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 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*. Our model shows that predatory manipulation decreases investment efficiency and affects market concentration. Our analysis further unveils product market competition as a channel through which buy orders increase manipulation profits and effectiveness, providing new insights into short sales regulation.

Keywords: Short sales, product market competition, stock price manipulation, predation, market concentration.

JEL classification: G14, G23, G31, D43, D82, D84.

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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.

In a seminal paper, Goldstein and Guembel (2008) show that uninformed speculators can profit by short selling a firm and inducing it to underinvest, reducing its value. Interestingly, a symmetric buy-side manipulation cannot occur in their model as it would lead to overinvestment, which also imposes losses to shareholders. In this paper, we develop a theory of manipulation where firms' competitive interactions allow both buying and shorting pressure to compose a manipulative trading strategy that distorts investment incentives and product market outcomes.

We show how manipulation arises in a 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, decreasing its value while increasing its competitor's. Because this uninformed trading pattern favors one firm to the detriment of the other, we refer to it as *predatory stock price manipulation.* By pairing trades in opposite directions, the speculator "doubles down" on her bet that only one firm will invest. This not only makes such outcome more likely to happen, but also allows her to profit on two fronts by closing her short and long positions at the lowest and highest possible prices, respectively. Hence, the speculator exploits strategic substitution between rivals to improve the effectiveness and profitability of manipulation.

Anecdotal evidence suggests that possibly manipulative stock trading is meaningful in shaping product markets. Casino, the third largest French retailer, has been under repeated attacks by hedge funds specialized in short selling, who mostly blamed the fierce product market competition in France for the bets against Casino. As a response to the attacks, Casino issued a statement claiming that its stock had been "subjected to coordinated downward speculative manipulations of an unprecedented scale".[1] Because of concerns over the refinancing requirements of the holding company, Casino started a divestment process by selling store sites, real estate, and several hypermarkets to the market leader Leclerc.[2] As a result of Casino's depressed stock price, Carrefour (the second largest retailer) approached Casino do discuss a takeover, with Carrefour's CEO justifying the bid due to the French market being "incredibly competitive."[3]

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

[1]See Financial Times, September 24, 2018, "Clashing merger claims add twist to Casino short-selling saga". Available at https://www.ft.com/content/a256488a-bcb0-11e8-8274-55b72926558f

[2]See Bloomberg, January 19, 2019, "Casino to sell six stores to Leclerc for about 100 million euros". Available at https://www.bloomberg.com/news/articles/2019-01-19/casino-to-sell-six-stores-to-leclerc-for-about-100-million-euros

[3]See Bloomberg, January 17, 2020. "Monoprix's owner can't shake the blues". Available at https://www.bloomberg.com/opinion/articles/2020-01-17/monoprix-owner-casino-can-t-shake-the-blues; and Rapports de Force, November 18, 2018, "Carrefour: apres le demantelement de Dia, Casino dans la ligne de mire?" Available at https://rapportsdeforce.fr/classes-en-lutte/carrefour-apres-le-demantelement-de-dia-casino-dans-la-ligne-de-mire-11182619

contain information about fundamentals, boards might optimally withhold funds following certain stock market outcomes.[4] We start by examining 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 firm targeted by short selling from undertaking negative NPV projects (Engelberg et al., 2012). As a result, overall resource allocation improves as boards of inefficient firms internalize competition effects and make better investment decisions.

Next, we consider the case where the speculator is possibly uninformed, in which case she plays a manipulative, predatory trading strategy. We show that predatory manipulation partially undermines stock markets' capacity of improving allocation. As price informativeness decreases, positive NPV investments might be cancelled, decreasing efficiency (but not below the level with no equity trading) and affecting expected product market concentration in firm values.

As the information contained in market orders is instantaneously incorporated into stock prices, the uninformed speculator always opens the long position at a higher price than the short position, therefore losing money in the initial trade. Therefore, a crucial condition for manipulation to be profitable is that the cost of placing a predatory order must be relatively low. This unveils a keen, fundamental trade off that the speculator faces. First, she needs predatory manipulation to be effective in preventing the firm targeted by short selling from investing. On the other hand, the information contained in the strategy cannot distort initial prices too much. If the predatory order widens the gap between stock prices excessively, it becomes too costly to establish the positions and impossible to profit enough when closing them. We show that, by lumping together multiple signals into predatory

[4] In the appendix, we show that our main results obtain in an alternative framework where firms need to raise *external* funds from capital providers who learn from stock prices, as in Goldstein et al. (2013).

orders, the speculator conceals certain information and minimizes price distortion, thus being able to profit in equilibrium.

A number of papers investigate the real economic implications of feedback channels such as price informativeness and learning by managers (e.g., Dow and Gorton (1997); Goldstein et al. (2013); Dow et al. (2017)). In particular, the work by Goldstein and Guembel (2008) lays the theoretical foundation for manipulation via short selling. More recently, Campello et al. (2020) study the impact of short selling costs on manipulation and show how contracts can induce managers to prevent manipulation through stock repurchases. Other papers also investigate how information production might be useful for managerial decisions (Gao and Liang, 2013; Goldstein and Yang, 2017, 2019). Specifically, Yang and Xiong (2021) consider a scenario where oligopolists learn from asset prices to make production decisions. The authors show that endogenous disclosure by firms has two implications: product market competition is detrimental to total surplus; and that noise trading in financial markets can improve price informativeness. Finally, Terovitis and Vladimirov (2021) explore a different mechanism through which buy side manipulation can arise: by creating a "buzz" around the target firm, attracting high-quality stakeholders.

Our paper contributes to the manipulation literature in the following aspects. By expanding the original framework by Goldstein and Guembel (2008), we unveil how uninformed speculators can profit by exploiting the competitive aspect of product markets.[5] This involves more sophisticated trading strategies that were not possible in previous models such as Goldstein and Guembel (2008) and Edmans et al. (2015). It follows that the presence of manipulation might not be

[5]In an early version, Goldstein and Guembel (2008) described a model with two firms that share strategic complementarity and had their combined stock traded in the equity market.

associated solely with the amount of short interest outstanding. In addition, our results suggest that the pairing of buy and sell trades might not necessarily reflect information. Whereas the prevalence of equity pairs trading in opposite directions has been previously documented (Chen et al., 2019; Barardehi et al., 2021), the possibility of it reflecting manipulative strategies rather than traders' information has been bypassed by the literature, to the best of our knowledge. Finally, our analysis allows us to make empirical predictions of manipulative trading in product market outcomes such as concentration and aggregate investment efficiency.

Tractability is a big challenge in a feedback model of competing firms. The structure of manipulation models—where prices and investment decisions are jointly determined—in addition to multiple shares being traded greatly increases the complexity of equilibria characterization. To address this issue, we make a methodological contribution to the literature. While keeping the standard assumption of multiple rounds of stock trading, in our model traders submit market orders only once, but the orders are lined up randomly and executed in sequence. This novel feature allows the speculator's strategies to be a function of her information only, and not of past orders. Thus, we are able to keep the model fairly tractable while preserving the information release structure necessary for manipulation to arise in equilibrium.

A rich literature studies how firms' financial structure can have implications to product market outcomes (Titman, 1984; Brander and Lewis, 1986; Maksimovic, 1988; Harris and Raviv, 1991) and, more specifically, to predatory strategies (Bolton and Sharfstein, 1990; Lyandres, 2006). These papers mostly focus on how firms can exploit their competitors' financial fragility to engage in more aggressive output strategies and improve their product market position. Peress (2010) investigates the interplay between insider trading and product markets. More recently, Bustamante and Donangelo (2017) and Bustamante and Fresard (2020) analyse industry returns and investment peer effects in the context of product market competition.

On the empirical side, Fresard (2010) and Cookson (2017, 2018) provide evidence that financially sound firms are better able to gain market share at the expense of industry rivals and to preempt entry threats by potential competitors. We contribute to this body of work by identifying manipulation as an alternative mean of firm predation. Instead of relying on financial fragility, our theory is based on the presence of feedback effects from secondary equity markets which, to the best of our knowledge, remains unexplored by the predation literature hitherto.

Our theoretical results suggest that effective stock trading regulation should account for product market aspects. Although the literature has acknowledged likely perverse consequences of short selling, prohibitive restrictions are arguably sub-optimal, as they might inhibit informed short selling, decreasing price informativeness and its disciplining effects (Karpoff and Lou, 2010; Fang et al., 2016; Engelberg et al., 2017; Campello et al., 2020; Barardehi et al., 2020; Matta et al., 2021). Our results suggest that regulations such as uptick rules and short selling fees should be more prevalent in product markets with strong incentives for predation—such as markets where firms compete in strategic substitutes and heavily concentrated markets—where short sales 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

In this Section we describe our model of investment decisions in the absence of financial markets. We show that under a certain parametric restriction there is an unique equilibrium in which both firms invest. This result serves as a benchmark for evaluating implications of financial markets and predatory manipulation on equilibria structure and investment efficiency.

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 $I \in [0, K]$ that possibly increases its firm value. Firms are governed by types $\theta_i^\omega > 0$, $i \in A, B$ that measure firm i's vulnerability 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.[6] Thus, we can interpret $\Theta - \theta_i^\omega I_{-i}$ as the NPV of a dollar invested by firm i.

Note that profits from investing only depend on types 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 decision implies

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

that optimal investment levels consist of binary decisions $I_i \in \{0, K\}$, $i \in A, B$.

As in Lin et al. (2019), we assume that managers have empire-building motives and wish to invest regardless of firm types.[7] However, in order to raise the initial outlay to invest, each manager needs the approval of their firm's board. Following Goldstein et al. (2013), we assume that raising funds is costly, and the board incurs a non-pecuaniary cost of $c > 0$ for each unit of capital raised. The boards are risk-neutral so that firm i's board payoff is 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 value net of its non-pecuniary cost of raising internal resources. Hence, the term $\Pi_i(\cdot)$ can be regarded as the investment's NPV from the perspective of firm i's board. We assume that boards are uninformed about firm 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 profitable, in expectation, for the board 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 the boards of their respective firms: while the former always want investments to be made, the latter is only willing to invest if either their own firm is strong or if their rival does not invest. On Appendix

[7] We can think of managers as maximizers of *gross* investment returns, whereas the firm value is based on net returns. We explicitly introduce this assumption in Appendix B, where we discuss an alternative formulation of the baseline model.

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 θ^ω besides their prior. Therefore, it features no feedback effects from financial markets into real decisions. In this setting, the model consists of a one shot game of imperfect information in which each investor chooses to invest or not and then payoffs 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* $I_i = K$, $i \in A, B$.

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

We study the efficiency of investment decisions across different scenarios to evaluate the implications of feedback effects. Expanding Goldstein et al. (2013) to our duopoly framework, we use the following efficiency criterion:

$$W(I_A, I_B, \theta^\omega_A, \theta^\omega_B) = \Pi_A + \Pi_B \tag{4}$$

where Π_i is given by equation (2). In our benchmark product market without equity trading, condition (3) implies that

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

which means that the equilibrium described in Proposition 1 is less efficient *ex-ante* than investment by a single firm. However, it is individually profitable for each firm to invest, as they don't internalize the negative effect of their own investment on their competitors. In what follows, we also make the following assumption:

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

which implies that

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

meaning that it's more efficient that both firms invest when they are strong as compared to the case where a single firm makes the investment.

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. Specifically, we assume that there is an equity market in which trading of firms securities takes place before the game described in Section 2.1 is played. The shares are claims to firms values and are liquidated once investment decisions are made. We assume that there are 3 players in the stock market: a strategic speculator, a noise trader and the market maker.

The strategic speculator 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 that are 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.[8] We refer to market orders that do not trade exactly 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, an overall null order $u = (0, 0)$ can be regarded 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 $t = 1, 2$. However, only one trader trades in each round: the market orders of the speculator and noise trader are randomly lined up and 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. Crucially, we assume that orders are submitted before the queuing so that the speculator cannot make her order contingent on her place in line. 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 further detail on Section 3.2.

Lastly, as in Kyle (1985), there is a market maker who sets equity prices and processes market orders at each round of trade out of his inventory. As usual

[8] For tractability, we assume that the speculator cannot trade more than one unit of each security. This constraint can arise from search costs, which limit how much one can trade of each share within a trading day.

in feedback models, we assume that the market maker is uninformed about firms types. At each period, the orders received are executed at prices set to the expected value of firms conditional on all the information available up to that period.[9] Crucially, the market maker does not know how traders were lined up so he can't distinguish between u_i and n_i.

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

While the noise trader acts randomly, the strategic trader bases her order on the information she has. In the present framework, we assume that she 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 is an assignment $u(S)$ that maps the signal received into the set of probability distributions over possible market orders.

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

A few things about the structure of the financial market are worth discussing before going further. First, we emphasize that our setting seeks to explain how

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

secondary financial markets might affect real decisions, as usual in the feedback literature. In our model, the financing of firms investments does not come from the issuance of stocks, as the shares being traded are already outstanding. The source of funds are firms' boards, who in turn base their decisions on the informational content of observed stock market outcomes. Hence, the described financial market is secondary in the sense that any effect it might have on firm decisions is via the informational content of prices.

Second, for tractability purposes, some assumptions about the financial market depart from usual ones in the literature and thus warrant further justification. 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)) usually 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 who is trading strategically and who is trading randomly. While this novel setting greatly reduces the complexity of the model by making the speculator's strategies contingent only on her signal and not on past orders, it still delivers the feature that orders observed by the market maker are only partially revealing, allowing for profitable manipulation to arise.

Finally, 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. While one can argue that null orders can also be informative, allowing them to reach the market maker would considerably increase the number of possible stock market outcomes and compromise the tractability of equilibria characterization.

Thus, our framework allows us to keep the model tractable while circumventing the strong assumption that speculators cannot submit partially null orders.[10] 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 market orders are executed conditional on the information available to the market maker such that he breaks even in expectation. In addition, 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

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

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

[10] Although this assumption further simplifies equilibria characterization.

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:

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

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 in the presence of stock markets and a perfectly informed speculator and 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*.

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.[11]

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, first consider the following trading strategy of the speculator,

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

which 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. Besides, she buys both shares when both firms are strong. Finally, she plays a mixed strategy following $S = (h,h)$. There, she submits a predatory order and 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 $\tilde{u}(S)$, 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, $p_B^{+-,+-}$, $p_B^{--,+-}$, $p_B^{+-,--}$ reveal that $u(S) = (1, -1)$. The last two cases occur because the order $(-1, -1)$ is out of the path of $\tilde{u}(S)$ and thus, when 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 investors keep their prior expectations about types and, hence, decide to 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 $\tilde{u}(S)$ 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.[12]

Condition (7) establishes that predatory orders are optimal to the speculator following any signal except (l, l). In that case, the speculator should buy the shares of both firms, which ensures that both will invest, as per $\tilde{g}$. The right-hand side of (7) implies that the value of strong firms when both invest is sufficiently high. Thus, the gain in stock value from ensuring that two strong firms invest more than offsets the profit from spreading stock prices with predatory orders in a attempt to close the positions when a single firm invests.

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 cancellation of investments is always unilateral on the equilibrium path, trading strategy $\tilde{u}$ is predatory as it induces one firm to gain value at its rival's cost.

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. We argue 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.

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

3.5 Empirical Predictions: Informed Predatory Trading

Our next results explore possible implications of informed predatory trading as described in Proposition 2 on investment efficiency as defined in equation (4).

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 values of both firms is greater in the equilibrium of Proposition 2 than in that of Proposition 1. The reason is that financial markets provide information that allows firms' boards to make better investment decisions. Predatory orders discipline managers and prevent boards from undertaking negative NPV investments.

To discuss the next empirical 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 firm value in the product market.[13]

Note that the symmetry of trading strategies and investment decisions imply that V_i's are 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 V_i's more likely. To capture this, we compute a measure

[13] We avoid using the term *market share*, as it usually refers to shares of output rather than firm value.

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 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 side of (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 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 the characterization of equilibria.

From the perspective of the market maker, any predatory order might have originated from three different signals when the speculator trades according to $\tilde{u}_M(\cdot)$. 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 alternative equilibria 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 $\tilde{u}_M(S)$ 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 high enough so that boards withhold funds. Similarly, condition (10) establishes the optimality of trading strategy $\tilde{u}_M(S)$. We provide a detailed description of these parametric conditions along the proof of the proposition in the appendix, where we also provide 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 only feature predatory manipulation 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 are aware that the stock market provide no additional information and thus optimally choose to ignore stock prices 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 Empirical Predictions: 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 by the board in the absence of the stock market. However, when the speculator is possibly uninformed and trades according to $\tilde{u}_M(S)$, 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 equity markets, predatory stock price manipulation reduces investment efficiency, but never below the level without equity markets.*

In words, predatory manipulation partially undermines the stock market's role of improving allocation. As the speculator might be uninformed, the informational content of stock prices is less accurate. However, it still improves investment decisions as compared to the equilibrium in Proposition 1.

Next, we discuss the implications of predatory manipulation as described in our proposed equilibrium on our measures of firm value share 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 equity markets with firms' boards following investment decisions $\tilde{g}$, the presence of predatory stock price manipulation in which a possibly uninformed speculator trades according to $\tilde{u}_M(S)$ further increases firm value concentration as compared to the equilibrium where a perfectly informed speculator trades according to $\tilde{u}(S)$.*

In the presence of equity markets, the effect of predatory manipulation as described by trading strategy $\tilde{u}_M(S)$ 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. The fact that expected firm value shares remain the same while their variance increases implies that predatory manipulation in the equilibrium described is a mean-preserving spread of firm value shares.

Finally, note that the symmetry of our proposed equilibria has implications to product market concentration. In particular, there are two symmetric features in our equilibrium with manipulation. 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 product market 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 does not hold in the specific case where firms are of different sizes and the speculator has an *ex ante* incentive to prey on the large firm.

4.3 The Profit from Predatory Manipulation and Alternative Equilibria

As usual in models of financial feedback from financial market to real decisions, the profitability of manipulation stems from the informational advantage the speculator has over boards and market maker granted by the signal received. In particular, even when the speculator is uninformed, she still has the informational advantage of knowing so as long as she could possibly be informed, as stated in Corollary 3.

As interim orders might have originated at the noise trader, information is only partially revealed by interim prices. This allows the speculator to establish a position in a moment she has informational advantage and closing it at a profit once O_2 is incorporated into prices.

An illustration of how predatory manipulation can be profitable follows. Suppose an uninformed speculator submits 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.[14] 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 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. Crucially, this is determined by how much information about firm types is contained on predatory orders. 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

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

board provide funds unless stock prices reveal that its firm was sold short by the speculator.[15]

Let $\pi(u|u(S), S, g(\cdot))$ be the speculator's expected profit of placing order u when she is expected to trade according to $u(S)$, the signal is S, and investment decisions are $g(\cdot)$. 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 profit:

$$\pi((1,-1)|\tilde{u}_M, \emptyset, \tilde{g}) = \pi((1,-1)|\hat{u}_M, \emptyset, \tilde{g}) =$$
$$\frac{1}{2}\left[p_A^{-+} - p_B^{-+} + \frac{\Theta K}{2}\right] + \frac{1}{2}\left[\frac{1}{4}\left(p_A^{++,-+} - p_B^{++,-+}\right)\right] \tag{11}$$

which is also the same for $u = (-1, 1)$ due to the symmetry of trading strategies and investment decisions.

The first term of the right-hand side of equation (11) corresponds to the case where the speculator is first in line, which happens with probability $\frac{1}{2}$. There, the speculator 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. The second term of the right-hand side reads as follows. With probability $\frac{1}{2}$, the speculator is second in line. 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, again, negative. Since, in this case, both firms enter, the speculator makes no profit when closing positions, as both the short and long positions are executed at the same price. For all other orders that the noise trader submits on $t = 1$, the speculator makes no profit at $t = 2$.

[15] Not necessarily in a predatory order.

One can see that the only source of profits from predatory manipulation comes from the possibility of successful predation—preventing one firm to from investing. Establishing the initial position is always costly for the speculator, 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. On one hand, she wants the predatory order to possibly hamper a firm's investment, which will induce price distortion in $t = 1$. On the other hand, if the predatory order distorts prices too much, it widens the gap between firms' stock prices to the point where the speculator can't profit from manipulation. In this case, it becomes too expensive to establish the predatory position, and the profit from successful manipulation at $t = 2$ is not enough to yield an overall positive payoff. This leads us to our next result.

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

Proposition 4 is due to the fact 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 equation (11) 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 the price distortion. By lumping together multiple signals and placing a predatory order whenever $S \neq (l, l)$ in $\tilde{u}_M$, the speculator conceals that she did not have observe $S = (h, h)$, which significantly decreases the cost of establishing the predatory position.

5 Concluding Remarks

We develop a theory of how product market competitive features can shape stock price manipulation possibilities in the presence of feedback effects from secondary markets. We show how uninformed speculators can exploit strategic substitution between firms by pairing a short sell and a buy trade on a pair of competitors. As prices carry informational content that is meaningful for investment decisions, this strategy keeps the firm targeted by short selling from investing, allowing the speculator to close both positions at a profit. Hence, we argue that our proposed trading strategy can be regarded as predatory stock manipulation.

We show that when the speculator is perfectly informed about firms' fundamentals, such predatory strategy increases investment efficiency, as stock price informativeness prevents managers from undertaking negative NPV investments. However, when the speculator is uninformed, this trading pattern partially undermines equity markets' capacity of providing information. As a result, *ex ante* firm values and investment efficiency decrease, but not below the level without equity markets. In addition, expected product market concentration in firm values increases in our proposed equilibrium.

We believe that our results constitute the first steps towards bringing together insights from the literatures on feedback effects and predation. While previous work has showed how short selling regulations face a trade off between preventing manipulation and maintaining price informativeness, our analysis focuses on the interplay between manipulation and competitive aspects, providing the first insights towards stock trading regulation designed at product market level. In particular, our theory posits that short selling restrictions should be more prevalent on markets where gains of predation are arguably higher.

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Appendix A Proofs

Proof of Proposition 1

On 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 $I_i = K$, $i \in \{A, B\}$ is the unique perfect Bayesian equilibrium of the game. $\square$

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 where $\alpha = 1$. Therefore, we provide only the proof of the more general case, that of Proposition 3. 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. Specifically, 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 trading strategy $\tilde{u}_M$. 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 (10) are identical and pin down 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 equity markets as long as

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

which is implied by the left-hand side of assumption (3). $\square$

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 financial markets 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). $\square$

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. $\square$

Proof of Corollary 4

In the equilibrium with predatory manipulation of Section 4.1, the 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 equity markets 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 $\alpha > 0$. □

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). □

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

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

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

$$
\begin{aligned}
p^{++} &= \left(\Theta - \left(\frac{3}{4}\theta^l + \frac{\theta^h}{4}\right) K\right) K \\
p_A^{+-} = p_B^{-+} &= \left(\Theta - \left(\frac{7 - 5\alpha + \alpha^2}{4(3-\alpha)(2-\alpha)}\theta^l + \frac{5 - 5\alpha + \alpha^2}{4(3-\alpha)(2-\alpha)}\theta^h\right) K\right) K \\
p_A^{-+} = p_B^{+-} &= \left(\frac{\Theta}{2} - \left(\frac{7 - 6\alpha + \alpha^2}{4(3-\alpha)(2-\alpha)}\theta^l + \frac{5 - 4\alpha + \alpha^2}{4(3-\alpha)(2-\alpha)}\theta^h\right) K\right) K \\
p^{--} &= \left(\frac{2 + 3\alpha}{4(1+\alpha)}\Theta - \left(\frac{\alpha}{4(1+\alpha)}\theta^l + \frac{3\alpha}{8(1+\alpha)}\theta^h\right) K\right) K
\end{aligned}
$$

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 financial markets and a perfectly informed speculator and, hence, without predatory manipulation. 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 manipulative orders.

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

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

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

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

$$\pi((0,-1)|(l,h)) = -\frac{\Theta K}{16} - \frac{3\theta^l K2}{16} + \frac{9\theta^h K^2}{32} \tag{36}$$

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

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 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 from equity markets to investment decisions in different ways. In particular, we follow Goldstein et al. (2013) more closely and assume that firms are financially constrained and, hence, need to raise external funds to invest.

As our model in Section 2.1, firms are run by managers who allocate investment funds, and possible firm 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.[16] Therefore, firm values are now given by

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

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, re-

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

gardless of firms' types.

In this formulation, capital providers are analogous to firms' boards in Section 2.1. For simplicity, we assume that capital providers incur an unitary cost of raising one unit of capital and, therefore, their 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 efficiency measure now aggregates payoffs across these agents as follows:[17]

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

Therefore, assumption (5) now reads

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

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

which has the same interpretation of Section 2.1.

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 financial markets, 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' 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 $\theta^h = 3$.