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 for the composition of the asset management industry. 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 when implementing corporate governance. Such strategic complementarities contrast the traditional strategic substitution in information acquisition and increase the equilibrium proportion of passive investors. Our results are robust to the various corporate governance approaches that passive investors take, and we provide a policy discussion on such approaches. Moreover, in our model, a rise in passive investment can increase both payoff volatility and price informativeness in equilibrium. We conclude with two relevant extensions to critical passive funds' corporate governance issues: ESG policies and product market competition.

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 surged, 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 allow them to shirk and destroy firm value. In contrast, informed active investors can use their information to implement meaningful corporate governance policies. Thus, because of their different information, active and passive investors have a natural conflict of interest when pursuing corporate governance.

In this paper, we develop a theoretical model to analyze the endogenous choice of investors to become active or passive when they internalize their impact on firms' value 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 volatility and price informativeness? And, what are the results of policy proposals put forward to improve the governance role of passive investors?

Our analysis generates a new, perhaps counter-intuitively, insight: we identify a conflict of interest based on information between active and passive investors which generates strategic com-

[1] Institutions own about 88% of the S&P 500 index, and 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, 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.

plementarities in investors' information acquisition choice. In other words, an investor's incentive to become active or passive increases when other investors make the same choice. Consequently, when strategic complementarities are at play, our model generates an amplification effect that exasperates the equilibrium share of passive investors, which can rationalize the increasing share of passive investment in the asset management industry.[3]

Our results offer a novel perspective into the consequences of the rise of passive investment in financial markets. Traditionally, information has a substitution role where active managers can exploit price deviations from fundamentals to improve their performance (Grossman and Stiglitz, 1976). As such, a rise in passive investment should benefit active investors by leaving more opportunities to extract gains from their information. Our main result demonstrates that, when including corporate governance, this reasoning may not be accurate; the growth of passive investment might be unbounded until every investor prefers to hold a passive portfolio. Such finding persists even when there are gains to be made from the information. Furthermore, we show that such strategic complementarities persist regardless of the actual approach that passive investors take to corporate governance.

To understand the origin of our results, let us briefly explain 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. 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 firm's insiders, or management, can destroy value unless meaningful corporate governance policies are implemented

[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 passive investment itself.

inside the firm. Specifically, we allow shareholders to vote their shares for a meaningful corporate governance policy, that 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 governance policy always increases the firm's payoff, and more so for the good-type firm.[5] Lastly, our model abstracts from free-riding problems, common in various forms of corporate governance, by allowing investors to implement corporate governance, i.e., vote their shares, at no cost.

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 a good firm and sell a bad firm since the expected return of a good firm is higher than for a bad firm.[6] Therefore, active investors maximize their portfolio return when a good firm realizes a high payoff, which demands a meaningful policy from corporate governance, and when a bad firm realizes a low payoff, for which an excessively deferential policy is enough. In contrast, passive investors always buy the firm because, being uninformed, they have no means of differentiating between a good and a bad firm. By the same token, passive investors can not base their votes for a corporate governance policy based on information. Therefore, passive investors' uninformed voting, unlike uninformed trading, comes at a cost to active investors, which generates strategic complementarities in investors' information acquisition choices.

To see the robustness of our identified conflict of interest, suppose first that passive investors

[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.

[5] Under this interpretation, passive investors, despite being uninformed, have full power to maximize a firm's payoff and improve corporate governance, which contrasts the information setting in Corum, Malenko, and Malenko (2021). Furthermore, the impact of a meaningful corporate governance policy can be the equal for both firm's types without impacting our complementary results as in the mechanism in Hellwig and Veldkamp (2009).

[6] In reality, active investors that are not allowed to short 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 a long/short portfolio.

always choose meaningful corporate governance policy for the firm they own. In such a case, a bad firm is highly likely to get a higher payoff than when taking a deferential policy. Nevertheless, a higher payoff for a bad firm is detrimental for active investors because they sell a bad firm. If, in contrast, passive investors take a deferential policy and allow management to shirk, they reduce the payoff of a good firm. Such a case remains detrimental to active investors because they buy a good firm. Finally, if passive investors do not vote their shares, or vote randomly, they remain detrimental to active investors because they still hold shares. Since the share of active vs. passive investment clears in equilibrium, passive investment decreases the power of the ownership stake that active investors can use against the shirking of the firm's insiders. Therefore, regardless of how passive investors vote their shares, the information asymmetry generates a conflict of interest between active and passive investors.

Our robust finding sheds light on how passive investors should vote for their shares and implement corporate governance, relevant for policymaking. 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." Therefore, 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. As discussed above, all approaches where passive investors' votes are uninformed, i.e., meaningful policies, deferential policies, or even banning passive investors voting, do not deter the self-reinforcing mechanism by which more investors choose passive investment. Hence, we propose voting based on information as the only policy to alleviate our identified conflict of interest. From a practical perspective, we see learning from price as equivalent to legislation that imposes an increased expense in passive funds stewardship.[7] Since information is costly, such legislation may lead to a rise in passive funds fees. It is important to note that this proposal is *not* equivalent to pro-rata voting. Price can aggregate information because

[7] This is not equivalent to higher investment in proxy advisory. Even if informed, proxy advisory offer one-size-fits-all recommendations unconditional on each investor's portfolio, as rationalized by Levit and Tsoy (2020), which leads to uninformed voting as evident in Malenko and Shen (2016).

it reflects short positions; in contrast, there is no such thing as a short vote.

We furthermore do a comparative statics exercise in the stable equilibrium of the model. We find that for such an equilibrium, uninformed voting increases the variance of the firm's payoff. Intuitively, passive investors increase the likelihood that some outcomes that were highly unlikely before, for example, adopting a meaningful corporate governance policy for a bad firm, become more likely. A wider range of possible payoffs increases the variance of firm payoff. An increase in the variance of a firm's payoff, which increases the incentives to acquire information, leads to higher price informativeness.[8] In contrast, a model that ignores the possibility of corporate governance, i.e., where passive investors do not affect a firm's payoff, generates an irrelevance result for price informativeness.[9] 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.

Finally, we conclude this paper with a model extension to two applications that offer very contrasting views on the role of passive investment: ESG investment and product market competition. 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 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.[10] For product market competition, passive investors have sparked heated discussions about their natural role as common-owners of shares across industries, especially for competing firms.[11] The main argument is that passive in-

[8] Kacperczyk, Van Nieuwerburgh, and Veldkamp (2009) show 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).

[9] Glebkin, Gondhi, and Kuong (2021) provide a general mechanism for such irrelevance result.

[10] 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.

[11] Passive investors are natural common-owners because, given their lack of information, a diversified portfolio is optimal for them, i.e. passive investors hold the market.

vestors reduce competition in the product market for firms they co-own.[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, which we interpret as a social loss. On the other 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. They make it easier for a good firm to betray anti-competitive agreements and steal market share; thus, bad firms are more likely to exit the market.

The rest of this paper is organized as follows. In section 2, we present a simple and very general model that is enough 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 rationalizes puzzling empirical findings. Section 6 offers the model extensions to discuss corporate governance implications on ESG 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

[12] 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)

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 and strategical 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 one most similar to us 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 their portfolio returns.

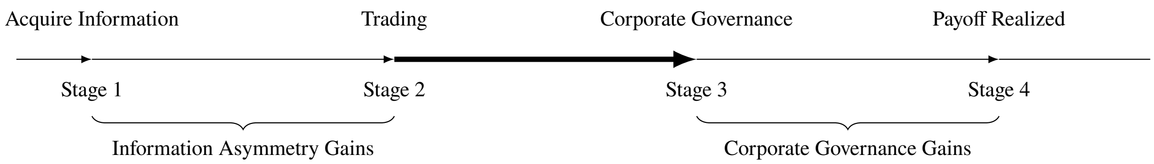
Moreover, our paper contributes to the fast-growing discussion on the impact of the rise of passive investing. The prominent view is that the growth of passive has distorted financial markets as a whole because passive investors do not gather firm-specific information. As such, passive investment leads 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. Glosten, Suresh, and Yuan (2017) 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). The firms' type is the hidden state of nature on which investors can acquire information.

The firm's corporate governance can result in a high payoff (V_H) if the firm follows a meaningful policy, or in a low payoff (V_L) if the firm follows a deferential policy and the firm's management is let to shirk, where $V_L < V_H$. We assume it is more costly to implement meaningful policies in a bad firm than in a good firm. Therefore, a good firm achieves a payoff V_H after choosing meaningful policies, while a bad firm only achieves the payoff $V_H - \epsilon$. The positive value ϵ, where $V_H - \varepsilon > V_L$, represent the wasted resources by implementing meaningful corporate governance in a firm that is of bad type.[13]

As a consequence, we define a social loss when the firm chooses a “wrong" policy. We assume that good firms ought to do well and achieve a higher payoff while bad firms ought to exit the market in the long run due to lack of funding associated with their lower payoff. Therefore, there is a social loss when the B firm follows a meaningful policy, because of wasted corporate governance efforts, and when the G firm follows a deferential policy, because of a lower payoff.[14] 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 times the loss in such case:

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

2.2 Agents

There are four types of agents that populate the economy.

2.2.1 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. Denote the precision $\gamma > \frac{1}{2}$ as the probability of a correct signal:[15]

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

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*

[13] The assumption $V_H - \varepsilon > V_L$ guarantees the existence of a principal-agent problem even in a bad firm.

[14] Our model does not allow for an explicit definition of welfare because of the presence of liquidity traders.

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

acquire information.

After observing the signal, investors choose their portfolio positions in the firm. We assume that informed investors have access to a leveraging technology denoted by κ.[16] Therefore, informed investors choose a position between $\{-\kappa, \kappa\}$ for a firm based on their information.[17] The uninformed investors do not have access to such leveraging technology and purchase *one* share of the firm. In other words, uninformed investors hold the market; which is the reason why we call uninformed investors "passive investors" for the rest of the paper. In contrast, informed investors choose their portfolio allocation conditional on information, and we call them "active investors" in what follows.

2.2.2 Liquidity traders

Liquidity traders arrive at the market randomly and do not participate in corporate governance, or vote 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.

2.2.3 A market maker

As in Kyle (1985), we assume that there exists a competitive market maker who observes order flows F. It sole role is to set an efficient price for the firm. The market maker absorbs any excess supply of shares and does not participate in corporate governance, or votes randomly.[18]

[16] Such leveraging technology is not necessary, but introduces an exogenous parameter that affects only informed investors and allows for sharp comparative statics.

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

[18] 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.

2.2.4 Firm's insiders

In reality, not all shares of a firm are available to trade in the financial market, and not every shareholder of a firm is willing to engage in corporate governance. To capture this feature, and to create smoothness in the corporate governance choices, we assume that a known mass of shares, $\bar{\varphi}$, is held by firm insiders for each firm. These firm's insiders may be founders, members of the management team or even employees. We assume they are endowed with such shares and do not trade in the financial market. Since actively participating in corporate governance can be costly for small shareholders, we assume that only a random fraction of firm insiders , denoted as φ uniformly distributed between $[0, \bar{\varphi}]$, engage in corporate governance. Such randomness makes the corporate strategy chosen by each firm a random variable.

Furthermore, we assume that firm's insiders have a private agenda against any meaningful corporate governance policy. The intuition being that if a policy has not been implemented, it is probably because insiders do not want to.[19]

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 management, but also among shareholders. In our model, conflict of interests arise among shareholders because of the different information sets of active and passive investors.

We choose *majority voting* as the method 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 do not vote. Therefore, only investors with a long position in a firm and firm's insiders can participate in corporate governance.

[19] Without this assumption there is no initial principal-agent problem that corporate governance can address.

2.3.1 Firm's insiders' voting decision

Insiders use their voting power to implement their hidden agenda, i.e., shirk, which leads to the payoff V_L of the firm. This assumption is meant to represent the principal-agent problem and perks that management can have access to in the absence of meaningful corporate governance policies.

2.3.2 Active investors' voting decision

Active investors vote their shares, if held long, to maximize their portfolio payoff. Therefore they will choose meaningful corporate governance policies and champion the payoff V_H.

2.3.3 Passive investors' voting

Given the emphasis of our paper, and the current empirical debate, we devote this section to discuss 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. In this case, passive investors, even though they do not actively pick firms based on information, are not passive owners and they implement meaningful corporate governance policies to champion the payoff V_H.
- 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. This is an alternative by which passive investors are passive owners but use their shares to allow for management's shirking, with leads to the payoff V_L.

3 Characterization of Equilibrium

In this section, 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 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 each firm for signal $S = S_G$;*
- *a short position in each 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 result in the payoff V_L. 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) and implement meaningful corporate governance policies to vote for for V_H. (iii) Passive investors of mass λ that can vote for V_H if $\zeta = 1$, hold their shares but not vote if $\zeta = 0$, and vote for V_L if $\zeta = -1$. The aggregate mass that each corporate governance policy receives for the type realization is:

$$
\begin{aligned}
&\text{If } \zeta = 1: \quad && \text{For } V_L: \underbrace{\varphi}_{\substack{\text{Firm}\\\text{managers}}} \quad && \text{For } V_H: \underbrace{\kappa(1-\lambda)\gamma}_{\substack{\text{Active investors}\\\text{with correct signal}}} + \underbrace{\lambda}_{\substack{\text{Passive}\\\text{investors}}};\\
&\text{If } \zeta = 0: && \text{For } V_L: \varphi && \text{For } V_H: \kappa(1-\lambda)\gamma;\\
&\text{If } \zeta = -1: && \text{For } V_L: \varphi + \lambda && \text{For } V_H: \kappa(1-\lambda)\gamma.
\end{aligned}
$$

We now proceed to calculate the probability that a corporate governance 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 V_H is the payoff achieved for each type realization as:

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

Where $q_G^\zeta \geq q_B^\zeta$.[20] Using the definition in Equation 1, the social loss is:

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

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

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 $\pi^{\zeta}(t)$ as the expected payoff of the firm for a realization of firm type as:

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

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:

$$\Pi(\lambda, \gamma, \kappa, \sigma_N, \bar{\varphi}, \zeta) = \pi^{\zeta}(G) - \pi^{\zeta}(B) \tag{4}$$

Intuitively, $\Pi(\cdot)$ captures the benefit that active investors obtain from the information of the type of the firm and voting based on such information. It represent the gain of a long-short portfolio based on the firm type. In Proposition 1 we proof that $\Pi(\cdot) > 0$ and in Proposition 2 we proof that $\Pi(\cdot)$ decreases as the share of passive investors increase.

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 efficient prices as:

$$P = \mathbb{E}[\pi_j | F = x] \tag{5}$$

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 normal 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:

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

where $\pi(t)$ corresponds 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 because the portfolio choice occurs 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:[21]

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

Based on the total law of expectation, we can derive the expected belief about market makers information given investors' signal.[22]

Then, we can prove the conjectured portfolio allocation and calculate the expected profit for active investors (denoted as Ω), summarized in Proposition 1.[23]

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 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

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

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

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

information, solving:

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

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 our model results 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 as follows:

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

Given this decomposition, we analyze how each component reacts to changes in the equilibrium share of passive investors, summarized in Proposition 2.[24]

Proposition 2. *It holds that*

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

$$\begin{cases} \frac{\partial \Pi(\hat{\lambda}, \gamma, \kappa, \bar{\varphi})}{\partial(\lambda)} > 0, & \textit{if } \lambda \leq \Lambda \\ \frac{\partial \Pi(\hat{\lambda}, \gamma, \kappa, \bar{\varphi})}{\partial(\lambda)} \leq 0 & \textit{otherwise} \end{cases}$$

$$\textit{Where:} \qquad \Lambda = \max\left[\frac{\gamma\kappa - \phi}{\gamma\kappa - \zeta}, 0\right] \qquad \forall \zeta \in \{-1, 0, 1\}$$

The first component, which we denote *information asymmetry*, is standard in models of informed trading (e.g., Grossman and Stiglitz, 1976).[25] As the fraction of active investors, $1 - \lambda$, increases, the market maker can extract more information from the order flows and sets the price closer to the payoff of the firms. Therefore, more active investors make the expected profit Ω of the active investors decrease. This generates the traditional substitution effect in investors' decisions to acquire information.

The second component, $\Pi(\hat{\lambda}, \gamma, \kappa, \bar{\varphi})$, is the main contribution of the paper, which we denote *corporate governance*. A model that ignores the variability from corporate governance has $\Pi(\cdot)$ as a

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

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

constant rather than a function of the equilibrium $\hat{\lambda}$. As the proportion of active investors increases, the conflict of interest among shareholders decreases and the gain from corporate governance increases for active investors. The occurs because the conflict of interest is the weakest among active investors.[26] Therefore, the more active investors appear in the market, the higher is the likelihood that they can influence the corporate strategies to maximize their portfolio payoff. This mechanism generates novel strategic complementarities in investors' decisions to acquire information.

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 is that, regardless of how passive investors vote their shares, the information asymmetry between active and passive investors, and hence the conflict of interests, prevails. In any case, the rise in passive investors takes away voting power from active investors, which they could use to implement meaningful policies for the firm, and reduces their expected profit from 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. The equilibrium $\hat{\lambda}$ is determined by the point at which

Parameter	Description	Value	Parameter	Description	Value
V_H	High payoff	2	γ	Signal precision	0.6
V_L	Low payoff	1	κ	Active investors leverage	3
ε	Corporate governance effort	0.5	$\bar{\varphi}$	Max voting power of insiders	1.5
ψ	Cost of information	0.05	σ_N	Noise traders volatility	1

Table 1: Parameters used for figures

[26] For the case of a perfect signal, there is no conflict of interest among active investors

the expected profit equals the cost of information ψ. We include in the figure the expected profit of active investors, Ω, for the different possible approaches that passive investors can take to vote their shares, i.e., $\zeta \in \{-1, 0, 1\}$. We furthermore highlight in the "x" axis the point at which strategic complementarities start, denoted Λ in Proposition 2, for each parameter ζ.

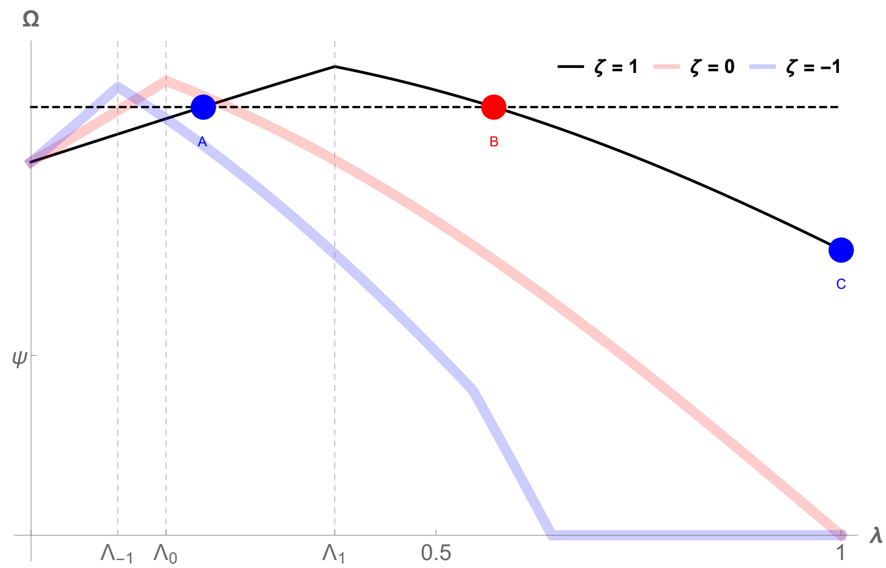


Figure 1: Expected profit for informed investors Ω as a function of the equilibrium share of passive λ.

Note that, the non-monotonicity in Ω potentially gives rise to multiple equilibria.[27] The cost of information, crosses Ω at two points, resulting in two interior solutions marked A in blue and B in red. 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. [28]

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

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

The equilibrium A in blue satisfies such condition while B in red does 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 corner equilibrium C of 100% passive investors. Such instability suggest that the total share of passive investors in the economy might be unbounded when including the variability induced by corporate governance.

4.3 Policy Discussion

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. To illustrate the debate we plot 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.

Based on the analysis in Section 4.2, we begin by noting that the social loss decreases in the share of passive investment for the range of λ that corresponds to a stable equilibrium. Such result arises from the fact that the signal of active investors is not perfect. If $\gamma = 1$, the social loss η would be strictly increasing in λ for the range of λ that corresponds to a stable equilibrium.

Passive investors as active owners:[29] This assumption coincides with our model parameter of $\zeta = 1$. Under such assumption, passive investors champion meaningful corporate governance policies for the firm they own regardless of whether this is efficient or not. This approach to corporate governance has the advantage of maximizing the return of investors, while it does not break the strategic complementarities identified in Proposition 2. Moreover, passive investors as active owners results in the smallest decrease in the social loss η for the range of λ that corresponds

the point.

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

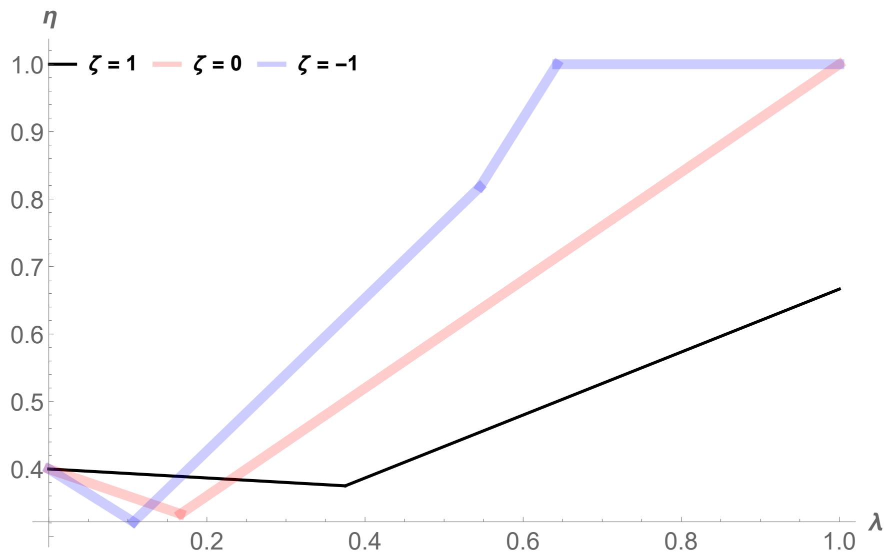


Figure 2: Economy efficiency as a function of λ.

to a stable equilibrium. The intuition being that it does not correct the errors of active investors since passive investors take the same side of active investors in their corporate governance role.

Passive investors as passive owners:[30] This assumption coincides with our model parameter of $\zeta = -1$. Under such assumption, passive investors completely side with management in the firm they own. This approach to corporate governance has the main issue of being against the fiduciary duty of investors of passive funds. Moreover, it does not break the strategic complementarities identified in Proposition 2. In contrast, under such approach, passive investors generate the largest decrease in the social loss η for the range of λ that corresponds to a stable equilibrium. Nevertheless, the range for which the equilibrium is stable is the smallest under such assumption.

Ban passive investors voting: This assumption coincides with our model parameter of $\zeta = 0$. Under such assumption, passive investors can hold shares but not implement any form of corporate governance. This approach to corporate governance been proposed by law scholars, see Dorothy

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

Shapiro Lund, on the grounds that passive funds are insufficiently informed. Nevertheless, we show that such approach does not break the strategic complementarities identified in Proposition 2 because passive investors hoard shares that could otherwise be used by active investors to vote against firm's insiders. Therefore, as long as passive investors take voting power away from active investors, our identified strategic complemetarities, and its consequences, prevail.

Passive voting based on information: We propose voting based on information as the only policy that can alleviate our identified strategic complemetarities. Specifically, we note that if passive investors learn from price, the conflict of interest between active and passive investors is attenuated. From a practical perspective we see learning from price as forcing an increased investment in stewardship for passive funds. Such investment is likely to increase passive fund's fees, decreasing ϕ in our model, and decrease the aggregate share of passive investment. It is important to note that this proposal is *not* equivalent to pro rata voting. Prices are aggregators of information because they reflect short positions, in contrast, there is no such thing as a short vote. Therefore for a firm of a bad type, no active investor holds such shares and the negative information cannot be reflected in the casted votes.

5 Comparative Statics

We now proceed to perform a comparative statics analysis in the stable equilibrium, aiming to highlight and contrast the effects of the information asymmetry gains and the corporate governance gains. We begin by analyzing the variance of payoff, and then follow by the price informativeness.

5.1 Variance

We plot the variance of payoffs as a function of the equilibrium share of passive investment λ for the different choices of parameter ζ. We include vertical lines for Λ_{-1}, Λ_0 and Λ_1 to focus on the stable equilibrium of the economy.

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

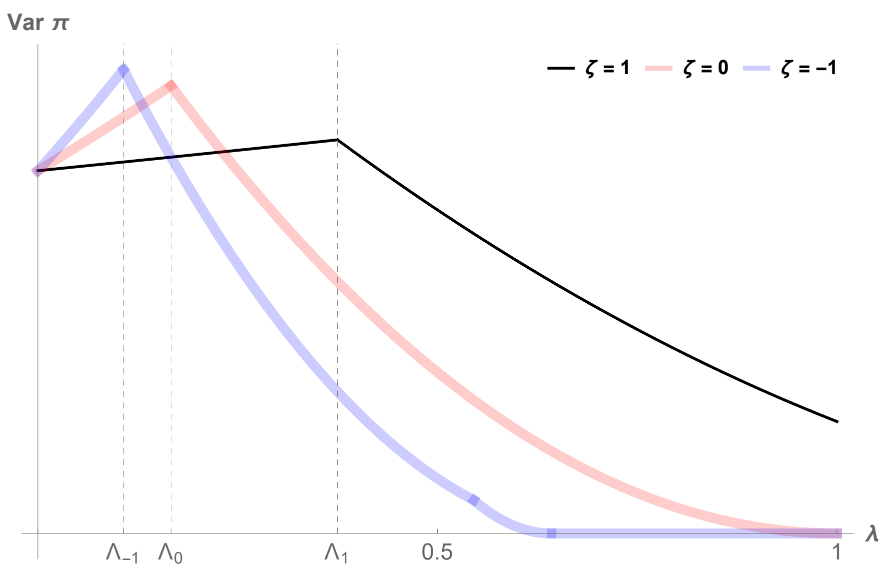


Figure 3: Variance of payoffs as a function of λ.

As with the case of $\frac{\partial \Pi(\hat{\lambda},\gamma,\kappa,\bar{\varphi})}{\partial(\lambda)}$ in Proposition 2 , the sign of the derivative $\frac{\partial \text{Var}(\pi)}{\partial(\lambda)}$ depends on the sign of $\left(\frac{\partial q_G^{\zeta}}{\partial \lambda} - \frac{\partial q_B^{\zeta}}{\partial \lambda}\right)$. When the latter is positive an increase in the share of passive investment increases the variance of payoffs.

The intuition is that an increase in the share of passive investment increases the likelihood that some outcomes that where highly unlikely without passive investment, for example a meaningful corporate governance policy for a bad firm, become more likely. Therefore, a wider range of possible outcomes obtained by the firms increases the variance of payoffs.

5.2 Informativeness

We define price informativeness as the variance explained from the prices as:[31]

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

Under such definition it is straightforward to see, from Proposition 2, that the direct effect of an increase in the share of passive investment λ decreases price informativeness.

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

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

5.2.1 Decrease in σ_N

We begin by analyzing an exogenous shock to noise traders. Through the indirect effect, less noise traders increase the equilibrium share of passive investors λ because the rent that can be extracted from the miss-pricing by the market maker is reduced. In other words, active investors have a harder time hiding the information in their trades and less investors choose to be active.

Notably, in a model without corporate governance, the increase in price informativeness that arises from less noise traders exactly cancels out with the decrease in price informativeness from more passive investors in equilibrium. The result is different when we include corporate governance because an increase in passive investment increases the variance of payoff. Therefore, more passive

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

investment makes the payoff of the firm more sensitive to its type, which increases the incentives to acquire information. The equilibrium share of passive investment after an exogenous decrease in noise traders is lower in a model that includes corporate governance than in a model which does not.

Figure 4 illustrates this effect for the different approaches that passive investors can take to corporate governance defined by the parameter ζ. We include, as contrast, in dotted lines the resulting informativeness for a model that does not consider the corporate governance channel rather takes $\Pi(\cdot)$ as a constant. For all three panels, it is evident that price informativeness increases with an increase in the equilibrium share of passive investment λ.

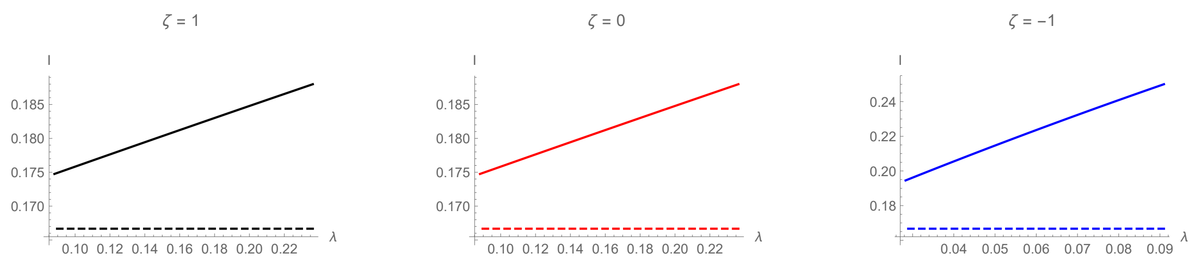


Figure 4: Price informativeness as a function of the equilibrium λ for a decrease in σ_N.

5.2.2 Increase in κ

We now analyze an exogenous shock to the leverage technology of active investors. Through the indirect effect, more leverage technology increase the equilibrium share of passive investors λ because a smaller share of passive investors reveal the same amount of information in the market. In other words, the product of the share of active investors multiplied by the leverage technology should remain constant in equilibrium since there are no changes to the information acquisition incentives in the market. The only possibility for a constant product of $(1-\lambda)\kappa$ when κ increases is a decrease in $(1-\lambda)$, i.e. increase in the share of passive investment.

Notably, in a model with out corporate governance, the increase in the leverage technology of active investors strictly decreases price informativeness in equilibrium by the reduction in the share of active investors which implies less information production. The result is different when we include corporate governance because an increase in passive investment also increases the variance of payoff as a side effect. Therefore, more passive investment, by making the payoff of the firm more sensitive to its type, increases the incentives to acquire information. The equilibrium effect of a rise in passive investment from an increase in the leverage technology of active investors cancels out in equilibrium.

Figure 5 illustrates this effect for the different approaches that passive investors can take to corporate governance defined by the parameter ζ. We include, as contrast, in dotted lines the resulting informativeness for a model that does not consider the corporate governance channel rather takes $\Pi(\cdot)$ as a constant. For all three panels, it is evident that price informativeness remains unaffected by an increase in the equilibrium share of passive investment λ.

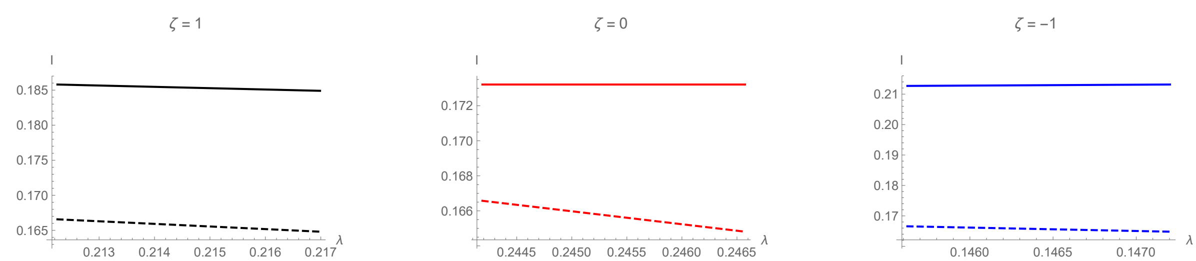


Figure 5: Price informativeness as a function of the equilibrium λ for an increase in κ.

5.2.3 Increase in γ

We conclude by analyzing an exogenous shock to the precision of the signal received by active investors. From Equation 9 we identify two effects of and increase in γ for the expected profit from information acquisition, Ω, and hence for the equilibrium λ. The first effect comes from the term

$2\gamma - 1$, such term is increasing in γ and represents the gain from portfolio selection and buying the good firm over the bad firm. Since it increases in γ it leads to an increase in active investors in equilibrium, i.e, a decrease in λ. The second effect comes from the term $(1 - \xi(\hat{\lambda}, \gamma, \kappa, \sigma_N)$, such term is decreasing in γ and represents the adverse selection of the market maker when observing the order flow. The market maker knowing that investors have more precise signals, moves the prices more aggressively with the order flow and makes it harder for active investors to extract rent from their information. Since this second effect decreases in γ it leads to less active investors in equilibrium, i.e., increase in λ. We pick for this comparative statics exercises the set of parameters where the latter effect dominates and an increase in γ increases the equilibrium share of passive investors λ.

In the term associated with corporate governance, the increase in the precision of the signal is strictly positive since it allows investors to implement more accurately a meaningful corporate governance policy for the good firms and not do so for the bad firms. An increase γ increases the expected payoff of informed investors. Therefore in a model that includes corporate governance, more passive investment increases the incentives to acquire information and price informativeness.

Figure 6 illustrates this effect for the different approaches that passive investors can take to corporate governance defined by the parameter ζ. For all three panels, it is evident that price informativeness increases with the increase in the equilibrium share of passive investment λ.

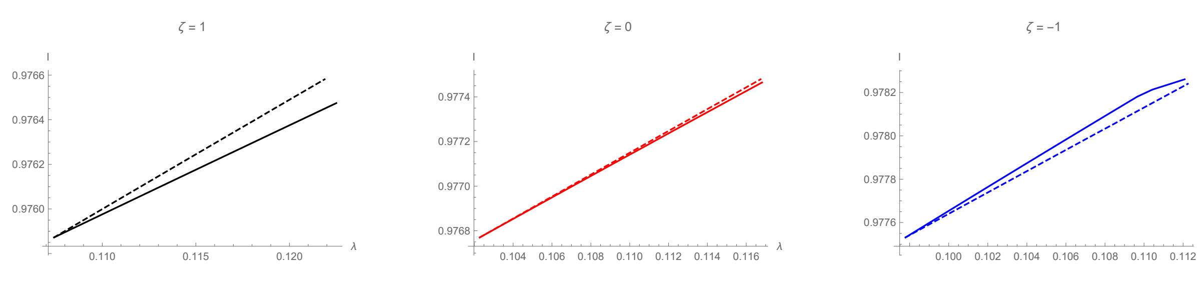


Figure 6: Price informativeness as a function of the equilibrium λ for an increase in γ.

5.3 Empirical predictions

In this subsection, we collect empirical predictions that arise from our comparative statics exercise and our main mechanism. We can generate two different types of tests that exploit the contrasting effects the traditional information asymmetry gains from information compared to our novel corporate governance gains . First, we generate predictions on the strength of our identified corporate governance channel for the rise of passive investments. Second, we generate predictions that rely on the equilibrium interaction of these two gains sources on volatility and price informativeness.

5.3.1 Rise of passive investment

Our mechanism relies on corporate governance, and specifically voting, creating strategic complementarities that exasperate the equilibrium share of passive investment. Therefore, a direct prediction of the mechanism unique to this model, is as follows.

Prediction 1: When the importance of voting increases, the flows from active to passive investment increase.[32]

5.3.2 Payoff volatility and price informativeness

The following list summarizes the predictions in terms of payoff volatility and price informativeness depending on the shocks to each exogenous variable. We compare the outcome for our model that includes corporate governance, with a traditional model that does not.

Prediction 2: When the cost of information ψ increases, the variance of firm's payoffs increase when corporate governance is at play; otherwise it is unaffected.[33]

Prediction 3: When the amount of noise traders σ_N decreases, the price informativeness

[32] For example, voting can become more important after exogenous regulatory changes to voting legislation.
[33] For example, an increase in ψ can arise from a decrease in passive investment fees.

increases if corporate governance is at play; otherwise it is unaffected.[34]

Prediction 4: When the leverage of active investors κ increases, the price informativeness is unaffected if corporate governance is at play; otherwise it decreases.[35]

6 Model Extensions

In this section we devote 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.

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

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

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

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 each of this two cases in an incremental manner. For ESG investment, we introduce two possible strategies that a firm can follow that, combined with its type, result in four possible values of the payoff function $V(\cdot)$. For product market competition, we introduce a second firm and study Cournot competition for a total of sixteen possible values of the payoff function $V(\cdot)$.

6.1 ESG Investment

The economy is composed by a firm of an unknown type, which can follow one of two possible corporate strategies. The corporate strategy is achievable by means of corporate governance, i.e. voting of the shares, and can be either a ESG strategy (A_{ESG}) or a standard "brown" strategy (A_S). Furthermore, a firm is, ex-ante, equally likely to be of a good type (G) or a bad type (B).

The final payoff of a firm, denoted V, depends both on the chosen corporate strategy and the firm type. We assume the following sorting on firm's payoff:

$$V(A_S, G) \geq V(A_{ESG}, G) \geq V(A_S, B) \geq V(A_{ESG}, B)$$

Furthermore, we assume that the monitoring for a good firm to take an ESG strategy entails a lower effort than monitoring a bad firm to take an ESG strategy. Without loss of generality we assume that the ESG strategy A^G can be achieved by a G firm at no effort whereas it requires an effort, $\varepsilon \geq 0$, for the B firm to achieve. We furthermore assume that $V(A_{ESG}, B) - \varepsilon > 0$.

Therefore, there is a social loss when the B firm follows an ESG strategy, because of wasted monitoring efforts, and when the G firm follows a standard strategy, because there should have been monitoring in place to aceive an ESG strategy. We use this intuition to define a measure of social loss η as follows:

$$\eta = \mathbb{P}(A_{ESG}|B)\varepsilon + \mathbb{P}(A_S|G)\Big(V(A_S, G) - V(A_{ESG}, G)\Big) \tag{11}$$

The rest of the model setting is the same as in our main model in Section 2 with the sole difference than instead of analyzing three possible cases for corporate governance of passive investors, we assume that they always vote for an ESG policy and insiders always vote for the standard strategy.

6.1.1 Equilibrium

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:

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

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

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:

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

(12)

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

Where $q_G \geq q_B$. Using the definition in Equation 11, the social loss is:

$$\eta = q_B\varepsilon + (1-q_G)\Big(V(A_S, G) - V(A_{ESG}, G)\Big)$$

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 $\pi_G \geq \pi_B$.

6.1.2 Results

To illustrate the equilibria in this model extension, we plot the expected profit of active investors, Ω, against the share of passive investors $\hat{\lambda}$ in Figure 7.[36] We highlight the shaded area as the range for which the equilibrium share λ corresponds to an stable equilibrium.

The main results for this model extension can be found in Figure 8. We plot on the left panel the probability that an ESG strategy is chosen as a function of the share of passive investors λ for each type of firm good and bad. In the right panel we show the social loss as a function of the share of passive investors λ. The shaded represents the range for which the equilibrium share λ corresponds to a stable equilibrium, hence the area we focus for our argument.

From Figure 8 we can observe that indeed an increase in 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

[36] The parameters used are: $\kappa = 3, \gamma = 0.8, \varphi = 1.5, V(A_S, G) = 4, V(A_{ESG}, G) = 3, V(A_S, B) = 2, V(A_{ESG}, B) = 1, \varepsilon = 0.5$

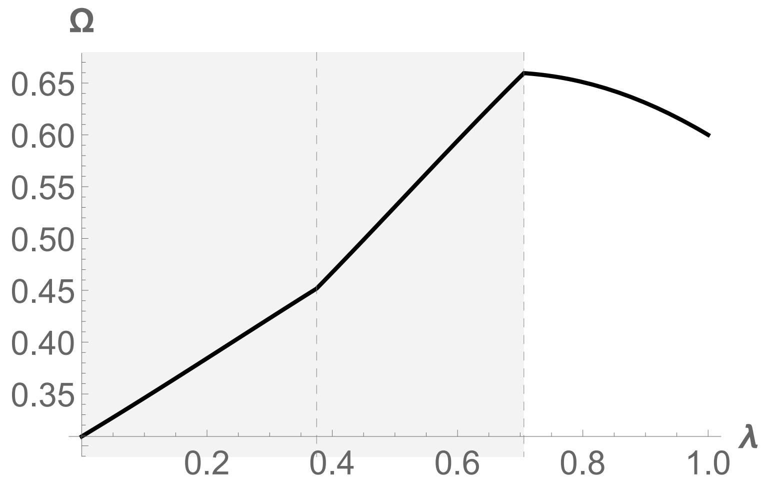


Figure 7: Expected profit for informed investors Ω as a function of λ.

for bad firms. If the goal of ESG investment is to materialize long term benefits from such policies, then passive investment are subsidizing bad firms that should actually exit the market.

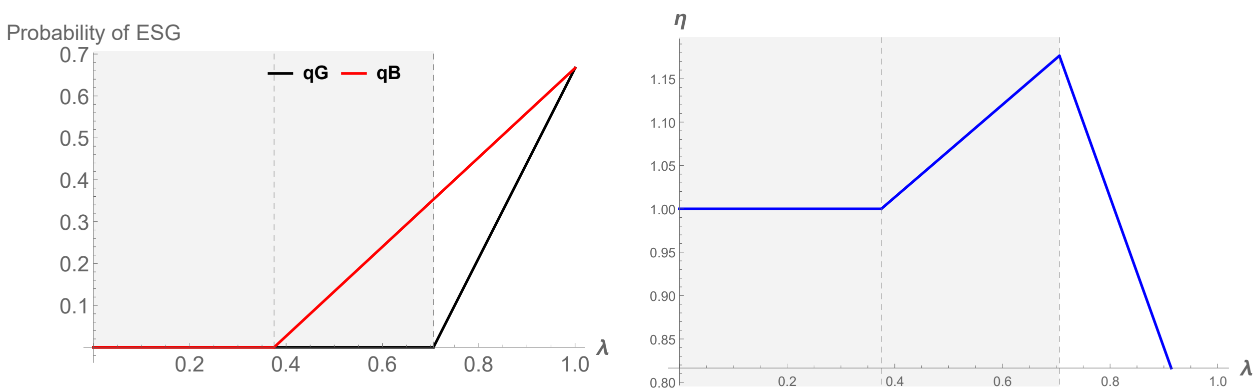


Figure 8: Left: Probability of ESG strategy being chosen as function of λ and Right: Social loss η as function of λ.

6.2 Product Market Competition

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 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 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.[37]

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. We then assume that the type of a firm is defined by its marginal cost, where $c^G < c^B$. For simplicity, we assume a linear demand function where the price of the good is determined by the quantities that each firm produce.[38]

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:

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

[37] 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.
[38] Specifically, the price of the good is $G(q_X, q_Y) = a - b(q_X + q_Y)$

Note that the quantity produced for each firm is jointly determined by the firm type and the corporate 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 $A^H(c^G) > A^L(c^G) > A^H(c^B) > A^L(c^B)$.[39]

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

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

Furthermore, we assume that the monitoring for a good firm to take a high aggressive strategy A^H entails a lower effort than monitoring a bad firm to take a highly aggressive strategy A^H. Without loss of generality we assume that a high aggressive strategy A^H can be achieved by a c^G firm at no effort whereas it requires an effort, $\varepsilon \geq 0$, for the c^B firm to achieve.

Therefore, there is a social loss when the B firm follows an A^H strategy, because of wasted monitoring efforts, and when the G firm follows a A^L strategy, because there should have been monitoring in place for such firm to increase production and the output of the economy. We use this intuition to define a measure of social loss η as follows:

$$\eta = \mathbb{P}(A^H|B)\varepsilon + \mathbb{P}(A^L|G)\Big(V_X\Big(A^H(c^G), A^H(c)\Big) - V_X\Big(A^L(c^G), A^H(c)\Big)\Big) \tag{13}$$

The rest of the model setting is the same as in our main model in Section 2 with the sole difference than instead of analyzing three possible cases for corporate governance of passive investors, we assume that they always vote for an A^L strategy and firm's insiders always vote for a A^H strategy.

[39] 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.

6.2.1 Equilibrium

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.[40] 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 13, the social loss is:

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

We proceed with the rest of the equilibrium in the same manner as in Section 3 where details of the solution can be found in Appendix B.

6.2.2 Results

To illustrate the equilibria in this model extension, we plot the expected profit of active investors, Ω, against the share of passive investors $\hat{\lambda}$ in Figure 9.[41] We highlight in the shaded area the range for which the equilibrium share λ corresponds to an stable equilibrium.

The main results for this model extension can be found in Figure 10. 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

[40] 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.

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

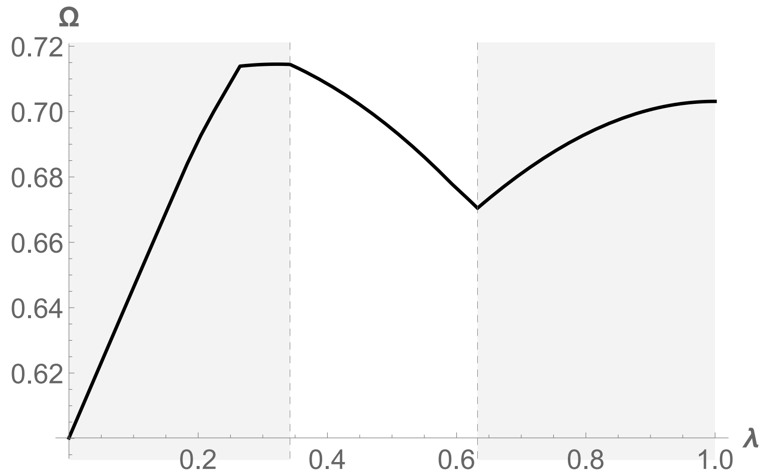


Figure 9: Expected profit for informed investors Ω as a function of λ.

equilibrium share λ corresponds to an stable equilibrium, hence the area we focus for our argument.

From Figure 10 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.

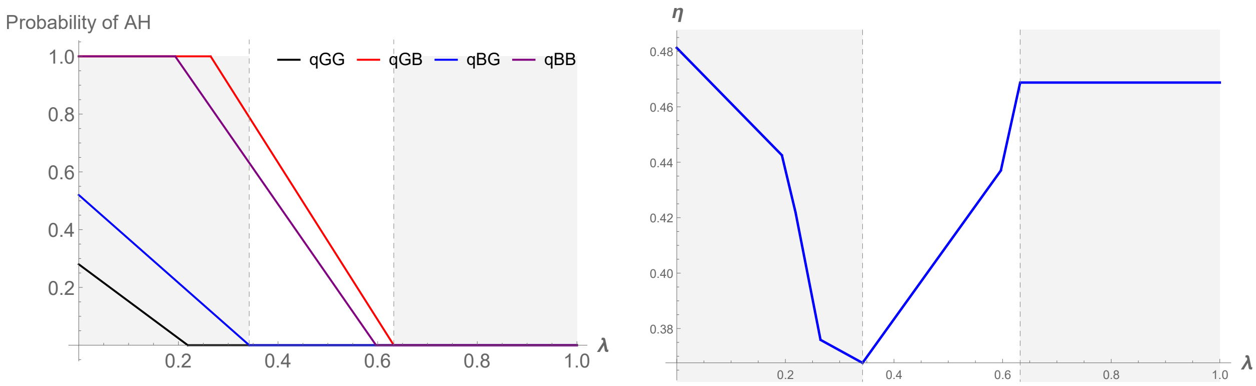


Figure 10: Left: Probability of a A^H strategy being chosen as function of λ and Right: Social loss η as function of λ.

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. Such finding persists even when there are gains to be made from the information. 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 $\pi(G) \geq \pi(B)$:

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

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:

$$Ret_G = \pi(G) - \xi\pi(G) - (1 - \xi)\pi(B)$$

$$Ret_B = \pi(B) - (1 - \xi)\pi(G) - \xi\pi(B)$$

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:

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

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

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.

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

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

(i)

By the chain rule we can write:

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

Given the definition of $\xi(\hat{\lambda}, \gamma, \kappa, \sigma_N)$ 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:

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

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

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

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

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

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

(ii)

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

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

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 $\Pi(\hat{\lambda},\gamma,\kappa,\bar{\varphi})$. 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 $\Pi(\hat{\lambda},\gamma,\kappa,\bar{\varphi})$ with respect of λ gives:

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

Since, $V_H - \varepsilon > V_L$, the sign of $\frac{\partial \Pi(\hat{\lambda},\gamma,\kappa,\bar{\varphi})}{\partial \lambda}$ depends on the both the sign of $\left(\frac{\partial q_G^{\zeta}}{\partial \lambda} - \frac{\partial q_B^{\zeta}}{\partial \lambda}\right)$ and that of

$\frac{\partial q_G^\zeta}{\partial \lambda}$.

We analyze all four possible cases:

$$
\begin{array}{llll}
(a) & \dfrac{\partial q_G^\zeta}{\partial \lambda} < 0 & \text{and} & \left(\dfrac{\partial q_G^\zeta}{\partial \lambda} - \dfrac{\partial q_B^\zeta}{\partial \lambda}\right) \leq 0 \\
(b) & \dfrac{\partial q_G^\zeta}{\partial \lambda} < 0 & \text{and} & \left(\dfrac{\partial q_G^\zeta}{\partial \lambda} - \dfrac{\partial q_B^\zeta}{\partial \lambda}\right) \geq 0 \\
(c) & \dfrac{\partial q_G^\zeta}{\partial \lambda} \geq 0 & \text{and} & \left(\dfrac{\partial q_G^\zeta}{\partial \lambda} - \dfrac{\partial q_B^\zeta}{\partial \lambda}\right) \leq 0 \\
(d) & \dfrac{\partial q_G^\zeta}{\partial \lambda} \geq 0 & \text{and} & \left(\dfrac{\partial q_G^\zeta}{\partial \lambda} - \dfrac{\partial q_B^\zeta}{\partial \lambda}\right) \geq 0
\end{array}
$$

The sign of $\frac{\partial \Pi(\hat{\lambda}, \gamma, \kappa, \bar{\varphi})}{\partial \lambda}$ for cases (a) or (d) is trivial. We show that case (b) cannot exist and that for case (c), it is still the case that $\frac{\partial \Pi(\hat{\lambda}, \gamma, \kappa, \bar{\varphi})}{\partial \lambda} < 0$ since $V_H - V_L > \varepsilon$.

For case (b) if $\frac{\partial q_G^\zeta}{\partial \lambda}$ is negative, then $\left(\frac{\partial q_G^\zeta}{\partial \lambda} - \frac{\partial q_B^\zeta}{\partial \lambda}\right)$ is always negative because $\frac{\partial q_B^\zeta}{\partial \lambda} > \frac{\partial q_G^\zeta}{\partial \lambda}$.

For case (c), $\frac{\partial q_G^\zeta}{\partial \lambda}$ is non-negative only if $\zeta = 1$ and $1 \geq \gamma\kappa > (1-\gamma)\kappa$, since $\gamma \in (\frac{1}{2}, 1)$. Then we can write the derivative of interest as:

$$
\frac{\partial \Pi(\hat{\lambda}, \gamma, \kappa, \bar{\varphi})}{\partial \lambda} = \frac{1 - (1-\gamma)\kappa}{\bar{\varphi}}\varepsilon - (V_H - V_L)\frac{(2\gamma - 1)\kappa}{\bar{\varphi}}
$$

It follows that $\frac{\partial \Pi(\hat{\lambda}, \gamma, \kappa, \bar{\varphi})}{\partial \lambda} < 0$ as long as:

$$
\begin{aligned}
\frac{1 - (1-\gamma)\kappa}{\bar{\varphi}}\varepsilon &< (V_H - V_L)\frac{(2\gamma - 1)\kappa}{\bar{\varphi}} \\
\varepsilon &< (V_H - V_L)\left(\frac{(2\gamma - 1)\kappa}{1 - (1-\gamma)\kappa}\right)
\end{aligned}
$$

The maximum value that $\left(\frac{(2\gamma-1)\kappa}{1-(1-\gamma)\kappa}\right)$ while satisfying $1 > (1-\gamma)\kappa$ and $\gamma \in (\frac{1}{2}, 1)$ is 2. Since $\varepsilon < V_H - V_L$, it holds that $\varepsilon < 2(V_H - V_L)$ and $\frac{\partial \Pi(\hat{\lambda}, \gamma, \kappa, \bar{\varphi})}{\partial \lambda} < 0$.

We now focus on case (d). The expression $\left(\frac{\partial q_G^\zeta}{\partial \lambda} - \frac{\partial q_B^\zeta}{\partial \lambda}\right)$ can only be positive if $\frac{\partial q_G^\zeta}{\partial \lambda} = 0$, and $\frac{\partial q_B^\zeta}{\partial \lambda} < 0$. Given that $q_G^\zeta > q_B^\zeta$ from Equation (2), only if the probability is constant at $q_G^\zeta = 1$ we can obtain $\frac{\partial q_G^\zeta}{\partial \lambda} = 0$ which is true for all lambda less than:

$$\lambda = \frac{\gamma\kappa - \phi}{\gamma\kappa - \zeta}$$

Therefore the point at which we start observing strategic complementarities is:

$$\Lambda = \max\left[\frac{\gamma\kappa - \phi}{\gamma\kappa - \zeta}, 0\right] \qquad \forall \zeta \in \{-1, 0, 1\}$$

□

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:

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

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

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

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

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

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:

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

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: Equilibrium product market competition

In this section, 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.

B.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 B.5, we show that this conjecture is valid.

B.2 Voting outcome

We begin by analyzing the optimal voting choice for an investor conditional on their portfolio allocation.[42] 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 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,

[42] 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 B.1.

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.[43]

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).

[43] Proof in the Appendix **??**

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)	$(\kappa,-\kappa)$	$(A^H,-)$	$\gamma(1-\gamma)$	γ^2	$(1-\gamma)^2$	$\gamma(1-\gamma)$
(S^B,S^G)	$(-\kappa,\kappa)$	$(-,A^H)$	$\gamma(1-\gamma)$	$(1-\gamma)^2$	γ^2	$\gamma(1-\gamma)$
(S^B,S^B)	$(-\kappa,-\kappa)$	$(-,-)$	$(1-\gamma)^2$	$\gamma(1-\gamma)$	$\gamma(1-\gamma)$	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:

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

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:

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

□

B.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:

$$\begin{aligned}\pi_X(c_X, c_Y) = {} & q_{c_X c_Y} q_{c_Y c_X} V_X\Big(A^H(c_X), A^H(c_Y)\Big) + (1 - q_{c_X c_Y})(1 - q_{c_Y c_X}) V_X\Big(A^L(c_X), A^L(c_Y)\Big) \\ & + q_{c_X c_Y}(1 - q_{c_Y c_X}) V_X\Big(A^H(c_X), A^L(c_Y)\Big) + (1 - q_{c_X c_Y}) q_{c_Y c_X} V_X\Big(A^L(c_X), A^H(c_Y)\Big)\end{aligned} \tag{14}$$

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:

$$\Pi(\lambda, \gamma, \kappa, \sigma_N, \bar{\varphi}) = \pi_X(G, G) - \pi_X(B, G) + \pi_X(G, B) - \pi_X(B, B) \tag{15}$$

B.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:

$$P_j = \mathbb{E}[\pi_j | F = x, F_Y = y], \qquad j \in \{X, Y\} \tag{16}$$

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:

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

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.

B.5 Verifying the Optimal Portfolio Choice

We now verify our conjectured portfolio choice in Section B.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.[44]

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

$$\Omega(\lambda,\gamma,\kappa,\sigma_N,\bar{\varphi}) = (2\gamma-1)(1-\xi(\lambda,\gamma,\kappa,\sigma_N))\Pi(\lambda,\gamma,\kappa,\sigma_N,\bar{\varphi}), \tag{17}$$

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

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

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

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:

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

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.

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

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 $\text{Ret}(\ell, \mathscr{s})$ to represent the return from a long position 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:

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

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

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

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

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

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

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

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

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

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

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

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:

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

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:

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

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 $\Pi(\cdot) > 0$.

□

B.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:

$$\Omega(\hat{\lambda},\gamma,\kappa,\sigma_N,\bar{\varphi}) - \psi = 0. \tag{18}$$

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., $\hat{\lambda} \in (0,1)$.