Active vs. Passive: Information Acquisition in the Presence of Corporate Governance *

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Abstract

We provide a theoretical framework to understand the implications of corporate governance on the composition of the asset management industry and financial markets. We allow investors to implement corporate governance in an otherwise standard information model. Our model generates new strategic complementarities in investors' decisions to acquire information due to a conflict of interest between active and passive investors arsing from their information asymmetry. Such strategic complementarities contrast the traditional substitution role of information, and we provide empirical predictions unique to our model based on comparative statics. Our results are robust to various approaches that passive investors can take to participate in corporate governance, and we discuss the policymakers' trade-offs when regulating their participation. We apply our insights to two critical passive funds' governance issues: ESG policies and product market competition from common ownership.

Keywords: mutual funds, passive investment, corporate governance, information acquisition, strategic complementarities, conflict of interests

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1 Introduction

The recent increase in firm ownership by institutional investors has raised scrutiny about their role in corporate governance.[1] A heated academic and policy debate on the impact of corporate governance by institutions has emerged, fueled by the intrinsic differences between active and passive investors.[2] By being uninformed, passive investors may not be able to conduct corporate governance in a meaningful way. For example, passive investors may fail to choose a trustworthy board of directors, decide a proper payment incentive for management, or select a value-enhancing strategic merge. Consequently, passive investors may behave excessively deferential towards management and exasperate a principal-agent problem by allowing them to shirk and destroy firm value. In contrast, informed active investors can use their information to select promising firms and implement meaningful corporate governance policies in them. Thus active and passive investors have a natural conflict of interest when pursuing corporate governance in the firms held in their portfolios.

In this paper, we develop a theoretical model to analyze the endogenous choice of investors to acquire information and become active or passive when they internalize their impact on a firm through corporate governance. We are particularly interested in the following questions. How does investors' capability to implement corporate governance affect their incentive to acquire information and the passive fund growth? What does this imply for price informativeness? And, what are the results of policy proposals put forward to regulate the governance role of passive investors?

Our analysis generates a new, perhaps counter-intuitive, insight: By introducing corporate governance, we find strategic complementarities in investors' ex-ante information acquisition de-

[1] The Big Three passive funds alone (BlackRock, State Street, and Vanguard) cast an average of 25% of the votes in the S&P 500 firms and one of them is the largest shareholder in 88% of S&P companies, see Bebchuk and Hirst (2019). McCahery, Sautner, and Starks (2016a) surveyed institutional investors and documented around 63% of the respondents directly interacted with management team regarding governance issues over the past 5 years.

[2] Lund (2018) and Bebchuk and Hirst (2019) claim that passive investors have low incentives to engage in monitoring. In contrast, Fisch, Hamdani, and Solomon (2019) and Kahan and Rock (2019) argue that competition among passive funds creates enough incentives to engage with the companies in their portfolios.

cisions, which makes the consequences of passive investment self-reinforcing. In other words, an investor's incentive to become active (or passive) increases when other investors make the same choice. Our finding offers a novel perspective into the consequences of the rise of passive investment in financial markets. These strategic complementarities contrasts the traditional substitution role of information, where a rise in passive investment benefits active investors by leaving more opportunities to extract gains from their information (Grossman and Stiglitz, 1976). Furthermore, strategic complementarities generate an amplification effect which can support multiple equilibria and make the growth of passive investment unbounded until every investor prefers to hold a passive portfolio.[3]

To explain our results, let us briefly introduce the framework. We present a model that has the novelty of allowing investors to implement corporate governance on top of acquiring information and trading in the financial market. The economy is composed of a firm that can be of a good or a bad type, with lower payoff. We introduce information asymmetry by *endogenously* allowing investors to pay a cost to receive a signal about the firm's type. *Active* investors are those who choose to acquire information, and *passive* investors are those who do not and are uninformed. We introduce a role for corporate governance by assuming a principal-agent problem where the firm's manager can destroy value unless a meaningful corporate governance policy is implemented. Specifically, we allow shareholders to vote their shares for a meaningful corporate governance policy which increases firm value, or for a deferential corporate governance policy, that allows managers to shirk and destroys firm value.[4] Notably, we assume that a meaningful corporate

[3] It is widely understood that the shift from active to passive investment arises from the under-performance (lower returns) after fees of active investment, see Fama and French (2010). In this context, our model highlights a novel reason for such under-performance: the rise of the passive investment itself.

[4] In reality, institutional investors can implement corporate governance through various channels, see McCahery, Sautner, and Starks (2016b) for a survey. We believe voting is the most straightforward mechanism that preserves realism while allowing all shareholders to express their interest and simultaneously giving more power to investors with a higher ownership share.

governance policy always increases the firm's payoff.[5]

The main mechanism behind our model is the conflict of interest between the firm's active and passive investors. Based on their information, active investors buy the good firm and short-sell the bad firm because the expected return of the good firm is positive and that of the bad firm is negative.[6] Therefore, active investors maximize their return when the good firm follows the meaningful policy, realizing a high payoff, and when the bad firm follows the deferential policy, realizing a low payoff by allowing management to shirk. In contrast, passive investors always hold the firm because, being uninformed, they have no means of differentiating the firm's type. Hence, the information asymmetry induces a different portfolio composition that generates a conflict of interest between active and passive investors. When many passive investors vote collectively for the same strategy, they effectively reduce the firm's payoff sensitivity to its type.[7] If a firm's payoff does not change much depending on its type, investors have a lower ex-ante incentive to acquire information about the firm's type. Hence, we find strategic complementarities where passive investment decreases investors' incentives to become active investors.

To see the robustness of our identified conflict of interest, suppose, for example, that passive investors always vote for the meaningful corporate governance policy for the firm they own. Then, the bad firm is more likely to realize a high payoff, which is detrimental for active investors because they short-sell the bad firm. The same logic applies to the cases when passive investors vote

[5] Under this interpretation, passive investors, despite being uninformed, can vote to improve corporate governance and maximize the firm's payoff, which differs from the information setting in Corum, Malenko, and Malenko (2021) where the firm's type determines the optical policy to be chosen. We extend our analysis to study this information structure in Section 6. Furthermore, our complementary results hold when both types of the firm have the same payoff after corporate governance as in Hellwig and Veldkamp (2009).

[6] In reality, active investors that are not allowed to short-sell are evaluated against a benchmark. To beat the benchmark, they overweight good firms and underweight bad firms. It is possible to express the total return of such a tilted portfolio as the sum of a long/short portfolio plus the benchmark's return. Thus, relative performance evaluation becomes equivalent to allowing a long/short portfolio.

[7] The survey study by McCahery, Sautner, and Starks (2016a) shows that most institutional investors follow the voting recommendations of proxy advisory firms. There are only five primary proxy advisory firms in the U.S.: Institutional Shareholder Services (ISS), Glass Lewis & Co., Egan-Jones Proxy Services, Segal Marco Advisors, and ProxyVote Plus.

for the deferential policy, vote randomly, or do not vote.[8] Therefore, regardless of how passive investors vote their shares, the conflict of interest between active and passive leads to strategic complementarities in information acquisition. It is worthwhile mentioning that there is one case when a small number of passive investors can actually generate substitution. Such a case occurs when a relatively small number of passive investors do not affect a good firm but increase the likelihood of a deferential policy being chosen in a bad firm. In such a case, a higher likelihood of a low payoff for the bad firm increases the expected payoff of active investors and, hence, increases the ex-ante incentives to acquire information.

Our findings shed light on policymakers' trade-off when regulating how passive investors should engage in corporate governance. We take the policy perspective from Fama (1970) where "the primary role of the capital market is allocation of ownership of the economy's capital stock." Hence, in our model, it is efficient for good firms to get funding and for bad firms to exit the market in the long run due to lack of funding. In other words, it is valuable to identify the firm type by relying on active investors' decision to "vote with their feet" when pursuing an efficient portfolio allocation. The tradeoff from the policymakers' perspective is that maximizing the firm value can contradict an efficient capital allocation. Suppose a regulation enhances the fiduciary duty of passive investors by requiring them to engage in governance to maximize the firm value. Such regulation can generate a social loss since the strategic complementarities generated from corporate governance drive away active investors. Therefore, passive investors might ultimately subsidize a bad firm that should have exited the market. On this matter, we propose voting based on the information in the firm's prices as a way to alleviate the conflict of interest between active and passive investors.

[8] If passive investors vote for the deferential policy, they reduce the payoff of a good firm; which is detrimental to active investors since they buy a good firm. If passive investors do not vote their shares or vote randomly, they remain detrimental to active investors. This is because the share of active vs passive investment clears in equilibrium. Hence, a rise in passive investment decreases the power of the ownership stake that active investors can use against the shirking of the firm's insiders.

We, furthermore, conduct a comparative statics exercise in the stable equilibrium of the model. We show that the rise in passive investment decreases (increases) the payoff variance when the equilibrium exhibits strategic complementarities (substitutions) from corporate governance. Notably, an increase in the payoff variance increases the ex-ante incentives to acquire information, leading to higher price informativeness, and vice versa.[9] In contrast, a model that ignores corporate governance, i.e., where passive investors do not affect a firm's payoff, does not impact price informativeness in equilibrium.[10] For example, when passive investors vote for the meaningful policy, an increase in the amount of noise trading can increase price informativeness in equilibrium. We develop empirical predictions based on out comparative statics results.

Finally, we conclude this paper with two model extensions that offer very contrasting views on the role of passive investors' corporate governance: ESG investment and product market competition. For ESG investment, passive investors that follow an ESG mandate have been regarded as champions of green policies.[11] For product market competition, passive investors have sparked heated discussions about their anti-competition role as common-owners across industries, especially for competing firms.[12] Under the lenses of our model, we show that both these angelic and demonizing views of passive investors are shortsighted and ignore the conflict of interest from information asymmetry. Even though passive investors increase green policies, they may do so at the expense of subsidizing bad firms and preventing them from exiting the market. On the other

[9] Kacperczyk, Van Nieuwerburgh, and Veldkamp (2009) present a mechanism by which information acquisition is more beneficial for signals with higher variance. Our finding is consistent with the empirical evidence in Bai, Philippon, and Savov (2013).

[10] The irrelevance arises because any change in the incentives to acquire information is fully internalized by the equilibrium change in the share of passive investment. Glebkin, Gondhi, and Kuong (2021) provide a general mechanism for such irrelevance result.

[11] Such intuition arises from the fact that ESG investment may represent lower monetary profits in the short horizon but may maximize payoffs in a long horizon (both monetary and non-monetary). By not being able to exit and sell shares under their mandate, passive investors are seen as endowed with an incentive to pursue ESG policies.

[12] Passive investors are natural common-owners because, a diversified portfolio is optimal for them given their lack of information, i.e. passive investors hold the market. This raises concerns that they can reduce competition in the product market for firms they co-own. Empirical evidence for such claim is found in Azar, Schmalz, and Tecu (2018) and as arising from miss-alignment of management incentives in Anton et al. (2021).

hand, even though passive investors decrease product market competition, while they do so, they raise the stakes for all firms by increasing the sensitivity of a firm's payoff to its type. Consequently, the lack of competition makes it easy for a good firm to betray anti-competitive agreements and steal market shares; thus, forcing bad firms to exit the market.

The rest of this paper is organized as follows. In section 2, we present a simple and very general model to highlight the main mechanism that this paper offers. In section 3, we describe our solution method and characterize the equilibrium of the economy. In section 4, we analyze the equilibria found and identify the two sources that can affect the incentives to acquire information while offering a policy discussion. In section 5, we develop a comparative statics exercise that generates unique empirical predictions. Section 6 offers a model extensions to discuss corporate governance implications on ESG policies and product market competition. Finally, section 7 contains the concluding remarks.

Literature Review Our paper contributes to understanding the effects of corporate governance in information acquisition. The existing theoretical work on corporate governance has focused on exogenous shareholder composition. For example, Maug and Rydqvist (2009) study strategic voting decisions of shareholders with heterogeneous information and examine the effectiveness of information aggregation through voting. Cvijanovic, Groen-Xu, and Zachariadis (2017) and Meirowitz and Pi (2019) investigate how investors' voting decisions rely on the likelihood that their voting is pivotal. Levit, Malenko, and Maug (2019) study the link between trading and voting and find that trading and voting are complementary. One notable exception which examines corporate governance in a setting allowing for endogenously determined asset management industry is Corum, Malenko, and Malenko (2021). They highlight that funds' incentives to engage in corporate governance depend on both management fees and asset under management. The impact of a rise in passive investing on corporate governance depends on whether it crowds out private savings or active funds. In contrast to these papers, our paper provides a model where investors can implement corporate governance to affect firms' payoff, while keeping endogenously both their decisions to acquire information and their trading in the financial market.

One strand of literature, which connects information, trading and corporate governance, focuses on blockholders. Edmans (2009) builds a link between blockholders' governance and managerial myopia. Back et al. (2018) study how market liquidity affects blockholders' efforts to affect the firm value. See more details in survey paper by Edmans (2014) and Edmans and Holderness (2017). Most of these papers model a single blockholders, which prevents them from capturing the collective equilibrium behaviour of investors that arise in our model.

Secondly, our theoretical model provides a new mechanism that generates strategic complementarities in information acquisition, which stands in contrast to the traditional substitution effect of information acquisition, see for example Grossman (1976); Grossman and Stiglitz (1980); Hellwig (1980). Dow, Goldstein, and Alexander (2015) study information acquisition for investors in an economy where the firm's investment decision depends on the information revealed from stock prices. Their model forms market breakdowns arising from the strategic complementarities between information production and efficiency in investment. Strategic complementarity in information acquisition can also emerge in the trading market when investors learn about a firm's payoff and stock supply simultaneously (Ganguli and Yang 2009), when traders learn different fundamentals affecting the firm value (Goldstein and Yang 2015), and when the cost of information is endogenously determined (Veldkamp 2006). Garcia and Strobl (2011) and Glebkin, Gondhi, and Kuong (2021) link investors' incentive to acquire information to their relative wealth concerns and funding constraints, highlighting the role of financial constraints in information production. Bond and García (2021) show that the feedback from indexing to price efficiency is also self-reinforcing. The most similar mechanism to our paper is Hellwig and Veldkamp (2009) where authors highlight that strategic actions can motivate strategic information acquisition. Our model shares a similar spirit where information facilitates coordination in the voting stage. However, in our model, voting itself is not a strategic action since an investor's voting decision does not depend on others' voting decisions. Nevertheless, the same information set leads to the same voting decision. Thus, in our model, strategic complementarities arise from information enabling a coordination among investors voting actions to maximize portfolio returns.

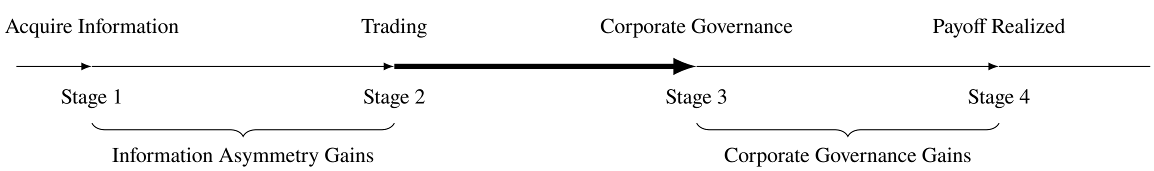
Moreover, our paper contributes to the fast-growing discussion on the impact of the rise of passive investment. The prominent view is that the growth of passive investment has distorted financial markets as a whole because passive investors do not gather firm-specific information. As such, passive investment leads to increased volatility (Sushko and Turner, 2018; Anadu et al., 2018), worse liquidity (Hamm, 2014), and higher systemic fragility (O'Hara and Bhattacharya, 2017). However, empirical work on price informativeness often shows the opposite. **?** document that ETF activity increases informational efficiency for stocks in the short run, and Bai and Ling (2014) find that overall markets are more informed even though the share of passive ownership has increase ed over the years. Buss and Sundaresan (2020) provides a theoretical framework to rationalize this price informativeness puzzling finding. Their model argues that passive ownership can reduce the cost of capital and incentivize managers' risk-taking behavior leading to more volatile payoffs. As a result, payoff volatility induces more information acquisition by active investors. Our model generates the prediction that the rise of passive can lead to an increase in price informativeness as well, due to the effect in payoff volatility even when we allow for an endogenous share of passive investment.

Finally, there are a few theoretical papers studying the endogenous size of active and passive sector. Berk and Green (2004) and Pástor and Stambaugh (2012) rationalizes the enormous size of active investing by assuming decreasing returns to scale for active asset managers. **?** include the search cost in a Grossman and Stiglitz (1976) model and predict that more money is allocated to the active sector when the search cost is lower. These models, however, can not explain the sharp rise of passive investing over the years, because the relative management fee between active and passive funds has been decreasing and the search cost is arguably lower due to easy access to the Internet. Our paper provides an explanation where the size of passive investing is affected by investors implementation of corporate governance.

2 Model

This section presents a simple model with a single firm. The key feature of the model is that all investors can implement corporate governance on top of deciding to acquire information and trade in the financial market.

This static model has four stages. First, investors decide to acquire information about the type of the firm. Second, based on the information acquired, investors choose a portfolio position and trade in the financial market with a competitive market maker and liquidity traders. Third, after becoming shareholders of a firm, investors can implement corporate governance by voting their shares for a policy. Finally, in the fourth stage, the type of the firms is revealed, and the investors' payoff is realized.



The thick arrow represent the innovative link of this paper. We call *Information Asymmetry Gains* the profit that investors can make from trading based on information; here we find the traditional strategic substitution in information acquisition. We call *Corporate Governance Gains* the profit that investors can make by affecting the firm's corporate governance policy; here we find strategic complementarities in information acquisition that stand in contrast to the traditional substitution role of information. Linking these two channels generate novel predictions for returns variance and price informativeness that are absent in a model that ignores such link.

We now proceed to describe each component of the model and then devote the section 2.3 to discuss in detail how investors implement corporate governance with its implications.

2.1 Firm

The economy is composed by a firm of an unknown type, which payoff is affected by corporate governance. A firm is, ex-ante, equally likely to be of a good type (G) or a bad type (B), which is less profitable. The firms' type is the hidden state of nature on which investors can acquire information.

A $G-$type firm achieves a high payoff V_H if it follows a meaningful governance policy, or a low payoff V_L if it follows a deferential policy which allows managers to shirk, where $V_L < V_H$. A $B-$type firm achieves $V_H - \epsilon$ if it follows a meaningful governance policy, or $V_L - \epsilon$ if it follows a deferential policy. We capture with ϵ the different profitability of the firm's type.

We define a social loss when the firm implements a "wrong" policy. We assume that $G-$type firms ought to do well and achieve a high payoff, while $B-$type firms ought to exit the market in the long run due to lack of funding. Therefore, there is a social loss when the $B-$type firm follows a meaningful policy due to wasted corporate governance efforts, and when the $G-$type firm follows a deferential policy.[13] Conceptually, the $B-$type firm is less profitable than the $G-$type firm, and hence investing in it leads to a negative return. This deters investors from holding $B-$type firm's shares and even induces informed investors to short-sell them. As a result, the share price of $B-$type firm is low, which prevents it from obtaining equity financing in the long run. We use this intuition to define a measure of social loss η as the probability that a deferential policy is followed by the G firm times the loss in such case plus probability of a meaningful policy is followed by the B firm

[13] Our model does not allow for an explicit definition of welfare for all investors because of the presence of liquidity traders. So we take a view as Fama (1970) to define social loss as the inefficient allocation.

times the loss in such case:

$$\eta = \Big(\mathbb{P}(\text{Meaningful Policy}|B) + \mathbb{P}(\text{Deferential Policy}|G)\Big)(V_H - V_L) \tag{1}$$

Note that our framework can be modified to apply to different firm's payoffs, and Section 6 is devoted to discuss two possible extensions.

2.2 Agents

There are four types of agents that populate the economy.

Investors Investors are risk-neutral with a unit mass, indexed by $i \in [0, 1]$. Each investor can acquire a noisy signal, S, about the type of the firm at a cost ψ. The precision $\gamma > \frac{1}{2}$ denotes the probability of a correct signal:[14]

$$\mathbb{P}(S = S_G|G) = \mathbb{P}(S = S_B|B) = \gamma$$

An investor decides to acquire information if the expected gains from acquiring information are higher than the signal cost ψ. We denote λ as the mass of investors who, endogenously, do *not* acquire information.

After observing the signal, investors choose their portfolio position in the firm. Due to the risk-neutral utility, we limit each investor to buy or sell one share only.[15] We assume that informed investors have access to a leveraging technology denoted by κ, and hence they choose a position from $\{-\kappa, \kappa\}$ conditional on their information.[16] We call the investors that acquire information "active investors" in what follows. In contrast, uninformed investors do not have information nor leveraging technology, and hence purchase *one* share of the firm. In other words, uninformed

[14] The assumption of an imprecise signal is simply meant to portray realism, while our results are strongest for a perfectly precise signal.

[15] One can interpret this assumption as a constraint on the trade size.

[16] The leveraging technology is not necessary for our key mechanism. We introduce it to offer rich comparative statics.

investors hold the market; which is the reason why we call uninformed investors "passive investors" for the rest of the paper.

Liquidity traders Liquidity traders arrive at the market randomly and do not participate in corporate governance (or choose a corporate governance policy randomly). The existence of liquidity traders prevents the prices from being fully revealing as in Grossman and Stiglitz (1976). We assume that the total order submitted by liquidity traders is N, which follow a Gaussian distributions with mean 0 and variance σ_N^2.

A market maker As in Kyle (1985), we assume that there exists a competitive market maker who observes the order flows from investors and liquidity traders. Its sole role is to set an efficient price in the trading stage. This setup implicitly guarantees that the market maker absorbs any excess supply of shares and clears the market. We assume the market make does not participate in corporate governance and will discuss the possible implications if they do.[17]

Firm's insiders We call firm insiders the founders, members of the management team, or employees with voting shares. The principal-agent problem arises from insiders' private agenda, for example, their preference for a quite life as in Bertrand and Mullainathan (2003). As such, insiders prefer the deferential policy, for the reason that if a policy has not been implemented, it is probably because insiders do not want to implement it. We assume that a known mass of shares, $\bar{\varphi}$, is held by firm insiders, and is not traded in the market. Since actively participating in corporate governance can be costly, we assume that only a random fraction of firm insiders, denoted as φ uniformly distributed between $[0, \bar{\varphi}]$, engage in governance. Such randomness makes the corporate strategy chosen by the firm a random variable.

[17] Even though this seems like a realistic assumption, it is not innocuous. If *all* market makers were to use their shares to vote for a meaningful corporate governance policy, and passive investors too, the rise in the share of passive investment would have no impact on a firm's payoff. A firm's payoff would not depend on corporate governance, and our model would be reduced to a benchmark information model with constant firm payoffs and no possible role for corporate governance.

2.3 Corporate Governance

This section specifies the mechanism by which investors implement corporate governance. Corporate governance aims to mitigate conflicts of interests between stakeholders, primarily between shareholders and insiders, but also among active and passive investors. Conflict of interests of the latter arises when two types of investors hold different portfolios, which is expected since the portfolio of active investors depends on information.

We choose *majority voting* as the approach for shareholders to implement corporate governance. We make two assumptions regarding how voting is implemented. First, the firm adopts a one-share-one-vote policy. Second, liquidity traders and the market maker do not vote. Therefore, only investors with a long position in a firm and firm's insiders participate in voting.

Firm's insiders' voting decision Insiders use their voting power to achieve their private agenda, i.e., shirk, which means they vote for a deferential corporate governance policy. This assumption is meant to capture the principal-agent problem where management can have exploit perks and destroy value in the absence of a meaningful corporate governance policies.

Active investors' voting decision Active investors vote their shares, if held long, to maximize their portfolio payoff. Therefore they choose a meaningful corporate governance policy.

Passive investors' voting Given the emphasis of our paper, and the current empirical debate, we consider three possible ways in which passive investors may implement corporate governance. The three possible scenarios are indicated by the parameter ζ.

- Case 1: $\zeta = 1$ Passive investors implement corporate governance to maximize their portfolio payoff and increase firm value. In this case, passive investors, even though they do not actively pick firms based on information, are not passive owners and they implement a meaningful corporate governance policy.
- Case 2: $\zeta = 0$ Passive investors do not implement corporate governance and simply hold

shares. In this case, all passive investors do not vote; though, as we show below, this does not mean that their presence does not affect the voting outcome.

- Case 3: $\zeta = -1$ Passive investors vote their shares in line with management and decrease firm value. This is an alternative by which passive investors are passive owners but use their shares to allow for management's shirking.

3 Characterization of Equilibrium

In this section, we characterize the model equilibrium by using backward induction. The analysis is conducted in six steps. First, we conjecture an optimal portfolio allocation based on information. Second, we aggregate the mass of votes to derive the voting outcome conditional on the possible realizations of a firm's type. Third, we compute the expected payoff of the firm, taking into account the randomness of the voting outcomes. Fourth, we determine the efficient price quoted by the competitive market maker, who observes order flows. Fifth, we verify that our conjectured portfolio choice for an investor (passive or active) is optimal. Lastly, we solve for the endogenous information acquisition decision, which determines the proportion of passive vs active investors.

3.1 Conjectured portfolio allocation

To specify how investors vote conditional on information, it is necessary to establish investor's portfolio allocation. We conjecture the following:

Conjecture 1. *a) Passive investors take a long position in the firm; b) Active investor takes:*

- *a long position in the firm for signal $S = S_G$;*
- *a short position in the firm for signal $S = S_B$;*

After solving for the equilibrium in section 3.5, we show that this conjecture is valid.

3.2 Voting outcome

We begin by aggregating the mass of votes that each corporate governance policy receives. Such mass depends on the firm type, as an example, we focus on the type realization G. There are three groups of agents with voting power. (i) Firm's insiders, who want to shirk and prefer deferential policy. Insiders accounts for the random fraction φ_X of votes. (ii) Active investors of total mass $(1-\lambda)$. From the mass of active investors, a fraction γ receives a correct signal (S_G), hold the firm long, and vote for meaningful policy. (iii) Passive investors of mass λ that can vote for meaningful policy if $\zeta = 1$, hold their shares but not vote if $\zeta = 0$, and vote for deferential policy if $\zeta = -1$. The aggregate mass that each corporate governance policy receives depending on passive investors' approach to corporate governance is:

$$\text{If } \zeta = 1: \quad \text{Deferential policy: } \underbrace{\varphi}_{\substack{\text{Firm}\\\text{managers}}} \qquad \text{Meaningful policy: } \underbrace{\kappa(1-\lambda)\gamma}_{\substack{\text{Active investors}\\\text{with correct signal}}} + \underbrace{\lambda}_{\substack{\text{Passive}\\\text{investors}}};$$

$$\text{If } \zeta = 0: \quad \text{Deferential policy: } \varphi \qquad \text{Meaningful policy: } \kappa(1-\lambda)\gamma;$$

$$\text{If } \zeta = -1: \quad \text{Deferential policy: } \varphi + \lambda \qquad \text{Meaningful policy:} \kappa(1-\lambda)\gamma.$$

We now proceed to calculate the probability that a meaningful policy is ultimately chosen. Such probability depends on the firms type realization and how passive investors vote. We define q_G^ζ and q_B^ζ as the probability that meaningful policy wins for $G-$type and $B-$type firm as :

$$\begin{aligned} q_G^\zeta &= \mathbb{P}(\underbrace{\zeta\lambda + \kappa(1-\lambda)\gamma}_{\text{Meaningful policy}} > \underbrace{\varphi}_{\text{Deferential policy}}) = \frac{1}{\bar{\varphi}}\Big(\zeta\lambda + \kappa\gamma(1-\lambda)\Big) \\ q_B^\zeta &= \mathbb{P}(\zeta\lambda + \kappa(1-\lambda)(1-\gamma) > \varphi) = \frac{1}{\bar{\varphi}}\Big(\zeta\lambda + \kappa(1-\gamma)(1-\lambda)\Big). \end{aligned} \tag{2}$$

Where $q_G^\zeta \geq q_B^\zeta$.[18] Using the definition in Equation 1, the social loss is written explicitly as:

$$\eta = (1 - q_G^\zeta + q_B^\zeta)(V_H - V_L).$$

3.3 Firms' Expected Payoff

The payoff of each firm is a random variable depending on the voting outcome, i.e., the chosen corporate governance policy. Using Equation (2), we denote π^ζ as the expected payoff of the firm for a realization of firm type as:

$$\pi^\zeta(G) = q_G^\zeta V_H + (1 - q_G^\zeta)V_L, \qquad \pi^\zeta(B) = q_B^\zeta(V_H - \epsilon) + (1 - q_B^\zeta)(V_L - \epsilon). \tag{3}$$

Note that Equation (3) nests all three cases of passive investors' corporate governance, where the values of q_t^ζ change depending on the parameter ζ.

At this point, it is useful to introduce a variable that captures the expected gain that active investors can obtain from corporate governance. Define $\Pi(\cdot)$ as:

$$\Pi(\lambda, \gamma, \kappa, \sigma_N, \bar{\varphi}, \zeta) = \pi^\zeta(G) - \pi^\zeta(B) = \epsilon + (q_G^\zeta - q_B^\zeta)(V_H - V_L). \tag{4}$$

Intuitively, $\Pi(\cdot)$ represent the gain of a long-short portfolio based on active investor's information about the firm's type. In Proposition 1 we proof that $\Pi(\cdot) > 0$ and in Proposition 2 we show how $\Pi(\cdot)$ varies as the share of passive investors changes.

3.4 Stock Prices

The competitive market maker observes the order flows for the firm, F, updates his beliefs about the realization of the firm's type, and sets the efficient price as

$$P^\zeta = \mathbb{E}[\pi^\zeta | F = x], \tag{5}$$

[18] Since $q_G^\zeta - q_B^\zeta = \frac{1}{\bar{\varphi}}\Big(\kappa(2\gamma - 1)(1 - \lambda)\Big) \leq 0$.

where x is the observed order flows for the firm. If a firm of the good type, a measure $(1-\lambda)\gamma$ of active investors receives a signal S_G and purchases κ shares; and a measure $(1-\lambda)(1-\gamma)$ receives a S_B signal and sell κ shares. Passive investors always buy one share. So, the aggregate order flow for the firm is:

$$F = \begin{cases} \lambda + N + \kappa(1-\lambda)(2\gamma-1), & \text{if } G \\ \lambda + N - \kappa(1-\lambda)(2\gamma-1), & \text{if } B. \end{cases}$$

After observing order flow $F = x$, the market maker updates his belief, based on Bayes' rule, on firm's type to a posterior probability denoted as $\rho(x)$:

$$\rho(x) = \mathbb{P}(G|F=x) = \frac{\mathbb{P}(F=x|G)\mathbb{P}(G)}{\mathbb{P}(F=x)} = \frac{\phi\left(\frac{x-\lambda-\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)}{\phi\left(\frac{x-\lambda-\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)+\phi\left(\frac{x-\lambda+\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)},$$

where $\phi(\cdot)$ represents the probability density function of the Gaussian distribution with mean 0 and variance 1. The efficient price that the market maker sets is the expectation over all possible firm's type realizations, resulting in:

$$P^{\zeta}(F=x) = \rho(x)\pi^{\zeta}(G) + (1-\rho(x))\pi^{\zeta}(B) \tag{6}$$

where $\pi(G)$ and $\pi(B)$ correspond to the expected payoff of the firm given its type realization as per Equation (3).

3.5 Verifying the Optimal Portfolio Choice

We now verify our conjectured portfolio choice in Section 3.1. The portfolio return for an investor is defined as the payoff minus the price of the firm. As a consequence, investors need to form an expectation of such price since they chose a portfolio before the market maker sets the price. To this purpose, investors form an expectation about how much information can the market maker extract from the order flow. We denote such expectation given the *true* type of the firm as ξ:[19]

$$\xi(\lambda,\gamma,\kappa,\sigma_N) \equiv \mathbb{E}[\rho(F)|G] = 1 - \mathbb{E}[\rho(F)|B] = \mathbb{E}\left[\frac{\phi\left(\frac{N}{\sigma_N}\right)}{\phi\left(\frac{N}{\sigma_N}\right) + \phi\left(\frac{N+2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)}\right].$$

Based on the total law of expectation, we can derive investors' expected belief about $\xi(\cdot)$ given their signal.[20] Then, we can prove the conjectured portfolio allocation and calculate the expected profit for active investors (denoted as Ω), summarized in Proposition 1.[21]

Proposition 1. *An active investor's optimal trading strategy follows the conjecture 1, and the expected profit is given by:*

$$\Omega(\lambda,\gamma,\kappa,\sigma_N,\bar{\varphi}) = (2\gamma-1)(1-\xi(\lambda,\gamma,\kappa,\sigma_N))\Pi(\lambda,\gamma,\kappa,\sigma_N,\bar{\varphi}), \tag{7}$$
$$\textit{where} \quad \Pi(\lambda,\gamma,\kappa,\sigma_N,\bar{\varphi}) = \pi(G) - \pi(B) > 0.$$

Note further that passive investors can be seen as receiving a signal of informativeness $\gamma = \frac{1}{2}$. It is then straightforward to show that passive investors have zero expected profit, making the conjecture of holding the whole market a valid conjecture.

3.6 Information Acquisition

Each investor decides whether to acquire information or not by comparing the gain from information acquisition, $\Omega(\cdot)$ and the cost, ψ. We can interpret the cost ψ as the difference in the fees of active investment minus those of of passive investment. The equilibrium proportion of passive investors is determined by the point $\hat{\lambda}$ such that a marginal investor is indifferent between acquiring or not information, solving:

$$\Omega(\hat{\lambda},\gamma,\kappa,\sigma_N,\bar{\varphi}) - \psi = 0. \tag{8}$$

[19] The proof of the equivalence $\mathbb{E}[\rho(F)|G] = 1 - \mathbb{E}[\rho(F)|B]$ is found in the Appendix A.3.

[20] For example, $\mathbb{E}[\rho(F)|S = S_G] = \mathbb{E}\Big[\mathbb{E}[\rho(F)|G]|S = S_G\Big] = \mathbb{E}\Big[\xi(\cdot)|S = S_G\Big]$.

[21] Proof is in the Appendix A.1.

There may be a corner solution $\hat{\lambda}$ depending on the cost of information acquisition. When the cost, ψ, is greater than the highest expected profit of active investors, no investor wants to become active and $\hat{\lambda} = 1$. On the contrary, the opposite corner solution occurs for a very small ψ, where every investor acquires information and $\hat{\lambda} = 0$. In the following, we focus on the range of ψ where an interior solutions exist, i.e., $\hat{\lambda} \in (0, 1)$.

4 Main Results

This section analyzes the equilibria of the model. We first describe the interplay between the two possible sources of expected profit for active investors—information asymmetry vs corporate governance—which determine the equilibrium share of passive investors. Here we highlight our main result: the existence of strategic complementarities, which can make the total share of passive investment unbounded in equilibrium. Importantly, such strategic complementarities exist *regardless* of the way passive investors implement corporate governance. We follow with a section that characterizes the potential multiple equilibria of the model and their stability. Finally, we close with a policy discussion on passive investors' corporate governance approach and its implications for our main mechanism.

4.1 Incentives to Acquire Information

We decompose the expected profit from information acquisition in Equation (8) into two components:

$$\Omega = \underbrace{(2\gamma - 1)(1 - \xi(\lambda, \gamma, \kappa, \sigma_N))}_{\substack{\text{Information}\\ \text{asymmetry}}} \underbrace{\Pi(\lambda, \gamma, \kappa, \bar{\varphi})}_{\substack{\text{Corporate}\\ \text{governance}}}. \tag{9}$$

Given this decomposition, we analyze how each component reacts to changes in the equilibrium share of passive investors, summarized in Proposition 2.[22]

Proposition 2. *It holds that (i) an increase in λ icreases the expected profit from information asymmetry:*

$$\frac{\partial(1-\xi(\lambda,\gamma,\kappa,\sigma_N))(2\gamma-1)}{\partial\lambda} \geq 0;$$

and (ii) an increase in λ can decrease the expected profit from corporate governance:

When $\zeta-(1-\gamma)\kappa > 0$*:*	*When* $\zeta-(1-\gamma)\kappa \leq 0$*:*
$\begin{cases} \frac{\partial\Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial\lambda} < 0, & \textit{If } \Lambda_0 \leq \lambda < \Lambda_1, \\ \frac{\partial\Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial\lambda} = 0, & \textit{If } \lambda \geq \Lambda_1. \end{cases}$	$\begin{cases} \frac{\partial\Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial\lambda} = 0, & \textit{If } \lambda \leq \frac{(1-\gamma)\kappa-\bar{\varphi}}{(1-\gamma)\kappa-\zeta}, \\ \frac{\partial\Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial\lambda} > 0, & \textit{If } \frac{(1-\gamma)\kappa-\bar{\varphi}}{(1-\gamma)\kappa-\zeta} < \lambda \leq \Lambda_0, \\ \frac{\partial\Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial\lambda} < 0, & \textit{If } \Lambda_0 < \lambda < \Lambda_1, \\ \frac{\partial\Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial\lambda} = 0, & \textit{If } \lambda \geq \Lambda_1. \end{cases}$
$\Lambda_0 = 0$ *and* $\Lambda_1 = \frac{(1-\gamma)\kappa-\bar{\varphi}}{(1-\gamma)\kappa-\zeta}$	$\Lambda_0 = \frac{\gamma\kappa-\bar{\varphi}}{\gamma\kappa-\zeta}$ *and* $\Lambda_1 = \frac{\gamma\kappa}{\gamma\kappa-\zeta}$

And we denote $\lambda \in (\Lambda_0, \Lambda_1)$ the region with strategic complementarities (i.e., $\frac{\partial\Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial\lambda} < 0$).

The derivative of the first component, which we denote *information asymmetry*, is positive and is standard in models of informed trading (e.g., Grossman and Stiglitz, 1976).[23] As the fraction of passive investors, λ, increases, the market maker can extract less information from the order flow and sets the price closer to the average payoff and away from the firm type's specific payoff. Therefore, more passive investors increase active investors' expected profit Ω. This generates the traditional substitution effect in investors' decisions to acquire information, i.e., the presence of passive investors incentivize more active investors to acquire information.

[22] The proof can be found in the Appendix A.2.

[23] The term on information asymmetry has two parts: First, $(2\gamma-1)$ that captures the informativeness of the signal. Second, $1-\xi(\hat{\lambda},\gamma,\kappa,\sigma_N)$ that captures the adverse selection between the active investors and the market maker.

The derivative of the second component, which we denote *corporate governance*, is the main contribution of the paper.[24] The rise of passive investors could be beneficial for active investors for a small share of passive investors, $\lambda < \Lambda_0$, but detrimental for a large number of passive investors, $\Lambda_0 < \lambda < \Lambda_1$. For the range $\Lambda_0 < \lambda < \Lambda_1$, we observe strict strategic complementarities where the presence of passive investors reduces the expected profit from information acquisition.

To understand the intuition behind this finding, it is helpful to acknowledge that active investors, based on their information, buy a $G-$type firm and sell a $B-$type firm. Therefore, active investors achieve the highest expected payoff when the $G-$type firm implements meaningful policy, with a high payoff, while $B-$type firm implements a deferential policy, with a low payoff. Hence, if the firm consistently implements a meaningful or a deferential policy, regardless of its type, the expected profit of active investors is diminished because they have less motivation to distinguish the firm type. When the share of passive investors is in (Λ_0, Λ_1), passive investors affect the probability of choosing a meaningful policy regardless of the firm type. In the extreme, the firm's policy only depends on passive investors' choice of corporate governance. Hence, the rise in passive investment decreases the ex-ante incentives to acquire information, generating strategic complementarities. In contrast, for a small number of passive investors, $\lambda \leq \Lambda_0$, a $G-$type firm has enough active investors to implement a meaningful policy with certainty. On the other hand, the likelihood of $B-$type firm implementing meaningful policy is reduced with the rise of passive investing since active investors do not hold it.[25] The lower payoff, via a deferential policy in the $B-$type firm, increases the expected payoff of active investors. Hence, the rise in passive investment increases the ex-ante incentives to acquire information and, in this case, can generate strategic substitutions.

Importantly, from Proposition 2, this result holds regardless of how passive investors vote—vote optimally by maximizing their portfolio payoff, do not vote, or vote with management. The reason

[24] A model that ignores the variability from corporate governance has $\Pi(\cdot)$ as a constant rather than a function of the equilibrium $\hat{\lambda}$; hence the derivative is zero.

[25] This arises from the inequality $\zeta < (1-\gamma)\kappa$, which implies that $\frac{\partial q_B^{\zeta}}{\partial \lambda} < 0$.

is that the main force to generate strategic complementarities lies in the conflict interests between active and passive investors, via their different expected portfolios after information acquisition. Regardless of how passive investors vote their shares, the information asymmetry, and, hence, their conflict of interests, prevails. Passive investors ignore the firm's type and can only engage collectively. Under any voting approach that is not conditional on information, a large number of passive investors takes away voting power from active investors, which decreases their incentives to acquire information.

4.2 Equilibrium Outcomes

To illustrate the equilibria that result from Equation (8), we plot the expected profit of active investors, Ω, against the share of passive investors $\hat{\lambda}$ in Figure 1. Unless stated otherwise, all figures use the parameters in the Table 1.

Parameter	Description	Value	Parameter	Description	Value
V_H	High payoff	2	γ	Signal precision	0.8
V_L	Low payoff	1	κ	Active investors leverage	2
ε	Firm's type difference	0.5	$\bar{\varphi}$	Max voting power of insiders	0.95
ψ	Cost of information	0.16	σ_N	Noise traders volatility	1

Table 1: Parameters used for figures

The equilibrium $\hat{\lambda}$ is determined by the point at which the expected profit equals the cost of information ψ. We include in the figure the expected profit of active investors, Ω, for the different approaches that passive investors take to vote their shares, i.e., $\zeta \in \{-1, 0, 1\}$. Furthermore, from Proposition 2, we highlight, shaded in the figure and in the x- axis, the interior region at which strategic complementarities hold, starting with Λ_0 and ending with Λ_1, for each parameter ζ. As mean of reference, we also include the Ω from a model without corporate governance, i.e., where $\Pi(\cdot)$ as a constant rather than a function of the equilibrium $\hat{\lambda}$.

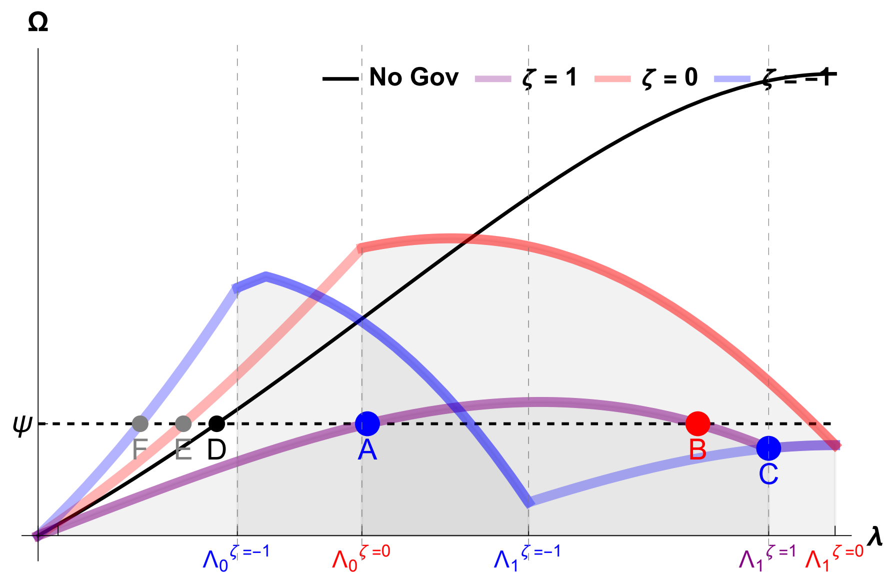


Figure 1: Expected profit for informed investors Ω as a function of the equilibrium share of passive λ. The shaded areas represent the region with strict strategic complementarities.

As shown in Figure 1, the non-monotonicity in Ω potentially gives rise to multiple equilibria.[26] The presence of multiple equilibria speaks to the empirical research that documents market fragility as a result of the rise of passive investors, see Anadu et al. (2018). We select the stable equilibrium in the presence of multiplicity. A stable equilibrium requires that the share of passive investment λ reverts back to the equilibrium point for small deviations in investors' beliefs on λ.[27]

Taking $\zeta = 1$ as an example, the cost of information, crosses Ω at two points, resulting in two interior solutions marked A in blue and B in red. The equilibrium A in blue is stable while B in

[26] When considering the information asymmetry channel solely, we can find at most one unique equilibrium because, from Proposition 2, Ω is a monotone function in λ.

[27] Put differently, a stable equilibrium is the solution Equation (8) where the profit function Ω is increasing in $\hat{\lambda}$ at that point.

red is not. At the equilibrium point marked B in red, if investors believe the fraction of passive is slightly higher, the expected profit of an active investor decreases. This triggers a self-reinforcing cycle where more investors would choose not to acquire information and eventually converge to the equilibrium point C. Such instability suggest that the total share of passive investors in the economy might be unbounded. Furthermore, in our chosen parameter set, $\Lambda_0 = 0$ and we observe no substitution from corporate governance. Therefore, the left-side stable equilibrium $\hat{\lambda}$ is always larger than that in a model without corporate governance (point A versus point D in Figure 1). In contrast, when $\zeta = 0$ or -1, the substitution from corporate governance reinforces the information asymmetry channel, and we see steeper slopes for Ω in Figure 1. As a consequence, the left-side equilibria of both cases, point E and point F, are on the left side of point D, the equilibrium of a model without corporate governance.

Furthermore, note that how passive engages in corporate governance affects the location of a stable equilibrium. For $\zeta = 1$ the left-side stable equilibrium $\hat{\lambda}$ is always larger than that in the case of $\zeta = 0$ or -1 (point A versus point E or F in Figure 1).This observations lead to our first empirical prediction:

Prediction 1: The flows from active to passive investment increase as passive investors engage in corporate governance to increase firm value.[28]

4.3 Regulation of Passive Investment Corporate Governance

The increasing ownership stake of passive investment has created a heated debate on its impact on the performance of companies and the economy. We devote this section to discuss the different sides of the debate on how passive investors implement corporate governance. We want to highlight the trade-off faced by policymakers when regulating how passive investors should vote. If the regulation imposes fiduciary duty on passive investors, which requires them to engage in governance

[28] For example, when voting can become more important after exogenous regulatory changes to voting legislation.

to maximize the firm value, as in $\zeta = 1$; such choice causes a large social loss in terms of efficiency.

To illustrate the impact of regulation, we plot, in Figure 2, our measure of social loss η, defined in Equation (1), as a function of the equilibrium share of passive investment λ for the different choices of parameter ζ. We begin by noting that our defined social loss is smallest when the $G-$type firm implements meaningful policy, which increases value, while $B-$type firm implements a deferential policy, which destroys value. In such case, only a $G-$type firm will be able to secure equity financing in the long run. In other words, the social loss depends on active investors' decision to "vote with their feet" by allocating portfolio efficiently. The social loss decreases in λ when the substitution effect from corporate governance is at play, i.e., $\lambda \in (0, \Lambda_0)$, and increases in λ when the complementarities are at play, i.e., $\lambda \in (\Lambda_0, \Lambda_1)$.

The intuition for such finding follows from Proposition 2. In the substitution region, the rise of passive does not affect $G-$type firm but increases the likelihood that a $B-$type firm takes a deferential policy. This incentivizes more investors to learn information and optimally allocate their funding to $G-$type firm exclusively, thereby reducing the social loss. In contrast, in the complementarities region, the rise of passive nudges the firm to the same corporate governance policy regardless of its type, which reduces the incentives to acquire information. With less active investors that vote with their feet, the $B-$type firm is more likely to get financed, reducing the financial market efficiency and increasing the social loss.

With this intuition in place, we analyze the different potential regulatory policies on passive investors' corporate governance. We focus on the stable equilibrium for our discussion.

Passive investors as active owners:[29] It is widely believe that the rise of passive investment is detrimental for corporate governance.[30] Nowadays, the Securities and Exchange Commission

[29] See Appel, Gormley, and Keim, 2016a and Appel, Gormley, and Keim, 2016b for empirical evidence.

[30] First, passive funds only track index and lack a financial incentive to ensure each firm in their portfolio is well-run. Second, learning information and intervening governance can be very costly. Third, there is a free-rider problem that passive funds can benefit from performance improving activities initiated by active investors. Therefore, passive investors do not engage enough in corporate governance.

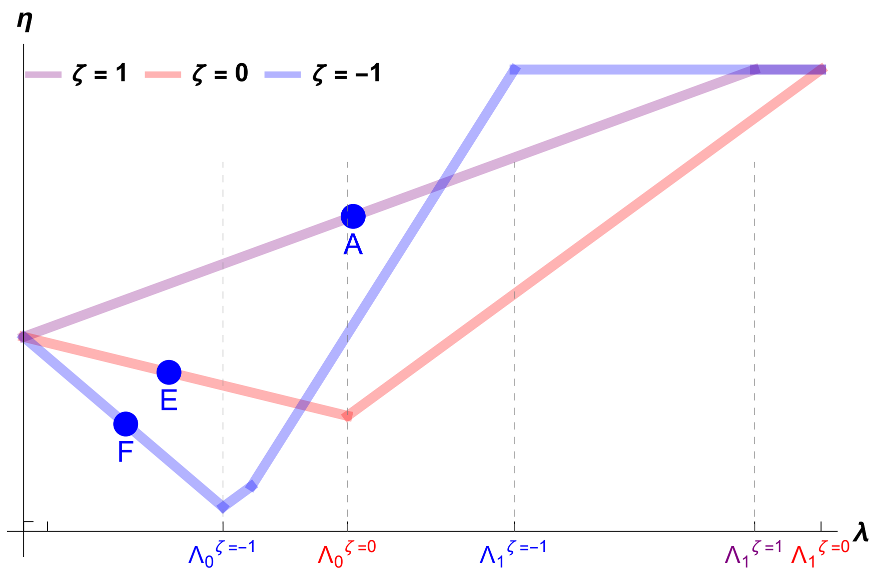


Figure 2: Social loss as a function of λ. Point A, E, F correspond to equilibrium $\hat{\lambda}$ in Figure 2.

(SEC) is proposing to enhance the disclosure rule for passive funds to make them accountable for their voting decisions.[31] In the extreme, such a policy force passive investors to engage in a meaningful corporate governance to maximize the firm value.

This policy coincides with our model parameter of $\zeta = 1$. Under such policy, passive investors champion the meaningful policy for the firm they own regardless of whether it is a $G-$type or $B-$type firm. This approach has the advantage of maximizing the return of passive investors, but it incurs a large social loss, as the strategic complementarities from governance drives away active investors and finance the $B-$type firm in the long run, see point A in Figure 2.

Ban passive investors voting: Another potential policy to address the issue of inaction of passive investors' governance is to ban passive voting, as proposed by Lund (2017). This policy coincides with our model parameter of $\zeta = 0$. Under such policy, passive investors can hold shares

[31] In 2021, the SEC proposed to "amend Form N-PX under the Investment Company Act of 1940 to enhance the information mutual funds, exchange-traded funds, and certain other funds currently report annually about their proxy votes and to make that information easier to analyze."

but not implement any form of corporate governance. Although this policy does not comply with the "one share one vote" rule, it can reduce the social loss when the equilibrium $\hat{\lambda}$, see point E lower than point A in Figure 2.

Passive investors as passive owners:[32] A policy that allows passive investors to vote with the management team coincides with our model parameter of $\zeta = -1$, where they completely side with management in the firm they own. Such policy is directly against the fiduciary duty to investors in passive funds. However, under such approach, passive investors generate the lowest social loss η, as shown by point D in Figure 2, since it increases the probability that a $B-$type firm lacks equity financing in the long run.

Passive vote based on information: We propose voting based on information as the only policy that can minimize the social loss induced by the votes of passive investors. Specifically, if passive investors were to learn from price, the conflict of interest between active and passive investors would be attenuated, and hence the region with strategic complementarities diminishes. It is worth pointing out voting based on information does *not* imply voting to maximize the firm value, or voting as active investors with shares, or by following the advice of a couple of key active investors. Prices are aggregators of information because they reflect all available information including short positions; in contrast, there is no such thing as a short vote. Therefore for the $B-$type firm, the negative information can never be reflected in the casted votes.

Finally, from a practical perspective, we see learning from price as forcing an increased investment in stewardship for passive funds to acquire information. Such investment is likely to increase passive fund's fees, decreasing ψ in our model, and decreasing the aggregate share of passive investment in equilibrium. Which creates a new dilemma: would passive funds like to follow a regulation that reduces their AUM?

We offer two important concluding remarks to this policy discussion. First, when institutional

[32] See Heath et al., 2019 for empirical evidence.

passive investors follow the voting recommendations of proxy advisory firms (McCahery, Sautner, and Starks 2016a), since such firms gather preferences instead of aggregated information about a firm.[33] Second, Proposition 2 shows that even for $\zeta - \gamma\kappa \leq 0$, if $\bar{\varphi} > \gamma\kappa$, a substitution region cannot not exist and $\Lambda_0 \leq 0$. Therefore, for firms with a big proportion of shares held by insiders, the rise in passive investors always creates a social loss because they never achieve enough power to overrule insiders' decision, but can subsidize a $B-$type firm in the long run.

5 Comparative Statics

We now proceed to perform a comparative statics analysis in the stable equilibrium and provide testable empirical predictions throughout the section. We concentrate on two outcomes: the variance of a firm payoffs and the price informativeness. We begin with a partial equilibrium analysis to generate the intuition necessary for the full general equilibrium results where we consider an endogenous share of passive investors λ.

5.1 Partial Effects

We begin by analyzing the impact of the rise of passive investment for the variance of the payoffs and the price informativeness. Note that the partial equilibrium change in λ is equivalent to the general equilibrium shock to the cost of information ψ, since ψ alone does not affect the expected profit Ω. Specifically, an increase in cost ψ leads to an increase in the share of passive investing, $\hat{\lambda}$.

[33] ISS and Glass Lewis publicly disclose their policy guidelines. Take ISS as the example, they survey institutional investors about their preference on a selected policy position, conduct roundtable discussions with a subset of investors, host a comment period to gather feedback, and finally release voting recommendations. Hence, proxy advisors recommendations are not based on information about a firm's is long term profitability.

Variance The variance of a firm can be calculated in close form as:

$$\mathrm{Var}^{\zeta}(\pi) = \frac{1}{2}\left(\pi^{\zeta}(G)\right)^2 + \frac{1}{2}\left(\pi^{\zeta}(B)\right)^2 - \left(\frac{1}{2}\pi^{\zeta}(G) + \frac{1}{2}\pi^{\zeta}(B)\right)^2 = \frac{1}{4}\left(q_G^{\zeta} - q_B^{\zeta}\right)^2 (V_H - V_L)^2$$

Since q_G^{ζ} and q_B^{ζ} are a function of the equilibrium share of passive investment λ, we plot the variance of payoffs as a function of λ for the different choices of parameter ζ in Figure 3. As in Proposition

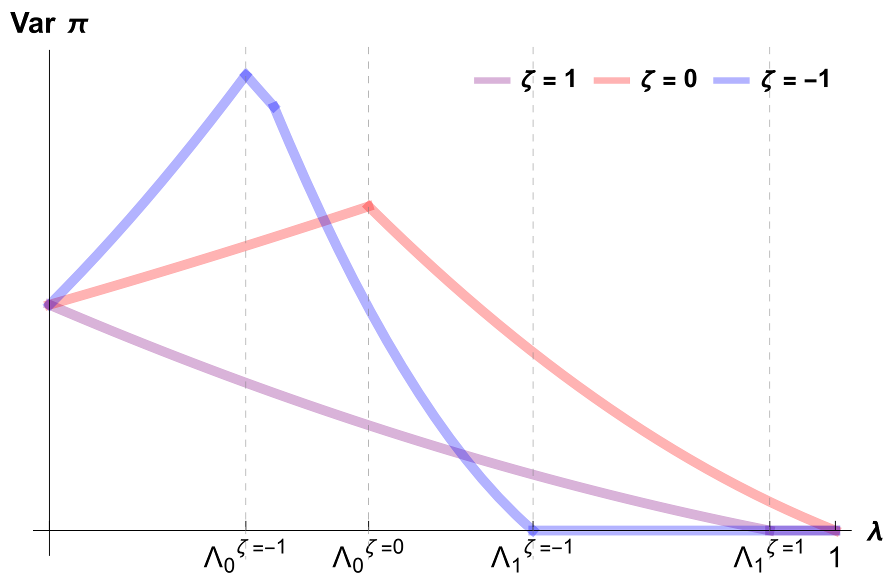


Figure 3: Variance of payoffs as a function of λ.

2, the sign of the derivative $\frac{\partial \mathrm{Var}^{\zeta}(\pi)}{\partial \lambda}$ depends on the sign of $\left(\frac{\partial q_G^{\zeta}}{\partial \lambda} - \frac{\partial q_B^{\zeta}}{\partial \lambda}\right)$, i.e., it depends on whether there are substitution or complementarities from corporate governance. When $\lambda \in (0, \Lambda_0)$, the payoff variance is increasing in the share of passive investment, as they increase the likelihood of a deferential policy being chosen for a $B-$type firm while not affecting such likelihood in a $G-$type firm. When $\lambda \in (\Lambda_0, \Lambda_1)$, the opposite effect emerges, since the rise of passive investment increases the likelihood that one specific governance policy is chosen, irrespective of the firm type, decreasing the variance of payoffs.

Informativeness We define price informativeness as the variance explained from the prices as:[34]

$$I = 1 - \frac{\mathbb{E}\Big[\mathrm{Var}(\pi|P)\Big]}{\mathrm{Var}(\pi)} = \frac{\mathrm{Var}(\mathbb{E}[\pi|P])}{\mathrm{Var}(\pi)} = \frac{\mathrm{Var}(P)}{\mathrm{Var}(\pi)} = 2\xi(\lambda,\gamma,\kappa,\sigma_N) - 1. \tag{10}$$

Under such definition it is straightforward to see, from Proposition 2, that the partial effect of an increase in the share of passive investment λ decreases price informativeness, as $\frac{\partial\xi(\lambda,\gamma,\kappa,\sigma_N)}{\partial\lambda} < 0$.

5.2 General Equilibrium Effects

We now focus on the more interesting cases where the change arises from an exogenous parameter that affects the equilibrium share $\hat{\lambda}$. We decompose the overall effect on price informativeness into two components: the direct effect which captures the effect of a change in an exogenous parameter x, and the indirect effect, which captures the effect through the change in equilibrium share $\hat{\lambda}$.

$$\frac{dI}{dx} = \underbrace{\frac{\partial I}{\partial x}}_{\text{Direct Effect}} + \underbrace{\frac{\partial I}{\partial\hat{\lambda}}\frac{\partial\hat{\lambda}}{\partial x}}_{\text{Indirect Effect}}, \qquad \text{where } \frac{\partial I}{\partial\hat{\lambda}} < 0.$$

The signs of the terms $\frac{\partial I}{\partial x}$ and $\frac{\partial I}{\partial\hat{\lambda}}$ are determined by Equation (10). Note that the general equilibrium result is the sum of the direct and indirect effects. Therefore, when they have opposite signs, the sign of the general equilibrium result depends on the strength of the indirect effect compared to the direct effect. The strength of the indirect effect is moderated the term $\frac{\partial\hat{\lambda}}{\partial x}$. When $\hat{\lambda}$ falls in the complementary region from corporate governance, the payoff variance decreases, which further increases the equilibrium share of passive investors, thereby strengthening the indirect effect. In contrast, when $\hat{\lambda}$ falls in the substitution region from corporate governance, more investors want to be active due to the increased payoff variance, which weakens the indirect effect.

We can understand the intuition behind the moderating effect of $\hat{\lambda}$ by taking as reference a model without corporate governance. If the firm's payoff is not affected by corporate governance

[34] A proof of the last equality is available in Appendix A.4.

and only depends on the type of the firm, the direct and indirect effects cancel each other out exactly. Therefore an exogenous shock to a model parameter x is irrelevant for price informativeness because the change via the direct effect is precisely offset by the equilibrium change in $\hat{\lambda}$ in the indirect effect. In contrast, including corporate governance affects the ex-ante incentives to acquire information. If the payoff variance increases (decreases), there is a further increase (decrease) in the incentives to acquire information than in a model without corporate governance. As a consequence, the equilibrium share of passive investment $\hat{\lambda}$ is smaller (larger) than in a model without corporate governance, making the indirect effect is weaker (stronger).

5.2.1 Decrease in σ_N

We begin by analyzing an exogenous shock to noise traders. The direct effect of reducing σ_N is an increase in price informativeness, $\frac{\partial I}{\partial \sigma_N} < 0$, as price is more revealing with less noises. In contrast, from the indirect effect, fewer noise traders increase the equilibrium share of passive investors because the rent that can be extracted from the mispricing by active investors is reduced. In other words, active investors have a harder time hiding the information in their trades and fewer investors choose to be active, which is captured by $\frac{\partial \lambda}{\partial \sigma_N} < 0$. Therefore, the aggregate indirect effect lowers price informativeness after a decrease in σ_N.

Notably, in a model *without* the corporate governance channel, the decrease in price informativeness from the direct effect exactly cancels out with the increase in price informativeness. We illustrate this irrelevance finding with the black line in Figure 4, the price informativeness, in equilibrium, does not move with σ_N if $\Pi(\cdot)$ is a constant.

The results are different when we include the corporate governance channel, which affects the payoff variance. When the equilibrium $\hat{\lambda}$ falls in the complementarities region (Λ_0, Λ_1) of corporate governance, a decrease in noise trading decreases informativeness, see the case of a positive slope for $\zeta = 1$ in Figure 4. Such result arises from the reduction in payoff variance, which induces

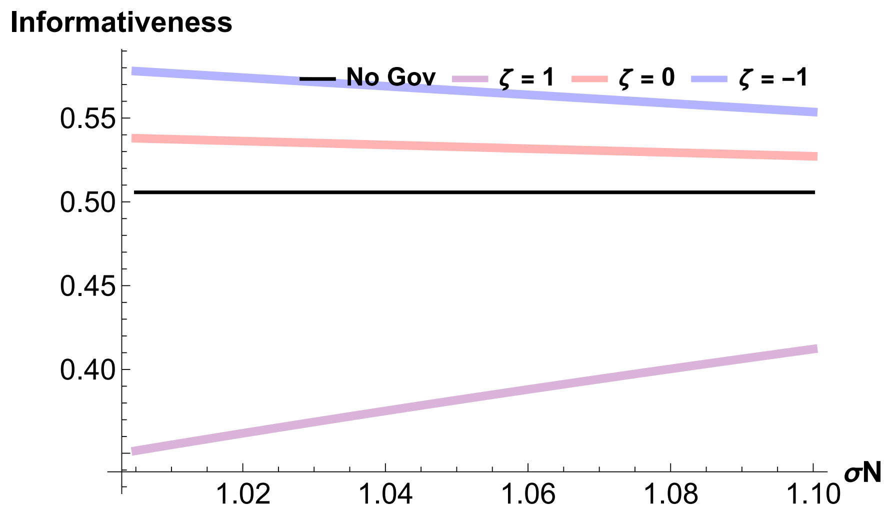


Figure 4: The impact of shocking σ_N on price informativeness.

more passive investors in equilibrium and strengthens the indirect effect. In contrast, when $\zeta = 0$ or -1, and the stable equilibrium $\hat{\lambda}$ is located in the substitution region $(0, \Lambda_0)$, a decrease in noise trading increases price informativeness. This is attributed to the increased payoff variance, which weakens the indirect effect. As passive investment makes the payoff of the firm more sensitive to its type, there is a stronger incentive to acquire information emerges ex-ante. This analysis leads to the empirical prediction:

Prediction 2: The causal relationship between the amount of noise traders σ_N and price informativeness increases as passive investors engage in corporate governance to increase firm value, and can turn positive when passive investors vote for meaningful corporate governance policies. [35]

[35] For example, a drop to retail investment or decrease in market volatility can represent an exogenous drop in σ_N.

5.2.2 Increase in κ

We now analyze an exogenous shock to the leverage technology of active investors. A direct effect of the rising κ is to increase price informativeness, coming from the price being more sensitive to the aggressive trades of active investors and their information, and captured by $\frac{\partial I}{\partial \kappa} > 0$. Nevertheless, since there is no fundamental change in the information acquisition incentives, the total amount of active shares $(1-\lambda)\kappa$ must remain constant in the equilibrium. Hence, a better leverage technology increases the equilibrium share of passive investors through the indirect effect, captured by $\frac{\partial \hat{\lambda}}{\partial \kappa} > 0$, which in aggregate reduces price informativeness.

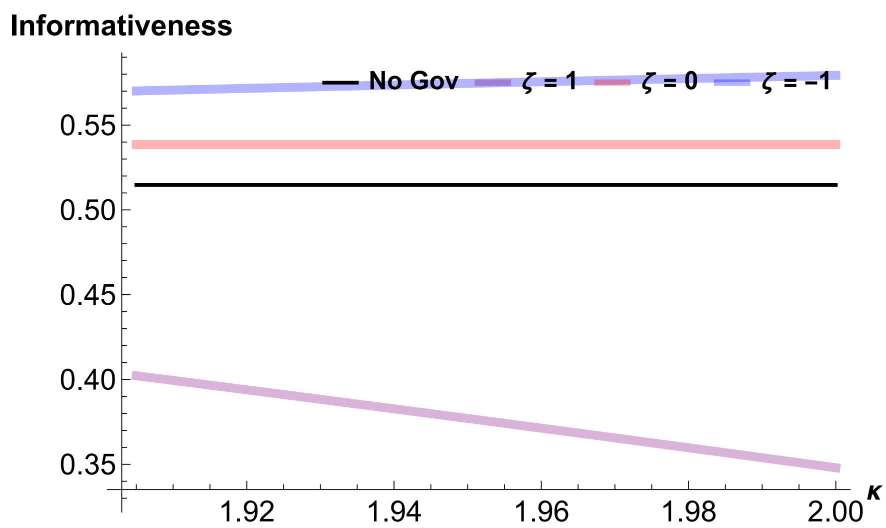


Figure 5: The impact of shocking κ on price informativeness.

As before, in a model without corporate governance, the direct and indirect effects offset each other exactly, and as a consequence price informativeness does not change through an exogenous change in κ. In contrast, when including corporate governance, the strength of indirect channel changes. An increase in κ results in a lower price informativeness when the indirect effect is stronger, i.e., when $\hat{\lambda}$ falls in the complementarities region, but increases price informativeness when $\hat{\lambda}$ lies in the substitution region. This gives the empirical prediction:

Prediction 3: The causal relationship between the leverage technology κ and price informativeness decreases as passive investors engage in corporate governance to increase firm value, and can turn negative when passive investors vote for meaningful corporate governance policies. [36]

5.2.3 The relationship between informativeness and $\hat{\lambda}$

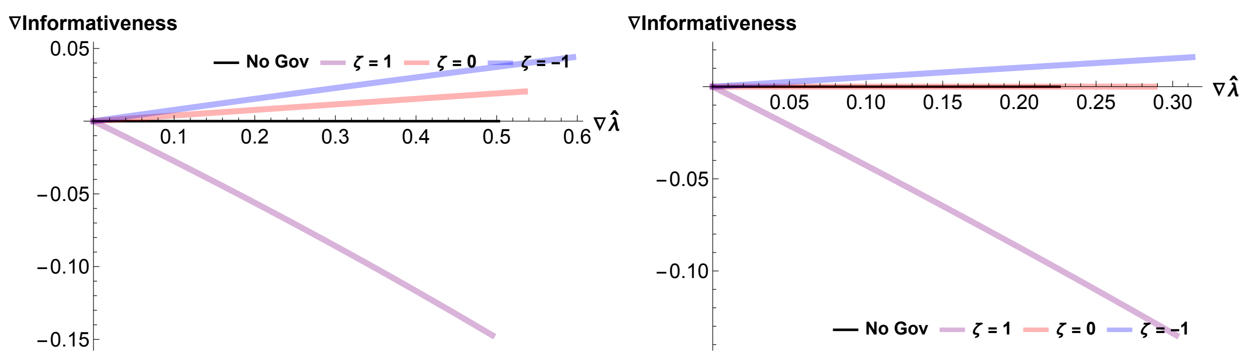


Figure 6: The relationship between price informativeness (I) and the equilibrium share of passive ($\Delta\hat{\lambda}$) when σ_N decreases (the left panel) and when κ increases (the right panel) As the range of $\hat{\lambda}$ changes for different ζ, we plot the relationship between the *change* in informativeness and the *change* in $\hat{\lambda}$.

We highlight that the presence of corporate governance can generate contrasting results in the relationship between price informativeness and the endogenous $\hat{\lambda}$, see Figure 6.[37]

Prediction 4: The association between the share of passive investment and price informativeness decrees as passive investors engage in corporate governance to increase firm value, and can turn negative when passive investors vote for meaningful corporate governance policies

[36] For example, a loosening on borrowing constraints or increase in the leverage ratio for financial intermediaries can represent an exogenous increase in κ.

[37] Note that, in this prediction, both the price informativeness and the share of passive are endogenously determined. Therefore, this is not a causal prediction. If the share of passive is shocked exogenously, for example when an active fund is acquired by a passive fund, then the rise in λ reduces price informativeness in the market as in Section 5.1.

6 Model Extensions

In this section, we extend our model to study two salient applications that attract strong discussions nowadays about the corporate governance role of passive funds: ESG investment and product market competition. These two applications offer very contrasting views on the role of passive investment in corporate governance.

For ESG investment, passive investors that follow an ESG mandate have been regarded as champions of green policies. Such intuition arises from the fact that ESG investment may represent lower monetary profits in the short horizon but can maximize payoffs in a long horizon (both monetary and non-monetary). Therefore, by not being able to exit and sell shares under their mandate, passive investors are seen as endowed with an incentive to pursue long term ESG policies.[38]

For product market competition, passive investors have sparked heated discussions by their natural role as common-owners of shares across industries and specially for competing firms. The main argument is that passive investors reduce competition in the product market for firms they co-own. Reduction of competition could either arise from a failure to provide enough incentives to managers to compete or from explicitly maximizing the portfolio return of passive investors by nudging firms to form cartels.

Under the lenses of our model we show that both the angelic and demonizing view of passive investors are shortsighted. Even though passive investors increase green policies, they may do so at the expense of keeping bad firms from exiting the market, which we interpret as an social loss. On the other hand, even though passive investors decrease product market competition, while they do so they increase the sensitivity of firm's payoff to its type and so bad firms are more likely to exit the market.

Below we detail our model extension. For ESG investment, we discuss different ranks of the

[38] Chowdhry, Davies, and Waters (2019) show that socially responsible activists subsidize firms to adopt green policies by investing in them when firms cannot credibly commit to pursuing social goals. Amon, Rammerstorfer, and Weinmayer (2021) analyze passive portfolio strategies based on ESG-weighting.

firm's payoffs and their subsequent implications. For product market competition, we introduce a second firm and study Cournot competition between the two firms.

6.1 ESG Investment

The economy is composed by a firm of an unknown type with equally probability to be of a good type (G) or a bad type (B). The firm can follow one of two possible corporate strategies: a ESG strategy (A_{ESG}) or an standard "brown" strategy (A_{Brown}). We further assume the firm's insiders favor the brown strategy to portray a tension between firms insiders and the external shareholders. The final payoff of a firm, denoted V, depends both on the chosen corporate strategy and the firm type. In the following, we separately discuss two possible ranking of firm payoffs, which lead to different implications.

Case A: $V(A_{ESG}, G) > V(A_{Brown}, G) \geq V(A_{ESG}, B) > V(A_{Brown}, B)$

When passive investors are committed to vote for an ESG strategy, this case matches our baseline model with $\zeta = 1$. Following the discussion in Section 4.3, the good intentions of passive investors' ESG mandate causes a social loss by driving away active investors and financing a $B-$type firm. If the goal of ESG investment is to materialize long term benefits, then passive investment is actually subsidizing bad firms that should have exited the market.

Case B: $V(A_{ESG}, G) > V(A_{Brown}, G) \geq V(A_{Brown}, B) > V(A_{ESG}, B)$

In this case, it is optimal for the $G-$type firm to implement the ESG strategy, but is costly for the $B-$type firm to do so. This setup differs from our baseline model because the best corporate governance policy to follow depends on the firm's type. This dependency enhances the ex-ante incentive to acquire information, and generates a substitution effect from corporate governance. If passive investors do not vote, vote randomly, or vote for the brown strategy, we again observe strategic complementarities.

To illustrate the equilibria from the case B, we plot the expected profit of active investors, Ω, against the share of passive investors $\hat{\lambda}$ in Figure 7.[39] $\zeta = 1$ ($\zeta = -1$) corresponds to the case that passive investors vote for the ESG (brown) strategy, $\zeta = 0$ corresponds to no voting or randomly voting for either policy.

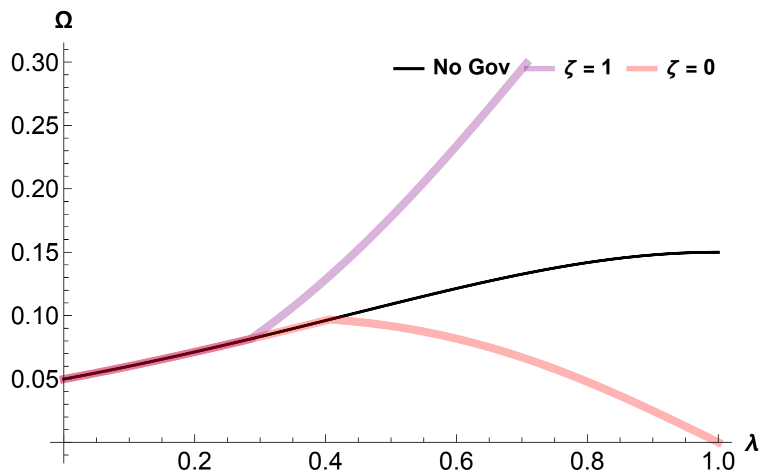


Figure 7: Expected profit for informed investors Ω as a function of λ.

Passive investors that champion ESG policies corresponds to a higher probability of an ESG strategy being chosen as the corporate governance outcome of the firm. Nevertheless, such an increase in ESG strategies chosen comes associated with an increase in the social loss because passive investors pursue ESG policies even for bad firms.

[39] The parameters used are: $\kappa = 2, \gamma = 0.8, \varphi = 0.95, V(A_{ESG}, G) = 3, V(A_{Brown}, G) = 2, V(A_{Brown}, B) = 2, V(A_{ESG}, B) = 1$. The details to solve the model can be found in Appendix B.

6.2 Product Market Competition

6.2.1 Model Setup

The economy is composed by two firms, X and Y, that compete with each other for market share. Each firm $j \in \{X, Y\}$ has a type, denoted c_j, and follows a corporate strategy, denoted A_j. The firms type is the hidden state of nature on which investors can acquire information. Each firm is equally likely to be a good (c^G) or a bad type (c^B), and the realization of its type is independent for each firm.[40] The final payoff of each firm, denoted V_j, depends on the realization of the types and the chosen corporate strategy for each firm. Importantly, since the firms compete with each other, their payoffs are correlated even if their type distribution is independent of each other.

The corporate strategy is an action that affects the degree of competition in the product market and is chosen by the firm's shareholders via corporate governance. We allow the choice of two corporate strategies, a highly aggressive strategy (A^H) or a low aggressive one (A^L). To establish a functional form for the corporate strategies, we assume that the two firms produce a homogeneous good and engage in quantity competition á la Cournot. For simplicity, we assume a linear demand function where the price of the good is determined by the quantities that each firm produce.[41]

In this setting, the most aggressive strategy for a firm is to produce the Cournot competition quantity. In contrast, the least aggressive strategy is a collusive strategy where the production is set by a monopolist who considers the two firms as a single entity. Therefore, we interpret the high aggressive strategy A^H as the Cournot competition quantity function and the low aggressive strategy A^L as the monopolist quantity function as:

$$A^H(c) = \frac{a - c}{3b}, \qquad A^L(c) = \frac{a - c}{4b}, \quad \forall c < a.$$

Note that the quantity produced for each firm is jointly determined by the firm type and the corporate

[40] There are four possible realizations: $(c_X, c_Y) \in \mathbb{S}^c = \{(c^G, c^G), (c^G, c^B), (c^B, c^G), (c^B, c^B)\}$, each equally likely.
[41] Specifically, the price of the good is $G(q_X, q_Y) = a - b(q_X + q_Y)$

strategy chosen. Nevertheless, due to the focus of our paper, we restrict the parameters space such that the difference in types (information) has a stronger effect than a different corporate strategy chosen for the quantity produced. Such assumption implies the sorting $A^H(c^G) > A^L(c^G) > A^H(c^B) > A^L(c^B)$.[42]

Finally, the payoff for firm $j \in \{X, Y\}$ can be written as:

$$V_j\Big(A_X(c_X), A_Y(c_Y)\Big) = \underbrace{A_j(c_j)}_{Quantity} \underbrace{\Big(a - b(A_X(c_X) + A_Y(c_Y)) - c_j\Big)}_{Margin}, \quad \forall A_j \in \{A^H, A^L\}$$

Therefore, there is a social loss when the $B-$ type firm follows an A^H strategy because of its inefficient production, and when the $G-$ type firm follows a A^L strategy, since it wastes its advantage in production. We use this intuition to define a measure of social loss η as follows:

$$\begin{aligned} \eta = {} & \mathbb{P}(A^H|B)\Big(V_X\Big(A^H(c^B), A^H(c)\Big) - V_X\Big(A^L(c^B), A^H(c)\Big)\Big) \\ & + \mathbb{P}(A^L|G)\Big(V_X\Big(A^H(c^G), A^H(c)\Big) - V_X\Big(A^L(c^G), A^H(c)\Big)\Big). \end{aligned} \tag{11}$$

The rest of the model setting is the same as in our main model in Section 2. The detailed steps to solvethe model can be found in Appendix C.

6.2.2 Results

We assume the firm's insiders always vote for an A^H strategy to maximize the firm value. Furthermore, to focus on the concerns of common ownership, we assume that passive investors vote for the A^L strategy for both firms to achieve the maximum monopoly gain.

To illustrate the equilibria in this model extension, we plot the expected profit of active investors, Ω, against the share of passive investors λ in Figure 8.[43] We highlight in the shaded area the range

[42] Without this assumption, the extended to which corporate governance affects firm's profits would be exaggerated. For example, the profit of two inefficient firms that choose to act as a cartel can be higher than that of two efficient firms that compete aggressively.

[43] The parameters used are: $a = 10, b = 2, c^B = 4, c^G = 1, \kappa = 3, \gamma = 0.6; \varphi = 0.5, \sigma_N = 1$.

for which the equilibrium share λ corresponds to an stable equilibrium.

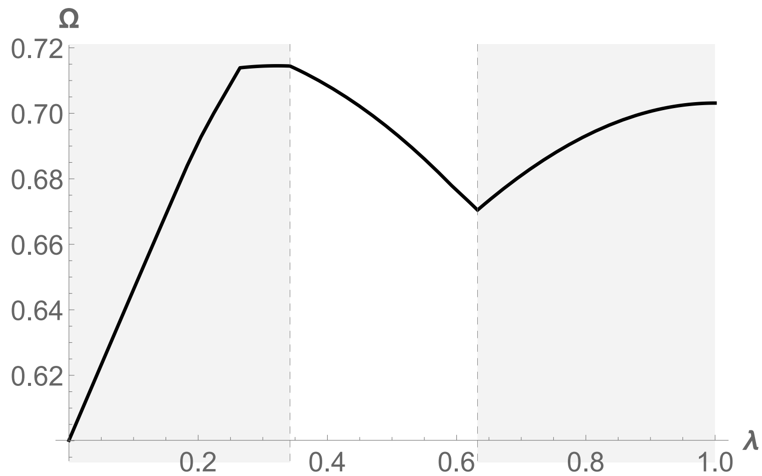


Figure 8: Expected profit for informed investors Ω as a function of λ.

The main results for this model extension can be found in Figure 9. We plot on the left panel the probability that a highly competitive strategy A^H is chosen as a function of the share of passive investors λ for each possible combination of firms types. In the right panel we show the social loss as a function of the share of passive investors λ. The shaded area represents the range for which the equilibrium share λ corresponds to an stable equilibrium, hence the area we focus for our argument.

From Figure 9 we can observe that indeed an increase in passive investors, which as common-owners reduce market competition, corresponds to a decrease in the probability of highly competitive strategy being chosen as the corporate governance outcome of a firm. Nevertheless, such a decrease in competition comes associated with a decrease in the social loss because passive investors increase the sensitivity of the payoff to the firm types.

For example, in the case that one firm is bad and the other good, the probability that a low competitive strategy is chosen in the bad firm, i.e. $1 - q_{BG}$, was quite low without passive investors. It could only occur if by mistake an active investors held both firms and voted for an strategy A^L in both of them. In contrast, as passive investors rise, the is a higher chance of a A^L strategy in the bad firm. Such shift in probability implies that the combination of strategy (A^L, A^H) for the bad and good firm respectively has a higher chance of occurring. Under such type of betrayal, the good firm can steal market share of the bad firm which is beneficial as seen by the decrease in social loss.

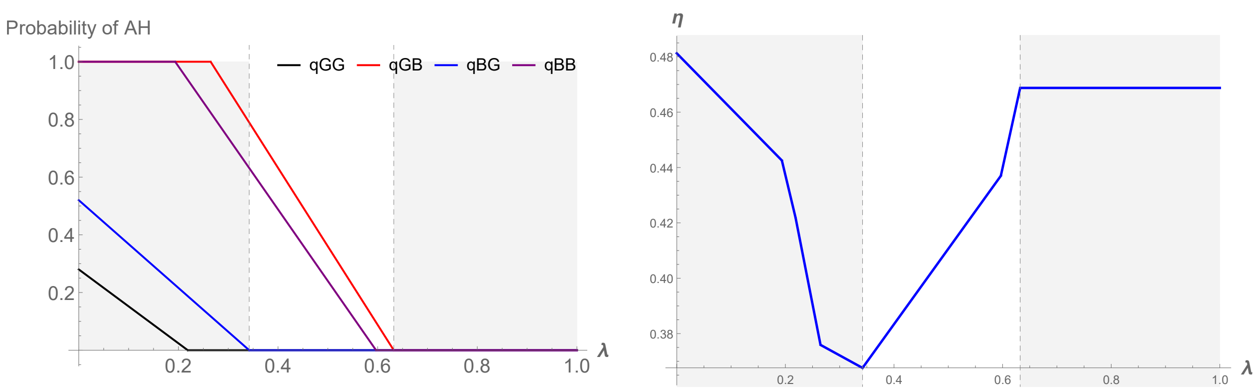


Figure 9: Probability of a A^H strategy being chosen as function of λ (left panel) and social loss η as function of λ (right panel).

7 Conclusion

This paper contributes to understanding the effects of corporate governance for information acquisition. We introduce a fully rational model in which institutional investors maximize their portfolio payoff conditional on their information. We allow all investors to influence the corporations they own and study in detail the contrasting implications that the gains from corporate governance have for the financial market. Our main contribution is that we identify a novel conflict of interest that gives rise to strategic complementarities where more passive investors increase the incentives of other investors to become passive as well.

Our main result shows that the profits of active investors can decrease with the rise of passive investment, which goes against the traditional sustainability role of information that a canonical information model implies. As a consequence, the growth in passive investment might be unbounded and reach 100% of passive investment. Therefore, we contribute to an explanation for the rise in the share of passive investment over the last two decades; a puzzling phenomenon because of the steady decrease in the fees of active funds with nearly constant fees of passive funds.

Furthermore, we show that a conflict of interest between active and passive investors exist regardless of the actual approach that passive investors take to implement corporate governance. Therefore we offer a new perspective to the policy discussion on how passive investors should vote for their shares and implement corporate governance, which is relevant for policymaking.

We highlight the need for a model, such as the one in this paper, to address the fact that the shares of active and passive investment are equilibrium outcomes. As such, the consequences for financial markets outcomes are affected by the interactions of a shock to exogenous variables and the consequential shift in the equilibrium. In this sense, we speak to the seemingly puzzling empirical evidence that surrounds the rise of passive investment and associates it with higher volatility and price informativeness.

Lastly, this paper offers a timely discussion of passive investment corporate governance for ESG investment and product market competition. We show that both the angelic and demonizing views of passive investors as champions for ESG policies and anticompetitive behavior are shortsighted and ignore the conflict of interest from information asymmetry. Even though passive investors can increase green policies, they may do so at the expense of subsidizing bad firms and preventing them from exiting the market, which we interpret as a social loss. On the other hand, even though passive investors can decrease product market competition, while they do so, they raise the stakes for all firms by increasing the sensitivity of a firm's payoff to its type. Thus, bad firms are more likely to exit the market.

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A Appendix: Proofs

A.1 Proof for Proposition 1

Proof. We begin by showing that $\pi(G) \geq \pi(B)$:

$$\begin{aligned}\pi(G) - \pi(B) &= q_G^{\zeta} V_H + (1 - q_G^{\zeta})V_L - \left[q_B^{\zeta}(V_H - \varepsilon) + (1 - q_B^{\zeta})(V_L - \epsilon)\right] \\ &= \varepsilon + (q_G^{\zeta} - q_B^{\zeta})(V_H - V_L) > 0\end{aligned}$$

Since $q_G^{\zeta} \geq q_B^{\zeta}$ from Equation 2 and $(V_H \geq V_L)$ it follows that $\pi(G) \geq \pi(B)$.

Given each realization of firms' type, we define the return as the payoff minus the expected prices, which is calculated by using the expectation about the market maker's belief $\xi(\cdot)$ as:

$$\begin{aligned}Ret_G &= \pi(G) - \xi\pi(G) - (1 - \xi)\pi(B) \\ Ret_B &= \pi(B) - (1 - \xi)\pi(G) - \xi\pi(B)\end{aligned}$$

To prove our conjecture 1, we need to show that after receiving the signal, our conjectured strategy dominates all other choices, that is, active investors get the maximized return following the conjectured manual. We obtain the expected returns of the conjectured strategy as follows:

$$\begin{aligned}\mathbb{E}[\text{Ret}|(S = S_G)] &= \gamma Ret_G + (1 - \gamma)Ret_B = (1 - \xi)(2\gamma - 1)(\pi(G) - \pi(B)); \\ \mathbb{E}[\text{Ret}|(S = S_B)] &= (1 - \gamma)Ret_G + \gamma Ret_B = -(1 - \xi)(2\gamma - 1)(\pi(G) - \pi(B)).\end{aligned}$$

Therefore our conjectured strategy is proved since $\pi(G) - \pi(B) \geq 0$.

Next, we calculate the ex-ante expected return for active investors:

$$\begin{aligned}\Omega &= \frac{1}{2}\mathbb{E}[\text{Ret}|(S = S_G)] - \frac{1}{2}\mathbb{E}[\text{Ret}|(S = S_B)] \\ &= (1 - \xi)(2\gamma - 1)(\pi(G) - \pi(B)).\end{aligned}$$

□

A.2 Proof of Proposition 2

Proof.

$$\frac{\partial(1 - \xi(\lambda, \gamma, \kappa, \sigma_N)(2\gamma - 1)}{\partial\lambda} > 0 \qquad \text{and} \qquad \frac{\partial\Pi(\lambda, \gamma, \kappa, \bar{\varphi})}{\partial\lambda} < 0.$$

We begin by showing first (i) $\frac{\partial(1-\xi(\lambda,\gamma,\kappa,\sigma_N))(2\gamma-1)}{\partial\lambda} > 0$ and we then proceed to (ii) $\frac{\partial\Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial\lambda} < 0$.

(i)

By the chain rule we can write:

$$\frac{\partial(1 - \xi(\lambda, \gamma, \kappa, \sigma_N))(2\gamma - 1)}{\partial\lambda} = -(2\gamma - 1)\frac{\partial\xi(\lambda, \gamma, \kappa, \sigma_N)}{\partial\lambda}$$

Given the definition of $\xi(\lambda, \gamma, \kappa, \sigma_N)$ and using the p.d.f. of the standard normal distribution $\phi(\cdot)$. We can write ξ as:

$$\xi(\lambda, \gamma, \kappa, \sigma_N) \equiv \int_{-\infty}^{\infty} \frac{\phi\left(\frac{x}{\sigma_N}\right)}{\phi\left(\frac{x}{\sigma_N}\right) + \phi\left(\frac{x+2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)} \frac{1}{\sigma_N}\phi\left(\frac{x}{\sigma_N}\right)dx$$

Using the chain rule we take the derivative as:

$$\frac{\partial \xi(\lambda,\gamma,\kappa,\sigma_N)}{\partial \lambda} = -\int_{-\infty}^{\infty} \frac{\phi\left(\frac{x}{\sigma_N}\right)^2}{\left(\phi\left(\frac{x}{\sigma_N}\right)+\phi\left(\frac{x+2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)\right)^2}\frac{1}{\sigma_N}\frac{\partial \phi\left(\frac{x+2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)}{\partial \lambda}dx$$

Using the property of the standard normal distribution where $\frac{\partial \phi(x)}{\partial x} = -x\phi(x)$, we write the previous derivative as:

$$\frac{\partial \xi(\lambda,\gamma,\kappa,\sigma_N)}{\partial \lambda} = -\int_{-\infty}^{\infty} \frac{\phi\left(\frac{x}{\sigma_N}\right)^2 \phi\left(\frac{x+2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)}{\left(\phi\left(\frac{x}{\sigma_N}\right)+\phi\left(\frac{x+2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)\right)^2}\left(\frac{x+2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)\frac{1}{\sigma_N}\left(\frac{2\kappa(2\gamma-1)}{\sigma_N}\right)dx$$

We now do a change of variable $y = x + 2\kappa(1-\lambda)(2\gamma-1)$ and use the expected value definition to write:

$$\begin{aligned}
\frac{\partial \xi(\lambda,\gamma,\kappa,\sigma_N)}{\partial \lambda} &= -\left(\frac{2\kappa(2\gamma-1)}{\sigma_N}\right)\int_{-\infty}^{\infty} \frac{\phi\left(\frac{y-2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)^2}{\left(\phi\left(\frac{y-2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)+\phi\left(\frac{y}{\sigma_N}\right)\right)^2}\left(\frac{y}{\sigma_N}\right)\frac{1}{\sigma_N}\phi\left(\frac{y}{\sigma_N}\right)dy \\
&= -\left(\frac{2(2\gamma-1)}{\sigma_N}\right)\mathbb{E}\left[\left(\frac{y}{\sigma_N}\right)\frac{\phi\left(\frac{y-2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)^2}{\left(\phi\left(\frac{y-2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)+\phi\left(\frac{y}{\sigma_N}\right)\right)^2}\right] \\
&= -\left(\frac{2(2\gamma-1)}{\sigma_N}\right)\mathbb{E}\left[\left(\frac{y}{\sigma_N}\right)\frac{1}{\left(1+\frac{\phi(y/\sigma_N)}{\phi((y-2\kappa(1-\lambda)(2\gamma-1))/\sigma_N)}\right)^2}\right]
\end{aligned}$$

Therefore, the sign of the derivative depends on the sign of the following expected value:

$$\begin{aligned}
\mathbb{E}\left[\left(\frac{y}{\sigma_N}\right)\frac{1}{\left(1+\frac{\phi(y/\sigma_N)}{\phi((y-2\kappa(1-\lambda)(2\gamma-1))/\sigma_N)}\right)^2}\right] &= \mathbb{E}\left[\frac{y}{\sigma_N}\right]\mathbb{E}\left[\frac{1}{\left(1+\frac{\phi(y/\sigma_N)}{\phi((y-2\kappa(1-\lambda)(2\gamma-1))/\sigma_N)}\right)^2}\right] \\
&\quad + \mathrm{Cov}\left[\frac{y}{\sigma_N}, \frac{1}{\left(1+\frac{\phi(y/\sigma_N)}{\phi((y-2\kappa(1-\lambda)(2\gamma-1))/\sigma_N)}\right)^2}\right].
\end{aligned}$$

It holds that $\mathbb{E}[y] \geq 0$, since $\gamma > \frac{1}{2}$, and $\mathbb{E}\left[\frac{1}{\left(1+\frac{\phi(y/\sigma_N)}{\phi((y-2\kappa(1-\lambda)(2\gamma-1))/\sigma_N)}\right)^2}\right] > 0$. We now focus on the sign of the co-variance term. Using the definition of ϕ we can explicitly write:

$$\frac{\phi(y/\sigma_N)}{\phi((y-2\kappa(1-\lambda)(2\gamma-1))/\sigma_N)} = Exp\left(\frac{2\kappa(1-\lambda)(2\gamma-1)\Big(2\kappa(1-\lambda)(2\gamma-1)-2y\Big)}{2\sigma_N^2}\right).$$

It is clear that

$$\frac{\partial \frac{\phi(y/\sigma_N)}{\phi((y-2\kappa(1-\lambda)(2\gamma-1))/\sigma_N)}}{\partial y} \leq 0, \text{ and hence } \mathrm{Cov}\left[\frac{y}{\sigma_N}, \frac{1}{\left(1+\frac{\phi(y/\sigma_N)}{\phi((y-2\kappa(1-\lambda)(2\gamma-1))/\sigma_N)}\right)^2}\right] \geq 0.$$

Therefore, $\frac{\partial \xi(\lambda,\gamma,\kappa,\sigma_N)}{\partial \lambda} \leq 0$.

(ii)

We begin by spelling out $\Pi(\lambda,\gamma,\kappa,\bar{\varphi})$ as:

$$\Pi(\lambda,\gamma,\kappa,\bar{\varphi}) = \varepsilon + (q_G^\zeta - q_B^\zeta)(V_H - V_L)$$

Note that the different probabilities of voting outcomes q_G^ζ and q_B^ζ defined in Equation (2) are the only functions of λ in $\Pi(\lambda,\gamma,\kappa,\bar{\varphi})$. The derivatives of q_G^ζ and q_B^ζ can be written as:

$$\frac{\partial q_G^\zeta}{\partial \lambda} = \frac{\zeta - \gamma\kappa}{\bar{\varphi}} \qquad \frac{\partial q_B^\zeta}{\partial \lambda} = \frac{\zeta - (1-\gamma)\kappa}{\bar{\varphi}}$$

$$\frac{\partial q_G^\zeta}{\partial \lambda} - \frac{\partial q_B^\zeta}{\partial \lambda} = -\frac{(2\gamma-1)\kappa}{\bar{\varphi}}.$$

Taking the derivative of the spelled out $\Pi(\lambda,\gamma,\kappa,\bar{\varphi})$ with respect of λ gives:

$$\frac{\partial \Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial \lambda} = (V_H - V_L)\left(\frac{\partial q_G^\zeta}{\partial \lambda} - \frac{\partial q_B^\zeta}{\partial \lambda}\right).$$

The sign of $\frac{\partial \Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial \lambda}$ depends on the sign of $\left(\frac{\partial q_G^\zeta}{\partial \lambda} - \frac{\partial q_B^\zeta}{\partial \lambda}\right)$. When both $q_G^\zeta \in (0,1)$ and $q_B^\zeta \in (0,1)$, it is trivial that $\frac{\partial \Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial \lambda} < 0$ as $-\frac{(2\gamma-1)\kappa}{\bar{\varphi}} < 0$.

We next analyze the four possible corner cases where the sign of $\frac{\partial \Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial \lambda}$ might be non-negative. Under the constraint $1 = q_G^{\zeta} \geq q_B^{\zeta} \geq 0$ these cases are (a) $q_G^{\zeta} = q_B^{\zeta} = 1$, (b) $q_G^{\zeta} = 1 > q_B^{\zeta}$, (c) $q_G^{\zeta} > q_B^{\zeta} = 0$ and (d) $q_G^{\zeta} = q_B^{\zeta} = 0$.

It is obvious that for cases (a) and (d) we have $\frac{\partial \Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial \lambda} = 0$. In contrast, the sign in case (b) and (c) depends on the sign of $\frac{\partial q_G^{\zeta}}{\partial \lambda}$ and $\frac{\partial q_B^{\zeta}}{\partial \lambda}$. To identify all cutoff points, we analyze all possible parameters regions that determine the signs of the derivatives as follows:

Region 1: $\frac{\partial q_B^{\zeta}}{\partial \lambda} > 0$ and $\frac{\partial q_G^{\zeta}}{\partial \lambda} > 0$. Hence, when $\zeta - \gamma\kappa > 0$, we have:

- Case (a) starts when $q_B^{\zeta} = 1$, from Equation (2), this holds for $\lambda \geq \frac{(1-\gamma)\kappa-\bar{\varphi}}{(1-\gamma)\kappa-\zeta}$.
- Case (b) happens for $\frac{\partial q_G^{\zeta}}{\partial \lambda} = 0$ and $\frac{\partial q_B^{\zeta}}{\partial \lambda} > 0$, making $\frac{\partial \Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial \lambda} < 0$.
- Case (c) and (d) cannot exist since, from Equation (2), $\zeta - (1-\gamma)\kappa > 0$ implies $q_B^{\zeta} > 0$.

Region 2: $\frac{\partial q_B^{\zeta}}{\partial \lambda} > 0$ and $\frac{\partial q_G^{\zeta}}{\partial \lambda} \leq 0$. Hence, when $\gamma\kappa \geq \zeta > \kappa(1-\gamma)$, we have:

- Case (a) starts when $q_B^{\zeta} = 1$, from Equation (2), this holds for $\frac{(1-\gamma)\kappa-\bar{\varphi}}{(1-\gamma)\kappa-\zeta} \leq \lambda \leq \frac{\gamma\kappa-\bar{\varphi}}{\gamma\kappa-\zeta}$. Note that the interval exists only when $\bar{\varphi} < \zeta$.
- Case (b) happens when $\frac{\partial q_G^{\zeta}}{\partial \lambda} = 0$ and $\frac{\partial q_B^{\zeta}}{\partial \lambda} > 0$ making $\frac{\partial \Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial \lambda} < 0$.
- Case (c) and (d) cannot exist since, from Equation (2), $\zeta - (1-\gamma)\kappa > 0$ implies $q_B^{\zeta} > 0$.

Region 3: $\frac{\partial q_B^{\zeta}}{\partial \lambda} \leq 0$ and $\frac{\partial q_G^{\zeta}}{\partial \lambda} \leq 0$. Hence, when $\zeta - \kappa(1-\gamma) \leq 0$, we have:

- Case (a) starts when $q_B^{\zeta} = 1$, from Equation (2), holds for $\lambda \leq \frac{(1-\gamma)\kappa-\bar{\varphi}}{(1-\gamma)\kappa-\zeta}$. Note that when $\bar{\varphi} \leq \zeta$, then $\frac{(1-\gamma)\kappa-\bar{\varphi}}{(1-\gamma)\kappa-\zeta} > 1$, and cases (b), (c) and (d) do not exist.
- Case (b) starts when $q_G^{\zeta} = 1$, from Equation (2), holds for $\lambda \leq \frac{\gamma\kappa-\bar{\varphi}}{\gamma\kappa-\zeta}$. In this case, we have $\frac{\partial q_B^{\zeta}}{\partial \lambda} < 0$, and hence $\frac{\partial \Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial \lambda} > 0$.
- Case (c) starts when $q_B^{\zeta} = 0$, from Equation (2), it holds for $\lambda \leq \frac{(1-\gamma)\kappa}{(1-\gamma)\kappa-\zeta}$. Since $\frac{\partial q_G^{\zeta}}{\partial \lambda} < 0$ we have $\frac{\partial \Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial \lambda} < 0$.

– Case (d) starts when $q_G^\zeta = 0$, from Equation (2), it holds for $\lambda \leq \frac{\gamma\kappa}{\gamma\kappa-\zeta}$.

As a conclusion, we can collapse Region 1 and Region 2 together, while we have two possible signs for $\frac{\partial\Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial\lambda}$ in Region 3.

Therefore, the region at which we observe strategic complementarities, that is $\frac{\partial\Pi(\lambda,\gamma,\kappa,\bar{\varphi})}{\partial\lambda} < 0$, is:

$$\begin{cases} 0 \leq \lambda \leq \frac{(1-\gamma)\kappa-\bar{\varphi}}{(1-\gamma)\kappa-\zeta}, & \text{if } \zeta > (1-\gamma)\kappa; \\ \frac{\gamma\kappa-\bar{\varphi}}{\gamma\kappa-\zeta} \leq \lambda \leq \frac{\gamma\kappa}{\gamma\kappa-\zeta}, & \text{if } \zeta \leq (1-\gamma)\kappa. \end{cases}$$

Note that we have the bounded region for λ, $0 \leq \lambda \leq 1$. For example, if $\zeta \geq (1-\gamma)\kappa$ and $\frac{(1-\gamma)\kappa-\bar{\varphi}}{(1-\gamma)\kappa-\zeta} < 0$, there is no λ such that the region with strategic complementarities exists.

□

A.3 Proof of $1 - \mathbb{E}[\rho(F)|G] = \mathbb{E}[\rho(F)|B]$

Proof. Recall that $F = \lambda + N + \kappa(1-\lambda)(2\gamma-1)$ when firm type is G and $F = \lambda + N - \kappa(1-\lambda)(2\gamma-1)$ when the firm type is B.

$$1 - \mathbb{E}[\rho(F)|G] = \mathbb{E}\left[\frac{\phi\left(\frac{N+2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)}{\phi\left(\frac{N}{\sigma_N}\right) + \phi\left(\frac{N+2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)}\right] = \int_{-\infty}^{\infty} \frac{\phi\left(\frac{n+2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)}{\phi\left(\frac{n}{\sigma_N}\right) + \phi\left(\frac{n+2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)} \frac{1}{\sigma_N}\phi\left(\frac{n}{\sigma_N}\right)dn$$

$$\overset{x=n+\kappa(1-\lambda)(2\gamma-1)}{=\!=} \int_{-\infty}^{\infty} \frac{\phi\left(\frac{x+\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)}{\phi\left(\frac{x-\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right) + \phi\left(\frac{x+\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)} \frac{1}{\sigma_N}\phi\left(\frac{x-\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)dx$$

$$\mathbb{E}[\rho(F)|B] = \mathbb{E}\left[\frac{\phi\left(\frac{N-2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)}{\phi\left(\frac{N}{\sigma_N}\right)+\phi\left(\frac{N-2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)}\right] = \int_{-\infty}^{\infty}\frac{\phi\left(\frac{n-2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)}{\phi\left(\frac{n}{\sigma_N}\right)+\phi\left(\frac{n-2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)}\frac{1}{\sigma_N}\phi\left(\frac{n}{\sigma_N}\right)dn$$

$$\overset{x=n-\kappa(1-\lambda)(2\gamma-1)}{=\!=} \int_{-\infty}^{\infty}\frac{\phi\left(\frac{x-\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)}{\phi\left(\frac{x-\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)+\phi\left(\frac{x+\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)}\frac{1}{\sigma_N}\phi\left(\frac{x+\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)dx$$

Therefore, $1-\mathbb{E}[\rho(F)|G] = \mathbb{E}[\rho(F)|B]$. □

A.4 Proof of Equation 10

Proof. We first note that by using the definition of expected value, it is possible to write explicitly the following terms:

$$\xi(\lambda,\gamma,\kappa,\sigma_N) \equiv \mathbb{E}[\rho(x)|G] = \int_{-\infty}^{\infty}\frac{\phi\left(\frac{x-\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)}{\phi\left(\frac{x-\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)+\phi\left(\frac{x+\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)}\frac{1}{\sigma_N}\phi\left(\frac{x-\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)dx$$

$$\mathbb{E}[\rho(F)^2|G] = \int_{-\infty}^{\infty}\frac{\phi\left(\frac{n}{\sigma_N}\right)^2}{\left(\phi\left(\frac{n}{\sigma_N}\right)+\phi\left(\frac{n+2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)\right)^2}\phi\left(\frac{n}{\sigma_N}\right)dn$$

$$\overset{x=n+\kappa(1-\lambda)(2\gamma-1)}{=\!=} \int_{-\infty}^{\infty}\frac{\phi\left(\frac{x-\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)^2}{\left(\phi\left(\frac{x-\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)+\phi\left(\frac{x+\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)\right)^2}\frac{1}{\sigma_N}\phi\left(\frac{x-\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)dx$$

$$\mathbb{E}[\rho(F)^2|B] = \int_{-\infty}^{\infty} \frac{\phi\left(\frac{n-2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)^2}{\left(\phi\left(\frac{n}{\sigma_N}\right)+\phi\left(\frac{n-2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)\right)^2}\phi\left(\frac{n}{\sigma_N}\right)dn$$

$$\overset{x=n-\kappa(1-\lambda)(2\gamma-1)}{=\!=} \int_{-\infty}^{\infty} \frac{\phi\left(\frac{x-\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)^2}{\left(\phi\left(\frac{x-\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)+\phi\left(\frac{x+\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)\right)^2}\frac{1}{\sigma_N}\phi\left(\frac{x+\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)dx$$

It is then easy to see that $\mathbb{E}[\rho(x)^2|G]+\mathbb{E}[\rho(x)^2|B] = \xi(\lambda,\gamma,\kappa,\sigma_N)$. Therefore we can define the following expectations:

$$\mathbb{E}[\rho(x)] = \frac{1}{2}\mathbb{E}[\rho(x)|G]+\frac{1}{2}\mathbb{E}[\rho(x)|B] = \frac{1}{2}(\xi+(1-\xi)) = \frac{1}{2}$$
$$\mathbb{E}[\rho(x)^2] = \frac{1}{2}\mathbb{E}[\rho(x)^2|G]+\frac{1}{2}\mathbb{E}[\rho(x)^2|B] = \frac{1}{2}\xi(\lambda,\gamma,\kappa,\sigma_N)$$

Using the definition of price from 6 we can write the variance of prices as:

$$\begin{aligned}\mathrm{Var}(P) = \mathbb{E}[P^2]-\mathbb{E}[P]^2 &= \mathbb{E}\left[\left(\rho(x)\pi(G)+(1-\rho(x))\pi(B)\right)^2\right]-\mathbb{E}[\rho(x)\pi(G)+(1-\rho(x))\pi(B)]^2\\ &= \mathbb{E}\left[\pi(B)^2+2\rho(x)\pi(B)(\pi(G)-\pi(B))+\rho(x)^2(\pi(G)-\pi(B))^2\right]-\left(\frac{1}{2}(\pi(G)-\pi(B))\right)^2\\ &= \frac{1}{4}(2\xi(\lambda,\gamma,\kappa,\sigma_N)-1)(\pi(G)-\pi(B))^2\end{aligned}$$

Since the variance of payoffs can be written as $\frac{1}{4}(\pi(G)-\pi(B))^2$ it follows that:

$$I = \frac{\mathrm{Var}(P)}{\mathrm{Var}(\pi)} = 2\xi(\lambda,\gamma,\kappa,\sigma_N)-1$$

□

B Appendix: ESG Investment

We use the same equilibrium approach as in Section 3 and the same conjecture as in Section 3.1. Since following a standard strategy represents a higher monetary payoff than a ESG strategy, active investors maximize their portfolio payoff by voting for a standard strategy when holding a the firm long.

We can now aggregate the votes that each strategy receives in equilibrium. The mass that each strategy receives for each type realization is:

$$\text{If the firm type is } G: \quad \text{For } A_{Brown}: \underbrace{\varphi}_{\substack{\text{Firms'}\\ \text{insiders}}} \qquad \text{For } A_{ESG}: \underbrace{\kappa(1-\lambda)\gamma}_{\substack{\text{Active investors}\\ \text{with correct signal}}} + \underbrace{\zeta\lambda}_{\substack{\text{Passive}\\ \text{investors}}};$$

$$\text{If the firm type is } B: \quad \text{For } A_{Brown}: \varphi + \kappa(1-\lambda)(1-\gamma) \qquad \text{For } A_{ESG}: \zeta\lambda.$$

We can now calculate the probability that a strategy is ultimately chosen. Such probability depends on the firms type realization. We define q_G and q_B as the probability that A_{ESG} is the strategy chosen for each type realization as:

$$q_G = \mathbb{P}(\underbrace{\zeta\lambda + \kappa(1-\lambda)\gamma}_{A_{ESG}} > \underbrace{\varphi}_{A_{Brown}}) = \frac{1}{\bar{\varphi}}\Big(\zeta\lambda + \kappa\gamma(1-\lambda)\Big)$$

$$(12) \qquad q_B = \mathbb{P}(\zeta\lambda > \varphi + \kappa(1-\lambda)(1-\gamma)) = \frac{1}{\bar{\varphi}}\Big(\zeta\lambda - \kappa(1-\gamma)(1-\lambda)\Big),$$

where $q_G \geq q_B$.

There is a social loss when the $B-$type firm follows an ESG strategy and when the G firm follows a brown strategy. We use this intuition to define a measure of social loss η as follows:

$$\eta = q_B\Big(V(A_{Brown}, B) - V(A_{ESG}, B)\Big) + (1 - q_G)\Big(V(A_{ESG}, G) - V(A_{Brown}, G)\Big).$$

We proceed with the rest of the equilibrium in the same manner as in Section 3 where our conjecture holds since with the new defined probabilities in Equation 12 it prevails that $\pi_G^{\zeta} \geq \pi_B^{\zeta}$. We can then derive:

$$\Pi(\cdot) = \pi_G^{\zeta} - \pi_B^{\zeta} = q_G^{\zeta} V(A_{ESG}, G) + (1 - q_G^{\zeta}) V(A_{Brown}, G) - \Big[q_B^{\zeta} V(A_{ESG}, B) + (1 - q_B^{\zeta}) V(A_{Brown}, B)\Big]$$

Under the assume payoff structure, $V(A_{ESG}, G) > V(A_{Brown}, G) \geq V(A_{Brown}, B) > V(A_{ESG}, B)$, we have $\Pi(\cdot) \geq 0$, such that the conjecture portfolio strategy is optimal.

C Appendix: Product Market Competition

We use the same equilibrium approach as in Section 3 and an equivalent conjecture to Section 3.1 in which we propose that an active investor goes long both firms after receiving the signal pair (S^G, S^G), goes long firm X (Y) but shorts firm Y (X) after receiving the signal pair (S^G, S^B) $((S^B, S^G))$, and shorts both firms after receiving the signal pair (S^B, S^B). We proof that following the A^H maximizes the payoff when active investors hold only one firm, but A^L maximizes the payoff when active investors hold both firm. The intuition is analogous to a Prisoner Dilemma game where the Nash equilibrium is to betray, choose A^H and steal market share, but the highest joint payoff is achieved by a cooperative strategy, choose A^L for both firms and reduce competition.

We can now aggregate the votes that each strategy receives in equilibrium. Such mass depends on the firm type, as an example, we focus on the type realization (c_E, c_E). There are three groups of agents that own voting rights. (i) Firm's managers, who vote for A^H, they account for the random fraction φ_X of votes. (ii) Active investors of total mass $(1-\lambda)$. From the mass of active investors a fraction $\gamma(1-\gamma)$ receives the incorrect signal (S^G, S^B), therefore hold an incorrect portfolio and vote for for A^H, and a fraction γ^2 receives the correct signal (S^G, S^G) and vote for A^L. (iii) Passive investors of mass λ that can vote for A^L. The aggregate mass that each strategy receives for the type realization (c_E, c_E) is:

$$\text{For } A^H: \underbrace{\varphi_X}_{\substack{\text{Firms}\\ \text{insiders}}} + \underbrace{\kappa(1-\lambda)\gamma(1-\gamma)}_{\substack{\text{Active investors}\\ \text{that vote for } A^H}} \qquad \text{For } A^L: \underbrace{\lambda}_{\substack{\text{Passive}\\ \text{investors}}} + \underbrace{\kappa(1-\lambda)\gamma^2}_{\substack{\text{Active investors}\\ \text{that vote for } A^L}}$$

We then proceed to calculate the probability that a strategy is ultimately chosen. Such probability depends on the firms type realization and how passive investors vote. We define q_{GG}, q_{GB}, q_{BF} and q_{BB} as the probability that A^H is the strategy chosen for firm X for each possible realization of firm types.[44] As example, q_{GG} is calculated as:

$$\begin{aligned} q_{GG} &= \mathbb{P}(\underbrace{\varphi_X + \kappa(1-\lambda)\gamma(1-\gamma)}_{A^H} > \underbrace{\lambda + \kappa(1-\lambda)\gamma^2}_{A^L}) \\ &= \mathbb{P}\Big(\varphi_X > \lambda + \kappa\gamma(1-\lambda)(2\gamma-1)\Big) = 1 - \frac{1}{\bar{\varphi}}\Big(\zeta\lambda + \kappa\gamma(1-\lambda)(2\gamma-1)\Big). \end{aligned}$$

We proceed in the same manner for all possible realizations of firms types and find as relationship $1 \geq q_{GB} \geq q_{BB} > q_{BG} > q_{GG} \geq 0$.

Using the definition in Equation 11, the social loss is:

$$\begin{aligned} \eta = &\frac{1}{2}(q_{BG} + q_{BB})\Big(V_X\Big(A^H(c^B), A^H(c)\Big) - V_X\Big(A^L(c^B), A^H(c)\Big)\Big) \\ &+ \frac{1}{2}(2 - q_{GB} - q_{GG})\Big(V_X\Big(A^H(c^G), A^H(c^B)\Big) - V_X\Big(A^L(c^G), A^H(c^B)\Big)\Big) \end{aligned}$$

We proceed with the rest of the equilibrium in the same manner as in Section 3.

Then, we characterize the equilibrium of the model by using backward induction. The analysis is conducted in six steps. First, we conjecture an optimal portfolio allocation based on information. Second, we derive the voting outcome for each possible realization of firm type. Third, we compute the expected payoff of each firm, taking into account the randomness of voting outcomes. Fourth, we determine the efficient prices quoted by the competitive market maker, who observes order flows. Fifth, we verify that our conjectured portfolio of an investor (passive or active) is optimal. Lastly, we solve for the endogenous information acquisition decision, which determines the proportion of passive vs active investors. The following analysis will focus on firm X, while the same procedure follows for firm Y.

[44] By means of symmetry, q_{GG}, q_{BG}, q_{GB} and q_{BB} determine the probability that A^H strategy is chosen for firm Y for each possible realization of firm type $\{(G,G), (G,B), (B,G), (B,B)\}$, respectively.

C.1 Conjectured portfolio allocation

To specify how investors vote conditional on information, it is necessary to establish investor's portfolio allocation. We conjecture the following:

Conjecture 2. *a) Passive investors take a long position in each firm.*

b) Active investor takes:

- *a long position in each firm for signal* $\{S_X, S_Y\} = \{S^G, S^G\}$*;*
- *a long position in firm X (Y) and short one in firm Y (X) for signal* $\{S_X, S_Y\} = \{S^G, S^B\}(\{S^B, S^G\})$*;*
- *a short position in each firm for signal* $\{S_X, S_Y\} = \{S^B, S^B\}$.

After solving for the equilibrium in section C.5, we show that this conjecture is valid.

C.2 Voting outcome

We begin by analyzing the optimal voting choice for an investor conditional on their portfolio allocation.[45] The optimal voting choice is summarized in the following proposition:

Proposition 3. *For an investors with position* θ_j *in firm* $j \in \{X, Y\}$ *it follows that:*

a) If $\theta_X = \theta_Y$*, the investor prefers to vote a low aggressive strategy* A^L *in both firms*

b) If $\theta_X > \theta_Y$ $(\theta_X < \theta_Y)$*, the investor prefers to vote a highly aggressive strategy* A^H *in firm X (Y), regardless of the decision of firm Y (X).*

Proof. **a)** A portfolio long in both firms only occurs if investors' information implies the same cost for both firms. This can occur for passive investors, who are uninformed, for which the firms are identical; or for active investors if they receive a signal that both firms are of the efficient type. In

[45] Conditioning on portfolio allocation equals conditioning on information, since the mapping from information to allocation is a bijective function based on the conjecture in Section C.1.

both circumstances, it follows that for firms of the same type and a long only portfolio, the best strategy is A^L in both firms since:

$$V_X\Big(A^L(c),A^L(c)\Big)+V_Y\Big(A^L(c),A^L(c)\Big)-\Big(V_X\Big(A^H(c),A^L(c)\Big)+V_Y\Big(A^H(c),A^L(c)\Big)\Big)=\frac{(a-c)^2}{144b}>0,$$
$$V_X\Big(A^L(c),A^L(c)\Big)+V_Y\Big(A^L(c),A^L(c)\Big)-\Big(V_X\Big(A^L(c),A^H(c)\Big)+V_Y\Big(A^L(c),A^H(c)\Big)\Big)=\frac{(a-c)^2}{144b}>0,$$
$$V_X\Big(A^L(c),A^L(c)\Big)+V_Y\Big(A^L(c),A^L(c)\Big)-\Big(V_X\Big(A^H(c),A^H(c)\Big)+V_Y\Big(A^H(c),A^H(c)\Big)\Big)=\frac{(a-c)^2}{36b}>0.$$

b) We focus our argument for the case investors hold long firm X and short firm Y, but the same argument holds for the reverse case. An investor prefers to vote for the strategy A^H in firm X, regardless of the choice in firm Y since:

$$V_X\Big(A^H(c_X),A^L(c_Y)\Big)-V_Y\Big(A^H(c_X),A^L(c_Y)\Big)-\Big(V_X\Big(A^L(c_X),A^L(c_Y)\Big)-V_Y\Big(A^L(c_X),A^L(c_Y)\Big)\Big)=\frac{5(a-c_X)^2}{144b}>0,$$
$$V_X\Big(A^H(c_X),A^H(c_Y)\Big)-V_Y\Big(A^H(c_X),A^H(c_Y)\Big)-\Big(V_X\Big(A^L(c_X),A^H(c_Y)\Big)-V_Y\Big(A^L(c_X),A^H(c_Y)\Big)\Big)=\frac{5(a-c_X)^2}{144b}>0.$$

□

Based on Proposition 3 we can now aggregate the mass of votes that each strategy receives. The following proposition summarizes such calculations for all possible realizations of firms types.

Proposition 4. *The probability that A^L is the strategy is:*

$$1-q_{GG}=\frac{1}{\bar{\varphi}}\Big(\lambda+\kappa\gamma(1-\lambda)(2\gamma-1)\Big)$$
$$1-q_{GB}=\frac{1}{\bar{\varphi}}\Big(\lambda-\kappa\gamma(1-\lambda)(2\gamma-1)\Big)$$
$$1-q_{BG}=\frac{1}{\bar{\varphi}}\Big(\lambda+\kappa(1-\gamma)(1-\lambda)(2\gamma-1)\Big)$$
$$1-q_{BB}=\frac{1}{\bar{\varphi}}\Big(\lambda-\kappa(1-\gamma)(1-\lambda)(2\gamma-1)\Big)$$

Where for it holds that, $1 \geq q_{GB} \geq q_{BB} > q_{BG} > q_{GG} \geq 0$.

Proof. We begin by accounting for the votes of active investors. Table 2 summarizes the proportion of active investors that receive a particular signal and their corresponding optimal allocation and voting decisions. For illustration, we take as an example the case that the firm's type realization is efficient, $(c_X, c_Y) = (G, G)$. Since an active investor has a probability γ^2 of receiving the correct signal (S^G, S^G), there are, by the law of large numbers, γ^2 fraction of such active investors. For each of them, the optimal portfolio allocation is (κ, κ), and the optimal voting strategy is (A^L, A^L). The same reasoning is used for each type realization to complete the columns in Table 2.

Signal	Allocation	Vote per share	Firm's type realization			
			(G,G)	(G,B)	(B,G)	(B,B)
(S^G, S^G)	(κ,κ)	(A^L, A^L)	γ^2	$\gamma(1-\gamma)$	$\gamma(1-\gamma)$	$(1-\gamma)^2$
(S^G, S^B)	(κ,-κ)	(A^H, -)	$\gamma(1-\gamma)$	γ^2	$(1-\gamma)^2$	$\gamma(1-\gamma)$
(S^B, S^G)	(-κ,κ)	(-, A^H)	$\gamma(1-\gamma)$	$(1-\gamma)^2$	γ^2	$\gamma(1-\gamma)$
(S^B, S^B)	(-κ,-κ)	(-, -)	$(1-\gamma)^2$	$\gamma(1-\gamma)$	$\gamma(1-\gamma)$	γ^2

Table 2: The left panel lists the optimal allocation and voting choice conditional on an active investor's signal. The right panel summarizes the proportion of active investors that receive a certain signal given the realization of the firm's type.

We aggregate the total amount of investors (passive, active and firm's insiders) that vote for each strategy, conditional on each approach that passive investors can take to vote their shares.

The total mass of investors that vote for strategy A^L minus the mass for A^H in firm X is summarized in Table 3 for each realization of the firms type.

Realization of firm type	Mass difference in votes $A^L - A^H$ for firm X
(G,G)	$\zeta\lambda + \kappa(1-\lambda)\gamma^2 - (\varphi_X + \kappa(1-\lambda)\gamma(1-\gamma))$
(G,B)	$\zeta\lambda + \kappa(1-\lambda)\gamma(1-\gamma) - \left(\varphi_X + \kappa(1-\lambda)\gamma^2\right)$
(B,G)	$\zeta\lambda + \kappa(1-\lambda)\gamma(1-\gamma) - \left(\varphi_X + \kappa(1-\lambda)(1-\gamma)^2\right)$
(B,B)	$\zeta\lambda + \kappa(1-\lambda)(1-\gamma)^2 - (\varphi_X + \kappa(1-\lambda)\gamma(1-\gamma))$

Table 3: The mass difference in votes $A^L - A^H$ for firm X conditional on the realization of firms type.

Solving for φ results in the probability that A^H gets chosen as:

$$q_{GG} = \mathbb{P}\Big(\varphi_X > \zeta\lambda + \kappa\gamma(1-\lambda)(2\gamma-1)\Big)$$
$$q_{GB} = \mathbb{P}\Big(\varphi_X > \zeta\lambda - \kappa\gamma(1-\lambda)(2\gamma-1)\Big)$$
$$q_{BG} = \mathbb{P}\Big(\varphi_X > \zeta\lambda + \kappa(1-\gamma)(1-\lambda)(2\gamma-1)\Big)$$
$$q_{BB} = \mathbb{P}\Big(\varphi_X > \zeta\lambda - \kappa(1-\gamma)(1-\lambda)(2\gamma-1)\Big)$$

Given that the support of the random variable φ_X is the interval $[0, \bar{\varphi}]$, it follows that if $0 \leq \zeta$, $q_{GB} = q_{BB} = 1$. Which explains the values of zero in proposition 4.

The sorting $1 \geq q_{GB} \geq q_{BB} > q_{BG} > q_{GG} \geq 0$ falls from:

$$(1 - q_{GG}) - (1 - q_{GB}) = \frac{2\gamma\kappa(1-\lambda)(2\gamma-1)}{\bar{\varphi}} > 0$$
$$(1 - q_{GG}) - (1 - q_{BG}) = \frac{\kappa(1-\lambda)(2\gamma-1)^2}{\bar{\varphi}} > 0$$
$$(1 - q_{GG}) - (1 - q_{BB}) = \frac{\kappa(1-\lambda)(2\gamma-1)}{\bar{\varphi}} > 0$$
$$(1 - q_{BG}) - (1 - q_{GB}) = \frac{\kappa(1-\lambda)(2\gamma-1)}{\bar{\varphi}} > 0$$
$$(1 - q_{BG}) - (1 - q_{BB}) = \frac{2\kappa(1-\lambda)(2\gamma-1)(1-\gamma)}{\bar{\varphi}} > 0$$
$$(1 - q_{BB}) - (1 - q_{GB}) = \frac{\kappa(1-\lambda)(2\gamma-1)^2}{\bar{\varphi}} > 0$$

□

C.3 Firms' Expected Payoff

The payoff of each firm is a random variable depending on the voting outcome, i.e., the chosen corporate strategy. Using Proposition 4, we denote $\pi_X(c_X, c_Y)$ as the expected payoff of firm X for a realization of firm type (c_X, c_Y) as:

$$\begin{aligned}\pi_X(c_X, c_Y) = {} & q_{c_X c_Y} q_{c_Y c_X} V_X\Big(A^H(c_X), A^H(c_Y)\Big) + (1 - q_{c_X c_Y})(1 - q_{c_Y c_X}) V_X\Big(A^L(c_X), A^L(c_Y)\Big) \\ & + q_{c_X c_Y}(1 - q_{c_Y c_X}) V_X\Big(A^H(c_X), A^L(c_Y)\Big) + (1 - q_{c_X c_Y}) q_{c_Y c_X} V_X\Big(A^L(c_X), A^H(c_Y)\Big)\end{aligned} \tag{13}$$

At this point it is useful to introduce a variable that captures the expected gain that active investors can obtain from corporate governance. Define $\Pi(\cdot)$ as:

$$\Pi(\lambda, \gamma, \kappa, \sigma_N, \bar{\varphi}) = \pi_X(G,G) - \pi_X(B,G) + \pi_X(G,B) - \pi_X(B,B) \tag{14}$$

C.4 Stock Prices

The competitive market maker observes the order flows for both firms, F and F_Y, updates his beliefs about the realization of firm's types, and sets the efficient prices as:

$$P_j = \mathbb{E}[\pi^{\zeta} | F = x, F_Y = y], \qquad j \in \{X, Y\} \tag{15}$$

The order flow F_j that the market maker observes is:

$$F_j = \begin{cases} \lambda + N_j + \kappa(1-\lambda)(2\gamma - 1), & \text{if } c_j = c^G \\ \lambda + N_j - \kappa(1-\lambda)(2\gamma - 1), & \text{if } c_j = c^B. \end{cases}$$

Note that the actions that an investor follows for one firm does not depend on the information of the other firm. According to our conjecture, an investor chooses to go long firm X with the signal $S_X = S^G$ regardless of what the signal for firm Y is. Therefore, the order flow of firm Y is not informative for firm X's type and can be ignored when determining the price of firm X.

After observing order flow $F = x$, the market maker updates his belief, based on Bayes' rule, on firm X's type to a posterior probability denoted as $\rho(x)$:

$$\begin{aligned} \rho(x) = \mathbb{P}(c_X = E | F = x) &= \frac{\mathbb{P}(F = x | c_X = c^G)\mathbb{P}(c_X = c^G)}{\mathbb{P}(F = x)} \\ &= \frac{\phi\left(\frac{x - \lambda - \kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)}{\phi\left(\frac{x - \lambda - \kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right) + \phi\left(\frac{x - \lambda - \kappa(1-\lambda)(1-2\gamma)}{\sigma_N}\right)}, \end{aligned}$$

where $\phi(\cdot)$ represents the probability density function of the normal distribution with mean 0 and variance 1. The efficient price that the market maker sets is the expectation over all possible firm's types realizations, resulting in:

$$\begin{aligned} P_X(F = x, F_Y = y) = {} & \rho(x)\rho(y)\pi_X(G, G) + \rho(x)(1 - \rho(y))\pi_X(G, B) \\ & + (1 - \rho(x))\rho(y)\pi_X\Big(A_X(I)), A_Y(E)\Big) + (1 - \rho(x))(1 - \rho(y))\pi_X(B, B), \end{aligned}$$

where $\pi_X\Big((A_X(c_X), A_Y(c_Y))\Big)$ corresponds to the expected payoff of firm X given its type realization as per Equation (3). It is worth noting that even though the liquidity traders, the type realization and the signals received by active investors are independent for both firms, the stock prices are *not* independent. This is because firm X's payoff is affected by the strategy adopted by firm Y. Hence, the market maker needs to infer the joint realization of the two firms' types to determine efficient stock prices.

C.5 Verifying the Optimal Portfolio Choice

We now verify our conjectured portfolio choice in Section C.1. To this purpose, investors form an expectation about how much information can the market maker extract from the order flow. We denote such expectation given the *true* type of the firm as ξ:

$$\xi(\lambda, \gamma, \kappa, \sigma_N) \equiv \mathbb{E}[\rho(F)|c_X = c^G] = 1 - \mathbb{E}[\rho(F)|c_X = c^B] = \mathbb{E}\left[\frac{\phi\left(\frac{N}{\sigma_N}\right)}{\phi\left(\frac{N}{\sigma_N}\right) + \phi\left(\frac{N+2\kappa(1-\lambda)(2\gamma-1)}{\sigma_N}\right)}\right].$$

Based on the total law of expectation, we can derive the expected belief about market makers information given investors' signal.[46]

Then, we can prove the conjectured portfolio allocation and calculate the expected profit for

[46] For example, $\mathbb{E}[\rho(F)|S^G = E] = \mathbb{E}\Big[\mathbb{E}[\rho(F)|c_X = E]|S^G = E\Big]$.

active investors (denoted as Ω), summarized in Proposition 5.

Proposition 5. *An active investor's optimal trading strategy follows the conjecture 2, and the expected profit is given by*

$$\Omega(\lambda, \gamma, \kappa, \sigma_N, \bar{\varphi}) = (2\gamma - 1)(1 - \xi(\lambda, \gamma, \kappa, \sigma_N))\Pi(\lambda, \gamma, \kappa, \sigma_N, \bar{\varphi}), \tag{16}$$

$$\text{where} \quad \Pi(\lambda, \gamma, \kappa, \sigma_N, \bar{\varphi}) = \pi_X(G, G) - \pi_X(B, G) + \pi_X(G, B) - \pi_X(B, B) > 0.$$

Note further that passive investors can be seen as receiving a signal of informativeness $\gamma = \frac{1}{2}$. It is then straightforward to show that passive investors have zero expected profit, making the conjecture of holding the whole market a valid conjecture.

Proof. Since firms X and Y are ex-ante identical, we can simplify notation we write the expected profit conditional on each realization of firms type as:

$$\pi_{GG} \equiv \pi_X(G, G) = \pi_Y(G, G) \qquad \pi_{GB} \equiv \pi_X(G, B) = \pi_Y(B, G)$$
$$\pi_{BG} \equiv \pi_X(B, G) = \pi_Y(G, B) \qquad \pi_{BB} \equiv \pi_X(B, B) = \pi_Y(B, B)$$

For the case of Cournot competition and using our assumption on the quantity sorting, specifically $A^L(c^E) > A^H(c^I)$, we can obtain the following relationships between the expected profits for each type realization:

$$(i) \quad \pi_{GB} > \pi_{GG} > \pi_{BB} > \pi_{BG}$$
$$(ii) \quad \pi_{GG} - \pi_{BG} > \pi_{GB} - \pi_{GG}$$
$$(iii) \quad \pi_{GB} - \pi_{BB} > \pi_{BB} - \pi_{BG}$$

Proof. We begin with the sortied relationships in condition (i) by writing out:

$$\begin{aligned}
\pi_{EI} - \pi_{EE} =& \frac{1}{144b}\big[(a-c_E)(q_{EI}((1-q_{IE})(a-c_I)+(a-c_I)+5(c_I-c_E)) \\
& + 3(3(c_I-c_E)-(a-c_I)) + q_{EE}(q_{EE}+1)(a-c_E) + 3(1-q_{IE})(a-c_I))\big] \\
\pi_{EE} - \pi_{II} =& \frac{1}{144b}\Big[\Big(18-q_{EE}^2-q_{EE}\Big)\Big((a-c_E)^2-(a-c_I)^2\Big) + (a-c_I)^2\Big(q_{II}^2+q_{II}-q_{EE}^2-q_{EE}\Big)\Big] \\
\pi_{II} - \pi_{IE} =& \frac{1}{144b}\big[(a-c_I)((a-c_E)((1-q_{EI})(q_{II}-q_{IE})+2(q_{EI}-q_{II})+q_{II}(q_{EI}-q_{II})+q_{EI}-q_{IE}) \\
& + (c_I-c_E)(3q_{IE}+2q_{IE}+q_{II}(q_{II}+1)+9))\big]
\end{aligned}$$

Furthermore, for conditions (ii) and (iii) we can write:

$$\begin{aligned}
\pi_{EE} - \pi_{IE} + \pi_{EE} - \pi_{EI} =& \frac{1}{144b}\Big[(a-c_I)(c_I-c_E)\Big(2\Big(1-q_{EE}^2\Big)+(q_{IE}-q_{EE})+6(1-q_{EI})+4q_{IE}+28\Big) \\
& + 2(a-c_E)(a-c_I)(q_{IE}(q_{EI}-q_{EE})+q_{EE}(q_{IE}-q_{EE})) + (a-c_E)(a-c_I)(q_{IE}-q_{EE}) \\
& +(a-c_E)^2(q_{EI}-q_{EE}) + (c_I-c_E)^2\Big(2\Big(1-q_{EE}^2\Big)+(1-q_{EE})+6(1-q_{EI})\Big)\Big] \\
\pi_{EI} - \pi_{II} + \pi_{IE} - \pi_{II} =& \frac{1}{144b}[(a-c_I)(c_I-c_E)(6(6-q_{IE})-2q_{EI}(q_{IE}-2)) \\
& +(a-c_I)^2(-q_{EI}(2q_{IE}+1)-q_{IE}+2q_{II}(q_{II}+1)) + (5q_{EI}+27) + (c_I-c_E)^2\big]
\end{aligned}$$

Since $1 \geq q_{EI}^{\zeta} \geq q_{II}^{\zeta} > q_{IE}^{\zeta} > q_{EE}^{\zeta} \geq 0$ from Proposition 4 and $3(c_I - c_E) - (a - c_I)$ from $A^L(c_E) \geq A^H(c_I)$, where $c_I \geq c_E$. It follows that all the previous expressions are not negative. □

Given each realization of firms' type, we define the return as the payoff minus the expected prices, which is calculated by using the expectation about the market maker's belief $\xi(\lambda, \gamma)$. The table below summarizes the return for firm X, the results for firm Y are symmetric.

To prove our conjecture 2, we need to show that after receiving one signal pair, our conjectured strategy dominates all other choices, that is, active investors get the maximized return following the conjectured manual. Using the notation $\mathrm{Ret}(\ell, \jmath)$ to represent the return from a long position

Realization of firms' type	Payoff_X - $\mathbb{E}[\text{Price}_X]$
(G, G)	$\text{Ret}^X_{GG} = \pi_{GG} - \xi^2\pi_{GG} - \xi(1-\xi)\pi_{GB} - \xi(1-\xi)\pi_{BG} - (1-\xi)^2\pi_{BB}$
(G, B)	$\text{Ret}^X_{GB} = \pi_{GB} - \xi(1-\xi)\pi_{GG} - \xi^2\pi_{GB} - (1-\xi)^2\pi_{BG} - \xi(1-\xi)\pi_{BB}$
(B, G)	$\text{Ret}^X_{BG} = \pi_{BG} - \xi(1-\xi)\pi_{GG} - (1-\xi)^2\pi_{GB} - \xi^2\pi_{BG} - \xi(1-\xi)\pi_{BB}$
(B, B)	$\text{Ret}^X_{BB} = \pi_{BB} - (1-\xi)^2\pi_{GG} - \xi(1-\xi)\pi_{GB} - \xi(1-\xi)\pi_{BG} - \xi^2\pi_{BB}$

Table 4: Payoff of the firm X minus the expected price for each realization of firm type

in firm X and a short position in firm Y, we obtain the expected returns of the conjectured strategy as follows:

$$\mathbb{E}[\text{Ret}(\ell, \ell)|(S^G, S^G)] = 2(2\gamma-1)(1-\xi)\Big((2\gamma-1)\xi(\pi_{GG} - \pi_{GB} - \pi_{BG} + \pi_{BB}) + \pi_{GG} - \pi_{BB}\Big);$$

$$\mathbb{E}[\text{Ret}(\ell, \mathscr{s})|(S^G, S^B)] = 2(2\gamma-1)(1-\xi)(\pi_{GB} - \pi_{BG});$$

$$\mathbb{E}[\text{Ret}(\mathscr{s}, \ell)|(S^B, S^G)] = 2(2\gamma-1)(1-\xi)(\pi_{GB} - \pi_{BG});$$

$$\mathbb{E}[\text{Ret}(\mathscr{s}, \mathscr{s})|(S^B, S^B)] = 2(2\gamma-1)(1-\xi)\Big(\pi_{GG} - \pi_{BB} - (2\gamma-1)\xi(\pi_{GG} - \pi_{GB} - \pi_{BG} + \pi_{BB})\Big).$$

As an example, assume an investor received the signal $\{S^G, S^G\}$ by which she should take a long position on both firms, following the conjecture. The investor first forms an expectation for each realization of firms' type conditional on the signal. With the signal $\{S^G, S^G\}$, his posterior on firms' type is $\{\gamma^2, \gamma(1-\gamma), \gamma(1-\gamma), (1-\gamma)^2\}$ for $\{(G, G), (G, B), (B, G), (B, B)\}$, respectively (see Table 2). Therefore, her expected return of taking a long position on both firms, by using Table 4, is:

$$\begin{aligned}\mathbb{E}[\mathrm{Ret}(\ell,\ell)|(S^G,S^G)] &= \gamma^2(\mathrm{Ret}^X_{GG}+\mathrm{Ret}^Y_{GG})+\gamma(1-\gamma)(\mathrm{Ret}^X_{GB}+\mathrm{Ret}^Y_{Ei})\\ &+(1-\gamma)\gamma(\mathrm{Ret}^X_{BG}+\mathrm{Ret}^Y_{BG})+(1-\gamma)^2(\mathrm{Ret}^X_{BB}+\mathrm{Ret}^Y_{BB})\\ &=2(2\gamma-1)(1-\xi)\Big((2\gamma-1)\xi(\pi_{GG}-\pi_{GB}-\pi_{BG}+\pi_{BB})+\pi_{GG}-\pi_{BB}\Big).\end{aligned}$$

To prove that our conjectured strategy is optimal, we need to show the following:

$$\begin{aligned}
a)\qquad & \mathbb{E}[\mathrm{Ret}(\ell,\ell)|(S^G,S^G)] \geq \mathbb{E}[\mathrm{Ret}(\ell,\mathscr{s})|(S^G,S^G)]\\
& \mathbb{E}[\mathrm{Ret}(\ell,\ell)|(S^G,S^G)] \geq \mathbb{E}[\mathrm{Ret}(\mathscr{s},\ell)|(S^G,S^G)]\\
& \mathbb{E}[\mathrm{Ret}(\ell,\ell)|(S^G,S^G)] \geq \mathbb{E}[\mathrm{Ret}(\mathscr{s},\mathscr{s})|(S^G,S^G)]\\
b)\qquad & \mathbb{E}[\mathrm{Ret}(\ell,\mathscr{s})|(S^G,S^B)] \geq \mathbb{E}[\mathrm{Ret}(\ell,\ell)|(S^G,S^B)]\\
& \mathbb{E}[\mathrm{Ret}(\ell,\mathscr{s})|(S^G,S^B)] \geq \mathbb{E}[\mathrm{Ret}(\mathscr{s},\ell)|(S^G,S^B)]\\
& \mathbb{E}[\mathrm{Ret}(\ell,\mathscr{s})|(S^G,S^B)] \geq \mathbb{E}[\mathrm{Ret}(\mathscr{s},\mathscr{s})|(S^G,S^B)]\\
c)\qquad & \mathbb{E}[\mathrm{Ret}(\mathscr{s},\ell)|(S^B,S^G)] \geq \mathbb{E}[\mathrm{Ret}(\ell,\ell)|(S^B,S^G)]\\
& \mathbb{E}[\mathrm{Ret}(\mathscr{s},\ell)|(S^B,S^G)] \geq \mathbb{E}[\mathrm{Ret}(\ell,\mathscr{s})|(S^B,S^G)]\\
& \mathbb{E}[\mathrm{Ret}(\mathscr{s},\ell)|(S^B,S^G)] \geq \mathbb{E}[\mathrm{Ret}(\mathscr{s},\mathscr{s})|(S^B,S^G)]\\
d)\qquad & \mathbb{E}[\mathrm{Ret}(\mathscr{s},\mathscr{s})|(S^B,S^B)] \geq \mathbb{E}[\mathrm{Ret}(\ell,\ell)|(S^B,S^B)]\\
& \mathbb{E}[\mathrm{Ret}(\mathscr{s},\mathscr{s})|(S^B,S^B)] \geq \mathbb{E}[\mathrm{Ret}(\mathscr{s},\ell)|(S^B,S^B)]\\
& \mathbb{E}[\mathrm{Ret}(\mathscr{s},\mathscr{s})|(S^B,S^B)] \geq \mathbb{E}[\mathrm{Ret}(\mathscr{s},\ell)|(S^B,S^B)]
\end{aligned}$$

We begin with cases (a) and (d) and note that, since the firms are ex-ante symmetric, it follows that:

$$\mathbb{E}[\mathrm{Ret}(\ell,\mathscr{s})|(S^G,S^G)] = \mathbb{E}[\mathrm{Ret}(\mathscr{s},\ell)|(S^G,S^G)] = 0$$

$$\mathbb{E}[\mathrm{Ret}(\ell,\mathscr{s})|(S^B,S^B)] = \mathbb{E}[\mathrm{Ret}(\mathscr{s},\ell)|(S^B,S^B)] = 0$$

$$\mathbb{E}[\mathrm{Ret}(\ell,\ell)|(S^G,S^G)] = -\mathbb{E}[\mathrm{Ret}(\mathscr{s},\mathscr{s})|(S^G,S^G)]$$

$$\mathbb{E}[\mathrm{Ret}(\mathscr{s},\mathscr{s})|(S^B,S^B)] = -\mathbb{E}[\mathrm{Ret}(\ell,\ell)|(S^B,S^B)]$$

Therefore, we can concentrate in solely showing that $\mathbb{E}[\mathrm{Ret}(\ell,\mathscr{s})|(S^G,S^G)]$ and $\mathbb{E}[\mathrm{Ret}(\mathscr{s},\mathscr{s})|(S^B,S^B)]$ are non-negative.

Furthermore, by the same symmetry argument, case (b) and (c) are identical and we can concentrate in only on case (b). We start by writing:

$$\mathbb{E}[\mathrm{Ret}(\ell,\ell)|(S^G,S^G)] = 2(2\gamma-1)(1-\xi)\Big((2\gamma-1)\xi(\pi_{GG}-\pi_{BG}-(\pi_{GB}-\pi_{GG}))+(1-(2\gamma-1)\xi)(\pi_{GG}-\pi_{BB})\Big);$$

$$\mathbb{E}[\mathrm{Ret}(\mathscr{s},\mathscr{s})|(S^B,S^B)] = 2(2\gamma-1)(1-\xi)\Big((2\gamma-1)\xi(\pi_{GB}-\pi_{BB}-(\pi_{BB}-\pi_{BG}))+(1-(2\gamma-1)\xi)(\pi_{GG}-\pi_{BB})\Big).$$

By conditions (i), (ii) and (iii) above, both expressions are not negative, since $1-(2\gamma-1)\xi \geq 0$ for $\gamma \in (\frac{1}{2},1)$ and $\xi \in (0,1)$. Now by analyzing case (b) we can write:

$$\begin{aligned}
\mathbb{E}[\mathrm{Ret}(\ell,\mathscr{s})|(S^G,S^B)] - \mathbb{E}[\mathrm{Ret}(\ell,\ell)|(S^G,S^B)] =& 2(2\gamma-1)(1-\xi)\Big(\pi_{GB}-\pi_{GG}+(1-(2\gamma-1)\xi)(\pi_{GG}-\pi_{BB}) \\
&+(2\gamma-1)\xi(\pi_{GG}-\pi_{BG}-(\pi_{GB}-\pi_{GG}))+\pi_{BB}-\pi_{BG}\Big) \\
\mathbb{E}[\mathrm{Ret}(\ell,\mathscr{s})|(S^G,S^B)] - \mathbb{E}[\mathrm{Ret}(\mathscr{s},\ell)|(S^G,S^B)] =& 4(2\gamma-1)(1-\xi)\Big(\pi_{GB}-\pi_{BG}\Big) \\
\mathbb{E}[\mathrm{Ret}(\ell,\mathscr{s})|(S^G,S^B)] - \mathbb{E}[\mathrm{Ret}(\mathscr{s},\mathscr{s})|(S^G,S^B)] =& 2(2\gamma-1)(1-\xi)\Big(2(\pi_{GB}-\pi_{GG})+(2\gamma-1)\xi(\pi_{GG}-\pi_{BB}) \\
&+(1-(2\gamma-1)\xi)(\pi_{GG}-\pi_{BG}-(\pi_{GB}-\pi_{GG}))\Big)
\end{aligned}$$

By conditions (i) and (ii) above, all three expressions are not negative. Therefore, our conjectured portfolio allocation is optimal for active investors conditional on the signal received.

Next, we calculate the ex-ante expected return for active investors:

$$\begin{aligned}\Omega &= \frac{1}{4}\Big(\mathbb{E}[\text{Ret}(\ell,\ell)|(S^G,S^G)] + \mathbb{E}[\text{Ret}(\ell,s)|(S^G,S^B)] + \mathbb{E}[\text{Ret}(s,\ell)|(S^B,S^G)] + \mathbb{E}[\text{Ret}(s,s)|(S^B,S^B)]\Big)\\ &= (1-\xi)(2\gamma-1)(\pi_{GG}+\pi_{GB}-\pi_{BG}-\pi_{BB}).\end{aligned}$$

We denote $\Pi(\lambda,\gamma,\kappa,\sigma_N,\bar{\varphi}) = \pi_{GG}-\pi_{BG}+\pi_{GB}-\pi_{BB}$. By using condition (i), it follows that that $\Pi(\cdot) > 0$.

□

C.6 Information Acquisition

Each investor decides whether to acquire information by comparing the gain from information acquisition, $\Omega(\cdot)$ and the cost, ψ. We can interpret the cost ψ as the difference in the fees of active investment minus the fees of passive investment. The equilibrium proportion of passive investors is determined by the point $\hat{\lambda}$ such that a marginal investor is indifferent between acquiring or not information, solving:

$$\Omega(\hat{\lambda},\gamma,\kappa,\sigma_N,\bar{\varphi}) - \psi = 0. \tag{17}$$

There may be a corner solution $\hat{\lambda}$ depending on the cost of information acquisition. When the cost, ψ, is greater than the highest expected profit of active investors, no investor wants to become active and $\hat{\lambda} = 1$. On the contrary, the opposite corner solution occurs for a very small ψ, where every investor acquires information and $\hat{\lambda} = 0$. In the following, we focus on the range of ψ where an interior solutions exist, i.e., $\hat{\lambda} \in (0,1)$.