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JEL Classification: G31, G32, L41, O31

Keywords: Competition, Cooperation, Co-opetition, Public and private ownership, Disruption, Innovation

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Disclosure, Co-opetition, and Disruptive Investment*

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December 1, 2022

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1 Introduction

Economists have long discussed how mandatory disclosure requirements for public firms affect their ability to stay innovative. While such requirements can help firms raise external financing by alleviating information asymmetries, disclosure can erode a firm's competitive edge by leaking information to current and potential new rivals (Verrecchia, 1983; Healy and Palepu, 2001; Leuz and Wysocki, 2016). Yet many large public firms do not seem averse to disclosure. For example, pharma and biotech firms, such as Eli Lilly, Pfizer, AstraZeneca, and Sanofi, publicly share data and information about their research through so-called Open Innovation platforms. The proclaimed benefits include helping the commercialization, adoption, and exploitation of innovations and coordinating on industry standards (Deloitte, 2015). What is more, some public firms have even been accused of disclosing too much information in an effort to engage in tacit collusion with rivals (Bourveau et al., 2020; Bertomeu et al., 2021; Pawliczek et al., 2022).

Such evidence suggests that disclosure matters when competing firms also seek to cooperate — a strategy known as "co-opetition" — thus, raising the question of how disclosure and co-opetition affect firms' incentives to pursue innovation and, more generally, disruptive investments. Tackling this question requires moving away from the extreme narratives of perfect competition and collusion underpinning most work in economics, but doing so seems pertinent, given the pervasiveness of co-opetition in practice (Brandenburger and Nalebuff, 1996). The importance of co-opetition has also been evident in the context of the COVID-19 crisis, during which regulators have promoted co-opetition to encourage break-through investments in the pharma and health industries (OECD, 2020; Crick and Crick, 2020).

In this paper, we develop a model showing that stricter disclosure requirements boost opportunities for co-opetition and, in doing so, raise firms' profit margins. In turn, the higher profitability makes raising financing for disruptive investments easier. Investments in marginally and very attractive investment opportunities increase the most. However, there is also a cost, as the higher profitability of existing operations makes their cannibalization costlier, which could erode commitment to disruptive investments. We show that this cost mainly encumbers moderately attractive investment opportunities, leading to underinvestment in such opportunities. We provide empirical evidence from the impact of stricter disclosure requirements on markups, profit margins, and innovation that supports the model's predictions.

Model preview and results. We embed a model of financing disruptive investments into a setting in which firms repeatedly interact in the product market by competing or cooperating with their existing technologies. Making a disruptive investment is potentially valuable for a firm because it can help displace its rival. Examples include investments in radical innovation or acquisitions of risky firms that develop such innovations, which can cause other firms to become obsolete or unable to keep up. The key features of the way we model a disruptive investment are that it (i) requires raising outside financing and incentivizing effort by firm insiders; and (ii) involves learning about the investment's viability over time, with the firm having the option to abandon the investment if the investment's success outlook turns out to be poor.

A central element in the model is that when a firm does not have a competitive edge, it might benefit from cooperating to avoid competition. We focus on implicit cooperation, not involving explicit agreements with rivals. Such cooperation can range from sharing knowledge and resources — as commonly practiced by large pharma and biotech firms — to competing less aggressively. It is important to stress that regulators do *not* consider such implicit coordination illegal (OECD, 2012). The main challenge with implicit cooperation is that firms may have incentives to deviate and profit at their rival's expense. Such deviations are difficult to detect since firms can only make noisy inferences about the other firms' actions.

In this framework, we show that more disclosure can help firms maintain implicit cooperation and that disclosure is most potent when (at least some of) it is mandatory. Mandatory disclosure — which in our model is enforced by the firm's choice of being public — ensures that there is a commonly-observed history of signals (indicative of whether firms deviate from implicit cooperation), around which firms can coordinate their actions. Consistent with our claim that mandatory disclosure improves firms' opportunities for cooperation, policymakers have argued that:

> "Greater transparency in the market ... [provides] firms with focal points around which to align their behavior" (OECD, 2012).

The main benefit of mandatory disclosure in our model is that it overcomes two related problems. First, it makes inferences about whether firms cooperate less noisy by ensuring that there is always a truthful, commonly observable history of signals. The important point is that firms must report specific information regardless of whether they find it optimal to do so. Second, mandatory disclosure takes away the leeway for firms to misreport or hide signals that will trigger a breakdown of cooperation. This is important, as a weaker threat of "punishment" following signals indicating deviation makes cooperative equilibria more difficult to sustain.[1]

[1] While the distinction between voluntary and mandatory disclosure is not a main focus in our paper, one implication of our analysis is that mandatory and voluntary disclosure act as complements rather than substitutes, when it comes to supporting cooperative equilibria.

This link between mandatory disclosure and implicit cooperation implies that mandatory disclosure will be beneficial for mature cash-cow businesses seeking to avoid head-on competition. Such firms can benefit from implicit cooperation, as it can enhance the profitability of their cash cow business. As is perhaps intuitive, the benefit of stricter disclosure is highest for (endogenously) larger firms in concentrated industries.[2]

More important, disclosure can also benefit firms pursuing co-opetition — that is, firms cooperating on existing technologies where they lack a competitive edge while simultaneously competing by pursuing disruptive investments that can displace their rivals. The key effect for such firms is that the higher profitability of existing operations (facilitated by mandatory disclosure) can help in raising financing for disruptive investments. It does so by improving a firm's exit options if the new investment's prospects turn out to be poor and it is abandoned. Clearly, this is very beneficial for marginally attractive investment opportunities that are very likely to be abandoned. Thus, such opportunities particularly benefit when co-opetition ensures that firms have valuable exit options from investment.

However, there is also a cost. When existing operations are more profitable, the opportunity cost of replacing them is higher. The resulting cannibalization considerations can erode firms' commitment not to abandon a disruptive investment following moderate (i.e., neither good nor bad) signals about its prospects. The lack of commitment, in turn, makes it more expensive for the firm to incentivize insiders to exert effort. In particular, when insiders anticipate that there is a higher probability that the investment is abandoned and, thus, their effort wasted, they require higher compensation (agency rent) to exert effort. Being forced to offer insiders a bigger piece of the pie means that the remaining piece that the firm can offer to outside financiers is smaller, resulting in underinvestment. Since firms with moderately attractive investment opportunities are most likely to receive moderate signals about their investments, they are most affected by this problem.

Finally, opportunities for cooperation have little downside when firms have very attractive investment prospects. In this case, commitment to such investments is not an issue, so cooperation opportunities again only benefit firms by increasing their profitability and, thus, their access to financing. In sum, co-opetition promotes investment in marginally and very attractive opportunities but depresses investment in moderately attractive ones.

Co-opetition is even more beneficial if multiple firms pursue disruptive investments at the same time. With such rivalry, cooperation puts commitment to disruptive investment less at risk, as the firms feel pressure to invest for fear of being left behind. Moreover,

[2] Implicit cooperation is easier when there are fewer firms in an industry. Thus, consolidation waves among public firms, as recently seen in the U.S. (Gao et al., 2013; Doidge et al., 2017), have likely made implicit cooperation easier. Moreover, further consolidation is more likely to encounter antitrust hurdles, reinforcing the benefits of implicit cooperation.

opportunities for cooperation can also help firms maintain high profitability on new technologies after rivals have caught up. That is, firms can transition from cooperating on their existing to cooperating on their new technologies. As in our pharma and biotech example, cooperation could then help firms internalize externalities that broaden the adoption of the newly-developed technologies (e.g., via common standards) or spur innovation by suppliers and customers (Gnyawali et al., 2006; Bushee et al., 2021). This larger benefit of co-opetition reduces the set of moderately attractive investment opportunities for which disclosure leads to underinvestment.

Empirical results. To motivate our theory's empirical relevance, we reexamine the evidence from the passage of the American Investors' Protection Act (AIPA), which increased disclosure requirements for innovative firms.[3] We choose this legislation because it has found a lot of interest among empiricists investigating the impact of disclosure on innovation, with the overall effects appearing very mixed. While some studies find a positive effect (Hegde et al., 2022), others find no effect (Saidi and Zaldokas, 2021) or an increase in innovation by rivals (Kim and Valentine, 2021). Our model can help explain such findings. In line with our predictions, we find that stricter disclosure requirements have led to an increase in marginally and very attractive innovations but a decrease in moderately attractive ones.

To support the relevance of the main channel behind our predictions, we examine the effect of the AIPA on disclosing firms' operating profit margins and markups. We find that firms more-affected by the law experience an increase in markups and profit margins. The increase is concentrated in firms offering similar products and services — arguably, firms more likely to benefit from cooperation. To confirm the robustness of these results, we show the same effect after the enactment of the Food and Drug Administration Amendments Act, which increased disclosure requirements in pharma and biotech firms.

Related literature. Our paper adds a new perspective to the literature, studying how mandatory disclosure requirements affect firms' disruptiveness and competitive standing. The new channel we highlight is that such disclosure can benefit firms by simultaneously facilitating cooperation and disruptive investment. By contrast, prior theory predicts that disclosure (even if socially beneficial) harms firms' profitability and innovation by eroding their competitive advantage (e.g., Bhattacharya and Ritter, 1983; Verrecchia, 1983). Despite the prominence of this argument, the evidence for it is mixed. On the negative side, Bernard (2016) shows that disclosure can guide entry by new rivals, and Breuer et al. (2022) show that both the profitability and innovation of small firms decrease, while those of larger

[3] This act mandated that firms disclose patent applications after eighteen months, regardless of whether the patents are eventually granted. Given that typically only about half of patents are granted (Carley et al., 2015) and that the evaluation process takes much longer than eighteen months, the new law has led to significant knowledge spillovers that would not have happened otherwise.

firms increase. On the positive side, there is evidence that higher disclosure standards are associated with more patenting (Hegde et al., 2022), especially in firms more-dependent on equity financing (Brown and Martinsson, 2019) and firms where disclosure can help reduce the performance-sensitivity of managerial turnover (Zhong, 2018). More generally, there is also evidence that disclosure improves financing and investment efficiency (Fu et al., 2012; Biddle et al., 2009) and can have positive spillovers for competing firms (Shroff et al., 2017). Our results shed light on such mixed findings. We should note that our theoretical predictions primarily apply to large firms, and our evidence is from such firms. Indeed, highlighting the importance of firm size, Breuer et al. (2022) find a positive impact of disclosure on innovation only for large firms but a negative one for the small firms that dominate their sample.

Our paper builds on the literature examining the role of imperfect information in achieving cooperation (see Kandori (2002) and Bo et al. (2018) for recent reviews). While this literature typically assumes that signals about actions are either publicly or privately observable (Green and Porter, 1984; Bhaskar and van Damme, 2002), in our setting, this choice is endogenous, as firms can choose between being public or private. The key innovation in our model is to endogenize the resulting impact of disclosure on firms' access to financing for disruptive investments. These contributions further differentiate our paper from Manso (2011), who also models innovation as a process involving learning and that can be abandoned if the success outlook turns out to be poor. In particular, while in Manso (2011), the firm's outside option of abandoning innovation is taken as given, in our paper, this outside option is endogenous, as it depends on the firms' opportunities for cooperation.

The empirical motivation that disclosure is instrumental for firms seeking implicit cooperation has steadily grown in recent years. Our basic premise that the information shared by public firms can help them cooperate or avoid competition has been recognized by regulators (OECD, 2012) and legal scholars (Steuer et al., 2011). Moreover, empirical research has documented that public firms appear to avoid head-on competition by implicitly cooperating on publicly sharing sensitive information about customers, contracts, and products (Bourveau et al., 2020). There is also evidence that tacit agreements are associated with firms disclosing more information in their revenue guidance, management forecasts, earning calls with analysts, and within industry associations (Bertomeu et al., 2020; Aryal et al., 2022; Pawliczek et al., 2022). The same also holds for firms pursuing co-opetition (Bushee et al., 2021). Notably, while most of these papers focus on voluntary disclosure, the firms they study are publicly listed or members of industry associations and, thus, also face mandatory disclosure requirements. Our theory shows that the latter is important, as voluntary disclosure is far more potent in supporting cooperative outcomes when accompanied by at least basic mandatory disclosure requirements.[4] We further contribute to this line of work by providing clear predictions for how implicit cooperation will affect disruptive investment and offer empirical support for our theory.

Our prediction that public firms, which are subject to strict disclosure requirements, will often find it easier than private firms to fund disruptive investment is counter to arguments that disruptive innovation will primarily originate in private firms. For example, Ferreira et al. (2014) argue that the lack of transparency in private firms offers better exit options for financiers, making it easier for private firms to raise funding for explorative innovation. By contrast, in our setting, firms and financiers have endogenously better exit options when firms are public and subject to mandatory disclosure. That makes it often easier to raise financing for disruptive investments. In line with our predictions, Acharya and Xu (2017) find that public firms in industries that depend on external financing spend more on innovation and have a better innovation profile than private firms, albeit going public may change the way that firms innovate (Bernstein, 2015). We add to this evidence by showing theoretically and empirically that stricter mandatory disclosure leads to an increase in marginally and very attractive innovation but a decrease in moderately attractive innovation.

2 Model

Two penniless firms are operating in the same industry and are run by their owner-managers. Financing is offered at competitive terms at which financiers just break even. All players are risk-neutral. Time is discrete and infinite, and the common discount factor is $\delta \in (0, 1)$.

Cooperation and Competition. Each firm $i = \{1, 2\}$ is endowed with a production technology whose cash flows in a given period t depend on the actions $a_i, a_j \in A = \{C, D\}$ taken by the firms in that period. These actions, "cooperate," action C, and "not cooperate," action D, are neither observable nor verifiable to outsiders. The actions taken by a firm give rise to privately-observed signals $y_i \in Y$ with a distribution $\pi(\cdot|a_i, a_j)$ over Y. Given an action profile $a = (a_i, a_j)$, a firm's *expected* cash flows in a period are given by

$$x_{a_i a_j} := \sum_{x \in X} g_i(a_i, y_i) \pi(y_i|a_i, a_j),$$

where g is the output of the firm's production technology given the firm's action a_i and the realization of its signal y_i. Each firm seeks to maximize the average discounted sum of its

[4] From this perspective, our results on the impact of disclosure on co-opetition and innovation touch upon the literature exploring the extent to which voluntary and mandatory disclosure are complements or substitutes (Bagnoli and Watts, 2007; Bertomeu, Vaysman, and Xue, 2021)

expected cash flows. We restrict attention to cases in which

$$x_{DC} > x_{CC} > x_{DD} \geq x_{CD}. \tag{1}$$

The interpretation of (1) is that the *expected* cash flows when both firms cooperate are higher than when no firm cooperates, and deviating from cooperation benefits the deviator at the expense of the firm that cooperates. Our formulation of the stage game is very general, as Assumption (1) can be micro-founded with most variations of standard models of competition, such as Cournot or Bertrand. To fix ideas, we give examples in Section 2.1. Throughout the analysis, we focus on pure strategies, but we also discuss the robustness of the results when allowing for mixed strategies. Furthermore, we make the standard assumption that the firms' strategies do not depend on irrelevant information.[5]

If firms do not cooperate (i.e., take the deviation action, D), they compete. Notably, any potential advantage of not cooperating is only temporary (as it only affects the payoff in the respective period). To achieve a permanent advantage, a firm must undertake a disruptive investment, which we model separately.

Disruptive Investment. We now embed a model of financing disruptive investment into the model of repeated strategic interaction described above. Specifically, apart from cooperating or competing on their existing operations, firms may compete by undertaking a disruptive investment opportunity that could displace the other firm. Typical examples involve pursuing in-house innovations or acquiring a technology that could shake up the industry if it succeeds.[6] For brevity, we refer to the disruptive investment as a disruptive technology that, if successful, replaces the firm's existing business.

The firms start out with their existing business (or technology) only. A disruptive investment opportunity could arrive with probability α at the beginning of each period. To concisely model that either none, both, or only one firm has investment opportunities, we assume that such investment opportunities arise only once for each firm. Initially, we assume that both firms observe whether their counterpart makes a disruptive investment, but subsequently, we relax this assumption. The investment requires a capital outlay of K, which the firm finances externally. Though precautionary cash hoarding can mitigate the agency problem we discuss in the model, we abstract from such hoarding to isolate cleanly the main novel effects. Ultimately, all that we need is that the firm does not have all the necessary cash to make its investment.

[5] That is, a firm's strategy depends only on its current posterior beliefs about the other firm's history of actions and signals and not on how the firm has reached these posterior beliefs.

[6] We do not analyze whether firms are better off developing innovation in-house or by acquiring innovative firms. We expect that when firms pursue the latter option, the prospect of being acquired by an incumbent will spur innovation in start-up firms, as in Phillips and Zhdanov (2013).

Our modeling of disruptive investments captures two main features common to such models (Aghion and Tirole, 1994; Manso, 2011): (i) developing the investment requires effort and (ii) involves learning about the investment's quality, with the firm having the option to abandon the investment if its success outlook turns out to be poor. Specifically, we assume that if the firm invests in period t, then at the interim date, $\tau_t = 0.5$, of that period, the owner-manager observes a state realization θ_i, which corresponds to the probability that the investment is successful. At this point, the firm has the exit option of falling back on its existing business and recouping L by liquidating the investment, possibly after renegotiating with its financiers. We assume that θ_i is observable but not verifiable and, thus, cannot be contracted upon. As is standard, the scope for renegotiations creates tension between continuation policies that are optimal ex post but not ex ante. As will become clear, when there are more than two state realizations of θ_i, this tension will generally affect the insiders' effort incentives. To captures this effect on effort, we assume that $\theta_i \in \Theta = \{0, \theta_M, \theta_G\}$, with $0 < \theta_M < \theta_G < 1$.[7]

The realizations of θ_i are drawn independently for each firm i, with $q^0_{\theta_i}$ denoting the probability of state θ_i if the owner-manager does not exert effort; $q^e_{\theta_i}$ denoting the probability of θ_i if she exerts effort, and $\Delta_{\theta_i} := q^e_{\theta_i} - q^0_{\theta_i}$ denoting the difference. We assume that effort increases the probability of success, $\sum_\Theta \Delta_{\theta_i}\theta_i > 0$, but comes at a non-monetary cost, c. An alternative interpretation of this cost is that it represents the loss of private benefits from allocating attention away from a privately preferred project. Throughout, we assume that investing is worth it only if the firm's owner-manager (also referred to as "firm insiders") exerts effort. Observe that the length of a period in our setting is meant to be relatively long, as it captures the period needed for a firm to develop the disruptive technology.

We embed this model of investment into the cooperation-competition game we described earlier in a natural way: If a firm does not abandon its disruptive investment at $\tau_t = 0.5$ and succeeds with it at the period's end, while the firm's competitor has no such success, the firm takes over the market and receives an expected cash flow of x_m in all remaining periods. The other firm's cash flows reduce to zero, and it exits in the next period. If the investment is unsuccessful, it generates zero, and the firm's only cash flows are from its existing technology, as described above. Thus, pursuing the investment is risky, but being successful allows a firm to displace its rival. If both firms successfully develop the disruptive technology, neither of them gains a meaningful advantage. The firms' expected cash flows in a period are then again x_{CC}, x_{CD}, x_{DC}, or x_{DD}, depending on whether both, one, or none of the firms cooperate.

[7] We have three state realizations, but the effect generalizes to *any* number of states higher than two. In the working paper version, we have solved the general case in which θ_i is continuous.

Definition of Mandatory Disclosure. We model a disclosure policy as a technology mapping private signals into publicly observable signals that are verifiable at no cost. In the baseline model, we assume that this mapping is perfect. In later sections, we allow for a probability σ that a signal reported by a firm cannot be understood, in which case the other firm's inference is a uniform draw from the set of signals Y. Stricter disclosure standards reduce such garbling of information.[8] Absent mandatory disclosure, signals remain private. We define voluntary disclosure as not costlessly verifiable, implying that it can be misreported by its sender.[9]

2.1 Examples of Competition and Cooperation

Example 1. Cooperation can refer to coordination on common standards, avoiding head on competition by specialization in different niches or technologies, or sharing data, knowledge, and resources. To model cooperation in this setting, suppose that if firms cooperate (e.g., share knowledge), each firm has a probability ρ of being successful at offering cutting-edge products that do not fully overlap with those of its rival. In that case, consumers are willing to pay a price p above the unit cost of production, k. If both firms are successful, each firm can sell a quantity of $\frac{d}{2}$, resulting in net cash flows of $\frac{d}{2}(p-k)$. If only firm i is successful, it can sell a quantity of d, resulting in net cash flows of $d(p-k)$. However, if firm i does not fully cooperate and hides crucial information, firm j's probability of having a distinct cutting-edge product in the period drops below ρ. For simplicity, assume that it drops to zero and that, when firms are unsuccessful, their cash flows are zero. Thus, if both firms cooperate, their expected payoffs are $x_{CC} = (\rho^2 \frac{1}{2} + \rho(1-\rho))d(p-k)$; if one firm deviates from cooperation, its expected payoff is $x_{DC} = \rho d(p-k)$, while that of the other firm is $x_{CD} = 0$; if neither firm cooperates, the expected payoffs are $x_{DD} = 0$. Signals can be defined here as $Y = \{S, F\}$ depending on whether a firm's product has succeeded (S) or failed (F), with $\pi(S|C,C) = \pi(S|D,C) = \rho$ and $\pi(S|D,D) = \pi(S|C,D) = 0$. Clearly, these signals are very noisy, but all we need is that they are correlated with the firms' actions. ▲

Example 2. The previous example can also be reinterpreted as firms cooperating not to compete on prices. Under this interpretation, the firms can split the demand, d, at the monopoly price p as long as they do not face a firm-specific negative demand shock and do not undercut each other by privately offering discounts to customers. Common to both examples is that firms find it hard to infer whether low cash flows are due to the other firm's actions or a firm-specific shock. ▲

[8] A perfect mapping (as in the baseline model) means that $\sigma = 0$.

[9] We discuss in detail the robustness of our results to this assumption below.

2.2 Applications With Differences in Disclosure Requirements

An obvious application of our analysis of forcing firms to switch to mandatory disclosure is analyzing the impact of laws increasing disclosure requirements. We discuss this application in Section 5 in the context of a law forcing all firms to disclose their patent applications.

Disclosure laws can also impact some firms but not others. The classic example is mandatory disclosure requirements for public firms. In what follows, we will adopt this example to illustrate our results in a context in which a firm can choose whether to be subject to mandatory disclosure. In practice, mandatory reporting for public firms includes reporting on new investments, R&D, large customers, products and services, and segment sales and earnings. Stock analysts and trading in financial markets further contribute to information production. All this information can be indicative of whether firms cooperate.[10] To keep our analysis transparent, the only difference between being public and private that we consider is that a public firm faces stricter mandatory disclosure requirements. Naturally, there are many other differences, not least the direct cost of disclosure, but incorporating their impact on our predictions will be straightforward.

The analysis of the two applications is almost identical. The main difference is that in the public-private application, we need to solve additionally for whether a firm wants to subject itself to disclosure by choosing to be public. We assume that this decision is made at the beginning of each period and cannot be changed until the end of that period. What we need is that a private firm that has undertaken the disruptive investment cannot go public on short notice at the interim date $\tau_t = 0.5$ of that period. This assumption can be justified by the fact that an IPO requires careful communication with financiers and regulators and typically takes months for firms to arrange. By contrast, an investment can arguably be abandoned more quickly. Such decisions are internal to the firm and do not typically require external validation or regulatory approvals.[11] Figure 1 summarizes the sequence of events. In Section 4.4, we discuss further applications of our model, such as the choice of whether to be a member of an industry association.

3 Disclosure, Co-opetition, and Disruptive Investment

Solving the model backward, we start with the case in which neither firm has a disruptive investment opportunity (i.e., both firms' investments have either succeeded, failed, or been

[10] We restrict attention to a single signal. Clearly, the more signals there are, the better the statistical inference about the firm's actions.

[11] In a previous working paper version, we also consider the case in which investment takes more than one period to complete, but that does not lead to additional interesting insights.

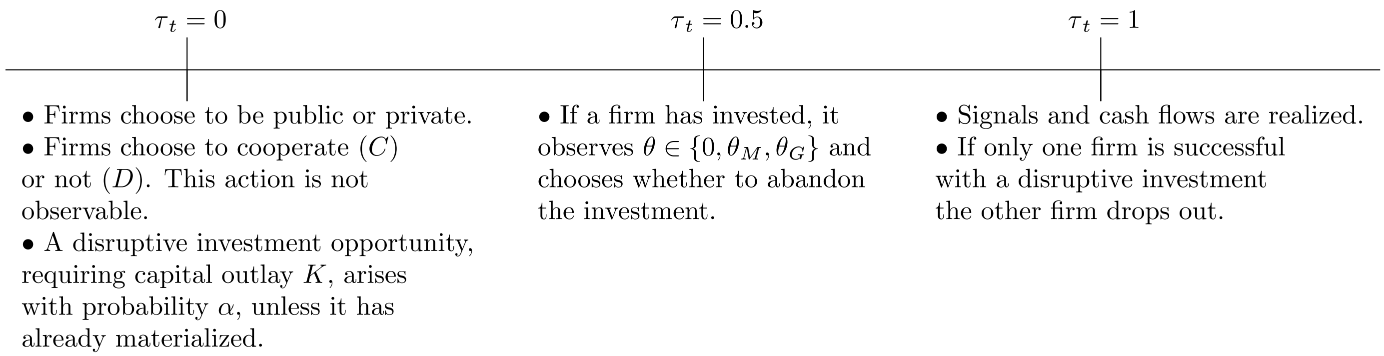

Figure 1: **Timeline of a period.**

abandoned) and show the distinct value of mandatory disclosure. Subsequently, we study the case of co-opetition, where firms can cooperate on their existing technology while also pursuing a disruptive investment.

3.1 The Importance of Disclosure for Implicit Cooperation

When neither firm has a disruption opportunity, the main choices they face are whether or not to cooperate and whether or not to be public (i.e., be subject to mandatory disclosure). However, maintaining cooperation is difficult, as the firms' actions are not observable. In particular, if one firm intends to cooperate, it is optimal for the other not to do so, as its expected cash flow from not cooperating, x_{DC}, is higher than that from cooperating, x_{CC}. The only Nash equilibrium of the stage game is that both firms do not cooperate.

In light of this problem, *mandatory* disclosure (and being public) can help firms support a cooperative equilibrium. Though actions remain unobservable and signals allow only for noisy inferences about these actions, mandatory disclosure of these signals offers a commonly observed history of signals around which the firms can coordinate their follow-up actions. Specifically, there is a perfect public equilibrium [PPE] in which both firms cooperate in period t and continue to cooperate in period $t+1$ if and only if both firms remain public and their disclosed signals are above a certain threshold indicating cooperation.[12] The argument is standard and can be easily illustrated with the knowledge-sharing and price competition examples described in Section 2.1. In these examples, there is a PPE in which both firms cooperate in period t and cooperate in period $t+1$ if they are successful (or face no adverse demand shocks) in period t (i.e., $y_{it}, y_{jt} = S$). Lack of success by one of the firms (i.e., $y_{it} = F$ or $y_{jt} = F$), triggers non-cooperation in all future periods. Since non-cooperation is the Nash equilibrium of the stage game, the action profile (D, D) is a self-enforcing (i.e.,

[12] In a PPE, the firms' strategies in every period depend only on the public history (i.e., disclosed signals) and not on the firms' private history (i.e., information about their prior actions).

incentive-compatible and credible) threat for any δ. In turn, the action profile (C, C) can be enforced if the benefit from continued cooperation satisfies:[13]

$$\begin{aligned} v^{pub} &= (1-\delta)\,(\rho^2 \frac{1}{2} + \rho\,(1-\rho))d\,(p-k) + \rho^2 \delta v^{pub} \\ &\geq (1-\delta)\,\rho d\,(p-k)\,. \end{aligned} \tag{2}$$

Condition (2) is satisfied if the firms sufficiently value future cooperation, i.e., $\delta \geq \frac{1}{2\rho}$.[14]

The crucial role of disclosure. We now show that the above simple argument breaks down if signals remain private, implying that mandatory disclosure plays a crucial role in supporting cooperation. At first sight, the basic problem when signals are private is the same: we need to determine the players' beliefs about the continuation strategies (and, thus, private histories) of their counterparties, conditional on their own private histories. The concept of PPE (e.g., Green and Porter, 1984) that we applied for the case of signal disclosure dramatically simplifies this problem by conditioning strategies only on commonly observable signals, which allows for a recursive formulation of equilibrium payoffs as in (2). However, this approach cannot be applied when signals are private, as then there is no commonly observable history of signals around which to align actions. The result is a stark difference in predictions (all proofs are in Appendix A):

Lemma 1 *Absent disclosure, firms cannot support a cooperative equilibrium.*

To illustrate the intuition, suppose that both firms are private and, thus, not subject to disclosure. Consider the following sequential equilibrium candidate. Firm i cooperates in period t and cooperates again in period $t+1$ if and only if its private signal y_{it} is above a threshold (the level of this threshold will be immaterial).

The problems with conditioning play on private signals are that (i) monitoring cooperation is more difficult (as inferences about actions are based on fewer signals) and (ii) the threat to punish deviations by abandoning cooperation following signals indicating deviations is less credible (not self-enforcing). The first point is obvious. To see the latter, suppose that a private firm observes a signal that should trigger abandoning cooperation. The private firm now faces a dilemma: abandoning cooperation will harm not only the other firm but also itself. What is more, the private firm anticipates that a signal indicating that the other firm has deviated must be wrong. Indeed, since both firms cooperate in the proposed

[13] We follow the convention of normalizing the firms' expected payoffs by multiplying them by $(1-\delta)$. This normalization implies that the repeated game payoffs are comparable to the stage game payoffs. Intuitively, the infinite constant stream of 1 utils has a value of 1.

[14] The existence of cooperative equilibria when there is a commonly observed history of signals is robust to alternative model formulations of competition. Green and Porter (1984), for example, model competition on quantities.

candidate equilibrium, the only (equilibrium) explanation for such a signal is that it is due to a negative demand shock rather than deviation by the other firm. This creates incentives for the firm to neglect its signal and continue cooperating. If this incentive dominates, supporting a cooperative equilibrium becomes impossible, as the lack of a credible threat to abandon cooperation will invite deviations from cooperation.

This is, indeed, what happens. For a private firm, say firm i, it would be rational to stop cooperating in period $t+1$ only if it expects the other firm, firm j, to do the same. However, this expectation does not depend on the signal that firm i receives, as in a cooperative equilibrium, the signals result from firm-specific demand shocks, which are uncorrelated with those of the other firm. That is, if firm i finds it optimal to cooperate following a good signal (as must be the case in equilibrium), the same is true following a bad signal. Thus, without a mechanism forcing firms to disclose all signals — regardless of whether they find it ex post optimal to do so — the firm will misreport its signal. This is a crucial difference to voluntary disclosure and points at the importance of mandatory disclosure.

In sum, the lack of a commonly observed history impedes the monitoring of cooperation and makes the threat of abandoning cooperation less credible, both of which are crucial impediments to sustaining cooperative equilibria. It is straightforward to extend the arguments to show that there can be no cooperative equilibrium in which one of the firms is public and the other private. Based on Lemma 1, our first main prediction is that firms that want to cooperate benefit from being public and subject to mandatory disclosure:

Proposition 1 *Suppose that neither firm has a disruptive investment opportunity. The firms can support a cooperative equilibrium if both firms choose to be public and, thus, be subject to mandatory disclosure requirements. The firms cannot achieve the same outcome if either one is private — i.e., not subject to mandatory disclosure.*

Voluntary and Mandatory Disclosure as Complements. Applied to the example of public pharma firms in the Introduction, Proposition 1 predicts that mandatory reporting of even basic signals can enable cooperation, which can take the form of voluntary sharing of much richer information. This raises the question of whether firms can entirely rely on voluntary reporting to achieve the same outcome. While it is possible to design cooperative equilibria under some conditions on the structure of signals and actions, such equilibria are more likely to break down, and the firms' maximum payoffs are lower compared to when disclosure is mandatory.[15] This fragility and lower profitability is all that we need for the

[15] Here, the idea is to construct equilibria where a firm's report does not affect its own future payoff but can be used to police the other firm (Compte, 1998). Loosely speaking, this is sometimes possible if an action gives rise to a probability distribution over signals that is statistically distinguishable from that of other actions and the distributions generated by the actions of other firms.

main qualitative insight from Proposition 1.[16]

The insight that voluntary disclosure is far more potent in supporting cooperative equilibria when accompanied by mandatory disclosure extends beyond our assumption that voluntary disclosure is non-verifiable. In particular, suppose that the problem of voluntary disclosure was, instead, that there is uncertainty about the firm's information endowment. In this case, it is possible for firms to hide information that they do not want to disclose ex post to rivals (Dye, 1985). In the context of Example 1, this implies that firms will worry that their counterparts are cherry-picking what to report — e.g., by reporting on only 30% of their investments. However, even very basic mandatory disclosure requirements can alleviate this problem. In particular, suppose that a firm has to report how much it has invested in total. Then, it becomes clear whether a firm is reporting on only 30% of its investments. Moreover, not reporting on the remaining 70% becomes a signal that the firm is hiding something, ultimately stimulating the firm to report everything (Milgrom, 1981). Thus, the implication is again that even basic mandatory disclosure can dramatically boost the truthfulness and completeness of voluntary disclosure, helping firms coordinate.[17]

Finally, note that when both firms are public, playing the cooperative equilibrium leads to higher expected payoffs for both firms compared to not cooperating, which is also an equilibrium. For this reason, we assume in what follows that the firms will play the cooperative equilibrium. Dealing more formally with equilibrium selection goes beyond the scope of our paper. In the presence of such multiplicity, cheap talk or focal points can sometimes help firms select the cooperative equilibrium (Farrell and Rabin, 1996). In our setting, voluntary disclosure that goes over and above the level mandated by regulators could also effectively signal a firm's willingness to play a cooperative equilibrium.

3.2 Co-opetition and Financing of Disruptive Investment

Proposition 1 discussed the case in which the firms do not have disruptive opportunities, which could be associated with mature cash cow businesses. Next, we formalize the idea of co-opetition, where firms may cooperate on their existing technology while simultaneously compete by making disruptive investments aimed at displacing rivals. We start with the case in which only one firm has such an investment opportunity, as most of the intuition can be derived from this case. Subsequently, we discuss the case in which both firms can invest.

[16] Similarly, if the firms' signals are sufficiently correlated or firms play mixed strategies, cooperative equilibria can also be supported even if signals are private (Bhaskar and van Damme, 2002), but these equilibria are again more likely to break down, and the firms' expected payoffs are lower.

[17] While this discussion distills the main effects making disclosure important in our model, it cannot do full justice to the literature. See Bertomeu et al. (2021) and Bertomeu and Liang (2015) and the references therein for discussions of other effects.

3.2.1 Co-opetition if Only One Firm Pursues Disruptive Investment

Let firm i be endowed with a disruption opportunity while the other firm has none (it has tried and failed). The question is how the opportunities to cooperate with the other firm affect firm i's incentives to invest and ability to raise funding if it is public. For the other firm, being public is (weakly) beneficial, as that provides the option to cooperate with firm i on their existing operations (Proposition 1).

The Firm's Investment and Financing Problem. Suppose that firm i wants to invest at the beginning of period t. To fund the investment outlay K, the firm offers a contract that specifies who has the control right to decide whether the investment should be abandoned at the intermediate date and allocates cash flow rights that depend on the investment's outcome. Without loss of generality, we assume that the firm offers an equity stake γ_A in case the investment is abandoned, γ_m if it succeeds and the firm takes over the market as a monopolist, and γ if the investment is unsuccessful. There is a wide range of securities that condition on the observable outcomes and implement the same solution.[18]

In a competitive capital market, outside financiers break even if

$$\sum_{\theta_i \in \Theta} q^e_{\theta_i} \left(\left(\theta_i \gamma_m \frac{x_m}{1-\delta} + (1-\theta_i)\, \gamma \mathrm{E}x \right) \mathbf{1}_{\theta_i} + \gamma_A \left(L + \mathrm{E}x \right) \left(1 - \mathbf{1}_{\theta_i} \right) \right) = K, \tag{3}$$

where $\mathbf{1}_{\theta_i}$ is an indicator function taking the value of one if the investment is continued after the realization of state θ_i at the intermediate date and zero if it is abandoned; $\mathrm{E}x = \frac{v^{pub}}{1-\delta}$ if both firms are public, and $\mathrm{E}x = x_{DD} + \frac{\delta v^{pub}}{1-\delta}$ if one of the firms is private in period t and, by Proposition 1, public thereafter. Although the difference between the two payoffs is just in the period t cash flows, the difference can be significant, as the length of the period is meant to capture the time needed for developing the disruptive investment.

Once the investment is started, the firm and financiers observe at the interim date of the period that the investment will be successful with probability θ_i. The investment is continued if doing so creates more joint surplus for both parties, compared to liquidating the investment and continuing with the existing business:

$$\begin{aligned} & \theta_i \frac{x_m}{1-\delta} + (1-\theta_i)\, \mathrm{E}x \geq L + \mathrm{E}x \\ \iff \quad & \frac{x_m}{1-\delta} \geq \frac{L}{\theta_i} + \mathrm{E}x. \end{aligned} \tag{4}$$

[18] These three outcomes fully characterize the owner-manager's incentive constraint (6), which poses the main restriction on contracting.

Financing contracts that lead to a different continuation rule and, thus, lower ex post expected surplus will be renegotiated. Without loss of generality, assume that the financier has all bargaining power in such renegotiations.

Using the financiers' break-even condition (3), firm i's net present value from investing is higher than its effort costs, c, and its outside option of not investing if

$$V_I := \sum_{\theta_i \in \Theta} q^e_{\theta_i} \left(\left(\theta_i \frac{x_m}{1-\delta} + (1-\theta_i)\,\mathrm{E}x \right) (1 - \mathbf{1}_{\theta_i}) + (L + \mathrm{E}x)\,\mathbf{1}_{\theta_i} \right) - K \geq c + \frac{v^{pub}}{1-\delta}. \quad (5)$$

Note that if the firm chooses not to invest, it is always better off being public (Proposition 1). Thus, the outside option on the right-hand side of (5) is always $\frac{v^{pub}}{1-\delta}$, regardless of whether the left-hand side of (5) is higher when the firm is private.

The firm's objective is to maximize V_I by optimally designing $\{\gamma, \gamma_m, \gamma_A\}$ and allocating the continuation control right at the intermediate date, anticipating that continuation decisions other than those given by (4) will be renegotiated. Furthermore, the contract is subject to the financiers' break-even condition (3) and the incentive constraint ensuring that the owner-manager exerts effort:

$$\sum_{\theta_i \in \Theta} \left(q^e_{\theta_i} - q^0_{\theta_i}\right) \left(\left(\theta_i \left(1-\gamma_m\right) \frac{x_m}{1-\delta} + (1-\theta_i)(1-\gamma)\,\mathrm{E}x \right) \mathbf{1}_{\theta_i} \right.$$
$$\left. + (1-\gamma_A)(L + \mathrm{E}x)\,(1 - \mathbf{1}_{\theta_i}) \right) \geq c. \quad (6)$$

When Cooperation Opportunities Erode Commitment to Investment. Cooperation opportunities increase the profitability of the firm's existing business, which is a double-edged sword when seeking financing to make the disruptive investment. On the one hand, the higher profitability of the firm's existing business could make raising financing easier, as it offers a better cushion if the investment turns out to have poor prospects and is abandoned. On the other hand, when existing operations are more profitable, the commitment to new investment could suffer, leading to higher agency costs and underinvestment.

More precisely, a public firm is less likely to continue the investment because its expected exit payoff, $\mathrm{E}x$, from abandoning the investment at the interim date is higher. Intuitively, cannibalizing the firm's existing business is costlier when both firms are public, as the option to cooperate with firm j increases the existing business' profitability. This raises the bar for how profitable the disruptive investment needs to be. In particular, a higher exit option means that the state realization, θ_i, needs to be higher for continuing the investment opportunity to be worth it. We can also express this statement in terms of the expected profit from a successful investment. In particular, observe that if

$$\frac{x_m}{1-\delta} \in (X', X''), \text{ where } \begin{cases} X' := & \frac{L}{\theta_M} + x_{DD} + \delta \frac{v^{pub}}{1-\delta} \\ X'' := & \frac{L}{\theta_M} + \frac{v^{pub}}{1-\delta} \end{cases}, \tag{7}$$

condition (4) is satisfied for signals $\{\theta_M, \theta_G\}$ if the firm is private (not subject to disclosure) but only for signal θ_G if it is public (and subject to disclosure).[19]

The higher probability of ex post abandonment affects firm insiders' ex ante incentives to exert effort to make the investment work. On the positive side, when contracts are optimally structured to pay firm insiders more if the investment is continued, a higher probability of abandonment creates stronger incentives to exert effort.

However, there is also a countervailing "wasted effort" effect. Specifically, when insiders' effort increases the probability not only of states in which the investment is continued but also in which the investment is abandoned, the insiders' effort is partially wasted. In our model, this occurs if $\Delta_{\theta_M} > 0$, i.e., when effort increases the probability of the intermediate state θ_M, and the investment is abandoned in that state.[20] The prospect of such abandonment makes it harder to incentivize effort. If this wasted effort effect is sufficiently strong, insiders need to be promised higher compensation ("agency rent") to exert effort, reducing the "piece of the pie" that can be pledged to external financiers and making it harder for the firm to raise financing. Before illustrating this intuition in more detail, we state the main result:

Proposition 2 *Suppose that only firm i can make a disruptive investment and that the other firm is public. If an investment opportunity is moderately attractive,* $\frac{x_m}{1-\delta} \in (X', X'')$, *and the wasted effort effect is sufficiently strong — i.e., there is a threshold* $\Delta^*_{\theta_M}$ *such that* $\Delta_{\theta_M} > \Delta^*_{\theta_M}$ *— firm i underinvests when it is public (and forced to disclose) compared to when it is private (and not forced to disclose). Being public improves firm i's access to funding and reduces underinvestment in all other cases, i.e., when* $\frac{x_m}{1-\delta} \leq X'$ *(investment is marginally attractive),* $\frac{x_m}{1-\delta} \geq X''$ *(investment is very attractive), or* $\Delta_{\theta_M} \leq \Delta^*_{\theta_M}$ *(wasted effort effect is weak).*

Proposition 2 compares the firm's ability to raise capital when it is public and private

[19] If the firm's choice of public or private ownership were *exogenously* fixed, we would have Ex instead of $\frac{v^{pub}}{1-\delta}$ also on the right-hand side of (5), and we would obtain in addition the standard effect that a higher outside option, Ex, makes it harder to satisfy the ex ante participation constraint. That is, a firm with a more valuable existing business is less likely to initiate the investment and cannibalize that business. We do not obtain this effect when the firms can choose between being public and private in every period. Then, the cannibalization argument enters entirely through the decision of whether to abandon investment. We return to this point in Section 5.1.

[20] With two states, there is no notion of an "intermediate state" explaining why the wasted effect does not arise. However, this problem is present whenever there are more than two states.

by comparing the maximum income pledgeable to financiers in either case. The pledgeable income is defined as the firm's expected cash flows net of the payments to firm insiders needed to incentivize effort. To illustrate the proof of Proposition 2, suppose that firm insiders are only paid if the firm's investment is successful but not otherwise (i.e., $\gamma_A = \gamma = 1$). By standard arguments, the incentive constraint (6) will bind, implying that if the firm is public, it will hold that $(1-\gamma_m)\frac{x_m}{1-\delta} = \frac{c}{\Delta_{\theta_G}\theta_G}$, resulting into an expected payment of $q^e_{\theta_G}(1-\gamma_m)\frac{x_m}{1-\delta} = \frac{q^0_G}{\Delta_{\theta_G}}c + c$ to firm insiders. The first term, $\frac{q^0_G}{\Delta_{\theta_G}}c$, on the right-hand side of this equality represents the agency rent need to be promised to firm insiders to exert effort. Instead, if the firm is private, from (6), it will hold that $(1-\gamma_m)\frac{x_m}{1-\delta} = \frac{c}{\sum_{\theta_i\in\{\theta_M,\theta_G\}}\Delta_{\theta_i}(1-\theta_i)}$, resulting into an expected payment to firm insiders of $\sum_{\theta_i\in\{\theta_M,\theta_G\}} q^e_{\theta_i}(1-\gamma_M)\frac{x_m}{1-\delta} = \frac{\sum_{\theta_i\in\{\theta_M,\theta_G\}} q^0_{\theta_i}\theta_i}{\sum_{\theta_i\in\{\theta_M,\theta_G\}}\Delta_{\theta_i}\theta_i}c + c$. Also here, the first term on the right-hand side corresponds to the firm insiders' agency rent. The object of interest is, now, the difference between these agency rents, which is:

$$\frac{\theta_M}{\Delta_{\theta_G}}\frac{q^0_{\theta_G}\Delta_{\theta_M} - q^0_{\theta_M}\Delta_{\theta_G}}{\theta_G\Delta_{\theta_G} + \theta_M\Delta_{\theta_M}}c.$$

Hence, the agency rent when the firm is public is lower if the wasted-effort effect is weak, $\Delta_{\theta_M} \leq \frac{q^0_{\theta_M}\Delta_{\theta_G}}{q^0_{\theta_G}}$, but higher if the wasted effort effect is strong, $\Delta_{\theta_M} > \frac{q^0_{\theta_M}\Delta_{\theta_G}}{q^0_{\theta_G}}$. If the wasted effort effect is sufficiently strong, the firm's pledgeable income will be higher when it is private. In the Appendix, we solve for the incentive and financing contracts maximizing the firm's pledgeable income under both disclosure regimes (i.e., being public or private) and show that these insights hold generally.

The difference in the wasted effort effect (and agency rent) between being public and private is most pronounced for moderately attractive investment opportunities (or, equivalently, for moderately attractive states θ_i), as then the decision of whether to continue or abandon investment is particularly sensitive to the firm's exit option of abandoning investment. In turn, it also holds that if the continuation decision in the two regimes is the same, there will be no difference in agency rent, and the higher profitability brought about by mandatory disclosure (and being public) always dominates. This is the case outside the intermediate region (X', X''). In particular, being public is preferable if the disruptive investment is highly attractive, $\frac{x_m}{1-\delta} \geq X''$. In this case, the firm is unlikely to abandon investment regardless of whether it is public or private (in both cases, it continues in states $\{\theta_M, \theta_G\}$). Thus, the agency costs are the same, but being public benefits the firm because it offers the opportunity to cooperate on the firms' existing businesses. Being public also dominates at the other extreme, i.e., $\frac{x_m}{1-\delta} \leq X'$, where the investment is marginally attractive. In this case, the continuation decision is again the same (the firm continues only in state θ_G), and the opportunities to cooperate on the firms' existing businesses are even more valuable.[21]

Robustness. A comment about the generality of Proposition 2 is in order. The case in which effort increases the probability of intermediate states ($\Delta_{\theta_M} > 0$ in our setting) is consistent with effort shifting probability mass in a first-order stochastic dominance sense (i.e., from the low to the middle and high states) or second-order stochastic dominance sense (from the low and high to the middle state), which are the two most common assumptions in agency models.[22] Thus, the prediction that moderately attractive investment opportunities are most affected by changes in the firm's exit options from investment will be common to any model in which (i) investment requires non-contractible effort; and (ii) investment can be abandoned upon learning about its prospects. The reason this effect is of special interest in our setting is that by Proposition 1, it endogenously depends on the prevailing disclosure requirements (and, thus, on whether the firm is public or private).

Finally, it is useful to benchmark Proposition 2 to the case in which effort is observable and contractible. In the absence of agency costs, insiders are only paid c to exert effort. Then, better ex post exit options from investment translate into higher ex ante profitability. That is, being public and subject to disclosure always benefits the firm.

3.2.2 Co-opetition if Both Firms Can Make Disruptive Investments

The benefits of disclosure and co-opetition in easing a firm's financing constraints receive even more weight if both firms have the option to make disruptive investments — that is, the intermediate region in which being private can be preferable shrinks. This case could be interpreted as the growth phase of an industry, where opportunities for disruptive investments are abundant, and firms compete to undertake such investments.[23]

To avoid being repetitive, we relegate the analysis to the Appendix, as it is very similar to that in the previous section. In what follows, we focus on the main qualitative difference, which is how the firm decides whether to continue the investment. Let q_j be the (endogenous) probability that firm j succeeds with its investment. After observing state θ_i, firm i optimally continues its investment (potentially, after renegotiating) if the owner-manager's and financier's joint surplus is higher compared to if the firm were to liquidate the investment

[21] Note that if firm i chooses not to invest in period t, it will also not invest in later periods, as it faces the same problem in all these periods. Thus, firm i either invests immediately when its investment opportunity arises or does not invest at all.

[22] If effort decreases the probability of the medium state θ_M, i.e., $\pi_{\theta_M} - q_{\theta_M} \leq 0$, the positive disciplining effect always dominates the wated effort effect.

[23] The predictions for the case in which only one firm has discovered a disruption opportunity are qualitatively similar to Proposition 2 and, thus, relegated to Appendix B.

and continue with the existing business:

$$(1-q_j)\left(\theta_i \frac{x_m}{1-\delta} + (1-\theta_i)\,\mathrm{E}x\right) + q_j\theta_i \mathrm{E}x \geq L + (1-q_j)\,\mathrm{E}x$$
$$\iff \quad \frac{x_m}{1-\delta} \geq \frac{L + \theta_i \mathrm{E}x\,(1-2q_j)}{\theta_i\,(1-q_j)}. \tag{8}$$

There are two main differences from the previous section. First, when both firms make a disruptive investment, abandoning the investment threatens the firm's survival, as the other firm may succeed with its investment (with probability q_j). Second, even if a firm succeeds with its investment, it may still have to share the market with the other firm if that firm also succeeds. Hence, the value of co-opetition is reinforced, as the firms can benefit from cooperation not only on their existing business if their investments fail (or are abandoned) but also on the new technologies if both firms succeed and still share the market. That is, firms transition from cooperation on their old to cooperation on their new(er) technologies.

The main insight in this section is that because of these two effects, the intermediate region in which raising financing is more difficult for public firms shrinks. For a sufficiently high level of competition on developing the disruptive technology, being public can even lead to more continuation and lower agency costs, and the intermediate region disappears altogether.

Proposition 3 *Suppose that both firms can make a disruptive investment. Mandatory disclosure, associated with being public, makes it harder to raise financing and leads to underinvestment if* $\frac{x_m}{1-\delta} \in (X_c', X_c'')$ *and* $\Delta_{\theta_M} > \Delta_{\theta_M}^*$*, where* X_c', X_c'' *and* $\Delta_{\theta_M}^*$ *are defined in the Appendix. Otherwise, being public makes it easier to raise financing. The intermediate region,* (X_c', X_c'')*, shrinks in the probability that a firm's competitor successfully invests in disruption.*

The probability that a firm will abandon the disruptive investment depends on its beliefs about the probability that the other firm will abandon its investment. This creates scope for multiple equilibria. There is also scope for multiple equilibria at the stage at which an investment is initiated. There are two effects. On the one hand, competition stimulates investment by eroding a firm's outside option of not investing. On the other hand, competition makes investment less attractive by reducing its net present value. Because of these conflicting effects, there are equilibria in which neither firm, only one, or both firms invest. Dealing with the important question of equilibrium selection goes beyond the scope of our paper, as all that is important to us is to highlight the difference in agency rent and how that difference impacts the firm's ability to raise financing (highlighted in Propositions 2 and 3).

4 Information Leakage, Firm Size, Liquidity, and Alternative Applications

In this section, we offer several extensions that illustrate under what conditions and for which firms the co-opetition equilibria we have derived are more relevant.

4.1 Information Leakage

A common argument in the literature is that mandatory disclosure associated with public ownership harms firms by forcing them to disclose sensitive information that could benefit competitors (Bhattacharya and Ritter, 1983; Verrecchia, 1983). To investigate this effect, we relax our assumption that it is common knowledge whether a firm invests and assume that this information leaks to outsiders only if a firm is public. The leakage of such information can then harm the firm, as it can help its rival make a more informed decision of whether to make a disruptive investment and, subsequently, whether to continue investment. While we do not mean to suggest that information leakage has no adverse effects on firms, we want to point out two mitigating points.

First, in equilibrium, a firm's decision to pursue a disruptive investment effectively becomes common knowledge, regardless of whether the firm is public or private. Specifically, a firm in our model only benefits from being public if its rival is also public. Yet when both firms are public, the leakage of information affects both firms. And if a firm chooses to be private, this can only be because it is making a disruptive investment. Otherwise, the firm could do better by being public and playing the cooperative equilibrium.

Lemma 2 *In equilibrium, a firm's decision to invest becomes common knowledge regardless of whether the firm is public or private.*

Second, even if we would assume that the choice between being public and private is dictated by considerations outside of our model, and one firm is public while the other private (in which case being public confers no cooperation benefit), there are cases in which the leakage of information can benefit a public firm. If the private firm considers investing in a given period t, the leakage of information that the public firm has also invested discourages the private firm from pursuing investment. In particular, for the private firm, the prospect that it may have to share the market even if its investment succeeds lowers the expected present value from investing or continuing an investment. Further reinforcing this effect is the fact that the public firm lacks information that the private firm is pursuing investment, so it will not be discouraged itself.[24] This "intimidation" effect arises when a firm is better off when its rival's probability of successful investment is lower, a sufficient condition for which is that $\frac{x_m}{1-\delta} \geq 2\mathrm{E}x$ (the profit when a firm displaces its rival is higher than the combined profit when the firms share the market).

Lemma 3 *Suppose that one firm is public while the other is private. If* $\frac{x_m}{1-\delta} \geq 2\mathrm{E}x$*, the leakage of information that a public firm has invested discourages its private competitor from pursuing investment in the same period, benefiting the public firm.*

4.2 Stricter Disclosure Requirements and Firm Size

So far, we have assumed that both firms are identical. We now let the firms differ in size and analyze how stricter disclosure requirements will affect firms depending on their size. Naturally, size is not an exogenous object. To endogenize differences in size, we give more structure to the competition and cooperation part of our model by adopting the assumptions from Examples 1 and 2 from Section 2.1. In addition, we assume that firm i is more cost-efficient than firm j, $k_i < k_j$. To simplify the exposition, assume that demand is inelastic. Specifically, if neither firm faces an adverse demand shock, the firms can sell a total quantity d as long as the price is below a reservation price p. We further relax the assumption in the baseline model that $\sigma = 0$ — i.e., that a signal sent by a firm is always unambiguously understood. Specifically, we assume that $\sigma > 0$, with stricter disclosure leading to a lower σ. The signal other firms infer from a firm's disclosure is common knowledge.[25]

Stricter disclosure requirements affect large and small firms differently. By opening up opportunities for cooperation, both types of firms can become more profitable. However, the difference for the smaller firm is more fundamental as the alternative could be that it exits the market altogether. In particular, the problem when firms have asymmetric cost structures is that cooperation is more difficult to sustain, as the more cost-efficient firm i can keep firm j out of the market by selling at a price just below k_j while still making a profit. That is, firm i will be large and have the whole market, as it will not allow firm j to enter. However, stricter disclosure requirements could make it profitable for firm i to allow the less cost-efficient firm to enter by facilitating cooperation between the firms. Intuitively, when both firms are public, they can benefit from avoiding a costly price war and implicitly cooperating on selling at the consumers' reservation price p as long as the less efficient firm stays small enough.

[24] Empirically, such effects have been documented by Cookson (2017, 2018) and Noh (2020).

[25] This assumption can be relaxed, but it simplifies the analysis by ensuring that firms can coordinate play around publicly observed signals.

Proposition 4 *Stricter disclosure requirements make it easier to support an equilibrium in which the less efficient firm is not forced to exit as long as it stays small enough with an equilibrium market share of* $\frac{p-k_j}{2p-k_i-k_j}$ *(which is less than* $\frac{1}{2}$*) and cooperates.*

Discussion: More than Two Firms, Newcomers, and Firm Size. The main insight from extending our model beyond two firms is that stricter disclosure will primarily benefit large firms by allowing them to cooperate with somewhat smaller, less efficient firms. Notably, however, very small firms are unlikely to benefit. In particular, more-efficient firms now face the following trade-off. On the one hand, preventing entry by less efficient firms requires selling at a price at which the latter firms do not make a profit (i.e., possibly below p), lowering profits. On the other hand, with more firms, each has more to gain from deviating and less to lose from reverting to non-cooperation. Moreover, coordinating play based on noisy signals becomes more difficult. The equilibrium level of entry balances these two effects with the result that endogenously larger (more efficient) firms will engage in implicit cooperation while keeping less efficient firms out of the market. That is, small firms are unlikely to benefit from the opportunities for easier implicit cooperation facilitated by stricter disclosure.[26]

What about newcomers introducing new technologies without legacy assets? For such firms, the ability to cooperate with an incumbent and cannibalization concerns are irrelevant. However, also a newcomer can benefit from cooperating after introducing a disruptive technology if its rival also develops that technology or quickly catches up. Being public (subject to mandatory disclosure) becomes then again beneficial. This reinforces the overall message that disclosure and co-opetition primarily benefit firms that have grown sufficiently following past success; disclosure is of little use to firms that are still to achieve success and critical size.

4.3 Endogenous Liquidity

A corollary of our model is that disclosure requirements lead to better exit options for financiers in public firms, endogenously improving the liquidity for such financiers when firms pursue disruptive investments. Since this prediction is the opposite of the assumptions in some related work (e.g., Ferreira et al., 2014), it is worth discussing it in more detail. Consider a simple extension of our model in which the financiers can encounter a liquidity shock at the interim date of the period in which they provide financing, forcing them to sell

[26] Given the large consolidation trend over the last decades, which has led to fewer and larger public firms (Gao et al., 2013; Doidge et al., 2017), our theory would predict that implicit cooperation among such firms has become easier.

their equity stakes. Assume that outsiders cannot distinguish whether the reason for selling is a bad intermediate signal θ_i or a liquidity shock. Better exit options from the investment guarantee that the downside risk for potential buyers of the equity stake is smaller. Thus, there will be a smaller adverse-selection discount for a financier selling due to a liquidity shock. Measuring liquidity by this adverse-selection discount, as in Eisfeldt (2004), we obtain:

Corollary 1 *Mandatory disclosure and being public improve the liquidity for financiers that must sell due to a liquidity shock.*

4.4 Alternative Applications

In Section 2.1, we discussed two specific applications of our model: a change in disclosure requirements affecting all firms, such as a change in legislation, or only some firms, such as in the case of public and private firms. Yet our results also apply to other settings. For example, firms could gain better access to information about their rivals by becoming shareholders in these rivals. Cooperation can then be achieved following the same arguments as in Proposition 1.[27] The main qualitative difference from our baseline model is that an equity stake reduces an acquirer's investment incentives, as the equity stake allows the acquirer to benefit from the target's investment. This effect is stronger the larger the acquirer's stake. If a firm buys a controlling equity stake in its competitor, it can shut it down without pursuing disruptive investment (Cunningham et al., 2021).

Another mechanism committing firms to share information is to become part of an industry association collecting price and trade statistics and making them available to members. Indeed, Kepler (2021) finds that public firms engage in less voluntary disclosure after entering formal alliances or becoming members of industry associations — both of which provide more efficient means of coordination (relying on mandatory disclosure). Related, Bertomeu et al. (2020) finds that firms disclose more information through industry associations when they appear more likely to be engaging in tacit collusion. Also notable is that recent advances in information technology such as the blockchain have made it easier for private firms to disseminate verifiable information about themselves to outsiders. In this line of argument, Cong and He (2019) contend that firms active on the blockchain may be better able to infer aggregate business conditions and detect deviations by serving as record keepers. This could

[27] Coordination and control through minority equity stakes is particularly wide-spread in continental Europe and East Asia (see La Porta et al., 1999; Claessens et al., 2000). Note that cooperation in this setting is achieved differently than in the recent literature on common ownership. That literature argues that publicly listed firms achieve coordination because managers maximize the value of the portfolio of all firms in which their shareholders have invested and not only the value of the firm they are managing (Schmalz, 2018).

help sustain collusive equilibria. Our main predictions for how opportunities for co-opetition will affect investment in disruption extend to cases in which cooperation is achieved over such alternative channels.

5 Empirical Implications and Evidence

In this section, we discuss the empirical relevance of two of our main predictions. First, based on Proposition 1 we predict that by facilitating cooperative equilibria:

Implication 1 *Stricter mandatory disclosure requirements allow firms to charge higher mark-ups, resulting in higher operating margins. The effect should be stronger for firms more similar to each other that can benefit more from cooperating.*

Second, based on Propositions 2-3, we predict that the impact of higher profitability on co-opetition is as follows:

Implication 2 *Stricter mandatory disclosure requirements lead to an increase in innovation in firms with marginally or very attractive investment opportunities and a decrease in innovation in firms with moderately attractive investment opportunities.*

There is extensive work in the economics and business literature on the impact of disclosure on innovation, and what is common is that the findings are very mixed. For example, among the most recent studies, some papers find that stricter disclosure requirements have led to more innovation (Hegde et al., 2022), while others find either no effect or the opposite (Saidi and Zaldokas, 2021; Breuer et al., 2022). There is also evidence that, in line with received theory, disclosure leads to information spillovers benefiting rivals (Kim and Valentine, 2021), but these findings are not accompanied by evidence that firms forced to disclose more are actually harmed.[28]

Our theory can shed light on such mixed findings. While a full-fledged empirical analysis goes beyond the scope of our paper, we provide evidence that could motivate and inform such work by extending the analysis in the above-mentioned papers. In particular, most of these papers have studied the passage of the American Inventor's Protection Act (AIPA). In what follows, we provide new evidence regarding the impact of this legislation, supporting our predictions and shedding light on some of the mixed findings in prior work.

[28] Space constraints prevent us from doing full justice to this very interesting strand of the literature. For a recent overview article, see Simpson and Tamayo (2020) and the references in the above-cited papers.

5.1 Evidence on the Impact of Mandatory Disclosure

The American Inventor's Protection Act (AIPA) mandated that firms disclose patent applications sooner. This regulation applied to both public and private firms, mitigating concerns that some public firms could have tried to escape the new legislation by going private. This is important, as it allows us to test the comparative static that, holding the firm's ownership type fixed: (i) an increase in disclosure improves the firm's opportunities for cooperation (Implication 1); (ii) leads to an increase in investment in marginally and very attractive innovation opportunities, and to a decrease in investment in moderately attractive innovation (Implication 2). In any case, our qualitative predictions are robust to interpreting the model as one considering a change in disclosure legislation. The only difference would be that we have to replace $\frac{v^{pub}}{1-\delta}$ with $x_{DD} + \frac{\delta v^{pub}}{1-\delta}$ on the right-hand side of expression (5) for the non-disclosure regime. This creates a stronger incentive to initiate investment under non-disclosure (see footnote 19), strengthening the negative effects and weakening the positive effects predicted in Implication 2. Thus, if anything, finding evidence for the positive effects of co-opetition should be more difficult.

Prior to the passage of the AIPA, information about patents only became available after they were granted, which was on average more than two years following application. The AIPA forced firms to make such information public after 18 months, even for patents that were not granted eventually. The law was enacted in November 1999, and it affected patent applications starting in November 2000. The key source of variation that we exploit is that the AIPA affected some industries more than others, as there is wide-ranging variation in the average time it took to approve patents in different industries in the pre-AIPA period. The idea is that industries with longer lags between patent application and grant date were more strongly affected by the passage of the AIPA. This allows us to construct a continuous treatment variable that is defined as the average time from patent application to grant date for the industry. For a more detailed description of the AIPA, we refer to Johnson and Popp (2003), Graham and Hegde (2015), and Hegde et al. (2022).

We expect that the passage of the AIPA has benefited firms by making publicly observable more signals around which firms can coordinate their actions (action C in our model; see Example 1). Since only about 50% of patents are typically approved (Carley et al., 2015), the earlier disclosure of patent applications combined with the disclosure of applications regardless of their subsequent approval has led to knowledge spillovers that would not have occurred otherwise. Notably, timely disclosing innovation outcomes is a typical example of knowledge that collectively benefits all firms but individually harms firms if not reciprocated.

As we have explained in Example 1, such knowledge spillovers offer useful signals around which to align behavior, as they can help firms avoid head-on competition by specializing in different niches or technologies and avoid duplication, especially when no firm has a clear edge over its rival. The public disclosure of such information can also help firms converge faster to common standards and maintain higher profits on new and old technologies for longer. Furthermore, knowledge spillovers can benefit firms by making implicit cooperation on sharing knowledge and resources easier to sustain, as mandatory disclosure leaves less scope for deviations. All of this should make it easier to charge higher markups (Proposition 1). The increase in markups should be strongest among firms whose products and services are more similar to those of other firms, as such firms stand to benefit the most from avoiding head-on competition (Implication 1).

Our second main prediction is that the disclosure of firms' existing innovation outcomes helps firms not only coordinate and achieve higher profitability on existing operations but also affects their follow-up investments in innovation. In particular, Implication 2 predicts that firms with marginally attractive opportunities benefit the most from cooperation and will increase their innovation output the most. Firms with very attractive opportunities will also benefit, though the effect might be weaker since financing such investments is likely to have faced fewer frictions also before the AIPA. By contrast, investment in moderately attractive investment opportunities is likely to decrease as the commitment to such opportunities declines the most. This non-monotone impact of disclosure on innovation can help explain why prior work has found that the AIPA's average impact on innovation is largely insignificant (Saidi and Zaldokas, 2021), which might appear at odds with findings that the knowledge spillovers triggered by the AIPA have had an overall positive impact on innovation (Kim and Valentine, 2021; Hegde et al., 2022).[29]

5.2 Methodology and Results

To test Implications 1 and 2, we estimate the following difference-in-differences regression

$$Y_{it} = \alpha + \beta_1 Post_t \times Treated_i + \gamma X_{i,t} + \nu_k + \nu_i + \mu_t + \varepsilon_{i,t}, \tag{9}$$

where the dependent variable Y_{it} is one of the following four variables: the natural logarithm of markups charged by firm i in year t; operating profit margins; the natural logarithm of the number of patents; or the natural logarithm of the forward citations of patents produced by the firm in year t, respectively. The last two variables are standard and used in all related

[29] Interestingly, Breuer et al. (2020) find that stricter reporting standards benefit innovative large firms, but the effect is the opposite for small firms. Indeed, the cooperation opportunities that we focus on are relevant mainly for larger players in concentrated industries (Proposition 4).

work investigating the impact of the AIPA on innovation output. Operating margins are calculated as in Grullon et al., (2019) as operating income before depreciation minus depreciation scaled by sales. Markups are calculated using De Loecker et al.'s (2020) production approach as $\theta_{kt}\frac{sale_{it}}{cogs_{it}}$ where $sale_{it}$ and $cogs_{it}$ are firm-level sales and cost of goods sold, and θ_{kt} is the output elasticity of inputs measured at industry level made available by De Loecker et al. (2020). Focusing on markups is interesting, as it shows whether firms can sell at higher prices compared to their variable costs of production. The use of firm fixed effects should mitigate concerns that differences in markups may be driven by differences in fixed costs, as it is unlikely that the fixed costs of firms systematically change around the reform. While we are aware that these measures of markups, profit margins, and innovation metrics are not perfect, our objective is to expand the evidence by staying as close as possible to the related literature on the AIPA and the recent literature documenting how the arguably lower levels of competition among (large) U.S. firms has increased their profitability. Financial information comes from Compustat, and patent information from Kogan et al.'s (2017) patent database.[30]

In equation (9), the treatment variable is the median time between the patent application and grant dates for the respective industry over the five years leading to the year 2000. Industries are defined at the four-digit SIC code level. The idea is that firms in industries with longer delays in the approval of their submitted patents will be more affected by the passage of the AIPA. Post is a dummy variable that takes the value of one in the four years following the passage of the act and zero in the four preceding years. The results are robust to taking shorter and longer periods.

The main coefficient of interest is β_1, which we expect to be positive in the analysis of markups and operating margins. In particular, the enactment of stricter disclosure should lead to higher markups. Since our model predicts that similar firms are likely to be able to benefit more from cooperation opportunities, we split the sample into firms that are more and less similar to other firms. To this end, we use Hoberg and Phillips' (2016) total similarity score, which measures how similar a firm's products and services are to those of other firms. We take the score from the year before the enactment of the AIPA to avoid that the new law might have affected that score. The score is available for about 60% of the firms.[31]

[30] We do not include a lagged dependent variable because we have firm fixed effects. The problem with including a lagged dependent variable is easiest to see with OLS. Suppose that one estimates $y_{i,t} = a + b_1 y_{i,t-1} + b_2 x_{i,t} + v_{i,t}$, where $v_{it} = f_i + u_{i,t}$ but $y_{i,t-1} = a + b_1 y_{i,t-2} + b_2 x_{i,t-1} + f_i + u_{i,t-1}$. Thus, $y_{i,t-1}$, and the composite error, $v_{i,t}$, are positively correlated because both contain f_i, and we would get an omitted variable bias. Similarly, if we include fixed effects (and we do a within transformation), the lagged mean of y, which will be on the right-hand side of the model now, will always be negatively correlated with the demeaned error u.

[31] Note that the sub-sample approach is equivalent to interacting all variables with a dummy for each

When testing for changes in innovation, we split the sample into three terciles depending on the average market value of patents produced in the same four-digit SIC code industry over the last five years.[32] The rationale is that industries that produce patents in the lowest tercile are likely to have less attractive innovation opportunities, whereas industries in the highest tercile should have the most attractive innovation opportunities. Firms in the middle tercile should correspond to the firms with moderately attractive innovation opportunities in our model. To proxy for the market value of new patents, we use the variable, Tsm, which is defined by equation (10) in Kogan et al. (2017) and made available by the authors. This variable represents the sum of the dollar value of patents produced by a firm in a given year, scaled by firm size. The dollar value of patents is calculated based on the firm's stock market reaction to the patents' announcement. For every industry, we take the average over the five years before the introduction of the AIPA.

$X_{i,t}$ is a vector of firm-level control variables that includes firm and median industry size, defined as $\ln(sale)$; sales, general and administrative costs scaled by sales; total debt over assets; firm and median industry age, defined as $\ln(age)$. The regressions control for firm, year, and industry fixed effects, as well as the median size and age of firms in the industry.[33] Following Bertrand et al. (2004), we choose the most conservative level of clustering of standard errors, which in our setting is at the four-digit industry SIC level. Table 1 offers an overview of the main variables of interest.

INSERT TABLE 1

Results. Table 2 presents the main results on how stricter disclosure affects profit margins and markups. These results are important, as they offer strong support for Implication 1, which captures the main channel proposed by our model (Implication 1). In line with that implication, we find that there is a significant increase in markups following the enactment of the AIPA. As predicted by our model, the increase in markups comes from the subsample of firms whose products and services are more similar to those of other firms. Among these firms, those with a one-year longer waiting time for patent approval have experienced a 16% increase in markups. This is economically significant and corresponds to 39% of that variable's standard deviation. The findings for the firm's operating margins presented in

subsample.

[32] The results are virtually identical if we take different windows over which we determine the mean market value of patents in the same industry.

[33] We include year fixed effects instead of a dummy "Post" for the post-AIPA years, as that improves precision and provides a better fit of the model. Specifically, this specification does not assume that all firms in the treatment (or untreated) group have the same average Y; and it allows the intercept to vary for each firm. Furthermore, it does not assume that a common change in Y around the event is a simple change in level; it allows a common change in Y to vary by year.

Panel B of Table 2 are virtually identical. Notably, these findings are in stark contrast to the standard argument that more disclosure harms innovative firms (Bhattacharya and Ritter, 1983).[34] We believe that these insights are important, as they highlight that within the same settings in which papers have documented spillover effects to rivals, disclosing firms are actually not harmed. Thus, while spillover effects are certainly important in practice, we need to expand existing theory to explain why stricter disclosure mandates have led to higher markups and profit margins. Our paper offers a step in this direction.

INSERT TABLES 2, 3, 4, AND 5

In line with Implication 2, Table 3 shows that the enactment of the AIPA has led to an increase in citations and patenting in firms in the lowest and highest tercile of innovation attractiveness. A one-year longer delay in patent approval corresponds to a 12 percentage point increase in citations and a five percentage points increase in patenting for firms in the lowest tercile. For firms in the highest tercile, there is a weak (insignificant) increase in patenting and a 31 percentage points increase in patent citations. By contrast, there is a strong decrease in both citations and patenting in the intermediate tercile. Thus, as predicted by our model, the effect of stricter disclosure requirements on investments in innovation depends on the ex ante attractiveness of innovation opportunities. This non-monotonic effect explains why studying the average effect of mandatory disclosure on innovation can yield insignificant results. Indeed, the average effect presented by model (1) in Tables 3 and 4 is insignificant. Together, our results on the positive impact of the AIPA on markups and its non-monotonic impact on innovation support our model predictions.

The key identifying assumption for the results is parallel trends. In Figures 2, 3, and 4, we provide evidence for this assumption by plotting the coefficient estimates of the following model

$$Y_{it} = \alpha + \sum_t \beta_t \left(Treated_i \times \mathbf{1}_t \right) + \gamma X_{i,t} + \nu_k + \nu_i + \mu_t + \varepsilon_{i,t}, \tag{10}$$

where $\mathbf{1}_t$ is an indicator that equals one if the event time is t. The omitted category is the first year in the observation window. That is, all estimates of β_t are relative to this period.

In line with Tables 2–4, the figures show a strong increase in markups and operating margins. The increase started after 2001, which is consistent with the idea that implicit cooperation needs time to unfold to show up in financial results. By contrast, investment in innovation — both the increase and especially the decrease — was, as expected, quicker to adapt. This could be explained by the fact that AIPA was passed already in 1999, giving forward-looking firms the opportunity to adjust their investments in innovation.

[34] The sum of the number of observations in models (2) and (3) is not equal to those in model (1), because the total similarity score is not available for all firms.

INSERT FIGURES 2, 3, AND 4

Robustness. We perform a battery of robustness tests and find the same results when choosing different event windows, sample splits, defining industries at the three (rather than four) SIC code level, and restricting attention to industries that produce more patents.[35]

One particular robustness test worth discussing in more detail is that the insights from Table 2, which support Implication 1, remain robust when we explore the effect of the Food and Drug Administration Amendments Act (FDAAA), signed into law on September 27, 2007 (Table 5). This act required that the results of all clinical trials in Phase II or above of drug development be publicly reported (see Aghamolla and Thakor (2020) for a detailed description). For this second experiment, we define our treatment variable as a dummy taking the value of one if a firm is a pharmaceutical company (a three-digit SIC code starting with 283 or a four-digit SIC code 8731). While this legislation did not significantly affect innovation in this industry (note that we cannot split the sample in three to test Implication 2, as only one industry was affected), we obtain virtually the same results for the impact on markups and profit margins. This is also the result that we are primarily interested in, as it speaks in favor of the channel proposed by our paper.

As a closing remark, we should note that our evidence is based on public firms, which are typically larger, and as discussed in Section 4.2, our theory primarily applies to larger firms. Breuer et al. (2022) find that disclosure harms profitability in small firms (though the effect is positive for large ones). This suggests that the negative effects of spillovers are more relevant for small firms and underscores the importance of investigating different samples when studying the multifaceted effects of disclosure.

6 Conclusion

Many firms subject to mandatory disclosure requirements are highly profitable and disruptive, defying predictions that such requirements harm them and dull their competitive edge. We propose a novel rationale that helps explain such evidence. We show that mandatory disclosure helps competing firms cooperate— a strategy known as "co-opetition." The cooperation we have in mind can range from sharing knowledge and resources to avoiding head-on competition. Pursuing co-opetition is arguably a legitimate objective of running businesses and is extensively discussed by practitioners and the strategic management literature. Such a strategy can be particularly valuable if it helps firms preserve high margins on their existing

[35] These robustness results are not included due to space constraints but are available in the paper's working paper version.

operations.

Co-opetition can also be valuable when firms pursue disruptive investments, but there is a trade-off. Better opportunities to implicitly cooperate with rivals and avoid head-on competition increase the profitability of existing operations. This could undermine the commitment to disruptive investments and lead the firm to abandon such investments following weak or moderate signals about their prospects.

Taken together, we show that these effects imply that stricter mandatory disclosure leads to more investments in firms with marginally or very attractive investment opportunities but less investment in firms with moderately attractive ones. For highly attractive investment opportunities, concerns about abandoning investment weigh little, and mandatory disclosure is valuable because of the cooperation opportunities it offers. Mandatory disclosure is also beneficial at the other extreme, as when investment opportunities are only marginally attractive, having better exit options reassures financiers. The weaker commitment to investment primarily harms firms (by increasing the agency costs) with moderately attractive investment opportunities, as the decision of whether to continue or abandon investment is least clear-cut for such firms and, thus, can benefit the most from commitment.

We support our model's predictions with evidence about the impact of stricter mandatory disclosure. In line with our predictions about the benefits of co-opetition, the evidence is that stricter disclosure requirements lead to higher markups and profit margins. The effects are stronger for firms offering more similar products and services, which are arguably more likely to benefit from implicit cooperation. The evidence further supports that stricter disclosure leads to an increase in innovation in industries with marginally or very attractive innovation opportunities and a decrease in innovation in industries with moderately attractive opportunities. For future work, it would be interesting to expand empirically and theoretically on the implications for overall welfare.

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Appendix A Proofs

Proof of Lemma 1. We focus on the case in which there is no mandatory disclosure and show that the only equilibrium that can be sustained is the repetition of the Nash equilibrium of the stage game after all histories. Since the only equilibrium of the stage game is (D, D), the result follows.

Consider a strategy profile $\sigma = ((\sigma_1^t)_{t=1}^{\infty}, (\sigma_2^t)_{t=1}^{\infty})$ for the two firms with $\sigma_i^t : H_i^t \to A_i$, where a private history of player i is an element $h_i^t = (y_{i0}, a_{i0}, ..., y_{it}, a_{it}) \in H_i^t$ and $A_i = \{C, D\}$. By convention, we have that $H^0 = \{\varnothing\}$. We refer to the two players as player i and player j, and take the first period of cooperation to be $t = 0$. Observe that for all y_{j0}, y_{i0} it holds that the probability that firm j has played the out-of equilibrium action $a_{j0} \neq \sigma_{j0}(\varnothing)$ and has received signal y_{j0} given that firm i has played its equilibrium strategy σ_{i0} and has received signal y_{i0} is simply $\mathbb{P}(a_{j0}, y_{j0}|\sigma_{i0}(\varnothing), y_{i0}) = 0$. This probability is independent of firm i's signal realization y_{i0}.

Furthermore, given that firm-specific demand shocks are drawn independently, in a pure strategies equilibrium, the probability that firm j plays its equilibrium strategy σ_{j0} and observes signal y_{j0} given that firm i plays its equilibrium action σ_{i0} and observes signal y_{i0} is

$$\mathbb{P}(\sigma_{j0}(\varnothing), y_{j0}|\sigma_{i0}(\varnothing), y_{i0}) = \frac{\pi(y_{i0}, y_{j0}|\sigma(\varnothing))}{\pi(y_{i0}|\sigma(\varnothing))} = \times_{j \neq i} \pi(y_{j0}|\sigma(\varnothing)).$$

The latter probability is also independent of firm i's signal y_{i0}. Since firm i's signal y_{i0} does not affect its belief about firm j's private history $h_j^0 = (y_{j0}, a_{j0})$, the continuation strategy of firm i induced by its strategy in $t = 0$, given the history in $t = 0$, must be independent of its signal y_{i0}. Similarly, the continuation strategy of firm j induced by its strategy in period 0, given the history in $t = 0$, must be independent of its signal y_{j0}. This means that expected continuation payoffs based on the signal in $t = 0$ do not affect firm i's strategy $\sigma_i(\varnothing)$ in $t = 0$. Since the same holds for firm j, the strategy profile $\sigma(\varnothing)$ must constitute a Nash equilibrium of the stage game in $t = 0$. Proceeding by induction, we can extend the argument to all remaining periods. **Q.E.D.**

Proof of Proposition 1. The argument follows from the discussion in the main text. Since the firms can only support a cooperative equilibrium if both firms are public and subject to mandatory disclosure, they will choose public ownership when trying to cooperate. **Q.E.D.**

Proof of Proposition 2. We compute the maximum pledgeable income (i.e., the maximum expected payoff) that the owner-manager can pledge to outside investors while satisfying the continuation rule (4) and the owner-manager's incentive constraint (6), under both public and private ownership. Observe that, regardless of whether the firm is public or private, maximizing the pledgeable income requires setting $\gamma_A = 1$, as this relaxes the incentive constraint (6), while increasing the firm's pledgeable income.

Suppose that $\frac{x_m}{1-\delta} \in (X', X'')$. That is, the continuation condition (4) is satisfied for $\{\theta_M, \theta_G\}$ if the firm is private but only for θ_G if it is public. As discussed in the main text, in all remaining cases, being public dominates. Since outsiders cannot distinguish between signals showing states θ_M and θ_G, the control right to continue the investment becomes important. Note that the owner-manager of firm i prefers to continue the investment at the intermediate date $\tau_t = 0.5$ if

$$\theta_i (1-\gamma_m) \frac{x_m}{1-\delta} + (1-\theta_i)(1-\gamma)\,\mathrm{E}x \geq (1-\gamma_A)(L + \mathrm{E}x)$$

Define for convenience the owner-manager's claims as $S_m := (1-\gamma_m) \frac{x_m}{1-\delta}$, $S := (1-\gamma)\,\mathrm{E}x$, and $S_A := (1-\gamma_A)(L + \mathrm{E}x)$.

The investor prefers continuation if

$$\theta_i \left(\frac{x_m}{1-\delta} - S_m \right) + (1-\theta_i)(\mathrm{E}x - S) \geq L + \mathrm{E}x - S_A. \tag{A.1}$$

In what follows let

$$PV^{pub} = \left(1 - q^e_{\theta_G}\right)\left(L + \frac{v^{pub}}{1-\delta}\right) + q^e_{\theta_G}\left(\theta_G \frac{x_m}{1-\delta} + (1-\theta_G)\frac{v^{pub}}{1-\delta}\right) \tag{A.2}$$

$$\begin{aligned} PV^{priv} = {} & \left(1 - q^e_{\theta_M} - q^e_{\theta_G}\right)\left(L + x_{DD} + \frac{\delta v^{pub}}{1-\delta}\right) \\ & + \sum_{\theta_i \in \{\theta_M, \theta_G\}} q^e_{\theta_i}\left(\theta_i \frac{x_m}{1-\delta} + (1-\theta_i)\left(x_{DD} + \frac{\delta v^{pub}}{1-\delta}\right)\right) \end{aligned} \tag{A.3}$$

denote the present values of investing depending on whether firm i is public and continues investment in state θ_G or private in which case it continues the investment in both states θ_M and θ_G.

Disclosure regime (public ownership) and cooperation. Suppose for now that the continuation decision lies with the financier and that he continues the investment if and only if it is ex post efficient to do so (i.e., $\theta_i = \theta_G$). After deriving the contract that maximizes the firm's pledgeable income, we verify that this allocation of control rights will, indeed, lead to ex post efficient continuation.

The insiders' incentive constraint is

$$\Delta_{\theta_G}\left(\theta_i S_m + (1-\theta_i) S - S_A\right) \geq c.$$

From this constraint, it is immediately apparent that setting $S_A = 0$ (i.e., $\gamma_A = 1$) increases the firm's pledgeable income while relaxing the insiders' incentive constraint.

Using that $S_A = 0$, it must hold that $\theta_G S_m + (1 - \theta_G) S \geq \frac{c}{\Delta_{\theta_G}}$. Maximizing the pledgeable income further requires this expression to be binding. Using this, we obtain that the maximum pledgeable income is

$$\begin{aligned} \Pi^{pub} &= PV^{pub} - q^e_{\theta_G} \left(\theta_G S_m + (1 - \theta_G) S \right) \\ &= PV^{pub} - q^e_{\theta_G} \frac{c}{\Delta_{\theta_G}}. \end{aligned}$$

We now verify that the financier makes the ex post efficient continuation decision at the intermediate date $\tau_t = 0.5$. Observe that if the signal is θ_M, then for $\frac{x_m}{1-\delta} \in (X', X'')$, condition (A.1) would not be satisfied for any $S_m, S \geq 0$. If the signal is θ_G, then condition (A.1) reduces to $\theta_G \left(\frac{x_m}{1-\delta} - \mathrm{E}x \right) - L \geq \frac{c}{\Delta_{\theta_G}}$, which is satisfied by the assumption that exerting effort increases the project's value from an ex ante perspective.

No disclosure regime (private ownership) and non-cooperation. If the firm is private, it continues the investment if $\theta_i \in \{\theta_M, \theta_G\}$, possibly after renegotiations. In what follows, we first solve for the contract maximizing the firm's pledgeable income for this continuation rule when there are no negotiations. Subsequently, we consider renegotiations.

From the incentive constraint, we obtain that the firm must retain an expected claim of at least

$$\sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i} \left(\theta_i S_m + (1 - \theta_i) S - S_A \right) \geq c. \tag{A.4}$$

From this constraint, it is again immediately apparent that setting $S_A = 0$ maximizes the firm's pledgeable income, while relaxing the incentive constraint.

To find the contract maximizing the firm's pledgeable income, define the Lagrangian

$$\begin{aligned} \Lambda &= PV^{priv} - \sum_{\theta_i \in \{\theta_M, \theta_G\}} \left(q^0_{\theta_i} + \Delta_{\theta_i} \right) \left(\theta_i S_m + (1 - \theta_i) S \right) \\ &\quad + \mu \left(\sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i} \left(\theta_i S_m + (1 - \theta_i) S \right) - c \right) + \zeta S + \xi S_m, \end{aligned} \tag{A.5}$$

where μ, ζ, ξ are the weakly positive Kuhn-Tucker multipliers. Note that it cannot be that $S = S_m = 0$, as then (A.4) is not satisfied. Thus, either $\mu, \zeta > 0$ or $\mu, \xi > 0$, and we can replace $\sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i} \left(\theta_i S_m + (1 - \theta_i) S \right)$ in the first line of (A.5) with c. Applying Kuhn

Tucker's theorem and taking the first-order conditions, we have

$$\begin{aligned}\frac{\partial \Lambda}{\partial S_m} &= -\sum_{\theta_i \in \{\theta_M, \theta_G\}} q^0_{\theta_i}\theta_i + \mu \sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i}\theta_i + \xi = 0 \\ \frac{\partial \Lambda}{\partial S} &= -\sum_{\theta_i \in \{\theta_M, \theta_G\}} q^0_{\theta_i}(1-\theta_i) + \mu \sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i}(1-\theta_i) + \zeta = 0\end{aligned}$$

If $\xi = 0$, we have that $\mu = \frac{\sum_{\theta_i \in \{\theta_M, \theta_G\}} q^e_{\theta_i}\theta_i}{\sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i}\theta_i}$. Plugging into the second first-order condition, we obtain

$$\left(q^0_{\theta_G}\Delta_{\theta_M} - q^0_{\theta_M}\Delta_{\theta_G}\right)\frac{\theta_G - \theta_M}{\theta_G\Delta_{\theta_G} + \theta_M\Delta_{\theta_M}} + \zeta.$$

Hence, if $q^0_{\theta_G}\Delta_{\theta_M} \leq q^0_{\theta_M}\Delta_{\theta_G}$, we must have that $\zeta > 0$. That is, $S = 0$ and $S_m = \frac{c}{\sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i}\theta_i}$. However, if $q^0_{\theta_G}\Delta_{\theta_M} > q^0_{\theta_M}\Delta_{\theta_G}$, we have a contradiction to the second first-order condition. In this case, we can set $\zeta = 0$, derive $\mu = \frac{\sum_{\theta_i \in \{\theta_M, \theta_G\}} q^0_{\theta_i}(1-\theta_i)}{\sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i}(1-\theta_i)}$ from the second first-order condition, and verify that $\xi > 0$. Hence, $S_m = 0$ and $S = \frac{c}{\sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i}(1-\theta_i)}$.

Renegotiations. We, now, consider whether renegotiations are needed. Consider the case in which $q^0_{\theta_G}\Delta_{\theta_M} \leq q^0_{\theta_M}\Delta_{\theta_G}$, in which case $S = 0$ and $S_m = \frac{c}{\sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i}\theta_i}$. Giving the continuation control right to the owner-manager ensures that she always continues the investment if $\theta_i \in \{\theta_M, \theta_G\}$ since she does not obtain anything in case of abandonment. Moreover, she also finds it weakly optimal to abandon investment if $\theta_i = 0$, as then her payoff is zero regardless of whether the investment is continued.

Next, consider the case in which $q^0_{\theta_G}\Delta_{\theta_M} > q^0_{\theta_M}\Delta_{\theta_G}$ in which case maximizing the firm's pledgeable income would require that $S_m = 0$ and $S = \frac{c}{\sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i}(1-\theta_i)}$. If the continuation control right is with the firm's owner-manager, she will have incentives to continue regardless of the state realization, leading to renegotiations if $\theta_i = 0$. Since the financiers have all bargaining power in renegotiations, the owner-manager's expected payoff from renegotiating is equal to her outside option of $S^r_A = \max\{S\mathbf{1}^r, S_A\}$, where $\mathbf{1}^r$ is an indicator function taking the value of one in case renegotiations take place. Observe that S_A cannot be the larger term, as the incentive constraint is then the same as (A.4), making it optimal to lower S_A. Furthermore, renegotiations always take place as long as $S > 0$. Hence, from the effort constraint:

$$\sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i}\left(\theta_i S_m + (1-\theta_i) S - S\mathbf{1}^r\right) \geq c,$$

we obtain that it is optimal to set $S = 0$, leading to the same contract as when $q^0_{\theta_G}\Delta_{\theta_M} \leq q^0_{\theta_M}\Delta_{\theta_G}$.

Finally, suppose that the continuation control right is with the financier. If the state is θ_M, then for $\frac{x_m}{1-\delta} \in (X', X'')$, condition (A.1) would not be satisfied for any $S_m, S \geq 0$, implying that there will be renegotiations. In such renegotiations, the owner-manager obtains her outside option $S^r = S_A$, implying that her effort constraint becomes

$$\sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i} \left(\theta_i S_m + (1-\theta_i) S_A - S_A\right) \geq c.$$

Thus, maximizing the firm's pledgeable income while relaxing the incentive constraint requires setting $S_A = 0$, resulting in $S^r = 0$, and we obtain the same outcome as above.

Thus, in all cases, the firm's maximum pledgeable income is

$$\Pi^{priv} = PV^{priv} - \frac{\sum_{\theta_i \in \{\theta_M, \theta_G\}} q^e_{\theta_i} \theta_i}{\sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i} \theta_i} c. \tag{A.6}$$

Comparing pledgeable incomes under public and private ownership. Comparing the maximum pledgeable income under public and private ownership, we obtain that

$$\Pi^{pub} - \Pi^{priv} = PV^{pub} - PV^{priv} - \frac{\theta_M}{\Delta_{\theta_G}} \frac{q^0_{\theta_G} \Delta_{\theta_M} - q^0_{\theta_M} \Delta_{\theta_G}}{\theta_G \Delta_{\theta_G} + \theta_M \Delta_{\theta_M}} c \tag{A.7}$$

Observe that, if $q^0_{\theta_G} \Delta_{\theta_M} \leq q^0_{\theta_M} \Delta_{\theta_G}$, being public leads to a higher pledgeable income. However, if $q^0_{\theta_G} \Delta_{\theta_M} > q^0_{\theta_M} \Delta_{\theta_G}$, the agency costs under private ownership are lower, which could make private ownership preferable. To find when being private dominates in this case, we use that from expressions (A.2)–(A.3)

$$PV^{pub} - PV^{priv} = \left(1 - \theta_G q^e_{\theta_G}\right) \left(v^{pub} - x_{DD}\right) + q^e_{\theta_M} \left(L - \theta_M \left(\frac{x_m}{1-\delta} - x_{DD} - \frac{\delta v^{pub}}{1-\delta}\right)\right).$$

Plugging this difference into expression (A.7) and differentiating with respect to Δ_{θ_M}, we obtain that $\frac{\partial\left(\Pi^{pub} - \Pi^{priv}\right)}{\partial \Delta_{\theta_M}} < 0$. Hence, in terms of comparative statics, we obtain that private ownership becomes more attractive as Δ_{θ_M} increases. In particular, there is a threshold $\Delta^*_{\theta_M}$ (where $\Delta^*_{\theta_M} > \frac{q^0_{\theta_M} \Delta_{\theta_G}}{q^0_{\theta_G}}$), implicitly defined by $\Pi^{pub} = \Pi^{priv}$, for which it holds that being private is better if $\Delta_{\theta_M} > \Delta^*_{\theta_M}$.[36] If the parameter values are such that $\Delta^*_{\theta_M} > 1 - q^0_{\theta_M} - q^0_{\theta_G}$, there are no Δ_{θ_M} and Δ_{θ_G} for which $\Pi^{pub} \leq \Pi^{priv}$, and being public is always optimal. **Q.E.D.**

[36] We do not give the explicit expression for $\Delta^*_{\theta_M}$, as it is not very informative.

Proof of Proposition 3. In analogy to the way we derived firm i's expected profit (5) in the previous section, we obtain that firm i's net present value from investing is higher than the owner-manager's effort cost, c, and outside options if

$$\begin{aligned} V_{II} \quad : &= \sum_{\theta_i \in \{0,\theta_M,\theta_G\}} \left(q^e_{\theta_i} \left((1-q_j) \left(\theta_i \frac{x_m}{1-\delta} + (1-\theta_i)\,\mathrm{E}x \right) + q_j \theta_i \mathrm{E}x \right) \mathbf{1}_{\theta_i} \right. \qquad \text{(A.8)} \\ & \qquad \left. + \left(L + (1-q_j)\,\mathrm{E}x\right)\left(1 - \mathbf{1}_{\theta_i}\right) \right) - K \\ &\geq \quad c + (1-q_j) \max\left(x_{a_i a_j} + \delta\left(V_I - c\right), \mathrm{E}x \right). \end{aligned}$$

The max-operator in the last line of expression (A.8) captures that if firm j's investment fails or is abandoned, firm i can still choose to invest in the following period as in Proposition 1.[37]

The owner-manager's problem is to design the financing contract to maximize V_{II} subject to the financier's break-even condition and the owner-manager' incentive constraint, while also anticipating that ex post inefficient continuation decisions at the intermediate date will be renegotiated. We state all of these constraints below, where we compute the maximum pledgeable income under public and private ownership when both firms make disruptive investments.

If only one firm invests, Proposition 2 applies. Observe that being public has no benefit if the other firm is private, as then the firms cannot cooperate in the investment period. Therefore, we compare the maximum pledgeable income under public and private ownership for firm i only for the case in which firm j is also public. The proof is a straightforward modification of the Proof of Proposition 2.

Consider the continuation rule (8). If $q_j \geq 1/2$, the right-hand side of the continuation rule (8) increases in Ex (i.e., in firms' expected payoff when the firms operate the same technology), which is higher when the firm is public. Hence, firm i is more likely to continue the investment if it is public than if it is private. Thus, the only case we need to consider is where, in equilibrium, $q_j < 1/2$ and

$$\frac{x_m}{1-\delta} \in \left(X'_c, X''_c\right), \text{ where } \begin{cases} X'_c := & \frac{L + \theta_M \left(x_{DD} + \delta \frac{v^{pub}}{1-\delta} \right)(1-2q_j)}{\theta_M (1-q_j)} \\ X''_c := & \frac{L + \theta_M \frac{v^{pub}}{1-\delta}(1-2q_j)}{\theta_M(1-q_j)} \end{cases} . \qquad \text{(A.9)}$$

That is, firm i continues the investment in states $\{\theta_M, \theta_G\}$ if the firm is private but only in

[37] As in Proposition 2, if it is not optimal for firm i to invest in the following period, it is also not optimal in all subsequent periods.

state θ_G if it is public. In all remaining cases, public ownership dominates. Note that firm i prefers to continue the investment if

$$(1-q_j)(\theta_i S_m + (1-\theta_i) S) + q_j \theta_i S \geq (1-q_j) S_A$$

while the investors if

$$(1-q_j)\left(\theta_i\left(\frac{x_m}{1-\delta}-S_m\right)+(1-\theta_i)(\mathrm{E}x-S)\right)+q_j\theta_i(\mathrm{E}x-S)\geq L+(1-q_j)(\mathrm{E}x-S_A)$$

In these expressions, S_B is the owner-manager's claim if both firms' investments succeed. As in Proposition 1, S_m, is the owner-manager's claims in case firm i's investment succeeds and it displaces firm j, S is the owner-manager's claim if both investments fail, and S_A is the owner-manager's claim if firm i abandons its investment.

Since any continuation decision that does not coincide with the socially optimal continuation rule will be renegotiated, we optimally allocate the continuation control right to the party that will take the efficient decision without renegotiating the initial contract, as this allows for more efficient ex ante contracting (by removing the renegotiation-proofness constraint). In what follows define

$$\begin{aligned} PV^{pub} &= (1-q_j)\left(\left(1-q^e_{\theta_G}\right)\left(L+\frac{v^{pub}}{1-\delta}\right)+q^e_{\theta_G}\left(\theta_G\frac{x_m}{1-\delta}+(1-\theta_G)\frac{v^{pub}}{1-\delta}\right)\right) \quad \text{(A.10)}\\ &+q_j\left(\left(1-q^e_{\theta_G}\right)L+q^e_{\theta_G}\theta_G\frac{v^{pub}}{1-\delta}\right)\\ PV^{priv} &= (1-q_j)\left(\left(1-q^e_{\theta_M}-q^e_{\theta_G}\right)\left(L+x_{DD}+\frac{\delta v^{pub}}{1-\delta}\right)\right. \quad \text{(A.11)}\\ &\left.+\sum_{\theta_i\in\{\theta_M,\theta_G\}}q^e_{\theta_i}\left(\theta_i\frac{x_m}{1-\delta}+(1-\theta_i)\left(x_{DD}+\frac{\delta v^{pub}}{1-\delta}\right)\right)\right)\\ &+q_j\sum_{\theta_i\in\{\theta_M,\theta_G\}}\left(\left(1-q^e_{\theta_G}\right)L+q^e_{\theta_i}\theta_i\left(x_{DD}+\frac{\delta v^{pub}}{1-\delta}\right)\right) \end{aligned}$$

the present value of investing depending on whether the firm is public or private, respectively. The incentive constraint that the owner-manager of firm i exerts effort becomes now

$$\sum_{\theta_i\in\{0,\theta_M,\theta_B\}}\left(q^e_{\theta_i}-q^0_{\theta_i}\right)\left(\left((1-q_j)(\theta_i S_m+(1-\theta_i)S)+q_j\theta_i S_B\right)\mathbf{1}_{\theta_i}+S_A\left(1-\mathbf{1}_{\theta_i}\right)\right)\geq c. \quad \text{(A.12)}$$

Disclosure regime (public ownership) and cooperation. This case applies if both firms are public. Suppose for now that the continuation decision lies with the financier. We assume for now and then verify that the financier will continue the investment if and only if it is efficient to do so and it satisfies (8).

To calculate the maximum pledgeable income, it is optimal to set $S_A = 0$, as this relaxes the incentive constraint (A.12), while increasing the pledgeable income. Thus, to exert effort, firm i's expected continuation stake must be at least $(1-q_j)(\theta_G S_m + (1-\theta_G) S) + q_j \theta_G S_B \geq \frac{c}{\Delta_{\theta_G}}$. With such a stake, the maximum pledgeable income to the financier is

$$\Pi^{pub} = PV^{pub} - q^e_{\theta_G} \frac{c}{\Delta_{\theta_G}}.$$

Just as in Proposition 2, it can be verified that the financier takes the ex post efficient continuation decision.

No disclosure regime (private ownership) and non-cooperation. This case applies if one of the firms is private. We proceed as in Proposition 2. To calculate the maximum pledgeable income, it is optimal again to set $S_A = 0$, as this relaxes the firm's incentive constraint (A.12), while increasing the pledgeable income. Note that this trivially implies that the firm continues the investment in both θ_M and θ_G. Hence, from the incentive constraint, we obtain that the firm must retain a claim that satisfies at least

$$\sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i} \left((1-q_j)(\theta_i S_m + (1-\theta_i) S) + q_j \theta_i S_B \right) = c. \tag{A.13}$$

To maximize the pledgeable income, define the Lagrangian

$$\begin{aligned} \Lambda &= PV^{priv} - \sum_{\theta_i \in \{\theta_M, \theta_G\}} \left(q^0_{\theta_i} + \Delta_{\theta_i} \right) \left((1-q_j)(\theta_i S_m + (1-\theta_i) S) + q_j \theta_i S_B \right) \qquad \text{(A.14)} \\ &\quad + \mu \left(\sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i} \left((1-q_j)(\theta_i S_m + (1-\theta_i) S) + q_j \theta_i S_B \right) - c \right) + \zeta S + \xi S_m + \psi S_B \end{aligned}$$

Applying Kuhn Tucker's theorem and taking the first-order conditions, we have

$$\begin{aligned} \frac{\partial \Lambda}{\partial S_m} &= -\sum_{\theta_i \in \{\theta_M, \theta_G\}} q^0_{\theta_i} \theta_i + \mu \sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i} \theta_i + \xi = 0 \\ \frac{\partial \Lambda}{\partial S} &= -\sum_{\theta_i \in \{\theta_M, \theta_G\}} q^0_{\theta_i} (1-\theta_i) + \mu \sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i} (1-\theta_i) + \zeta = 0 \\ \frac{\partial \Lambda}{\partial S_B} &= -\sum_{\theta_i \in \{\theta_M, \theta_G\}} q^0_{\theta_i} \theta_i + \mu \sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i} \theta_i + \psi = 0. \end{aligned}$$

where we have used that in all cases, we must have $\mu > 0$, and we have replaced

$$\sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i} \left((1 - q_j) \left(\theta_i S_m + (1 - \theta_i) S \right) + q_j \theta_i S_B \right)$$

with c in the first line of (A.14). Just as in Proposition 2, we obtain that if $q^0_{\theta_G} \Delta_{\theta_M} < q^0_{\theta_M} \Delta_{\theta_G}$, it is optimal to set $S = 0$ and $(1 - q_j) S_m + q_j S_B = \frac{c}{\sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i} \theta_i}$. However, if $q^0_{\theta_G} \Delta_{\theta_M} > q^0_{\theta_M} \Delta_{\theta_G}$, we have $S_m = S_B = 0$ and $S = \frac{c}{(1-q_j) \sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i} (1 - \theta_i)}$.

We can check now for renegotiations as in Proposition 2 and in analogy that proposition, we obtain that

$$\Pi^{priv} = PV^{priv} - \frac{\sum_{\theta_i \in \{\theta_M, \theta_G\}} q^0_{\theta_i} \theta_i}{\sum_{\theta_i \in \{\theta_M, \theta_G\}} \Delta_{\theta_i} \theta_i} c.$$

Comparing pledgeable incomes with public and private ownership. Comparing the maximum pledgeable income under public and private financing for firm i, we obtain that

$$\Pi^{pub} - \Pi^{priv} = PV^{pub} - PV^{priv} - \frac{\theta_M}{\Delta_{\theta_G}} \frac{q^0_{\theta_G} \Delta_{\theta_M} - q^0_{\theta_M} \Delta_{\theta_G}}{\theta_G \Delta_{\theta_G} + \theta_M \Delta_{\theta_M}} c$$

Observe that, if $q^0_{\theta_G} \Delta_{\theta_M} \leq q^0_{\theta_M} \Delta_{\theta_G}$, being public leads to a higher pledgeable income. However, if $q^0_{\theta_G} \Delta_{\theta_M} > q^0_{\theta_M} \Delta_{\theta_G}$, the agency costs under private ownership are lower, which could make private ownership preferable. Since it holds again that $\frac{\partial \left(\Pi^{pub} - \Pi^{priv} \right)}{\partial \Delta_{\theta_M}} < 0$, we obtain again that private ownership is preferable only if Δ_{θ_M} is above a threshold $\Delta^{**}_{\theta_M}$ (where $\Delta^{**}_{\theta_M} > \frac{q^0_{\theta_M}}{q^0_{\theta_G}} \Delta_{\theta_G}$), implicitly defined by $\Pi^{pub} = \Pi^{priv}$.

Finally, since

$$\frac{\partial \left(X''_c - X'_c \right)}{\partial q_j} = - \frac{v_{pub} - x_{DD}}{\left(1 - q_j\right)^2} < 0.$$

it holds that the distance between X''_c and X'_c is decreasing in q_j. **Q.E.D.**

Proof of Lemma 2. Suppose that if both firms are public, they also play the cooperative equilibrium (regardless of whether they are investing). In this case, there can be no equilibrium in which the firm chooses to be private and outsiders place a probability less than one that the firm is investing in that period. Suppose to a contradiction that such an equilibrium existed. Then, it must be the case that a firm that has no intention to invest in a period prefers being private in that period. However, this is contradicted by the fact that such a firm can do be better by deviating and cooperating with the other firm. **Q.E.D.**

Proof of Lemma 3. We show that when both firms invest in the same period, the leakage of information that the public firm has invested, makes continuing the investment less attractive for the private firm. Let q_i^0 be firm i's probability of investment success if it invests. Furthermore, let $\alpha_{i,t}$ be the probability that firm j assigns to firm i investing in period t. Suppose that firm firm j has invested in period t. Then, its decision to continue with the disruptive technology after observing θ_j at the interim stage of that period is given by

$$\begin{aligned} & \alpha_{i,t}\left(\left(1-q_i^0\right)\left(\theta_j \frac{x_m}{1-\delta}+\left(1-\theta_j\right) \mathrm{E} x\right)+q_i^0 \theta_j \mathrm{E} x\right)+\left(1-\alpha_{i,t}\right)\left(\theta_j \frac{x_m}{1-\delta}+\left(1-\theta_j\right) V_{f,j}\right) \\ \geq\ & L+\alpha_{i,t}\left(1-q_i^0\right) \mathrm{E} x+\left(1-\alpha_{i,t}\right) V_{f,j} \end{aligned} \tag{A.15}$$

where $\mathrm{E}x = x_{DD} + \delta\frac{v^{pub}}{1-\delta}$ if one of the firms is private in t and $\mathrm{E}x = \frac{v^{pub}}{1-\delta}$ if both firms are public in t. $V_{f,j}$ is firm j's expected payoff if it attempts investing and fails. We do not derive this payoff explicitly, as we only need two properties. First, $\mathrm{E}x \geq V_{f,j}$, as firm j can be displaced by firm i in a later period. Second, $V_{f,j}$ decreases in the likelihood that firm i invests in displacing it in a later period. Note that since an increase in the probability that firm i invests in period t means that the probability that firm i invests in a subsequent period decreases, we have that $\frac{\partial V_{f,j}}{\partial \alpha_{i,t}} > 0$.

Taking all terms to the left-hand side of expression (A.15) and taking the derivative with respect to $\alpha_{i,t}$, it holds

$$\begin{aligned} & \theta_j\left(\left(1-q_i^0\right)\left(\frac{x_m}{1-\delta}-\mathrm{E} x\right)+q_i^0 \mathrm{E} x\right)-\theta_j\left(\frac{x_m}{1-\delta}-V_{f,j}\right)-\frac{\partial V_{f,j}}{\partial \alpha_{i,t}}\left(1-\alpha_{i,t}\right) \theta_j \\ =\ & \theta_j\left(V_{f,j}-\mathrm{E} x-q_i^0\left(\frac{x_m}{1-\delta}-2 \mathrm{E} x\right)\right)-\frac{\partial V_{f,j}}{\partial \alpha_{i,t}}\left(1-\alpha_{i,t}\right) \theta_j . \end{aligned}$$

A sufficient condition that the last expression is negative is that the monopoly profits are at least as high as the joint duopoly profits, i.e., $\frac{x_m}{1-\delta} \geq 2\mathrm{E}x$.[38] Hence, if $\frac{x_m}{1-\delta} \geq 2\mathrm{E}x$ and firm i is public, when firm j learns that firm i has also invested ($\alpha_{it} = 1$), the parameter space for which firm j abandons investment is larger compared to when $\alpha_{it} < 1$. Moreover, if $\frac{x_m}{1-\delta} \geq 2\mathrm{E}x$, increases in q_i^0 make (A.15) more difficult to satisfy.

Since the argument for firm i holds in reverse — i.e., a larger parameter space for which firm j abandons investment, increases the parameter space for which firm i continues investment (further increasing q_i^0) — we obtain the proposition's statement. That is, if $\frac{x_m}{1-\delta} \geq 2\mathrm{E}x$, the leakage of information that firm i has invested can benefit firm i by increasing the probability that firm j abandons investment. **Q.E.D.**

[38]This condition is satisfied out in all standard models of competition such as Cournot and Bertrand.

Proof of Proposition 4. Consider an PPE candidate in which firms cooperate in period t and cooperate in $t+1$ if the publicly observable signal is $\widetilde{y}_i, \widetilde{y}_j = (S, S)$; the firms revert to action D for any other signal realization. The latter is a credible threat since (D, D) corresponds to the Nash equilibrium of the stage game. While there are also equilibria with lighter punishments, the analysis of such equilibria is qualitatively the same. Let λ and $1-\lambda$ be the market shares of firm j and i respectively.

Consider the outcomes of a firm's reporting. If a firm reports signal y_{it}, the other firm infers y_{it} with probability $1-\sigma$; with probability σ, the signal is pure noise, and the other firm's inference is correct only with probability $\frac{1}{2}$. That is, a signal is misunderstood with probability $\frac{1}{2}\sigma$ and correctly understood with probability $1-\frac{1}{2}\sigma$. Hence, the cooperation action (C, C) can be enforced (i.e., is incentive compatible) for the less efficient firm j if

$$\begin{aligned}
\widehat{v}_j^{pub} &= (1-\delta)\left(\lambda\rho^2 + \rho(1-\rho)\right) y(p-k_j) + \delta\left(\frac{1}{2}\sigma + \rho - \sigma\rho\right)^2 \widehat{v}_j^{pub} \\
&\geq (1-\delta)\rho y(p-k_j) + \delta\left(\frac{1}{2}\sigma + \rho - \sigma\rho\right)\frac{1}{2}\sigma\widehat{v}_j^{pub}
\end{aligned}$$

After some manipulations, this constraint boils down to $\delta \geq \delta_j^* := \frac{1-\lambda}{\left(\frac{1}{2}\sigma+\rho-\sigma\rho\right)\left(1-\frac{1}{2}\sigma(1+\lambda)\right)}$.

For the more cost-efficient firm, abandoning cooperation means that it reduces prices and takes over the market. Thus, the action profile (C, C) can be enforced for that firm if

$$\begin{aligned}
\widehat{v}_i^{pub} &= (1-\delta)\left((1-\lambda)\rho^2 + \rho(1-\rho)\right) d(p-k_i) \\
&\quad +\delta\left(\left(\frac{1}{2}\sigma + \rho - \sigma\rho\right)^2 \widehat{v}_i^{pub} + \left(1 - \left(\frac{1}{2}\sigma + \rho - \sigma\rho\right)^2\right)\rho d(k_j - k_i)\right) \\
&\geq (1-\delta)\rho d(p-k_i) \\
&\quad +\delta\left(\frac{1}{2}\sigma\left(\frac{1}{2}\sigma + \rho - \sigma\rho\right)\widehat{v}_i^{pub} + \left(1 - \frac{1}{2}\sigma\left(\frac{1}{2}\sigma + \rho - \sigma\rho\right)\right)\rho d(k_j - k_i)\right).
\end{aligned}$$

After some manipulations, this constraint reduces to $\delta \geq \delta_i^* := \frac{\lambda}{\left(\frac{1}{2}\sigma+\rho-\sigma\rho\right)\left(\frac{p-k_j}{p-k_i}(1-\sigma)+\frac{1}{2}\sigma\lambda\right)}$.

Having derived δ_j^* and δ_i^*, we can show now that, in equilibrium, it must be that $\lambda < \frac{1}{2}$. To see this, observe that if the firms had equal market share, $\lambda = 1/2$, we have that $\delta_i^* > \delta_j^*$, and the more cost-efficient firm would have stronger incentives to deviate. Countering these incentives requires that the more cost-efficient firm retains a higher market share. Cooperation is easiest to maintain when $\delta_i^* = \delta_j^*$, which is true for $\lambda = \frac{p-k_j}{2p-k_i-k_j} < \frac{1}{2}$. Although this market share does not depend on the probability with which reporting is misunderstood, this probability still plays a major role as it affects both δ_i^* and δ_j^*. In particular, it is straightforward to check that for all parameter values for which $\delta_i^*, \delta_i^* \leq 1$, we δ_j^* and δ_i^* increase in σ. That is, stricter disclosure (lower σ), makes it easier to sustain cooperation by lowering both δ_i^* and δ_j^*. **Q.E.D.**

Appendix B For Online Publication: Additional Results

Cooperation When Only One Firm Has the Option to Invest. We can proceed as in Propositions 1–3 to show that cooperation on the existing businesses cannot be achieved with private ownership. It can be achieved with public ownership if the firms sufficiently value future cooperation, i.e., δ is sufficiently high. The critical threshold for δ is higher than in Section 3.2, as the firms expect that their rival may invest in the future and end cooperation. Recall that being public is optimal for the firms when they do not invest, as this gives them the option to cooperate. For the same reason, if a firm is not public when it raises financing, it is optimal to go public in the subsequent period if its investment fails or is abandoned.

To analyze firm i's decision to invest, we proceed as in Proposition 2 with few small modifications. The continuation rule (4) at the interim date of the period in which the firm invests becomes

$$\theta_i \left(\frac{x_m}{1-\delta} - V_f \right) \geq L,$$

where $V_f \in \left\{ V_f^{pub}, V_f^{priv} \right\}$ replaces Ex as firm i's expected payoff if it attempts investing but fails, in which case the two firms cooperate until firm j potentially takes over the market. Note that $V_f \leq \mathrm{E}x$ since firm i might be displaced by firm j in the future. Replacing Ex by V_f also in the investor's break-even condition, firm i's investment condition, which is the analogue to expression (5), becomes

$$V_{III} := \sum_{\theta_i \in \{0, \theta_M, \theta_B\}} q_{\theta_i}^e \left(\left(\theta_i \frac{x_m}{1-\delta} + (1-\theta_i) V_f \right) \mathbf{1}_{\theta_i} + (L + V_f)(1 - \mathbf{1}_{\theta_i}) \right) - K \geq c + V_d. \tag{B.1}$$

In this expression V_d is the firm's expected payoff if it delays investment.[39] The owner-manager's incentive constraint is again given by (6). Note that if condition (B.1) cannot be satisfied, delaying is optimal not only in period t but also in all subsequent periods until firm j obtains the option to invest (at which point Proposition 3 applies). Clearly, it is optimal to cooperate with firm j until that point. If condition (B.1) can be satisfied, then proceeding

[39] It is ambiguous whether V_d is larger than $\frac{v^{pub}}{1-\delta}$. We do not give the precise expressions for V_f and V_d, as they are not informative for the analysis.

as in Proposition 1, it holds:

Proposition B.1 *Suppose that only firm i can make a disruptive investment in the current period, but firm j might also be able to invest in a future period. Being public makes it harder to raise financing and invest in disruption if the investment opportunities are moderately attractive*

$$\frac{x_m}{1-\delta} \in \left(X_e', X_e''\right), \text{ where } \begin{cases} X_e' := & \frac{L}{\theta_M} + V_f^{priv} \\ X_e'' := & \frac{L}{\theta_M} + V_f^{pub} \end{cases} \tag{B.2}$$

and the agency problems are server: $\Delta_{\theta_M} > \Delta_{\theta_M}^{***}$ (where $\Delta_{\theta_M}^{***}$ is implicitly defined by the condition that the firm is indifferent between being public and private). The cooperation benefit of being public dominates in all other cases.

Finally, observe that $X_e'' - X_e' = v^{pub} - x_{DD}$, which is the same as distance as between X'' and X' (Proposition 1) albeit the cutoff points are different.[40]

[40]Note that $V_f^{pub} - V_f^{priv} = v_{pub} - x_{DD}$, as the firm optimally goes public if the investment fails. Thus, the only difference between the two payoffs is in the expected cash flows in the investment period.

Table 1: **Summary Statistics.** This table shows the summary statistics for the main variables used in the analysis. $Ln(1+markup)$ is defined as the natural logarithm of the ratio of sales to cost of goods sold times the output elasticity of inputs measured at the industry level, computed as in De Loecker et al. (2020). $Ln(1+operating\ margins)$ is the natural logarithm of one plus $operating\ margins$, where $operating\ margins$ is defined as in Grullon et al. (2019) as operating income before depreciation minus depreciation scaled by sales. $Ln(1+patents)$ is the natural logarithm of the firm's patents produced in a given year. $Ln(1+citations)$ is the natural logarithm of the forward citations of patents produced in a given year. $Similarity$ is the Hoberg and Phillips (2016) total similarity score. $Ln(sales)$ is the natural log of sales, adjusted to inflation (base year 1999). $SG\&A/sales$ is sales, general, and administrative expenses over sales. $Total\ debt/assets$ is the sum of the firm's total debt over its assets. $Ln(age)$ is the natural logarithm of the firm's age, which is computed as the number of years since the firm's first entry in Compustat. The attractiveness of innovation corresponds to the mean market value of patents (provided by Kogan et al., 2017), produced between 1996 and 2000 in the same four-digit SIC industry. $Patent\ approval\ delay$ measures the mean difference in years between the filing date and the grant date across all patents granted in the same four-digit SIC industry between 1996 and 2000.

	Mean	Median	Sd	N
Ln(1+markup)	0.914	0.839	0.410	101,847
Ln(1+operating margins)	0.123	0.155	0.395	89,845
Ln(1+patents)	0.243	0.000	0.800	117,856
Ln(1+citations)	0.504	0.000	1.487	117,856
SG&A/sales	0.762	0.266	2.386	80,239
Total debt/assets	0.323	0.193	0.600	106,691
Ln(sale)	4.481	4.564	2.715	101,048
Industry ln(sale)	4.395	4.145	1.588	117,837
Ln(age)	2.112	2.197	0.974	117,847
Industry ln(age)	2.042	1.946	0.536	117,786
Similarity	10.813	2.382	21.945	63,136
Patent approval delay (at 4-digit SIC level)	2.012	1.975	0.325	349
Attractiveness of innovation (at 4-digit SIC level)	325.683	15.476	1361.798	345

Table 2: **Effect of Mandatory Disclosure on Markups and Operating Margins.** This table shows changes in markups in the years around the enactment of the AIPA based on the difference in differences specification (9). The dependent variable in models (1)-(3) is $Ln(1 + markup)$, where *markup* is defined as the natural logarithm of the ratio of sales to cost of goods sold times the output elasticity of inputs measured at industry level, computed as in De Loecker et al. (2020). The dependent variable in models (4)-(6) is $Ln(1 + operating\ margins)$, where *operating margins* is defined as in Grullon et al. (2019) as operating income before depreciation minus depreciation scaled by sales. *Treatment* measures the median difference in years between the filing date and the grant date across all patents granted in the respective industry between 1996 and 2000. All industries are defined at the four-digit SIC level. *Post* is a dummy variable equal to one for the years following the enactment of AIPA. *Similarity* is the Hoberg and Phillips (2016) total similarity score in the year before the enactment of the AIPA. Models (2) and (3) split the sample depending on whether the firms are below (no effect) or above the median of this measure in the year 2000. The control variables are firm and median industry $Ln(sales)$, which is the natural log of sales, adjusted to inflation (base year 1999); $SG\&A/sales$, which is sales, general, and administrative expenses over sales; $Ln(age)$ and $Industry\ ln(age)$, which is the natural logarithm of the firm's age, calculated as the number of years since the firm's entry in the Compustat database; and $Total\ debt/assets$. These variables are winsorized at 1%. Robust standard errors clustered at the four-digit SIC level are in parentheses. *, **, and *** indicate that the coefficient is statistically significant at the 10%, 5%, and 1% levels, respectively.

	Ln(1+markup)			Ln(1+operating margins)		
	All firms	Low similarity	High similarity	All firms	Low similarity	High similarity
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment x post	0.113**	0.011	0.164***	0.062***	0.015	0.076***
	(0.055)	(0.012)	(0.045)	(0.013)	(0.010)	(0.018)
SG&A/sales	-0.014***	-0.016***	-0.023***	-0.506***	-0.744**	-1.048***
	(0.002)	(0.004)	(0.004)	(0.157)	(0.333)	(0.193)
Total debt/assets	-0.008*	0.003	(0.026)	-0.041***	-0.026*	-0.082***
	(0.005)	(0.012)	(0.018)	(0.014)	(0.014)	(0.022)
Ln(sales)	0.000	-0.013**	(0.001)	0.070***	0.044	0.026*
	(0.005)	(0.006)	(0.005)	(0.014)	(0.029)	(0.013)
Industry ln(sales)	0.003	0.006**	-0.015	-0.001	0.001	-0.013
	(0.010)	(0.003)	(0.023)	(0.005)	(0.003)	(0.016)
Ln(age)	0.014*	0.015	0.007	0.014*	0.008	0.031
	(0.008)	(0.010)	(0.022)	(0.008)	(0.010)	(0.019)
Industry ln(age)	-0.040**	-0.009	-0.096***	0.005	0.001	0.017
	(0.016)	(0.006)	(0.031)	(0.008)	(0.007)	(0.019)
Firm FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	72,779	23,161	18,551	67,671	22,387	17,284
Adjusted R-squared	0.032	0.013	0.098	0.196	0.277	0.342

Table 3: **Effect of Mandatory Disclosure on Innovation.** This table shows changes in innovation in the years around the enactment of the AIPA, based on the difference in differences specification (9). The dependent variable is $ln(1+patents)$. $Treatment$ measures the median difference in years between the filing date and the grant date across all patents granted in the same four-digit SIC industry between 1996 and 2000. $Post$ is a dummy variable equal to one for the years following the enactment of the AIPA. To proxy for the attractiveness of innovation, we use the market value of patents (provided by Kogan et al., 2017), produced between 1996 and 2000 in the same four-digit SIC industry. Models (2), (3), and (4) split the sample depending on whether a firm is in the lowest, middle, or highest tercile according to this measure in the year 2000. The control variables are firm and median industry $Ln(sales)$, which is the natural log of sales, adjusted to inflation (base year 1999); $SG\&A/sales$, which is sales, general, and administrative expenses over sales; $Ln(age)$ and $Industry\ ln(age)$, which is the natural logarithm of the firm's age, calculated as the number of years since the firm's entry in the Compustat database; and $Total\ debt/assets$. These variables are winsorized at 1%. Robust standard errors clustered at the four-digit SIC level are in parentheses. *, **, and *** indicate that the coefficient is statistically significant at the 10%, 5%, and 1% levels, respectively.

	ln(1+patents)			
	All firms	Attractiveness lowest tercile	Attractiveness middle tercile	Attractivenss highest tercile
	(1)	(2)	(3)	(4)
Treatment x post	0.015	0.055***	-0.147***	0.103
	(0.047)	(0.017)	(0.039)	(0.100)
SG&A/sales	0.008***	0.005***	0.009***	0.009*
	(0.003)	(0.002)	(0.003)	(0.005)
Total debt/assets	-0.015***	-0.013	-0.025**	-0.014**
	(0.005)	(0.009)	(0.011)	(0.007)
Ln(sales)	0.043***	0.030***	0.049***	0.047***
	(0.010)	(0.006)	(0.012)	(0.017)
Industry ln(sales)	-0.010	0.001	-0.027	-0.020
	(0.009)	(0.008)	(0.018)	(0.028)
Ln(age)	0.145***	0.080***	0.157**	0.171***
	(0.032)	(0.017)	(0.065)	(0.063)
Industry ln(age)	0.062**	0.001	0.098**	0.074
	(0.025)	(0.016)	(0.044)	(0.072)
Firm FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	73,218	23,918	21,017	28,073
Adjusted R-squared	0.037	0.013	0.039	0.063

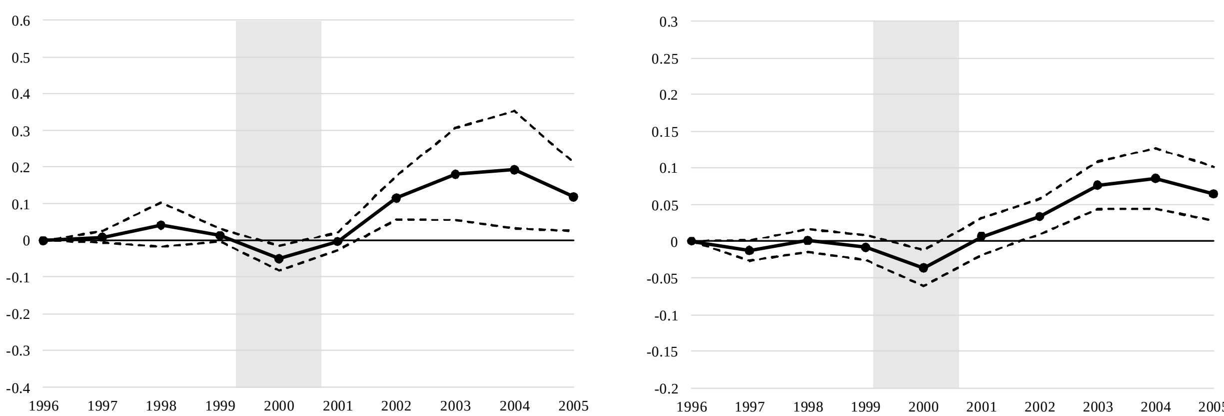
Table 4: **Effect of Mandatory Disclosure on Innovation.** This table shows changes in patent citations in the years around the enactment of the AIPA, based on the difference in differences specification (9). The dependent variable is $ln(1 + citations)$. $Treatment$ measures the median difference in years between the filing date and the grant date across all patents granted in the same four-digit SIC industry between 1996 and 2000. $Post$ is a dummy variable equal to one for the years following the enactment of the AIPA. To proxy for the attractiveness of innovation, we use the market-value of patents (provided by Kogan et al., 2017), produced between 1996 and 2000 in the same four-digit SIC industry. Models (2), (3), and (4) split the sample depending on whether a firm is in the lowest, middle, or highest tercile according to this measure in the year 2000. The control variables are firm and median industry $Ln(sales)$, which is the natural log of sales, adjusted to inflation (base year 1999); $SG\&A/sales$, which is sales, general, and administrative expenses over sales; $Ln(age)$ and $Industry\ ln(age)$, which is the natural logarithm of the firm's age, calculated as the number of years since the firm's entry in the Compustat database; and $Total\ debt/assets$. These variables are winsorized at 1%. Robust standard errors clustered at the four-digit SIC level are in parentheses. *, **, and *** indicate that the coefficient is statistically significant at the 10%, 5%, and 1% levels, respectively.

	ln(1+citations)			
	All Firms	Attractiveness lowest tercile	Attractiveness middle tercile	Attractivenss highest tercile
	(1)	(2)	(3)	(4)
Treatment x post	0.105	0.112***	-0.151**	0.348**
	(0.073)	(0.035)	(0.064)	(0.163)
SG&A/sales	0.019***	0.013***	0.021**	0.023**
	(0.005)	(0.004)	(0.008)	(0.010)
Total debt/assets	-0.034***	-0.031	-0.057**	-0.029*
	(0.012)	(0.021)	(0.028)	(0.017)
Ln(sales)	0.111***	0.065***	0.104***	0.137***
	(0.021)	(0.012)	(0.027)	(0.038)
Industry ln(sales)	-0.022	0.000	-0.054	-0.030
	(0.015)	(0.016)	(0.033)	(0.051)
Ln(age)	0.423***	0.264***	0.443***	0.497***
	(0.069)	(0.036)	(0.166)	(0.117)
Industry ln(age)	0.121***	0.009	0.100	0.172*
	(0.044)	(0.032)	(0.071)	(0.089)
Firm FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	73,218	23,918	21,017	28,073
Adjusted R-squared	0.032	0.017	0.03	0.049

Table 5: **Effect of Mandatory Disclosure on Markups and Operating Margins (FDAAA).** This table shows changes in markups in the years around the enactment of the FDAAA based on the difference in differences specification (9). The dependent variable in models (1)-(3) is $Ln(1 + markup)$, where $markup$ is defined as the natural logarithm of the ratio of sales to cost of goods sold times the output elasticity of inputs measured at the industry level, computed as in De Loecker et al. (2020). The dependent variable in models (4)-(6) is $Ln(1 + operating\ margins)$, where $operating\ margins$ is defined as in Grullon et al. (2019) as operating income before depreciation minus depreciation scaled by total sales. $Treatment$ is an indicator variable taking the value of one if the firm is a biotech or pharma firm, defined as firms with a three-digit SIC code 283 and firms with a four-digit SIC code 8731. $Post$ is a dummy variable equal to one for the years following the enactment of the FDAAA. $Similarity$ is the Hoberg and Phillips (2016) total similarity score in the year before the enactment of the FDAAA. Models (2) and (3) split the sample depending on whether the firms are below (no effect) or above the median of this measure in the year 2006. The control variables are firm and median industry $Ln(sales)$, which is the natural log of sales, adjusted to inflation (base year 1999); $SG\&A/sales$, which is sales, general, and administrative expenses over sales; $Ln(age)$ and $Industry\ ln(age)$, which is the natural logarithm of the firm's age, calculated as the number of years since the firm's entry in the Compustat database; and $Total\ debt/assets$. These variables are winsorized at 1%. Robust standard errors clustered at the four-digit SIC level are in parentheses. *, **, and *** indicate that the coefficient is statistically significant at the 10%, 5%, and 1% levels, respectively.

	Ln(1+markup)			Ln(1+operating margins)		
	All firms	Low similarity	High similarity	All firms	Low similarity	High similarity
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment x post	0.078***	0.046	0.110***	0.011	(0.003)	0.033**
	(0.024)	(0.056)	(0.019)	(0.014)	(0.018)	(0.015)
SG&A/sales	-0.012***	(0.004)	-0.013*	-0.353*	(0.076)	-0.990***
	(0.002)	(0.008)	(0.007)	(0.188)	(0.117)	(0.093)
Total debt/assets	0.003	(0.012)	(0.042)	-0.022*	-0.051**	-0.039***
	(0.007)	(0.015)	(0.029)	(0.011)	(0.021)	(0.014)
Ln(sales)	0.009	0.010	0.008	0.064***	0.097***	0.013
	(0.009)	(0.008)	(0.009)	(0.013)	(0.014)	(0.011)
Industry ln(sales)	0.006*	0.006*	-0.015*	0.000	0.001	-0.014
	(0.003)	(0.003)	(0.008)	(0.004)	(0.003)	(0.010)
Ln(age)	-0.003	0.001	-0.010	-0.021***	-0.024*	0.000
	(0.008)	(0.011)	(0.012)	(0.008)	(0.013)	(0.010)
Industry ln(age)	-0.013	-0.004	0.005	-0.001	-0.004	-0.002
	(0.012)	(0.007)	(0.019)	(0.005)	(0.006)	(0.009)
Firm FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	56,354	15,453	13,644	52,451	15,055	13,051
Adjusted R-squared	0.017	0.005	0.024	0.224	0.136	0.506

Figure 2: **Parallel trends in markups and operating margins.** This figure shows changes in markups in the years around the enactment of the AIPA. The estimates β_t and their 90% confidence intervals are from the difference in differences specification (10). The dependent variable in Panel A is $ln(1 + markup)$, and it is defined as the log of the ratio of sales to cost of goods sold times the output elasticity of inputs measured at the industry level, computed as in De Loecker et al. (2020). The dependent variable in Panel B is $Ln(1 + operating\ margins)$, where $operating\ margins$ is defined as in Grullon et al. (2019) as operating income before depreciation minus depreciation scaled by sales. $Treatment$ measures the median difference in years between the filing date and the grant date across all patents granted in the respective industry between 1996 and 2000. All industries are defined at the four-digit SIC level. $\mathbf{1}_t$ is an indicator function that equals one if the event time is t. The control variables are firm and median industry $Ln(sales)$, which is the natural log of sales, adjusted to inflation (base year 1999); $SG\&A/sales$, which is sales, general, and administrative expenses over sales; $Ln(age)$ and $Industry\ ln(age)$, which is the natural logarithm of the firm's age, calculated as the number of years since the firm's entry in the Compustat database; and $Total\ debt/assets$. These variables are winsorized at 1%. Robust standard errors clustered at the four-digit SIC level.



Panel A: Markups

Panel B: Operating margins

Figure 3: **Parallel trends in patenting.** This figure shows changes in innovation in the years around the enactment of the AIPA. The estimates β_t and their 90% confidence intervals are from the difference in differences specification (10). The dependent variable is $Ln(1+patents)$. $Treatment$ measures the median difference in years between the filing date and the grant date across all patents granted in the same four-digit SIC industry between 1996 and 2000. $\mathbf{1}_t$ is an indicator function that equals one if the event time is t. The control variables are firm and median industry $Ln(sales)$, which is the natural log of sales, adjusted to inflation (base year 1999); $SG\&A/sales$, which is sales, general, and administrative expenses over sales; $Ln(age)$ and $Industry\ ln(age)$, which is the natural logarithm of the firm's age, calculated as the number of years since the firm's entry in the Compustat database; and $Total\ debt/assets$. These variables are winsorized at 1%. Robust standard errors clustered at the four-digit SIC level. Panels A and B plot the results for the lowest and middle terciles. We do not present the plot for the highest tercile, as the results there are insignificant

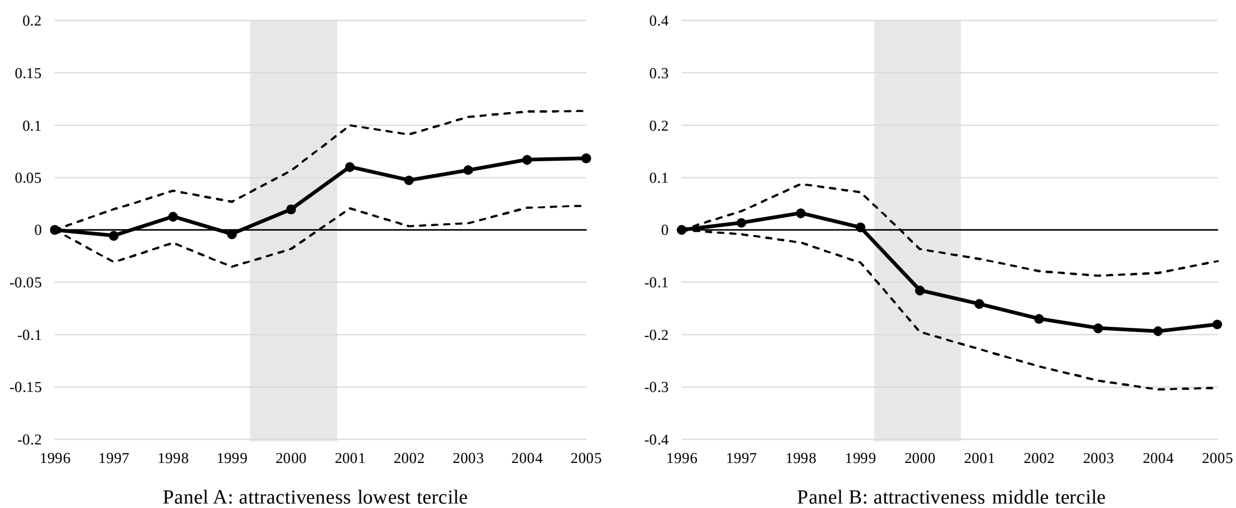


Figure 4: **Parallel trends in forward citations.** This figure shows changes in innovation in the years around the enactoment of the AIPA. The estimates β_t and their 90% confidence intervals are from the difference in differences specification (10). The dependent variable is $Ln(1 + citations)$. $Treatment$ measures the median difference in years between the filing date and the grant date across all patents granted in the same four-digit SIC industry between 1996 and 2000. $\mathbf{1}_t$ is an indicator function that equals one if the event time is t. The control variables are firm and median industry $Ln(sales)$, which is the natural log of sales, adjusted to inflation (base year 1999); $SG\&A/sales$, which is sales, general, and administrative expenses over sales; $Ln(age)$ and $Industry\ ln(age)$, which is the natural logarithm of the firm's age, calculated as the number of years since the firm's entry in the Compustat database; and $Total\ debt/assets$. These variables are winsorized at 1%. Robust standard errors clustered at the four-digit SIC level.