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## Abstract

We study how beliefs about firm value respond to public information stemming from either public announcements or shareholder meetings. We focus on settings with homogeneous shareholders (i.e., agents with common preferences and opinions), where information is about which course of action is best for the firm. The analysis illustrates that extant work dismissing homogeneous shareholders models has over-reached. Counter to the received wisdom, these models can explain increases in trading volume after public events (a pattern which is documented by several empirical papers). Two economic insights surface. First, when homogeneous shareholders anticipate that firm decisions will be guided by information, the presence of differences in belief about the firm's fundamentals and best course of action need not lead to differences in belief about firm value. Second, when voting is not fully informative, homogeneous shareholders will seek to generate informational rents from trading after the vote. Both of these incentive effects will tend to generate increases in trading volume after public events.



JEL Classification: D72, D82, D83, D84

Keywords: Public information, Shareholder voting, Trade, Information aggregation, Disagreement



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# Public Information as a Source of Disagreement Among Shareholders*

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December 6, 2022

**Abstract**

We study how beliefs about firm value respond to public information stemming from either public announcements or shareholder meetings. We focus on settings with homogeneous shareholders (i.e., agents with common preferences and opinions), where information is about which course of action is best for the firm. The analysis illustrates that extant work dismissing homogeneous shareholders models has over-reached. Counter to the received wisdom, these models can explain increases in trading volume after public events (a pattern which is documented by several empirical papers). Two economic insights surface. First, when homogeneous shareholders anticipate that firm decisions will be guided by information, the presence of differences in belief about the firm's fundamentals and best course of action need not lead to differences in belief about firm value. Second, when voting is not fully informative, homogeneous shareholders will seek to generate informational rents from trading after the vote. Both of these incentive effects will tend to generate increases in trading volume after public events.

**JEL classification**: D72, D82, D83, G34

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# 1 Introduction

Traditionally, scholarship on firm decision-making and corporate governance treats shareholders as homogeneous: they have *common preferences* (i.e., they all care about the value of the firm),[1] and *common opinions* (i.e., they share a common understanding of the world, and how to interpret new information about the firm and the world). A large body of work on corporate governance arrangements maintains this homogeneity assumption and focuses on tensions between value-maximizing shareholders and management who may have alternative goals (e.g., Meckling and Jensen 1976; Shleifer and Vishny 1989; Bolton and Scharfstein 1990; Dewatripont and Tirole 1994; Yermack 2010; Fos et al. 2018; Malenko and Malenko 2019).[2]

However, the homogeneous approach has detractors. There are two strands of arguments. First, some researchers provide reasons why shareholders may have heterogeneous preferences in some contexts.[3] While these arguments make the point that shareholders are not necessarily identical, they do not refute the key premise of the homogeneity approach, i.e., that shareholders seek to maximize some objectives that depend positively on a common factor, say, firm value and thus many of the insights from models with homogenous shareholders are known to carry over.[4]

The second strand of arguments represents a more serious challenge to the homogeneous-shareholder approach: they provide evidence of abnormal trading volumes after public events that are taken to be inconsistent with models with homogeneous shareholders.[5] Central to

[1]Milton Friedman famously argued in an article published in the New York Time Magazine: corporate executives have a direct responsibility to the shareholders "[...] to conduct the business in accordance with their desires, which will generally be to make as much money as possible while conforming to the basic rules of the society [...]." Friedman (1970).

[2]The homogeneous-shareholder approach was also the basis for early work on markets and lead to the no-trade theorems (Geanakoplos, 1992). Scholars of finance moved on from this impossibility result by introducing the possibility of some traders whose behavior is non-pecuniary, so called noise traders (Kyle, 1985). Work building off Kyle typically retains the homogeneity assumption for at least the explicitly modeled rational traders.

[3]As well summarized by Levit et al. (2019), heterogeneity among shareholders may arise due to differences in investment horizons (Bushee 1998; Gaspar et al. 2005), tax status (Desai and Jin 2011), ownership of other firms (Cvijanović et al. 2016; He et al. 2019), attitudes toward risk, corporate governance philosophies and social and political ideologies (Bolton et al. 2020; Bubb and Catan 2019).

[4]The classic papers on common values voting indeed made clear that the voters can differ, e.g., in their willingness to trade off successes and failures in different underlying states (see, e.g., Feddersen and Pesendorfer 1998), or in their private valuations of the alternatives (see, e.g., Feddersen and Pesendorfer 1997). For some concrete examples of corporate governance papers with "partially" homogeneous shareholders, see, e.g., Bernhardt et al. (2018), Levitt, Malenko, and Maug (2021, 2022), and Matsusaka and Shu (2021).

[5]Kandel and Pearson (1995) look at the release of earnings reports and Bollerslev et al. (2018) focus on Federal Open Market Committee meetings. Li et al. (2022) focus on mutual funds and consider shareholder meetings as the key public events. These papers suggest relaxing the common opinion assumption, to instead embrace so-called difference-of-opinion models (see, e.g., Harris and Raviv 1993; Kandel and Pearson 1995;

these arguments is a seemingly compelling expectation that when information is publicly released this should cause Bayesian decision-makers to learn and that, in an homogeneous-shareholder setting, this learning must cause assessments of the value of a firm to become more similar. Naturally, then, when potential traders' beliefs all become closer together a willingness to trade must also fall, and so it is argued that homogeneous-shareholder models predict a reduction in trade after public events. This clashes with the empirical findings that trade volumes increase after public events.

In this paper, we argue that disregarding the homogeneous-shareholder approach based on the second strand of arguments is premature. We show that the interpretation of previous empirical studies has been based on an incomplete understanding of how Bayesian beliefs of homogeneous shareholders about firm value change in response to public events.

We retain the standard homogeneity assumption (shareholders have common preferences and common opinions), and explicitly study how beliefs about firm value respond to public events. We showcase two ways that public events may impact beliefs by focusing on settings where a firm must ultimately make a payoff-relevant decision. In the first, there is a public announcement which may impact the choice made by firm leadership, and hence the value of the firm. In the second, information about the outcome of shareholder voting is the public announcement. When an economic decision is being made, the beliefs of homogeneous shareholders about firm value need not behave the same way. In particular, they may diverge when public information is revealed. The previously cited work did not appreciate this nuance.

Two key economic intuitions drive our findings. First, even when decision-makers possess very different interim beliefs about which action is best for the firm, they may not have very different interim beliefs about the ultimate value of the firm if they anticipate that firm decision-making will be guided by the information ultimately available to the policymaker. The key to seeing this is recognizing that two agents that possess different information (and thus beliefs) about which action is best will also possess different beliefs about which action will be chosen. When a public signal is revealed, this will change both their assessments of which action is best and which action will be chosen. A public signal favoring one course of action will lead an agent that already thought that action was best (and likely to be chosen) to be even more optimistic. By contrast, it will leave an agent that thought that action was sub-optimal to now believe it is better than she thought, and it will also cause her to believe it is more likely to be chosen. Importantly this latter agent now sees tension between her earlier information and this new information and she is thus likely to be less optimistic that

Boot et al. 2006). An alternative approach taken by Mukerji et al. (2021) is to consider shareholders that are averse to ambiguity and heterogeneous in their degree of such aversion.

the option that is likely to be chosen is in fact the optimal one. Accordingly, while public information will cause decision-maker's beliefs about what action is best to become more congruent it may not cause convergence of their beliefs about the likelihood that the correct action will be chosen. We show that public information may lead to divergence in firm's valuation by shareholders.

Second, in some settings (and in particular for the type of public events studied by Li et al. 2022) the public events stem from collective choices made by the investors at shareholders meetings. Here, we draw on the existing literature showing that we should not expect shareholder voting to fully reveal the information that shareholders possess (Austen-Smith and Banks 1996; Feddersen and Pesendorfer 1996; Myerson 1998; Maug and Rydqvist 2009; Meirowitz and Pi 2022). Accordingly, after the market learns how shareholders voted, the shareholders themselves will in fact have heterogeneous beliefs about the likelihood that the alternative that won the vote is in fact optimal. Importantly, we find that the level of disagreement between shareholders about firm value might increase from before the vote until after the vote (and thus trading volume might increase as well).

After developing this intuition through the study of canonical and purposely sparse models, we extract predictions about the dynamics of market action. We connect our results to extant findings about trading behavior after public announcements/events. Our analysis justifies a far more optimistic reading of the homogeneous-shareholder models and recently articulated empirical patterns. While there may ultimately be compelling justifications to move beyond those models, we conclude that extant work may have been too quick to dismiss this classic approach.

## 2 Model

We have a finite set of shareholders, $N$, with cardinality $n$, assumed to be odd. At any point in time, shareholder $i \in N$ estimates the value of the firm, $x$, using all the information available to her. The real value of the firm $x$ depends on the state of the world $\omega \in \Omega = \{\alpha, \beta\}$ and on a decision $k \in K = \{A, B\}$. We assume that:

$$\begin{aligned} x(A,\alpha) &= x(B,\beta) = 1, \\ x(B,\alpha) &= x(A,\beta) = 0. \end{aligned} \tag{1}$$

The model has four discrete stages:

**First stage**. Nature draws the state of the world from $\Omega$ with equal probability. The shareholders do not observe the state, but they are aware of the state generating process.

**Second stage**. Each shareholder $i \in N$ receives an independent signal $s \in S = \{s_a, s_b\}$, drawn in the following manner: if the state is $\alpha$ then $s_a$ is drawn with probability $q_\alpha$, and $s_b$ is drawn with probability $1 - q_\alpha$; while, if the state is $\beta$ then $s_a$ is drawn with probability $q_\beta$, and $s_b$ is drawn with probability $1 - q_\beta$, with $q_\alpha > \frac{1}{2} > q_\beta$. The values of $q_\alpha$ and $q_\beta$ are common knowledge.

A decision $k \in K = \{A, B\}$ is made either by command or by majority voting. If the decision is made by command,[6] the decision is affected by a public signal. We assume the public signal is realized in a different period (the third stage) from the decision-making period (the fourth stage). If the decision is made by majority voting, there is no third stage and the decision simply depends on the voting result (the fourth stage).

**Third stage**. A public signal $\hat{s} \in \hat{S} = \{\hat{s}_a, \hat{s}_b\}$ is drawn and revealed to the shareholders. If the state is $\alpha$ ($\beta$), then $\hat{s}_a$ ($\hat{s}_b$) is drawn with the commonly known probability $Q > \frac{1}{2}$, and $\hat{s}_b$ ($\hat{s}_a$) is drawn with probability $1 - Q$. In section 3.1 we relax the symmetry assumption and allow for state dependent conditional probabilities.

**Fourth stage**. If the decision is made by command, then it is $A$ with probability $p > \frac{1}{2}$ and $B$ with probability $1 - p$ if the public signal is $\hat{s}_a$, and $B$ with probability $p$ and $A$ with probability $1 - p$ if the public signal is $\hat{s}_b$. If the decision is made by majority voting, then shareholders vote simultaneously either for $A$ or $B$, and the alternative with the most votes wins. Abstention is not allowed. At the end, uncertainty about the state of the world is resolved, and the value of the firm is revealed.

We measure disagreement at a given period by the difference between the most optimistic and the most pessimistic belief about $x$. Disagreement at time $t$ may depend on shareholders' public history $H$ (public signal, decision, voting outcome) and private history $h = (h_i)_{i \in N}$ (private signals, individual voting decisions). Formally, we write

$$d^t(H, h) = \left| \max_{i \in N} E[x \mid H, h_i] - \min_{i \in N} E[x \mid H, h_i] \right|.$$

When disagreement does not vary with private histories $h$, nor with the public history $H$, we simply write $d^t$ for $d^t(H, h)$.

# 3 Decision by Command

If the decision is made by command and $p = 1$, then expectations about the value of the firm do not change between stages three and four, for every possible realization of the public and the private signals. This is true because the shareholders understand that the decision

[6] This is meant to capture the case in which another actor, e.g., the manager, is in charge of the decision.

is fully determined by the public signal (A if $\hat{s}_a$ and B if $\hat{s}_b$).[7] Hence, when $p = 1$ the only interesting comparison for the evolution of disagreement is between the second and the third period. When $p \in (\frac{1}{2}, 1)$, the level of disagreement can change both between stage two and stage three, and between stage three and stage four.

We assume throughout that at least two shareholders have received different private signals—otherwise, $d^4 = d^3 = d^2 = 0$—and focus first on the second stage of the model, before the public signal is revealed.

**Proposition 1.** *After receiving their private signal, but before the public signal is revealed ($t = 2$), shareholders have the same expectation of the value of the firm even if they receive different private signals.*

The intuition behind Proposition 1 is the following. Before the public signal is revealed, shareholders with different private information disagree on the likelihood of each state of the world (because $\Pr(\omega = \alpha | s_a) \neq \Pr(\omega = \alpha | s_b)$). However, they do not disagree on the expected value of the firm $x$, because this is determined by the probability that the commander makes the correct decision. And this probability is equal to $pQ + (1-p)(1-Q)$ in both states. Hence, the private signals play no role in determining expectations regarding the value of the firm, $x$, before the public signal is realized.

**Example 1.** *Assume that $q_\alpha = 0.6$, $q_\beta = 0.1$, $Q = 0.75$ and $p = 0.9$. Note that we use these values of the parameters for all the examples in the paper. Given these parameters, the shareholders' beliefs at the end of stage 2 about the state and the policy to be implemented are given by the following table:*

| | $s = s_a$ | $s = s_b$ |
|---|---|---|
| $\Pr(\omega = \alpha, k = A \| s)$ | 0.600 | 0.215 |
| $\Pr(\omega = \alpha, k = B \| s)$ | 0.257 | 0.092 |
| $\Pr(\omega = \beta, k = A \| s)$ | 0.043 | 0.208 |
| $\Pr(\omega = \beta, k = B \| s)$ | 0.100 | 0.485 |
| $E[x \| s]$ | 0.700 | 0.700 |

*Shareholders who receive different signals have profound disagreements about the likelihood of different states and policies. But the expected value of the firm, which is equal to* $\Pr(\omega = \alpha, k = A) + \Pr(\omega = \beta, k = B)$ *is the same for both types of shareholders.*

[7] Of course, even in this case, shareholders who received different signals in stage two can hold very different beliefs.

The following proposition focuses on disagreement after the public signal is revealed ($t = 3$) and after the decision is implemented ($t = 4$):

**Proposition 2.** *The public signal causes disagreement about the expected value of $x$ at $t = 3$ (i.e. $d^3 > d^2$). If $p < 1$, the decision further exacerbates disagreement about the expected value of $x$ at $t = 4$ (i.e. $d^4 > d^3$).*

To explain the result, let us focus first on the evolution of disagreement between stages 2 and 3. Observe that if two shareholders agree on the expected value of the firm after they observe the public signal, they must have agreed on its expected value also in the previous stage. But the converse is not true. If shareholders receive opposing private signals, they have different expectations both about the state of the world and about the policy to be implemented: each shareholder believes that the state of the world likely matches with her own signal, and that the decision is likely to match the true state of the world (with probability $pQ + (1 - p)(1 - Q)$). However, since the relevant feature to form expectations about $x$ is to match the state with the right policy, both type of shareholders attach the same value to $x$ at the second stage.

Why does the public signal increase disagreement? Suppose, without loss of generality, that shareholders observe the public signal $\hat{s}_a$. With the public signal $\hat{s}_a$, shareholders learn that: (i) state $\alpha$ is more likely than expected and (ii) policy $A$ is more likely to be implemented than policy $B$. While shareholders still disagree on the state of the world ($Pr(\alpha|s_a, \hat{s}_a) > Pr(\alpha|s_b, \hat{s}_a)$), they agree that the likelihood of A being implemented is equal to $p$. This implies that a shareholder who received signal $s_a$ (resp. $s_b$) is now more optimistic (resp. pessimistic) about the adequacy of the likely decision. This generates the divergence in beliefs about the value of the firm between the two types of shareholders.

Let us now turn our attention to the evolution of disagreement between the third and the fourth stage of the game, i.e., between the revelation of the public signal and the decision. If $p < 1$, there is still uncertainty about the policy implemented at the end of stage 3. This uncertainty brings the expectations of two shareholders who received opposite signals closer because two shareholders who received different private signals realize that both the policy they believe is best and the one they believe is worst have a chance to be implemented. The uncertainty about which policy will be implemented then decreases the expected valuation of a shareholder whose signal coincides with the public signal and increase the one of a shareholder whose signal does not coincide. When the policy is finally implemented, the policy-related uncertainty is resolved and hence expectations diverge even more.

We illustrate these intuitions by continuing our previous example.

**Example 1** (continued)**.** *The next table shows how shareholders' beliefs about the state and the policy to be implemented change after the public signal* $\hat{s}_a$ *is revealed:*

| | $s = s_a$ | $s = s_b$ |
|---|---|---|
| $\Pr(\omega = \alpha, k = A \| s, \hat{s}_a)$ | 0.853 | 0.514 |
| $\Pr(\omega = \alpha, k = B \| s, \hat{s}_a)$ | 0.095 | 0.057 |
| $\Pr(\omega = \beta, k = A \| s, \hat{s}_a)$ | 0.047 | 0.386 |
| $\Pr(\omega = \beta, k = B \| s, \hat{s}_a)$ | 0.005 | 0.043 |
| $E[x \| s, \hat{s}_a]$ | 0.858 | 0.557 |

*After receiving the public signal* $\hat{s}_a$*, while shareholders still disagree about the state of the world (*$Pr(\alpha|s_a, \hat{s}_a) = 0.947$ *and* $Pr(\alpha|s_b, \hat{s}_a) = 0.571$*), they now agree that the likelihood of A being implemented is 0.9 (before the public signal, the beliefs that A would be implemented were 0.643 and 0.423, respectively). This generates the divergence in beliefs about the value of the firm:* $d_3 = 0.301$*.*

*The next table indicates the beliefs when a policy is implemented:*

| | $k = A$ | | $k = B$ | |
|---|---|---|---|---|
| | $s = s_a$ | $s = s_b$ | $s = s_a$ | $s = s_b$ |
| $\Pr(\omega = \alpha, k = A \| s, \hat{s}_a, k)$ | 0.947 | 0.571 | – | – |
| $\Pr(\omega = \alpha, k = B \| s, \hat{s}_a, k)$ | – | – | 0.947 | 0.571 |
| $\Pr(\omega = \beta, k = A \| s, \hat{s}_a, k)$ | 0.053 | 0.429 | – | – |
| $\Pr(\omega = \beta, k = B \| s, \hat{s}_a, k)$ | – | – | 0.053 | 0.429 |
| $E[x \| s, \hat{s}_a, k]$ | 0.947 | 0.571 | 0.053 | 0.429 |

*When a policy is finally implemented, it reduces the uncertainty about the policy implemented further, and this generates even higher disagreement. See that independently of the commander's decision, the disagreement about the expected value of the firm is equal to* $d_4 = 0.376 > d_3$*.*

## 3.1 Extension: Asymmetric Precision of the Public Signal

One might wonder whether our result that disagreement increases after a public signal is revealed (i.e., $d^3 > d^2$) is an artifact of the assumption that the public signal is "correct" with the same probability in either state of the world. Indeed, the finding that $d^2 = 0$ requires this assumption. But the result that $d^3 > d^2$ does not. To see this, assume now that if the state is $\alpha$ (resp. $\beta$), then $\hat{s}_a$ is drawn with probability $Q > \frac{1}{2}$ (resp. $1 - Q + \gamma$), and $\hat{s}_b$ is drawn with the complimentary probability, with $\gamma \in (Q-1, Q-\frac{1}{2})$. By continuity of $E[x|s]$ and $E[x|s,\hat{s}]$ in $\gamma$ it follows that $\lim_{\gamma\to 0} d^2 = 0$ and $\lim_{\gamma\to 0} d^3 > \delta$, for some $\delta > 0$, and hence our main observation remains valid even when the public signal is asymmetric, provided that the asymmetry (i.e., the value of $|\gamma|$) is not too large. In fact, even if the asymmetry is large, there is at least one realization of the public signal such that $d^3 > d^2$. In other words, a weaker version of our result (i.e., there is a positive probability that disagreement will increase after the revelation of the public signal) is true independently of the degree of asymmetry in the private and the public signals.

# 4 Decision Made by Voting

In this section we consider the case of decision made through shareholder voting and examine whether expectations might diverge after the vote tally is made public. If elections fully aggregated information, all shareholders would end up with the same beliefs regardless of their differential information at stage 2. What happens if voting is not fully-revealing? Given the assumption that the states of nature are equiprobable, whether fully revealing (sometimes called sincere) voting is an equilibrium phenomenon depends on whether the signals differ sufficiently in their informativeness. Therefore, we assume that $q_\alpha < 1 - q_\beta$ so that, at the voting stage, there is a mixed strategy equilibrium in which shareholders who receive signal $s_a$ vote for $A$ and shareholders who receive signal $s_b$ mix between voting for $A$ and voting $B$.[8]

To ease notation, we denote a vote in favor of $A$ by $v_i = 1$ and a vote in favor of $B$ by $v_i = 0$. The quantity $v = \sum_{i=0}^{n} v_i$ denotes the number of shareholders who voted for $A$. The quantity $v' = \sum_{j\in N-\{i\}} v_j$ denotes the number of shareholders except shareholder $i$ herself who voted for $A$. We also denote by $m = Pr(v_i = 0 \mid s_b)$ the share of shareholders who vote for $B$ among those who receive a private signal $s_b$ in the mixed equilibrium.

The following proposition focuses on disagreement among shareholders before the vote:

**Proposition 3.** *Before the vote ($t = 2$), shareholders receiving different private signals have different expectations of the value of the firm (i.e., $d_2 > 0$).*

When the decision is made by voting, the probability of making the correct decision in state $\alpha$ is different than in state $\beta$. The reason is that voting involves the aggregation of

[8]See that $q_\alpha < 1 - q_\beta$ is a necessary but not sufficient condition for having a mixed strategy equilibrium. If $1 - q_\beta$ is close to $q_\alpha$, and $n$ is not too large, sincere voting is an equilibrium and therefore full information aggregation is achieved. However, for any $q_\alpha \neq 1 - q_\beta$ there is an $\overline{n} < \infty$ such that for any $n > \overline{n}$ there is a mixed strategy equilibrium. The exact condition for a mixed strategy equilibrium to exist is $\log\left(\frac{q_\alpha}{q_\beta}\right) \geq \frac{n+1}{n-1}\log\left(\frac{1-q_\alpha}{1-q_\beta}\right)$. This is a standard result in the voting literature. See, e.g., Bouton et al. (2018) and references therein.

private information, which has asymmetric informativeness in different states. In particular, since we have assumed $q_\alpha < 1 - q_\beta$, the probability of making the correct decision in state $\alpha$ is lower than that in state $\beta$. This is simply because shareholders' private signal is more informative in state $\beta$, which helps information aggregation. Thus, before voting, a shareholder with signal $s_b$ has a higher expectation of firm value than a shareholder with signal $s_a$.

Note that this result is closely related to our discussion about decision by command that $d^2 > 0$ when the precision of the public signal is asymmetric. In that case, we also have that the decision is more likely to be correct in one state than the other, which drives a wedge in the valuations of shareholders who receive different signals.

We now illustrate this with a numerical example.

**Example 2.** *Consider the parameters $n = 9$, $q_\alpha = 0.6$ and $q_\beta = 0.1$. With these parameters there is a mixed strategy equilibrium in which shareholders who received signal $s_a$ vote for A and shareholders who received signal $s_b$ vote for A (B) with probability 0.156 (0.844). Taking into account their signal and equilibrium play, the shareholders' beliefs at the end of stage 2 about the state of the world and the policy to be implemented are given by the following table:*

| | $s = s_a$ | $s = s_b$ |
|---|---|---|
| $\Pr(\omega = \alpha, k = A \vert s)$ | 0.778 | 0.279 |
| $\Pr(\omega = \alpha, k = B \vert s)$ | 0.079 | 0.028 |
| $\Pr(\omega = \beta, k = A \vert s)$ | 0.014 | 0.070 |
| $\Pr(\omega = \beta, k = B \vert s)$ | 0.128 | 0.622 |
| $E[x \vert s]$ | 0.906 | 0.902 |

*Note that, while the valuations differ, the difference is small (0.004, which compares to a maximum disagreement of 1). As we will see below, this is a feature common to all values of the parameters, with the difference vanishing when $n$ grows large.*

The next proposition focuses on disagreement among shareholders after the vote:

**Proposition 4.** *After the vote ($t = 4$), shareholders who receive different signals but vote similarly still disagree about the expected firm value. In particular, $d_4 > 0$.*

To understand the intuition of this result, let us consider two shareholders who receive different signals but nonetheless vote for the same alternative, $A$. Given a vote tally $v$, these two shareholders draw exactly the same inference about the number of votes for $A$ other shareholders cast. This means that, without taking into account their private signals, these two shareholders have the same post-voting posterior about the state of the world. Yet, because they received different signals, they end up with different post-voting posteriors. Note that for the mechanism to work, one needs to have some shareholders with signal $s_b$ voting for $A$. This also insures that the posterior belief just described is non-degenerate.[9]

It remains to determine whether shareholders' disagreement increases or decreases after the vote. The answer actually depends on the realized vote tally $v$. We illustrate this point with the same numerical example as above.

**Example 2** (continued)**.** *Recall that, before knowing the tally, the difference in beliefs about $x$ between players with different private information was* 0.004*. How does knowing the tally affect this difference? If the total number of votes for A is between 1 and 8, the difference in beliefs between a shareholder who received the private signal $s_a$ and another one who received signal $s_b$ and voted for A* ***increases*** *(see column $d_4$ in the table below). See that the difference is particularly striking when the election is (close to) a tie ($v = 4$ or $v = 5$).*

| $v$ | $k$ | $\Pr(\alpha \mid v)$ | $E[x \mid s_a, v' = v-1]$ | $E[x \mid s_b, v' = v-1]$ | $d_4$ |
|---|---|---|---|---|---|
| 0 | $B$ | 0.001 | - | - | - |
| 1 | $B$ | 0.004 | 0.991 | 0.999 | 0.008 |
| 2 | $B$ | 0.025 | 0.946 | 0.996 | 0.049 |
| 3 | $B$ | 0.139 | 0.740 | 0.975 | 0.235 |
| 4 | $B$ | 0.500 | 0.315 | 0.861 | 0.546 |
| 5 | $A$ | 0.861 | 0.931 | 0.500 | 0.431 |
| 6 | $A$ | 0.975 | 0.988 | 0.861 | 0.127 |
| 7 | $A$ | 0.996 | 0.998 | 0.975 | 0.023 |
| 8 | $A$ | 0.999 | 1.000 | 0.996 | 0.004 |
| 9 | $A$ | 1.000 | 1.000 | 0.999 | 0.001 |

*This result is the confluence of two effects. First, knowing the tally eliminates the uncertainty on which policy will be implemented: A is implemented if $v \geq 5$ and B is implemented otherwise. Second, because shareholders receiving signal $s_b$ use a mixed strategy, there is asymmetric information between $s_a$ and $s_b$ shareholders. In particular, an $s_b$ shareholder who has voted for A knows that there has been $v - 1$ votes for A plus one vote for A after a signal of $s_b$, while an $s_a$ shareholder knows that there has been $v - 1$ votes for A plus one vote for A after a signal of $s_a$. Thus, the two types of shareholders infer a different overall number of signals $s_a$ and $s_b$ in the population, with the $s_b$ shareholders inferring about one*

[9] Shareholders who receive the same signal but vote differently also disagree on the expected firm value. Shareholders who receive $s_b$ and vote for $B$ put a higher weight on $\omega = \alpha$ than those who receive $s_b$ but vote for $A$. This is because, for a given vote tally $v$, shareholders who voted for $B$ observe a higher number of votes in favor of $A$ among others' votes. Such shareholders thus have intermediate beliefs with respect to those described in the theorem, which is why we ignore them in the result's statement (remember that we focus on the maximal disagreement).

*more signal $s_b$. And, as suggested by the first column of the table, for relatively close elections, one extra signal in favor of $B$ has a very substantial impact on the belief about the state of nature.*

*By contrast, when the vote tally is $v = 9$, i.e., all shareholders vote for $A$, then the disagreement among two shareholders with different signals decreases after the vote. This is because, in that case, the vote tally becomes overwhelmingly informative that the state of nature is $\alpha$. Even if the two types of shareholders still infer a different overall number of signals $s_a$ and $s_b$ in the population from the vote tally, they are both almost sure that the state is $\alpha$ and hence that the decision is correct.*

The result in the example proves to have some generality. In particular, we can prove the following result when $n$ grows large:

**Proposition 5.** *If the election outcome is close to a tie (i.e., $v = \frac{n+1}{2} + r$ with $r \in \mathbb{Z}$) then if $n$ is sufficiently large, the disagreement after voting is larger than the disagreement before voting (i.e., $\lim_{n\to\infty} d^4 > \lim_{n\to\infty} d^2$).*

Proposition 5 proves that when $n$ grows large, if the election is almost tied, the disagreement among shareholders is necessarily larger after than before voting. Note that how large $n$ needs to be depends on $r$. The intuition of this result is in two parts. First, when $n$ grows large, the disagreement before the vote vanishes. This is because shareholders expect the outcome of the election to be the correct one ($A$ in state $\alpha$ and $B$ in state $\beta$) with a probability that tends to 1. Second, when $n$ grows large, shareholders disagree after voting if the election is close to a tie. In that case, the outcome of the election does not provide much information to the shareholders about the state of nature. The difference in valuation for two shareholders who voted for $A$ but received different signal is essentially the difference in beliefs about the state of nature given that there are $\frac{n-1}{2} + r$ signals $s_a$ in the population or $\frac{n+1}{2} + r$ signals $s_a$ in the population. This difference is positive even at the limit.

One might wonder whether the very substantial differences in beliefs in the event of a tie in the example above are an artifact of the small electorate, or if such a large difference can occur when $n$ is large. As the next example shows, substantial disagreement can occur even when $n$ is large. This is due to the s-shaped form of the beliefs about the state of nature given a number of signals $s_a$.

**Example 2** (continued). *Suppose now that $n \to \infty$. If the election outcome is close to a tie ($v = \frac{n+1}{2}$), the disagreement after voting is substantial:*[10]

$$\lim_{n\to\infty} d_4 = \left| \frac{1}{1 + \frac{q_\beta}{q_\alpha}\left(\frac{1-q_\alpha}{1-q_\beta}\right)} - \frac{1}{1 + \left(\frac{1-q_\alpha}{1-q_\beta}\right)^0} \right| = 0.43,$$

*which compares to a maximum disagreement of* 1.

Note however that the probability of an almost tied election (i..e, $v = \frac{n+1}{2}$) tends to zero when $n$ grows large. Thus, Proposition 5 does not say anything about the expected disagreement after the vote.

We can also prove that, when $n$ grows large, the disagreement after the vote vanishes when the vote tally is unanimously in favor of $A$, i.e., $v = n$ (the proof is similar to the proof of Proposition 5). This generalizes another part of the example above.

# 5 Pricing Rules, Transaction Fee, and Trading

The previous sections discuss the divergence in expectations of firm value but do not explicitly discuss the implications for share trading. In this section, we model a financial market in which shareholders can trade their shares in the frameworks studied in Sections 3 and 4. We assume that the market is semi-efficient. Hence, the stock price of the firm reflects all public information.[11]

For the sake of expositional clarity, we work under the assumption that, when the decision is made by command, it is in line with the realization of the public signal with probability 1, i.e., $p = 1$. As discussed above, in that case, the expectations about firm value do not change between stages 3 and 4. It is thus unnecessary to distinguish between these two stages. In what follows, we thus allow for trade at two different stages: (i) stage 2, when shareholders only have their private signals, and (ii) stage 4, when the decision has been made (and the public signal has been revealed for the decision by command).

We denote the price at stage 2 by $P_2$ and the price at stage 4 by $P_4$. Then, $P_2 = Pr(k = \omega)$, which is the probability that the decision that will be made at stage 4 is correct. In the case of voting, this probability takes into account the voting equilibrium. At stage 4, $P_4(k, H) = Pr(k = \omega | H, k)$, which is the probability that the chosen policy $k$ is correct con-

[10]The formula to calculate $\lim_{n\to\infty} d_4$ is derived in the proof of Proposition 5.

[11]Although there is a long debate over market efficiency (see the review by Malkiel 2003), recent empirical evidence shows that the stock market is efficient in quickly reflecting public events (e.g., Chordia and Miao 2020; Gregoire and Martineau 2022; Martineau 2021).

ditional on the public information available $H$. In the case of decision by command, the public information available is the public signal and the decision by the manager. In the case of voting, $H$ is the vote tally $v$ and (from which the decision $k$ can also be determined).

Shareholders who trade, buying or selling, need to pay a transaction fee, $\epsilon > 0$. So, at either stage, a shareholder wants to buy (sell) one share only if her expectation of the firm value is greater (smaller) than the stock price plus (minus) the transaction fee.

We remain somehow agnostic vis-a-vis the way the market clears. Most of our results indeed hold if there are liquidity traders that can help the market to clear (Kyle 1985's model), or if such traders do not exist and hence trading occurs only among shareholders explicitly modelled (No Additional Liquidity model, or NAL for short). We explicitly state when a result is sensitive to the market clearing assumption.

*Decision Made by Command*

For the case of decision by command, we can show that trade occurs only after the public signal is revealed (and the decision has been made):

**Proposition 6.** *There are positive transaction fees $\epsilon > 0$ such that (i) no shareholder wants to trade in stage 2, and (ii) both types of shareholders want to trade in stage 4.*

This result is a direct consequence of Propositions 1 and 2. The former shows that shareholders do not disagree in stage 2. Costly trade is thus not possible. The latter shows that shareholders disagree in stage 4. They thus want to trade even if there is a small transaction fee.

*Decision Made by Voting*

Similarly, for the case of decision by voting, we can show that trade occurs only after the vote:

**Proposition 7.** *Given an arbitrarily small transaction fee $\epsilon > 0$, there is a group size $\overline{n}$ such that, for any $n > \overline{n}$, (i) no shareholder wants to trade in stage 2, and (ii) there is trade in stage 4 after some vote tallies. Moreover, voting and stage 4 trading strategies are as follows:*

| | | Trading Strategy if... | |
|---|---|---|---|
| Signal | Vote | $k = A$ | $k = B$ |
| $s_a$ | Vote for A | Buy | Sell |
| $s_b$ | Vote for A | Sell | Buy |
| | Vote for B | Hold | Hold |

The intuition is as follows. Before the vote (stage 2), the price $P_2$ reflects the fact that the voting decision in stage 4 is expected to be accurate (the probability the decision is correct tends to 1 when the number of shareholders grows large). The private signals lead to a difference in expectations of the firm value between shareholders who received different signals, but this difference is vanishingly small and hence not sufficient to compensate for the transaction fee. Thus, no shareholder wants to trade before the vote. After the vote (stage 4), the situation is different. As we have seen in Proposition 5, at some vote tallies, beliefs about the accuracy of the decision can be substantially affected by one extra signal in favor of A or B. Consider for instance a shareholder who received a signal $s_b$ but voted for A. Compared to the public information revealed by the vote tally, this shareholder holds private information: she knows she voted insincerely for $A$ while the market only attaches a probability to the vote being insincere. Thus, she has more confidence that the state is $\beta$ than the market. Thus, when the transaction fee is small, if the vote outcome is such that A (resp. B) is adopted, then she wants to sell (resp. buy), as her expectation about the value of the firm is strictly below (resp. above) the price. Finally, note that shareholders who vote for $B$ have no valuable private information after the vote since everyone infers that they received a signal $s_b$. These shareholders thus never want to trade with a positive transaction fee.

**Example 2** (continued)**.** *How much trade is there in the previous example? For what tallies is trading volume highest? Does voting against the winner increase the likelihood of selling? Assume that the transaction fee is* $\epsilon = 0.0035$*. In that case, no type wants to trade in stage 2 despite the difference in beliefs about* $x$ *between players with different private information. However, there is trade with positive probability in stage 4. For the Kyle's market clearing model, trade occurs with probability* 80.95% *in state* $w = \alpha$ *and with probability* 91.58% *in state* $w = \beta$ *(overall probability of* 86.26%*). For the NAL model of market clearing, trade occurs with probability* 24.9% *in* $w = \alpha$ *and with probability* 44.0% *in state* $w = \beta$ *(overall probability of* 34.4%*).*

*While some discussion above highlighted belief spread at close tallies and thus might lead one to expect volume to be a single-peaked function of the vote tally, this is note the case. The relationship between these two quantities is indeed non-monotonic. The key forces at work here are that (i) in the equilibrium described in Proposition 7, a shareholder trades only if she voted for A (hence the number of shareholders willing to trade is increasing the vote tally in favor of A), but (ii) for large vote tallies, the difference between the price and a shareholder's expectation of firm value vanishes (and hence the willingness to trade is not large enough to compensate for the trading fee). Note that this intuition is for the case in which all buying and selling orders on the market clear (i.e. the Kyle's model). If not, then the relationship* *between vote tally and volume of trade is also non-monotonic, but the reason is that there are too few sellers when the tally is large. Table 1 illustrate these results (columns 6 and 7).*

| | | | | | $E(Volume)$ | | $Pr(sell)$ | |
|---|---|---|---|---|---|---|---|---|
| $v$ | $P_2$ | $k$ | $P_4$ | $\|P_4 - P_2\|$ | NAL | Kyle | $v_i \neq k$ | $v_i = k$ |
| 0 | 0.903 | B | 0.999 | 0.096 | 0 | 0 | - | 0 |
| 1 | | | 0.996 | 0.092 | 0 | 1.000 | 0.418 | 0 |
| 2 | | | 0.975 | 0.071 | 0.478 | 2.000 | 0.428 | 0 |
| 3 | | | 0.861 | 0.042 | 0.663 | 3.000 | 0.484 | 0 |
| 4 | | | 0.500 | 0.403 | 0.789 | 4.000 | 0.661 | 0 |
| 5 | | A | 0.861 | 0.042 | 0.608 | 5.000 | 0 | 0.162 |
| 6 | | | 0.975 | 0.071 | 0.599 | 6.000 | 0 | 0.107 |
| 7 | | | 0.996 | 0.092 | 0 | 0.674 | 0 | 0.096 |
| 8 | | | 0.999 | 0.096 | 0 | 0.756 | 0 | 0.095 |
| 9 | | | 1.000 | 0.097 | 0 | 0.000 | - | 0 |
| Weighted Mean: | | | 0.903 | 0.107 | 0.532 | 3.065 | 0.250 | 0.052 |

**Table 1:** Prices Before and After Voting And Expected Trading Volume. Columns 2-5 show price information and the winning alternative for each tally $v$. Columns 6 and 7 display the $E(volume)$. NAL captures expected number of orders that clear when there is no additional liquidity, and Kyle's market captures the expected number of orders that are placed (and would clear in the model of Kyle). Columns 8 and 9 show the odds of putting in an order to sell conditional on casting a vote against or in favor of the winner at the relevant tally.

*Table 1 reveals several other interesting patterns. First, the expected price after voting in the market is U-shaped. Second, in terms of magnitudes, price change is rather low at all vote tallies but near ties. Third, we see that at low tallies dissenting votes is strongly predictive of offering to sell and, overall, the probability of selling when dissenting is higher than when not dissenting.*

# 6 Discussion of Empirical Implications

In this section, we first connect our theoretical findings with extant empirical work. We then discuss new testable predictions highlighted by our model.

## 6.1 Empirical Connections

Connecting our findings with extant empirical work comes down to the consideration of how the model(s) match up with a relatively small number of documented patterns.

A series of papers have looked at how markets respond to public announcements and firm decisions. Taken together, the models analyzed in Sections 3 and 4 are capable of explain-ing several patterns that others have argued are inconsistent with models of homogeneous shareholders.

Before discussing the details, it is important to draw a distinction between the findings on shareholder meetings and the findings from a study of other public events and announcements. Our first model (in Section 3) applies to both classes of analysis because a large fraction of potential traders are not involved in shareholder meetings and so to them the shareholder meeting is just a public source of information. But our second model (in Section 4) captures additional incentives and behavior that is germane to agents that are involved in both voting and trading.

Using event studies targeted at public announcements, several papers have documented increased trading volume following public announcements of this form. Kandel and Pearson (1995) focus on earnings reports and Bollerslev et al. (2018) focus on Federal Open Market Committee meetings. In both papers, abnormal trading volume is found just after the public announcements and in general there is less price change than one would expect given the volume. Our results show that these findings should not be taken as evidence against models of homogeneous investors. Indeed, Proposition 6 (drawing on Proposition 2) says that trade should spike after a public announcement (e.g., earning report), if the information revealed affects shareholders' beliefs both about what the best course of action is for the management, and about what the management will actually do in the future. This is in stark contrast with the effect of a public announcement that is relevant for the valuation of the firm only through previously enacted management decisions. In that later case, the public announcement can only reduce disagreement among shareholders (since there is no uncertainty about what the management will do), and hence trading volumes (as discussed, e.g., in Bollerslev et al. 2018).

Another important finding in these papers is the lack of substantial price change following announcements. This is taken to be a puzzle and several previous studies (e.g., Kandel and Pearson 1995; Bollerslev et al. 2018; Li et al. 2022) take this as evidence that homogeneous models cannot fit the data. Our model of decision by command provides an explanation for the lack of price change. In the baseline version of that model ($p = 1$), the equilibrium price in period 2 is $P_2 = Q$ and at period 4 the price is also $Q$ and thus there is a prediction of no change in price. When we relax the symmetry assumptions about the informativeness of the public signal, there is potentially some price change but this change is continuous in the source of asymmetry, i.e., $\gamma$.

Another relevant source of public information is shareholder meetings. Li et al. (2022) find high trading volume and small price changes after shareholder meetings. They argue that theories based on homogeneous shareholders cannot account for such patterns. Concerning high trading volume, they say: “We would not expect a systematic relationship between voting and post-meeting trades if voting only aggregates private signals” (page 1814). Although the baseline command model offers a direct challenge to this argument, our section on voting and in particular Proposition 7 offers an additional equilibrium force that challenges this conclusion. In particular, the systematic relationship they found (i.e., more trade after the vote) is what we would expect in any model in which voting does not perfectly aggregate the private signals. This pattern would thus surface in the extant Bayesian learning models that do not make strong symmetry assumptions (for example, Maug and Rydqvist 2009 show that voting will only partially reveal the private information held by voters). Accordingly, we find that traditional homogeneous shareholder models also yield the prediction “[...] that shareholder’s beliefs may diverge more after observing voting outcomes.” (Li et al. 2022, page 1813).

Empirical work generally finds small price changes after shareholders meetings. As mentioned already for traders that are not involved in voting, shareholder meetings are strategically equivalent to decision by command. And that model predicts no price change after the public event. In a hybrid model in which some traders are voters and some are not, we might see some forces for price change coming out of shareholders, but as Table 1 illustrates the price changes are generally low (especially at the tallies likely to be realized in equilibrium).

Another natural question that has been asked is whether lopsided or close votes have larger effects on market behavior. Li et al. (2022) find that the vote tally does not matter and that abnormal trading volumes occur both after close and non-close votes. As we discussed at the end of Section 5, our model predicts a non-monotonic relationship between trade volume and the vote tally, which is in line with this empirical finding.[12]

We may also ask whether voting behavior is correlated with which side of the market a shareholder/fund is on. Li et al. (2022) find that shareholders that voted for the losing alternative tend to sell. While we do not find that voting for the losing alternative always implies that one will want to sell, as mentioned above it is the case that in our model this pattern is predicted for some ranges of parameters. From Proposition 7, and in particular the table characterizing trading strategies we can show that it requires that signal qualities are not too asymmetric. This is the case for Example 2 above.

[12]Note that testing empirically a monotonic relationship between volume of trade and the vote tally is challenging. Indeed, if a study pools over votes in which half the time a large tally is support for B (the policy that is optimal in the state that generates more informative private signals), and half the time a low tally is support for B, then a positive relationship between volume of trade and vote tally would show as flat in the data.

## 6.2 Testable Predictions

Our model produces several new testable predictions.

Proposition 1 says that shareholders may disagree about the fundamentals of the firm and about what the best course of action is for management, but nonetheless not disagree in their valuation of the firm. This requires that these shareholders disagree about what they believe the management will do in the future. Why? If shareholders anticipate that optimal decisions will be made then shareholders that form different beliefs about the actions management should or will take do not necessarily form different beliefs about firm value, because they anticipate that information will be used to guide firm decisions.

In practical terms, this means that debate and competing arguments in traditional media and social media platforms about what actions are best for the firm need not match up with trading volume prior to the time that either key information about the future decision is made public (see Proposition 6) or the firm actually makes the decision (see Proposition 7).

This result highlights the feature that shareholders' valuation of the firm is not necessarily the same as their assessments of certain fundamentals or the likely firm decision. Testing this result requires data about shareholders' beliefs that go beyond their valuation of the firm. For instance, it would be useful to explore shareholders' beliefs about key decisions that the firm has to make in the near future and check whether differences in such beliefs is compatible with shareholders having similar valuations of the firm. We are not aware of any such measure in the literature.[13]

Another testable prediction directly related to this result is that public announcements may have a very different effect on shareholders' valuations depending on whether it is relevant for the valuation of the firm only through previously enacted management decisions, or through future management decisions. In the former case, the public announcement can only reduce disagreement among shareholder, and hence reduce trade. In the latter case, it can increase disagreement, and then increase trade. One alternative to test that prediction would be to identify announcements that are directly related to previous decisions of the management (e.g., patent decision, authorization or ban on products, regional economic shocks for firm with clear regional patterns of foreign investments), and then examine if trading volume decreases after these announcements.

Finally, our model offers a more refined assessment of the association between voting behavior at the meeting, and trading behavior after the meeting. In particular, our model

[13]Existing empirical literature typically measures disagreement among investors based on their sentiments about stock performance expressed on social media (e.g., Cookson and Niessner 2020, Giannini et al. 2019, and Antweiler and Frank 2004) or dispersion in analysts' earnings forecast's (e.g., Diether et al. 2002). Both these measures are closely related to the investors' valuation of the firm.

predicts when selling should be positively associated with dissenting votes. To understand these predictions, recall that Proposition 7 and its table show that a shareholder wants to buy (sell) when her private information more strongly supports (challenges) the chosen policy than the inference that the market makes from her vote.

Starting from there, it is helpful to treat separately the cases of each chosen policy. Suppose first that B has been chosen. A vote against B can either come from a shareholder with private signal $s_a$ playing a pure strategy or a shareholder with private signal $s_b$ that happened to vote A. The former sells and the latter buys. A non-dissenting vote (for B) occurs only if a shareholder has type $s_b$ and she voted for B. This shareholder does not trade (and more importantly she does not sell) and thus, if B was chosen, we unambiguously see that dissenting votes are predictive of both buying and selling as opposed to not trading.

Suppose now that A is chosen. A dissenting vote must have been cast by a shareholder with type $s_b$ and this shareholder does not trade. On the other hand, a supporting vote could have been cast by a shareholder with either signal. In that case, the odds of buying are higher as this occurs when the shareholder's signal supported the chosen policy (signal $s_a$), whereas selling requires getting the minority signal ($s_b$) and randomly opting to vote against this signal.

As discussed above, when the model is not too asymmetric, the average effect has the same direction as the finding in Li et al. (2022). Table 1 shows that Example 2 above is one such specification. On the other hand, if the signal qualities are very asymmetric, then the opposite finding holds on average.

Pooling across chosen policies and signal qualities is likely to lead to too much measurement error, but building on this discussion we see that to test those predictions, one option would be to go back to the data in studies like Li et al. (2022) and determine when passage coincides with A (the correct choice in the state in which the signals are not very informative). We could then test whether selling is positively associated with dissenting votes when B is chosen but not when A is.[14]

[14] Note that the data in Li et al. (2022) pool across realizations in which either outcome is chosen. It is then ambiguous which effect dominates.

# 7 Conclusions

We study how beliefs about firm value respond to public information stemming from either public announcements or shareholder meetings. We analyze two different models in which shareholders have the same state-contingent preferences but private signals about the state of the world. We find that the effect of public announcements depends crucially on whether the released information also affects future decisions by the management of the firm. When this is the case, shareholders holding different information may nonetheless have the same assessment of the firm's value. This can happen because the informational differences also lead to different beliefs about what management is going to decide in the future. These shareholders then react differently to the release of public information since, for some of them, this information reinforces their beliefs about what decision management will make, while for others, this information challenges their beliefs. We show that this divergence in beliefs can lead to an increase in trading volume after public announcements, even if prices do not change. This is in line with empirical patterns of trade identified in the literature. We argue that these patterns should not be used as an argument to dismiss the homogeneous approach to corporate governance.

This point is consequential as there are various reasons why it is important to determine whether corporate governance is generally a problem involving homogeneous shareholders, or if heterogeneity prevails. How one thinks about evaluating governance, and thus the desirability of regulations that impact governance, is centrally tied to this issue. If, to a first approximation, governance is a problem of common preferences, then the welfare analysis can be quite powerful and conceptually straightforward. In a common preferences problem, there is a natural benchmark–the probability of making the correct (or full-information) decision. In these contexts, assessments of regulations or institutional choices involve simply assessing how a possible change impacts the odds of making the correct decision. In contrast, for problems that fall outside this scope one generally needs to make interpersonal comparisons and evaluate a gain to one group of investors at the expense of another. As such, the welfare analysis of those problems is at best muddled and at worst conceptually ill-defined (see e.g., Jensen 2001).

A brief review of works assessing governance features and reforms illustrates that extant evaluations depend critically on whether shareholders are homogeneous. For instance, Hayden and Bodie (2008) discuss how the optimal allocation of voting rights among shareholders depends on whether shareholders share common goals. The desirability of communication among shareholders also depends on the approach taken: with common preferences, communication can aid information aggregation (Coughlan 2000; Gerardi and Yariv 2007), whereas with heterogeneous preferences it seems inconsequential. The desirability of regulations about vote trading and empty voting are different in homogeneous preference environments (Christoffersen et al. 2007; Esö et al. 2014; Brav and Mathews 2011) than in heterogeneous preferences ones (Hu and Black 2007, 2008; Casella et al. 2012). Finally, assessments of the consequences of regulation of proxy advisors also depend on the perspective (see Malenko and Malenko 2019; Malenko et al. 2021; Buechel et al. 2022; Ma and Xiong 2021 for the case of homogeneous preferences, and Matsusaka and Shu 2021 for the case of heterogeneous preferences).

If shareholders' actions are mainly driven by differences in opinions, then several important corporate governance mechanisms would turn out to be inefficient or create more chaos. For example, the literature on agency problem and contract theory suggests that compensating CEOs based on stock performance can incentivize CEOs to work for the interests of shareholders (e.g., Holmström 1979). However, if stock prices mainly depend on marginal traders' opinions rather than information about firms' fundamental value, then CEOs are not necessarily induced to devote more effort into improving firms' fundamental value. Similarly, if selling is driven by different opinions rather than private information, then the exit of a blockholder should not be interpreted as a negative signal on firm value, and thus the "Wall Street Walk" (Admati and Pfleiderer 2009) would inefficiently discipline a hard-working manager who enhances firm value but is unfavored in the blockholder's idiosyncratic opinions. Finally, the desirability and organization of the communication between shareholders and managers also depends on whether shareholders have common or heterogeneous opinion (see Levit 2019, 2020 for a model with common opinion, and Kakhbod et al. 2022 for a difference-of-opinion model).

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# A Proofs

*Proof of Proposition 1.* See that the expected value of $x$ in period 2 is given by:

$$\begin{aligned} E[x|s] &= \Pr(\omega = \alpha|s) \times [pQ + (1-p)(1-Q)] \\ &+ \Pr(\omega = \beta|s) \times [pQ + (1-p)(1-Q)] \\ &= pQ + (1-p)(1-Q), \text{ for every } s \in S \end{aligned} \tag{2}$$

and, thus, $d^2 = 0$. □

*Proof of Proposition 2.* Suppose without the loss of generality that the realization of the public signal is $\hat{s}_a$.

$$\begin{aligned} E[x|s_a, \hat{s}_a] &= Pr(k = \omega|s_a, \hat{s}_a) \\ &= Pr(\omega = \alpha|s_a, \hat{s}_a)Pr(k = A \mid \hat{s}_a) + Pr(\omega = \beta|s_a, \hat{s}_a)Pr(k = B \mid \hat{s}_a) \\ &= pPr(\omega = \alpha|s_a, \hat{s}_a) + (1-p)(1 - Pr(\omega = \alpha|s_a, \hat{s}_a)) \\ &= (1-p) + (2p-1)Pr(\omega = \alpha|s_a, \hat{s}_a) \end{aligned}$$

A similar formula applies to $E[x|s_b, \hat{s}_a]$. Hence, the disagreement between shareholders who received different signals is:

$$\begin{aligned} d_3 &= (2p-1)|Pr(\omega = \alpha|s_a, \hat{s}_a) - Pr(\omega = \alpha|s_b, \hat{s}_a)| \\ &= (2p-1)d_4 \end{aligned}$$

where $d_4$ measures the disagreement at time $t = 4$ when the decision is $k = A$:

$$d_4 = |Pr(\omega = \alpha|s_a, \hat{s}_a) - Pr(\omega = \alpha|s_b, \hat{s}_a)|.$$

Note that $d_4$ also coincides with the disagreement at time $t = 4$ when the decision is $k = B$ since $Pr(\omega = \alpha|\cdot) = 1 - Pr(\omega = \beta|\cdot)$. We may write:

$$d_4 = \left| \frac{q_\alpha Q}{q_\alpha Q + q_\beta(1-Q)} - \frac{(1-q_\alpha)Q}{(1-q_\alpha)Q + (1-q_\beta)(1-Q)} \right|.$$

Obviously, $d_4 \geq d_3 > d_2 = 0$ when $q_\alpha \neq q_\beta$. Moreover, when $p < 1$, $d_4 > d_3$. □

*Proof of Proposition 3.* At stage 2, the expectation of firm value of a shareholder who received signal $s_a$ is

$$\begin{aligned}
&Pr(k=\omega|s_a, v_i=1)\\
&=Pr(k=A|\omega=\alpha, v_i=1)Pr(\omega=\alpha|s_a)+Pr(k=B|\omega=\beta, v_i=1)Pr(\omega=\beta|s_a) \qquad (3)\\
&=Pr(v'\geq \tfrac{n-1}{2}|\omega=\alpha)\tfrac{q_\alpha}{q_\alpha+q_\beta}+Pr(v'<\tfrac{n-1}{2}|\omega=\beta)\tfrac{q_\beta}{q_\alpha+q_\beta}
\end{aligned}$$

Since voters who receive $s_b$ are indifferent between voting for $A$ and $B$ in equilibrium, we can simply consider those that vote for $A$. Therefore,

$$\begin{aligned}
&Pr(k=\omega|s_b, v_i=1)\\
&=Pr(k=A|\omega=\alpha, v_i=1)Pr(\omega=\alpha|s_b)+Pr(k=B|\omega=\beta, v_i=1)Pr(\omega=\beta|s_b) \qquad (4)\\
&=Pr(v'\geq \tfrac{n-1}{2}|\omega=\alpha)\tfrac{1-q_\alpha}{2-q_\alpha-q_\beta}+Pr(v'<\tfrac{n-1}{2}|\omega=\beta)\tfrac{1-q_\beta}{2-q_\beta-q_\alpha}
\end{aligned}$$

Obviously, $Pr(k=\omega|s_a, v_i=1)$ is different from $Pr(k=\omega|s_b, v_i=1)$ as $q_\alpha \neq q_\beta$. □

*Proof of Proposition 4.* Throughout the proof, we assume that $k=A$ is the outcome of the voting process. An $s_a$-shareholder's expectation of firm value is

$$\begin{aligned}
E[x|v', s_a, k=A] &= Pr(\omega=\alpha|v', s_a)\\
&= \frac{Pr(v', s_a|\omega=\alpha)}{Pr(v', s_a|\omega=\alpha)+Pr(v', s_a|\omega=\beta)}\\
&= \frac{\binom{n-1}{v'}z^{v'}(1-z)^{n-1-v'}q_\alpha}{\binom{n-1}{v'}z^{v'}(1-z)^{n-1-v'}q_\alpha+\binom{n-1}{v'}y^{v'}(1-y)^{n-1-v'}q_\beta} \qquad (5)\\
&= \frac{1}{1+\left(\frac{y}{z}\right)^{v'}\left(\frac{1-y}{1-z}\right)^{n-1-v'}\frac{q_\beta}{q_\alpha}},
\end{aligned}$$

where

$$\begin{aligned}
z &:= Pr(v_i=1|\omega=\alpha)\\
&= Pr(v_i=1|s_a)Pr(s_a|\omega=\alpha)+Pr(v_i=1|s_b)Pr(s_b|\omega=\alpha) \qquad (6)\\
&= q_\alpha+(1-m)(1-q_\alpha)
\end{aligned}$$

and

$$\begin{aligned}
y &:= Pr(v_i=1|\omega=\beta)\\
&= Pr(v_i=1|s_a)Pr(s_a|\omega=\beta)+Pr(v_i=1|s_b)Pr(s_b|\omega=\beta) \qquad (7)\\
&= q_\beta+(1-m)(1-q_\beta).
\end{aligned}$$

An $s_b$-shareholder who votes for $A$ expects $x$ to be

$$\begin{aligned} E[x|v', s_b, k = A] &= Pr(\omega = \alpha|v', s_b) \\ &= \frac{Pr(v', s_b|\omega = \alpha)}{Pr(v', s_b|\omega = \alpha) + Pr(v', s_b|\omega = \beta)} \\ &= \frac{\binom{n-1}{v'} z^{v'}(1-z)^{n-1-v'}(1-q_\alpha)}{\binom{n-1}{v'} z^{v'}(1-z)^{n-1-v'}(1-q_\alpha) + \binom{n-1}{v'} y^{v'}(1-y)^{n-1-v'}(1-q_\beta)} \\ &= \frac{1}{1 + \left(\frac{y}{z}\right)^{v'} \left(\frac{1-y}{1-z}\right)^{n-1-v'} \frac{1-q_\beta}{1-q_\alpha}}. \end{aligned} \tag{8}$$

Since we assume that both shareholders vote for $A$, we have $v' = v - 1$ for both of them. Since $q_\alpha \neq q_\beta$, we have that $E[x|v', s_a, k = A]$ is different from $E[x|v', s_b, k = A]$. The proof for $k = B$ is similar, and thus omitted. □

*Proof of Proposition 5.* We want to prove that for fixed $r$ when $n \to \infty$, the disagreement among voters is larger after than before voting if the outcome of the election is a tie. We will first show that $\lim_{n\to\infty} d^2 = 0$ and then that $\lim_{n\to\infty} d^4 > 0$.

Note first that, the mixed strategy of $s_b$-shareholders, $m$, must be such that $\lim_{n\to\infty} z = \lim_{n\to\infty} 1 - y$ (otherwise, conditional on being pivotal, one state becomes infinitely more likely than the other, see, e.g., Austen-Smith and Banks (1996)). One obtains from (6) and (7) that the following must hold at the limit:

$$q_\alpha + (1-m)(1-q_\alpha) = 1 - q_\beta - (1-m)(1-q_\beta) \quad \Leftrightarrow \quad (1-m)(2 - q_\alpha - q_\beta) = 1 - q_\alpha - q_\beta,$$

so that $m = \frac{1}{2-q_\alpha-q_\beta}$ at the limit. It follows that, at the limit, $z = \frac{1-q_\beta}{2-q_\alpha-q_\beta}$, which is strictly higher than $1/2$ since $q_\beta < q_\alpha$. Since $z = Pr(v_i = 1|\omega = \alpha)$, this directly implies that

$$\lim_{n\to\infty} \Pr\left(v' \geq \frac{n-1}{2}|\omega = \alpha\right) = \lim_{n\to\infty} \Pr\left(v' < \frac{n-1}{2}|\omega = \beta\right) = 1.$$

Plugging that in equations (3) and (4) , we obtain

$$\begin{aligned} \lim_{n\to\infty} \Pr(k = \omega|s_a) = \lim_{n\to\infty} &\left( \Pr\left(v' \geq \frac{n-1}{2}|\omega = \alpha\right) \frac{q_\alpha}{q_\alpha + q_\beta} \right. \\ &\left. + \Pr\left(v' < \frac{n-1}{2}|\omega = \beta\right) \frac{q_\beta}{q_\alpha + q_\beta} \right) \\ &= \frac{q_\alpha}{q_\alpha + q_\beta} + \frac{q_\beta}{q_\alpha + q_\beta} = 1, \end{aligned}$$

and

$$\lim_{n\to\infty} \Pr(k=\omega|s_b) = \lim_{n\to\infty}\left(\Pr\left(v' \geq \frac{n-1}{2}|\omega=\alpha\right)\frac{1-q_\alpha}{1-q_\alpha+1-q_\beta}\right.$$
$$\left. + \Pr\left(v' < \frac{n-1}{2}|\omega=\beta\right)\frac{1-q_\beta}{1-q_\alpha+1-q_\beta}\right)$$
$$= \frac{1-q_\alpha}{1-q_\alpha+1-q_\beta} + \frac{1-q_\beta}{1-q_\alpha+1-q_\beta} = 1.$$

Thus

$$\lim_{n\to\infty} d^2 = \lim_{n\to\infty} |\Pr(k=\omega|s_a) - \Pr(k=\omega|s_b)| = 0,$$

that is, for $n\to\infty$, the disagreement before voting vanishes.

We can now compute $\lim_{n\to\infty} d^4$, the limit disagreement after voting. In the mixed equilibrium, a shareholder who receives signal $s_b$ is indifferent between voting for $A$ and voting for $B$. This requires that

$$\Pr(\omega=\alpha|s_b)\Pr(v'=\tfrac{n-1}{2}|\omega=\alpha) = \Pr(\omega=\beta|s_b)\Pr(v'=\tfrac{n-1}{2}|\omega=\beta)$$

or:

$$\frac{\Pr(v'=\frac{n-1}{2}|\omega=\beta)}{\Pr(v'=\frac{n-1}{2}|\omega=\alpha)} = \tfrac{\Pr(\omega=\alpha|s_b)}{\Pr(\omega=\beta|s_b)}. \quad (9)$$

We also know that

$$\Pr(\omega=\alpha|s_b) = \frac{1-q_\alpha}{2-q_\alpha-q_\beta} \text{ and } \Pr(\omega=\beta|s_b) = \frac{1-q_\beta}{2-q_\alpha-q_\beta},$$

and that

$$\Pr(v'=\frac{n-1}{2}|\omega=\alpha) = \begin{pmatrix} n-1 \\ \frac{n-1}{2}\end{pmatrix}(z(1-z))^{\frac{n-1}{2}}, \text{ and}$$
$$\Pr(v'=\frac{n-1}{2}|\omega=\beta) = \begin{pmatrix} n-1 \\ \frac{n-1}{2}\end{pmatrix}(y(1-y))^{\frac{n-1}{2}}.$$

Plugging these objects in (9), we obtain

$$\left(\frac{y(1-y)}{z(1-z)}\right)^{\frac{n-1}{2}} = \frac{1-q_\alpha}{1-q_\beta}. \quad (10)$$

We now consider two shareholders who both voted for $A$ but received different signals (when $n$ is large, these two shareholders almost surely exist), so that $v' = v-1 = \frac{n-1}{2}+r$ for both of them. Assuming that $k = A$ (i.e. $r \geq 0$), we may apply (5) and (6) to compute the expected value of the firm given that $v' = \frac{n-1}{2} + r$ :

$$E[x|v' = \frac{n-1}{2} + r, s_a] = \frac{1}{1 + \left(\frac{y}{z}\right)^{\frac{n-1}{2}+r} \left(\frac{1-y}{1-z}\right)^{\frac{n-1}{2}-r} \frac{q_\beta}{q_\alpha}},$$

and

$$E[x|v' = \frac{n-1}{2} + r, s_b] = \frac{1}{1 + \left(\frac{y}{z}\right)^{\frac{n-1}{2}+r} \left(\frac{1-y}{1-z}\right)^{\frac{n-1}{2}-r} \frac{1-q_\beta}{1-q_\alpha}}.$$

Using (10) , these expected valuations boil down to

$$E[x|v' = \frac{n-1}{2} + r, s_a] = \frac{1}{1 + \frac{1-q_\alpha}{1-q_\beta} \frac{q_\beta}{q_\alpha} \left(\frac{y(1-z)}{z(1-y)}\right)^r}$$

and

$$E[x|v' = \frac{n-1}{2} + r, s_b] = \frac{1}{1 + \left(\frac{y(1-z)}{z(1-y)}\right)^r}.$$

As $z = \frac{1-q_\beta}{2-q_\alpha-q_\beta} = 1 - y$ at the limit, we have

$$\lim_{n\to\infty} \frac{y}{z} = \lim_{n\to\infty} \frac{1-z}{1-y} = \frac{1-q_\alpha}{1-q_\beta}. \tag{11}$$

We thus obtain:

$$E\left[x|v' = \frac{n-1}{2} + r, s_a\right] \quad \to_{n\to\infty} \quad \frac{1}{1 + \frac{q_\beta}{q_\alpha} \left(\frac{1-q_\alpha}{1-q_\beta}\right)^{2r+1}} \tag{12}$$

and

$$E\left[x|v' = \frac{n-1}{2} + r, s_b\right] \quad \to_{n\to\infty} \quad \frac{1}{1 + \left(\frac{1-q_\alpha}{1-q_\beta}\right)^{2r}}. \tag{13}$$

Note that shareholders voting for $B$ have no valuable private information since their private signal can be inferred from the vote outcome, their expectation of the firm's value must thus be intermediate between the two expectations considered above. Therefore, we have

$$\lim_{n\to\infty} d_4 = \lim_{n\to\infty}\left|E\left[x|v' = \frac{n-1}{2}+r, s_a\right] - E\left[x|v' = \frac{n-1}{2}+r, s_b\right]\right|$$
$$= \left|\frac{1}{1+\frac{q_\beta}{q_\alpha}\left(\frac{1-q_\alpha}{1-q_\beta}\right)^{2r+1}} - \frac{1}{1+\left(\frac{1-q_\alpha}{1-q_\beta}\right)^{2r}}\right|,$$

which is positive since $q_\alpha \neq q_\beta$. Thus, for $v = \frac{n+1}{2}+r$, with $r \geq 0$, we have that $\lim_{n\to\infty} d^4 > \lim_{n\to\infty} d^2$. The proof for $r \leq 0$ is similar and thus omitted. □

*Proof of Proposition 6.* The proof is straightforward. We know from Proposition 1 that, at stage 2, expectations about the value of the firm are independent of the signal received. This means that all shareholders have identical expectations about the value of the firm, and that these expectations are identical to the price $P_2 = Q$, as $p = 1$. Therefore, for any strictly positive transaction fee, there are no incentives to trade in stage 2.

At stage 4, given $p = 1$, the price is simply the probability that the public signal is correct: $P_4 = Q$. Proposition 2 shows that, at stage 4, there is disagreement among shareholders who receive different signals. From the proof of Proposition 2, it is straightforward to show that the price is necessarily strictly between the two expectations: $P_4 \in (\min_s\{E[x|s]\}, \max_s\{E[x|s]\})$. Therefore, for any $\epsilon$ smaller than both $P_4 - \min_s\{E[x|s]\}$ and $\max_s\{E[x|s]\} - P_4$, there is trade in stage 4. Note that the conclusion holds both in Kyle's and in the NAL trade models. □

*Proof of Proposition 7.* **Stage 2.** We first prove that no one wants to trade before voting. When $n \to \infty$, $P_2$, the stock price before voting, converges to 1.

$$\begin{aligned}\lim_{n\to\infty} P_2 &= \lim_{n\to\infty} Pr^*(k=\omega)\\ &= \lim_{n\to\infty} Pr(t \geq \frac{n+1}{2}|\omega=\alpha)Pr(\omega=\alpha)\\ &+ \lim_{n\to\infty} Pr(t \leq \frac{n-1}{2}|\omega=\beta)Pr(\omega=\beta)\\ &= 1,\end{aligned} \tag{14}$$

because $\lim_{n\to\infty} Pr(t \geq \frac{n+1}{2}|\omega=\alpha) = 1$ and $\lim_{n\to\infty} Pr(t \leq \frac{n-1}{2}|\omega=\beta) = 1$.

As for a shareholder's expectation of firm value, we know that $E[x|s_a] = Pr(k = \omega|s_a) \to_{n\to\infty} 1$ and $E[x|s_b] = Pr(k=\omega|s_b) \to_{n\to\infty} 1$ from the proof of Proposition 5.

Therefore, the difference between a shareholder's expectation of firm value and the price before voting goes to 0 as $n \to \infty$, no matter what signal the shareholder gets. That is:

$$\forall s \in S, \qquad \lim_{n\to\infty} |P_2 - E[x|s]| = 0.$$

Accordingly, given the arbitrarily small transaction fee, $\epsilon > 0$, a shareholder's trading profits are strictly negative at the limit, equal to $-\epsilon$. So, no shareholder wants to trade before voting.

**Stage 4.** We first show that for any $n$ and any election outcome $v$, if the transaction fee is arbitrarily small, shareholders who voted for $B$ never want to trade, while those who voted for $A$ want to buy (resp. sell) if the chosen policy is aligned (resp. misaligned) with their private signal. In a second step, we show that there are (small) positive fees $\epsilon > 0$ such that trade occurs *for any* sufficiently large $n$, when the vote is sufficiently close.

**Stage 4: Trading strategies.** We first compute the the posterior probability of the state being $\alpha$ after any combination of public and private histories. Given the (public) vote outcome $v$, this probability is:

$$\begin{aligned} Pr(\omega = \alpha|v) &= \frac{Pr(v|\omega=\alpha)}{Pr(v|\omega=\alpha) + Pr(v|\omega=\beta)} \\ &= \frac{\binom{n}{v} z^v (1-z)^{n-v}}{\binom{n}{v} z^v (1-z)^{n-v} + \binom{n}{v} y^v (1-y)^{n-v}} \qquad (15) \\ &= \frac{1}{1 + \left(\frac{y}{z}\right)^v \left(\frac{1-y}{1-z}\right)^{n-v}}. \end{aligned}$$

Consider a shareholder who receives the signal of $s_b$. In the trading stage, the shareholder observes $v$ and $v_i$, and privately knows $s_i = s_b$. Applying (8), the shareholder's posterior is

$$\begin{aligned} Pr(\omega = \alpha|v, v_i, s_b) &= \frac{1}{1 + \left(\frac{y}{z}\right)^{v-v_i} \left(\frac{1-y}{1-z}\right)^{n-1-(v-v_i)} \frac{1-q_\beta}{1-q_\alpha}} \\ &= \begin{cases} \dfrac{1}{1 + \left(\frac{y}{z}\right)^v \left(\frac{1-y}{1-z}\right)^{n-v} \frac{1-z}{1-y} \cdot \frac{1-q_\beta}{1-q_\alpha}} & \text{if } v_i = 0 \\ \dfrac{1}{1 + \left(\frac{y}{z}\right)^v \left(\frac{1-y}{1-z}\right)^{n-v} \frac{z}{y} \cdot \frac{1-q_\beta}{1-q_\alpha}} & \text{if } v_i = 1. \end{cases} \end{aligned}$$

Since

$$\frac{1-z}{1-y} \cdot \frac{1-q_\beta}{1-q_\alpha} = \frac{m(1-q_\alpha)}{m(1-q_\beta)} \cdot \frac{1-q_\beta}{1-q_\alpha} = 1,$$

we have $Pr(\omega = \alpha|v, v_i = 0, s_b) = Pr(\omega = \alpha|v)$. This is because a shareholder voting for $B$ has no valuable private information (at equilibrium, it is public knowledge that she received $s_b$). Since

$$\begin{aligned}\frac{z}{y} \cdot \frac{1-q_\beta}{1-q_\alpha} &= \frac{q_\alpha + (1-m)(1-q_\alpha)}{q_\beta + (1-m)(1-q_\beta)} \cdot \frac{1-q_\beta}{1-q_\alpha} \\ &= \frac{q_\alpha - q_\alpha q_\beta + (1-m)(1-q_\alpha)(1-q_\beta)}{q_\beta - q_\alpha q_\beta + (1-m)(1-q_\alpha)(1-q_\beta)} \\ &> 1,\end{aligned}$$

we know that $Pr(\omega = \alpha|v, v_i = 1, s_b) < Pr(\omega = \alpha|v)$. This is because a shareholder voting for $A$ but receiving $s_b$ has private information making her less optimistic about the state being $\alpha$ than if she only had public information.

Then, consider that a shareholder receiving the signal of $s_a$. Recall that $v_i(s_a) = 1$ in equilibrium. Applying (5), the shareholder's posterior is

$$Pr(\omega = \alpha|v, s_a) = \frac{1}{1 + \left(\frac{y}{z}\right)^{v-1} \left(\frac{1-y}{1-z}\right)^{n-1-(v-1)} \frac{q_\beta}{q_\alpha}}.$$

Because

$$\begin{aligned}\frac{z}{y} \cdot \frac{q_\beta}{q_\alpha} &= \frac{q_\alpha + (1-m)(1-q_\alpha)}{q_\beta + (1-m)(1-q_\beta)} \cdot \frac{q_\beta}{q_\alpha} \\ &= \frac{q_\alpha q_\beta + (1-m)q_\beta - (1-m)q_\alpha q_\beta}{q_\alpha q_\beta + (1-m)q_\alpha - (1-m)q_\alpha q_\beta} \\ &< 1,\end{aligned}$$

we have $Pr(\omega = \alpha|v, v_i = 1, s_a) > Pr(\omega = \alpha|v)$. This is because a shareholder receiving $s_a$ has private information making her more optimistic about the state being $\alpha$ than if she only had public information.

We conclude that the following ordering of posteriors holds for any outcome $v$:

$$Pr(\omega = \alpha|v, v_i = 1, s_b) < Pr(\omega = \alpha|v) = Pr(\omega = \alpha|v, v_i = 0, s_b) < Pr(\omega = \alpha|v, s_a).$$

When $k = A$, the price after voting is $P_4(k = A, v) = Pr(\omega = \alpha|v)$ and we have for any information $H$, $E[x|H] = Pr(\omega = \alpha|H)$, so that:

$$E[x|v, v_i = 1, s_b, k = A] < P_4(k = A, v) = E[x|v, v_i = 0, s_b, k = A] < E[x|v, s_a, k = A].$$

Thus, when $k = A$, for an arbitrarily small transaction fee, shareholders voting for $B$ want to hold, those voting for $A$ want to buy if they received a signal $s_a$ and they want to sell if they received a signal $s_b$.

Similarly, when $k=B$, we have $P_4(k=B,v)=1-Pr(\omega=\alpha|v)$ and for any information $H$, $E[x|H]=1-Pr(\omega=\alpha|H)$. We obtain:

$$E[x|v,s_a,k=B]<P_4(k=B,v)=E[x|v,v_i=0,s_b,k=B]<E[x|v,v_i=1,s_b,k=B].$$

Thus, when $k=B$, for an arbitrarily small transaction fee, shareholders voting for $B$ want to hold, those voting for $A$ want to buy if they received a signal $s_b$ and they want to sell if they received a signal $s_a$.

**Stage 4: Occurrence of trade.**

We show that given any $\bar{r}\in\mathbb{N}$, there are small transaction fees $\epsilon$ such that trade occurs if $v=\frac{n+1}{2}+r$ with $r<\bar{r}$ whenever $n$ is large enough.

First, assuming that $k=A$ (i.e. $r\geq 0$), we compute $P_4(k=A,v)$ using its definition (15), the mixed equilibrium condition (10) and then the limit condition (11):

$$\begin{aligned}P_4(k=A,v)=Pr(\omega=\alpha|v)&=\frac{1}{1+(\frac{y}{z})^{\frac{n+1}{2}+r}(\frac{1-y}{1-z})^{\frac{n-1}{2}-r}}\\&=\frac{1}{1+\frac{y}{z}(\frac{y(1-z)}{z(1-y)})^r\times\frac{1-q_\alpha}{1-q_\beta}}\\&\to_{n\to\infty}\frac{1}{1+(\frac{1-q_\alpha}{1-q_\beta})^{2r+2}}.\end{aligned}$$

We thus have that the price after voting converges to a limit of the form $\frac{1}{1+C}$ with $C:=(\frac{1-q_\alpha}{1-q_\beta})^{2r+2}$. Now observe from (12) and (13) that

$$E_a:=\lim_{n\to\infty}E[x|v=\frac{n+1}{2}+r,v_i=1,s_a]=\frac{1}{1+C\frac{q_\beta(1-q_\beta)}{q_\alpha(1-q_\alpha)}}$$

and

$$E_b:=\lim_{n\to\infty}E[x|v=\frac{n+1}{2}+r,v_i=1,s_b]=\frac{1}{1+C(\frac{1-q_\beta}{1-q_\alpha})^2}.$$

As $q_\beta<q_\alpha<1-q_\beta$, we also have $q_\beta<1-q_\alpha<1-q_\beta$ and thus $(\frac{1-q_\beta}{1-q_\alpha})^2>1>\frac{q_\beta(1-q_\beta)}{q_\alpha(1-q_\alpha)}$. We obtain that $E_b<\lim_{n\to\infty}P_4(k=A,v)<E_b$. Hence, for any given $r\geq 0$, there are small enough transaction fees such that trade occurs after a voting outcome $v=\frac{n+1}{2}+r$ whenever $n$ is large enough. Note that the conclusion holds both in Kyle's and in the NAL trade models. The proof for $r<0$ is similar and thus omitted. □