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by Daniel Hoang and Martin Ruckes

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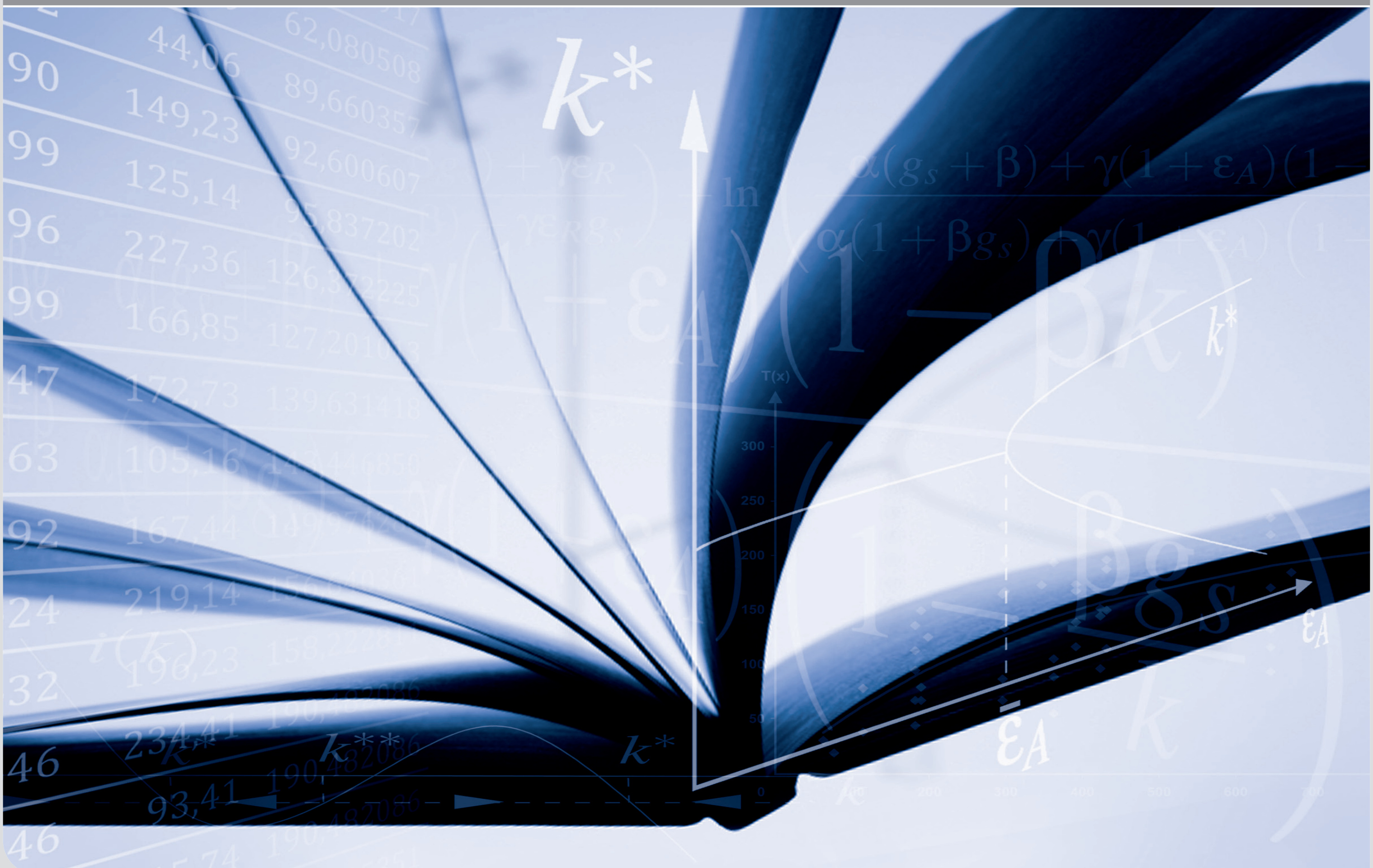

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The Effects of Disclosure Policy on Risk Management Incentives and Market Entry*

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Abstract

This paper studies the effects of hedge disclosure requirements on corporate risk management and product market competition. The analysis is based on a simple model of market entry and shows that incumbent firms engage in risk management when these activities remain unobserved by outsiders. The resulting equilibrium is desirable from a social standpoint. Financial markets are well informed and entry is efficient. However, potential attempts for more transparency by additional disclosure requirements introduce a commitment device that provides firms with incentives to distort risk management activities thereby influencing entrant beliefs. In equililibrium, firms engage in significant risk-taking. This behavior limits entry and adversely affects the nature of competition in industries. Our findings thus suggest that more disclosure on risk management may change risk management in socially undesirable ways.

JEL Classification: D82, G3, L1, M4

Keywords: Risk Management, Hedge Disclosures, Market Entry, Signal Jamming

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The Effects of Disclosure Policy on Risk Management Incentives and Market Entry

Abstract

This paper studies the effects of hedge disclosure requirements on corporate risk management and product market competition. The analysis is based on a simple model of market entry and shows that incumbent firms engage in risk management when these activities remain unobserved by outsiders. The resulting equilibrium is desirable from a social standpoint. Financial markets are well informed and entry is efficient. However, potential attempts for more transparency by additional disclosure requirements introduce a commitment device that provides firms with incentives to distort risk management activities thereby influencing entrant beliefs. In equililibrium, firms engage in significant risk-taking. This behavior limits entry and adversely affects the nature of competition in industries. Our findings thus suggest that more disclosure on risk management may change risk management in socially undesirable ways.

1 Introduction

"The fallacy that disclosure costs nothing has long been implicit in SEC rules. ... The more-is-always-better view fails to recognize that disclosing a risk often changes the risk itself. Disclosure inevitably affects behavior, not necessarily in socially desirable ways."

Merton Miller and Christopher Culp, WSJ (June 25, 1996); in a comment on SEC plans to mandate disclosures on how companies manage their risks

Recent research in accounting, finance, and industrial organization suggests that the interactions between firms in the product market can considerably affect hedging incentives (Mello and Ruckes, 2005; Adam, Titman, and Dasgupta, 2007; Loss, 2012).[1] This paper identifies a previously unrecognized hedging determinant in the context of market entry by a potential rival. Our theory demonstrates that the disclosure of a firm's risk position has considerable implications on the firm's hedging incentives and can also adversely affect social welfare.[2]

We focus on a stylized setting of entry with an incumbent and an entrant. The entrant is uncertain of its future profitability in the market and uses the persistent component of current profits of the incumbent to decide whether to enter. The established firm can engage in risk management, which reduces the noisiness of corporate earnings as a signal of market profitability and thus improves their informativeness. Our findings suggest that if risk management is unobservable, the incumbent has strong incentives to engage in hedging under quite general conditions. Because entrants may interpret high profits as favorable market conditions, incumbent firms are trapped into risk management activities. They seek to minimize the variance of realized profits to minimize the probability of entry. Potential market entry hence creates strong forces to reduce risk, even when firms are risk-neutral. The resulting equilibrium is also socially desirable: the financial market is well informed about product market profitability and entry is "relatively" efficient. This finding contrasts pronouncedly with equilibrium results in a regime with observable risk management activities. Then, the incumbent is forced to credibly communicate its exposure which could reveal proprietary information that

[1] It is well recognized that firms have strong incentives to engage in corporate risk management in the presence of market imperfections that induce concavities in the firm's payoff functions (e.g., convex tax schedules, deadweight cost of financial distress, or costs of external financing; see Smith and Stulz, 1985; Stulz, 1990; Froot, Scharfstein, and Stein, 1993). These models typically analyze the firm in isolation.

[2] We will use the terms "hedging" and "risk management" interchangeably throughout.

an entrant may exploit. At the same time, the observability of risk management activities provides the incumbent with a strategic device to credibly communicate the absence of information contained in its financial reports when less hedging lowers the informativeness of earnings. We show that the incumbent indeed uses this commitment device and jams the signal sent to potential entrants by engaging in risk-taking to discourage entry. This obsfuscation strategy reduces the probability of entry, increases incumbent profits, and decreases social welfare.

To portray the consequences of disclosure, we consider two polar regimes (taken to be exogeneous to the model): i) a regime of non-observability in which firms cannot disclose risk management activities, and ii) a regime of perfect observability and disclosure. Under the former, we implicitly assume that either credible disclosure of hedging positions or their verification are sufficiently costly. Thus, even if a firm has incentives to disclose risk management activities voluntarily, factors outside the scope of the model make *privately* producing a sufficient level of disclosure commitment unprofitable for the firm when not included with mandated requirements. In fact, disclosure requirements related to risk impose substantial direct costs on firms, mainly because they are particularly complicated to implement.[3] [4] Possibly more importantly, additional disclosures to achieve greater transparency generally require substantial economy-wide investments by firms, the auditing industry and financial market participants. So any move towards a more transparent hedge disclosure regime is characterized by substantial scale economies and is only financially bearable if it applies to a large set of firms. The multi-faceted nature of risk management reinforces these arguments. Risk management is generally not limited to risk transfers with derivatives and other securities, but also includes off-balance measures such as insurance contracts, supplier-customer-agreements as well as a plethora of operational measures often referred to as "natural hedges" (e.g., plant choices or exercising market power to pass on cost shocks to customers).[5] Consequently, irrespective of the causes, credible disclosure of a firm's risk management activity requires substantial (potentially private) investments in disclosure and verification technology.

While the nature of risk management and disclosure suggest impediments for voluntary disclosure of risk

[3] See, for instance, Corman (2006): At General Electric, more than 40 full-time accounting personnel solely ensure the adequacy of hedge accounting – in addition to many business managers involved in the preparation process of any documentation.

[4] In the appendix, we also present a more extensive summary of the institutional background and current accounting standards.

[5] For example, recent empirical evidence by Bodnar et. al. (2011) suggests that operational risk management is considerably more important than risk management through financial contracts for all classes of risk except for FX risk. See also Servaes, Tamayo, and Tufano, 2009 for similar findings. We refer to Smith (1995) for a comprehensive overview on financial and non-financial risk management instruments.

management activities by fims, standard setters move increasingly toward further disclosure to service the information needs of capital markets. In studying the admittedly extreme case of perfect observability of hedging activity, we examine consequences of additional mandated hedge disclosures, which a policy-maker may enforce in an attempt for greater transparency. Such mandated requirements could create unintended welfare-decreasing externalities in the product market beyond any cost imposed by the mandatory regime per se.

We develop our arguments further in the following four sections. In sections 2, we elaborate on related literature. In section 3, we present the structure and the assumptions of the model. In section 4, we analyze equilibrium strategies under non-observability and observability of hedging activities. Furthermore, we elaborate on the implications of our results for disclosure regulation, corporate risk management, and anti-trust policy. Section 5 contains concluding remarks.

2 Related Literature

Our paper is related to previous works in accounting, finance, and industrial organization.

Literature on Hedge Disclosure. DeMarzo and Duffie (1995) analyze a model of risk management where corporate profits serve as a signal of a manager's ability. They demonstrate that with nondisclosure of hedging activity, full hedging is an equilibrium policy for managers. If hedge decisions are disclosed, however, managers have an incentive to forego risk management opportunities to render inference about their ability difficult for outside investors. Kanodia, Mukherji, Sapra, and Venugopalan (2000) investigate the desirability of hedge disclosures and their informational effect on futures prices. They show that disclosure of hedge activities improves price efficiency in the futures market and industry output. Sapra (2002) studies hedge disclosures with a focus on the trade-offs between production and risk management distortions. He finds that mandatory hedge disclosure drives a firm to take extreme positions in the futures market. We follow these papers in evaluating risk management decisions under a mandatory hedge disclosure regime relative to the benchmark situation in which firms cannot disclose their risk management activities. None of these papers considers product-market competition.

Literature on Risk Management and (Post-entry) Competition. Liu and Parlour (2009), Adam, Dasgupta, and Titman (2007), Mello and Ruckes (2005), and Loss (2012) study the relationship between risk management and competition. Liu and Parlour (2009) consider the interaction between hedging and bidding in a winner-takes-all auction context in which hedging renders winning more valuable and losing more costly. They find that the ability to hedge with financial instruments makes firms bid more aggressively because of running the risk of overhedging if they lose. Adam, Dasgupta, and Titman (2007) investigate firms' risk management choices in an industry equilibrium in which endogenous output prices are a function of aggregate investment and hedging decisions. They illustrate that a single firm's incentive to hedge increases if more firms in the industry choose not to hedge and vice versa. They also relate industry characteristics to the proportion of firms that hedge. Mello and Ruckes (2005) study optimal hedging and production strategies of financially constrained firms in imperfectly competitive markets. They find that oligopolistic firms hedge the least when they face intense competition and firms' financial conditions are similar. Likewise, Loss (2012) examines risk management of competing firms facing credit constraints. He shows that firms' hedging incentives depend on a) the correlation between the competitors' available internal funds to make profitable investments and b) whether competitors' investments mutually reinforce or mutually offset investment returns. The reason is that hedging can ensure that firms optimally coordinate profitable investments and financing policies. This literature implicitly assumes that firms' risk management activities are typically non-observable (or credible disclosure of such positions is sufficiently costly). None of these papers studies the informational effects of additional hedge disclosures on risk management activities of competing firms.

Literature on Risk Management, Hedge Disclosure, and (Post-entry) Competition. Only few studies (Allaz, 1992; Hughes and Kao, 1997; Hughes, Kao, and Williams, 2002; Hughes and Williams, 2008) consider the effects of disclosure of *hedging activities* on product competition.[6] Like our study, these works consider mandated hedge disclosure and non-disclosure regimes. While the welfare implications of these studies (e.g., industry output) are not clear-cut, they tend to favor the postulate that hedge disclosure is pro-competitive and thus welfare-improving (Hughes and Williams, 2008). However, these papers (like the works cited in the previous paragraph) examine situations in which firms face *post*-entry competition (or situations in which entry entails little cost) by looking at how hedge disclosure affects production output decisions of Cournot duopolists. By contrast, our study explicitly investigates *pre*-entry competition showing that disclosure deters market entry and can thereby reduce social welfare.[7]

[6] Prior studies on disclosure in the context of competition primarily focus on the role of private information about demand and cost and its revelation among competitors (e.g., Darrough, 1993, among others).

[7] In this regard, our paper is related to accounting research studying industry externalities of disclosure on market entry (Hwang and Kirby, 2000; Darrough and Stoughton, 1990; Feltam and Xie, 1992; Feltham, Gigler, and Hughes, 1992). For instance, Hwang and Kirby (2000) study mandatory disclosure of firm-specific cost information and the effect on an incumbent's production quantity in a Cournot oligopoly if entry occurs.

3 The Model

3.1 Overview

We model a non-cooperative game among the established firm (or *incumbent*) I and the market entrant (or *rival*) R. The model consists of two periods, $t = 1, 2$. In the first period, the incumbent operates as a monopolist. The entrant observes the incumbent's first-period earnings and uses these to decide whether to enter the market in the second period. Firms are risk-neutral, and discount rates are zero.

3.2 Payoffs

The realization of first-period earnings of the incumbent is publicly observable. We assume these earnings y_1 are uncertain and given by

$$y_1 = \eta + \epsilon, \tag{1}$$

where η denotes the quality of the market and ϵ a stochastic noise term. Nature chooses η from a normal distribution with mean $\bar{\eta} > 0$ and variance σ_η^2. The pre-entry earnings are also exposed to the stochastic component ϵ, which can be interpreted as the firm's aggregated transitory exposure. It is independently distributed from η and also drawn from a normal distribution with variance σ_ϵ^2. We set its mean to zero for convenience. ϵ may incorporate both market-wide uncertainty, such as fluctuations in commodity prices, as well as firm-specific uncertainty, such as effects of shorter or longer than average machine stoppages during production. The prior distributions over η and ϵ are common knowledge. Neither η nor ϵ are directly observed, and they are unknown to the entrant. Market quality η is persistent in both periods.[8]

The incumbent may engage in hedging transactions that allow for controlling the distribution of ϵ. Specifically, we adopt a variant of DeMarzo and Duffie's (1995) characterization of hedging activity by assuming that the variance of ϵ is linear in the level of hedging $h \in [0, 1]$ and given by $(1 - h)\sigma_\epsilon^2$. Thus, $h = 0$ if the incumbent does not engage in hedging, and $h = 1$ if the incumbent fully hedges. As a consequence,

[8] Using these distributional assumptions enhances the tractability of our results. The posterior will also be distributed normally, and parameters can be updated by simple rules well-known from the literature on "conjugate priors." As we will see below, although using the normal distribution is convenient for ease of exposition, non-positive profits are possible such that either attracting entry or exit from the industry may be optimal if exit barriers are absent. For the sake of technical convenience, we follow convention in the literature (e.g., Vives, 1984, Gal-Or, 1985, Darrough, 1993) and ignore this artificial possibility by assuming relatively small variance. Then, such an event becomes unlikely. In section 5.1.2, we formalize this assumption explicitly.

the resulting distribution of y_1 given the *prior estimate* of the market quality η is normal with mean $\bar{\eta}$ and variance $\sigma_y^2 := \sigma_\eta^2 + (1-h)\sigma_\epsilon^2$. We follow the literature (e.g., Froot, Scharfstein, and Stein, 1993) in assuming that hedging is costless and has no effect on the expected level of y_1. Recall that the incumbent may hedge in a number of ways. Corporate hedging is not limited to a risk transfer with marketable securities. Rather, operational activities or insurance contracts may also provide effective risk management to reduce the incumbent's exposure.

In the second period, earnings of both firms are given by

$$y_{i,2} = (1-\delta_i)\eta, \tag{2}$$

where $i \in \{I, R\}$ and $\delta_i \in (0,1)$ parameterizes the duopoly profit from post-entry competition if entry has occurred.[9] The case of the incumbent enjoying a monopoly position in the second period is normalized to $\delta_I = 0$ and $\delta_R = 1$.

Our formulation of pre- and post-entry earnings in (1) and (2) is worth exploring in more detail. First, profits are serially correlated. High first-period earnings of the incumbent therefore provide favorable news about second-period profitability. Second, earnings of both firms are positively correlated and move in the same direction given a change in the market quality η. Taken together, these characteristics capture the notion that high profits of an established firm lead potential entrants to believe their own future profits are likely to be high as well. This raises the probability of entry by other firms.[10] Hence, in our formulation, η can be interpreted as a permanent and common measure of market profitability that similarly affects firm performance across the industry – factors such as the size of the market, the responsiveness of demand to changes in product prices, the firms' access to distribution channels, product differentiation over substitute products, or bargaining power over customers.

[9] The parameter δ_i captures effects from duopoly competition that remain unspecified in our reduced-form model. These effects are well-known from the literature on industrial organization. First, if entry occurs, the entrant takes market share away from the incumbent. Second, entry intensifies price competition, as more firms imply lower prices. The magnitude of these effects may vary with the type of competition (quantity vs. price), the degree of product differentiation (homogeneous vs. heterogeneous), as well as demand and cost conditions. For reference, see Tirole (1986). Note that our results do not depend on particular parameter choices of δ_i.

[10] There is strong empirical support that high historical profits are positively related to market entry. We refer to surveys by Geroski (1995) and Siegfried and Evans (1994).

3.3 Information Structure

We make two informational assumptions.

First, although first-period earnings of the incumbent are publicly observable, the realization of the firm's aggregated exposure ϵ is not. In this regard, thinking of ϵ as an unspecified function of both the numerous risks to which a firm is exposed and the firm's sensitivity to changes in these risks is useful. As a consequence, even if the hedging choice of the incumbent were observable, the entrant could not distinguish whether profits are high due to favorable market conditions or due to positive realizations of ϵ.

Second, we assume that neither firm knows the quality of the market. Hence, the incumbent and the entrant share the prior distribution of the market quality while making their decisions. Therefore, our model is not a signaling model. In particular, the incumbent may not strategically exploit an informational advantage. Industries are frequently subject to random shocks that factors such as general economy, technological innovations, regulation, and so forth can cause. After such shocks, uncertainty about the quality of a market will likely remain similarly unresolved for both firms. Although we recognize that firms attempt to acquire information about the realization of these shocks and may also possess access to superior information, we abstract from these considerations in order to isolate the effects of hedging. Symmetric information about the quality of the market enables a clear-cut analysis without adding another effect from private information.

We summarize the sequence of actions and events in Figure 1.

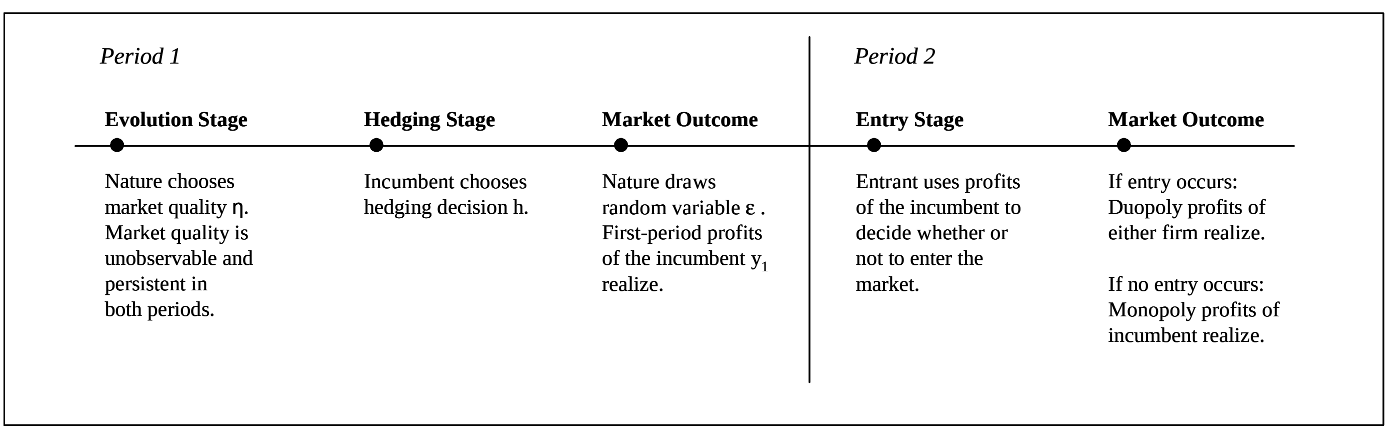

Figure 1: Sequence of actions and events

4 Analysis

In the next sections, we examine equilibrium strategies for two informational regimes: (i) a regime in which risk management activity is not observable; (ii) a regime with mandatory hedge disclosures with risk management activity being fully revealed.

4.1 Risk Management and Market Entry when Hedging Choice is Not Observable

If hedging activity of the incumbent is non-observable, the entrant may condition its belief about the quality of the market only on the observed profits of the incumbent and not on whether the incumbent hedges or not. Then, given the informational assumptions made above, even though the game has a sequential structure, we can solve it "as if" the two firms' choices were simultaneous. Each firm formulates and responds to a belief about what the other firm's actual choice is. As a consequence, to solve for equilibrium, we can proceed as follows. We begin with the analysis of entry conditional on a particular belief of the entrant about the incumbent's action. Conditional on this conjecture, we can solve for endogenous entry thresholds as a function of observed profits. Then, we investigate the incumbent's optimal hedging strategy and ask which strategy is preferred given a particular conjecture of the entrant. In equilibrium, the incumbent's optimal strategy and the entrant's conjecture converge.

4.1.1 Updating and Entry Strategies

Let market entry incur sunk costs to the entrant of K. The entrant chooses to enter if entry costs are less than expected post-entry profits. It appears reasonable to assume that the entrant's ex-ante perception of post-entry profitability relative to its costs of entry is too low to justify entry and

$$(1 - \delta_R)\bar{\eta} < K \, . \tag{3}$$

Thus, the entrant requires a positive piece of information from the first-period product market outcome in order to enter the market. Possibly the strongest argument to motivate (3) is that the entrant has decided to refrain from entering the market in period 1. In addition, even if structural changes such as technological advances or patent expirations put the entrant into a structurally more favorable position in period 2 than in period 1, the incumbent is likely to use its monopolistic position during period 1 to erect or strengthen entry barriers that raise the entrant's cost of entry K. Such additional costs may result, for example, from reputational effects and marketing advantages of incumbency (Bain, 1956) or from exclusive contracts between buyers and the incumbent seller (Aghion and Bolton, 1987).[11] Even though we believe the situation characterized by (3) is the typical one, market situations in which the opposite holds most likely exist.

However, at the end of period 1, new information arrives. The entrant observes the first-period profits y_1 of the incumbent. Since distributions of η and ϵ are common knowledge, the entrant can draw inferences from y_1. Concretely, conditional on the conjecture about the unobservable hedging choice of the incumbent h^*, the entrant updates prior beliefs about market quality η according to Bayes' rule. The mode of Bayesian learning considered here follows from the normality and independency of η and ϵ and is well known from, e.g., DeGroot (1970, p. 167) and Cyert and DeGroot (1974). Note that the posterior distribution of η is also normal.

Specifically, following the observation of y_1 and given a conjecture about the unobservable hedging choice of the incumbent, h^*, posterior mean and variance of η are

$$\bar{\eta}' = E(\eta \mid y_1, h^*) = \alpha y_1 + (1-\alpha)\bar{\eta} \tag{4}$$

and

$$\sigma_\eta^{2\prime} = \sigma_\eta^2(1-\alpha), \tag{5}$$

where

$$\alpha := \frac{\sigma_\eta^2}{\sigma_\eta^2 + (1-h^*)\sigma_\epsilon^2}\ . \tag{6}$$

Equations (4) to (6) have natural interpretations. First, from equation (4), the revised mean $\bar{\eta}'$ is a weighted average of the observed profit y_1 and the unconditional mean $\bar{\eta}$. Hence, observing a *higher-than-expected* first-period profit of the incumbent, $y_1 > \bar{\eta}$, lifts the prior mean upward since strong profits of the incumbent are more likely for a high η and vice versa. Second, from equations (5) and (6), $\sigma_\eta^{2\prime} < \sigma_\eta^2$: the entrant has a more precise (i.e., higher quality) estimate of the market than it had ex-ante. In the extreme case, when the incumbent fully hedges, $\sigma_\eta^{2\prime}$ equals zero. Third, posterior estimates put more weight on signal y_1 if α is large. In fact, α strictly increases in h and decreases in σ_ϵ^2. The intuition is straightforward. The more a firm hedges (a high h) and the lower the initial variance of the noise term σ_ϵ^2, the more informative realized profits are about the quality of the market relative to the initial estimate. Hence, the entrant attributes a strong

[11] The economics literature has proposed numerous and conflicting definitions of entry barriers (see Carlton, 2004 and Schmalensee, 2004). Our argument most closely follows the recent definition by McAfee, Mialon, and Williams (2004): a barrier to entry is a cost that a new entrant must and that incumbents do not or have not had to incur. For comprehensive treatments of barriers to entry, see also von Weizsäcker (1980) and Tirole (1988).

first-period result rather to favorable market quality than to good luck. The consequence is a significant revision of the prior.

Considering these results leads to the entrant's revised perception about post-entry profits and establishes the following entry rule. Given a conjecture h^* about the unobservable hedging choice of the incumbent, entry occurs if (and only if) expected post-entry profits exceed the cost of entry

$$(1-\delta_R)E(\eta \mid y_1, h^*) > K,$$

which, by using (4), implies entry if y_1 satisfies

$$y_1 > \beta + \gamma(1-h^*) =: y^*, \tag{7}$$

where

$$\beta := \frac{K}{1-\delta_R} \text{ and } \gamma := \frac{\sigma_\epsilon^2}{\sigma_\eta^2}\left(\frac{K}{1-\delta_R} - \bar{\eta}\right).$$

The threshold value y^* denotes the first-period profit of the incumbent above which the entrant chooses to enter the market.

A number of interesting properties are associated with the entry threshold y^*. These characteristics obviously are corollaries of the properties of conditions (4) to (6). Using (3) implies $\gamma > 0$; hence, $y^* > \bar{\eta}$. In addition, more hedging strictly decreases y^*. The reason is straightforward. If the incumbent engages in more hedging activities, first-period profits become less noisy and reveal more about the true value of η and hence the expected post-entry profitability of the entrant. As a result, realized profits must rise less sharply above the prior mean to trigger entry. In contrast, increases in entry costs K and increases in (the intensity of competition) δ_R negatively affect post-entry profitability of the entrant, which in turn raises y^*. The opposite is true for the prior mean $\bar{\eta}$.

4.1.2 Hedging Strategies and Equilibrium

We are now ready to analyze equilibrium strategies using the findings of the previous section. In equilibrium, the firms' expectations about each other's strategies are consistent, and each firm is choosing a best response to what it believes the other firm will do. Constructing an equilibrium of the game between the incumbent and the entrant hence involves several steps. We start from a postulate on the entrant's conjecture about the incumbent's hedging strategy h^*, which implies an entry threshold value y^* computed from the updating rules derived above. Then, we solve for the incumbent's best response to this particular conjecture and finally derive the conditions under which h^* is indeed the optimal strategy for the incumbent.

The incumbent chooses h^* to maximize the expected profits given its belief on what the entrant is likely to think about the incumbent's strategy. Although the choice of the incumbent may influence the entrant's learning through the information content of first-period profits y_1, hedging does not alter its expected value $E(y_1)$. Therefore, to solve for an equilibrium, considering the incumbent's expected second-period profits is sufficient. We need not explicitly account for first-period profits in the incumbent's maximization.

Suppose the entrant anticipates a hedging strategy h^* by the incumbent. Let this conjecture by (7) imply an entry threshold y^*. What is optimal for the incumbent given this conjecture? Recall that the entrant's entry decision depends on the realization of first-period profits y_1 relative to the entry threshold y^*. If $y_1 > y^*$ entry occurs and the incumbent receives $(1-\delta_I)E(\eta \mid y_1, h)$; otherwise, the entrant chooses to not enter and the incumbent remains monopolist with monopoly profit $E(\eta \mid y_1, h)$. Note that the expression $E(\eta \mid y_1, h)$ is the expected market quality conditional on the realization of first-period profits y_1 and given the actual hedging strategy h.[12] Since $E(\eta \mid y_1, h)$ is a function of the random variable y_1, it is itself a normally distributed random variable. Let $f(y_1 \mid h)$ denote the density of y_1 given hedging choice h. Then, the incumbent's expected second-period earnings Π – from an *ex-ante* perspective – are

$$\begin{aligned}\Pi: &= \int_{-\infty}^{y^*} E(\eta \mid y_1, h) f(y_1 \mid h) dy_1 + (1-\delta_I)\int_{y^*}^{+\infty} E(\eta \mid y_1, h) f(y_1 \mid h) dy_1 \quad (8)\\ &= (1-\delta_I)\bar{\eta} + \underbrace{\delta_I \int_{-\infty}^{y^*} E(\eta \mid y_1, h) f(y_1 \mid h) dy_1}_{=:\text{Monopoly Rent } V}, \quad (9)\end{aligned}$$

where the first expression in (8) represents the *expected profit from duopoly* and the second gives the *expected rent from remaining monopolist*. We denote this rent by V ("*Value of Incumbency*") in the following. Note that the integral may be interpreted as the first moment of the normal variable $E(\eta \mid y_1, h)$ that is censored on the interval $y_1 \in (y^*, +\infty)$.

Since the expected duopoly profit, $(1-\delta_I)\bar{\eta}$, is independent of the hedging choice h, restricting attention to the incumbent's expected monopoly rent V in the following is convenient. V can be written as

$$\begin{aligned}V: &= \delta_I\left(\alpha\left[\bar{\eta}F(y^* \mid h) - \sigma_y^2 f(y^* \mid h)\right] + (1-\alpha)\bar{\eta}F(y^* \mid h)\right)\\ &= \delta_I\left[\bar{\eta}F(y^* \mid h) - \sigma_\eta^2 f(y^* \mid h)\right]\\ &= F(y^* \mid h)\underbrace{\delta_I\left(\bar{\eta} - \sigma_\eta^2 \frac{f(y^* \mid h)}{F(y^* \mid h)}\right)}_{=\delta_I E(E(\eta|y_1,h)|y_1 \le y^*)}, \quad (10)\end{aligned}$$

[12] Recall that realized profits y_1 are only an imprecise signal of second-period earnings (induced by η) as long as $h \neq 1$.

where $F(\cdot)$ is the cumulative distribution of y_1. Note that the first line follows from using (4) as well as well-known results concerning censored normal distributions. The second line follows from substituting α from condition (6). We find the third line particularly useful for the subsequent analysis. It captures the basic relationship between means of *truncated* and *censored* normal distributions.[13] Note that $F(y^* \mid h)$ denotes the probability that the incumbent remains monopolist since first-period profits have realized below the entry threshold y^*.

Equation (10) has an intuitive interpretation. The monopoly rent V equals to the probability of the incumbent remaining monopolist, $F(y^* \mid h)$, multiplied by the expected rent conditional on the incumbent remaining monopolist, $\delta_I E(E(\eta \mid y_1, h) \mid y_1 \leq y^*)$.[14] Thus, in choosing the optimal hedging strategy h^* to maximize the monopoly rent V, the incumbent solves

$$\max_{h\in[0,1]} F(y^* \mid h)\delta_I \left(\bar{\eta} - \sigma_\eta^2 \frac{f(y^* \mid h)}{F(y^* \mid h)}\right). \tag{11}$$

The solution to (11) characterizes the set of strategies that is individually optimal for the incumbent, given a conjecture that implies an entry threshold of y^*. Then, by assuming a positive monopoly rent V with

$$\bar{\eta} > \sigma_\eta, \tag{12}$$

the optimal hedging choice of the incumbent can be summarized as follows.[15]

Lemma 1 *Given any conjecture about the entry threshold y^*, the monopoly rent V has no local maximum*[16] *on $h \in [0,1]$. Its maximum h^* is attained on the boundaries of $h \in [0,1]$. A unique cutoff $\hat{y} \in (A, B)$*

[13] Suppose a normally distributed random variable x truncated at $x = a$. Then, its mean yields $E(x \mid x \leq a) = \int_{-\infty}^{a} xf(x \mid x \leq a)dx = \frac{E(x^*)}{Prob(x \leq a)} = \frac{E(x^*)}{F(a)}$, where $f(x \mid x \leq a) = \frac{f(x)}{Prob(x \leq a)}$ and $E(x^*)$ denotes the mean of the censored normal variable x^*. The intuition is that in recognizing the truncation, the conditional density is scaled in such a way that it integrates to one on the interval below a. The properties of truncated normal distributions have been studied extensively in Johnson, Kotz, and Balakrishnan (1995).

[14] Note that the first expectation is with respect to first-period profit y_1 and the second expectation with respect to market quality η.

[15] This assumption corresponds to the hitherto implicit assumption on the distribution of η that we elaborated in footnote 9. Section A.2 of the appendix contains a formal treatment. It is important to note that the admissible range of parameters to ensure $V > 0$ cannot be pinned down analytically, as only estimates for $\bar{\eta} - \sigma_\eta^2 \frac{f(y^*|h)}{F(y^*|h)} > 0$ exist (see the literature on the *Mill's Ratio*, $\frac{1-F(y^*|h)}{f(y^*|h)}$; e.g., Patel and Read, 1996, and DasGupta, 2008). The parameter restriction is made for reasons of tractability and does not qualitatively affect any of our results.

[16] A *global* extreme point that is not an *interior point* of the domain of V is not considered a *local* extreme point.

exists such that

$$h^* = 1 \qquad \textit{for} \quad y^* > \hat{y},$$
$$h^* = 0 \qquad \textit{for} \quad y^* < \hat{y}, \textit{ and}$$
$$h^* \in [0,1] \quad \textit{for} \quad y^* = \hat{y},$$

where

$$A := \frac{1}{2}\left(\bar{\eta} + \sqrt{\bar{\eta}^2 + 4\sigma_\eta^2}\right) \textit{ and } B := \frac{\bar{\eta}(\sigma_\eta^2 - \sigma_\epsilon^2)}{2\sigma_\eta^2} + \frac{1}{2}\sqrt{\frac{(\sigma_\eta^2 + \sigma_\epsilon^2)(4\sigma_\eta^2 + \bar{\eta}^2(\sigma_\eta^2 + \sigma_\epsilon^2))}{\sigma_\eta^4}}.$$

Proof. See appendix. ■

The important insight of *Lemma 1* is that the incumbent either chooses to fully hedge ($h^* = 1$) or chooses to leave its exposure completely open ($h^* = 0$). For example, if the incumbent believes the entrant has an entry threshold higher than $\hat{y}$, the best response is $h^* = 1$. The cutoff $\hat{y}$ denotes the value of y^* for which the incumbent is indifferent between *hedging* with $h^* = 1$ and *no hedging* with $h^* = 0$.[17] To capture the intuition for this result, it is helpful to explore the effects of a marginal change in h on the monopoly rent V in more detail.

Following the decomposition proposed in (10), the total change in V with respect to h

$$\frac{\partial V}{\partial h} = \underbrace{\frac{\partial F(y^* \mid h)}{\partial h}\delta_I\left(\bar{\eta} - \sigma_\eta^2 \frac{f(y^* \mid h)}{F(y^* \mid h)}\right)}_{\text{(a) ``Probability Effect'' (+)}} + \underbrace{F(y^* \mid h) \times \frac{\partial}{\partial h}\delta_I\left(\bar{\eta} - \sigma_\eta^2 \frac{f(y^* \mid h)}{F(y^* \mid h)}\right)}_{\text{(b) ``Value Effect'' (+/-)}} \tag{13}$$

can be decomposed into two very intuitive effects:[18] We find that (13) is simply the sum of (a) the marginal change in the probability of remaining monopolist weighted by the *conditional* monopoly rent if y_1 is *not* exceeding y^* ("Probability Effect") and (b) the marginal change in this conditional monopoly rent weighted by the probability of remaining monopolist ("Value Effect").

(a) "Probability Effect": A higher level of hedging lowers the dispersion of the incumbent's realized first-period profit y_1. As a consequence, hedging shifts probability mass below the entry threshold y^*, which due to assumption (3) is larger than the ex ante expected market profitability $\bar{\eta}$, and makes outliers to the right tail of the distribution less likely. It simply affects the probability that the observation will fall in the part of the distribution that induces the entrant to stay out of the market. Thus, the "Probability Effect" provides an incentive for the incumbent to fully hedge its transitory exposure. Figure 2 gives an intuitive graphical representation of this effect.

[17] Note that no closed-form solution for $\hat{y}$ exists. We show uniqueness and existence of $\hat{y}$ in the appendix.

[18] The reformulation has some similarity to the Tobit decomposition introduced by McDonald and Moffitt (1980).

(b) "Value Effect": The incumbent's conditional monopoly rent depends on the distribution of states of market quality η for which, based on a given entry threshold y^*, entry does not occur. For example, if the incumbent fully hedges, entry does not take place only if the realized η is indeed below y^*. If the incumbent does not hedge its entire transitory exposure, the entrant may refrain from entering with certain probability even if η is large. Such "errors" by the entrant may turn out to be profitable (but also detrimental) for the incumbent as entry decreases the incumbent's profits proportionally to market quality. So while the "Probability Effect" suggests the incumbent has clear incentives to hedge, the "Value Effect" is ambiguous. In particular, it is positive or outweighed by the "Probability Effect" if the entry threshold y^* is sufficiently large.

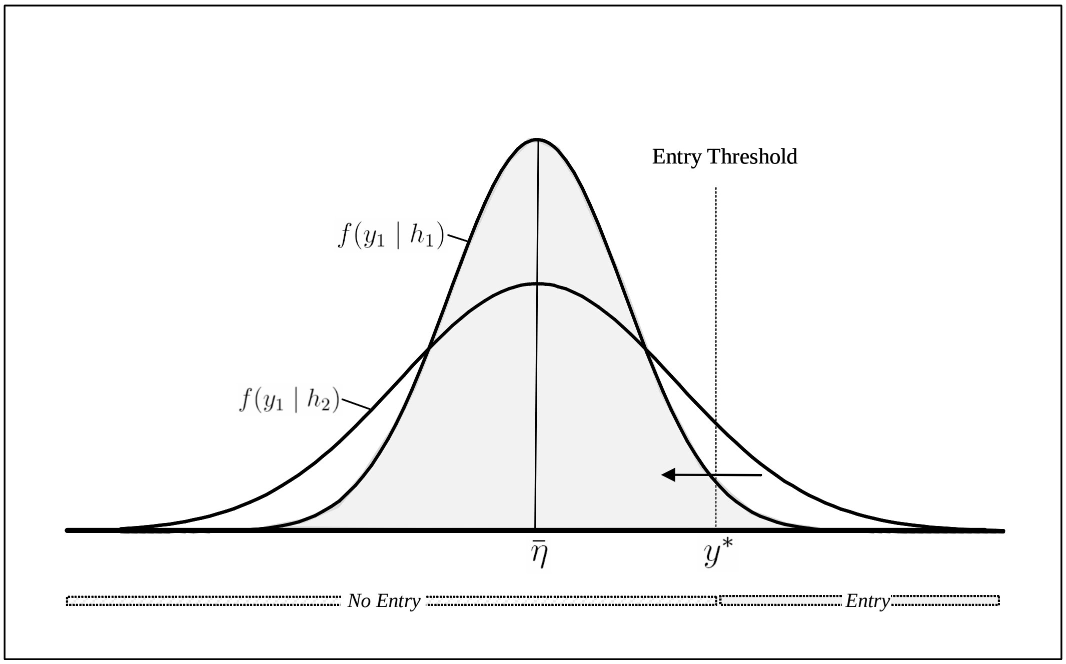

Figure 2: "Probability Effect" for strategies h_1 and h_2, where $h_1 > h_2$.

We are now ready to construct the equilibrium in our model, which the following proposition summarizes. Recall that (7) gives the entrant's best response curve to an arbitrary conjecture h^*, and *Lemma 1* gives the incumbent's best response to an arbitrary conjecture y^*. The unique intersection of the best response curves – as depicted in Figure 3 – pins down the pure-strategy equilibrium. Then, the best response of either firm is consistent with the other firm's belief. For ease of notation, let y^* and h^* denote the equilibrium strategies in the following.

Proposition 1 *In a non-disclosure regime with unobservable risk management activity, a unique equilibrium* *exists. Depending on parameter values, the equilibrium strategy of the incumbent is either:*

(a) full hedging ($h^* = 1$) *with an entry threshold of* $y^* = \frac{K}{1-\delta_R}$, *whenever* $\frac{K}{1-\delta_R} > \hat{y}$;

(b) no hedging ($h^* = 0$) *with an entry threshold of* $y^* = \frac{K}{1-\delta_R} + \frac{\sigma_\epsilon^2}{\sigma_\eta^2}\left(\frac{K}{1-\delta_R} - \bar{\eta}\right)$, *whenever* $\frac{K}{1-\delta_R} + \frac{\sigma_\epsilon^2}{\sigma_\eta^2}\left(\frac{K}{1-\delta_R} - \bar{\eta}\right) < \hat{y}$; *or*

(c) a mixed strategy between $h^* = 1$ *(with probability* p^**) and* $h^* = 0$ *(with probability* $1 - p^*$*) with an entry threshold of* $y^* = \hat{y}$, *otherwise.*

Proof. See appendix. ■

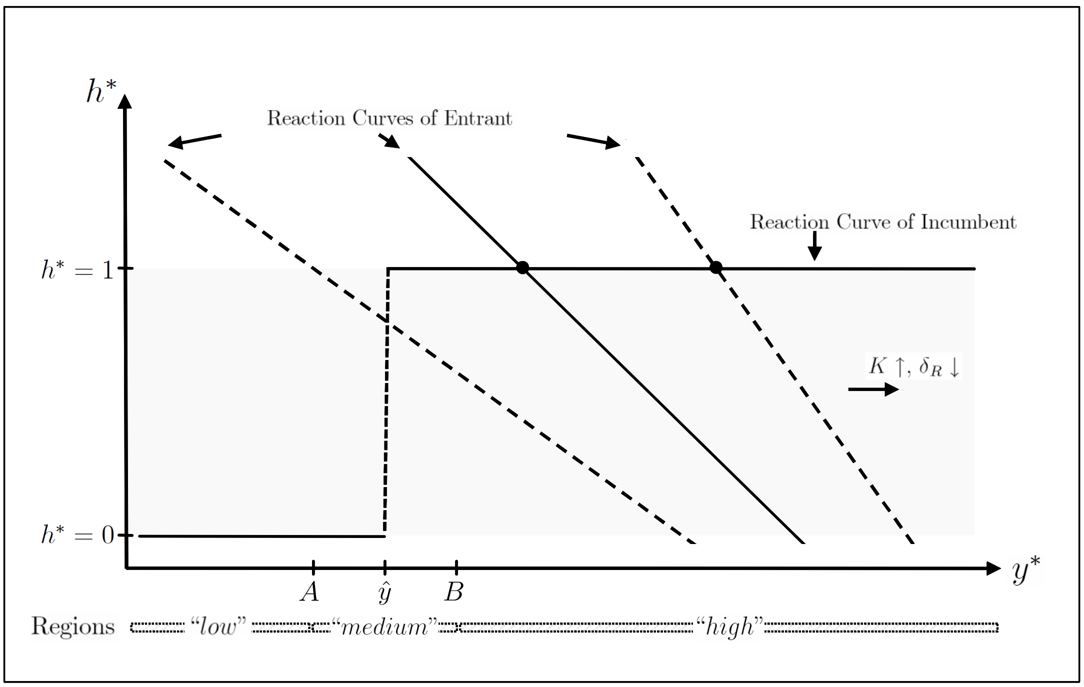

Figure 3: A graphical representation of the reaction curves of incumbent and entrant.

Proposition 1 demonstrates that three cases exist. In the first and most interesting case, when parameters are such that the equilibrium entry threshold is above the cutoff $\hat{y}$, engaging in risk management activities is optimal for the incumbent. The threat of entry creates strong forces to reduce risk – even if firms are risk-neutral.[19] In the second case, when the equilibrium entry threshold y^* is below the cutoff $\hat{y}$, the incumbent

[19] In this regard, the model also offers an explanation for why risk-neutral firms may wish to engage in risk management activities in the absence of financial market imperfections.

does not have an incentive to reduce its temporary risk exposure. Although risk management still would increase the chances that the entrant stayed out of the market, the incumbent would suffer disproportionately from a decrease in the value of incumbency conditional on remaining monopolist. In the third case, a mixed strategy equilibrium occurs. The incumbent is indifferent and hence randomizes between *hedging* and *no hedging*. The entrant remains uncertain about the risk management strategy of the incumbent.

4.1.3 A Numerical Example

We illustrate Proposition 1 with a numerical example for three straightforward settings. Table 1 presents equilibria for various entry cost K with all other parameters held fixed. Each column shows, for a particular entry cost K, the equilibrium strategies (h^*, y^*), the *expected* second-period profits of incumbent and entrant (Π_I^*, Π_R^*), and the entry probability (q^*). The examples involve a market quality η that is drawn from a normal distribution with mean $\bar{\eta} = 50$ and standard deviation $\sigma_\eta = 20$. The incumbent's exposure ϵ is drawn from a normal distribution with mean zero and standard deviation $\sigma_\epsilon = 10$. The effects of competition are captured by $\delta_I = \delta_E = 0.6$, which implies (as in the standard Cournot situation) total profits in a duopoly are lower than in a monopoly. Given these parameter values, it is easily verified that the interval [57.02, 57.18] contains the discrete jump of the incumbent's best reaction function $h(y^*)$ at $\hat{y}$ as shown in Figure 3.

Recall that $\hat{y}$ cannot be solved for analytically. Nevertheless, a numerical solution, which is $\hat{y} = 57.096$, can be obtained. Then, it is straightforward to show that if $K \leq 22.27$, the incumbent does not hedge $(h^* = 0)$, whereas if $K \geq 22.84$, the incumbent engages in risk management $(h^* = 1)$.[20] Otherwise, the incumbent chooses a mixed strategy $p^* \in (0, 1)$. Therefore, each of the three entry cost levels in Table 1, namely $K = 21.9$, $K = 22.6$, and $K = 23.2$, corresponds to one of the three different regions described above. Notice also that the expected second-period profits of the incumbent Π_I^* strictly increase in K, whereas the expected second-period profits of the entrant Π_R^* and the entry probability q^* strictly decrease in K.

Parameters	$\bar{\eta} = 50$, $\sigma_\eta = 20$, $\sigma_\epsilon = 10$, $\delta_I = 0.6$, $\delta_R = 0.6$		
	Region "low"	Region "medium"	Region "high"
Entry cost	$K = 21.9$	$K = 22.6$	$K = 23.2$
Equilibrium results	$h^* = 0$	$p^* = 0.5$	$h^* = 1$
	$y^* = 56$	$y^* = \hat{y} = 57.096$	$y^* = 58$
	$\Pi_I^* = 34.0$	$\Pi_I^* = 34.6$	$\Pi_I^* = 35.2$
	$\Pi_R^* = 2.0$	$\Pi_R^* = 1.91$	$\Pi_R^* = 1.8$
	$q^* = 0.394$	$q^* = 0.368$	$q^* = 0.345$

Table 1: A numerical example illustrating the effect of an increasing entry cost K.

[20] These bounds for K can be easily derived by solving for K in the two cases in which the reaction curve of the entrant crosses either $(\hat{y}, 0)$ or $(\hat{y}, 1)$.

4.2 Risk Management and Market Entry when Hedging Choice is Observable

In this section, we consider the case in which the entrant observes h. This case corresponds to a regime with additional disclosures on a firm's risk management activities. We explore the economic consequences of such requirements on the equilibrium hedging behavior of firms given the competitive threat of market entry.

In contrast to the earlier situation in which h was not observable and therefore the entrant was unaware of the risk management choice previously made by the incumbent, the incumbent now must disclose its level of hedging. Risk management activities are perfectly revealed. The important implication is that both situations differ in their timing. In the earlier analysis, the entrant reacts to a conjecture about the hedge decision of the incumbent and both firms act "as if" they moved simultaneously. Now the firms decide truly sequentially. As we will see below, the incumbent's hedge decision therefore has an additional informational and strategic effect on the entrant's entry threshold.

Solving for (subgame perfect) equilibrium is straightforward. The incumbent must anticipate the optimal reaction of the entrant to both, the *hedging strategy* h of the incumbent and the observed *first-period profit* y_1. Entry takes place if (and only if) expected post-entry profits exceed the cost of entry

$$(1-\delta_R)E(\eta \mid y_1, h) > K,$$

which by using (4) implies entry, if y_1 exceeds the threshold value

$$y^*(h) := \beta + \gamma(1-h), \tag{14}$$

where

$$\beta := \frac{K}{1-\delta_R} \text{ and } \gamma := \frac{\sigma_\epsilon^2}{\sigma_\eta^2}\left(\frac{K}{1-\delta_R} - \bar{\eta}\right).$$

A similar condition for market entry appeared in the analysis of the non-disclosure regime in section 5.1 (recall the entrant's optimal entry decision from equation (7)). However, observe that in the regime we consider here, the threshold value $y^*(h)$ is truly the entrant's reaction to the *observed* hedging strategy h (and hence a function of h), whereas in the earlier analysis, y^* is the entrant's response to an *unobserved, conjectured, and fixed* hedging choice. To put it differently, $y^*(h)$ gives an entry schedule specifying the entrant's optimal choice for each *observed* action of the incumbent, h, and each first-period profit realization, y_1. Since the incumbent can solve for the entrant's optimal choice as easily as the entrant can, the incumbent anticipates that its hedge decision h will be met with the reaction $y^*(h)$.

As a consequence, the incumbent's maximization over the monopoly rent V as characterized in (8) to (11) now yields

$$\max_{h\in[0,1]} \underbrace{\delta_I \int_{-\infty}^{y^*(h)} E(\eta \mid y_1, h) f(y^*(h), h) dy_1}_{=:\text{Monopoly Rent } V} . \tag{15}$$

This maximization problem is similar to the one analyzed in section 5.1.2. The difference is that the incumbent may now elect a point on the entrant's reaction function $y^*(h)$ that maximizes its own expected profits.

Before proceeding with the analysis of equilibrium, we state our central result.

Proposition 2 *In a mandatory hedge disclosure regime with observable risk management activity, a unique (subgame perfect) equilibrium exists. In this equilibrium, the incumbent does not hedge ($h^* = 0$). The threshold value $y^*(h^*)$ above which the entrant chooses to enter the market in equilibrium is given by $y^*(h^* = 0) = \frac{K}{1-\delta_R} + \frac{\sigma_\epsilon^2}{\sigma_\eta^2}\left(\frac{K}{1-\delta_R} - \bar{\eta}\right)$.*

Proof. See appendix. ■

The proposition states that a mandatory hedge disclosure regime may drive firms to decrease risk management activities. The reason is subtle and combines two notions. First, recall that hedging eliminates noise from the incumbent's profits, thereby increasing the informativeness of first-period profits about market quality. Second, if hedging choices are disclosed, the entrant conditions its posterior belief about the market quality on one additional and credible signal (besides the first-period profit y_1), namely, the hedge decision h. Therefore, in contrast to the previous case of non-observability, risk management now has a *direct influence* on the entry threshold above which the entrant chooses to enter the market. Mandatory hedge disclosure gives rise to a strategic benefit to the incumbent of not engaging in risk management activities.

To see the intuition, differentiate (14) – the upper limit of the integration in (15) – with respect to h. Using (3) implies $\gamma > 0$; hence, *more hedging* strictly *decreases* $y^*(h)$. If the incumbent engages in more hedging activities, first-period profits are less noisy, reveal more about the true quality of the market η, and allow the entrant to better infer from first-period profits. In contrast, if the incumbent does not hedge at all, realized profits y_1 are a less precise signal of η, which results in an upward shift of the entry threshold $y^*(h)$. This upward shift in the entry threshold (induced by the strategic influence of the observable hedge decision on the entrant's behavior) is clearly beneficial to the incumbent and is in fact the dominating effect in Proposition 2.[21] Note that the result in Proposition 2 does not depend on the values of δ_I or δ_R. This implies that the result holds even if post-entry profits in the disclosure regime are different from those in case of non-disclosure.[22]

Therefore, the implication of Proposition 2 is that in a mandatory disclosure regime, hedging is not in the incumbent's interest, as hedging leads to an entrant making a more precise competitive move. In fact, the result establishes that the incumbent has an incentive to garble the information conveyed through the first-period profit y_1 and that mandatory disclosure encourages excessive risk-taking. The natural incentives to engage in hedging activity under many circumstances as Proposition 1 posits are destroyed.

Corollary 1 *Under the parameter values of Proposition 1a, the volatility of the incumbent's first-period profit is strictly higher in a mandatory hedge disclosure regime than in a non-disclosure regime. Also, the informativeness of profits about a firm's intrinsic value in a mandatory hedge disclosure regime is strictly lower than the informativeness of profits in a non-disclosure regime.*

Proof. The variance of first-period profits is given by $\sigma_\eta^2 + \sigma_\epsilon^2$ (mandatory hedge disclosure regime) and σ_η^2 (non-disclosure regime). Comparing the "signal-to-noise ratios" yields $\frac{\sigma_\eta^2}{\sigma_\eta^2+\sigma_\epsilon^2} < \frac{\sigma_\eta^2}{\sigma_\eta^2} = 1$. This establishes the corollary. ■

Two implications immediately emerge from the corollary. First, profits in a mandatory disclosure regime are more volatile as firms' risk management activities go down. As a result, we should observe a higher variability in firms' profits following a regulatory act, even though the variability of the underlying fundamentals (here: η) is kept constant. Second, profits are less informative about a firm's *intrinsic value/quality*, thereby increasing informational asymmetries between firms and outside stakeholders. As a consequence, earnings become less useful as indicators for a firm's intrinsic value not only for competitors but also for other uninformed parties, in particular, outside investors. The reason is that less risk management implies a lower signal-to-noise ratio due to more total variance in profits from noise. Interestingly, our model suggests that a mandatory disclosure regime, which is a regulator's attempt for greater transparency, is associated with a higher magnitude of informational asymmetries and less "real transparency" about a firm's current condition.

[21] By comparing the upper limits of the integration in (8) and (15), it is easy to see that this strategic effect of hedging does not exist in the earlier analysis of unobservable hedging.

[22] Hughes and Williams (2008) argue that commitments tend to have pro-competitive effects in oligopolies, leading to lower industry profits.

Corollary 2 *Under the parameter values of Proposition 1a, the probability of entry in a mandatory hedge disclosure regime is strictly lower than the probability of entry in a non-disclosure regime.*

Proof. See appendix. ■

Corollary 2 implies that the mandatory disclosure regime may negatively affect industry structure. The increase of uncertainty about the quality of the market raises barriers to entry. Therefore, disclosure fosters more concentrated industry structures and inhibits competition. This externality of disclosure policy would most likely be undesirable from a social and economic point of view for most industries as the lower probability of entry reduces social surplus in any typical concretization of our reduced-form market representation. This finding is different from Hwang and Kirby (2000) where disclosure requirements do not affect entry rates and welfare effects arise exclusively after entry.

5 Conclusion

This paper analyzes the interaction between hedge disclosures, corporate risk management, and pre-entry product-market competition. We demonstrate that the disclosure requirements of a firm's risk position substantially affect equilibrium hedging strategies. If risk management is observable, even risk-neutral firms typically have strong incentives to engage in risk management activities in order to reduce the likelihood of entry. In this regard, we provide a novel explanation for why firms may wish to engage in risk management. The model also demonstrates that under additional disclosure requirements, hedging may not be an equilibrium strategy if firms face the threat of entry in their product markets. Hence, our findings shed light on the desirability of more transparent accounting standards and suggest that more disclosure on risk management may change risk management incentives of firms in undesirable ways. While our model focuses on the negative effect of hedge disclosure requirements and the resulting excessive risk-taking on entry rates, there are potentially significant "side-effects" of leaving exposure unhedged. These include slower learning about management quality (DeMarzo and Duffie, 1995) and investment distortions due to variable cash flows (Froot, Scharfstein and Stein, 1993) and may further reduce the desirability of additional hedge disclosure requirements.

A Appendix

A.1 Institutional Background

In the main body of the paper, we look at unintended economic consequences when standard setters move toward *additional* disclosures, but we do not take a position on whether existing standards yet imply observability of a firm's risk-management activities. Given the significant attempts for more expanded disclosure on financial instruments in the late 90s, the answer to this question is not clear-cut. Practitioners are aware that financial statements generally do not. The risk management literature (see the review in Section 2) typically works under the non-observability assumption. Examining the institutional environment in more detail might therefore be worthwhile. We argue that current accounting regimes help to discipline less sophisticated users of financial derivatives, but they at best give an indication of the effectiveness of a firm's risk management activities.[23]

In June 1998, the Financial Accounting Standards Board (FASB) issued SFAS No. 133 (1998), entitled *Accounting for Derivative Instruments and Hedging Activities,* a detailed and complex set of accounting and disclosure requirements. According to those accounting rules – meanwhile amended mainly by SFAS No. 138 (2000), SFAS No. 149 (2003), SFAS No. 155 (2006) – accounting treatment generally requires derivatives to be "marked-to-market" on the balance sheet with changes in fair value recorded in net income. Under prior accounting standards, derivatives were either netted against the hedged item or not recognized in the balance sheet at all. The standard, however, permits special accounting treatment – "hedge accounting" – if firms meet a set of requirements regarding hedge effectiveness and documentation. Roughly speaking, if a transaction qualifies for this treatment, gains and losses of financial instrument and hedged item are recognized in net income in the same period: "Fair value hedge accounting" expands fair value accounting to the hedged item. "Cash flow hedge accounting" allows firms to recognize changes in the fair value of derivatives in "other comprehensive income (owner's equity)" on the balance sheet until the hedged transaction affects earnings. "Hedge accounting for net investments in a foreign operation" does not allow to account for gains or losses in net income; rather, firms must recognize changes directly in "other comprehensive income."

There is a *second* accounting standard that addresses financial instruments. In January 1997, the Securities and Exchange Commission (SEC) issued a new standard for the disclosure of market risk inherent in financial

[23] This section owes much to Ryan (2007) and several publications of the CFA Institute, most notably Gastineau, Smith, and Todd (2001).

instruments: *Disclosure of accounting policies for derivative financial instruments and derivative commodity instruments and disclosure of quantitative and qualitative information about market risk inherent in derivative financial instruments, other financial instruments and derivative commodity instruments (FRR No. 48).* FRR No. 48 sought to address the SEC's concern that risk of financial instruments was neither understood well enough by firms' top management nor presented in financial reports transparently and completely. The new rule requires public companies to report *forward-looking* numerical measures of their market risk exposures (i.e., to changes in interest rates, exchange rates, commodity prices, equity prices) *related to financial instruments and derivatives.* Firms may choose from three alternative methods to disclose these risk categories: the tabular approach, the value-at-risk approach, and the sensitivity approach.

In this paper, we posit that despite SFAS No. 133 and FRR No. 48 risk management activities of firms are at best imperfectly observable. A number of reasons motivate this postulate – some of them result from current accounting standards and some from the nature of risk management per se: First, under SFAS No. 133, gains and losses of financial instruments, although accounted for in earnings, are in large parts invisible. Firms generally are not required to disclose their location on the income statement; indeed, they can and do classify them in any of several line items – in cost of goods sold, SG&A expenses, or directly in earnings. Unless a firm chooses to disclose this information, disentangling the effects of financial instruments is impossible.[24] More importantly, even if a firm does so, each accounting alternative ("marked-to-market," "cash flow hedge accounting," and so forth) produces substantially different interim statements. Their informativeness as well as market participants' ability to use these in order to understand risk management activity is unclear.[25] In fact, the FASB is currently evaluating whether current accounting standards add more confusion rather

[24] Another major concern is the mixing of *realized* and *realizable* results that cannot be distinguished properly. As a FASB member in the Energy Trading Working Group phrases it in a comment letter, "It is very difficult even for sophisticated investors to extract this information by carefully comparing and contrasting the statement of operations, the balance sheet and the statement of cash flows. In fact, for many individual investors, and for most practical purposes, it is impossible" (Goodman, 2005).

[25] The information content of hedge disclosures and the ability of market participants to understand these has received little attention in finance and accounting research. Notable exceptions are Gigler, Kanodia, and Venugopalan (2007), who study the information content of "cash flow hedge accounting" in terms of providing an early warning of financial distress. As they put it, "In its application, mark-to-market accounting sometimes results in a mixed-attribute-model, whereby some items are marked-to-market while others are carried at historical cost. While...academics have...noted this less than perfect application, they tend...to abstract away from the issue." In a more recent study, Campbell (2009) examines the information content of unrealized cash flow hedge positions about future cash flow levels and investigates how capital markets incorporate this information into their valuation of the firm.

than more transparency (FASB, 2008 and FASB, 2010).[26]

Second, the usefulness of the disclosures made under FRR No. 48 is limited, mostly due to the wide discretion over how firms may report and measure risk as well as the resulting inconsistency of methods and reporting periods. Similar to the case of SFAS No. 133, each reporting alternative has its own information content in terms of level of aggregation, time horizons over which risk is measured, and indication of nonlinear exposures and covariances. This issue is even amplified as firms may not need to consistently choose the same method across different types of risk. Firms may also define the dimension of "risk" in terms of value, earnings, or cash flows. Despite the obvious interconnections, these alternative measures are not identical and are likely to be inconsistent. Clearly, this reasoning might not be applicable to all types of risk management activities or all types of firms. However, taken together, these arguments (among many others) certainly imply that current disclosure standards at least render the assessment of risk management activities by outsiders extremely difficult.

Third, and most importantly, SFAS No. 133 and FRR No. 48 apply to risk management with financial instruments only. In practice, however, corporate hedging is not limited to a risk transfer with marketable securities. For instance, purchase of insurance or contractual agreements with suppliers to lock-in prices can also provide effective risk management. Many of these alternative instruments are off-balance and, by nature, not observable by third parties; just like actions often referred to as "natural hedges" that are at best imperfectly observable. Examples are the choice of plant locations to have costs and revenues in the same currency or strong market power to pass on cost shocks to customers (Gaspar and Massa, 2006).[27] Finally, observability of risk management activity might be hardly justifiable in the case of non-public firms.

[26]In June 2008, the FASB released proposed amendments to SFAS No. 133 with the intent to "simplify accounting for hedging activities; improve the financial reporting of hedging activities to make the accounting model and associated disclosures more useful and easier to understand for users of financial statements; ...and address differences resulting from recognition and measurement anomalies between the accounting for derivative instruments and the accounting for hedged items" (FASB, 2008).

[27]For example, recent empirical evidence by Bodnar, Giambona, Graham, Harvey, and Marston (2011) (et. al.) suggests that operational risk management is considerably more important than risk management through financial contracts for all classes of risk except for FX risk. See also Servaes, Tamayo, and Tufano, 2009 for similar findings. We refer to Smith (1995) for a comprehensive overview on financial and non-financial risk management instruments.

A.2 Proof of Lemma 1

The proof involves several steps. The procedure in the proof is (i) to show V has no local maximum (the first part of the lemma) and (ii) to determine the behavior of $\frac{\partial V(h)}{\partial h}$ on $h \in [0,1]$ for all admissible parameter values. The second step is the main difficulty. The proof involves three lemmas:

1. **Lemma 2:** *The monopoly rent V has no* ***local maximum*** *on $h \in [0,1]$. A unique* ***local minimum*** *$h^0 \in (0,1)$ exists if and only if $A < y^* < B$, where*

$$B := \frac{\bar{\eta}(\sigma_\eta^2 - \sigma_\epsilon^2)}{2\sigma_\eta^2} + \frac{1}{2}\sqrt{\frac{(\sigma_\eta^2 + \sigma_\epsilon^2)(4\sigma_\eta^2 + \bar{\eta}^2(\sigma_\eta^2 + \sigma_\epsilon^2))}{\sigma_\eta^4}}$$

   and

$$A := \frac{1}{2}(\bar{\eta} + \sqrt{\bar{\eta}^2 + 4\sigma_\eta^2}).$$

2. **Lemma 3:** *On $h \in [0,1]$, if $y^* \geq B$, the monopoly rent V has a* ***global maximum****, which is $h^* = 1$,* whereas *if $y^* \leq A$, the* ***global maximum*** *is $h^* = 0$.*
3. **Lemma 4:** *On $h \in [0,1]$, if $A < y^* < B$, a unique cutoff $\hat{y}$* exists *such that if $y^* > \hat{y}$ then $h^* = 1$, whereas if $y^* < \hat{y}$ then $h^* = 0$*, and if $y^* = \hat{y}$ the incumbent is indifferent between $h^* = 1$ and $h^* = 0$.

Lemma 2 *The monopoly rent V has no* ***local maximum*** *on $h \in [0,1]$. A unique local minimum $h^0 \in (0,1)$ exists if and only if $A < y^* < B$, where*

$$B := \frac{\bar{\eta}(\sigma_\eta^2 - \sigma_\epsilon^2)}{2\sigma_\eta^2} + \frac{1}{2}\sqrt{\frac{(\sigma_\eta^2 + \sigma_\epsilon^2)(4\sigma_\eta^2 + \bar{\eta}^2(\sigma_\eta^2 + \sigma_\epsilon^2))}{\sigma_\eta^4}}$$

and

$$A := \frac{1}{2}(\bar{\eta} + \sqrt{\bar{\eta}^2 + 4\sigma_\eta^2}).$$

Proof. The procedure in the proof is straightforward. We solve for the usual first- and second-order conditions. To reduce the notational burden, define

$$\sigma_y^2 := \sigma_\eta^2 + (1-h)\sigma_\epsilon^2; \tag{16}$$

thus, the density of y_1 at $y_1 = y^*$ given hedging choice h is

$$f(y^* \mid h) := \frac{1}{\sigma_y\sqrt{2\pi}} e^{-\frac{1}{2}(\frac{y^*-\bar{\eta}}{\sigma_y})^2}.$$

Recall from (10) that $V = \delta_I \left[F(y^* \mid h) \times \bar{\eta} - \sigma_\eta^2 \times f(y^* \mid h)\right]$; hence

$$
\begin{aligned}
\frac{\partial V(h)}{\partial h} &= \delta_I \left[\bar{\eta} \frac{\partial F(y^* \mid h)}{\partial h} - \sigma_\eta^2 \frac{\partial f(y^* \mid h)}{\partial h}\right] \\
&= \delta_I \left[\bar{\eta} \frac{(y^* - \bar{\eta})\sigma_\epsilon^2}{2\sigma_y^2} f(y^* \mid h) + \sigma_\eta^2 \, \sigma_\epsilon^2 \frac{(y^* - \bar{\eta})^2 - \sigma_y^2}{2\sigma_y^4} \, f(y^* \mid h)\right] \\
&= \delta_I f(y^* \mid h) \left[\bar{\eta} \frac{(y^* - \bar{\eta})\sigma_\epsilon^2}{2\sigma_y^2} + \sigma_\eta^2 \, \sigma_\epsilon^2 \frac{(y^* - \bar{\eta})^2 - \sigma_y^2}{2\sigma_y^4}\right] \\
&= \delta_I f(y^* \mid h) \frac{\sigma_\epsilon^2}{2\sigma_y^4} \left[\bar{\eta}(y^* - \bar{\eta})\sigma_y^2 + \sigma_\eta^2 \, \left((y^* - \bar{\eta})^2 - \sigma_y^2\right)\right], \qquad (17)
\end{aligned}
$$

where the second line follows from both using (23) and using

$$
\begin{aligned}
\frac{\partial f(y^* \mid h)}{\partial h} &= -f(y^* \mid h) \frac{(y^* - \bar{\eta})^2 \, \sigma_\epsilon^2}{2\sigma_y^4} + f(y^* \mid h) \frac{\sigma_\epsilon^2}{2\sigma_y^2} \\
&= -f(y^* \mid h) \sigma_\epsilon^2 \frac{(y^* - \bar{\eta})^2 - \sigma_y^2}{2\sigma_y^4}. \qquad (18)
\end{aligned}
$$

Substituting for (16) and solving the first-order condition $\frac{\partial V(h)}{\partial h} = 0$ yields

$$
h^0 = \frac{\bar{\eta}(y^* - \bar{\eta})\sigma_\epsilon^2 + \sigma_\eta^2 ({y^*}^2 - y^* \bar{\eta} - \sigma_\epsilon^2) - \sigma_\eta^4}{\sigma_\epsilon^2 (\bar{\eta}(y^* - \bar{\eta}) - \sigma_\eta^2)}. \qquad (19)
$$

Imposing $h^0 \in (0,1)$ implies that h^0 is on the interval $(0,1)$ if and only if

$$
\underbrace{\frac{1}{2}(\bar{\eta} + \sqrt{\bar{\eta}^2 + 4\sigma_\eta^2})}_{:=A} < y^* < \underbrace{\frac{\bar{\eta}(\sigma_\eta^2 - \sigma_\epsilon^2)}{2\sigma_\eta^2} + \frac{1}{2}\sqrt{\frac{(\sigma_\eta^2 + \sigma_\epsilon^2)(4\sigma_\eta^2 + \bar{\eta}^2(\sigma_\eta^2 + \sigma_\epsilon^2))}{\sigma_\eta^4}}}_{:=B}. \qquad (20)
$$

Checking for the second-order condition yields

$$
\frac{\partial^2 V(h^0)}{\partial h^2} = \underbrace{e^{\frac{\bar{\eta}(y^* - \bar{\eta}) - \sigma_\eta^2}{2\sigma_\eta^2}} \frac{\sigma_\epsilon^4 \left(\bar{\eta}(y^* - \bar{\eta}) - \sigma_\eta^2\right)^4}{2\sqrt{2\pi}\sigma_\eta^2 (y^* - \bar{\eta})^6}}_{>0} \sqrt{-\frac{(y^* - \bar{\eta})^2 \sigma_\eta^2}{\underbrace{\bar{\eta}(y^* - \bar{\eta}) - \sigma_\eta^2}_{<0 \text{ from } (20)}}} > 0. \qquad (21)
$$

Hence, if $h^0 \in (0,1)$ exists, it is a local minimum. Note that the expression under the square root in (21) is never negative if (20) holds.[28] This establishes that h^0 is the unique local extreme point, a minimum, iff $A < y^* < B$, where

$$
A := \frac{1}{2}(\bar{\eta} + \sqrt{\bar{\eta}^2 + 4\sigma_\eta^2})
$$

[28] Calculating $\frac{\delta^2 V(h)}{\delta h^2}$ and substituting for h^0 is straightforward. However, the expression is lengthy and reveals no additional insight. We therefore omit its exposition here. The derivation is available upon request.

and

$$B := \frac{\bar{\eta}(\sigma_\eta^2 - \sigma_\epsilon^2)}{2\sigma_\eta^2} + \frac{1}{2}\sqrt{\frac{(\sigma_\eta^2 + \sigma_\epsilon^2)(4\sigma_\eta^2 + \bar{\eta}^2(\sigma_\eta^2 + \sigma_\epsilon^2))}{\sigma_\eta^4}}.$$

■

Lemma 3 *On $h \in [0,1]$, if $y^* \geq B$, the monopoly rent V has a **global maximum**, which is $h^* = 1$, whereas if $y^* \leq A$, the **global maximum** is $h^* = 0$.*

Proof. Recall that in (17) the term $\bar{\eta}\sigma_y^2(y^* - \bar{\eta}) + \sigma_\eta^2 \left((y^* - \bar{\eta})^2 - \sigma_y^2\right)$ alone determines the algebraic sign of the derivative, because the other terms are positive. It is straightforward to show that

$$\frac{\partial V(h)}{\partial h} > 0 \text{ on } h \in [0,1] \text{ if } y^* \geq B$$

and

$$\frac{\partial V(h)}{\partial h} < 0 \text{ on } h \in [0,1] \text{ if } y^* \leq A.$$

Hence, the incumbent's optimal strategy is attained at the boundaries: $h^* = 1$ if $y^* \geq B$ and $h^* = 0$ if $y^* \leq A$. This establishes the lemma. ■

Lemma 4 *On $h \in [0,1]$, if $A < y^* < B$, a unique cutoff $\hat{y}$ exists such that if $y^* > \hat{y}$ then $h^* = 1$, whereas if $y^* < \hat{y}$ then $h^* = 0$, and if $y^* = \hat{y}$ the incumbent is indifferent between $h^* = 1$ and $h^* = 0$.*

Proof. From *Lemma 2* it is known that if the conjectured entry threshold belongs to the interval $A < y^* < B$, a unique local minimum $h^0 \in (0,1)$ exists. This means that in this interval, the (global) maximum of V is attained on the boundaries $h^* = 0$ or $h^* = 1$. We prove the existence and uniqueness of $\hat{y}$ by examining the behavior of the difference in the monopoly rent at the boundaries, $V(y^* \mid h = 0)$ and $V(y^* \mid h = 1)$ (see Figure 3b).

Define $\Delta V(y^*) = V(y^* \mid h = 1) - V(y^* \mid h = 0)$. Note that $\hat{y}$ solves $\Delta V(y^*) = 0$, which cannot be done explicitly since no closed-form solution for $\hat{y}$ exists. We therefore apply the intermediate value theorem to establish the lemma.

Clearly, $\Delta V(A) < 0$ and $\Delta V(B) > 0$ from *Lemma 2*. Therefore, according to the intermediate value theorem, the continuous function $\Delta V(y^*)$ must have at least one zero on $[A, B]$. Since $\frac{\partial \Delta V(y^*)}{\partial y^*} > 0$ for all $y^* \in [A, B]$ (which we prove below), it follows that $\Delta V(y^*)$ has a unique zero.

First, differentiating $\Delta V(y^*)$ with respect to y^* yields

$$\frac{\partial \Delta V(y^*)}{\partial y^*} = f(y^* \mid h=1)y^* - f(y^* \mid h=0)\frac{\bar{\eta}\sigma_\epsilon^2 + y^*\sigma_\eta^2}{\sigma_\epsilon^2+\sigma_\eta^2},$$

and therefore proving $\frac{\partial \Delta V(y^*)}{\partial y^*} > 0$ on $[A,B]$ is equivalent to proving

$$\frac{f(y^* \mid h=1)}{f(y^* \mid h=0)}\frac{y^*}{\frac{\bar{\eta}\sigma_\epsilon^2+y^*\sigma_\eta^2}{\sigma_\epsilon^2+\sigma_\eta^2}} = e^{-\frac{(y^*-\bar{\eta})^2\sigma_\epsilon^2}{2\sigma_\eta^2(\sigma_\epsilon^2+\sigma_\eta^2)}}\frac{y^*(\sigma_\epsilon^2+\sigma_\eta^2)^{\frac{3}{2}}}{\sigma_\eta\left(\bar{\eta}\sigma_\epsilon^2+y^*\sigma_\eta^2\right)} > 1.$$

The solution is found by recognizing that e^{-x} is an upper bound of $\frac{1}{(x+1)^2}$ on $x \in [0,2]$ and observing that $0 \leq \frac{(y^*-\bar{\eta})^2\sigma_\epsilon^2}{2\sigma_\eta^2(\sigma_\epsilon^2+\sigma_\eta^2)} \leq 2$ for $y^* \in [A,B]$. Then, for $y^* \in [A,B]$,

$$\begin{aligned}
& e^{-\frac{(y^*-\bar{\eta})^2\sigma_\epsilon^2}{2\sigma_\eta^2(\sigma_\epsilon^2+\sigma_\eta^2)}}\frac{y^*(\sigma_\epsilon^2+\sigma_\eta^2)^{\frac{3}{2}}}{\sigma_\eta\left(\bar{\eta}\sigma_\epsilon^2+y^*\sigma_\eta^2\right)} > \frac{1}{(\frac{(y^*-\bar{\eta})^2\sigma_\epsilon^2}{2\sigma_\eta^2(\sigma_\epsilon^2+\sigma_\eta^2)}+1)^2}\frac{y^*(\sigma_\epsilon^2+\sigma_\eta^2)^{\frac{3}{2}}}{\sigma_\eta\left(\bar{\eta}\sigma_\epsilon^2+y^*\sigma_\eta^2\right)} \\
= \; & \frac{4y^*\sigma_\eta^3\left(\sigma_\epsilon^2+\sigma_\eta^2\right)^{\frac{7}{2}}}{\left(\bar{\eta}\sigma_\epsilon^2+y^*\sigma_\eta^2\right)((y^*-\bar{\eta})^2\sigma_\epsilon^2+2\sigma_\epsilon^2\sigma_\eta^2+2\sigma_\eta^4)^2} > \frac{4\sigma_\eta^3\left(\sigma_\epsilon^2+\sigma_\eta^2\right)^{\frac{5}{2}}}{((y^*-\bar{\eta})^2\sigma_\epsilon^2+2\sigma_\epsilon^2\sigma_\eta^2+2\sigma_\eta^4)^2} > 1,
\end{aligned}$$

where the second line follows from using $y^* > \bar{\eta}$ and the third from (12) after some lines of algebra. As a consequence, a unique solution $\hat{y} \in (A,B)$ exists such that $\Delta V(\hat{y}) = 0$. Hence, if $y^* > \hat{y}$ then $h^* = 1$, whereas if $y^* < \hat{y}$ then $h^* = 0$. By definition, $y^* = \hat{y}$ leaves the incumbent indifferent between $h^* = 1$ and $h^* = 0$. This establishes the lemma. ■

A.3 A Formal Treatment to $V > 0$ if Equation (12) Holds

In the following, we prove that the monopoly rent V is positive on $h \in [0,1]$ if $\bar{\eta} > \sigma_\eta$, which is equivalent to proving $\frac{\bar{\eta}}{\sigma_\eta^2} > \frac{f(y^*|h)}{F(y^*|h)}$.

Proof. Observe that $\frac{f(y^*|h)}{F(y^*|h)}$ cannot be represented in terms of elementary functions. The solution is found by recognizing an upper bound for $\frac{f(y^*|h)}{F(y^*|h)}$, namely,

$$\sigma_y^{-1}\frac{2}{\frac{y^*-\bar{\eta}}{\sigma_y}+\sqrt{\left(\frac{y^*-\bar{\eta}}{\sigma_y}\right)^2+4}} > \frac{f(y^* \mid h)}{F(y^* \mid h)}, \text{ for } y^* > \bar{\eta}. \tag{22}$$

Then, by utilizing $y^* - \bar{\eta} > 0$ and $\bar{\eta} > \sigma_\eta$, it is straightforward to show that

$$\frac{\bar{\eta}}{\sigma_\eta^2} > \max_{h\in[0,1]} \sigma_y^{-1}\frac{2}{\frac{y^*-\bar{\eta}}{\sigma_y}+\sqrt{\left(\frac{y^*-\bar{\eta}}{\sigma_y}\right)^2+4}} = \frac{2}{y^*-\bar{\eta}+\sigma_\eta\sqrt{\left(\frac{y^*-\bar{\eta}}{\sigma_\eta}\right)^2+4}},$$

which establishes the claim. Inequality (22) follows from

$$\frac{2}{x+\sqrt{x^2+4}} > \frac{\varphi(x)}{\Phi(x)}, \text{ for } x>0$$

and

$$\sigma_y^{-1}\frac{\varphi(\frac{y^*-\bar{\eta}}{\sigma_y})}{\Phi(\frac{y^*-\bar{\eta}}{\sigma_y})} = \frac{f(y^* \mid h)}{F(y^* \mid h)},$$

where $\varphi(x)$ denotes the pdf of the standard normal distribution and $\Phi(x)$ its cdf. ■

A.4 A Formal Investigation of the Probability and Value Effects

The first expression, the "Probability Effect," is *positive* as

$$\frac{\partial F(y^* \mid h)}{\partial h} = \frac{(y^*-\bar{\eta})\sigma_\epsilon^2}{2\sigma_y^2} f(y^* \mid h) > 0. \tag{23}$$

Here the important insight is that hedging increases the probability of deterring entry. The interpretation is intuitive.

The second part of (13), the "Value Effect," reflects the effect of h on the conditional monopoly rent in the second period given that y_1 is *not* exceeding y^*. While the "Probability Effect" suggests the incumbent has clear incentives to fully hedge, the "Value Effect" is ambiguous. From (13), the sign of the "Value Effect" (and therefore the overall sign of the derivative) obviously is contingent on $-\frac{f(y^*|h)}{F(y^*|h)}$ being increasing or decreasing in h. For instance, it is straightforward to verify that if $-\frac{f(y^*|h)}{F(y^*|h)}$ is increasing in h, then the "Value Effect" and therefore the total monopoly rent V is increasing in h as well. As a consequence, the incumbent chooses a full hedge, $h^* = 1$.

More generally, applying the quotient rule

$$-\frac{\partial}{\partial h}\frac{f(y^* \mid h)}{F(y^* \mid h)} = \underbrace{-\frac{\frac{\partial}{\partial h}f(y^* \mid h)F(y^* \mid h)}{F(y^* \mid h)^2}}_{(+/-)} + \underbrace{\frac{\frac{\partial}{\partial h}F(y^* \mid h)f(y^* \mid h)}{F(y^* \mid h)^2}}_{(+)}$$

and equation (23) (namely, $\frac{\partial F(y^*|h)}{\partial h} > 0$) reveals the key for the "Value Effect" being increasing or decreasing is how the density $f(y^* \mid h)$ changes at the threshold level y^*. The "Value Effect" increases in h, either if $\frac{\partial}{\partial h}f(y^* \mid h) < 0$ or if $f(y^* \mid h)$ increases not too rapidly in h. In fact, it can be easily shown that this is true if y^* is sufficiently large. The "Value Effect" decreases in h, however, if $\frac{\partial}{\partial h}f(\cdot)$ increases quickly in h, which is true if y^* is sufficiently small. It is interesting that in this case, either of the two effects – "Probability Effect" or "Value Effect" – may actually dominate the equilibrium outcome.

A.5 Proof of Proposition 1

A graphical illustration to the proof of the (a) and (b) parts of Proposition 1 follows in Figure 3. It is easy to show that the best reaction curves of incumbent and entrant can cross only once. Recall from (7) that the reaction curve of the *entrant* is given by $y^* = \beta + \gamma(1 - h^*)$, where from (3) $\beta > 0$ and $\gamma > 0$. This implies that $h^* = 1 + \frac{\beta}{\gamma} - \frac{1}{\gamma}y^*$ is downward sloping. The pattern of the best response function of the *incumbent* – it is non-continuous and involves a *jump up* at $y^* = \hat{y}$, where $\hat{y} \in (A, B)$ – follows from *Lemma 1*. The mixed-strategy equilibrium – the (c) part of Proposition 1 – can be easily derived. The incumbent is indifferent between playing $h^* = 1$ and $h^* = 0$ if $y^* = \hat{y}$. When the incumbent randomizes over these strategies, the induced outcome to the entrant corresponds to a lottery over the pure-strategy payoffs weighted by the probabilities with which $h^* = 0$ and $h^* = 1$ are being played. Hence, $p^* \in (0, 1)$ solves $(1 - \delta_R)\left(p^* E(\eta \mid \hat{y}, h^* = 1) + (1 - p^*)E(\eta \mid \hat{y}, h^* = 0)\right) = K$.

A.6 Proof of Proposition 2

By using (10) and (15), the incumbent's monopoly rent V in the mandatory hedge disclosure regime is

$$\begin{aligned} V(y^*(h), h) := \quad & \delta_I \int_{-\infty}^{y^*(h)} E(\eta \mid y_1, h) f(y^*(h), h) dy_1 \\ = \quad & F(y^*(h), h) \times \delta_I \left(\bar{\eta} - \sigma_\eta^2 \frac{f(y^*(h), h)}{F(y^*(h), h)}\right), \end{aligned}$$

where $F(y^*(h), h)$ denotes the probability of remaining monopolist and $\delta_I \left(\bar{\eta} - \sigma_\eta^2 \frac{f(y^*(h),h)}{F(y^*(h),h)}\right)$ denotes the value of incumbency conditional on y_1 *not* exceeding $y^*(h)$. Following the decomposition proposed in (10), the total change in the monopoly rent $V(y^*(h), h)$ with respect to h can be disaggregated into

$$\begin{aligned} \frac{dV(y^*(h), h)}{dh} = \quad & \underbrace{\frac{dF(y^*(h), h)}{dh} \times \underbrace{\delta_I \left(\bar{\eta} - \sigma_\eta^2 \frac{f(y^*(h), h)}{F(y^*(h), h)}\right)}_{>0 \text{ from (12)}}}_{\text{“Probability Effect”}} \\ & + \underbrace{\underbrace{F(y^*(h), h)}_{>0} \times \frac{d}{dh} \delta_I \left(\bar{\eta} - \sigma_\eta^2 \frac{f(y^*(h), h)}{F(y^*(h), h)}\right)}_{\text{“Value Effect”}}. \end{aligned}$$

Proposition 2 follows immediately from showing that $\frac{dV(y^*(h),h)}{dh} < 0$ on $h \in [0, 1]$. The proof clearly involves two lemmas:

1. **Lemma 5:** *The probability of the incumbent remaining monopolist strictly decreases in the incumbent's hedging choice h; hence* $\frac{dF(y^*(h),h)}{dh} < 0$.

2. **Lemma 6:** *The value of incumbency conditional on y_1 not exceeding $y^*(h)$ strictly decreases in the incumbent's hedging choice h; hence* $\frac{d}{dh}\delta_I\left(\bar{\eta}-\sigma_\eta^2\frac{f(y^*(h),h)}{F(y^*(h),h)}\right)<0$.

Both lemmas can be established as follows.[29]

Lemma 5 *The probability of the incumbent remaining monopolist strictly decreases in the incumbent's hedging choice h; hence* $\frac{dF(y^*(h),h)}{dh}<0$.

Proof. Taking the total derivative of $F(y^*(h),h)$ with respect to h yields

$$\begin{aligned}\frac{dF(y^*(h),h)}{dh} &= \underbrace{\frac{\partial F(y^*(h),h)}{\partial y^*(h)}\frac{dy^*(h)}{dh}}_{\text{"Strategic Effect"}}+\frac{\partial F(y^*(h),h)}{\partial h}\\ &= f(y^*(h),h)\left(-\frac{\sigma_\epsilon^2}{\sigma_\eta^2}\left(\frac{K}{1-\delta_R}-\bar{\eta}\right)+\frac{(y^*(h)-\bar{\eta})\sigma_\epsilon^2}{2\sigma_y^2}\right)\\ &= f(y^*(h),h)\frac{\sigma_\epsilon^2}{\sigma_\eta^2}\underbrace{\left(\frac{K}{1-\delta_R}-\bar{\eta}\right)}_{>0\text{ from (3)}}\left(-1+\frac{1}{2}\right)<0. \qquad (24)\end{aligned}$$

The first term in the first line reflects the incumbent's first-mover (i.e., Stackelberg leader) position. This "strategic effect" results from the influence of the hedging choice h on the entry threshold and does not exist in the earlier analysis of unobservable hedging activity. The second line follows from $\frac{\partial F(y^*(h),h)}{\partial y^*(h)}=f(y^*(h),h)$, $\frac{dy^*(h)}{dh}=-\frac{\sigma_\epsilon^2}{\sigma_\eta^2}\left(\frac{K}{1-\delta_R}-\bar{\eta}\right)$, and $\frac{\partial F(y^*(h),h)}{\partial h}=\frac{(y^*(h)-\bar{\eta})\sigma_\epsilon^2}{2\sigma_y^2}f(y^*(h),h)$, which follows along the lines from (23). The third line substitutes $y^*(h)$ from (14). ■

Lemma 6 *The value of incumbency conditional on y_1 not exceeding $y^*(h)$ strictly decreases in the incumbent's hedging choice h; hence* $\frac{d}{dh}\delta_I\left(\bar{\eta}-\sigma_\eta^2\frac{f(y^*(h),h)}{F(y^*(h),h)}\right)<0$.

Proof. Taking the total derivative of $\delta_I\left(\bar{\eta}-\sigma_\eta^2\frac{f(y^*(h),h)}{F(y^*(h),h)}\right)$ with respect to h yields

$$\begin{aligned}&\frac{d}{dh}\delta_I\left(\bar{\eta}-\sigma_\eta^2\frac{f(y^*(h),h)}{F(y^*(h),h)}\right)\\ &= -\delta_I\sigma_\eta^2\frac{\frac{df(y^*(h),h)}{dh}F(\cdot)-\frac{dF(y^*(h),h)}{dh}f(\cdot)}{F(\cdot)^2}<0 \qquad (25)\end{aligned}$$

[29] In what follows, we will omit the functional dependence of $f(\cdot)$ and $F(\cdot)$ on $y^*(h)$ and h for notational convenience where possible.

if the sign of the numerator in (25) is positive. This can be easily established by using $\frac{dF(y^*(h),h)}{dh} < 0$ from (24) and

$$\begin{aligned}\frac{df(y^*(h),h)}{dh} &= \frac{\partial f(y^*(h),h)}{\partial y^*(h)}\frac{dy^*(h)}{dh} + \frac{\partial f(y^*(h),h)}{\partial h} \\ &= \left(\frac{(y^*(h)-\bar{\eta})}{\sigma_y^2} * \frac{\sigma_\epsilon^2}{\sigma_\eta^2}\left(\frac{K}{1-\delta_R} - \bar{\eta}\right) - \frac{\sigma_\epsilon^2\left((y^*(h)-\bar{\eta})^2 - \sigma_y^2\right)}{2\sigma_y^4}\right) f(\cdot) \\ &= \frac{\sigma_\epsilon^2\left(\sigma_\epsilon^2(1-h)(K-(1-\delta_R)\bar{\eta})^2 + \sigma_\eta^2(K-(1-\delta_R)\bar{\eta})^2 + \sigma_\eta^4(1-\delta_R)\right)}{2\sigma_\eta^4(1-\delta_R)^2\sigma_y^6} f(\cdot) > 0.\end{aligned}$$

Observe that the second line follows from $\frac{\partial f(y^*(h),h)}{\partial y^*(h)} = -\frac{(y^*(h)-\bar{\eta})}{\sigma_y^2} f(y^*(h),h)$, $\frac{dy^*(h)}{dh} = -\frac{\sigma_\epsilon^2}{\sigma_\eta^2}\left(\frac{K}{1-\delta_R} - \bar{\eta}\right)$ and from using $\frac{\partial f(y^*(h),h)}{\partial h} = -\frac{\sigma_\epsilon^2\left((y^*(h)-\bar{\eta})^2-\sigma_y^2\right)}{2\sigma_y^4} f(y^*(h),h)$, which has been derived in (18). The third line follows from substituting for (14). The threshold value $y^* = \frac{K}{1-\delta_R} + \frac{\sigma_\epsilon^2}{\sigma_\eta^2}\left(\frac{K}{1-\delta_R} - \bar{\eta}\right)$ follows from (14). ■

A.7 Proof of Corollary 2

Proof. In a mandatory hedge disclosure regime, the entry threshold is given by

$$y_D^* = \frac{K}{1-\delta_R} + \frac{\sigma_\epsilon^2}{\sigma_\eta^2}\left(\frac{K}{1-\delta_R} - \bar{\eta}\right),$$

whereas the entry threshold in a non-disclosure regime under the parameter values of Proposition 1a is

$$y_{ND}^* = \frac{K}{1-\delta_R}.$$

Clearly, $y_D^* > y_{ND}^*$. Note that the probability of entry is given by $1 - \Phi\left(\frac{y_D^*-\bar{\eta}}{\sqrt{\sigma_\eta^2+\sigma_\epsilon^2}}\right)$ and $1 - \Phi\left(\frac{y_{ND}^*-\bar{\eta}}{\sqrt{\sigma_\eta^2}}\right)$, respectively, where $\Phi(\cdot)$ denotes the cdf of the standard normal distribution. Observe that $\frac{\partial \Phi(x)}{\partial x} > 0$ for all x. Showing that $\frac{y_D^*-\bar{\eta}}{\sqrt{\sigma_\eta^2+\sigma_\epsilon^2}} > \frac{y_{ND}^*-\bar{\eta}}{\sqrt{\sigma_\eta^2}}$ establishes the result. ■

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