous probabilistic information to study the role of independent news in democracies. We show the existence of information traps wherein a rise in independent journalism can be detrimental to the expected quality of elected leadership in the presence of party-influenced media, especially in democracies where the potential difference in leadership standards are high. We also show that an intermediate cost of influence maximizes the expected quality of the winning politician. Our model also considers the role of identity-specific favoritism, and shows that depending on the quality of independent news outlets, either a fully biased or a completely unbiased electorate corresponds to the highest level of ex-ante leadership quality.

7 Appendix

Proof of Proposition 1:

Let $\bar{m}_i$ and $\underline{m}_i$ be the investments in the private media by politician i of type $\bar{v}$ and $\underline{v}$ respectively. Let $z_j = p\bar{v}_j\bar{m}_j + (1-p)\underline{v}_j\underline{m}_j$ be the probability that politician j's private media (with $j \neq i$) emits the positive signal $\bar{s}$. The optimization problem of politician i with quality $v_i \in \{\underline{v}, \bar{v}\}$ are given respectively by

$$\max_{\bar{m}_i \in [0,1]} U_i(\bar{v}) = \mu((1-p)+\frac{p}{2})+(1-\mu)\left[\bar{v}_i\bar{m}_i(1-z_j)+\frac{1}{2}\bar{v}_i\bar{m}_iz_j+\frac{1}{2}(1-\bar{v}_i\bar{m}_i)(1-z_j)\right]-c\bar{m}_i^2. \tag{1}$$

and

$$\max_{\underline{m}_i \in [0,1]} U_i(\underline{v}) = \mu\left(\frac{(1-p)}{2}\right)+(1-\mu)\left[\underline{v}_i\underline{m}_i(1-z_j)+\frac{1}{2}\underline{v}_i\underline{m}_iz_j+\frac{1}{2}(1-\underline{v}_i\underline{m}_i)(1-z_j)\right]-c\underline{m}_i^2 \tag{2}$$

The first and second order conditions of optimization are given by

$$\frac{\partial U_i(\bar{v})}{\partial \bar{m}_i} = \frac{(1-\mu)\bar{v}}{2} - 2c\bar{m}_i = 0 \text{ and } \frac{\partial U_i(\underline{v})}{\partial \underline{m}_i} = \frac{(1-\mu)\underline{v}}{2} - 2c\underline{m}_i = 0$$

and

$$\frac{\partial^2 U_i(\bar{v})}{\partial \bar{m}_i^2} = \frac{\partial^2 U_i(\underline{v})}{\partial \underline{m}_i^2} = -2c.$$

Note that the first order conditions for politician i is independent of m_j and the second order condition for maximization is satisfied. This implies that the investment game has a dominant strategy for each party. Define $\tilde{\mu} = 1 - \frac{4c}{\underline{v}}$ and $\hat{\mu} = 1 - \frac{4c}{\bar{v}}$. From the above we have the optimal level of investments for each $i = 1, 2$ given by

$$\bar{m}_i = \begin{cases} \frac{\bar{v}(1-\mu)}{4c} & \text{if } \mu > \hat{\mu} \\ 1 & \text{if } \mu \leq \hat{\mu} \end{cases}, \tag{3}$$

$$\underline{m}_i = \begin{cases} \frac{\underline{v}(1-\mu)}{4c} & \text{if } \mu > \tilde{\mu} \\ 1 & \text{if } \mu \leq \tilde{\mu} \end{cases} \tag{4}$$

Observe that $\bar{m}_i \geq \underline{m}_i$ and so the good signals $\bar{s}$ are always more likely to come from high-quality politicians. Hence the assumed voting strategy is indeed a best response and this construction yields a perfect Bayesian equilibrium where expected quality of elected politician is given by

$$\mathbb{E}[v] = \begin{cases} p\bar{v} + (1-p)\underline{v} + p(1-p)(\bar{v}-\underline{v})\left(\mu + \frac{(1-\mu)^2(\bar{v}^2-\underline{v}^2)}{4c}\right) & \text{if } \mu > \hat{\mu} \\ p\bar{v} + (1-p)\underline{v} + p(1-p)(\bar{v}-\underline{v})\left(\mu + (1-\mu)\left(\bar{v} - \frac{(1-\mu)\underline{v}^2}{4c}\right)\right) & \text{if } \tilde{\mu} < \mu \leq \hat{\mu} \\ p\bar{v} + (1-p)\underline{v} + p(1-p)(\bar{v}-\underline{v})\left(\mu + (1-\mu)(\bar{v}-\underline{v})\right) & \text{if } \mu \leq \tilde{\mu} \end{cases}$$

Note that that $\mathbb{E}[v]$ is continuous at $\hat{\mu}$ and $\tilde{\mu}$. Thus,

$$\frac{\partial \mathbb{E}[v]}{\partial \mu} = \begin{cases} p(1-p)(\bar{v}-\underline{v})\left(1 - \frac{(1-\mu)(\bar{v}^2-\underline{v}^2)}{2c}\right) & \text{if } \mu > \hat{\mu} \\ p(1-p)(\bar{v}-\underline{v})\left(1 - \bar{v} + \frac{(1-\mu)\underline{v}^2}{2c}\right) & \text{if } \tilde{\mu} < \mu < \hat{\mu} \\ p(1-p)(\bar{v}-\underline{v})(1-\bar{v}+\underline{v}) & \text{if } \mu < \tilde{\mu} \end{cases} \tag{5}$$

Let $\mu < \hat{\mu}$. Here we need to consider the possibilities that $\tilde{\mu} < \mu < \hat{\mu}$ or $\mu < \tilde{\mu}$. Note from (5) that $\frac{\partial \mathbb{E}[v]}{\partial \mu} > 0$ always holds for both these possibilities, since $\bar{v} \leq 1$.
Let $\bar{\mu} = 1 - \frac{2c}{\bar{v}^2 - \underline{v}^2}$. Note that $(\bar{v}^2 - \underline{v}^2)/2 > \max\{\frac{\bar{v}}{4}, c\}$ implies $\bar{\mu} > \max\{0, \hat{\mu}\}$. Note that when $0 < c < \bar{v}/4$ holds we have $\hat{\mu} > 0$. Furthermore, when $\mu > \hat{\mu}$, note from (5) that whenever $\mu < (>)\bar{\mu}$, we have $\frac{\partial \mathbb{E}[v]}{\partial \mu} < (>)0$. This proves part (i) of the proposition.

Note that when $\bar{v}/4 < c < (\bar{v}^2 - \underline{v}^2)/2$, there exists $\hat{\mu}(c) < 0 < \bar{\mu}(c) < 1$. In this case, if $0 < \mu < \bar{\mu}(c)$, we have $\frac{\partial \mathbb{E}[v]}{\partial \mu} < 0$, else $\frac{\partial \mathbb{E}[v]}{\partial \mu} > 0$. This proves part (ii) of the proposition. Part

(iii) follows immediately by noting that $\frac{\partial \bar{\mu}}{\partial c} = -\frac{2}{\bar{v}^2 - \underline{v}^2} < 0$ and $\frac{\partial \hat{\mu}}{\partial c} = -\frac{4}{c} < 0$.

□

Proof of Proposition 2:

The proof of Proposition 2 is straightforward and seen directly from the first derivative of $\mathbb{E}[v]$ with respect to c given by

$$\frac{\partial \mathbb{E}[v]}{\partial c} = \begin{cases} -p(1-p)(\bar{v}-\underline{v})\left(\frac{(1-\mu^2)(\bar{v}^2-\underline{v}^2)}{4c^2}\right) & \text{if } c > c_2 \\ p(1-p)(\bar{v}-\underline{v})\left(\frac{(1-\mu)^2\underline{v}^2}{4c^2}\right) & \text{if } c_1 < c < c_2 \\ 0 & \text{if } c < c_1 \end{cases} \tag{6}$$

□

Proof of Proposition 3:

Define $\mu_1 = 1 - \frac{2c\alpha}{\underline{v}\beta}$ and $\mu_2 = 1 - \frac{2c\alpha}{\bar{v}\beta}$. The optimal level of investments for each $i = 1, 2$ is given by

$$\bar{m}_i = \begin{cases} \left(\frac{(1-\mu)\bar{v}\beta}{2c\alpha}\right)^{\frac{1}{\alpha-\beta}} & \text{if } \mu > \mu_2 \\ 1 & \text{if } \mu \leq \mu_2 \end{cases}, \tag{7}$$

and

$$\underline{m}_i = \begin{cases} \left(\frac{(1-\mu)\underline{v}\beta}{2c\alpha}\right)^{\frac{1}{\alpha-\beta}} & \text{if } \mu > \mu_1 \\ 1 & \text{if } \mu \leq \mu_1 \end{cases} \tag{8}$$

The second order conditions for optimisation are satisfied given $\alpha > \beta$. Note further that $\bar{m}_i \geq \underline{m}_i$ in equilibrium, which in turn implies that the favorable signal $\bar{s}$ is more likely to come from a high-quality politician. Hence the assumed voting strategy is indeed a best response which qualifies it to be a part of a Perfect Bayesian Equilibrium. We now obtain

$$\frac{\partial \mathbb{E}[v]}{\partial \mu} = \begin{cases} p(1-p)(\bar{v}-\underline{v})\left(1 - (\frac{\alpha-\beta+1}{\alpha-\beta})(\bar{v}^{\frac{\alpha-\beta+1}{\alpha-\beta}} - \underline{v}^{\frac{\alpha-\beta+1}{\alpha-\beta}})(\frac{\beta(1-\mu)}{2c\alpha})^{\frac{1}{\alpha-\beta}}\right) & \text{if } \mu > \mu_2 \\ p(1-p)(\bar{v}-\underline{v})\left(1 - \bar{v} + (\frac{\alpha-\beta+1}{\alpha-\beta})(\underline{v}^{\frac{\alpha-\beta+1}{\alpha-\beta}})(\frac{\beta(1-\mu)}{2c\alpha})^{\frac{1}{\alpha-\beta}}\right) & \text{if } \mu_1 < \mu < \mu_2 \\ p(1-p)(\bar{v}-\underline{v})(1-\bar{v}+\underline{v}) & \text{if } \mu < \mu_1 \end{cases} \tag{9}$$

To prove the proposition, the following cases need to be considered:

Case 1. $\mu < \mu_2$. Note from (9) that $\frac{\partial \mathbb{E}[v]}{\partial \mu} > 0$ always holds for this case.

Case 2. Consider $\mu > \mu_2$. Define $\zeta = \left(\frac{(\alpha-\beta)}{(\alpha-\beta+1)\left(\bar{v}^{\frac{\alpha-\beta+1}{\alpha-\beta}} - \underline{v}^{\frac{\alpha-\beta+1}{\alpha-\beta}}\right)}\right)^{\alpha-\beta}$ and $\mu_3 = 1 - \frac{2c\alpha\zeta}{\beta}$.

Note that for this case $\frac{\partial \mathbb{E}[v]}{\partial \mu} < (>) 0$ whenever $\mu < (>) \mu_3$.

When $1/\zeta > \max\{\frac{2c\alpha}{\beta}, \bar{v}\}$, we have $0 < \mu_3$ and $\mu_3 > \mu_2$. It follows from above that for this parametric zone we have $\frac{\partial \mathbb{E}[v]}{\partial \mu} < 0$ for all $\mu \in (\mu_2, \mu_3)$. It further follows that for any other parametric zone, we have $\frac{\partial \mathbb{E}[v]}{\partial \mu} > 0$.

□

Proof of Proposition 4:

The optimization problem of the politician i with quality $v_i \in \{\underline{v}, \bar{v}\}$ are given respectively by

$$\max_{\bar{m}_i \in [0,1]} U_i(\bar{v}) = \mu((1-p)+\tau p)+(1-\mu)[f(\bar{v}_i, \bar{m}_i)(1-z_j)+\tau f(\bar{v}_i, \bar{m}_i)z_j+\tau(1-f(\bar{v}_i, \bar{m}_i))(1-z_j)]-g(\bar{m}_i) \tag{10}$$

and

$$\max_{\underline{m}_i \in [0,1]} U_i(\underline{v}) = \mu\tau(1-p)+(1-\mu)[f(\underline{v}_i, \underline{m}_i)(1-z_j)+\tau f(\underline{v}_i, \underline{m}_i)z_j+\tau(1-f(\underline{v}_i, \underline{m}_i))(1-z_j)]-g(\underline{m}_i), \tag{11}$$

where recall that $z_j = p\bar{v}\bar{m}_j + (1-p)\underline{v}\underline{m}_j$. Clearly, i is the favored politician if $\tau > 1/2$ and disfavored if $\tau < 1/2$. The first order conditions of optimization are given by

$$\frac{\partial U_i(\bar{v})}{\partial \bar{m}_i} = (1-\mu)f'(\bar{v}_i, \bar{m}_i)(1-\tau+z_j(2\tau-1)) - g'(\bar{m}_i) = 0 \tag{12}$$

$$\frac{\partial U_i(\underline{v})}{\partial \underline{m}_i} = (1-\mu)f'(\underline{v}_i, \underline{m}_i)(1-\tau+z_j(2\tau-1)) - g'(\underline{m}_i) = 0 \tag{13}$$

where, $f' = \frac{\partial f(v_i,m_i)}{\partial m_i}$ and $g' = \frac{\partial g(v_i,m_i)}{\partial m_i}$. From these it follows that politician i has a dominant strategy if and only if $\tau = 1/2$.

The second order conditions are

$$\frac{\partial^2 U_i(\bar{v})}{\partial \bar{m}_i^2} = (1-\mu)f''(\bar{v}_i, \bar{m}_i)(1-\tau+z_j(2\tau-1)) - g''(\bar{m}_i)$$

and

$$\frac{\partial^2 U_i(\underline{v})}{\partial \underline{m}_i^2} = (1-\mu)f''(\underline{v}_i, \underline{m}_i)(1-\tau+z_j(2\tau-1)) - g''(\underline{m}_i)$$

where, $f'' = \frac{\partial^2 f(v_i,m_i)}{\partial m_i^2} \le 0$ and $g'' = \frac{\partial^2 g(v_i,m_i)}{\partial m_i^2} > 0$. Note that $1-\tau+z_j(2\tau-1) > 0$ when $\tau > 1/2$. When $\tau < 1/2$ and $z_j > 1/2$, we have $1-z_j+\tau(2z_j-1) > 0$. Also when $\tau < 1/2$ and $z_j < 1/2$, it follows that $1-z_j+\tau(2z_j-1) > 0$. This along with $f'' \le 0$ and $g'' > 0$ ensures that the second-order conditions are negative.

We now show that if i is the favored politician, then m_i and m_j are strategic complements while if i is the disfavored politician then they are strategic substitutes. To do this, we first need to define the notion of strategic complementarity or substitutability in Bayesian settings. Here, the relevant variable is $z_j = p\bar{v}\bar{m}_j + (1-p)\underline{v}\underline{m}_j$. We say that the investment game exhibits strong strategic complementarity (substitutability) if $\bar{m}_i$ and $\underline{m}_i$ increase (decrease) when z_j increases. The relation is weak if $\bar{m}_i$ and $\underline{m}_i$ increase (decrease) when $\bar{m}_j$ and $\underline{m}_j$ increase. Given this, from (12), we have

$$(1-\mu)(1-\tau+z_j(2\tau-1)) = \frac{g'(\bar{m}_i)}{f'(\bar{v}_i,\bar{m}_i)} \tag{14}$$

When $\tau > 1/2$, increase in $\bar{m}_j$ and $\underline{m}_j$ increases the left hand side of the above equation since then z_j increases. Hence, in order to restore equality, the right hand side must also increase. Note that given our assumptions on g and f, we know that for any $x \in \mathbb{R}$ we have

$$\frac{\partial \frac{g'(x)}{f'(v,x)}}{\partial x} = \frac{g''f' - g'f''}{(f')^2} > 0.$$

Using the Envelope Theorem, this further implies that for the right hand side of (14) to increase we need $\bar{m}_i$ to increase. Using the same arguments for the low quality type of politician i, we conclude that the game exhibits strategic complementarity for the favored politician i. This also directly proves that for the disfavored candidate (for whom, τ falls below 1/2), the game exhibits strategic substitutability.

□

Proof of Proposition 5:

Let $\bar{m}_1$ and $\underline{m}_1$ be the investments in the private media by the favored politician 1 who is of type $\bar{v}$ and $\underline{v}$ respectively. Similarly, $\bar{m}_2$ and $\underline{m}_2$ are the investments made by the disfavored politician 2 of type $\bar{v}$ and $\underline{v}$ respectively. Let $z_1 = p\bar{v}\bar{m}_1 + (1-p)\underline{v}\underline{m}_1$, $z_2 = p\bar{v}\bar{m}_2 + (1-p)\underline{v}\underline{m}_2$ be the probability that politician private media emits the positive signal $\bar{s}$. The optimization problem of politician 1 and 2 with quality $v_i \in \{\underline{v}, \bar{v}\}$, $i \in \{1, 2\}$ are given respectively by

$$\max_{\bar{m}_1 \in [0,1]} U_1(\bar{v}) = \mu((1-p)+p\tau)+(1-\mu)(\bar{v}\bar{m}_1(1-z_2)+\bar{v}\bar{m}_1 z_2\tau+(1-\bar{v}\bar{m}_1)(1-z_2)\tau)-c\bar{m}_1^2 \tag{15}$$

$$\max_{\underline{m}_1 \in [0,1]} U_1(\underline{v}) = \mu((1-p)\tau)+(1-\mu)(\underline{v}\underline{m}_1(1-z_2)+\underline{v}\underline{m}_1 z_2\tau+(1-\underline{v}\underline{m}_1)(1-z_2)\tau)-c\underline{m}_1^2 \tag{16}$$

$$\max_{\bar{m}_2 \in [0,1]} U_2(\bar{v}) = \mu((1-p)+p(1-\tau))+(1-\mu)(\bar{v}\bar{m}_2(1-z_1)+\bar{v}\bar{m}_2 z_1(1-\tau)+(1-\bar{v}\bar{m}_2)(1-z_1)(1-\tau))-c\bar{m}_2^2 \tag{17}$$

$$\max_{\underline{m}_2 \in [0,1]} U_2(\underline{v}) = \mu((1-p)(1-\tau))+(1-\mu)(\underline{v}\underline{m}_2(1-z_1)+\underline{v}\underline{m}_2 z_1(1-\tau)+(1-\underline{v}\underline{m}_2)(1-z_1)(1-\tau))-c\underline{m}_2^2 \tag{18}$$

The above maximization problems yield the following first order conditions:

$$\frac{\partial U_1(\bar{v})}{\partial \bar{m}_1} = (1-\mu)\bar{v}(1-z_2+z_2\tau-(1-z_2)\tau)-2c\bar{m}_1 = 0 \tag{19}$$

$$\frac{\partial U_1(\underline{v})}{\partial \underline{m}_1} = (1-\mu)\underline{v}(1 - z_2 + z_2\tau - (1-z_2)\tau) - 2c\underline{m}_1 = 0 \tag{20}$$

$$\frac{\partial U_2(\bar{v})}{\partial \bar{m}_2} = (1-\mu)\bar{v}(1 - z_1 + z_1(1-\tau) - (1-z_1)(1-\tau)) - 2c\bar{m}_2 = 0 \tag{21}$$

$$\frac{\partial U_2(\underline{v})}{\partial \underline{m}_2} = (1-\mu)\underline{v}(1 - z_1 + z_1(1-\tau) - (1-z_1)(1-\tau)) - 2c\underline{m}_2 = 0 \tag{22}$$

The second order conditions are:

$$\frac{\partial^2 U_1(\bar{v})}{\partial \bar{m}_1^2} = \frac{\partial^2 U_1(\underline{v})}{\partial \underline{m}_1^2} = \frac{\partial^2 U_2(\bar{v})}{\partial \bar{m}_2^2} = \frac{\partial^2 U_2(\underline{v})}{\partial \underline{m}_2^2} = -2c.$$

From the first order conditions, we therefore have the optimal level of investments in equilibrium to be:

$$\bar{m}_1 = \frac{\bar{v}(1-\mu)(2c(1-\tau) + \tau(2\tau-1)(1-\mu)(p\bar{v}^2 + (1-p)\underline{v}^2))}{4c^2 + (1-\mu)^2(2\tau-1)^2(p\bar{v}^2 + (1-p)\underline{v}^2)^2} \tag{23}$$

$$\underline{m}_1 = \frac{\underline{v}(1-\mu)(2c(1-\tau) + \tau(2\tau-1)(1-\mu)(p\bar{v}^2 + (1-p)\underline{v}^2))}{4c^2 + (1-\mu)^2(2\tau-1)^2(p\bar{v}^2 + (1-p)\underline{v}^2)^2} \tag{24}$$

$$\bar{m}_2 = \frac{\bar{v}(1-\mu)(2c\tau - (1-\tau)(2\tau-1)(1-\mu)(p\bar{v}^2 + (1-p)\underline{v}^2))}{4c^2 + (1-\mu)^2(2\tau-1)^2(p\bar{v}^2 + (1-p)\underline{v}^2)^2} \tag{25}$$

$$\underline{m}_2 = \frac{\underline{v}(1-\mu)(2c\tau - (1-\tau)(2\tau-1)(1-\mu)(p\bar{v}^2 + (1-p)\underline{v}^2))}{4c^2 + (1-\mu)^2(2\tau-1)^2(p\bar{v}^2 + (1-p)\underline{v}^2)^2} \tag{26}$$

We now define the following: Let $\sigma_1 = (1-\tau)^2\bar{v}^2 + 4(2\tau-1)(p\bar{v}^2 + (1-p)\underline{v}^2)(\tau\bar{v} - (2\tau - 1)(p\bar{v}^2 + (1-p)\underline{v}^2))$, and $\sigma_2 = -16\bar{v}^4p^2\tau^2 + 16\bar{v}^4p^2\tau - 4\bar{v}^4p^2 + 8\bar{v}^3p\tau^2 - 12\bar{v}^3p\tau + 4\bar{v}^3p + 32\bar{v}^2\underline{v}^2p^2\tau^2 - 32\bar{v}^2\underline{v}^2p^2\tau + 8\bar{v}^2\underline{v}^2p^2 - 32\bar{v}^2\underline{v}^2p\tau^2 + 32\bar{v}^2\underline{v}^2p\tau - 8\bar{v}^2\underline{v}^2p + \bar{v}^2\tau^2 - 8\bar{v}\underline{v}^2p\tau^2 + 12\bar{v}\underline{v}^2p\tau - 4\bar{v}\underline{v}^2p + 8\bar{v}\underline{v}^2\tau^2 - 12\bar{v}\underline{v}^2\tau + 4\bar{v}\underline{v}^2 - 16\underline{v}^4p^2\tau^2 + 16\underline{v}^4p^2\tau - 4\underline{v}^4p^2 + 32\underline{v}^4p\tau^2 - 32\underline{v}^4p\tau + 8\underline{v}^4p - 16\underline{v}^4\tau^2 + 16\underline{v}^4\tau - 4\underline{v}^4$.

We further define $c_1^* = \frac{(1-\mu)(\bar{v}(1-\tau)+\sqrt{\sigma_1})}{4}$, $c_2^* = \frac{(1-\mu)(\bar{v}\tau+\sqrt{\sigma_2})}{4}$, $c_3^* = \frac{(1-\tau)(2\tau-1)(1-\mu)(p\bar{v}^2+(1-p)\underline{v}^2)}{2\tau}$, $c_4^* = \frac{(1+\sqrt{2})(2\tau-1)(1-\mu)(p\bar{v}^2+(1-p)\underline{v}^2)}{2}$ and $\tilde{c} = \max\{c_1^*, c_2^*, c_3^*, c_4^*\}$.

We now state and prove the following lemma:

Lemma 1. *The equilibrium investment levels have an interior solution whenever $c > \tilde{c}$ and $\sigma_2 > 0$.*

Proof of Lemma 1:

Note that $\bar{m}_1 > \underline{m}_1 > 0$ follows immediately from (23) and (24). We also have $\bar{m}_1 - 1 = -\frac{4(c-c_1^*)(c-\frac{(1-\mu)(\bar{v}(1-\tau)-\sqrt{\sigma_1})}{4})}{4c^2+(1-\mu)^2(2\tau-1)^2(p\bar{v}^2+(1-p)\underline{v}^2)^2}$ with σ_1 being always positive since $(\tau\bar{v} - (2\tau-1)(p\bar{v}^2 + (1-p)\underline{v}^2)) > 0$. Note further that whenever $c > c_1^*$, we have $(c - \frac{(1-\mu)(\bar{v}(1-\tau)-\sqrt{\sigma_1})}{4}) > 0$. Hence it follows that $\bar{m}_1 < 1$ whenever $c > c_1^*$. It also follows immediately from (25) and (26) that

$\bar{m}_2 > \underline{m}_2 > 0$ whenever $c > c_3^*$. Also, $\bar{m}_2 - 1 = -\frac{4(c-c_2^*)(c-\frac{(1-\mu)(\bar{v}\tau-\sqrt{\sigma_2})}{4})}{4c^2+(1-\mu)^2(2\tau-1)^2(p\bar{v}^2+(1-p)\underline{v}^2)^2}$. This implies that $\bar{m}_2 < 1$ whenever $\sigma_2 > 0$ and $c > c_2^*$. We therefore ensure that $0 < \underline{m}_1 < \bar{m}_1 < 1$ and $0 < \underline{m}_2 < \bar{m}_2 < 1$ when $c > \tilde{c}$ and $\sigma_2 > 0$. This completes the proof of the lemma. The conditions of the lemma are non-empty (for example, when $\bar{v} = 1, \underline{v} = 0.5, \tau = 0.6, p = 0.5, \mu = 0.3$ implies $c_1^* = 0.1803$, $c_2^* = 0.1596$, $c_3^* = 0.0292$, $c_4^* = 0.1056$, $\sigma_2 = 0.0975$, and $\tilde{c} = 0.1803$).

Note from expressions (23) to (26) that the equilibrium level of investment for a high quality favored politician is higher than that of a low quality favored politician (since $\bar{v} > \underline{v}$). A similar observation may be made for the disfavored politician. These in turn ensure that the voting strategy followed is rational.

The expected quality of the elected politician is:

$$\mathbb{E}[v] = \mu(p^2\bar{v} + 2p(1-p)\bar{v} + (1-p)^2\underline{v}) + (1-\mu)(p^2\bar{v} + (1-p)^2\underline{v} + p(1-p)(\bar{v}\bar{m}_1(1-\underline{v}\underline{m}_2)\bar{v} + (\bar{v}\bar{m}_1\underline{v}\underline{m}_2 + (1-\bar{v}\bar{m}_1)(1-\underline{v}\underline{m}_2))(\tau\bar{v} + (1-\tau)\underline{v}) + (1-\bar{v}\bar{m}_1)\underline{v}\underline{m}_2\underline{v}) + p(1-p)(\bar{v}\bar{m}_2(1-\underline{v}\underline{m}_1)\bar{v} + (\bar{v}\bar{m}_2\underline{v}\underline{m}_1 + (1-\bar{v}\bar{m}_2)(1-\underline{v}\underline{m}_1))(\tau\underline{v} + (1-\tau)\bar{v}) + (1-\bar{v}\bar{m}_2)\underline{v}\underline{m}_1\underline{v})) \quad (27)$$

which simplifies to

$$\mathbb{E}[v] = p\bar{v} + (1-p)\underline{v} + p(1-p)(\bar{v}-\underline{v})(\mu + \frac{2c(1-\mu)^2(\bar{v}^2-\underline{v}^2)(2\tau^2-2\tau+1)}{4c^2+(1-\mu)^2(2\tau-1)^2(p\bar{v}^2+(1-p)\underline{v}^2)^2}) \quad (28)$$

From (28), differentiating with respect to τ yields

$$\frac{\partial\mathbb{E}[v]}{\partial\tau} = p(1-p)(\bar{v}-\underline{v})(\frac{4c(1-\mu)^2(\bar{v}^2-\underline{v}^2)(2\tau-1)(4c^2-(1-\mu)^2(p\bar{v}^2+(1-p)\underline{v}^2)^2)}{(4c^2+(1-\mu)^2(2\tau-1)^2(p\bar{v}^2+(1-p)\underline{v}^2)^2)^2}) \quad (29)$$

From (29) it follows that $\frac{\partial\mathbb{E}[v]}{\partial\tau} > (<)0$ whenever $(4c^2 - (1-\mu)^2(p\bar{v}^2 + (1-p)\underline{v}^2)^2) > (<)0$, which simplifies to $\mu > (<)1 - \frac{2c}{p\bar{v}^2+(1-p)\underline{v}^2}$. It immediately follows that $\tau^* = 1$ maximizes $\mathbb{E}[v]$ when $\mu > 1 - \frac{2c}{p\bar{v}^2+(1-p)\underline{v}^2}$, and $\tau^* = 1/2$ maximizes $\mathbb{E}[v]$ when $\mu < 1 - \frac{2c}{p\bar{v}^2+(1-p)\underline{v}^2}$. To finally prove that the cut-off value of μ is non-empty, note that for the numerical example for interior solution provided earlier, the value of $1 - \frac{2c}{p\bar{v}^2+(1-p)\underline{v}^2} = 0.2$ for $c = 0.25$.

□

Details from Footnote 9. As claimed in the intuition, we show that when $\mu > 1 - \frac{2c}{p\bar{v}^2+(1-p)\underline{v}^2}$, we have $\frac{\partial\bar{m}_2}{\partial\tau} - |\frac{\partial\bar{m}_1}{\partial\tau}| > 0$, $\frac{\partial\underline{m}_2}{\partial\tau} - |\frac{\partial\underline{m}_1}{\partial\tau}| > 0$ and $(\frac{\partial\bar{m}_2}{\partial\tau} - |\frac{\partial\bar{m}_1}{\partial\tau}|) - (\frac{\partial\underline{m}_2}{\partial\tau} - |\frac{\partial\underline{m}_1}{\partial\tau}|) > 0$. Furthermore, we show that when $\mu < 1 - \frac{2c}{p\bar{v}^2+(1-p)\underline{v}^2}$, we have $|\frac{\partial\bar{m}_2}{\partial\tau}| - \frac{\partial\bar{m}_1}{\partial\tau} > 0$, $|\frac{\partial\underline{m}_2}{\partial\tau}| - \frac{\partial\underline{m}_1}{\partial\tau} > 0$ and $(|\frac{\partial\bar{m}_2}{\partial\tau}| - \frac{\partial\bar{m}_1}{\partial\tau}) - (|\frac{\partial\underline{m}_2}{\partial\tau}| - \frac{\partial\underline{m}_1}{\partial\tau}) > 0$.

To prove this, define $A = (1-\mu)(p\bar{v}^2 + (1-p)\underline{v}^2)$. Note that we may express $4c^2 - 4c(2\tau-1)A - (2\tau-1)^2A^2 = 4(c-c_4^*)(c + \frac{(\sqrt{2}-1)(2\tau-1)(1-\mu)(p\bar{v}^2+(1-p)\underline{v}^2)}{2})$. Note that $(c + \frac{(\sqrt{2}-1)(2\tau-1)(1-\mu)(p\bar{v}^2+(1-p)\underline{v}^2)}{2}) > 0$. This implies that $4c^2 - 4c(2\tau-1)A - (2\tau-1)^2A^2 > 0$ whenever $c > c_4^*$. Furthermore, $4c^2 - 4c(2\tau-1)A - (2\tau-1)^2A^2 > 0$ also implies that

$4c^2 + 4c(2\tau - 1)A - (2\tau - 1)^2 A^2 > 0$ holds. Also note that $\mu > (<) 1 - \frac{2c}{p\bar{v}^2 + (1-p)\underline{v}^2}$ implies $2c - A > (<) 0$.

From expressions (23) to (26) we have

$$\frac{\partial \bar{m}_1}{\partial \tau} = -\frac{\bar{v}(1-\mu)(2c-A)(4c^2 - (2\tau-1)^2 A^2 - 4c(2\tau-1)A)}{(4c^2 + (1-\mu)^2(2\tau-1)^2(p\bar{v}^2 + (1-p)\underline{v}^2)^2)^2} \tag{30}$$

$$\frac{\partial \underline{m}_1}{\partial \tau} = -\frac{\underline{v}(1-\mu)(2c-A)(4c^2 - (2\tau-1)^2 A^2 - 4c(2\tau-1)A)}{(4c^2 + (1-\mu)^2(2\tau-1)^2(p\bar{v}^2 + (1-p)\underline{v}^2)^2)^2} \tag{31}$$

$$\frac{\partial \bar{m}_2}{\partial \tau} = \frac{\bar{v}(1-\mu)(2c-A)(4c^2 + 4c(2\tau-1)A - (2\tau-1)^2 A^2)}{(4c^2 + (1-\mu)^2(2\tau-1)^2(p\bar{v}^2 + (1-p)\underline{v}^2)^2)^2} \tag{32}$$

$$\frac{\partial \underline{m}_2}{\partial \tau} = \frac{\underline{v}(1-\mu)(2c-A)(4c^2 + 4c(2\tau-1)A - (2\tau-1)^2 A^2)}{(4c^2 + (1-\mu)^2(2\tau-1)^2(p\bar{v}^2 + (1-p)\underline{v}^2)^2)^2} \tag{33}$$

When $c > c_4^*$ and $\mu > 1 - \frac{2c}{p\bar{v}^2 + (1-p)\underline{v}^2}$, we have $\frac{\partial \bar{m}_1}{\partial \tau} < 0$, $\frac{\partial \underline{m}_1}{\partial \tau} < 0$, $\frac{\partial \bar{m}_2}{\partial \tau} > 0$ and $\frac{\partial \underline{m}_2}{\partial \tau} > 0$. From expressions (30) to (33) we also have

$$\frac{\partial \bar{m}_2}{\partial \tau} - |\frac{\partial \bar{m}_1}{\partial \tau}| = \frac{8\bar{v}(1-\mu)(2c-A)c(2\tau-1)A}{(4c^2 + (1-\mu)^2(2\tau-1)^2(p\bar{v}^2 + (1-p)\underline{v}^2)^2)^2} > 0 \tag{34}$$

and

$$\frac{\partial \underline{m}_2}{\partial \tau} - |\frac{\partial \underline{m}_1}{\partial \tau}| = \frac{8\underline{v}(1-\mu)(2c-A)c(2\tau-1)A}{(4c^2 + (1-\mu)^2(2\tau-1)^2(p\bar{v}^2 + (1-p)\underline{v}^2)^2)^2} > 0 \tag{35}$$

from which we have

$$\left(\frac{\partial \bar{m}_2}{\partial \tau} - |\frac{\partial \bar{m}_1}{\partial \tau}|\right) - \left(\frac{\partial \underline{m}_2}{\partial \tau} - |\frac{\partial \underline{m}_1}{\partial \tau}|\right) = \frac{8(\bar{v} - \underline{v})(1-\mu)(2c-A)c(2\tau-1)A}{(4c^2 + (1-\mu)^2(2\tau-1)^2(p\bar{v}^2 + (1-p)\underline{v}^2)^2)^2} > 0 \tag{36}$$

This completes the proofs of our claims made while explaining the result in Proposition for the case $\mu > 1 - \frac{2c}{p\bar{v}^2 + (1-p)\underline{v}^2}$.

When $c > c_4^*$ and $\mu < 1 - \frac{2c}{p\bar{v}^2 + (1-p)\underline{v}^2}$, we have shown that $2c - A < 0$, and from (30) to (33) we therefore have $\frac{\partial \bar{m}_1}{\partial \tau} > 0$, $\frac{\partial \underline{m}_1}{\partial \tau} > 0$, $\frac{\partial \bar{m}_2}{\partial \tau} < 0$ and $\frac{\partial \underline{m}_2}{\partial \tau} < 0$. We also have

$$|\frac{\partial \bar{m}_2}{\partial \tau}| - \frac{\partial \bar{m}_1}{\partial \tau} = \frac{8\bar{v}(1-\mu)(A-2c)c(2\tau-1)A}{(4c^2 + (1-\mu)^2(2\tau-1)^2(p\bar{v}^2 + (1-p)\underline{v}^2)^2)^2} > 0 \tag{37}$$

and

$$|\frac{\partial \underline{m}_2}{\partial \tau}| - \frac{\partial \underline{m}_1}{\partial \tau} = \frac{8\underline{v}(1-\mu)(A-2c)c(2\tau-1)A}{(4c^2 + (1-\mu)^2(2\tau-1)^2(p\bar{v}^2 + (1-p)\underline{v}^2)^2)^2} > 0 \tag{38}$$

From expressions (37) and (38) we have

$$\left(|\frac{\partial \bar{m}_2}{\partial \tau}| - \frac{\partial \bar{m}_1}{\partial \tau}\right) - \left(|\frac{\partial \underline{m}_2}{\partial \tau}| - \frac{\partial \underline{m}_1}{\partial \tau}\right) = \frac{8(\bar{v} - \underline{v})(1-\mu)(A-2c)c(2\tau-1)A}{(4c^2 + (1-\mu)^2(2\tau-1)^2(p\bar{v}^2 + (1-p)\underline{v}^2)^2)^2} > 0 \tag{39}$$

□

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