Socially Responsible Divestment

Finance Working Paper N° 823/2022

July 2023

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Abstract

Blanket exclusion of “brown” stocks is seen as the best way to reduce their negative externalities by starving them of capital. We show that a more effective strategy may be tilting -- holding a brown stock if the firm has taken a corrective action. While such holdings allow the firm to expand, they also encourage the action. We derive conditions under which tilting dominates exclusion for externality reduction. If the action is not publicly observable, the investor might not tilt even if she can gather private information on the action -- tilting would lead to accusations of greenwashing. The presence of an arbitrageur who buys underpriced stocks increases the relative effectiveness of tilting. A responsible investor who is partially profit-motivated may be more likely to tilt than one whose sole objective is minimizing externalities.

Keywords: Socially responsible investing, sustainable investing, externalities, exclusion, divestment, tilting, exit, governance

JEL Classifications: D62, G11, G34

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Abstract

Blanket exclusion of "brown" stocks is seen as the optimal divestment strategy as it starves them of capital, reducing externalities. We show that a more effective strategy may be tilting – holding a brown firm if it has taken a corrective action, thereby rewarding reform. If the action is not publicly observable, the investor might not tilt even if she can gather private information on it. The presence of an arbitrageur who buys underpriced stocks increases the relative effectiveness of tilting versus exclusion. A partially profit-motivated investor is more likely to tilt than one whose sole objective is minimizing externalities.

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Responsible investing – the practice of incorporating environmental, social, and governance ("ESG") factors into investment decisions – is becoming increasingly mainstream. In 2006, the United Nations established the Principles for Responsible Investment, which was signed by 63 investors managing a total of $6.5 trillion. By the end of 2021, this had grown to 3,404 investors, representing $121 trillion.

One goal of responsible investing is financial – to improve risk-adjusted returns, by incorporating ESG factors that are not fully priced by the market. However, critics argue that this is simply investing, not responsible investing (e.g. Edmans, 2023; Mackintosh, 2022). The more distinctive goal is social – to reduce a company's externalities, which is a particular objective of environmental and social ("ES") investing. Investors can affect externalities through two channels. The first is engagement, which even when effective is often costly. For example, Engine No. 1 spent $30 million placing three climate-friendly directors onto Exxon's board, compared to its stake of $40 million. The second is divestment: selling "brown" companies that exert negative externalities, increasing their cost of capital and hindering their expansion. This paper studies the optimal divestment strategy to mitigate externalities.

Under the cost of capital channel, the most powerful divestment strategy is blanket exclusion of externality-producing industries, a strategy pursued by many investors. 1,500 asset owners, collectively managing $40 trillion, have publicly committed to divest from fossil fuels. Turning to asset managers, the Net Zero Asset Managers Initiative has committed to net-zero aligned portfolios, which many signatories define as meeting a carbon footprint target and is thus achieved through divesting emitting companies. Consistent with this, asset managers such as Schroders link CEO pay to the carbon emissions of their portfolio. In turn, practitioners and the general public hold investors accountable for their holdings of brown firms. In 2020, Extinction Rebellion protesters dug up a lawn outside Trinity College, Cambridge in protest of its investment in fossil fuels . Beyond climate, academic studies of greenwashing by asset managers analyze the ESG ratings of their portfolio holdings (e.g. Gibson et al. (2022), Kim and Yoon (2022), and Liang, Sun, and Teo (2022)).

However, this argument considers only one channel through which divestment can affect a company's real actions – the primary markets channel, whereby divestment affects new capital raising. As the survey of Bond, Edmans, and Goldstein (2012) points out, investors can also have real effects through a secondary markets channel. Specifically, trading leads to the stock price reflecting a manager's real actions, thus rewarding or punishing him for taking them.

Even if a firm is in an irremediably brown sector, where externalities are always negative, the manager may be able to take corrective actions to mitigate these externalities. Blanket exclusion fails to reward such actions because the firm is divested no matter what. Thus, it may be optimal for a responsible investor to pursue a "tilting" strategy, where she tilts away from a brown industry but is willing to hold firms that reform.

We build a model in which responsible investment affects firm behavior through both above channels. There is a brown firm that emits negative externalities. The firm's manager can take a non-contractible corrective action that reduces both externalities and firm value. The firm also raises capital which it uses to fund an expansion, increasing both firm value and externalities. The firm's manager is concerned with both firm value and the stock price, although the results continue to hold if he is concerned with firm value alone.

The firm is owned by a continuum of risk-averse, profit-motivated, atomistic investors ("households"), and a risk-neutral responsible investor who is able to take large positions and have price impact; we thus refer to her as a blockholder. In the baseline model, her objective is to minimize the firm's externalities. To do so, she announces an investment strategy that depends on whether the firm takes a corrective action. Without loss of generality, the strategy is either exclusion where she never holds the firm, or tilting where she invests if and only if it takes the action. We initially assume that the blockholder can commit to her strategy. Some funds advertise themselves as excluding certain industries; deviation will lead to client withdrawals and potentially regulatory action. Other funds announce a tilting strategy which involves investing in leaders in brown industries. Deviating and excluding entire industries may increase tracking error, reduce risk-adjusted returns, or lead to investors withdrawing to cheaper passive funds that pursue exclusion.

We show that the optimal divestment strategy balances two forces. On the one hand, since the brown firm continues to produce negative externalities even under the corrective action, the blockholder wishes to minimize its size. She does so through blanket exclusion – by holding none of the brown firm's shares, they have to be held entirely by risk-averse households, who require a risk premium for doing so. This minimizes the stock price, similar to Heinkel, Kraus, and Zechner (2001), and thus the new funds the firm can raise. On the other hand, the investor wishes to incentivize the action. Exclusion provides no such incentives, since the firm is always divested. Tilting rewards the action – by buying shares, the blockholder reduces the number that must be held by households, thus increasing the stock price.

Intuitively, the blockholder's strategy is analogous to an incentive contract. Exclusion corresponds to paying the manager a flat salary, which minimizes the cost to the firm but provides no incentives. Tilting incentivizes the action, but is costly – in a contracting setting, the cost is the monetary value of the incentive; in a responsible investment setting, the cost is financing the expansion of a brown firm. This analogy highlights how exclusion may be suboptimal, despite being widely advocated – it is tantamount to giving zero incentives.

The optimal divestment strategy involves tilting if the corrective action is effective at reducing the externality, if the action is less costly and if the manager's stock price concerns are high. In such cases, the blockholder does not need to offer large share purchases to incentivize the action, and so the additional expansion and externalities created are low. Exclusion may thus be optimal for industries such as controversial weapons, where it is difficult to reduce the harm produced. In contrast, tilting may be preferred for fossil fuels, where managers can take corrective actions such as developing clean energy.[1] As a result, externalities may fall if the manager is more short-term oriented, since the blockholder may tilt and induce the action. This result contrasts common concerns that managerial short-termism is socially undesirable.

One might also think that exclusion is optimal if the firm has significant external financing needs, because it is particularly important to stifle capital raising. However, there is an opposing force. The effect of the action is plausibly multiplicative in firm size – reducing the per-unit amount of pollution has a greater impact in a firm that produces more. If the firm is raising large amounts of new capital, it becomes even more important to induce reform. Overall, the amount of capital raised has a hump-shaped effect on the relative effectiveness of exclusion, as does the profitability of the investment opportunity for similar reasons.

We extend the model to the case in which the corrective action is unobservable, and so the investor can only condition her investment on a noisy public signal of the action. The noise may result from imperfect ES ratings, poor disclosure standards, or attempts by the brown firm to greenwash. The noisier the signal, the greater the reward the investor needs to offer the manager to induce the action, and the more likely she is to choose exclusion. This result highlights a new benefit of ES disclosure – it allows investors to induce corrective actions without having to promise large amounts of capital.

Importantly, even if the blockholder can gather perfect information about the manager's

[1] Cohen, Gurun, and Nguyen (2021) show that the fossil fuel industry produces more green patents than nearly any other sector, suggesting that companies within this industry can take corrective actions.

action at an arbitrarily small cost, she may not do so. It may seem that such information will allow her to induce the action at lower cost – since the blockholder will always invest if the manager has taken the action, he will do so even if the promised investment is small. However, the blockholder may end up buying a company that has taken the action even though the public signal suggests that it has not, i.e. ends up owning a stock with a low ES rating. If the blockholder suffers sufficiently large fund outflows from doing so (as in Hartzmark and Sussman (2019)), she will not base her purchases on her private information. This reduces her incentives to gather it in the first place, and may deter her from inducing the action.

A common criticism of divestment is that arbitrageurs can buy divested stocks, attenuating the price impact. We introduce an arbitrageur who is purely profit motivated, like households, but has price impact. He optimally buys half the shares that are not purchased by the blockholder, lessening the impact of her trading decisions. This makes tilting less effective (since the arbitrageur partially offsets the blockholder's trades, she needs to promise an even larger purchase to induce the action), but also exclusion less effective (since he buys up underpriced stock and reduces the impact on the cost of capital). Since the arbitrageur buys half of the free float, his impact is greater on exclusion, where the blockholder's trade is zero and the free float is the total shares outstanding, than on tilting. Therefore, tilting is more likely to be optimal in the presence of arbitrageurs.

In our final extension, the blockholder's objective function includes trading profits as well as externalities. Our core result on the relative effectiveness of tilting and exclusion continues to hold. Moreover, and surprisingly, there are conditions under which the blockholder will induce the action if and only if she is partially profit-motivated. In particular, if tilting leads to more externalities, a responsible investor will choose exclusion, but a profit-motivated blockholder may tilt as this involves buying shares from risk-averse households and thus earning a premium for risk-bearing. We also consider the case in which the blockholder is unable to commit to a trading strategy. In the absence of commitment, a blockholder concerned only with externalities cannot induce the action. Once the action has been taken, she has no incentive to buy shares because doing so will help the firm expand. Thus, any promise to buy shares upon the reform is non-credible. However, a sufficiently profit-motivated investor will buy shares to earn trading profits. She is more willing to do so if the action has been taken, as the action minimizes the additional externalities created by her share purchases. Therefore, a profit motivation makes it credible for the blockholder to tilt. A policy implication is that ensuring that funds fulfill their fiduciary duty to generate financial returns may support, rather than be at the expense of, social returns.

While our paper considers secondary market trading by equity investors, our results will continue to hold for secondary market trading by debt investors. Loan sales decrease the price of debt and hinder future debt capital raising. Many prior divestment theories require the manager to care about the stock price (e.g. due to equity-based pay or concerns with takeover threat), because divestment operates through lowering the stock price. They would not apply to debt since some managers may be unconcerned by the debt price. Here, all results hold even if the manager cares only about firm value, and thus continue to apply to debt investors. Our results also continue to hold if the blockholder provides primary debt or equity capital, such as a bank loan or venture capital investment to a start-up. A policy to never finance such companies may seem optimal by hindering them from expanding; in October 2022, Lloyds became the first UK bank to announce that it would not finance new oil and gas projects. However, being willing to provide primary capital to brown firms that are best-in-class may encourage such companies to reform.

1 Related Literature

This paper is related to the theoretical literature on responsible investment. Heinkel, Kraus, and Zechner (2001) feature a set of responsible investors that refuse to hold brown stocks. Divestment by them requires financial investors to hold more stocks, increasing the risk they bear and lowering the stock price. As a result, some firms take corrective actions to obtain a higher price, similar to the tilting mechanism in our paper. Models of governance through exit, such as Admati and Pfleiderer (2009), Edmans (2009), and Edmans and Manso (2011), also feature the idea that making divestment contingent upon an action induces the action. These papers do not feature externalities and are thus not models of responsible investment. Instead, the channel is that the action increases firm value and is privately observed by the investor; thus, investor purchases convey this private information to the market and increase the stock price. In Heinkel et al. and our paper, the action reduces firm value and is publicly observed.

Two working papers also feature the idea that making capital contingent upon a corrective action induces the action, although the capital is primary rather than secondary. In Oehmke and Opp (2022), a responsible investor can induce a clean technology by proposing a green bond that stipulates this technology; the investor is willing to buy the bond at a loss and so the firm issues it despite the stipulation. In our paper, the blockholder always makes a profit from investing, and so tilting does not require investors willing to make losses.[2] Financial returns are relevant since fiduciary duty may limit asset managers' ability to sacrifice profits to achieve social objectives (see, e.g., Gosling and MacNeil (2023)); BlackRock opposed many climate resolutions in 2022 because they did not "consider them to be consistent with our clients' long-term financial interests." In Landier and Lovo (2020), a responsible investor sets a cap to externalities which reduces firm profits, and withholds financing from any firm that exceeds this cap. While they also feature mainstream investors who may also provide funds, the firm may be unable to find such investors (and is thus not financed) due to search frictions. As a result, the firm may limit externalities to safeguard financing, even though doing so also reduces output.

All of the above papers show that making either primary or secondary capital contingent upon an action induces the action, similar in spirit to tilting. However, none of them consider exclusion – unconditionally starving a company of capital to hinder its expansion and reduce its externalities, which is the main argument used for divestment in practice. Our paper thus models capital raising to finance an expansion and the externalities produced by a firm to be increasing in its scale. In Heinkel et al. (2001), responsible investors' demands are deterministic – they automatically buy stocks of a reformed brown company – while we study the choice between divestment strategies by a strategic investor.[3] In the exit papers, exclusion is moot since there are no externalities. Oehmke and Opp (2022) intentionally shut off exclusion by considering risk-neutral investors and a perfectly elastic supply of capital from financial investors; in Landier and Lovo (2020) outflows of capital from responsible investors are offset by inflows of capital from mainstream investors, which are perfect substitutes because production is deterministic and investors are risk-neutral.

A second difference is that the papers making primary capital contingent on a corrective action require the action to be both known by the investor ex ante and also to be contractible.

[2] In a similar vein, in Chowdhry, Davies, and Waters (2018), the impact investor makes a donation in return for the entrepreneur committing to pursue social goals.

[3] While we consider the relative effectiveness of different divestment strategies, other papers compare divestment with other mechanisms to reduce externalities. Broccado, Hart, and Zingales (2022) and Gollier and Pouget (2022) show that engagement is more effective than divestment if investors have a binding vote on whether firms are green or brown. They provide the normative implication that such a vote may be useful; however, no such vote currently exists.

In reality, investors may not have the specialist expertise to know what actions a company can take ex ante, even if they can evaluate whether it has done so ex post. In the language of Dow and Gorton (1997), they may have retrospective information, but not prospective information – their expertise is evaluating companies not running companies, or stock selection rather than activism. A second reason why BlackRock started to oppose climate resolutions was due to concerns that they micromanaged the company.[4]

Other papers on responsible investment study different questions; in particular, they also do not model externalities or study different strategies pursued by responsible investors – instead, investors' demands are automatic given their tastes. Davies and Van Wesep (2018) demonstrate that the low price from divestment raises the number of shares granted to the manager if his equity-based pay is fixed in dollar terms, paradoxically rewarding him. Pedersen, Fitzgibbons, and Pomorski (2021) focus on the asset pricing implications of responsible investing and solve for the ESG-efficient frontier. Goldstein et al. (2022) show that responsible investors can increase the cost of capital, because their trades reflect ES rather than financial performance, thus making the stock price less informative about financials. These papers do not involve new financing and investment, so the lower stock price from divestment has no real effects. Pastor, Stambaugh, and Taylor (2021) model how greater taste for green companies increases their valuation and reduces equilibrium expected returns. While firms make investment decisions, they are financed by internal cash flow and so there is no primary markets channel through which the stock price affects investment.

Some empirical studies examine the effectiveness of blanket exclusion as a responsible investing strategy, finding mixed results. Teoh, Welch, and Wazzan (1999) show that the South Africa exclusion campaign had a negligible effect on company valuations. The model and calibration of Berk and van Binsbergen (2021) show that ES-motivated exclusion has little effect on the cost of capital, because arbitrageurs can buy the underpriced stocks. In our model, the manager cares about the stock price for reasons other than the cost of capital, and the investor can tilt as well as exclude. We find that arbitrageurs attenuate the impact of exclusion, but increase the relative effectiveness of tilting. Berk and van Binsbergen's empirical estimation studies the effect of being added to the FTSE USA 4 Good Select Index, i.e. the price impact of positive screening; in our model, exclusion involves negative screening. It is thus closer to the

[4] See "BlackRock warns it will vote against more climate resolutions this year." *Financial Times*, May 10, 2022.

asset pricing model of Zerbib (2022), which shows that exclusion leads to a return premium of 2.79% per year. Green and Vallée (2022) find that bank divestment policies cause a reduction in both total debt and total assets for coal firms they have relationships with, and that there is limited substitution between capital from lenders with and without divestment policies. Pastor, Stambaugh, and Taylor (2022) document a significant return differential between German green bonds and otherwise-equivalent non-green twins, demonstrating that arbitrageurs cannot fully eliminate any price drop resulting from divestment. They study twin bonds where a perfect arbitrage exists; for equities, the effect of divestment may be higher.

Turning to tilting, Hartzmark and Shue (2023) find that holdings by responsible funds in aggregate are significantly increasing in the percentage reduction of firm emissions but independent of the absolute reduction. This provides the normative implication that tilting strategies should focus on rewarding brown, rather than green, firms for reducing their externalities (as in our model), since a given percentage reduction translates into a large absolute reduction. More broadly, despite the presence of arbitrageurs, Koijen and Yogo (2019) find a significant effect of institutional investor demand on asset prices, and the survey of Edmans and Holderness (2017) summarizes the evidence for the effectiveness of "governance through exit". In an ES context, Gantchev, Giannetti, and Li (2022) show that the threat of exit following negative ES incidents disciplines managers to improve ES performance. Exit is only possible if the investor is willing to hold brown firms in the first place. Heath et al. (2023) show that ES funds select firms with good ES performance, but that their selection does not improve such performance. This may be the case because some funds engage in exclusion rather than tilting.

2 The Model

2.1 Players and Timing

We consider a single firm with a risk-neutral manager ("M"). The firm is in a brown industry and thus emits negative externalities, to be specified later. The initial number of shares is normalized to one. The financial market consists of a continuum of risk-averse, profit-motivated, atomistic investors ("households"), indexed by $i \in [0, 1]$, and a risk-neutral responsible investor that aims to minimize the externalities produced by the firm, whom we refer to as a blockholder

("B").[5]

There are four dates, $t \in \{0, 1, 2, 3\}$. At $t = 0$, B announces an investment strategy $x(a)$ that depends on a publicly-observable action $a \in \{0, 1\}$ taken by the firm. We will sometimes refer to $a = 1$ as the "corrective action", or simply the "action", such as a fossil fuel company investing in clean energy, an alcohol company reducing the alcohol content of its drinks, or a gambling company promoting responsible gambling. The strategy $x(0) = x(1) = 0$ represents "exclusion", where B never holds the firm regardless of its action; the strategy $\{x(0) = 0,\ x(1) > 0\}$ represents "tilting", where B tilts away from the stock – she does not hold it if $a = 0$, but owns a strictly positive amount if $a = 1$. The blockholder's initial stake is zero, but all of our results would be unchanged if she had a positive initial stake, in which case "exclusion" would involve divestment, not just non-investment. Practitioners sometimes refer to tilting as a "best-in-class" strategy. We build a parsimonious model with only one firm so the best-in-class concept does not apply literally, but if the model were extended to multiple firms, buying only those that take corrective actions involves investing in those that are best-in-class.[6]

Initially, we assume that B can commit to the investment strategy. For example, an asset manager can launch a fund with a stated investment strategy to exclude brown firms, such as the Vanguard ESG FTSE Social Index fund; deviating may lead to client withdrawals and reputational damage. Alternatively, it can launch a fund with a tilting strategy, such as the Royal London Sustainable World fund. Such funds claim to add value through active management and company-specific analysis; not holding any firms in a brown industry may lead to withdrawals as it would be cheaper to hold a passive exclusionary fund. In addition, avoiding entire industries will increase tracking error and may reduce risk-adjusted returns; Hong and Kacperczyk (2009) find that alcohol, tobacco, and gambling stocks significantly outperform their peers, and Baker, Hollifield, and Osambela (2022) show theoretically that ES-conscious funds should hold brown stocks to hedge against brown states. Deviating from either exclusion or tilting strategies may also lead to regulatory action: the UK's Financial

[5] The results would be qualitatively unchanged if B were also risk-averse, since non-investment by the blockholder would mean that each household has to hold more shares, leading to inefficient risk-sharing as in Heinkel, Kraus, and Zechner (2001).

[6] Note that "best-in-class" would refer to buying the companies within an industry that have experienced the greatest decline in externalities, rather than those with the lowest level of externalities, as the strategy rewards companies that have taken corrective actions.

Conduct Authority has forced funds to remove "sustainability" labels from their name due to deviating from their stated strategy, and includes "sustainable improvers" (tilting) as one of the three permissible strategies. In Section 6.1 we consider the case in which B is unable to commit to her investment strategy.

At $t = 1$, M takes action $a \in \{0, 1\}$. Choosing the action $(a = 1)$ reduces the firm's externalities and decreases firm value by $c > 0$, net of any benefit., otherwise it would automatically be taken without the need for responsible investment. At $t = 2$, the firm issues $q \in (0, 1)$ additional shares to finance an investment project and investors trade claims to the firm's terminal value. At $t = 3$, the firm generates both a terminal cash flow and externalities.

The manager's action is non-contractible. It is very difficult to specify ex ante what corrective actions a company can take, particularly because it depends on factors such as technological feasibility (e.g. the affordability of renewable energy or carbon capture). In addition, a company's ES performance depends on many dimensions, and it is impossible to measure all of them and put them into a contract. Instead, responsible investors base their decision to invest in a company on a range of quantitative and qualitative factors.

2.2 Firm Value and Externalities

The firm's terminal value is specified as:

$$V = \theta + rI - ca, \tag{1}$$

where $\theta \sim N(\mu, \sigma)$ represents the random return generated by the firm's assets in place. The cost of the action is captured by ca and the gross return from the new investment is given by rI with $r > 1$.[7] The firm finances the investment by issuing new shares so that $I = pq$. To focus on the main economic mechanism – the blockholder's trade-off between providing incentives for the action and less capital for brown investments – we take the firm's issuance decision q as given. For example, q may be limited by the amount of equity that can be raised without the agency costs of outside equity becoming too severe. With fixed q, lower demand for the firm's stock by the blockholder reduces the stock price p and thus the level of investment $I = pq$.

[7] We assume the cost c does not reduce the funds available for investment. For example, it could represent the choice of a greener technology, which requires no up-front investment but reduces future profits. If the cost c did reduce investment I, then this would create an additional benefit to tilting – the firm uses some capital to reduce its externalities rather than to expand.

This setting involves constant returns to scale – the firm can invest any amount I, with a constant gross return of r. An alternative assumption would be to have decreasing returns to scale and endogenous q, which would substantially complicate the model without qualitatively changing the results.[8] A decrease in the stock price p would reduce the optimal level of q, lowering investment as in the current setup.

The firm's operations generate a negative externality f to society:

$$f(\theta, rI, a) = \lambda(\theta + rI)(1 - \xi a). \tag{2}$$

The externality depends on the firm's assets in place θ, the payoff from investment rI, and the action a. The parameter $\lambda > 0$ scales the externality and $\xi \in (0, 1)$ determines the efficacy of the action. The action can never fully eliminate the externality: a fossil fuel company will still retain its fossil fuel assets even if it also develops clean energy, an alcohol company will still have negative health effects even if it introduces low-alcohol drinks, and a gambling company will still lead to addiction even if it promotes responsible gambling.

Since the externality is increasing in firm size, there are two ways in which the blockholder's trading can reduce externalities. The first is by increasing the cost of capital and thus constraining investment. The second is by directly rewarding the manager for taking the action. The functional form for f implies that the action reduces the externality in a multiplicative way. For example, if the action involves developing a less polluting technology, this is implemented firm-wide and thus has a larger effect on larger firms. In Appendix B.1 we show that the main results continue to hold if the action has an additive effect on the externality that is independent of firm size. This extension also captures the case where the action has a multiplicative effect, as in (2), as well as a cost that is multiplicative in firm size.

As mentioned in the introduction, other papers deliberately shut down the exclusion channel by featuring risk neutrality and externalities that do not scale with the firm. Our paper models exclusion by containing an externality that scales with firm size and risk-averse households so that divestment by the blockholder has a price impact. This captures the main argument for

[8] The per-share value of the firm is given by $v \equiv \frac{V}{1+q}$, and so q affects both the numerator (through affecting investment and thus aggregate value) and denominator. Thus, if q were endogenous, it would not be solvable in closed form. Similarly, if the return on investment r were stochastic, the risk premium in equation (8) would depend on the stock price p, causing the market-clearing condition to become non-linear in p. Thus, for tractability, we assume r is deterministic.

exclusion used in practice – to starve the firm of capital and hinder its expansion – and allows us to study the choice between different divestment strategies. The parameter q allows for variation on how much external capital firms require; q will be low in firms that finance their investments with retained earnings.

2.3 Manager's Problem

The manager's utility depends on the equilibrium stock price p and the per-share firm value v:

$$U_m = \omega p + (1 - \omega)v, \tag{3}$$

with $\omega \in [0, 1]$. The concern for the short-term stock price ω is standard in the literature and can arise from a number of sources introduced by prior research, such as takeover threat (Stein, 1988), termination threat (Edmans, 2011), or reputational concerns (Narayanan, 1985; Scharfstein and Stein, 1990). All our results continue to hold if $\omega = 0$, because a manager fully aligned with firm value v will still care about the stock price p as it will affect the terms at which he will raise equity; we feature the parameter ω as it affects the relative effectiveness of exclusion and tilting. Heinkel, Kraus, and Zechner (2001), Pastor, Stambaugh, and Taylor (2021), and Broccado, Hart, and Zingales (2022) feature $\omega = 1$, i.e. the manager is only concerned about the stock price.

At $t = 1$, the manager solves:

$$\max_{a \in \{0,1\}} \mathbb{E}[U_m], \tag{4}$$

where the expectation is taken over θ. Importantly, the manager takes the blockholder's investment policy $x(a)$ as given when choosing a.

2.4 Financial Market

The blockholder commits to a demand schedule $x(a)$. Households maximize a standard mean-variance objective with constant absolute risk aversion parameter $\gamma > 0$. When submitting their demands, households condition on the action a and the stock price p:

$$\max_{x_i} \mathbb{E}[x_i(v - p)|a, p] - \frac{\gamma}{2} Var(x_i(v - p)|a, p). \tag{5}$$

Their demand function is thus given by:

$$x_i = \frac{\mathbb{E}[v|a,p] - p}{\gamma Var(v|a,p)}. \tag{6}$$

Market clearing requires that total demand equals supply:

$$x(a) + \int_0^1 x_i di = 1 + q. \tag{7}$$

Solving for p yields:

$$p = \mathbb{E}[v|a,p] - \gamma Var(v|a,p)\left(1 + q - x(a)\right) \tag{8}$$

with $\mathbb{E}[v|a,p] = \frac{\mu + rI - ca}{1+q}$, $Var(v|a,p) = \frac{\sigma^2}{(1+q)^2}$, and $I = qp$.

The stock price p is the certainty equivalent per-share value of the firm. The second term represents the risk discount, which is increasing in risk $Var(\cdot)$, household risk aversion γ, and the number of shares held by households $1 + q - x(a)$. An increase in the blockholder's demand raises the stock price by reducing the number of shares that risk-averse investors need to hold.

2.5 Blockholder's Problem

The blockholder chooses the investment strategy $x(a)$ to minimize the expected externality:

$$\min_{x(a)} \mathbb{E}[f(\theta, rI, a)]. \tag{9}$$

In Section 6, we allow the blockholder's objective function to comprise both trading profits and externalities.

We assume that $0 \leq x(a) \leq 1 + q$. The assumption $x(a) \geq 0$ results from short-sale constraints, which are standard in the blockholder exit literature (e.g. Admati and Pfleiderer, 2009; Edmans, 2009); otherwise, blockholders have no special role as any investor can exit, regardless of her initial stake. However, this assumption is not necessary for our results. If short-sales are possible, all the results continue to apply except that B need not be a blockholder – she can be any large investor.[9] Similarly, $x(a) \leq 1 + q$ means that the blockholder cannot buy more than the entire firm, i.e. households cannot short sell. If this assumption is relaxed,

[9] We would only need a limit on the maximum possible short-sales to prevent the stock price in equation (8) from turning negative.

our results become stronger as the blockholder has a greater ability to reward the action.

3 Optimal Investment Strategies

We solve the model by backwards induction. We first re-write the equilibrium stock price as a function of B's strategy and the action. We take the stock price in equation (8), plug in $I = pq$ and solve for p:

$$p(a) = \frac{\mu - ca - \left(1 - \frac{x(a)}{1+q}\right)\gamma\sigma^2}{1 + q - rq}. \tag{10}$$

The intuition is as follows. Absent an investment decision, the stock price is the certainty equivalent firm value divided by the number of shares $(1+q)$. One may think that investment should add an additional term to firm value in the numerator. However, since the value of the investment is $rqp(a)$, it effectively reduces the number of shares by rq in the denominator.[10]

To ensure that $p(a)$ is positive, we assume that $\mu > \gamma\sigma^2 + c$ so that expected firm value is not outweighed by the risk premium and the cost of the action, and that $1 + q - rq > 0$ so the effective number of shares does not turn negative. The second condition can be rewritten $r < \frac{1+q}{q}$. Intuitively, if r is sufficiently large, then households demand more shares when the price is higher, since their funds will be invested in a very profitable investment opportunity, leading to an upward-sloping demand curve.

We next solve for M's optimal choice of a. He takes the action if $\mathbb{E}[U_m|a=1] \geq \mathbb{E}[U_m|a=0]$. Plugging in the earlier expressions for $p(a)$ and $\mathbb{E}[v]$ shows that this inequality is satisfied if and only if:

$$x(1) - x(0) \geq \frac{c(1+q)}{\gamma\sigma^2\left[\omega + (1-\omega)z\right]} \equiv \overline{\Delta}_x \tag{11}$$

where

$$z \equiv \frac{rq}{1+q} \in (0,1). \tag{12}$$

The action $a = 1$ has two effects on M's objective function. First, it incurs a cost c which

[10] To see this, we have:

$$\begin{aligned} \text{Market value of firm} &= \text{Certainty equivalent fundamental value of firm} \\ p(1+q) &= \text{Certainty equivalent assets in place} + rqp \\ p(1+q-rq) &= \text{Certainty equivalent of assets in place} \end{aligned}$$

reduces firm and thus the stock price; the latter in turn lowers investment and further reduces v. Second, it increases the blockholder's demand from $x(0)$ to $x(1)$, raising the stock price p and thus investment and firm value. Thus, M takes the action if the second force is sufficiently strong, i.e. B tilts with a high $x(1) - x(0)$.

The last step is to solve for B's optimal policy $x(a)$. The previous assumptions $\mathbb{E}[f(\theta, rI, 1)] > \mathbb{E}[f(\theta, rI, 0)]$ and $\frac{\partial f(\theta, rI, a)}{\partial I} > 0$, and the fact that $p(0)$ increases with $x(0)$, imply that the blockholder sets $x(0) = 0$ and so the only optimal strategies are exclusion and tilting. It immediately follows from (11) that the blockholder can implement $a = 1$ by setting $x(1) \geq \overline{\Delta}_x$ and $a = 0$ by setting $x(1) \in [0, \overline{\Delta}_x)$. We assume that

$$c \leq \gamma\sigma^2 \left[\omega + (1-\omega)z\right] \tag{13}$$

so that the constraint $x(1) \leq 1 + q$ does not bind.[11] Proposition 1 gives the blockholder's optimal strategy; all proofs are given in the Appendix.

Proposition 1 *(Blockholder's strategy): The blockholder's optimal strategy is given as follows:*

(i) If $\xi \geq \overline{\xi}$, the optimal strategy is tilting, i.e. $x(1) = \overline{\Delta}_x$ and $x(0) = 0$, and the manager chooses $a = 1$;

(ii) If $\xi < \overline{\xi}$, the optimal strategy is exclusion, i.e. $x(1) = x(0) = 0$, and the manager chooses $a = 0$.

The threshold $\overline{\xi} \equiv \frac{(1-\omega)c}{(1-\omega)c + (\frac{\mu}{z} - \gamma\sigma^2)(\omega + \frac{z}{1-z})}$ is increasing in (c, γ, σ) and decreasing in (ω, μ). If $\omega = 0$, then $\overline{\xi}$ is decreasing in (r, q). If $\omega \in (0, 1)$, then $\overline{\xi}$ is hump-shaped in (r, q). The threshold $\overline{\Delta}_x$ is defined in equation (11).

The intuition is as follows. The blockholder's investment strategy $x(a)$ is analogous to an incentive contract provided to a manager, except that incentives are not provided by cash, but through purchasing shares which raises the stock price.[12] A higher stock price increases the manager's payoff directly as the manager places weight ω on the stock price, and indirectly by

[11] In the extensions, condition (13) will differ, and we will state the new required condition.

[12] A second difference is that an incentive contract is contingent upon output, whereas the blockholder's strategy is contingent upon the action a. We only require the action a to be publicly observable, but not contractible. Section 4 studies the case in which a is not publicly observable.

increasing the proceeds from capital raising and thus firm value. As in a compensation model, it is optimal to give the lowest possible reward upon $a = 0$. In a contracting setting with limited liability, this involves zero pay; in an investment setting with short-sales constraints, this involves zero demand. Whether to reward $a = 1$ depends on whether the benefits of the action exceed the costs. In a contracting setting, the cost is the financial cost of pay. In our investment setting, the cost is that a higher stock price raises investment and thus the externality. This analogy highlights the drawback of exclusion strategies, despite them being practiced by many investors – they are tantamount to giving the manager zero reward for desirable actions.

The blockholder tilts if the effectiveness of the action ξ is sufficiently high. Then, the most effective way to reduce externalities is to incentivize the manager to reform, rather than to starve the firm of funds through exclusion. The threshold $\overline{\xi}$ is lower (i.e. tilting is more likely to be optimal) if stock price concerns ω are high and the cost of the action c is low. This reduces the number of shares $\overline{\Delta}_x$ that B needs to purchase to induce the action. As a result, conditional on $\xi \geq \overline{\xi}$ (and thus $a = 1$), higher stock price concerns ω are socially optimal as it allows the action to be induced with fewer purchases and thus externalities. This result contrasts standard "governance through exit" models. In such models, B induces the action by reflecting it in the stock price through her trading, and so higher ω increases the blockholder's effectiveness. Despite this, the optimal ω is zero – the action improves firm value, and so if M cared exclusively about firm value, he would take the action even without blockholder trading. In our setting, the action reduces firm value due to the cost c, and so the only motive for $a = 1$ is to increase p; the magnitude of this motive depends on ω. Thus, a higher ω can be optimal for inducing the action, in contrast to common concerns that managerial short-termism is necessary detrimental for society. Appendix B.2 more fully analyzes how f is decreasing in ω.

Turning to other comparative statics, tilting is also preferred if the firm is large (high μ) and risk σ and risk aversion γ are small, because this increases the stock price and thus the amount of investment. In addition, high μ increases assets in place. Both factors lead to greater firm value and thus a greater benefit from the multiplicative action a. Lower risk and risk aversion also mean that exclusion has a less negative effect on the stock price.

Finally, the capital raised by the firm (q) and the profitability of the investment (r) have non-monotonic effects on $\overline{\xi}$. One might think that they should have an unambiguous effect –

the greater the capital raised, the more important the cost of capital channel, and thus the more valuable exclusion is to increase the cost of capital. However, there is a force in the opposite direction – the greater the capital raised, the more important the action is to reduce the externalities from the new investment. If q and r are sufficiently high, such a large amount of capital is raised that this second force dominates and further increases in q and r make tilting more effective.

In Appendix B.1, we consider the case in which the action has an additive effect on the externality that is independent of firm size, for example if the cost c involves donating money to charity which reduces the externality by $\lambda\xi$. This extension also captures the case in which the action has a multiplicative effect on the externality, as in (2), and the cost of the action is also multiplicative in expected firm size. In the core model, the action has a fixed cost c, such as the cost of developing a greener technology which, once invented, can be implemented costlessly across the firm. However, if the technology is already known (and thus does not require a fixed development cost) but its implementation involves a higher per-unit cost of production, then this cost will scale with firm size. The key result that tilting is preferred if and only if ξ exceeds a cutoff continues to hold, as do the comparative statics with respect to c and ω. However, the effects of q and r now become monotonic (greater levels lead to exclusion being preferred), and μ, γ, σ no longer affect the optimal strategy.

4 Unobservable Corrective Action

In this section, we consider the case in which the action is not publicly observable. As a result, B cannot condition her holdings on a. Instead, there is a public signal $s \in \{0, 1\}$ which is correlated with the action, such as an ES rating. The signal precision is given by

$$\tau \equiv \Pr[s = a|a] \in [0.5, 1). \tag{14}$$

Superior disclosure standards, more trusted third-party verification of disclosures, or greater consensus between ES rating agencies (which Berg, Kölbel, and Rigobon (2022) show to disagree significantly) will increase precision. Alternatively, if M is able to greenwash, i.e. give the impression of taking the action without actually doing so, then τ is lower. The signal is publicly observed at $t = 2$, before trade in the secondary market takes place. The blockholder conditions her holdings on this signal, $x(s) \geq 0$. Households have rational expectations and correctly conjecture the manager's equilibrium action.

We proceed in two steps. First, we take the signal precision as given and analyze how τ affects the optimal investment strategy. Second, we endogenize signal precision and allow the manager to choose τ ex ante.

4.1 Optimal Investment Strategies

Following the same steps as in the baseline model, M takes the action if and only if:

$$x(1) - x(0) \geq \frac{1}{2\tau - 1} \frac{(1-\omega)c(1+q)(1-z)}{\gamma\sigma^2(\omega + (1-\omega)z)} \equiv \widehat{\Delta}_x(\tau). \tag{15}$$

The threshold $\widehat{\Delta}_x$ is decreasing in signal precision τ: $\frac{\partial \widehat{\Delta}_x}{\partial \tau} < 0$. Intuitively, B has to provide M stronger incentives to take the action when the public signal is less precise. If $\tau = \frac{1}{2}$, the signal is uninformative about the action. Since the blockholder is unable to reward the action, the manager always chooses $a = 0$.[13]

The blockholder's optimal strategy is given by Proposition 2:[14]

Proposition 2 *(Unobservable action): The blockholder's optimal strategy is tilting and the manager chooses $a = 1$ if and only if*

$$\xi \geq \overline{\xi}_{unob}(\tau) \equiv 1 - \frac{\frac{\mu}{z} - \gamma\sigma^2}{\frac{\mu}{z} - \gamma\sigma^2 + c\left(\frac{\tau}{2\tau-1}\frac{1-\omega}{\omega + \frac{z}{1-z}} - 1\right)}. \tag{16}$$

Otherwise, it is exclusion and the manager chooses $a = 0$. The tilting strategy involves $x(1) = \widehat{\Delta}_x(\tau)$. $\overline{\xi}_{unob}(\tau)$ is increasing in (c, γ, σ) and decreasing in (ω, μ, τ).

As in the baseline model, B chooses tilting if the action is sufficiently effective. This threshold is decreasing in signal precision τ. A higher τ means that it is less costly for B to implement the action, and so tilting is preferable to exclusion. Note that $\overline{\xi}_{unob}(\frac{1}{2}) = 1$: if the signal is pure noise, then B always chooses exclusion. In this sense, exclusion is more "robust"

[13] Note that there is a discontinuity in $\widehat{\Delta}_x$ around $\tau = 1$, i.e. $\lim_{\tau\to 1} \widehat{\Delta}_x$ differs from the threshold in Section 3. For any $\tau < 1$, households ignore the public signal and rely on their equilibrium conjecture $\widehat{a}$ to predict the corrective action. However, if the signal is perfectly informative ($\tau = 1$), they rely exclusively on the signal.

[14] The equivalent of condition (13), to ensure $x(1) \leq 1 + q$, is $c \leq \frac{\gamma\sigma^2[\omega + (1-\omega)z](2\tau-1)}{(1-\omega)(1-z)}$.

than tilting – it is a simple strategy for B to execute, that does not rely on her ability to observe the action. However, this robustness comes at a cost of providing no incentives to take it.

Proposition 2 thus highlights a new benefit of superior ES disclosure. Common arguments are that ES disclosure allows investors to allocate capital according to ES performance, and to hold managers to account. Both of these channels operate here, but there is an additional force – by allowing investors to allocate capital according to ES performance, they can induce corrective actions without having to commit to a significant investment in a brown firm.

4.2 Blockholder Private Information

We now allow the blockholder to gather private information on the action after it has been taken but before she trades. We assume the cost of information acquisition is arbitrarily small, and if B is indifferent between acquiring information and remaining uninformed, she prefers the latter. Other market participants remain uninformed about a, although they continue to observe the public signal s.

If the blockholder acquires private information on a, we assume that she can commit to an investment that conditions on a. Since both the manager and blockholder know when $a = 1$, the blockholder can reward the manager by purchasing stock if $a = 1$.[15] If the blockholder does not acquire information, then she can only base her investment strategy on the signal s. If the company has a low ES rating (i.e., $s = 0$), but B buys a stake in it (i.e., $x > 0$), she suffers a loss of $g > 0$ from client outflows, consistent with the evidence of Hartzmark and Sussman (2019).[16]

[15] If the blockholder reneges on this commitment, and the action becomes publicly observable with a lag so it becomes known that she has reneged, then she will be unable to induce the action in any other firms going forwards. The same logic means that B is able to commit to acquiring information. If she reneges on this commitment, she will be uninformed about a and thus will not be able to reward the manager by purchasing stock if $a = 1$. Allowing for a divestment strategy that conditions both on a and s would not change the result since the action a is perfectly predictable in equilibrium.

[16] Such outflows arise because clients use portfolio ES ratings to assess how responsible an investor the blockholder is. With rational expectations, every client would understand B's strategy and anticipate that M always chooses $a = 1$; thus, $s = 0$ provides no information about M's action. However, some clients may be unaware that B is able to obtain private information, that she is following a tilting strategy, or that M is able to take a corrective action. A rational expectations microfoundation is that there are multiple blockholder types, and one blockholder type places no weight on externalities and thus will hold an unreformed brown company to earn the profits from risk-bearing. Thus, $x > 0$ despite $s = 0$ causes clients to downwardly revise their beliefs that the blockholder is a responsible investor. $g > 0$ also captures any other cost from holding companies with

The blockholder's objective function is to minimize the sum of the firm's externalities, her cost of information acquisition, and her loss from outflows, i.e.

$$f + g(1-s)\mathcal{I}_{\{x>0\}}.$$

Proposition 3 *(Blockholder private information):*

(i) *If $\tau \geq \frac{1}{2} + \frac{1}{2}\frac{1-\omega}{\frac{1+z}{1-z}+\omega}$, the blockholder remains uninformed and chooses tilting if and only if $\xi > \overline{\xi}_{unob}(\tau)$, as in Proposition 2.*

(ii) *Suppose $\frac{1}{2} < \tau < \frac{1}{2} + \frac{1}{2}\frac{1-\omega}{\frac{1+z}{1-z}+\omega}$ and let*

$$\overline{\xi}_{in}(g) \equiv \frac{(1-\omega)\,c + \frac{(1-\tau)g}{\lambda}\frac{1-z}{z}\left(\omega + \frac{z}{1-z}\right)}{(1-\omega)\,c + \left(\frac{\mu}{z} - \gamma\sigma^2\right)\left(\omega + \frac{z}{1-z}\right)}. \tag{17}$$

$$\overline{\xi}_{un}(g) \equiv 1 - \frac{\frac{(1-\tau)g}{\lambda}\frac{1-z}{z}\left(\omega + \frac{z}{1-z}\right)}{c\left(\frac{\tau}{2\tau-1}(1-\omega) - \frac{1}{1-z}\right)}. \tag{18}$$

Then, there exists $g^* > 0$ that satisfies $\overline{\xi}_{unob}(\tau) = \overline{\xi}_{in}(g^*)$ such that:

(a) *If $g \geq g^*$, the blockholder remains uninformed and chooses tilting if and only if $\xi > \overline{\xi}_{unob}(\tau)$.*

(b) *If $g < g^*$, the blockholder chooses exclusion if $\xi < \overline{\xi}_{in}(g)$, informed tilting if $\overline{\xi}_{in}(g) < \xi < \overline{\xi}_{un}(g)$, and uninformed tilting if $\xi > \overline{\xi}_{un}(g)$. In this case $\overline{\xi}_{in}(g) < \overline{\xi}_{unob}(\tau) < \overline{\xi}_{un}(g)$, with $\lim_{g\nearrow g^*}\overline{\xi}_{in}(g) = \overline{\xi}_{unob}(\tau) = \lim_{g\nearrow g^*}\overline{\xi}_{un}(g)$.*

(c) *The equilibrium expected externality is increasing in g.*

Proposition 3 shows that B is less likely to acquire information when the loss from outflows g is large. Absent such losses, it is efficient for B to acquire private information as she does not need to promise as large a purchase to induce the action – since M knows that B will have observed that he has taken the action, he will be willing to do so even if the promised purchases are low. However, by committing to condition her strategy on a, the blockholder exposes herself to the risk that she ends up purchasing shares if $a = 1$ even if $s = 0$ – investing

low ES ratings, such as reputational losses or allegations of greenwashing.

in a company that the public thinks has taken no corrective action. If the loss from client outflows is sufficiently large, the blockholder is less likely to acquire private information which, in turn, increases the cost of inducing the action and deters her from doing so in the first place.

In reality, many responsible investors claim to gather private information on firms' social performance. However, they have no incentive to do so if they are unable to trade on private information, due to being evaluated on how their investments vary with publicly observable signals.

As is standard, B excludes if ξ is sufficiently low. If $g < g^*$, then B engages in informed tilting if ξ is sufficiently high. If ξ crosses a second, higher, threshold, B engages in uninformed tilting. Intuitively, if the action is sufficiently effective, then M undertakes it even if B is uninformed, i.e. bases her trades on a noisy signal rather than the actual action.

4.3 Optimal Disclosure

In this section, we return to the case in which a is unobservable to all investors, and allow the manager to choose τ ex ante by engaging in disclosure. We assume that if the manager is indifferent between different values of τ, he chooses the lowest possible τ of $\frac{1}{2}$ as this would be strictly optimal if disclosure were costly. We also assume the choice of τ is made public, so that B can condition her investment strategy on τ.

The equivalent of condition (13), to ensure $x(1) \leq 1 + q$, is $c \leq \frac{\gamma\sigma^2[\omega+(1-\omega)z]}{1+\omega+(1-\omega)z}$. Under this assumption, Proposition 4 gives M's optimal disclosure policy and shows how it affects B's optimal investment strategy.

Proposition 4 *(Optimal disclosure policy). If and only if*

$$\xi \geq 1 - \frac{\frac{\mu}{z} - \gamma\sigma^2}{\frac{\mu}{z} - \gamma\sigma^2 + c\frac{1-\omega}{\omega+\frac{z}{1-z}}} \equiv \overline{\xi}_{disc}, \tag{19}$$

then the manager chooses $\tau^* = \max\{\widehat{\tau}(\xi), \tau^{min}\} \in \left(\frac{1}{2}, 1\right)$ *where* $\widehat{\tau}(\xi)$ *satisfies* $\xi = \overline{\xi}_{unob}(\tau)$ *and* τ^{min} *satisfies* $\widehat{\Delta}_x(\tau^{min}) = 1 + q$*, the blockholder chooses tilting, and the manager chooses* $a = 1$*. Otherwise, the manager chooses* $\tau = \frac{1}{2}$*, the blockholder chooses exclusion, and the manager chooses* $a = 0$*. The threshold* $\overline{\xi}_{disc}$ *decreases in* (μ, ω)*, increases in* (c, γ, σ)*, and is hump-shaped in* (r, q)*.*

The manager discloses information (i.e. chooses $\tau > \frac{1}{2}$), and the blockholder chooses tilting, if and only if the action is sufficiently effective. The threshold for ξ decreases in the manager's stock price concerns. This is because disclosure increases the stock price if the manager has taken the action. One might think that M should choose full disclosure ($\tau = 1$) so that his action is always reflected in the signal ($s = 1$). In contrast, the manager deliberately discloses noisy signals, so that the blockholder has to promise a high investment $x(1)$ upon the action in order to induce it. Indeed, $\widehat{\tau}(\xi)$ is the minimum disclosure that persuades the blockholder to implement the action.

The model considers a blockholder who chooses optimally between tilting and exclusion strategies. Stepping outside the model, if there was a probability that the blockholder only implements exclusion strategies (e.g. due to lack of sophistication, or its clients believing that exclusion is the best way to invest responsibly), then the greater this probability, the more likely it is for the manager to choose minimal disclosure ($\tau = \frac{1}{2}$). Thus, if the economy contains more responsible investors that are open to adopting a tilting strategy, this would encourage firms to disclose more information about their ES activities, in turn reinforcing investors' incentives to adopt the tilting strategy. Relatedly, if the blockholder's investment strategy and the manager's disclosure choice were made simultaneously, rather than sequentially, then tilting and disclosure would be strategic complements – the manager will disclose more if he expects that the blockholder will tilt. Thus, there would be multiple equilibria where tilting is self-fulfilling. As a result, regulation that encourages either disclosure or tilting (e.g. not punishing responsible firms for holding brown stocks) could help coordinate on the tilting, high-disclosure equilibrium.

5 Presence of Arbitrageur

A common criticism of divestment strategies is they allow arbitrageurs to buy brown firms at depressed prices, attenuating the impact of divestment on prices. This section extends the model to incorporating an arbitrageur, A, who is purely profit-motivated like households, and is risk-neutral and can take large stakes and have price impact like the blockholder. We return to the case in which the action a is publicly observable; this simplifies the analysis as it means that firm value (which is net of c, if $a = 1$) is publicly observable.

With probability $\eta \in (0, 1]$, A arrives after B has announced her investment strategy and

M has taken action a. The presence of the arbitrageur is public information. He trades an amount y at $t = 2$ to maximize $\Pi_A(y) = y(v - p)$. The equivalent of condition (13), to ensure $x(1) \leq 1 + q$, is $c \leq \gamma\sigma^2[\omega + (1-\omega)z]\left(1 - \frac{\eta}{2}\right)$. Under this assumption, the solution is given in Proposition 5:

Proposition 5 *(Arbitrageur). If the arbitrageur is present, his trading volume and profit are given by*

$$y^*(x) = \arg\max_y \Pi_A(y) = \frac{1 + q - x}{2} \tag{20}$$

$$\Pi_A(y^*(x)) = \left(\frac{1}{2}\frac{1 + q - x}{1 + q}\right)^2 \gamma\sigma^2 \tag{21}$$

and, conditional on x, the stock price is given by

$$p(x, a, y^*(x)) = \frac{\mu - ca - \left(1 - \frac{\eta}{2}\right)\left(1 - \frac{x}{1+q}\right)\gamma\sigma^2}{1 + q - rq}. \tag{22}$$

The blockholder's optimal strategy is tilting and the manager chooses $a = 1$ if and only if

$$\xi \geq \overline{\xi}_{arb} \equiv \frac{(1-\omega)c}{(1-\omega)c + \left(\frac{\mu}{z} - \left(1 - \frac{\eta}{2}\right)\gamma\sigma^2\right)\left(\omega + \frac{z}{1-z}\right)}. \tag{23}$$

Otherwise, it is exclusion and the manager chooses $a = 0$. The tilting strategy involves

$$x(1) = \frac{(1+q)c}{\left(1 - \frac{\eta}{2}\right)\gamma\sigma^2[\omega + (1-\omega)z]}. \tag{24}$$

As is standard, A buys half of the free float not acquired by B, as shown in (20). Comparing (22) with (10), there is an additional $(1 - \frac{\eta}{2})$ term in the numerator, which multiplies the term containing x and means that the blockholder's trade has a lower effect on the stock price. Intuitively, if A is present, she buys half of the free float, so B's impact is halved. As a consequence, (24) contains an additional $(1 - \frac{\eta}{2})$ term in the denominator – since the blockholder has smaller price impact, she must promise a higher purchase to induce the action, which makes tilting more expensive to implement. Exclusion also becomes less effective because the arbitrageur partially reverses the impact of exclusion on the stock price and the cost of capital. Since the arbitrageur buys half of the free float, his impact is decreasing in the blockholder's trade. Thus, while the arbitrageur makes both exclusion and tilting less effective, the impact is greater on exclusion as the blockholder's trade is zero. As a result, the threshold in (23) is decreasing in η – the greater the probability of the arbitrageur appearing, the more likely the blockholder is to tilt.

6 Profit-Motivated Responsible Investor

This section extends the blockholder's objective function to comprise trading profits as well as externalities. She now maximizes

$$U_B = \varphi x (v - p) - (1 - \varphi) f(\theta, rI, a), \tag{25}$$

where $\varphi \in [0, 1]$ parametrizes the blockholder's concern for profits. The baseline model is a special case where $\varphi = 0$. We consider two sub-cases: in the first, B cannot commit to an investment strategy; in the second, she can. We use "profit-motivated" to denote a blockholder with $\varphi > 0$ and "responsible" for $\varphi = 0$.

6.1 No Commitment

Suppose that B cannot commit to an investment strategy, i.e. she chooses her trade at $t = 2$ optimally after the action a has become public at $t = 1$. In the baseline model where $\varphi = 0$, the blockholder will always choose $x = 0$. Her trading decision has no influence on the action since it has already been taken; her only objective is to minimize firm size which is achieved through $x = 0$. Thus, in equilibrium, M will choose $a = 0$ and the expected externality is $\lambda \frac{\mu - z\gamma\sigma^2}{1-z}$.

If $\varphi > 0$, B's objective function includes profit. Given action a, she maximizes her expected utility by choosing:

$$x^* (a) = \frac{1+q}{2} \max \left\{ 1 - \frac{1-\varphi}{\varphi} \frac{z}{1-z} \lambda (1 - a\xi), 0 \right\}. \tag{26}$$

The profit-motivated blockholder buys shares, since there are gains from trade between the risk-neutral blockholder and the risk-averse households. Moreover, $x^* (1) \geq x^* (0)$: the blockholder buys more shares when the manager takes the action, even though it reduces firm value. The intuition is as follows. The action's impact on firm value does not affect trading profits, because the action is public and thus fully reflected in the stock price. However, the action means that buying shares, and thus helping the company expand, has a less positive impact on externalities. Thus, buying shares has the same benefit (trading profits are unchanged) and a lower cost (externalities are smaller) and so the blockholder buys more shares if $a = 1$.

The manager has rational expectations about the blockholder trade $x^*(a)$. As in the baseline model, he takes the action if and only if

$$x^*(1) - x^*(0) \geq \overline{\Delta}_x, \tag{27}$$

where $\overline{\Delta}_x$ is given by (11). The equilibrium is given by Proposition 6.

Proposition 6 *(Profit-motivated blockholder, no commitment): Suppose the blockholder cannot commit to an investment strategy. In equilibrium:*

(i) If $\xi \leq \frac{2c}{\gamma\sigma^2[\omega+(1-\omega)z]}$, *the blockholder buys* $x^*(0)$ *shares and* $a^* = 0$.

(ii) If $\xi > \frac{2c}{\gamma\sigma^2[\omega+(1-\omega)z]}$, *there exists* $0 < \underline{\varphi}(\xi) < \overline{\varphi}(\xi) < 1$ *such that:*

- *(a) If* $\varphi \in [\underline{\varphi}(\xi), \overline{\varphi}(\xi)]$, *the blockholder buys* $x^*(1)$ *shares and* $a^* = 1$.
- *(b) If* $\varphi \notin [\underline{\varphi}(\xi), \overline{\varphi}(\xi)]$, *the blockholder buys* $x^*(0)$ *shares and* $a^* = 0$.

(iii) Let $f^*(\varphi)$ *be the externalities where the blockholder's weight on profits is* φ. *Then, there exists* $\xi_{NC} \in (0,1)$ *and* $\varphi_{NC}(\xi) \leq \overline{\varphi}(\xi)$ *such that:*

- *(a) If* $\xi \leq \max\left\{\frac{2c}{\gamma\sigma^2[\omega+(1-\omega)z]}, \xi_{NC}\right\}$ *then* $f^*(\varphi) = f^*(0)$ *if* $\varphi < \underline{\varphi}(\xi)$, *and* $f^*(\varphi) > f^*(0)$ *if* $\varphi \geq \underline{\varphi}(\xi)$.
- *(b) If* $\xi > \max\left\{\frac{2c}{\gamma\sigma^2[\omega+(1-\omega)z]}, \xi_{NC}\right\}$ *then* $f^*(\varphi) = f^*(0)$ *if* $\varphi < \underline{\varphi}(\xi)$, $f^*(\varphi) < f^*(0)$ *if* $\varphi \in [\underline{\varphi}(\xi), \varphi_{NC}(\xi)]$, *and* $f^*(\varphi) > f^*(0)$ *if* $\varphi \geq \varphi_{NC}(\xi)$.

Part (i) states that, as in the baseline model, the blockholder cannot induce the action if it is sufficiently ineffective. Part (ii) demonstrates that, if the action is sufficiently effective, the blockholder can induce it if profit motives fall within an intermediate range. On the one hand, they need to be sufficiently high to induce the blockholder to buy shares even though doing so also increases externalities. On the other hand, the blockholder's concern for externalities also has to be sufficiently high that she buys significantly more shares when $a = 1$ than when $a = 0$.

Even if profit motives allow the blockholder to induce the action, this does not automatically mean that externalities fall, since profit motives also lead the blockholder to buy shares which helps the firm expand. Part (iii) shows that, for an intermediate range of profit motives and a sufficiently effective action, the former effect outweighs the latter and so externalities do fall.

The intuition is as follows. In the baseline model, the blockholder is able to commit to buying more shares when the action is taken. If the blockholder cannot commit, and is only concerned with externalities, she will not buy shares, regardless of the manager's action, as doing so increases externalities. Profit motives substitute for the ability to commit – they make it individually rational for the blockholder to buy more shares when $a = 1$, effectively committing her to reward the action.

While a profit motivation makes it credible for the blockholder to reward the action, it may lead to the blockholder buying more shares than necessary to induce the action. In Appendix B.3, we show that a regulation that caps the stake that an investor may hold in brown firms can induce the action while also limiting firm expansion, thus lowering externalities overall. The blockholder will not voluntarily impose such a cap as it reduces her trading profits, hence the role of regulation in doing so.

6.2 Commitment

This subsection allows the blockholder to commit to a trading strategy, as in the baseline model. The equilibrium is given by Proposition 7.

Proposition 7 *(Profit-motivated blockholder, commitment):*

(i) *The firm's externalities in equilibrium increase with φ.*

(ii) *There exists $\overline{\xi}_C > 0$ such that the profit-motivated blockholder induces the action if and only if $\xi \geq \overline{\xi}_C$. Moreover,*

  (a) *If $\overline{\Delta}_x \leq \frac{1+q}{2}$ then $\overline{\xi}_C < 1$, and if $\overline{\Delta}_x > \frac{1+q}{2}$ then there is $\varphi^* > \frac{z\lambda}{1-z+z\lambda}$ such that $\overline{\xi}_C < 1$ if and only if $\varphi < \varphi^*$.*

(b) *If* $\frac{1+q}{2} < \overline{\Delta}_x$ *and* $\varphi < \frac{z\lambda}{1-z+z\lambda}$, *then* $\overline{\xi}_C < \overline{\xi}$.

Part (i) shows that, under commitment, a profit-motivated investor will always generate (weakly) more externalities than a responsible investor, who by definition minimizes externalities. The greater the weight the investor puts on trading profits, the larger are the expected externalities in equilibrium. Part (ii) shows that, as in the baseline model, a profit-motivated investor tilts if the action is sufficiently effective. Intuitively, large ξ makes tilting attractive since it reduces externalities (as in the baseline model), but also because it enables the profit-motivated investor to earn the gains from trade at a lower social cost. Part (iia) confirms that this condition is satisfied for a non-empty range of parameter values, i.e. profit-motivated investors continue to tilt in some cases. Part (iib) gives sufficient conditions for the threshold for ξ to be lower for a profit-motivated investor than a responsible one. If these conditions are satisfied, then when $\xi \in \left(\overline{\xi}_C, \overline{\xi}\right)$, a responsible investor excludes but a profit-motivated investor tilts. Intuitively, even though tilting leads to more externalities, it also generates trading profits which the profit-motivated investor is concerned about but the responsible investor is not.

7 Conclusion

This paper has analyzed the optimal investment strategy of a responsible investor who aims to minimize the externalities emitted by a brown firm. While exclusion minimizes the stock price and thus the amount of externality-enhancing investment the firm can undertake, it provides no incentives for the firm to undertake a corrective action. Tilting encourages the action at the cost of providing capital to a brown firm and allowing it to expand. The optimal strategy is for the investor to tilt if the action is effective at reducing externalities and comes at little cost to firm value, and also if the manager's stock price concerns are high, as then the blockholder does not need to promise a large investment to induce reform. Surprisingly, greater capital needs may reduce the relative effectiveness of exclusion, even though it increases the cost of capital.

We extend the model to the case in which the action is not observable, but a noisy signal is. The noisier the signal, the greater the reward the investor needs to offer to induce the action, and the less likely she is to tilt. Even if the blockholder has the option to acquire private information about the manager's action at an arbitrarily small cost, she may refrain from doing so if there is a cost to investing in a company that has taken a corrective action but the public is unaware of this fact. If there is an arbitrageur who buys underpriced stock, exclusion becomes relatively less effective as the arbitrageur offsets its effect on the stock price.

Finally, if the blockholder is partially profit-motivated, this gives her greater incentives to tilt, since she makes a profit from buying shares from risk-averse households. In particular, if the blockholder is unable to commit to an investment strategy, one whose sole objective is to minimize externalities can never credibly tilt, since she has no incentives to buy shares after the action has been taken. A profit motivation effectively commits the blockholder to buy more shares if the action is taken, i.e. to tilt.

Our paper considers secondary market trading, and demonstrates that tilting can be effective even if non-investment by the blockholder does not directly starve the firm of capital because the shares are bought by households. The mechanisms will continue to hold if the blockholder is providing primary capital, such as a new loan or primary equity financing to a start-up. It may seem that withholding primary financing from brown firms is the most responsible investing strategy as it hinders them from expanding. However, being willing to provide primary capital to brown firms that are best-in-class will encourage such companies to reduce their externalities.

Our results have a number of potential implications for policymakers. Most obviously, it highlights that regulators should not automatically punish sustainable funds that hold brown stocks as a measure of an investor's sustainability. Under the EU's Sustainable Finance Disclosure Regulation, Article 9 funds are viewed as the most sustainable, and likely attract most client inflows, but they are prevented from holding any brown stocks even if they are best-in-class. Similarly, the EU's Non-Financial Reporting Directive requires institutional investors to report the percentage of their portfolio that is environmentally sustainable, as defined by their alignment with the EU Taxonomy. This also encourages investors to exclude rather than tilt. In contrast, regulators should police the opposite behavior – sustainable funds that claim to be actively managed but blanketly exclude certain sectors. Just as regulators are scrutinizing actively-managed mainstream funds that act like closet indexers, they could also scrutinize actively-managed sustainable funds that engage in blanket exclusion. A quite separate implication is that ensuring that funds fulfill their fiduciary duty to generate financial returns for their clients is not inconsistent with social returns, and may actually support it by giving funds incentives to tilt if commitment is not possible.

Various standard-setting bodies (e.g. the Value Reporting Framework and the World Economic Forum) are developing common metrics for company ES performance. A frequently-stated advantage of such standards is that they allow policymakers and savers to evaluate which funds are greenwashing by studying the average metrics of their portfolio companies. However, such behavior will deter investors from gathering their own private information and using it to tilt in a less costly way.

While our analysis has focused on brown industries, a similar result likely applies for green industries. Some sustainable funds will be significantly more likely to own a company if it is in a green sector. However, such a blanket policy provides few incentives for companies within this sector to increase their positive externalities, since they will likely be held anyway. A tilting strategy, which overweights green industries but avoids "worst-in-class" companies within such sectors, may be more effective than blanket inclusion. An investment strategy that tilts away from brown sectors and towards green sectors will require similar amounts of capital to one that automatically excludes the former and includes the latter. While tilting requires capital to hold best-in-class brown firms, it also saves capital by avoiding worst-in-class green firms.

The model suggests potential avenues for future research. One extension is to multiple firms. In addition to demonstrating that the optimal divestment strategy might involve buying firms that are literally best-in-class, featuring these firms as competing with each other in the same industry would have implications for how the investor's divestment strategy affects product market interactions. A second extension is to multiple responsible investors. They may increase the power of tilting if multiple investors are able to reward the manager for the action. In contrast, if they compete for client flows and unsophisticated clients view funds that blanketly exclude as being more responsible, such competition may discourage tilting. A third is to a dynamic setting, where past actions may affect the effectiveness of future ones – for example, if there are diminishing returns to corrective actions, the blockholder may start off tilting but later switch to exclusion. Note that changes to parameters such as the effectiveness of the action can already be studied by our comparative statics, but new results may emerge that are unique to a dynamic setting such as an increased ability to commit.

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A For Online Publication: Proofs

Proof of Proposition 1. B's objective function is given by $\mathbb{E}[f(\theta, rI, a)]$ with $I = qp(a)$. The equilibrium stock price, as a function of a, is given by:

$$p(a) = \begin{cases} \frac{\mu - \gamma\sigma^2 + \frac{x(1)}{1+q}\gamma\sigma^2 - c}{1+q-rq} & \text{if } a = 1 \\ \frac{\mu - \gamma\sigma^2}{1+q-rq} & \text{if } a = 0. \end{cases} \tag{28}$$

If $a = 1$, the realized, and thus the expected, externality increases in $x(1)$ through its impact on $p(1)$. As a result, B's objective given $a = 1$ is minimized at the smallest possible value that implements $a = 1$, $x(1) = \overline{\Delta}_x$. It follows that B implements $a = 1$ by choosing $x(1) = \overline{\Delta}_x$ if and only if:

$$x(1) = \overline{\Delta}_x \Leftrightarrow \mathbb{E}[f(\theta, rqp(0), 0)] \geq \mathbb{E}[f(\theta, rqp(1; x(1) = \overline{\Delta}_x), 1)]. \tag{29}$$

Otherwise, B is better off implementing $a = 0$ and sets $x(1) = x(0) = 0$. Evaluating $\mathbb{E}[f]$ at $a \in \{0, 1\}$ leads to the following condition for tilting:

$$x(1) = \overline{\Delta}_x \Leftrightarrow \xi \geq \frac{rq\left(p\left(1\right) - p\left(0\right)\right)}{\mu + rqp\left(1\right)}. \tag{30}$$

Evaluating $p(a)$ at $a \in \{0, 1\}$ and using $x(1) = \overline{\Delta}_x$ leads to:

$$\overline{\xi} = \frac{\frac{\overline{\Delta}_x}{1+q}\gamma\sigma^2 - c}{\frac{\mu}{z} - \gamma\sigma^2 + \frac{\overline{\Delta}_x}{1+q}\gamma\sigma^2 - c} = \frac{c\left(1 - \omega\right)}{\left(\frac{\mu}{z} - \gamma\sigma^2\right)\left(\omega + \frac{z}{1-z}\right) + c\left(1 - \omega\right)} \tag{31}$$

where we have used $\overline{\Delta}_x = \frac{c(1+q)}{\gamma\sigma^2[\omega + (1-\omega)z]}$.

It immediately follows from the expression for $\overline{\xi}$ that $\frac{\partial\overline{\xi}}{\partial\mu} < 0$, $\frac{\partial\overline{\xi}}{\partial\gamma} > 0$, and $\frac{\partial\overline{\xi}}{\partial\sigma} > 0$. For the effect of c, we can divide the expression above by c to see that $\frac{\partial\overline{\xi}}{\partial c} > 0$. For the effect of ω, we re-write the expression as:

$$\overline{\xi} = \frac{c}{\left(\frac{\mu}{z} - \gamma\sigma^2\right) g_1(\omega) + c} \tag{32}$$

with $g_1(\omega) \equiv \left(\omega + \frac{z}{1-z}\right)\frac{1}{1-\omega}$ and $g_1'(z) = \frac{1}{(1-\omega)^2(1-z)} > 0$ because $z \in (0, 1)$. It follows that $\frac{\partial\overline{\xi}}{\partial\omega} < 0$ if $\omega \in [0, 1)$. If $\omega = 1$, then $\overline{\xi} = 0$.

For the effect of z, and thus (r, q), we re-write the expression above as:

$$\overline{\xi} = \frac{(1-\omega)\,c}{g_2(z) + (1-\omega)\,c} \tag{33}$$

with $g_2(z) = \left(\frac{\mu}{z} - \gamma\sigma^2\right)\left(\omega + \frac{z}{1-z}\right)$. If $\omega = 1$, then $\overline{\xi}$ does not depend on z. If $\omega < 1$, then the sign of $\frac{\partial\overline{\xi}}{\partial z}$ is the opposite of $g_2'(z)$, which is equal to:

$$g_2'(z) = \frac{\mu - \gamma\sigma^2}{(1-z)^2} - \frac{\omega\mu}{z^2}. \tag{34}$$

Also note that $g_2''(z) > 0$, $\lim_{z\to 0} g'(z) = -\infty$ if $\omega > 0$ and $\lim_{z\to 0} g'(z) > 0$ if $\omega = 0$, and that $\lim_{z\to 1} g'(z) = \infty$. It follows that $g_2(z)$ is U-shaped in z if $\omega > 0$ and that it is increasing in z if $\omega = 0$. As a result, $\overline{\xi}$ is hump-shaped in (r, q) if $\omega > 0$ and decreasing in (r, q) if $\omega = 0$. ■

Proof of Equation (15). The equilibrium stock price given s is given by:

$$p(\widehat{a}, s) = \frac{\mu - c\widehat{a} - \left(1 - \frac{x(s)}{1+q}\right)\gamma\sigma^2}{1 + q - rq}, \tag{35}$$

where $\widehat{a}$ denotes the action conjectured by households.

If M chooses $a = 1$, his expected utility is given by:

$$\mathbb{E}[U_m|a=1] = \omega\left[\tau p(\widehat{a},1) + (1-\tau)p(\widehat{a},0)\right] + (1-\omega)\frac{\mu + rq\left[\tau p(\widehat{a},1) + (1-\tau)p(\widehat{a},0)\right] - c}{1+q}.$$

If he chooses $a = 0$, his expected utility is given by:

$$\mathbb{E}[U_m|a=0] = \omega\left[\tau p(\widehat{a},0) + (1-\tau)p(\widehat{a},1)\right] + (1-\omega)\frac{\mu + rq\left[\tau p(\widehat{a},0) + (1-\tau)p(\widehat{a},1)\right]}{1+q}.$$

Conditional on tilting, M chooses $a = 1$ if and only if $\mathbb{E}[U_m|a=1] \geq \mathbb{E}[U_m|a=0]$, which is equivalent to the condition in equation (15). ■

Proof of Proposition 2. For $\tau \in (\frac{1}{2}, 1)$, B chooses tilting, $(x(1) = \widehat{\Delta}_x, x(0) = 0)$ if (i) the expected externality with $a = 1$ and $x(1) = \widehat{\Delta}_x$ is lower than under $a = 0$ and $x(1) = 0$, and (ii) $x(1) \leq 1 + q$. It follows from the expression for $\widehat{\Delta}_x(\tau)$ that condition (ii) is equivalent to $c \leq \frac{\gamma\sigma^2[\omega+(1-\omega)z](2\tau-1)}{(1-\omega)(1-z)}$. Otherwise, she chooses exclusion and sets $x(1) = x(0) = 0$. Suppose

$c \leq \frac{\gamma\sigma^2[\omega+(1-\omega)z](2\tau-1)}{(1-\omega)(1-z)}$, then B chooses tilting if:

$$
\begin{aligned}
\left[\mu + rq\left(\tau p(1,1) + (1-\tau)p(1,0)\right)\right](1-\xi) \leq \mu + rqp(0,0) \Leftrightarrow \\
1-\xi &\leq \frac{\mu + rqp(0,0)}{\mu + rq\left(\tau p(1,1) + (1-\tau)p(1,0)\right)} \Leftrightarrow \\
1-\xi &\leq \frac{\mu + \frac{z}{1-z}\left(\mu - \gamma\sigma^2\right)}{\mu + \frac{z}{1-z}\left(\mu - c - \left(1 - \frac{\tau\hat{\Delta}_x}{1+q}\right)\gamma\sigma^2\right)} \Leftrightarrow \\
\xi &\geq 1 - \frac{\frac{\mu}{z} - \gamma\sigma^2}{\frac{\mu}{z} - \gamma\sigma^2 - c + \gamma\sigma^2\frac{\tau\hat{\Delta}_x}{1+q}} \Leftrightarrow \\
\xi &\geq 1 - \frac{\frac{\mu}{z} - \gamma\sigma^2}{\frac{\mu}{z} - \gamma\sigma^2 + c\left(\frac{\tau}{2\tau-1}\frac{1-\omega}{\omega+\frac{z}{1-z}} - 1\right)} \equiv \overline{\xi}_{\text{unob}}(\tau).
\end{aligned}
$$

It immediately follows that $\overline{\xi}_{\text{unob}}(\tau)$ increases in (c, γ, σ) and decreases in (μ, τ). Moreover, it decreases in ω because $\frac{1-\omega}{\omega+\frac{z}{1-z}}$ decreases in ω. For $\tau = \frac{1}{2}$, B always chooses exclusion. ■

Proof of Proposition 3. We start by calculating B's payoff in different scenarios, assuming that $c \leq \frac{\gamma\sigma^2[\omega+(1-\omega)z](2\tau-1)}{(1-\omega)(1-z)}$ so that she can implement tilting, which is shown in Proposition 2. If $c > \frac{\gamma\sigma^2[\omega+(1-\omega)z](2\tau-1)}{(1-\omega)(1-z)}$, then B always chooses exclusion. First, if B chooses exclusion, then M chooses $a = 0$, and B's payoff is independent of her private information and given by

$$\Pi_{exclusion} = -\lambda\left[\mu + rqp(0)\right].$$

In particular, B never acquires information if she intends to use exclusion.

Second, if B is uninformed about a and chooses tilting, she must be conditioning her trade on s. Therefore, she never suffers outflows and her payoff from tilting is

$$\Pi^{un}_{tilting} = -\lambda\left[\mu + rq\left(\tau p(1,1) + (1-\tau)p(1,0)\right)\right](1-\xi).$$

Third, if B is informed about a and chooses tilting, where she conditions her trade on a, her expected payoff is

$$\Pi^{in}_{tilting} = -\lambda\left(\mu + rqp(1)\right)(1-\xi) - (1-\tau)g.$$

Overall, if B prefers uninformed tilting over exclusion if and only if $\Pi^{un}_{tilting} > \Pi_{exclusion} \Leftrightarrow \xi >$

$\overline{\xi}(\tau)$. She prefers informed tilting over exclusion if and only if $\Pi^{in}_{tilting} > \Pi_{exclusion} \Leftrightarrow$

$$\begin{aligned}
-\lambda\left(\mu + rqp(1)\right)(1-\xi) - (1-\tau)\,g \geq -\lambda\left[\mu + rqp(0)\right] &\Leftrightarrow \\
\xi \geq \frac{rq\left[p(1)-p(0)\right] + \frac{(1-\tau)g}{\lambda}}{\mu + rqp(1)} &\Leftrightarrow \\
\xi \geq \frac{\frac{z}{1-z}\left[-c + \frac{x(1)}{1+q}\gamma\sigma^2\right] + \frac{(1-\tau)g}{\lambda}}{\mu + \frac{z}{1-z}\left[\mu - c - \left(1 - \frac{x(1)}{1+q}\right)\gamma\sigma^2\right]} &\Leftrightarrow \\
\xi \geq \frac{-c + \frac{x(1)}{1+q}\gamma\sigma^2 + \frac{(1-\tau)g}{\lambda}\frac{1-z}{z}}{\frac{\mu}{z} - \gamma\sigma^2 - c + \frac{x(1)}{1+q}\gamma\sigma^2} &\Leftrightarrow \\
\xi \geq \overline{\xi}_{\text{in}}(g) \equiv \frac{(1-\omega)\,c + \frac{(1-\tau)g}{\lambda}\frac{1-z}{z}\left(\omega + \frac{z}{1-z}\right)}{(1-\omega)\,c + \left(\frac{\mu}{z} - \gamma\sigma^2\right)\left(\omega + \frac{z}{1-z}\right)}&.
\end{aligned}$$

Note that

$$\begin{aligned}
\overline{\xi}_{\text{unob}}(\tau) > \overline{\xi}_{\text{in}}(g) &\Leftrightarrow \\
1 - \frac{\frac{\mu}{z} - \gamma\sigma^2}{\frac{\mu}{z} - \gamma\sigma^2 + c\left(\frac{\tau}{2\tau-1}\frac{1-\omega}{\omega + \frac{z}{1-z}} - 1\right)} > \frac{(1-\omega)\,c + \frac{(1-\tau)g}{\lambda}\frac{1-z}{z}\left(\omega + \frac{z}{1-z}\right)}{(1-\omega)\,c + \left(\frac{\mu}{z} - \gamma\sigma^2\right)\left(\omega + \frac{z}{1-z}\right)} &\Leftrightarrow \\
\frac{\frac{\mu}{z} - \gamma\sigma^2}{\frac{\mu}{z} - \gamma\sigma^2 + c\left(\frac{\tau}{2\tau-1}\frac{1-\omega}{\omega + \frac{z}{1-z}} - 1\right)} c\left[\frac{\tau}{2\tau-1}(1-\omega) - \frac{1}{1-z}\right] > \frac{(1-\tau)\,g}{\lambda}\frac{1-z}{z}\left(\omega + \frac{z}{1-z}\right) &\Leftrightarrow \\
\left(1 - \overline{\xi}(\tau)\right) c\left[\frac{\tau}{2\tau-1}(1-\omega) - \frac{1}{1-z}\right] > \frac{(1-\tau)\,g}{\lambda}\frac{1-z}{z}\left(\omega + \frac{z}{1-z}\right)&
\end{aligned}$$

Moreover, we have that $\frac{\tau}{2\tau-1}(1-\omega) - \frac{1}{1-z} > 0 \Leftrightarrow \tau < \frac{1}{2-(1-z)(1-\omega)}$. Thus,

$$\begin{aligned}
\overline{\xi}_{\text{unob}}(\tau) > \overline{\xi}_{\text{in}}(g) &\Leftrightarrow \\
\tau < \frac{1}{2-(1-z)(1-\omega)} \text{ and } \overline{\xi}_{\text{unob}}(\tau) < \overline{\xi}_{\text{un}}(g)&
\end{aligned}$$

where

$$\overline{\xi}_{\text{un}}(g) \equiv 1 - \frac{\frac{(1-\tau)g}{\lambda}\frac{1-z}{z}\left(\omega + \frac{z}{1-z}\right)}{c\left[\frac{\tau}{2\tau-1}(1-\omega) - \frac{1}{1-z}\right]}.$$

B prefers informed tilting over uninformed tilting if and only if $\Pi^{in}_{tilting} > \Pi^{un}_{tilting} \Leftrightarrow$

$$-\lambda\left(\mu + rqp(1)\right)(1-\xi) - (1-\tau)\,g > -\lambda\left[\mu + rq\left(\tau p(1,1) + (1-\tau)p(1,0)\right)\right](1-\xi) \Leftrightarrow$$
$$p(1) + \frac{1}{rq}\frac{(1-\tau)\,g}{\lambda}\frac{1}{1-\xi} < \tau p(1,1) + (1-\tau)p(1,0) \Leftrightarrow$$
$$\frac{\mu - c - \left(1 - \frac{x(a=1)}{1+q}\right)\gamma\sigma^2}{1+q-rq} + \frac{1}{rq}\frac{(1-\tau)\,g}{\lambda\,(1-\xi)} < \tau\frac{\mu - c - \left(1 - \frac{x(s=1)}{1+q}\right)\gamma\sigma^2}{1+q-rq} + (1-\tau)\frac{\mu - c - \gamma\sigma^2}{1+q-rq} \Leftrightarrow$$
$$\frac{x(a=1)}{1+q}\gamma\sigma^2 + \frac{1+q-rq}{rq}\frac{(1-\tau)\,g}{\lambda\,(1-\xi)} < \tau\frac{x(s=1)}{1+q}\gamma\sigma^2 \Leftrightarrow$$
$$\frac{\frac{c(1+q)}{\gamma\sigma^2[\omega+(1-\omega)z]}}{1+q}\gamma\sigma^2 + \frac{1-z}{z}\frac{(1-\tau)\,g}{\lambda\,(1-\xi)} < \tau\frac{\frac{1}{2\tau-1}\frac{(1-\omega)c(1+q)(1-z)}{\gamma\sigma^2[\omega+(1-\omega)z]}}{1+q}\gamma\sigma^2 \Leftrightarrow$$
$$\frac{c}{\omega+(1-\omega)z} + \frac{1-z}{z}\frac{(1-\tau)\,g}{\lambda\,(1-\xi)} < \frac{\tau}{2\tau-1}(1-\omega)(1-z)\frac{c}{\omega+(1-\omega)z}$$

That is, $\Pi^{in}_{tilting} > \Pi^{un}_{tilting} \Leftrightarrow$

$$\tau < \frac{1}{2-(1-z)\,(1-\omega)} \text{ and } \xi < \overline{\xi}_{\text{un}}\,(g)\,.$$

We consider two cases:

1. Suppose $\overline{\xi}_{\text{unob}}\,(\tau) < \overline{\xi}_{\text{in}}\,(g)$. There are three sub cases:

   (a) If $\xi < \overline{\xi}_{\text{unob}}\,(\tau)$ then B prefers exclusion over both informed and uninformed tilting and hence she never becomes informed and always chooses exclusion.

   (b) If $\overline{\xi}_{\text{unob}}\,(\tau) < \xi < \overline{\xi}_{\text{in}}\,(g)$ then B prefers uninformed tilting over exclusion, and exclusion over informed tilting. Therefore, B never becomes informed and she choose tilting.

   (c) If $\overline{\xi}_{\text{in}}\,(g) < \xi$, then exclusion is an inferior strategy. Recall $\overline{\xi}\,(\tau) < \overline{\xi}_{\text{in}}\,(g)$ implies either $\tau \geq \frac{1}{2-(1-z)(1-\omega)}$, in which case we have $\Pi^{in}_{tilting} < \Pi^{un}_{tilting}$, or $\overline{\xi}_{\text{un}}\,(g) < \overline{\xi}_{\text{unob}}\,(\tau)$, which given $\overline{\xi}_{\text{unob}}\,(\tau) < \overline{\xi}_{\text{in}}\,(g) < \xi$, implies $\overline{\xi}_{\text{un}}\,(g) < \xi$, i.e. $\Pi^{in}_{tilting} < \Pi^{un}_{tilting}$. Either way, B remains uninformed.

   We conclude, if $\overline{\xi}_{\text{unob}}\,(\tau) < \overline{\xi}_{\text{in}}\,(g)$ then B remains uninformed. She chooses exclusion if and only if $\xi < \overline{\xi}_{\text{unob}}\,(\tau)$. Note that if $\tau < \frac{1}{2-(1-z)(1-\omega)}$ then $\overline{\xi}_{\text{unob}}\,(\tau) > \overline{\xi}_{\text{in}}\,(0)$, and hence, there is $g^* > 0$ that satisfies $\overline{\xi}_{\text{unob}}(\tau) = \overline{\xi}_{\text{in}}(g^*)$, such that $\overline{\xi}_{\text{unob}}(\tau) < \overline{\xi}_{\text{in}}(g) \Leftrightarrow g > g^*$. Note that if $\overline{\xi}_{\text{unob}}(\tau) = \overline{\xi}_{\text{in}}(g^*)$ and $\tau < \frac{1}{2-(1-z)(1-\omega)}$, then it must be $\overline{\xi}_{\text{unob}}(\tau) = \overline{\xi}_{\text{un}}(g^*)$

2. Suppose $\overline{\xi}_{\text{unob}}(\tau) > \overline{\xi}_{\text{in}}(g)$. There are three sub cases:

   (a) If $\xi < \overline{\xi}_{\text{in}}(g)$ then B prefers exclusion over both informed and uninformed tilting and hence she never becomes informed and always chooses exclusion.

   (b) If $\overline{\xi}_{\text{in}}(g) < \xi < \overline{\xi}_{\text{unob}}(\tau)$ then B prefers informed tilting over exclusion, and exclusion over uninformed tilting. Therefore, B becomes informed and chooses tilting.

   (c) If $\overline{\xi}_{\text{unob}}(\tau) < \xi$, then exclusion is an inferior strategy. Recall $\overline{\xi}_{\text{unob}}(\tau) > \overline{\xi}_{\text{in}}(g)$ implies $\tau < \frac{1}{2-(1-z)(1-\omega)}$ and $\overline{\xi}_{\text{un}}(g) > \overline{\xi}_{\text{unob}}(\tau)$. Therefore, in this case, $\overline{\xi}_{\text{in}}(g) < \overline{\xi}_{\text{unob}}(\tau) < \overline{\xi}_{\text{un}}(g)$. B chooses informed tilting if $\xi < \overline{\xi}_{\text{un}}(g)$, and uninformed tilting if $\xi > \overline{\xi}_{\text{un}}(g)$.

We conclude that if $\overline{\xi}_{\text{unob}}(\tau) > \overline{\xi}_{\text{in}}(g)$ then B chooses exclusion if $\xi < \overline{\xi}_{\text{in}}(g)$, informed tilting if $\overline{\xi}_{\text{in}}(g) < \xi < \overline{\xi}_{\text{un}}(g)$, and uninformed tilting if $\xi > \overline{\xi}_{\text{un}}(g)$.

Finally, suppose $\xi < \overline{\xi}_{\text{unob}}(\tau)$. Note that externalities are lower under exclusion than informed tilting if and only if $\xi < \overline{\xi}_{\text{in}}(0)$. Therefore, if $\xi < \overline{\xi}_{\text{in}}(0)$ then g has no impact on the externalities in equilibrium. If $\overline{\xi}_{\text{in}}(0) < \xi < \overline{\xi}_{\text{unob}}(\tau)$ then larger g increases the externalities in equilibrium by increasing the likelihood of exclusion in a region where informed tilting generates lower externalities.

Second, suppose $\xi > \overline{\xi}_{\text{unob}}(\tau)$. Note that externalities are lower under informed tilting than uninformed tilting if and only if $\xi < \overline{\xi}_{\text{un}}(0)$. Therefore, if $\xi > \overline{\xi}_{\text{un}}(0)$ then g has no impact on the externalities in equilibrium. If $\overline{\xi}_{\text{unob}}(\tau) < \xi < \overline{\xi}_{\text{un}}(0)$ then larger g increases the externalities in equilibrium by increasing the likelihood of uninformed tilting in a region where informed tilting generates lower externalities. ■

Proof of Proposition 4. We have shown before that $\overline{\xi}_{\text{unob}}(\tau)$ is a decreasing function of τ. Moreover, $\lim_{\tau\to 1}\overline{\xi}_{\text{unob}}(\tau) < 1$. If $\lim_{\tau\to 1}\overline{\xi}_{\text{unob}}(\tau) > \xi$ then B chooses exclusion regardless of τ. In this case, M chooses $\tau = \frac{1}{2}$. Suppose $\lim_{\tau\to 1}\overline{\xi}_{\text{unob}}(\tau) \leq \xi$, there exists $\widehat{\tau}(\xi) \in (\frac{1}{2}, 1)$ such that, $\xi \geq \overline{\xi}_{\text{unob}}(\tau) \Leftrightarrow \tau \geq \widehat{\tau}(\xi)$. Moreover, suppose that $\widehat{\Delta}_x(\tau) \leq 1 + q$. We can write the expected payoff and stock price as functions of τ as follows

$$\mathbb{E}[p(\tau)] = \frac{\mu - \gamma\sigma^2 + \left(\frac{\tau\widehat{\Delta}_x(\tau)}{1+q}\gamma\sigma^2 - c\right)\mathbf{1}_{\tau\geq\widehat{\tau}(\xi)}}{1+q-rq} \tag{36}$$

and

$$\mathbb{E}[v(\tau)] = \frac{\mu + rq\mathbb{E}[p(\tau)] - c\mathbf{1}_{\tau\geq\widehat{\tau}(\xi)}}{1+q}. \tag{37}$$

M's expected utility can be rewritten as:

$$\begin{aligned}
\mathbb{E}[U_m(\tau)] &= \omega\mathbb{E}[p(\tau)] + (1-\omega)\mathbb{E}[v(\tau)] \\
&= [\omega + (1-\omega)z]\,\mathbb{E}[p(\tau)] + (1-\omega)\frac{\mu - c\cdot\mathbf{1}_{\tau\geq\widehat{\tau}(\xi)}}{1+q} \\
&= [\omega + (1-\omega)z]\left(\frac{\mu-\gamma\sigma^2}{1+q-rq} + \frac{\frac{\tau\widehat{\Delta}_x(\tau)}{1+q}\gamma\sigma^2 - c}{1+q-rq}\cdot\mathbf{1}_{\tau\geq\widehat{\tau}(\xi)}\right) + (1-\omega)\frac{\mu - c\cdot\mathbf{1}_{\tau\geq\widehat{\tau}(\xi)}}{1+q} \\
&= [\omega + (1-\omega)z]\,\frac{\mu-\gamma\sigma^2}{1+q-rq} + (1-\omega)\frac{\mu}{1+q} \\
&+ \left([\omega + (1-\omega)z]\,\frac{\frac{\tau\widehat{\Delta}_x(\tau)}{1+q}\gamma\sigma^2 - c}{1+q-rq} - (1-\omega)\frac{c}{1+q}\right)\cdot\mathbf{1}_{\tau\geq\widehat{\tau}(\xi)} \\
&= [\omega + (1-\omega)z]\,\frac{\mu-\gamma\sigma^2}{1+q-rq} + (1-\omega)\frac{\mu}{1+q} \\
&+ \frac{c}{1+q}\left(\frac{\tau}{2\tau-1}(1-\omega) - \frac{1}{1-z}\right)\cdot\mathbf{1}_{\tau\geq\widehat{\tau}(\xi)}
\end{aligned}$$

Note that $\frac{\tau}{2\tau-1}$ decreases in τ. Thus, M chooses $\tau = \widehat{\tau}(\xi)$ if $\frac{\widehat{\tau}(\xi)}{2\widehat{\tau}(\xi)-1}(1-\omega) - \frac{1}{1-z} > 0$, and $\tau = \frac{1}{2}$ otherwise. Note that

$$\frac{\tau}{2\tau-1}(1-\omega) - \frac{1}{1-z} > 0 \Leftrightarrow \tau < \frac{1}{1+\omega+(1-\omega)z}$$

Thus, M chooses $\tau = \widehat{\tau}(\xi)$ if $\widehat{\tau}(\xi) < \frac{1}{1+\omega+(1-\omega)z}$, and $\tau = \frac{1}{2}$ otherwise.

Next, we plug in $\tau = \frac{1}{1+\omega+(1-\omega)z}$ into $\widehat{\Delta}_x(\tau)$ to check whether B's position is less than $1+q$. It follows that $\widehat{\Delta}_x\left(\frac{1}{1+\omega+(1-\omega)z}\right) \leq 1+q$ is equivalent to $c \leq \frac{\gamma\sigma^2[\omega+(1-\omega)z]}{1+\omega+(1-\omega)z}$. In this case, B can afford to implement tilting at $\tau = \frac{1}{1+\omega+(1-\omega)z}$. If instead $c > \frac{\gamma\sigma^2[\omega+(1-\omega)z]}{1+\omega+(1-\omega)z}$, then B cannot implement tilting for any $\tau < \frac{1}{1+\omega+(1-\omega)z}$ because $\widehat{\Delta}_x(\tau)$ is decreasing in τ. Hence, M chooses

$\tau = \frac{1}{2}$.

Suppose $c \leq \frac{\gamma\sigma^2[\omega+(1-\omega)z]}{1+\omega+(1-\omega)z}$ and recall that $\widehat{\tau}(\xi)$ satisfies $\xi = \overline{\xi}_{\text{unob}}(\tau)$, and since $\overline{\xi}_{\text{unob}}(\tau)$ is a decreasing function,

$$\widehat{\tau}(\xi) < \frac{1}{1+\omega+(1-\omega)z} \Leftrightarrow$$
$$\xi > \overline{\xi}_{\text{unob}}\left(\frac{1}{1+\omega+(1-\omega)z}\right)$$

Next, we use the expression for $\overline{\xi}_{\text{unob}}$ to re-write the condition above as:

$$\xi > 1 - \frac{z^{-1}\mu - \gamma\sigma^2}{z^{-1}\mu - \gamma\sigma^2 + c\frac{(1-z)(1-\omega)}{z+\omega-z\omega}} \equiv \overline{\xi}_{\text{disc}}.$$

The right-hand side of this condition increases in c, γ, σ and it decreases in μ, ω. It is hump-shaped in z, and thus in r, q.

Finally, we solve for the lowest value of $\tau \in \left(\frac{1}{2}, \frac{1}{1+\omega+(1-\omega)z}\right)$ that satisfies $\widehat{\Delta}_x(\tau^{\min}) = 1+q$. This leads to $\tau^{\min} = \frac{1}{2}\left(1 + \frac{c(1-\omega-(1-\omega)z)}{\gamma\sigma^2(\omega+(1-\omega)z)}\right)$. For any $\xi \geq \overline{\xi}(\tau^{\min})$, M sets $\tau^* = \tau^{\min}$ because any $\tau < \tau^{\min}$ would lead to exclusion. ■

Proof of Proposition 5. Given x, a, and y, the stock price is given by:

$$p(x,a,y) = \frac{\mu - ca - \left(1 - \frac{x+y}{1+q}\right)\gamma\sigma^2}{1+q-rq}. \tag{38}$$

Thus, A's profit is given by:

$$\begin{aligned}
\Pi_A(y) &= y\left(v(x,a,y) - p(x,a,y)\right) \\
&= y\left(\frac{\mu + rqp(x,a,y) - ac}{1+q} - p(x,a,y)\right) \\
&= y\left(\frac{\mu - (1-q-rq)\,p(x,a,y) - ac}{1+q}\right) \\
&= y\left(\frac{\mu - \left[\mu - ca - \left(1 - \frac{x+y}{1+q}\right)\gamma\sigma^2\right] - ac}{1+q}\right) \\
&= y\frac{\left(1 - \frac{x+y}{1+q}\right)\gamma\sigma^2}{1+q}
\end{aligned}$$

and so his trade is given by:

$$y^*(x) = \arg\max_y \Pi_A(y) = \frac{1+q-x}{2}$$

which yields a profit of

$$\Pi_A(y^*(x)) = \left(\frac{1}{2}\frac{1+q-x}{1+q}\right)^2\gamma\sigma^2.$$

Thus, B expects the stock price to be

$$\begin{aligned}
p(x,a,y^*(x)) &= (1-\eta)\frac{\mu - ca - \left(1 - \frac{x}{1+q}\right)\gamma\sigma^2}{1+q-rq} + \eta\frac{\mu - ca - \left(1 - \frac{x+y^*(x)}{1+q}\right)\gamma\sigma^2}{1+q-rq} \\
&= \frac{\mu - ca - \left(1 - \frac{x}{1+q} - \eta\frac{y^*(x)}{1+q}\right)\gamma\sigma^2}{1+q-rq} \\
&= \frac{\mu - ca - \left(1 - \frac{x}{1+q} - \eta\frac{\frac{1+q-x}{2}}{1+q}\right)\gamma\sigma^2}{1+q-rq} \\
&= \frac{\mu - ca - \left(1 - \frac{\eta}{2}\right)\left(1 - \frac{x}{1+q}\right)\gamma\sigma^2}{1+q-rq}
\end{aligned}$$

M chooses $a=1$ if and only if

$$\begin{aligned}
\omega p\left(x\left(1\right),1\right)+\left(1-\omega\right)\frac{\mu+rqp\left(x\left(1\right),1\right)-c}{1+q} &> \omega p\left(x\left(0\right),0\right)+\left(1-\omega\right)\frac{\mu+rqp\left(x\left(0\right),0\right)}{1+q} \\
\left[\omega+(1-\omega)z\right]\left[p\left(x\left(1\right),1\right)-p\left(x\left(0\right),0\right)\right] &> \left(1-\omega\right)\frac{c}{1+q} \\
x\left(1\right)-x\left(0\right) &> \frac{\left(1+q\right)c}{\left(1-\frac{\eta}{2}\right)\gamma\sigma^{2}\left[\omega+(1-\omega)z\right]}
\end{aligned}$$

B chooses tilting if and only if

$$\begin{aligned}
\xi &\geq \frac{rq\left(p\left(1\right)-p\left(0\right)\right)}{\mu+rqp\left(1\right)} \\
&= rq\frac{\frac{-c+\left(1-\frac{\eta}{2}\right)\left(\frac{\Delta_x}{1+q}\right)\gamma\sigma^2}{1+q-rq}}{\mu+rq\frac{\mu-c-\left(1-\frac{\eta}{2}\right)\left(1-\frac{\Delta_x}{1+q}\right)\gamma\sigma^2}{1+q-rq}} \\
&= \frac{-c+\left(1-\frac{\eta}{2}\right)\left(\frac{\Delta_x}{1+q}\right)\gamma\sigma^2}{\frac{\mu}{z}-c-\left(1-\frac{\eta}{2}\right)\left(1-\frac{\Delta_x}{1+q}\right)\gamma\sigma^2} \\
&= \frac{\left(1-\omega\right)c}{\left(1-\omega\right)c+\left(\frac{\mu}{z}-\left(1-\frac{\eta}{2}\right)\gamma\sigma^2\right)\left(\omega+\frac{z}{1-z}\right)}.
\end{aligned}$$

The condition $x(1)\leq(1+q)$ is equivalent to $c\leq\gamma\sigma^2[\omega+(1-\omega)z]\left(1-\frac{\eta}{2}\right)$. If $c>\gamma\sigma^2[\omega+(1-\omega)z]\left(1-\frac{\eta}{2}\right)$, then B cannot implement tilting and chooses $x(1)=x(0)=0$. ■

Proof of Proposition 6. We define

$$E\left[U\left(a,x\right)\right] = \varphi x\left(v\left(x,a\right)-p\left(x,a\right)\right)-\left(1-\varphi\right)\lambda\left(\mu+qrp\left(x,a\right)\right)\left(1-a\xi\right)$$

where $p\left(x,a\right)=\frac{\mu-ca-(1-\frac{x}{1+q})\gamma\sigma^2}{1+q-rq}$ and $v=\frac{\mu+rqp(x,a)-ca}{1+q}$. Observe that $\varphi x\left(v\left(x,a\right)-p\left(x,a\right)\right)=\varphi\frac{x}{1+q}(1-\frac{x}{1+q})\gamma\sigma^2$. Thus

$$x^*\left(a\right)=\arg\max_{x\geq0}\ E\left[U\left(a,x\right)\right]=\frac{1+q}{2}\max\left\{1-\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda\left(1-a\xi\right),0\right\}$$

and

$$E\left[U\left(a,x^{*}\left(a\right)\right)\right]=\begin{cases}\varphi\frac{1-\left[\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda(1-a\xi)\right]^{2}}{4}\gamma\sigma^{2}-\\ \left(1-\varphi\right)\lambda\left(\mu+z\frac{\mu-ca-\frac{1+\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda(1-a\xi)}{2}\gamma\sigma^{2}}{1-z}\right)\left(1-a\xi\right) & \text{if } 1\geq\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda\left(1-a\xi\right)\\ -\left(1-\varphi\right)\lambda\left(\mu+z\frac{\mu-ca-\gamma\sigma^{2}}{1-z}\right)\left(1-a\xi\right) & \text{else.}\end{cases} \tag{39}$$

Consider parts (i) and (ii). Note that

$$x^{*}(1)-x^{*}(0)=\frac{1+q}{2}\times\begin{cases}\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda\xi & \text{if } \frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda\leq 1\\ 1-\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda\left(1-\xi\right) & \text{if } 1<\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda<\frac{1}{1-\xi}\\ 0 & \text{if } \frac{1}{1-\xi}\leq\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda\end{cases} \tag{40}$$

Thus, $x^{*}(1)-x^{*}(0)>\overline{\Delta}_{x}$ if and only if $\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda\leq 1$ and $\frac{1+q}{2}\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda\xi>\frac{c(1+q)}{\gamma\sigma^{2}[\omega+(1-\omega)z]}$, or $1<\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda<\frac{1}{1-\xi}$ and $\frac{1+q}{2}\left(1-\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda\left(1-\xi\right)\right)>\frac{c(1+q)}{\gamma\sigma^{2}[\omega+(1-\omega)z]}$. These conditions can be rewritten as

$$\begin{aligned}\frac{1}{\xi}\frac{2c}{\gamma\sigma^{2}\left[\omega+(1-\omega)z\right]}<\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda\leq 1 \text{ or}\\ 1<\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda<\frac{1}{1-\xi}\left(1-\frac{2c}{\gamma\sigma^{2}\left[\omega+(1-\omega)z\right]}\right).\end{aligned}$$

Notice

$$\frac{1}{\xi}\frac{2c}{\gamma\sigma^{2}\left[\omega+(1-\omega)z\right]}<\frac{1}{1-\xi}\left(1-\frac{2c}{\gamma\sigma^{2}\left[\omega+(1-\omega)z\right]}\right)\Leftrightarrow\xi>\frac{2c}{\gamma\sigma^{2}\left[\omega+(1-\omega)z\right]}.$$

Thus, if $\xi\leq\frac{2c}{\gamma\sigma^{2}[\omega+(1-\omega)z]}$ then the condition is empty. That is, $x^{*}(1)-x^{*}(0)\leq\overline{\Delta}_{x}$, $a=0$, and B buys $x^{*}\left(0\right)$ shares. If $\xi>\frac{2c}{\gamma\sigma^{2}[\omega+(1-\omega)z]}$ then the condition above is reduced to

$$\frac{1}{\xi}\frac{2c}{\gamma\sigma^{2}\left[\omega+(1-\omega)z\right]}<\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda<\frac{1}{1-\xi}\left(1-\frac{2c}{\gamma\sigma^{2}\left[\omega+(1-\omega)z\right]}\right)\Leftrightarrow\varphi\in\left(\underline{\varphi}\left(\xi\right),\overline{\varphi}\left(\xi\right)\right)$$

where

$$\overline{\varphi}(\xi) \equiv \frac{\frac{z}{1-z}\lambda}{\frac{z}{1-z}\lambda + \frac{1}{\xi}\frac{2c}{\gamma\sigma^2[\omega+(1-\omega)z]}}$$
$$\underline{\varphi}(\xi) \equiv \frac{\frac{z}{1-z}\lambda}{\frac{z}{1-z}\lambda + \frac{1}{1-\xi}\left(1-\frac{2c}{\gamma\sigma^2[\omega+(1-\omega)z]}\right)}.$$

Thus, if $\varphi \in \left(\underline{\varphi}(\xi), \overline{\varphi}(\xi)\right)$ then $x^*(1) - x^*(0) > \overline{\Delta}_x$, $a = 1$, and B buys $x^*(1)$ shares. If $\varphi \notin \left(\underline{\varphi}(\xi), \overline{\varphi}(\xi)\right)$ then $x^*(1) - x^*(0) \le \overline{\Delta}_x$, $a = 0$, and B buys $x^*(0)$ shares.

Consider part (iii). Note that $x^*(a)$ weakly increases in φ. If M chooses $a^* = 0$ in equilibrium, then the externalities increase with φ if $x^*(0) > 0 \Leftrightarrow \frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda < 1 \Leftrightarrow \frac{\frac{z}{1-z}\lambda}{1+\frac{z}{1-z}\lambda} < \varphi$, and are invariant to φ otherwise. Note that $\xi > \frac{2c}{\gamma\sigma^2[\omega+(1-\omega)z]}$ implies $\frac{1}{\xi}\frac{2c}{\gamma\sigma^2[\omega+(1-\omega)z]} < 1 < \frac{1}{1-\xi}\left(1-\frac{2c}{\gamma\sigma^2[\omega+(1-\omega)z]}\right)$ and hence $\frac{\frac{z}{1-z}\lambda}{1+\frac{z}{1-z}\lambda} \in \left(\underline{\varphi}(\xi), \overline{\varphi}(\xi)\right)$. That is, if $\varphi < \underline{\varphi}(\xi)$ then $\varphi < \frac{\frac{z}{1-z}\lambda}{1+\frac{z}{1-z}\lambda}$, and hence, $x^*(0) = 0$.

Suppose M chooses $a^* = 1$ in equilibrium. Then, it must be $\varphi \in \left[\underline{\varphi}(\xi), \overline{\varphi}(\xi)\right]$, and the externalities are given by

$$\lambda\left(\mu + z\frac{\mu - c - \frac{1+\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda(1-\xi)}{2}\gamma\sigma^2}{1-z}\right)(1-\xi),$$

which is increasing in φ. Notice

$$\lambda\left(\mu + z\frac{\mu - c - \frac{1+\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda(1-\xi)}{2}\gamma\sigma^2}{1-z}\right)(1-\xi) < \lambda\frac{\mu - z\gamma\sigma^2}{1-z} \Leftrightarrow$$
$$\frac{\left(\frac{\mu}{z} - c - \frac{1}{2}\gamma\sigma^2\right)(1-\xi) - \left(\frac{\mu}{z} - \gamma\sigma^2\right)}{\frac{1}{2}(1-\xi)^2\gamma\sigma^2} < \frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda \Leftrightarrow$$
$$\varphi < \varphi_{NC}(\xi) \equiv \frac{\frac{z}{1-z}\lambda}{\frac{z}{1-z}\lambda + \frac{\left(\frac{\mu}{z}-c-\frac{1}{2}\gamma\sigma^2\right)(1-\xi)-\left(\frac{\mu}{z}-\gamma\sigma^2\right)}{\frac{1}{2}(1-\xi)^2\gamma\sigma^2}}$$

and

$$\frac{\left(\frac{\mu}{z}-c-\frac{1}{2}\gamma\sigma^2\right)(1-\xi)-\left(\frac{\mu}{z}-\gamma\sigma^2\right)}{\frac{1}{2}(1-\xi)^2\gamma\sigma^2}<\frac{1}{1-\xi}\left(1-\frac{2c}{\gamma\sigma^2\left[\omega+(1-\omega)z\right]}\right)\Leftrightarrow$$

$$\xi>\xi_{NC}\equiv\frac{\frac{4c}{\omega+(1-\omega)z}-c}{\frac{\mu}{z}-\gamma\sigma^2+\frac{4c}{\omega+(1-\omega)z}-c}.$$

Thus, if $\xi\leq\max\left\{\frac{2c}{\gamma\sigma^2[\omega+(1-\omega)z]},\xi_{NC}\right\}$ then $\varphi_{NC}(\xi)\leq\underline{\varphi}(\xi)$ and $f^*(\varphi)\geq f^*(0)$ for all $\varphi>0$, with a strict inequality if and only if $\varphi>\underline{\varphi}(\xi)$. If $\xi>\max\left\{\frac{2c}{\gamma\sigma^2[\omega+(1-\omega)z]},\xi_{NC}\right\}$ then $\varphi_{NC}(\xi)>\underline{\varphi}(\xi)$. Thus, if $\varphi\in(0,\underline{\varphi}(\xi)]$ then $f^*(\varphi)=f^*(0)$, if $\varphi\in\left(\underline{\varphi}(\xi),\varphi_{NC}(\xi)\right)$ then $f^*(\varphi)<f^*(0)$, and if $\varphi\in(\varphi_{NC}(\xi),1)$ then $f^*(\varphi)>f^*(0)$. ■

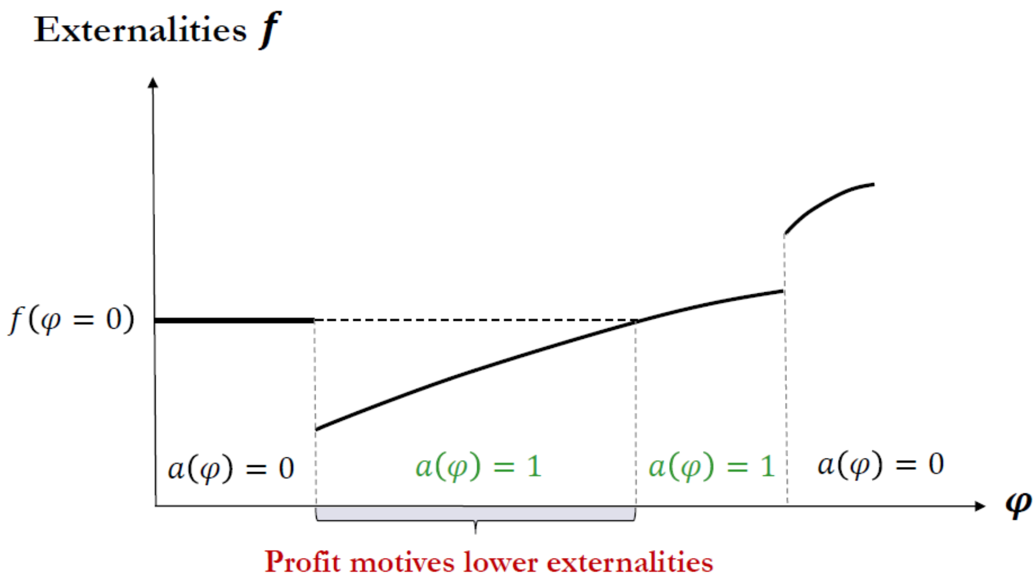

Figure 1: Comparative statics of f with respect to φ

Proof of Proposition 7. To see part (i), let $x^*(a,\varphi)$ be the optimal trade of B if her type is φ and M takes action a. We let $f(\varphi)$ and $\pi(\varphi)$ be the externalities and trading profits in equilibrium that are induced by strategies $x^*(a,\varphi)$, respectively. The equilibrium utility of type φ is $\varphi\pi(\varphi)-(1-\varphi)f(\varphi)$. Suppose to the contrary there are $\varphi'<\varphi''$ such that $f(\varphi')>f(\varphi'')$, that is, a blockholder with a greater profits motive induces less externalities in equilibrium. This implies either $x^*(0,\varphi')\neq x^*(0,\varphi'')$ or $x^*(1,\varphi')\neq x^*(1,\varphi'')$. Notice

$f(\varphi') > f^*(\varphi'')$ implies $\pi(\varphi') > \pi(\varphi'')$. Otherwise,

$$\varphi'\pi(\varphi') - (1-\varphi') f(\varphi') < \varphi'\pi(\varphi'') - (1-\varphi') f(\varphi'')$$

and type φ' has a profitable deviation from $x^*(a,\varphi')$ to $x^*(a,\varphi'')$, a contradiction. Suppose $f(\varphi') > f^*(\varphi'')$ and $\pi(\varphi') > \pi(\varphi'')$. By revealed preferences of types φ' and φ'' we have

$$\varphi'\pi(\varphi') - (1-\varphi') f(\varphi') > \varphi'\pi(\varphi'') - (1-\varphi') f(\varphi'') \Leftrightarrow \varphi' > \frac{\frac{f(\varphi')-f(\varphi'')}{\pi(\varphi')-\pi(\varphi'')}}{1+\frac{f(\varphi')-f(\varphi'')}{\pi(\varphi')-\pi(\varphi'')}}$$
$$\varphi''\pi(\varphi'') - (1-\varphi'') f(\varphi'') > \varphi''\pi(\varphi') - (1-\varphi'') f(\varphi') \Leftrightarrow \varphi'' < \frac{\frac{f(\varphi')-f(\varphi'')}{\pi(\varphi')-\pi(\varphi'')}}{1+\frac{f(\varphi')-f(\varphi'')}{\pi(\varphi')-\pi(\varphi'')}}$$

Since $\varphi'' > \varphi'$, we have a contradiction.

Consider part (ii). Suppose B wants to induce $a = 0$ in equilibrium. Given $a = 0$, the optimal strategy is $x_C(0) = \frac{1+q}{2}\max\left\{1 - \frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda, 0\right\}$ and $x(1)$ such that $x(1) - x_C(0) \le \overline{\Delta}_x$ (e.g., $x(1) = x_C(0)$). This will generate B an expected payoff of

$$U_C(0) = \varphi\frac{x_C(0)}{1+q}\left(1 - \frac{x_C(0)}{1+q}\right)\gamma\sigma^2 - (1-\varphi)\lambda\left(\frac{\mu}{1-z} - \frac{z}{1-z}\gamma\sigma^2\left(1 - \frac{x_C(0)}{1+q}\right)\right).$$

Note that this term does not depend on ξ. If B wants to induce $a = 1$ in equilibrium, she will choose $x(0) = 0$ and

$$\begin{aligned} x_C(1) &= \max\left\{\frac{1+q}{2}\max\left\{1 - \frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda(1-\xi), 0\right\}, \overline{\Delta}_x\right\} \\ &= \frac{1+q}{2}\max\left\{1 - \frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda(1-\xi), \frac{2c}{\gamma\sigma^2[\omega + (1-\omega)z]}\right\}. \end{aligned}$$

This will generate B an expected payoff of

$$U_C(1) = \varphi\frac{x_C(1)}{1+q}\left(1 - \frac{x_C(1)}{1+q}\right)\gamma\sigma^2 - (1-\varphi)\lambda\left(\frac{\mu - zc}{1-z} - \frac{z}{1-z}\gamma\sigma^2\left(1 - \frac{x_C(1)}{1+q}\right)\right)(1-\xi).$$

We consider two cases:

1. If $\overline{\Delta}_x > \frac{1+q}{2}\max\left\{1 - \frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda(1-\xi), 0\right\}$ then $x_C(1) = \overline{\Delta}_x$ and it does not depend on

ξ. In this case,

$$\frac{dU_C(1)}{d\xi} = (1-\varphi)\lambda\left(\frac{\mu - zc}{1-z} - \frac{z}{1-z}\gamma\sigma^2\left(1 - \frac{\overline{\Delta}_x}{1+q}\right)\right).$$

Notice

$$\frac{dU_C(1)}{d\xi} > 0 \Leftrightarrow \mu/z - c - \gamma\sigma^2 > -\gamma\sigma^2\frac{\overline{\Delta}_x}{1+q},$$

which always holds given that $\overline{\Delta}_x > 0$, $z \in (0,1)$, and the assumption $\mu - c - \gamma\sigma^2 > 0$.

2. If $\overline{\Delta}_x \leq \frac{1+q}{2}\max\left\{1 - \frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda(1-\xi), 0\right\}$ then $x_C(1) = \frac{1+q}{2}\left(1 - \frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda(1-\xi)\right) > 0$, which is the optimal trade of B. Therefore,

$$\frac{dU_C(1)}{d\xi} = \frac{\partial U_C(1)}{\partial\xi} + \frac{\partial U_C(1)}{\partial x}|_{x=x_C(1)} \times \frac{\partial x_C(1)}{\partial\xi}.$$

By the envelope theorem, $\frac{\partial U_C(1)}{\partial x}|_{x=x_C(1)} = 0$. Also,

$$\frac{\partial U_C(1)}{\partial\xi} = (1-\varphi)\lambda\left(\frac{\mu - zc}{1-z} - \frac{z}{1-z}\gamma\sigma^2\frac{1 + \frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda(1-\xi)}{2}\right)$$

where

$$\frac{\partial U_C(1)}{\partial\xi} > 0 \Leftrightarrow \mu/z - c - \gamma\sigma^2 > -\gamma\sigma^2\frac{1 - \frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda(1-\xi)}{2}$$

which always holds given that $1 - \frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda(1-\xi) > 0$, $z \in (0,1)$, and the assumption $\mu - c - \gamma\sigma^2 > 0$.

Since $U_C(1)$ increases in ξ and $U(0)$ is invariant to ξ, there exists $\overline{\xi}_C > 0$ such that $U_C(1) > U_C(0)$ if and only if $\xi \geq \overline{\xi}_C$, as required.

Consider part (2.a). We prove $\overline{\xi}_C < 1$. Indeed, if $\xi = 1$ then inducing $a = 1$ implies no externalities and

$$U_C(1) \ = \varphi\frac{x_C(1)}{1+q}\left(1 - \frac{x_C(1)}{1+q}\right)\gamma\sigma^2.$$

If $\frac{1}{2} \geq \frac{c}{\gamma\sigma^2[\omega+(1-\omega)z]}$ then $x_C(1) = \frac{1+q}{2}$ which is the quantity that maximizes the unconstrained gains from trade, and therefore it must be $U_C(1) > U_C(0)$. Suppose $\frac{1}{2} < \frac{c}{\gamma\sigma^2[\omega+(1-\omega)z]}$. In this case, $x_C(1) = \frac{(1+q)c}{\gamma\sigma^2[\omega+(1-\omega)z]}$ and

$$U_C(1) = \varphi \frac{c}{\gamma\sigma^2[\omega+(1-\omega)z]}\left(1-\frac{c}{\gamma\sigma^2[\omega+(1-\omega)z]}\right)\gamma\sigma^2$$

Assumption (13), $\frac{c}{\gamma\sigma^2[\omega+(1-\omega)z]} \leq 1$, guarantees $U_C(1) \geq 0$. If $1-\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda \leq 0$ then $x_C(0) = 0$ and

$$U_C(0) = -(1-\varphi)\lambda\left(\frac{\mu}{1-z}-\frac{z}{1-z}\gamma\sigma^2\right) < 0$$

and thus, $U_C(1) > U_C(0)$, that is, $\overline{\xi}_C < 1$. Suppose $1-\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda > 0$. Then, $x_C(0) = \frac{1+q}{2}\left(1-\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda\right)$ and

$$\begin{aligned} U_C(0) &= \varphi\frac{x_C(0)}{1+q}\left(1-\frac{x_C(0)}{1+q}\right)\gamma\sigma^2 - (1-\varphi)\lambda\left(\frac{\mu}{1-z}-\frac{z}{1-z}\gamma\sigma^2\left(1-\frac{x_C(0)}{1+q}\right)\right) \\ &= \varphi\left[\frac{1}{4}\gamma\sigma^2\left(1-\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda\right)^2 - \frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda\left(\frac{\mu}{z}-\gamma\sigma^2\right)\right]. \end{aligned}$$

Notice $U_C(0)$ increases in φ. Moreover, if $\varphi = 1$ then $U_C(0) > U_C(1)$ and if $\varphi = \frac{\frac{z}{1-z}\lambda}{1+\frac{z}{1-z}\lambda}$ then $U_C(0) < U_C(1)$. Therefore, if $\frac{1}{2} < \frac{c}{\gamma\sigma^2[\omega+(1-\omega)z]}$ then there is $\varphi^* \in (\frac{z\lambda}{1-z+z\lambda}, 1)$ such that if $\varphi < \varphi^*$ then $\overline{\xi}_C < 1$, and otherwise, $\overline{\xi}_C = 1$.

Finally, we prove part (2.b). Recall that in the baseline model, when $\varphi = 0$, then B induces $a = 1$ if and only if $\xi \geq \frac{\gamma\sigma^2\frac{\overline{\Delta}_x}{1+q}-c}{\mu/z-\gamma\sigma^2+\gamma\sigma^2\frac{\overline{\Delta}_x}{1+q}-c}$. Suppose $\varphi > 0$ but $\frac{1+q}{2}\max\left\{1-\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda(1-\xi), 0\right\} < \overline{\Delta}_x$ and $1-\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda < 0$. Then, $x_C(1) = \overline{\Delta}_x$ and $x_C(0) = 0$. That is, although $\varphi > 0$, B's optimal trade that induces action a is the same as in the baseline model when $\varphi = 0$. Note that $U_C(1) > U_C(0)$ if and only if

$$\frac{\overline{\Delta}_x}{1+q}\left(1-\frac{\overline{\Delta}_x}{1+q}\right)\gamma\sigma^2 > \frac{1-\varphi}{\varphi}\lambda\left[\left(\frac{\mu-zc}{1-z}-\frac{z}{1-z}\gamma\sigma^2\left(1-\frac{\overline{\Delta}_x}{1+q}\right)\right)(1-\xi)-\left(\frac{\mu}{1-z}-\frac{z}{1-z}\gamma\sigma^2\right)\right]$$

$$\xi > \frac{\gamma\sigma^2\frac{\overline{\Delta}_x}{1+q}-c-\frac{\frac{\overline{\Delta}_x}{1+q}\left(1-\frac{\overline{\Delta}_x}{1+q}\right)\gamma\sigma^2}{\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda}}{\mu/z-\gamma\sigma^2+\gamma\sigma^2\frac{\overline{\Delta}_x}{1+q}-c} = \overline{\xi}_C$$

Thus, if $\frac{\overline{\Delta}_x}{1+q} < 1$ and $\frac{\gamma\sigma^2\frac{\overline{\Delta}_x}{1+q}-c-\frac{\frac{\overline{\Delta}_x}{1+q}\left(1-\frac{\overline{\Delta}_x}{1+q}\right)\gamma\sigma^2}{\frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda}}{\mu/z-\gamma\sigma^2+\gamma\sigma^2\frac{\overline{\Delta}_x}{1+q}-c} < \xi < \frac{\gamma\sigma^2\frac{\overline{\Delta}_x}{1+q}-c}{\mu/z-\gamma\sigma^2+\gamma\sigma^2\frac{\overline{\Delta}_x}{1+q}-c}$ then B chooses $a = 0$ if

$\varphi = 0$ but $a = 1$ if $\varphi > 0$. Note that sufficient conditions that satisfies these conditions are $\frac{1+q}{2} < \overline{\Delta}_x$ and $\varphi < \frac{z\lambda}{1-z+z\lambda}$. ■

B Supplemental Analyses

B.1 Additive Externality

This Appendix considers the case in which the action a has an additive effect on the externality, i.e. $f(\widetilde{A}, rI, a) = \lambda\left(\widetilde{A} + rI - \xi a\right)$. Proceeding as in Section 3 leads to Proposition 8.

Proposition 8 *(Blockholder's strategy, additive externality): The blockholder's optimal strategy is tilting if*

$$\xi \geq \bar{\xi}_{add} \equiv \frac{c}{\frac{1}{z}\frac{\omega}{1-\omega} + 1}. \tag{41}$$

Otherwise, it is exclusion. The tilting strategy involves $x(1) = \overline{\Delta}_x$. $\bar{\xi}_{add}$ is increasing in (c, r, q), decreasing in ω, and independent of (μ, γ, σ).

Proof of Proposition 8. The expected externality given $a \in \{0, 1\}$ is given by:

$$\mathbb{E}[f|a = 1] = \lambda\left(\mu + \frac{z}{1-z}\left(\mu - \gamma\sigma^2 - c + \frac{\gamma\sigma^2}{1+q}\overline{\Delta}_x\right) - \xi\right) \tag{42}$$

and

$$\mathbb{E}[f|a = 0] = \lambda\left(\mu + \frac{z}{1-z}\left(\mu - \gamma\sigma^2\right)\right). \tag{43}$$

It follows that $\mathbb{E}[f|a = 1] \leq \mathbb{E}[f|a = 0]$ is equivalent to

$$\xi \geq \frac{z}{1-z}\left(\frac{\gamma\sigma^2}{1+q}\overline{\Delta}_x - c\right) \equiv \bar{\xi}_{\text{add}} \tag{44}$$

where $\overline{\Delta}_x = \frac{c(1+q)}{\gamma\sigma^2[\omega+(1-\omega)z]}$. Plugging in this expression leads to

$$\bar{\xi}_{\text{add}} = \frac{cz}{(1-z)}\left(\frac{1}{\omega + (1-\omega)z} - 1\right) = \frac{c}{\frac{1}{z}\frac{\omega}{(1-\omega)} + 1}. \tag{45}$$

It immediately follows that $\bar{\xi}_{\text{add}}$ increases in c, r, and q and that it decreases in ω. ■

We discuss only the comparative statics that differ from the multiplicative case. Now, exclusion is unambiguously more preferred if the capital raised by the firm (q) and the profitability of the investment (r) are sufficiently high. When the firm is raising more capital, it is particularly important to stifle capital raising. Since the effect of the additive action is independent of the amount of capital raised, there is no opposing force. In contrast, μ, γ, and σ no longer have an effect on the optimal strategy, since the effect of the additive action is independent of the amount of new investment and thus the stock price.

The analysis is identical for the case in which the action has multiplicative effect on the externality, as in (2), and the cost of the action is also multiplicative in expected firm size so that firm value is given by $V = \theta + rI - ca(\mu + rI)$ rather than $V = \theta + rI - ca$ as in the core model. Since firm size affects both the benefits and costs of the action, it drops out and reduces to the additive model.

B.2 Short-Termism

This Appendix shows that the expected externalities in equilibrium decreases with ω. First note that tilting is more effective than exclusion if and only if

$$\lambda \left(\mu + rq \frac{\mu - ca - \gamma\sigma^2}{1 + q - rq} \right) > \lambda \left(\mu + rq \frac{\mu - ca - \left(1 - \frac{\overline{\Delta}_x}{1+q}\right)\gamma\sigma^2}{1 + q - rq} \right)(1 - \xi) \Leftrightarrow$$

$$\lambda\mu + z \frac{\mu - ca - \gamma\sigma^2}{1 - z} > \lambda \left(\mu + z \frac{\mu - ca - \gamma\sigma^2 + \frac{c}{\omega + (1-\omega)z}}{1 - z} \right)(1 - \xi) \Leftrightarrow$$

$$\omega > \omega^* \equiv \max\left\{0, \frac{z}{1-z} \frac{1-\xi}{\xi} \frac{c}{\mu - z(c + \gamma\sigma^2)} - \frac{z}{1-z}\right\}.$$

Moreover, conditional on tilting, $E[f] = \lambda \left(\mu + z \frac{\mu - ca - \gamma\sigma^2 + \frac{c}{\omega + (1-\omega)z}}{1-z} \right)(1 - \xi)$, which is a decreasing function of ω.

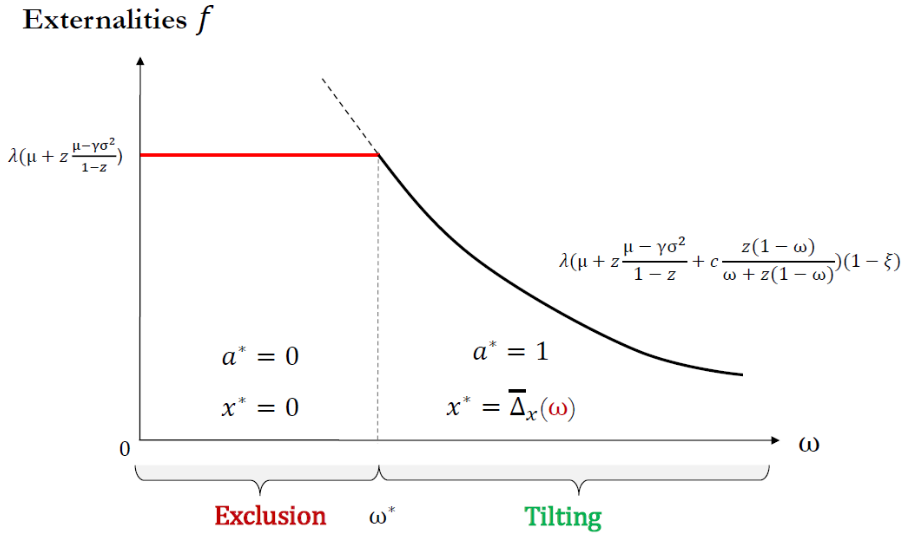

Figure 2: Comparative statics of f with respect to ω

B.3 Cap on Holdings

In this Appendix, we study a variation of the setting without commitment (see Section 6.1). We consider a cap on the blockholder's position $\overline{x} \geq 0$ such that $x(a) \leq \overline{x}$. We proceed in two steps. First, we show that B never wants to commit to such a cap.w

Proposition 9 *The blockholder never commits to a cap on her trades.*

Proof. Note that $\overline{x}$ can only make B better off if it changes M's equilibrium choice of a. If a is unchanged, then, by definition, $x^*(a)$, which is given by (26), maximizes B's expected utility and any $\overline{x} \neq x^*(a)$ makes B (weakly) worse off. Since B's position is weakly smaller with a cap, we only need to consider the case in which the cap changes M's choice from $a^* = 1$ to $a^* = 0$. This, in turn, requires $\overline{x}$ such that $\overline{x} - x^*(0) < \overline{\Delta}_x$. It is sufficient to consider the case $\overline{x} = x^*(0)$ because, again, any cap $\overline{x} < x^*(0)$ would make B worse off, and any $x^*(0) < \overline{x} < x^*(0) + \overline{\Delta}_x$ is observationally equivalent to $\overline{x} = x^*(0)$ because $a^* = 0$ in this case.

In other words, the question is whether $E\left[U\left(1, x^*\left(1\right)\right)\right] \geq E\left[U\left(0, x^*\left(0\right)\right)\right]$. Notice the optimality of $x^*\left(1\right)$ when $a = 1$ implies

$$E\left[U\left(1, x^*\left(1\right)\right)\right] \geq E\left[U\left(1, x^*\left(0\right)\right)\right]$$

We argue $E[U(1,x)] > E[U(0,x)]$ for every $x \geq 0$. Indeed,

$$E[U(1,x)] - E[U(0,x)] = \varphi x \begin{pmatrix} v(x,1) - v(x,0) \\ +p(x,0) - p(x,1) \end{pmatrix} - \begin{pmatrix} (1-\varphi)\lambda(\mu + qrp(x,1))(1-\xi) \\ -(1-\varphi)\lambda(\mu + qrp(x,0)) \end{pmatrix}$$

$$= \varphi x \left(\left(\frac{rq-1-q}{1+q} \right) (p(x,1) - p(x,0)) - \frac{c}{1+q} \right) - (1-\varphi)\lambda \begin{pmatrix} (\mu + qrp(x,1))(1-\xi) \\ -(\mu + qrp(x,0)) \end{pmatrix}$$

$$= \varphi x \left(\left(\frac{rq-1-q}{1+q} \right) \left(\frac{-c}{1+q-rq} \right) - \frac{c}{1+q} \right) - (1-\varphi)\lambda \begin{pmatrix} (\mu + qrp(x,1))(1-\xi) \\ -(\mu + qrp(x,0)) \end{pmatrix}$$

$$= 0 - (1-\varphi)\lambda \begin{pmatrix} (\mu + qrp(x,1))(1-\xi) \\ -(\mu + qrp(x,0)) \end{pmatrix}$$

$$= -(1-\varphi)\lambda \begin{pmatrix} \left(\mu + qrp(x,0) - c\frac{qr}{1+q-rq}\right)(1-\xi) \\ -(\mu + qrp(x,0)) \end{pmatrix}$$

$$= (1-\varphi)\lambda \left(\xi[\mu + qrp(x,0)] + c\frac{qr}{1+q-rq}(1-\xi) \right)$$

$$> 0$$

Therefore,

$$E[U(1,x^*(1))] \geq E[U(1,x^*(0))] > E[U(0,x^*(0))],$$

as required.

Intuitively, given x, action a does not affect B's trading profits since it is fully priced in by households. However, it does reduce externalities, both directly and also indirectly by reducing the stock price and thus new capital raising. Therefore, given trade x, B is better off inducing the corrective action. ■

Next, we analyze whether a cap can lower the expected externality. If the cap has no effect then we assume it is infinity.

Proposition 10 *There is* $\bar{\xi} \in (0,1]$ *such that:*

1. *If* $\xi < \bar{\xi}$ *then absent a cap* $a^* = 0$ *and* $x^* = x^*(0)$. *The optimal cap is* $\overline{x}^* = 0$ *and under the optimal cap* $a^* = 0$.

2. *If* $\xi \geq \bar{\xi}$ *then absent a cap* $a^* = 1$ *and* $x^* = x^*(1)$. *There is* $\widehat{\xi}_1$ *such that:*

(a) *If* $\xi > \widehat{\xi}_1$ *then the optimal cap is* $\overline{x}^* = x^*(0) + \overline{\Delta}_x$ *and under the optimal cap* $a^* = 1$*.*

(b) *If* $\xi < \widehat{\xi}_1$ *then the optimal cap is* $\overline{x}^* = 0$ *and under the optimal cap* $a^* = 0$*.*

Proof. We distinguish between the two cases $x^*(1) - x^*(0) \geq \overline{\Delta}_x$ (so that $a^* = 1$) and $x^*(1) - x^*(0) < \overline{\Delta}_x$ (so that $a^* = 0$).

1. If $x^*(1) - x^*(0) < \overline{\Delta}_x$, then M does not take the corrective action without a cap. Since a cap $\overline{x}$ can only reduce B's position, we have that $a^* = 0$ with any cap. It follows that for $\overline{x} > x^*(0)$, the cap is not binding and the expected externality is given by $-\lambda\left(\mu + qrp\left(x^*(0), 0\right)\right)$. If $\overline{x} \leq x^*(0)$, then the cap is binding and the expected externality equals $-\lambda\left(\mu + qrp\left(\overline{x}, 0\right)\right)$. Since p strictly increases in x, it follows that the optimal cap is equal to $\overline{x}^* = 0$. Note that

$$x^*(1) - x^*(0) < \overline{\Delta}_x \Leftrightarrow$$

$$\frac{1+q}{2}\left(\max\left\{1 - \frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda\left(1-\xi\right), 0\right\} - \max\left\{1 - \frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda, 0\right\}\right) < \frac{c(1+q)}{\gamma\sigma^2\left[\omega + (1-\omega)z\right]}$$

The left-hand side increases in ξ, equals 0 if $\xi = 0$, and is positive for $\xi = 1$. Thus, there is $\bar{\xi} \in (0, 1]$ such that $x^*(1) - x^*(0) < \overline{\Delta}_x \Leftrightarrow \xi < \bar{\xi}$.

2. If $x^*(1) - x^*(0) \geq \overline{\Delta}_x$, then M takes the corrective action without a cap. In this case, the expected externality is equal to $-\lambda\left(\mu + qrp\left(x^*(1), 1\right)\right)(1-\xi)$. There are three cases to consider:

   (a) If $\overline{x} > x^*(1)$, then the cap does not bind and the expected externality is the same as without the cap.

   (b) If $\overline{x} \leq x^*(1)$ and $\overline{x} - x^*(0) \geq \overline{\Delta}_x$, then the manager takes the corrective action and B holds $\overline{x}$. As before, since the expected externality increases in x it is optimal to set $\overline{x} = x^*(0) + \overline{\Delta}_x$.

   (c) If $\overline{x} \leq x^*(1)$ and $\overline{x} - x^*(0) < \overline{\Delta}_x$, then the manager does not take the action. In this case, it is optimal to set $\overline{x} = 0$.

   Hence, we have to compare the expected externality under $\overline{x} = x^*(0) + \overline{\Delta}_x$ and $\overline{x} = 0$:

$$E[f|\overline{x} = 0] = -\lambda\left(\mu + qrp\left(\overline{x} = 0, 0\right)\right) = -\lambda\frac{z^{-1}\mu - \gamma\sigma^2}{z^{-1} - 1}$$

and

$$E[f|\overline{x} = x^*(0) + \overline{\Delta}_x] = -\lambda \left(\mu + qrp\left(\overline{x} = x^*(0) + \overline{\Delta}_x, 1\right)\right)(1-\xi) \tag{46}$$

$$= -\lambda(1-\xi)\frac{z^{-1}\mu - \gamma\sigma^2 + \frac{x^*(0)+\overline{\Delta}_x}{1+q}\gamma\sigma^2 - c}{z^{-1}-1}$$

It follows that the expected externality is lower with the cap at $x^*(0) + \overline{\Delta}_x$ if and only if

$$(1-\xi)\left(z^{-1}\mu - \gamma\sigma^2 + \frac{x^*(0)+\overline{\Delta}_x}{1+q}\gamma\sigma^2 - c\right) < z^{-1}\mu - \gamma\sigma^2$$

$$\Leftrightarrow \xi > 1 - \frac{z^{-1}\mu - \gamma\sigma^2}{z^{-1}\mu - \gamma\sigma^2 + \frac{x^*(0)+\overline{\Delta}_x}{1+q}\gamma\sigma^2 - c} \equiv \widehat{\xi}_1$$

Let $K_1 \equiv \frac{1-\varphi}{\varphi}\frac{z}{1-z}\lambda$. Note that $x^*(1) - x^*(0) \geq \overline{\Delta}_x$ implies that:

$$x^*(1) - x^*(0) \geq \overline{\Delta}_x \Leftrightarrow \begin{cases} \xi \geq \frac{2c}{K_1\gamma\sigma^2[\omega+(1-\omega)z]} \equiv \widehat{\xi}_2 & \text{if } K_1 \leq 1 \\ \xi \geq \frac{2c}{K_1\gamma\sigma^2[\omega+(1-\omega)z]} + \frac{K_1-1}{K_1} \equiv \widehat{\xi}_3 & \text{if } 1 < K_1 < \frac{1}{1-\xi} \end{cases} \tag{47}$$

If $K_1 \leq 1$, then $\widehat{\xi}_2$ can be greater or less than $\widehat{\xi}_1$. However, if $1 < K_1 < \frac{1}{1-\xi}$, then $\widehat{\xi}_3 < \widehat{\xi}_1$. Given $\xi > \widehat{\xi}_1$, the optimal cap that minimizes expected externalities is given as follows:

$$\overline{x}^* = \begin{cases} x^*(0) + \overline{\Delta}_x & \text{if } K_1 \leq 1 \text{ and } \xi \geq \widehat{\xi}_2 \text{ and if } 1 < K_1 < \frac{1}{1-\xi}; \\ 0 & \text{otherwise.} \end{cases}$$

If $\xi \leq \widehat{\xi}_1$, then $\overline{x}^* = 0$, as discussed before.

■

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