Predatory Stock Price Manipulation

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Abstract

We develop a model where feedback effects from equity markets to firms' access to finance allow uninformed traders to profit by short selling a firm's stock while going long on its product market competitor. Because this strategy distorts the investment incentives of the firm targeted by short selling to the benefit of its rival, we label it *predatory stock price manipulation*. While predatory manipulation undermines the stock market's capacity of improving allocation, efficiency losses are attenuated by gains from predation. Our analysis unveils firms' competitive interactions as a channel through which speculators can increase manipulation profits and effectiveness while hedging against product market shocks, providing new insights into equity markets and short sales regulation.

Keywords: Stock price manipulation, predation, product market competition, feedback effect.

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1 Introduction

Although secondary equity markets do not affect flows of capital to firms directly, they carry important informational content that might be meaningful to managerial decisions (Bond et al., 2012). This feedback channel suggests that speculators can trade equity strategically in order to induce particular outcomes even when uninformed about economic fundamentals, which is known as stock price manipulation (Allen and Gale, 1992). In the context of product markets, speculators can potentially exploit competition between rivals to profit by trading multiple stocks in a way that benefits particular firms. While a rich body of literature investigates how traders can harness feedback effects, little is known about how product market interactions can expand the boundaries of stock price manipulation, possibly due to tractability challenges in feedback models with multiple firms.

In a seminal article, Goldstein and Guembel (2008) show that uninformed speculators can profit by short selling a firm and inducing it to underinvest, reducing its value. In their model of a single firm, profitable manipulation is one-sided in nature, as uninformed buy orders would lead to overinvestment, which also imposes losses to shareholders. Our paper shows how competitive interactions among firms fundamentally change the scope for manipulation, allowing buy and sell orders to compose a manipulative strategy with novel implications to investment efficiency, equity and product markets.

We show how manipulation arises in an innovative model of imperfect information and equity trading where rival duopolists make simultaneous investment decisions that are strategic substitutes. In the model, an uninformed speculator short sells a firm's share while buying its competitor's in a *predatory stock market order*. This strategy leads to the unilateral cancellation of investments by the firm targeted by short selling, transferring value to its competitor. Therefore, we refer to this uninformed trading pattern as *predatory stock price manipulation*.

From the perspective of the speculator, our proposed strategy improves on manipulation that trades in a single direction for various reasons. By pairing trades in opposite directions, the speculator "doubles down" on her bet that only one firm will invest, making such outcome more likely to happen while profiting on two fronts: by closing the short and long positions at the lowest and highest possible prices, respectively. Thus, she exploits strategic substitution by sending a clear signal about the information she might possess. In addition, the strategy hedges against shocks that are common to both firms.

In terms of empirical relevance, the pairing of buy and sell trades of stocks within the same industry is well documented (Barardehi et al., 2022). While this trading pattern is typically attributed to informed traders, factors like information diffusion and liquidity provision cannot fully explain it, suggesting that there are potentially other economic channels at play (Chen et al., 2019). Our theory offers one such channel, namely feedback effects in competitive product markets.

In our framework, managers need to raise an investment outlay from firms' boards, who observe trading in a secondary equity market. As equity prices may contain information about fundamentals, boards might optimally withhold funds following certain stock market outcomes.[1] First, we examine how *informed* predatory stock trading can arise when the speculator knows firms' types. In this case, price informativeness exerts a disciplining role by preventing the target of short selling from undertaking negative NPV projects (Engelberg et al., 2012; Deng

[1] The assumption that insiders might be uninformed about the firm's fundamentals or investment prospects is not necessary, however. On the appendix, we show that our main results obtain in an alternative framework where firms are financially constrained and need to raise *external* funds by pledging future cash flows to capital providers who learn from stock prices, as in Goldstein et al. (2013).

et al., 2020). As a result, overall resource allocation improves as inefficient firms internalize competition externalities and make better investment decisions.

Next, we consider a possibly uninformed speculator who plays a manipulative, predatory trading strategy. Akin to other feedback models, as price informativeness deteriorates, positive NPV investments might be cancelled, decreasing efficiency. However, we show that manipulation only partially undermines the stock markets' capacity of improving allocation because bypassed investments benefit competitors due to strategic substitution, attenuating efficiency losses. Hence, from a pure efficiency perspective, the existence of an equity market unambiguously improves allocation regardless of the extent of manipulation, as opposed to previous models with multiple firms (Goldstein and Guembel, 2005).

As the information contained in market orders is instantaneously incorporated into stock prices, the speculator always opens the long position at a higher price than the short one, thereby losing money when placing a predatory order. This unveils a fundamental trade-off that the speculator faces. On the one hand, she needs manipulation to be effective in preventing the firm targeted by short selling from investing. On the other hand, the information released by the strategy cannot distort initial prices too much. If pair trading in opposite directions widens the gap between prices excessively, it becomes too costly to establish the position and impossible to offset the losses when closing it. We show that, by lumping together multiple signals into predatory orders, the speculator conceals certain information and minimizes price distortion, thus being able to profit in equilibrium.

Tractability is challenging in feedback models where prices and investment decisions are jointly determined. This is particularly the case with multiple firms and shares traded, which exponentially increases the complexity of equilibria. We address this issue by employing a novel structure. While keeping the standard assumption of multiple rounds of equity trading, traders submit market orders only once, but the orders are lined up randomly and executed in sequence. This feature allows the speculator's strategy to be a function of her information only and not of past orders, which greatly simplifies characterization while still obtaining manipulation in equilibrium.

A number of papers investigate the real economic implications of various feedback channels (e.g., Jarrow (1992); Dow and Gorton (1997); Khanna and Sonti (2004); Goldman and Strobl (2013); Edmans et al. (2015); Dow et al. (2017)). In particular, Goldstein and Guembel (2008) lay the theoretical foundation for manipulation via short selling. More recently, Campello et al. (2020) study the impact of short selling costs and show how managers can use stock repurchase contracts to prevent manipulation. Other papers investigate how information production might be useful for managerial decisions (Chang and You, 2010; Gao and Liang, 2013; Goldstein and Yang, 2017, 2019; Terovitis, 2022). Of note, Yang and Xiong (2021) study endogenous information disclosure when oligopolists learn from asset prices to make production decisions. Finally, Terovitis and Vladimirov (2021) explore a different mechanism through which buy side manipulation can arise: by attracting high-quality stakeholders to the target firm.

Our paper contributes to the literature on feedback effects and manipulation in the following aspects. We unveil how speculators can exploit competition to improve manipulation profits and effectiveness while mitigating their exposure to aggregate shocks. As practical implications, the prevalence of manipulation might not be associated solely with the amount of short interest outstanding, and pairs trading might not necessarily reflect information (Chen et al., 2019; Barardehi et al., 2022). More generally, we show how indirect channels of information dissemination through firm networks, such as learning from peers' valuations to make investment decisions (Foucault and Fresard, 2014), might be subject to manipulation motives. Our results also suggest that equity markets' capacity of improving allocation via the informational content of prices depends not only on the prevalence of manipulation and managerial incentives (Singh and Yerramilli, 2014; Strobl, 2014), but also on the nature of firms' interactions in product markets. In addition, our model allows us to predict consequences of manipulation on product market outcomes such as concentration. Finally, we are able to keep the model tractable while preserving the informational structure necessary for manipulation to arise in equilibrium, thereby making a methodological contribution.

A rich body of work studies the interplay between product markets and capital structure (Titman, 1984; Brander and Lewis, 1986; Maksimovic, 1988; Harris and Raviv, 1991; Boot and Vladimirov, 2019), insider trading (Peress, 2010), industry returns (Bustamante and Donangelo, 2017), and investment decisions (Bustamante and Fresard, 2020). In particular, Bolton and Sharfstein (1990) develop a theory of how firms can exploit competitors' financial fragility, and derive the implications of these predatory incentives on optimal financial contracting. Lyandres (2006) shows how debt as a commitment device to engage in aggressive output strategies (Brander and Lewis, 1986) depends on the degree of competitive interaction between product market rivals. Fresard (2010) and Cookson (2017, 2018) provide empirical evidence that financially sound firms are better able to gain market share and to preempt entry threats by potential competitors. We contribute by identifying manipulation as an alternative mean of firm predation. Instead of relying on financial fragility, our theory is based on feedback effects from equity markets which, to the best of our knowledge, has been bypassed by the literature so far.

Our theoretical results imply that the usefulness of stock trading regulations might depend on product market aspects. Although the literature has acknowledged likely perverse consequences of short selling for driving stock prices down (Campello and Graham, 2013; Brunnermeier and Oehmke, 2013), prohibitive restrictions are arguably sub-optimal as they inhibit informed short selling, decreasing price informativeness and its disciplining effects (Karpoff and Lou, 2010; Fang et al., 2016; Engelberg et al., 2017; Matta et al., 2021; Tsai et al., 2021; Deng et al., 2020, 2022). While competition might attenuate the burden of manipulation on equity markets, manipulation still undermines allocation and can systematically benefit particular firms, contributing to unequal product market outcomes. Hence, our results suggest that regulations such as uptick rules and short selling fees are more effective in product markets with strong incentives for predation, where short sales, especially when paired with buy orders, are more likely to reflect manipulative strategies than information about fundamentals.

The rest of the paper is organized as follows. Section 2 describes our baseline model in the absence of equity markets. Section 3 introduces stock markets with a perfectly informed speculator. Section 4 introduces predatory manipulation, characterizes our proposed equilibrium, and discusses possible consequences of manipulation on firms outcomes. Section 5 concludes and the appendix presents the proofs of our results and an alternative formulation of our baseline model.

2 Baseline Model

This section presents our baseline model of investment decisions. Although simple from a product market perspective, it features the key element for our proposed stock trading strategy to arise when we introduce financial markets: strategic substitution in investments. We show that, in the absence of financial markets and under a certain parametric restriction, there is an unique equilibrium in which both firms invest. This result serves as benchmark to evaluate implications of stock trading on equilibria structure and product market outcomes.

2.1 The Product Market

There are two firms, A and B, that compete in a product market. Each firm is run by a manager that can make an investment $I \in [0, K]$. Firms are governed by types $\theta_i^\omega > 0$, $i \in \{A, B\}$ that measure firm i's exposure to its competitor's investment. Specifically, firm i can be "strong", with $\omega = l$ or "weak" with $\omega = h$, where $\theta^h > \theta^l$. Types occur with probability $\frac{1}{2}$ independently across firms. The value of firm i, given by $V_i(\cdot)$, depends on the firm's own type and both firms' investment decisions in the following way:

$$V_i(I_i, I_{-i}, \theta_i^\omega) = (\Theta - \theta_i^\omega I_{-i})\, I_i \tag{1}$$

where $-i$ indexes firm i's competitor. I_i is the investment decision of firm i and Θ is the investment's overall profitability.[2] Thus, we can interpret $\Theta - \theta_i^\omega I_{-i}$ as the NPV of a dollar invested by firm i, which includes the negative externality that a firm's investment imposes on its competitor, implying that investment decisions are strategic substitutes.

Note that profits from investing depend on types only when both firms invest. In addition, not investing is an outside option that yields a value of zero with certainty. Finally, linearity of a firm's value on its own investment implies that optimal investment levels consist of binary decisions $I_i \in \{0, K\}$, $i \in \{A, B\}$.[3]

[2]For easiness of exposition we omit the assets in place in the definition of firm value. Their inclusion has no major implications to the analysis.

[3]This investment decision structure can be motivated in a setting where firms make the investment to enter a Cournot product market where competition increases fixed costs, which are given by $\theta_i^w I_{-i}$. Hence, firms' types are irrelevant when only one firm invests, in which case

As in Lin et al. (2019), we assume that managers have empire-building motives and wish to invest regardless of firms' types. However, in order to raise the initial outlay to invest, each manager needs the approval of their firm's board.[4] Akin to Goldstein et al. (2013), we assume that raising funds is costly, and the board incurs a non-pecuniary cost of $c > 0$ for each unit of capital raised.[5] The boards are risk-neutral so that their payoffs are given by

$$\Pi_i(I_i, I_{-i}, \theta_i^\omega) = (\Theta - \theta_i^\omega I_{-i})I_i - cI_i \tag{2}$$

which states that the board's payoff is the firm's value net of the cost of raising internal resources. Hence, we can think of $\Pi_i(\cdot)$ as the investment's NPV from the perspective of firm i's board. We assume that boards are uninformed about firms' types. We also make the following parametric assumption:

$$\mathbb{E}(\theta^\omega) \leq \frac{\Theta - c}{K} < \theta^h \tag{3}$$

where $\mathbb{E}(\theta^\omega) = \frac{\theta^l + \theta^h}{2}$ is the unconditional expected value of θ^ω. In words, the left inequality on condition (3) implies that, without means of gathering additional information about θ^ω, it is *ex-ante* profitable to invest. On the other hand, the right inequality on (3) states that the board incurs a loss when its firm is weak and both firms invest. This framework introduces an agency problem between managers and their boards: while the former always want to invest, the latter are only willing to provide funds if either their own firm is strong or if their rival does

it becomes a monopolist, and not investing yields zero profits on that market.

[4]Managers might also want to invest if their compensation is based on firm value, which is free from the cost of raising capital in this framework.

[5]We can think of managers as maximizing *gross* investment returns when firm values are based on net returns. In Appendix B, we explicitly make this assumption in an alternative formulation where the firm is financially constrained and must raise funds from external capital providers, as in Goldstein et al. (2013).

not invest. On Appendix B, we show how our main results obtain in an alternative setting that builds on Goldstein et al. (2013).

As the baseline model described here is absent of stock markets, firms' boards have no information about types besides their priors. In this setting, the model consists of a one shot game of imperfect information where each firm invests or not and then profits are realized. Our first result describes its unique Bayesian equilibrium.

Proposition 1 *There is an unique equilibrium of the model with no equity markets, in which* $I_A = I_B = K$.

Hence, in the absence of any further information, the boards of both firms choose to provide funds and managers make the investments.

To study the efficiency of investment decisions across different scenarios, we adapt Goldstein et al.'s (2013) criterion to our duopoly framework as follows:

$$W(I_A, I_B, \theta_A^\omega, \theta_B^\omega) = \Pi_A + \Pi_B \tag{4}$$

where $W(\cdot)$ measures investment efficiency and Π_i is given by equation (2). In our benchmark product market without equity trading, the right-hand side inequality of condition (3) implies that

$$W(K, 0, \theta_A^\omega, \theta_B^\omega) > W(K, K, \mathbb{E}(\theta^\omega), \mathbb{E}(\theta^\omega))$$

which means that investment by a single firm is *ex-ante* more efficient than the equilibrium described in Proposition 1. However, firms don't internalize the negative effect of their own investment on their competitors, so investing is the dominant strategy in this case. In what follows, we also make the following assumption:

$$2\theta^l < \frac{\Theta - c}{K} \tag{5}$$

which implies that

$$W(K, K, \theta_A^l, \theta_B^l) > W(K, 0, \theta_A^\omega, \theta_B^\omega)$$

meaning that investment by two strong firms is more efficient than investment by a single firm. Thus, any mechanism that truthfully reveals information about types would improve efficiency by inducing weak firms to internalize the negative externalities of their investments.

3 The Model With Financial Markets

3.1 The Stock Market

We adapt the one-firm stock market framework of Goldstein and Guembel (2008) and others to our duopoly setting, where the shares of both firms are traded. The shares are claims to firms' values and are liquidated once investment decisions are made. There are four periods: one where information is received, two where stock trading takes place, and one in which the game described in Section 2.1 is played and profits are realized. There are three players in the stock market: a strategic speculator, a noise trader and the market maker.

The strategic speculator receives a possibly informative signal about firms' types and can submit a market order of buying, selling, or not trading one share of each firm. Once the orders are submitted, they are processed at current stock prices set by the market maker. As in Goldstein and Guembel (2008), we say that an order of 1 stands for "buy", −1 stands for "sell", and 0 stands for not trading—

or a "null" order. Thus, the speculator's market order is a pair $u = (u_A, u_B)$ where $u_i \in \{-1, 0, 1\}$ specifies her trading of each stock.[6] Henceforth, we refer to market orders that trade only one of the stocks as partially null orders. We assume that the speculator begins with no position on either firm, i.e., she has no shares to start with. Thus, one can think of an overall null order $u = (0, 0)$ as "opting out" of the stock market, which yields a reservation payoff of zero. In addition, an order of -1 on either firm can be regarded as a short sale.

Besides the speculator, there is a non-strategic noise trader that submits a uniformly random market order $n = (n_A, n_B)$ that specifies his trading of one share of each firm. We assume that n_A and n_B are independent and that the noise trader does not submit null orders, i.e., $n_i \neq 0$. Thus, each share is either bought or sold short with equal probabilities.

As usual in feedback models, there are two rounds of stock trading. However, only one trader trades in each round: the market orders of the speculator and noise trader arrive randomly and are executed sequentially. Therefore, with probability $\frac{1}{2}$ the speculator's order is first in line and the noise trader's is second whereas the opposite occurs with equal probability. In addition, we assume that null orders by the speculator are replaced by another random order from the noise trader before reaching the market maker. The speculator, however, only establishes positions on firms she actively trades. This is a simplifying assumption that will be discussed in detail on Section 3.2.

Following Kyle (1985), there is a market maker who sets equity prices and executes orders out of his inventory. As usual in feedback models, we assume that

[6] For tractability, we assume that the speculator cannot trade more than one unit of each security. This restriction can arise from borrowing costs or limited lending supply on the short leg and wealth constraints on the long leg. More generally, search costs can also impose limits on how many shares of a firm one can trade within a trading day.

the market maker is uninformed about types. At each round of trading, the orders received are processed at prices equal to the expected value of firms conditional on the information available up to that period.[7] Importantly, the market maker does not know how traders were lined up so he can't distinguish between their orders.

After stock trading takes place, investment decisions are made and open positions are liquidated so profits can be transferred to shareholders. Hence, the payoff of the speculator comes from opening and closing positions at different prices.

In summary, the model can be described in a timeline of four periods: $t = 0, 1, 2, 3$. In $t = 0$, the speculator receives a signal and submits an order based on it, while the noise trader submits a random order. In $t = 1$, orders are randomly lined up and the first in line is executed by the market maker. In $t = 2$, the second order in line is processed. In $t = 3$, investment decisions are made, open positions are liquidated and the speculator and firms realize profits.

3.2 Discussion

Tractability is notoriously challenging in models of financial feedback, where prices and investment decisions are jointly determined. This is particularly true in our duopoly model where the shares of both firms are traded. To wit, the large number of cases to consider can render analytical characterization of equilibria prohibitively complex. Hence, we make two key assumptions to preserve tractability. Since these assumptions depart from usual models in the literature, we discuss them in more detail in this section.

As in Goldstein and Guembel (2008), our model features two rounds of stock trading, which is crucial for manipulation profits to arise. However, previous models (e.g., Kyle (1985); Goldstein and Guembel (2008); Campello et al. (2020))

[7] A detailed description about price setting is made on Section 3.3.

typically assume that both the speculator and the noise trader trade in each round but their orders are pooled so that the market maker cannot observe individual components. In contrast, we assume that only one trader trades in each period, but the market maker cannot tell them apart. Whereas Glosten and Milgrom (1985) employ a similar structure, in their model information is received upon traders' arrival, which is fundamentally different and unsuitable for our manipulation framework. Instead, our novel setting greatly reduces the complexity of the model by making the speculator's strategies contingent on her signal only and not on past orders. Still, it preserves the feature that orders observed sequentially by the market maker are only partially revealing, allowing for profitable manipulation to arise in equilibrium.

Second, we assumed that null orders by the speculator are replaced by other random orders from the noise trader. This, together with the assumption that noise traders always trade implies that the market maker never observes null orders. Allowing null orders to reach the market maker would considerably increase the number of possible stock market outcomes and compromise tractability. Thus, our framework allows us to keep the model tractable while circumventing the strong assumption that speculators cannot submit partially null orders.[8] Our reasoning carries two underlying premises: that submitting a null order on a stock is the same as not trading it and that there is always someone willing to actively trade any share outstanding.

3.3 Price Setting

In each trading period, the market maker executes orders at prices such that he breaks even in expectation conditional on the information available. In addition,

[8] Although this assumption further simplifies equilibria characterization.

he does not know how traders were lined up. Thus, he receives pairs of orders O_1, O_2 – respective to each trading period, where $O_t \in \{-1,1\} \times \{-1,1\}$. The first term of O_t refers to trading of firm A's share whereas the second refers to firm B. For instance, $O_2 = (1,-1)$ means that, in $t = 2$, an order to buy a share of firm A and to sell a share of firm B was received.

To describe prices, we adopt the following notation:

$$p_i^{sign(O_1)} = \mathbb{E}\left(V_i | O_1\right)$$
$$p_i^{sign(O_1,O_2)} = \mathbb{E}\left(V_i | O_1, O_2\right)$$

For instance, p_A^{+-} is the price of a share of firm A in $t = 1$ when $O_1 = (1,-1)$. Similarly, $p_B^{--,-+}$ is the price of a share of firm B in $t = 2$ when orders were $O_1 = (-1,-1)$ and $O_2 = (-1,1)$.

Note that once the orders of both periods are realized, the timing in which they were received is innocuous. All the market maker knows is that one was submitted by the speculator and the other, by the noise trader. This implies that once O_1, O_2 are known, we can flip them around without changing firms' stock prices. For instance, $p_i^{++,--} = p_i^{--,++}$ and $p_i^{+-,-+} = p_i^{-+,+-}$

The fact that one order is received before the other only matters in the first round of trade ($t = 1$) which we will henceforth refer to as the *interim* trading period. Interim prices are determined by a weighted average of prices at $t = 2$ in which the weights are the probabilities of receiving each corresponding order conditional on the order received in $t = 1$. Let $q(O_2|O_1)$ be the probability of observing O_2 in $t = 2$ conditional on having received O_1 in the first period. Then we have, for instance:

$$p_A^{+-} = q\left((1,1)|(1,-1)\right) p_A^{+-,++} + q\left((1,-1)|(1,-1)\right) p^{+-,+-}$$
$$+ q\left((-1,1)|(1,-1)\right) p^{+-,-+} + q\left((-1,-1)|(1,-1)\right) p_A^{+-,--}$$

Since stock prices reflect the expected value of firms conditional on all the orders processed up to that point, variation in prices across firms is driven by uncertainty regarding firms types and—in the interim period—investment decisions.

3.4 Equilibrium with Informed Predatory Stock Trading

In this section, we describe an equilibrium of the model with stock markets and a perfectly informed speculator. Then, we contrast its structure and implications to our baseline model in Section 2. In particular, we show how the speculator can use stock trading as a mean of predation against one of the firms, inducing its board to withhold investment funds. As we will see, she achieves this by submitting orders of the type $(u, -u)$, with $u \in \{-1, 1\}$, which we will henceforth refer to as *predatory orders*.

Here, we assume that the speculator receives a perfectly informative signal S that reveals firms' types, which means $S \in \{(l,l); (l,h); (h,l); (h,h)\}$ each happening with probability $\frac{1}{4}$. Therefore, the speculator's strategy $u(S)$ maps the signal received into the set of probability distributions over possible market orders.

In the presence of equity markets, firms' boards decide whether to provide funds after observing stock prices. Thus, their strategies are decision functions $g_i\left(p_i^{sign(O_1,O_2)}\right) \in \{0, K\}$, $i \in \{A, B\}$. Although stock prices of both firms are public knowledge, we omit firm i's rival share price as an argument of $g_i(\cdot)$ for ease of exposition.[9]

As in Goldstein and Guembel (2008), this framework features feedback effects from equity prices to real investment decisions which, in turn, must be reflected on prices. Thus, an equilibrium of the model with stock markets consists of:

i) A trading strategy contingent on the signal received by the speculator, $u(S)$, that maximizes her expected final payoff given the price setting by the market maker and boards' investment decisions.

ii) Investment decisions $g = \left\{ g_i \left(p_i^{sign(O_1,O_2)} \right) \right\}_{i \in \{A,B\}}$ such that boards' expected net profit of investment is maximized given the speculator's trading strategy and the price setting.

iii) Price setting by the market maker, $p_i^{sign(O_1)}$ and $p_i^{sign(O_1,O_2)}$, $i \in \{A, B\}$ such that he breaks even in expectations given trading strategies and investment decisions.

Finally, in order for the equilibrium to be *predatory*, exactly one of the firms must cancel investments following certain stock market outcomes.

To characterize an equilibrium of the model with stock markets and a perfectly informative signal, consider the following trading strategy of the speculator, which

[9] In equilibrium, the price of a firm's share completely determines its rival's.

we define as $\tilde{u}(\cdot)$.

$$\tilde{u}(l,l) = (1,1)$$
$$\tilde{u}(l,h) = (1,-1)$$
$$\tilde{u}(h,l) = (-1,1)$$
$$\tilde{u}(h,h) = \begin{cases} (1,-1), \text{ with probability } \frac{1}{2} \\ (-1,1), \text{ with probability } \frac{1}{2} \end{cases}$$

Strategy $\tilde{u}$ says that when firms are of different types, the speculator submits a predatory order against the weak firm and in favor of the strong one. When both firms are strong, she buys both shares. Finally, she plays a mixed strategy when both firms are weak. There, she submits a predatory order where firms are randomly selected with equal probabilities.

Whereas the speculator could always target one specific firm when $S = (h,h)$ instead of randomizing, the fact that she begins with no stock position implies that expected profits of preying upon either firm is the same. Thus, the profit is also the same when mixing between predatory orders with any probability. In particular, mixing with equal probabilities greatly reduces the number of unique prices to be determined in equilibrium, as opposite predatory orders generate symmetric prices. For instance, under $\tilde{u}$, we have that $p_A^{+-} = p_B^{-+}$ and $p_A^{++,-+} = p_B^{++,+-}$.

The next step is to characterize investment decisions. Consider the following profile $\tilde{g} = \left\{\tilde{g}_i\left(p_i^{sign(O_1,O_2)}\right)\right\}_{i\in\{A,B\}}$

$$\tilde{g_A}\left(p_A^{sign(O_1,O_2)}\right) = \begin{cases} 0, \text{ if } p_A \in \{p_A^{-+,-+}, p_A^{--,-+}, p_A^{-+,--}\} \\ K, \text{ otherwise} \end{cases}$$

and, symmetrically:

$$\tilde{g}_B\left(p_B^{sign(O_1,O_2)}\right) = \begin{cases} 0, \text{ if } p_B \in \{p_B^{+-,+-}, p_B^{--,+-}, p_B^{+-,--}\} \\ K, \text{ otherwise} \end{cases}$$

In words, $\tilde{g}$ states that boards provide investment funds unless it is revealed that their firm was targeted by a predatory order. For instance, $p_B^{+-,+-}$, $p_B^{--,+-}$, and $p_B^{+-,--}$ reveal that $u = (1, -1)$. The last two cases occur because the order $(-1, -1)$ is not played in $\tilde{u}$, so if the market maker observes it, he knows it must have come from the noise trader, which in turn reveals the speculator's order. The cases in this example are the only ones in which investor of firm B decides not to invest. Note that the sequence of orders $(O_1, O_2) = (-1, -1), (-1, -1)$ is out of the equilibrium path. Following such orders, we assume that boards keep their prior expectations about types and invest, as follows from Assumption 3.

Our next proposition establishes the existence of conditions under which the strategies described constitute an equilibrium.

Proposition 2 *If it holds that*

$$\frac{1}{3}\theta^l + \frac{2}{3}\theta^h < \frac{\Theta - c}{K} \tag{6}$$

and

$$7\theta^h - 5\theta^l < \frac{\Theta}{K} \leq \frac{55}{3}(\theta^h - \theta^l) \tag{7}$$

Then trading strategy $\tilde{u}$ and investment decisions $\tilde{g}$ constitute an equilibrium of the model with equity markets and a perfectly informed speculator.

Condition (6) ensures the optimality of investment decisions $\tilde{g}$. It states that boards' profit-to-investment ratio is high enough so that providing investment funds is profitable unless market orders reveal that their firm was targeted by a predatory order, which reveals that the firm is weak.[10]

Condition (7) establishes that predatory orders are optimal to the speculator following any signal except (l, l). The left-hand inequality in (7) implies that the speculator should try to keep weak firms from investing, whereas the right-hand one implies that the combined value of strong firms is sufficiently high. Thus, if the speculator observes (l, l), she should buy both shares and ensure both firms invest, as per $\tilde{g}$. In this case, the gain in stock value from ensuring that both firms invest more than offsets the profit from attempting to prey upon one firm.

The equilibrium in Proposition 2 does not feature manipulation as the speculator always trades based on an informative signal. However, it lays the foundation to why manipulation can effectively arise when the speculator is possibly uninformed: investments might optimally be withheld following certain stock market outcomes, as described by strategy $\tilde{g}$. In addition, our results from Section 2 imply that investments would be made in the absence of stock markets. Since the retention of investments is always unilateral on the equilibrium path, trading strategy $\tilde{u}$ is predatory as it transfers value from one firm to its rival.

An important distinction between our model and usual predation models is that, in our setting, predatory behavior is practiced by stock traders instead of firms. However, note that our framework features a speculator preying upon a firm even if she has no stakes in its competitor. Thus, firms and their stakeholders have stronger incentives to engage in predatory manipulation against competitors than the neutral speculator that we describe in our model.

[10]In which case, providing funds is not profitable *ex-ante* by Assumption (3).

3.5 Implications: Informed Predatory Trading

Our next result explore possible implications of informed predatory trading as described in Proposition 2 on investment efficiency.

Corollary 1 *The presence of equity markets with a perfectly informed speculator increases ex-ante investment efficiency.*

Since trading strategy $\tilde{u}$ is *ex-ante* symmetric across firms, Corollary 1 implies that the expected payoffs of both firms' boards are greater in the equilibrium of Proposition 2 than in Proposition 1. The reason is that financial markets provide information that allows boards to make better decisions and internalize investment externalities. In particular, predatory orders discipline managers by preventing them from undertaking negative NPV investments.

To discuss the next implication of our model with financial markets, let us introduce the notion of the relative value of a firm in the product market as follows

$$VS_i(I_A, I_B, \theta_A^{\omega}, \theta_B^{\omega}) = \frac{V_i}{V_A + V_B} \tag{8}$$

where $V_i(\cdot)$ is the value of firm i as defined in equation (1). Hence, $VS_i(\cdot)$ measures firm i's share of total value.

Note that the symmetry of trading strategies and investment decisions imply that expected VS_i for each firm is unaffected by the introduction of equity markets. As in the equilibrium where firms always invest, expected value shares of both firms are $\frac{1}{2}$. Nevertheless, informed predatory orders might lead a single firm to invest, thus making extreme values of VS more likely. To capture this, we compute a measure of firm value concentration in the product market using the Herfindahl-Hirschman index. Specifically, we define *ex-ante* concentration as follows:

$$HHI = \mathbb{E}\left(VS_A^2 + VS_B^2\right)$$

where expectation is taken over the distribution of outcomes given types, trading strategies and investment decisions, which allows us to compare concentration across equilibria. Our next result discusses the effect of equity markets on our measure of concentration.

Corollary 2 *In the equilibrium with equity markets, a perfectly informed speculator that trades according to strategy $\tilde{u}$, and firms' boards that follow investment decisions $\tilde{g}$, firm value concentration is higher than in the equilibrium with no equity markets.*

Even considering the symmetry of our proposed equilibrium with stock trading, the HHI with equity markets and an informed trader need not be greater than in the equilibrium with no financial markets. On the one hand, predatory trading allows value shares of one and zero on the equilibrium path, which tends to increase expected concentration. On the other hand, conditional on both firms investing, the probability that they have the same type is higher, which tends to decrease expected concentration. It turns out that condition (7) implies that the first effect dominates. Specifically, the left-hand inequality in (7) states that the investment's NPV should be high enough so that predatory orders are optimal except when $S = (l, l)$. As a result, the baseline HHI when both firms invest is relatively small, which amplifies the positive effect of equity markets on the HHI with predatory orders. In Section 4.2, we discuss in more details the implications of asymmetric equilibria on firm value concentration.

4 Predatory Stock Price Manipulation

Having established the feedback channel through which stock markets affect real investment decisions of product market rivals, we now describe how predatory stock manipulation can arise in equilibrium and discuss its implications on investment efficiency. Consider a model with stock markets similar to that described in Section 3, but with a different signal structure. Along the lines of Goldstein and Guembel (2008) we now assume that the speculator might receive an uninformative signal about firm types. With probability α, the signal is informative and reveals types. With probability $1-\alpha$, the signal is empty and the speculator is uninformed. To wit, there are five possible signals the speculator can receive: $S \in \{(l,l);(l,h);(h,l);(h,h);\emptyset\}$ with respective probabilities $\{\frac{\alpha}{4};\frac{\alpha}{4};\frac{\alpha}{4};\frac{\alpha}{4};1-\alpha\}$. Hence, the model in Section 3 can be regarded as a special case of the current model, in which $\alpha = 1$.

Recall that firm boards observe no signal and are unaware of whether the speculator is informed or not. Thus, even when uninformed about firms types, the speculator still has informational advantage over investors and the market maker for knowing that she is, in fact, uninformed.

Similar to Allen and Gale (1992) and Goldstein and Guembel (2008), we define stock price manipulation as the uninformed trading of shares that induces real outcomes that are favorable to the speculator's position. Additionally, in order for manipulation to be characterized as predatory, the outcomes induced by manipulative strategies must favor one firm to the detriment of its rival. Thus, predatory manipulation consists on the speculator being able to profit from predatory orders even when uninformed about types by distorting investment decisions via the feedback channel.

4.1 Equilibrium With Predatory Manipulation

For an equilibrium to feature predatory manipulation, one more requirement must be met in addition to those described in session 3.4. The manipulative trading strategy must assign predatory orders to empty signals, i.e., $u(\emptyset) = (u, -u)$ where $u \in \{-1, 1\}$. In addition, these orders must successfully induce a firm to cancel investments following certain stock market outcomes.

Consider a trading strategy for the speculator $\tilde{u}_M(S)$ described as follows: $\tilde{u}_M(S) = \tilde{u}(S)$ for $S \in \{(l,l);(l,h);(h,l);(h,h)\}$ with $\tilde{u}(\cdot)$ as defined in Section 3.4. In addition, $\tilde{u}_M(\emptyset) = \tilde{u}(h,h)$. In words, the speculator acts exactly like in the equilibrium described in Section 3.4, except that she pools the signals (h,h) and $\emptyset$ into the same mix of actions. In these cases, she submits a predatory order with firms randomly chosen with equal probabilities. Again, although equilibria might admit other randomizations between $(-1,1)$ and $(1,-1)$, we choose a symmetric strategy, as this property is nicely embodied in stock prices and simplifies characterization.

From the perspective of the market maker, any predatory order might have originated from three different signals when the speculator trades according to $\tilde{u}_M$. As it turns out, the pooling of different signals—including $\emptyset$—into the same actions is crucial for the effectiveness of manipulation. By doing so, the speculator avoids revealing when she is uninformed. We discuss this in further details in Section 4.3, where also consider the existence of an alternative equilibrium with predatory manipulation.

For $\alpha < 1$, stock prices following any orders in both trading periods are certainly different from those on Section 3. However, no change on the structure investment decisions is required. Our next proposition states that there exists a equilibrium featuring our proposed manipulation provided that some parametric conditions are met.

Proposition 3 *If it holds that*

$$\frac{2-\alpha}{4-\alpha}\theta^l + \frac{2}{4-\alpha}\theta^h < \frac{\Theta - c}{K} \leq \frac{2(1-\alpha)}{4-\alpha}\theta^l + \frac{2+\alpha}{4-\alpha}\theta^h \tag{9}$$

and

$$\frac{7\theta^h - (3+2\alpha)\theta^l}{2-\alpha} < \frac{\Theta}{K} \leq \left(\frac{4+\alpha}{4-\alpha}\right)\left(\frac{18+4\alpha}{\alpha(1+\alpha)}\right)(\theta^h - \theta^l) \tag{10}$$

Then trading strategy $\tilde{u}_M$ and investment decisions $\tilde{g}$ constitute an equilibrium of the model with equity markets and a possibly uninformed speculator.

Thus, for a certain range of parameters, the speculator is able to profit by manipulating stock prices in a way that induces one of the firms to underinvest. Analogously to Proposition 2, condition (9) reflects the optimality of $\tilde{g}$. Here, knowing that a firm was targeted by a predatory order does not ensure it is weak, but its expected type is still weak enough to prevent boards from investing. Similarly, condition (10) establishes the optimality of trading strategy $\tilde{u}_M$. Its left-hand side implies that the speculator should submit a predatory order even when uninformed because the gains from predation more than offsets the risk of holding the share of an weak firm that invests. On the other hand, if both firms are strong and the noise trader's order does not reveal types, the market maker will price both stocks below their true value, so the speculator profits when closing the long positions. The right-hand side of condition (10) implies that these profits dominate predation gains when $S = (l, l)$.

On Appendix A, we provide the proof Proposition 3 together with a detailed description of its parametric conditions and an illustrating example with parameter values. Our next corollary describes how the existence of an equilibrium with predatory manipulation depends on α.

Corollary 3 *An equilibrium of the model with financial markets can feature predatory manipulation only if the speculator is possibly informed.*

Our result in Corollary 3 is typical of models of financial feedback and manipulation. As in Allen and Gale (1992), manipulation can be effective in shaping real decisions as long as the speculator is possibly informed, i.e., if $\alpha > 0$. If $\alpha = 0$, then firms' boards (or external capital providers) are aware that the stock market provides no additional information and thus optimally choose to ignore it when making investment decisions. As a result, boards' provide funds based on their prior beliefs about firm types. Thus, we can think of the model without equity markets of section 2 as a special case of the model with financial markets in which the speculator is always uninformed.

4.2 Implications: Predatory Manipulation

As we have seen in Section 3.5, a market for firms' equity and an informed speculator leads to the cancellation of negative NPV investments that would be made in the absence of the stock market. However, when the speculator is possibly uninformed and trades according to $\tilde{u}_M$, cancelled investments need not have negative NPV. In fact, conditional on the speculator being uninformed, any cancelled investment necessarily has a positive NPV according to condition (3). This has implications to investment efficiency as stated in our next corollary.

Corollary 4 *In the presence of an equity market, predatory stock price manipulation reduces ex-ante investment efficiency. However, the existence of an equity market unambiguously increases ex-ante investment efficiency.*

In other words, predatory manipulation only partially undermines the stock market's role of improving allocation. As the speculator might be uninformed, the informational content of prices is less accurate. Nevertheless, the existence of an equity market improves investment decisions as compared to the equilibrium in Proposition 1. This contrasts with results from an early version of Goldstein and Guembel (2008)[11] where the authors considered two firms that shared strategic complementarities and had a single claim on their combined value traded on the equity market. There, the existence of a stock market could worsen allocation if there was excessive manipulation. However, when the shares of competitors are traded separately, the firm targeted by a manipulative buy order gains value from investing (as in Khanna and Sonti (2004) and Terovitis and Vladimirov (2021)), which attenuates efficiency losses caused by bypassed positive NPV investments. Thus, despite enabling manipulation, the stock market always brings *some* incremental efficiency to our duopoly framework.

Corollary 4 is a consequence of strategic substitution in investment decisions, as can be easily shown on its proof in Appendix A. Whereas we do not attempt to make general claims about the desirability of financial markets—as it exerts other roles than what we discuss in our model—our results still bring an interesting insight. To wit, the equity market's capacity of improving efficiency might depend not only on the extent of manipulative trading, but also on the nature of firms' interactions in product markets.

Next, we discuss the implications of predatory manipulation on our measures

[11] Goldstein and Guembel (2005)

of share of total firm value and concentration defined in Section 3.5. Similar to the case of a perfectly informed speculator, the symmetry of the manipulative strategy $\tilde{u}_M$ implies that *ex-ante* firm value shares are unaffected by manipulation. However, as manipulation further makes extreme values of firm value shares more likely, it has implications to concentration, as our next corollary states.

Corollary 5 *In the presence of an equity market, investment decisions $\tilde{g}$, and trading strategy $\tilde{u}_M$, predatory manipulation further increases firm value concentration as compared to the equilibrium with a perfectly informed speculator.*

With an equity market, the effect of predatory manipulation as described by trading strategy $\tilde{u}_M$ on the HHI is unambiguous. Specifically, a lower value of α has two implications. First, it increases the likelihood that only one firm will invest. Second, conditional on both firms investing, it reduces the probability that firms have the same type. Both these effects tend to increase concentration. Since expected shares of total firm value remain the same while their variance increases, predatory manipulation in the equilibrium described is a mean-preserving spread of VS_A and VS_B.

Finally, note that there are two symmetric features of our equilibrium with manipulation that have implications to product market concentration. First, both firms have the same value of assets in place, i.e., they are *ex-ante* similar. Second, following $S \in \{(h, h), \emptyset\}$, the speculator randomizes between predatory orders with equal probabilities. Under either of these assumptions, predatory manipulation will always lead to more extreme outcomes, increasing expected concentration as compared to the equilibrium with no stock trading. Nevertheless, an asymmetric equilibrium where an *ex-ante* larger firm is always targeted by predatory orders following $S \in \{(h, h), \emptyset\}$ would feature a lower concentration than our baseline equilibrium with no equity markets. Hence, our results on concentration would not hold in the specific case where firms are of different sizes and the speculator has an *ex-ante* incentive to prey upon the large firm.

4.3 The Profit from Predatory Manipulation and Alternative Equilibria

As usual in models of financial feedback from financial markets to real decisions, the profitability of manipulation stems from the informational advantage of the speculator granted by the signal received. Even when the speculator is uninformed, she still has the informational advantage of knowing so, as long as she could possibly be informed, as per Corollary 3. As the interim order might have been placed by the noise trader, information is only partially revealed by interim prices. This allows the speculator to establish positions when she has superior information and closing them at a profit once O_2 is incorporated into prices.

An illustration of how predatory manipulation can be profitable follows. Suppose an uninformed speculator places an order $(1, -1)$ that is executed in $t = 1$. In this period, the speculator's payoff is $-p_A^{+-} + p_B^{+,-}$, which is negative. This is due to the fact that, in our proposed equilibrium, such order ensures that firm A will make the investment while making investment by firm B less likely, and thus $p_A^{+-} > p_B^{+,-}$. If, at $t = 2$, n is such that both firms invest, the speculator makes no profit at that period because she closes the long position on A and the short position in B at equal prices.[12] This outcome, thus, yields an overall negative profit. However, if n is such that firm B does not invest, the speculator closes the long position on A at $p_A = \Theta K$, which is the highest price possible, while closing

[12]This is due to the fact that the symmetric nature of strategies $\tilde{u}_M$ and $\tilde{g}$ are reflected into prices.

the short position on B at zero, thus profiting on the trade of both stocks. In addition, the predatory order in $t = 1$ makes such outcome more likely to happen as compared to trading a single share, which more than offsets $t = 1$ losses and yields an overall positive expected payoff.

The key to profitable predatory manipulation lies in the cost of establishing a predatory position on competitors. Crucially, this is determined by how much information about firm types predatory orders reveal. To see this, let's consider an alternative trading strategy that features predatory manipulation and show how it cannot be part of an equilibrium when the speculator is possibly uninformed.

Define trading strategy $\hat{u}_M(S)$ as follows: $\hat{u}_M(S) = \tilde{u}_M(S)$ for $S \neq (h, h)$, and $\hat{u}_M(h, h) = (-1, -1)$. Thus, the only difference between the two strategies is the market order when the speculator knows that both firms are weak. Under $\hat{u}_M$, the speculator short sells the stock of both firms instead of placing a predatory order.

Boards' investment decisions are the same as before, given by $\tilde{g}$, with a slightly different interpretation, however. Now, market orders $O_1 = (-1, -1), O_2 = (-1, -1)$ are on the equilibrium path, and reveal that both firms are weak. In this case, we assume that each firm invests with probability $\frac{1}{2}$, which is an equilibrium of the subgame as per assumption (3). Thus, by following $\tilde{g}$, a firm's board provide investment funds with certainty unless stock prices reveal that its firm was sold short by the speculator.[13]

When the speculator follows either trading strategy $\hat{u}$ or $\tilde{u}$, she places a predatory order following $S = \emptyset$, which in both cases yields the following expected

[13] But not necessarily in a predatory order, as opposed to $\tilde{u}_M$.

profit:[14]

$$\frac{1}{2}\left[p_A^{-+} - p_B^{-+} + \frac{\Theta K}{2}\right] + \frac{1}{2}\left[\frac{1}{4}\left(p_A^{++,-+} - p_B^{++,-+}\right)\right] \tag{11}$$

The first term of expression (11) corresponds to the case where the speculator is first in line, which happens with probability $\frac{1}{2}$. There, she establishes the predatory position at $p_A^{-+} - p_B^{-+}$, which is negative. With probability $\frac{1}{2}$, the noise trader places an order that induces the firm targeted by the predatory order in $t = 1$ to cancel investments, in which case the speculator profits ΘK, otherwise she gets zero from closing both positions at equal prices. The second term reads as follows. With probability $\frac{1}{2}$, the speculator' order arrives second. In this case, if the noise trader submitted $(1, 1)$ on the first period, then the speculator establishes the predatory position at $p_A^{++,-+} - p_B^{++,-+}$, which is also negative, and the speculator again makes zero profits when closing positions. For all other orders that the noise trader submits on $t = 1$, the speculator makes zero profits at $t = 2$.

One can see that the only source of profits from predatory manipulation comes from successful predation—preventing one firm from investing. Establishing the initial position is always costly as the information embedded in prices implies that the long position is opened at a higher price than the short one. This nicely illustrates the speculator's trade off. She wants the predatory order to possibly hamper the target firm's investment, which will inevitably induce price distortion in $t = 1$. However, if price distortion is too large, it widens the gap between firms' stock prices to the point where the speculator cannot offset losses when closing positions. This leads us to our next result.

[14]The example follows from placing an order $(-1, 1)$, but the payoff is the same as placing $(1, -1)$ due to the symmetry of both $\hat{u}$ and $\tilde{u}$.

Proposition 4 *Under investment decisions $\tilde{g}$, trading strategy $\hat{u}_M$ can be part of an equilibrium only if the speculator is perfectly informed.*

Proposition 4 states that predatory manipulation cannot be profitable under strategy $\hat{u}_M$. Whereas there is an equilibrium in which speculators play $\hat{u}_M$ if $\alpha = 1$, no such equilibrium exists if $\alpha < 1$. The reason is as follows. Conditional on the speculator placing a predatory order, under $\tilde{u}_M$, the probability of firms being of different types ($S \in \{(l,h),(h,l)\}$) is $\frac{2}{4-\alpha}$. However, under $\hat{u}_M$, this probability is $\frac{1}{2-\alpha}$, which is higher. This implies that, when the speculator trades according to $\hat{u}$, a predatory order widens the gap between stock prices excessively: $p_A^{-+} - p_B^{-+}$ and $p_A^{++,-+} - p_B^{++,-+}$ are negative numbers large enough to offset the profit from predation, rendering expression (11) unambiguously negative.

When the speculator follows $\tilde{u}_M$ and places a predatory order, the market maker attaches a positive probability to the speculator having observed (h,h), which minimizes price distortion. By lumping together multiple signals and placing a predatory order whenever $S \neq (l,l)$, the uninformed speculator conceals that she did not observe $S = (h,h)$, which significantly decreases the cost of establishing the predatory position, enabling equilibrium profits.

5 Concluding Remarks

We develop a theory of how product market competition can shape stock price manipulation in the presence of feedback effects from secondary equity markets to firms' access to finance. We show how uninformed speculators can exploit strategic substitution in competitors' investment decisions by pairing a short sell and a buy trade on their stocks. This induces the firm targeted by short selling to forego profitable investments and lose value to its rival, allowing the speculator to close both positions at a profit. Hence, we label it predatory stock manipulation. From the perspective of the speculator, this strategy improves the effectiveness and profitability of manipulation as compared to trading a single share while also hedging against idiosyncratic shocks to the product market and the economy.

When the speculator is perfectly informed about firms' fundamentals, such predatory strategy increases investment efficiency by preventing managers from undertaking negative NPV investments. While predatory trading decreases price informativeness when the speculator is uninformed, we find that the equity market unambiguously improves efficiency regardless of the extent of manipulation because efficiency losses are attenuated by gains from predation. Finally, we show how predatory manipulation affects product market outcomes, and how the speculator must strike a balance between manipulation effectiveness and price distortion to be able to profit in equilibrium.

We believe that this study is the first to bring together the literatures on feedback effects and firm predation. While previous work has showed how short selling regulations face a trade-off between preventing manipulation and preserving price informativeness, our analysis focuses on the interplay between manipulation and competitive aspects. Hence, we provide novel insights on how product market interactions can affect the effectiveness of stock trading regulations.

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Appendix A Proofs

Proof of Proposition 1

On the one hand, we have that $\Pi_i(0, I_{-i}, \theta_i^\omega) = 0$ so that boards have an outside option that yields zero payoff regardless of their own type and rival's action. On the other hand, $\Pi_i(K, 0, \theta_i^\omega) = (\Theta - c)K$ and $\mathbb{E}_{\theta^\omega}(\Pi_i(K, K, \theta_i^\omega)) = (\Theta - c - \mathbb{E}(\theta^\omega)K)\,K$. Assumption (3) implies that both these payoffs are strictly positive so that providing investment funds is a strictly dominant strategy. Therefore $I_A = I_B = K$ is the unique perfect Bayesian equilibrium of the game. □

Proof of Propositions 2 and 3

In this Section we provide the proof of our main result, Proposition 3. As previously mentioned, the framework in Section 3 can be regarded as a special case of the framework in Section 4 with $\alpha = 1$. Therefore, we provide only the proof of the more general case. All the steps described here can be used as a mean of proving Proposition 2 by picking $\alpha = 1$.

The first step to fully characterize an equilibrium of the game is to derive stock prices in both trading periods. First, we derive $t = 2$ prices, which depend on expected firm types conditional on orders O_1, O_2 and boards investment decisions. These prices are

$$p^{++,++} = p^{--,++} = (\Theta - \theta^l K)K$$

$$p_A^{+-,+-} = p_A^{--,+-} = p_B^{-+,-+} = p_B^{--,-+} = \Theta K$$

$$p_A^{-+,-+} = p_A^{--,-+} = p_B^{+-,+-} = p_B^{--,+-} = 0$$

$$p^{+-,-+} = \left(\Theta - \left(\frac{2-\alpha}{4-\alpha}\theta^l + \frac{2}{4-\alpha}\theta^h\right) K\right) K$$

$$p_A^{++,+-} = p_B^{++,-+} = \left(\Theta - \left(\frac{6-\alpha}{2(4-\alpha)}\theta^l + \frac{2-\alpha}{2(4-\alpha)}\theta^h\right) K\right)$$

$$p_A^{++,-+} = p_B^{++,+-} = \left(\Theta - \left(\frac{6-3\alpha}{2(4-\alpha)}\theta^l + \frac{2+\alpha}{2(4-\alpha)}\theta^h\right) K\right)$$

$$p^{--,--} = \left(\Theta - \frac{\theta^l + \theta^h}{2} K\right) K$$

Note that we make use of the symmetry of strategies $\tilde{u}_M$ and $\tilde{g}$ to compute stock prices. Specifically, prices that follow orders in the same direction for both firms need not be indexed by firm, e.g., $p_A^{++,++} = p_B^{++,++} = p^{++,++}$. With $t = 2$ prices, interim stock prices are computed as described in Section 3.3. These prices are

$$p^{++} = \left(\Theta - \left(\frac{12+11\alpha-4\alpha^2}{4(1+\alpha)(4-\alpha)}\theta^l + \frac{4+\alpha}{4(1+\alpha)(4-\alpha)}\theta^h\right) K\right) K$$

$$p_A^{+-} = p_B^{-+} = \left(\Theta - \left(\frac{56-22\alpha+3\alpha^2}{8(4-\alpha)(6-\alpha)}\theta^l + \frac{40-10\alpha-\alpha^2}{8(4-\alpha)(6-\alpha)}\theta^h\right) K\right) K$$

$$p_A^{-+} = p_B^{+-} = \left(\frac{12-\alpha}{4(6-\alpha)}\Theta - \left(\frac{56-30\alpha+\alpha^2}{8(4-\alpha)(6-\alpha)}\theta^l + \frac{40-2\alpha+\alpha^2}{8(4-\alpha)(6-\alpha)}\theta^h\right) K\right) K$$

$$p^{--} = \left(\frac{4+\alpha}{8}\Theta - \frac{\alpha}{4}\theta^l K\right) K$$

Given such prices, we can compute the speculator's expected profits following any order she submits, conditional on strategies $\tilde{u}_M$ and $\tilde{g}$.

Inequalities (9) and (10) establish sufficient conditions under which there are no profitable deviations from the proposed strategies $\tilde{u}_M$ and $\tilde{g}$. Specifically, condition (9) ensures that, given trading strategy $\tilde{u}_M$ and price setting, a firm's board is better off by withholding investment funds following market orders that reveal that the speculator placed a predatory order against their firm, but not otherwise.

For ease of exposition, in the rest of this proof we omit the investment decisions and the trading strategy that the market maker expects the speculator to follow from our notation. Hence, in the following analysis, $\pi(u|S)$ represents the speculator's expected payoff of placing order u after receiving signal S provided that investment decisions and trading strategies are expected to be $\tilde{g}$ and $\tilde{u}_M$, respectively.

Condition (10) refers to the trading strategy. It implies that, provided that firm boards are following $\tilde{g}$ and the market maker expects the speculator to trade according to $\tilde{u}_M$, then $\pi((1,1)|(l,l)) > \pi((1,-1)|\emptyset) > 0 > \pi((-1,-1)|(h,h))$. Thus, inequality (10) ensures that predatory orders are profitable and also dominate other orders except following $S = (l,l)$.

We proceed by computing payoffs for each possible signal and arguing that under condition (10), there are no profitable deviations from $\tilde{u}_M$. Note that when $S \notin \{(h,l);(l,h)\}$, placing a predatory order against one firm or the other yields equivalent profits, as does mixing between them.

First, suppose $S = (l,l)$. In this case, we have

$$\pi((1,1)|(l,l)) = -p^{++} - \frac{p_A^{+-,++} + p_B^{+-,++}}{2} + 2(\Theta - \theta^l K)K \tag{12}$$

$$\pi((1,-1)|(l,l)) = \pi((-1,1)|(l,l)) = \frac{p_B^{+-} - p_A^{+-}}{2} + \frac{p_B^{++,+-} - p_A^{++,+-}}{8} + \frac{\Theta K}{4} \tag{13}$$

$$\pi((-1,-1)|(l,l)) = p^{--} - \Theta K + \frac{7\theta^l K^2}{8} + \frac{\theta^h K^2}{8} \tag{14}$$

$$\pi((1,0)|(l,l)) = \pi((0,1)|(l,l)) = -\frac{p^{++} + p_A^{+-}}{4} - \frac{p_A^{++,-+} + p^{+-,-+}}{16} + \frac{3\Theta K}{4} - \frac{5\theta^l K^2}{8} \tag{15}$$

$$\pi((-1,0)|(l,l)) = \pi((0,-1)|(l,l)) = \frac{p^{--} + p_A^{-+}}{4} + \frac{p_A^{++,-+} + p^{+-,-+}}{16} - \frac{\Theta K}{2} + \frac{7\theta^l K^2}{16} \tag{16}$$

Inequality (10) implies that $u = (1,1)$ dominates predatory orders. It also implies that predatory orders dominate $(1,0); (0,1); (-1,0); (0,-1); (-1,-1)$. We thus conclude that the speculator chooses $(1,1)$.

For the next case, suppose $S = (l,h)$. Here, profits are

$$\pi((1,1)|(l,h)) = -p^{++} - \frac{p_A^{+-,++} + p_B^{+-,++}}{4} + \frac{3\Theta K}{2} - \frac{\theta^l K^2}{2} - \theta^h K^2 \tag{17}$$

$$\pi((1,-1)|(l,h)) = \frac{p_B^{+-} - p_A^{+-}}{2} + \frac{p_B^{++,+-} - p_A^{++,+-}}{8} + \frac{\Theta K}{4} + \frac{(\theta^h - \theta^l)K^2}{4} \tag{18}$$

$$\pi((-1,-1)|(l,h)) = p^{--} - \frac{3\Theta K}{4} + \frac{(\theta^l + 3\theta^h)K^2}{8} \tag{19}$$

$$\pi((1,0)|(l,h)) = -\frac{p^{++} + p_A^{+-}}{4} - \frac{p_A^{++,+-}}{8} - \frac{p_A^{-+,++} + p^{-+,+-}}{16} + \frac{3\Theta K}{4} - \frac{5\theta^l K^2}{8} \tag{20}$$

$$\pi((0,-1)|(l,h)) = \frac{p^{--} + p_A^{-+}}{4} + \frac{p_A^{++,-+} + p^{+-,-+}}{16} - \frac{7\Theta K}{16} - \frac{3\theta^l K^2}{32} - \frac{15\theta^h K^2}{32} \tag{21}$$

Note that here we are omitting orders $(-1,1)$, $(-1,0)$ and $(0,1)$ as they yield unambiguously lower payoffs than $(1,-1)$, $(0,-1)$ and $(1,0)$, respectively. It is also unambiguous that $\pi((1,1)|(l,h)) < 0$ and $\pi((1,-1)|(l,h)) > \pi((1,-1) |(l,l))$. It is also true that $\pi((1,-1)|(l,l)) > \max\{\pi((1,0)|(l,h)); \pi((0,-1)|(l,h))\}$. Finally, condition (10) implies that $\pi((1,-1)|(l,h)) > \pi((-1,-1)|(h,h)) > \pi((-1,-1)|(l,h))$. Thus, we conclude that the speculator chooses $(1,-1)$. Symmetrically, $(-1,1)$ is the speculator's most profitable order when $S = (h,l)$.

Now, if the signal is $S = (h, h)$, then we have

$$\pi((1,1)|(h,h)) = -p^{++} - \frac{p_A^{+-,++} + p_B^{+-,++}}{4} + \frac{3\Theta K}{2} + \frac{\theta^l K^2}{2} - \frac{3\theta^h K^2}{2} \tag{22}$$

$$\pi((1,0)|(h,h)) = \pi((0,1)|(h,h)) = -\frac{p^{++} + p_A^{+-}}{4} + \frac{\Theta K}{2} - \frac{3\theta^h K^2}{8} \tag{23}$$

$$\pi((-1,0)|(h,h)) = \pi((0,-1)|(h,h)) = \frac{p_A^{-+} + p^{--}}{2} - \frac{5\Theta K}{16} + \frac{\theta^h k^2}{4} \tag{24}$$

$$\pi((-1,-1)|(h,h)) = p^{--} - \frac{3\Theta K}{4} + \frac{\theta^h K^2}{2} \tag{25}$$

Here, $\pi((-1,1)|(h,h)) = \pi((1,-1)|(h,h))$ are given by (13). Condition (10) implies that $\pi((-1,-1)|(h,h)) < 0$, and it also holds that $\pi((-1,-1)|(h,h)) > \pi((-1,0)|(h,h))$. We also have that $\pi((1,-1)|(h,h)) > \pi((1,0)|\emptyset) > \pi((1,0)|(h,h))$. Finally, $\pi((1,1)|(h,h))$ is negative. In summary, the speculator should choose any randomization between predatory orders. We thus assume that she does so with equal probabilities for the sake of symmetry.

Finally, we analyse the case of $S = \emptyset$. We have

$$\pi((1,0)|\emptyset) = \pi((0,1)|\emptyset) = -\frac{p^{++} + p_A^{+-}}{4} + \frac{\Theta K}{2} - \frac{3(\theta^l + \theta^h)K^2}{16} \tag{26}$$

$$\pi((-1,0)|\emptyset) = \pi((0,-1)|\emptyset) = \frac{p^{--} + p_A^{-+}}{4} - \frac{5\Theta K}{16} + \frac{(\theta^l + \theta^h)K^2}{8} \tag{27}$$

Here, we omit the other possible payoffs as they are equal to others that were described previously. Again, $\pi((-1,1)|\emptyset) = \pi((1,-1)|\emptyset)$ are given by (13). We also have that $\pi((1,1)|\emptyset) = \pi((1,1)|(h,l))$, which is negative. Moreover, $\pi((1,-1)|\emptyset) = \pi((1,-1)|(h,h)) > \pi((-1,-1)|(h,h)) > \pi((-1,-1)|\emptyset)$. In addition, it is unambiguous that $\pi((1,-1)|\emptyset) > \pi((1,0)|\emptyset)$. Finally, we have that $\pi((1,-1)|\emptyset) = \pi((1,-1)|(h,h)) > \pi((0,-1)|(h,h)) > \pi((0,-1)|\emptyset)$ and the same argument holds for $(-1,0)$. We thus conclude that the speculator chooses a symmetric randomization of predatory orders when $S = \emptyset$.

The arguments above show how condition (10) ensures that $\tilde{u}_M$ is optimal to the speculator given $\tilde{g}$ and price setting of the market maker. Now, we proceed to show how $\tilde{g}$ is optimal to boards given $\tilde{u}_M$ and price setting.

Following stock prices, boards use Bayes rule to update their beliefs about their firm's type. The expected payoff of lending funds is given by the expectation of $\Pi_i(\cdot)$ conditional on the orders observed. In our proposed equilibrium, this expectation should be negative for an board when it is revealed that it's firm was targeted by a predatory order, and positive otherwise. Thus, we must have

$$\mathbb{E}_{\theta_A^\omega}(\Pi_A(K,K,\theta_A^\omega)|p_A^{+-,-+}) > 0 > \mathbb{E}_{\theta_A^\omega}(\Pi_A(K,K,\theta_A^\omega)|p_A^{-+,-+}) \tag{28}$$

Where $p_A^{+-,-+}$ can be shown to be the second worse outcome for firm A's board in terms of expectations about θ_A^ω. The right side of inequality (28) states that firm A's board is better off by not investing when prices are either $p_A^{-+,-+}, p_A^{--,-+}$ or $p_A^{-+,--}$. By plugging expected values of θ_A^ω, one can show that conditions (28) and (9) are identical and pinpoint the stock market outcomes where investments have negative NPV.

Finally, it can be shown that condition (9) implies condition (3) and does not contradict (5). We finish by showing that the conditions for the equilibrium can be met by means of examples. The parameter values $\alpha = \frac{1}{2}$, $\Theta = 60$, $K = 2$, $c = \dfrac{388}{7}$, $\theta^l = 1$ and $\theta^h = 3$ satisfy the requirements for an equilibrium with predatory manipulation. An equilibrium with stock markets and a perfectly informed speculator can be represented by the following parameter values: $\alpha = 1$, $\Theta = \frac{15}{7}$, $K = \frac{2}{35}$, $\theta^l = 1$ and $\theta^h = 3$. □

Proof of Corollary 1

In the baseline model of Section 2, investment efficiency is $2(\Theta - c - \mathbb{E}(\theta^\omega)K)K$. Under the equilibrium described in Section 3.4, we have

$$\mathbb{E}(W) = \left(\frac{13}{8}(\Theta - c) - \left(\frac{3\theta^l}{4} + \frac{\theta^h}{2}\right)K\right)K \tag{29}$$

This is greater than the efficiency without an equity market as long as

$$\frac{\Theta - c}{K} < \frac{2\theta^l + 4\theta^h}{3}$$

which is implied by the left-hand side of assumption (3). □

Proof of Corollary 2

In the baseline model, firm value concentration is given by

$$HHI = \frac{1}{4} + \frac{1}{2}\left(\frac{((\Theta - \theta^l K)K)^2 + ((\Theta - \theta^h K)K)^2}{((2\Theta - (\theta^l + \theta^h)K)K)^2}\right) \tag{30}$$

whereas in the equilibrium with a financial market and no manipulation of Section 3.4, we have

$$HHI = \frac{9}{16} + \frac{1}{4}\left(\frac{((\Theta - \theta^l K)K)^2 + ((\Theta - \theta^h K)K)^2}{((2\Theta - (\theta^l + \theta^h)K)K)^2}\right) \tag{31}$$

One can show that (31) is greater than (30) as long as

$$\frac{\Theta}{K} > \frac{(1-a)\theta^l + (1+a)\theta^h}{2}$$

where $a = \sqrt{\frac{2}{3}}$, which is true by assumption (10). □

Proof of Corollary 3

By inspecting condition (9), one can see that the interval for which investment decisions $\tilde{g}$ are optimal collapses if $\alpha = 0$. This stems from the fact that if firm boards know that the speculator is always uninformed, they will optimally choose to ignore the stock market and the model collapses to that in Section 2. □

Proof of Corollary 4

In the equilibrium with predatory manipulation of Section 4.1, investment efficiency is

$$\mathbb{E}(W) = \left(\frac{12+\alpha}{8}(\Theta - c) - \left(\frac{2+\alpha}{4}\theta^l + \frac{\theta^h}{2}\right)K\right)K \tag{32}$$

Subtracting (32) from (29), one gets

$$(1-\alpha)\left(\frac{\Theta - c}{8} - \frac{\theta^l K}{4}\right)K$$

which, for $\alpha < 1$, is a positive number by assumption (5). Moreover (32) is greater than the investment efficiency without a stock market as long as

$$\frac{\Theta - c}{K} < \frac{(4-2\alpha)\theta^l + 4\theta^h}{4-\alpha}$$

which is implied by assumption (3) for $\alpha \geq 0$ given that investment decisions are strategic substitutes ($\theta^l, \theta^h > 0$). $\square$

Proof of Corollary 5

Conditional on any signal $S \neq \emptyset$, firm value concentration under the equilibrium in Section 3.4 is the same as in the equilibrium in Section 4.1. Thus, it suffices to show that the expected concentration of the equilibrium with manipulation conditional on $S = \emptyset$ is larger than the overall concentration of the equilibrium with equity markets and a perfectly informed speculator.

Following $S = \emptyset$, expected concentration is

$$HHI = \frac{5}{8} + \frac{1}{2}\left(\frac{((\Theta - \theta^l K)K)^2 + ((\Theta - \theta^h K)K)^2}{((2\Theta - (\theta^l + \theta^h)K)K)^2}\right)$$

which is unconditionally greater than (31). $\square$

Proof of Proposition 4

First, we show that trading strategy $\hat{u}_M$ and investment decisions $\tilde{g}$ cannot constitute an equilibrium when $\alpha < 1$.

Under trading strategy $\hat{u}_M$, investment decisions $\tilde{g}$ are optimal if and only if

$$\frac{\theta^l + \theta^h}{2} < \frac{\Theta - c}{K} \leq \frac{1-\alpha}{2-\alpha}\theta^l + \frac{1}{2-\alpha}\theta^h \tag{33}$$

where the left-hand side of the inequality is already implied by assumption (3). The right-hand side of inequality (33) states that a firm's board should withhold investment funds when it is revealed that the firm was sold short by the speculator. This condition can still be written as in expression (28). Under these strategies,

$t=2$ stock prices are given by

$$p^{++,++} = (\Theta - \theta^l K)K$$

$$p_A^{+-,+-} = p_A^{--,+-} = p_B^{-+,-+} = p_B^{--,-+} = \Theta K$$

$$p_A^{-+,-+} = p_A^{--,-+} = p_B^{+-,+-} = p_B^{--,+-} = 0$$

$$p^{+-,-+} = p^{--,++} = \left(\Theta - \frac{\theta^l + \theta^h}{2}K\right)K$$

$$p_A^{++,+-} = p_B^{++,-+} = \left(\Theta - \left(\frac{3-\alpha}{2(2-\alpha)}\theta^l + \frac{1-\alpha}{2(2-\alpha)}\theta^h\right)K\right)$$

$$p_A^{++,-+} = p_B^{++,+-} = \left(\Theta - \left(\frac{3-2\alpha}{2(2-\alpha)}\theta^l + \frac{1}{2(2-\alpha)}\theta^h\right)K\right)$$

$$p^{--,--} = \left(\frac{\Theta}{2} - \frac{\theta^h}{4}K\right)K$$

Again, we use the symmetry of $\hat{u}_M$ to compute stock prices. Using $t=2$ prices, we compute interim prices as described in Section 3.3, to get

$$p^{++} = \left(\Theta - \left(\frac{3}{4}\theta^l + \frac{\theta^h}{4}\right)K\right)K$$

$$p_A^{+-} = p_B^{-+} = \left(\Theta - \left(\frac{7-5\alpha+\alpha^2}{4(3-\alpha)(2-\alpha)}\theta^l + \frac{5-5\alpha+\alpha^2}{4(3-\alpha)(2-\alpha)}\theta^h\right)K\right)K$$

$$p_A^{-+} = p_B^{+-} = \left(\frac{\Theta}{2} - \left(\frac{7-6\alpha+\alpha^2}{4(3-\alpha)(2-\alpha)}\theta^l + \frac{5-4\alpha+\alpha^2}{4(3-\alpha)(2-\alpha)}\theta^h\right)K\right)K$$

$$p^{--} = \left(\frac{2+3\alpha}{4(1+\alpha)}\Theta - \left(\frac{\alpha}{4(1+\alpha)}\theta^l + \frac{3\alpha}{8(1+\alpha)}\theta^h\right)K\right)K$$

For ease of exposition, we omit the trading strategy and investment decisions from our payoff notation again. In the following analysis, $\pi(u|S)$ represents the speculator's expected payoff of placing order u after receiving signal S provided that investment decisions and trading strategies are expected to be $\tilde{g}$ and $\hat{u}_M$, respectively.

By plugging the above prices in expression (11), we get

$$\pi((1,-1)|\emptyset) = -\frac{\alpha(5-\alpha)(\theta^h - \theta^l)K^2}{16(3-\alpha)(2-\alpha)} \tag{34}$$

which is negative for any $\alpha \in (0,1]$. Hence, the speculator cannot profit from predatory manipulation by trading according to $\hat{u}_M$.

Next, we show that $\hat{u}_M$ and $\tilde{g}$ can constitute an equilibrium of the model with an equity market and a perfectly informed speculator. Thus, for the following analysis, we assume that $\alpha = 1$. For consistency of notation, we refer to $\hat{u}_M$ in the case where $\alpha = 1$ as $\hat{u}$ to explicitly convey that it does not involve manipulation.

Suppose that, in addition to condition (33), the following expression also holds, ensuring the optimality of trading strategy $\hat{u}$.

$$\max\left\{\frac{7\theta^l - 4\theta^h}{8}, \frac{10\theta^l - 7\theta^h}{2}\right\} < \frac{\Theta}{K} \leq \frac{11\theta^h - 2\theta^l}{6} \tag{35}$$

As in the proof of Propositions 2 and 3, we proceed by computing expected payoffs of placing each possible order following any possible signal and arguing that, provided that conditions (33) and (35) hold and firms' boards follow $\tilde{g}$, there are no profitable deviations from trading strategy $\hat{u}$. Since the assumption that $\alpha = 1$ simplifies the expressions considerably, we report final payoffs.

First, suppose $S = (l,l)$. In this case, we have $\pi((1,-1)|(l,l))$ given by equation (34), and

$$\pi((1,1)|(l,l)) = \frac{(\theta^h - \theta^l)K^2}{2}$$

$$\pi((1,0)|(l,l)) = \pi((0,1)|(l,l)) = \frac{3(\theta^h - \theta^l)K^2}{16}$$

$$\pi((-1,0)|(l,l)) = \pi((0,-1)|(l,l)) = -\frac{\Theta K}{16} + \frac{5\theta^l K}{16} - \frac{7\theta^h K^2}{32}$$

$$\pi((-1,-1)|(l,l)) = -\frac{\Theta K}{4} + \frac{3\theta^l K^2}{4} - \frac{3\theta^h K^2}{8}$$

Clearly, $\pi((1,1)|(l,l)) > \pi((1,0)|(l,l)) > 0$. In addition, the left-hand side of condition (35) implies both that $\pi((1,1)|(l,l)) > \pi((-1,-1)|(l,l))$ and $\pi((-1,0)|(l,l)) < 0$. Since the predatory order yields a negative payoff, we conclude that the speculator buys both stocks.

Next, if $S = (l,h)$, profits are

$$\begin{aligned}
\pi((1,1)|(l,h)) &= -\frac{(\theta^h - \theta^l)K^2}{2} \\
\pi((1,-1)|(l,h)) &= \frac{5(\theta^h - \theta^l)K^2}{8} \\
\pi((1,0)|(l,h)) &= \frac{3(\theta^h - \theta^l)K^2}{16} \\
\pi((0,-1)|(l,h)) &= -\frac{\Theta K}{16} - \frac{3\theta^l K^2}{16} + \frac{9\theta^h K^2}{32} \qquad (36) \\
\pi((-1,-1)|(l,h)) &= -\Theta K + \frac{\theta^l K^2}{4} + \frac{\theta^h K^2}{8}
\end{aligned}$$

We omit orders $(0,1)$ and $(-1,0)$ as they yield lower payoffs than $(0,-1)$ and $(1,0)$, respectively. We have that $\pi((1,-1)|(l,h)) > \pi((1,0)|(l,h)) > 0 > \pi((1,1)|(l,h))$. Also, the left-hand side of condition (35) ensures that the predatory order dominates both $(0,-1)$ and $(-1,-1)$. Hence, the speculator chooses $(1,-1)$, and the symmetric argument applies for $S = (h,l)$, where she chooses $(-1,1)$.

Finally, if $S = (h,h)$, profits are

$$\pi((1,1)|(h,h)) = -\frac{3(\theta^h - \theta^l)K^2}{2}$$

$$\pi((-1,-1)|(h,h)) = -\frac{\Theta K}{4} - \frac{\theta^l K^2}{4} + \frac{5\theta^h K^2}{8}$$

Here, both $\pi((1,1)|(h,h))$ and $\pi((1,-1)|(h,h))$ are negative, with the latter showed by expression (34). $\pi((0,-1)|(h,h))$ is given by (36) and it's strictly larger than $\pi((1,0)|(h,h))$. Finally, the right-hand side of condition (35) implies that $\pi((-1,-1)|(h,h)) > \pi((0,-1)|(h,h))$, and its left-hand side implies that $\pi((-1,-1)|(h,h)) > 0$ and so the speculator short sells both stocks, which concludes the proof. □

Appendix B Alternative structure

In this section, we consider an alternative version of our baseline model to show that one can motivate the feedback channel in different ways. In particular, we follow Goldstein et al. (2013) more closely and assume that firms are financially constrained and need to raise external funds to invest.

Similar to Section 2.1, firms are run by managers who allocate investment funds, and possible firms' types are the same. One unit of investment by firm i generates a cash flow of $\Theta - \theta_i^\omega I_{-i}$. However, we assume that firms are short on internal funds, and need to raise external finance for the investment's initial outlay. Each firm can borrow $I_i \in [0, K]$ from a capital provider by pledging a given fraction $\beta \in (0,1)$ of the investment's cash flow.[15] Therefore, firm values are now given by

[15] We assume that β is the same for both firms to preserve the symmetry of our proposed equilibrium.

$$V_i(I_i, I_{-i}, \theta_i^\omega) = (1-\beta)\,(\Theta - \theta_i^\omega I_{-i})\,I_i \tag{37}$$

which is the remainder of the investment's cash flow after paying back the capital provider.

We assume that the investment always generates a positive cash flow, which implies that

$$\theta^h < \frac{\Theta}{K} \tag{38}$$

In addition, we assume that the each manager maximizes their firm's value. Hence, condition (38) implies that managers always invest when funds are available, regardless of firms' types.

In this formulation, capital providers are analogous to firms' boards in Section 2.1. Capital providers' payoffs are given by

$$\Pi_i(I_i, I_{-i}, \theta_i^\omega) = \beta(\Theta - \theta_i^\omega I_{-i})I_i - I_i \tag{39}$$

which is the proportion they capture from the investment cash flow net of the initial outlay. As in Goldstein et al. (2013), we assume that capital providers are uninformed of firm types. Therefore, condition (3) now reads

$$\mathbb{E}(\theta^\omega) \leq \frac{\beta\Theta - 1}{\beta K} < \theta^h \tag{40}$$

which states that a capital provider should provide funds under prior expectations about its firm type, but not when its firm is weak and the competitor invests.

In order to measure investment efficiency, we need to consider the value of the cash flow generated by investments net of the initial outlays—investments' overall NPV. Since now the value of cash flows are split between firms and capital providers, our investment criterion now aggregates payoffs across these agents as follows:[16]

$$W(I_A, I_B, \theta_A^\omega, \theta_B^\omega) = \Pi_A + \Pi_B + V_A + V_B = \sum_{i \in \{A,B\}} (\Theta - \theta_i^\omega I_{-i})\, I_i - I_i \qquad (41)$$

Similar to Section 2.1, we assume that

$$W(K, K, \theta_A^l, \theta_B^l) > W(K, 0, \theta_A^\omega, \theta_B^\omega) \geq W(K, K, \mathbb{E}(\theta^\omega), \mathbb{E}(\theta^\omega))$$

which can be rewritten as

$$2\theta^l < \frac{\Theta - 1}{K} \leq \theta^l + \theta^h \qquad (42)$$

The structure of the equity market remains the same, where the shares traded are claims to firm values as given by equation (37). In this context, assumption (38) implies that the value of a firm's equity is always increasing in the level of investment I_i. As Goldstein et al. (2013) discuss, this feature is suitable to describe the equity of financially constrained firms that cannot undertake value-increasing investments without raising external capital.

Within this framework, our main results follow. First, in the absence of a financial market, there is an unique Bayesian equilibrium in which capital providers always lend funds, as per condition (40). This outcome is inefficient as compared to when only one firm invests, as implied by assumption (42). In the presence of equity markets, capital providers observe stock prices to learn about firms'

[16]Using a measure of investment efficiency based only on capital providers' payoffs has no qualitative implications to our main results.

fundamentals and decide whether to lend investment funds. If the speculator is possibly uninformed, an equilibrium with predatory manipulation exists if the speculator trades according to $\tilde{u}_M$, capital providers follow decisions $\tilde{g}$, and both (10) and the following condition hold.

$$\frac{2-\alpha}{4-\alpha}\theta^l + \frac{2}{4-\alpha}\theta^h < \frac{\beta\Theta - 1}{\beta K} \leq \frac{2(1-\alpha)}{4-\alpha}\theta^l + \frac{2+\alpha}{4-\alpha}\theta^h \tag{43}$$

which is analogous to condition (9). This equilibrium has the same properties as that of the framework presented in Section 4. As an example, the following parameter values satisfy the above conditions: $\alpha = \frac{1}{2}$, $\Theta = \frac{4}{3}$, $K = \frac{1}{9}$, $\beta = \frac{63}{68}$, $\theta^l = 1$, and $\theta^h = 3$. We also illustrate an equilibrium with a perfectly informed speculator with the following parameter values: $\alpha = 1$, $\Theta = \frac{6}{5}$, $K = \frac{1}{15}$, $\beta = \frac{46}{47}$, $\theta^l = 1$, and $\theta^h = 3$.