Journal of Decision Science and Optimization
Vol. 2 (2026), No. 3, pp. 172-190
DOI: https://doi.org/10.55578/jdso.2611.012

ARTICLE

Management Control Optimization under Managerial Overconfidence: A Principal–Agent Model of Business Development Decisions

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Received: 17 Oct 2026, Revised: 3 Nov 2026, Accepted: 9 Nov 2026, Published: 13 Nov 2026

Abstract

Business development decisions require resource commitments under uncertain opportunity quality, giving managerial judgment a central role in investment evaluation. This study develops an agency model to examine how managerial overconfidence shapes optimal incentive intensity and monitoring intensity. A behavioral parameter captures the manager's overestimation of opportunity value, while the board anticipates the investment response and selects both control instruments. Equilibrium analysis examines how biased beliefs, environmental uncertainty, effort costs, and monitoring costs influence control choices. Overconfidence raises perceived investment returns and increases managerial effort for given control choices. Comparative statics suggest that stronger bias reduces optimal incentive intensity and increases optimal monitoring intensity. Inflated expectations provide investment motivation and reduce the need for financial rewards. Monitoring reduces evaluation error losses outside the compensation measure. Numerical illustrations show lower optimal incentive shares and higher monitoring intensity as overconfidence increases. These findings connect managerial cognition with endogenous control design and clarify how behavioral and informational conditions shape business development decisions. The model distinguishes the motivational effects of overconfidence from evaluation losses outside compensation measures and characterizes the optimal control response to each effect.

Keywords: Management control optimization; Managerial overconfidence; Business development decisions; Incentive intensity; Monitoring intensity

1. INTRODUCTION

Business development (BD) requires resource commitments to market expansion, technological initiatives, strategic partnerships, and capability development. Such commitments require firms to evaluate opportunities whose economic value remains uncertain during project development [1,2]. Boards face an informational constraint because managers possess expertise that supports assessments of technological feasibility and market potential. Delegation grants managers discretion over opportunity evaluation and resource allocation, creating an agency problem that connects investment choices with incomplete information [3-5].

Organizations use management control systems to guide investment decisions under uncertainty and information asymmetry [6,7]. Incentive intensity and monitoring intensity shape managerial effort and resource allocation through distinct mechanisms [8,9]. Compensation links managerial rewards to performance outcomes, while monitoring supplies information for investment evaluation and oversight [10,11]. Research examines how firms combine these instruments to align effort with organizational objectives and improve decision quality [12,13]. Existing explanations emphasize hidden action and hidden information as determinants of control design [14,15]. Managerial cognition introduces a further consideration because subjective opportunity assessments influence how managers respond to control instruments [16].

Overconfidence causes decision makers to overestimate expected opportunity value [17,18]. Technological and market uncertainty complicate evaluation, prompting managers to interpret

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incomplete signals through subjective judgments [19]. Inflated expectations can encourage investment effort that exceeds the level objective project conditions justify. Distorted judgment creates a control problem even when managers pursue organizational growth. Financial incentives may reinforce investment expansion when managers overestimate its returns, raising questions about how firms should combine motivation and oversight [20,21].

This study develops an agency model to examine how managerial overconfidence changes optimal incentive intensity and monitoring intensity in business development decisions. Environmental uncertainty constrains effort productivity, while a separate behavioral parameter captures inflated perceptions of opportunity quality [22,23]. Within this structure, the manager chooses investment effort and the board anticipates that response when selecting control instruments. Separation of uncertainty from biased beliefs clarifies how informational conditions and managerial judgment shape equilibrium choices [24,25]. Analytical modeling provides a framework for tracing these relationships and examining their implications for control optimization [26,27].

By incorporating managerial cognition into endogenous control design, the analysis connects management control research with behavioral explanations of strategic decisions [28,29]. The contribution lies in separating the effort motivation generated by inflated expectations from evaluation losses outside the compensation measure. This distinction builds on research concerning performance measurement and information evaluation [30,31]. Incentive adjustment addresses the cost of inducing effort, while monitoring reduces evaluation losses under the specified control structure. Opportunity evaluation makes business development a relevant setting because resource commitments depend on judgments about technological feasibility, market demand, and future returns [32-34]. Examining these conditions helps explain how firms can adjust control choices to managerial bias and strategic uncertainty.

2. LITERATURE REVIEW

2.1. Agency Theory and Management Control

Agency theory examines decision problems that arise when owners delegate authority to managers. Separation of ownership and control can create divergent objectives, while information asymmetry limits owners' ability to assess managerial choices [3]. Incentive contracts and monitoring provide instruments for addressing these problems [8,35]. Contract design links rewards to outcomes, and oversight supplies information about actions and performance. Together, these instruments define a control problem in which the principal must balance managerial motivation, information quality, and control costs.

Management control research examines how organizations combine incentives and monitoring to support organizational objectives [6,7]. Performance measures determine how rewards respond to managerial contributions, making signal quality relevant to incentive design [10]. Interactions among tasks, rewards, and information complicate the choice of control instruments [11]. Standard agency formulations treat managers as decision makers who maximize expected utility under specified beliefs and constraints [36,37]. Within this framework, optimal contracts address the costs of inducing effort and allocating risk [38]. Chatzopoulou et al. [39] show that procedural justice shapes the effects of monitoring and incentive alignment on agency costs. Their findings establish managerial motivation as a condition governing control effectiveness. Biased opportunity assessments introduce a related consideration because managerial beliefs can alter the effort response that the principal anticipates.

2.2. Incentive and Monitoring Choices in Business Development Decisions

Business development decisions concern opportunity pursuit and resource commitment under uncertain future returns [1,2,33]. Managers assess market potential, technological feasibility, and partner contributions, while boards select control arrangements with limited access to opportunity information [15]. Evaluation quality matters because resource commitments can shape subsequent strategic choices and constrain revision [13]. Computational research shows that feedback topology shapes how governance intensity responds to strategic misalignment in business development systems [16]. This finding supports treating control adjustment as part of opportunity development and motivates examination of the incentive and monitoring choices governing managerial decisions.

Incentives influence the manager's expected reward from effort, whereas monitoring changes the information available for evaluation and oversight [6]. Research identifies interactions through which monitoring can reinforce or weaken the effects of incentive alignment [9]. The relevance of such interactions depends on whether both instruments affect the same actions, performance measures, or organizational losses. Multitask agency analysis shows that incentive choices depend on task characteristics and the available performance measures [11]. Signal aggregation research establishes that information sensitivity and precision affect performance evaluation [10]. Control optimization must account for these relationships alongside effort costs and monitoring costs. Subjective opportunity judgments add complexity because identical control choices can induce different effort levels when managers hold different beliefs concerning expected returns [22,23,28,29]. Kim and Park [40] find that boards apply stronger bonus target ratcheting to overconfident CEOs, with a larger response under strong monitoring environments. This evidence supports examining how managerial overconfidence shapes the board's choice of control arrangements.

2.3. Managerial Overconfidence and Decision Distortion

Behavioral research identifies overconfidence as a source of distorted managerial judgment. Evidence concerning acquisition premiums links executive hubris with corporate acquisition decisions [41]. Studies of acquisition activity and corporate investment associate CEO overconfidence with choices that reflect inflated assessments of expected value [42,43]. Innovation research identifies further consequences for resource allocation and organizational outcomes [21]. Computational research shows how cognitive bias distorts exploration and exploitation in algorithmic decision processes and how adaptive intervention changes search structure [44]. This process perspective complements evidence on corporate decisions and supports examining the mechanisms through which bias affects development activity. The present model focuses on managerial effort and the board's incentive and monitoring choices.

Inflated expectations increase the perceived marginal return from pursuing an opportunity [18]. Conventional effort problems arise when managers bear private effort costs but receive a share of the resulting value [36,38]. Overconfidence changes this balance by increasing the return that managers expect from their actions. Financial rewards can amplify that response, creating a potential conflict between effort induction and decision quality [24,25,28]. Graziano and Luporini [34] show that overconfidence can reduce incentive pay, while severance costs can offset this benefit when managers have bargaining power. Their findings support examining motivational benefits alongside other costs of managerial bias. Distinguishing effort motivation from evaluation losses extends this reasoning to the control choices examined here.

2.4. Managerial Bias and Control Optimization

Existing research provides foundations for analyzing agency relationships, control instruments, and biased decisions [7,17,37]. Integrating these foundations requires attention to how managerial beliefs enter the principal's optimization problem. A board that anticipates inflated opportunity assessments must evaluate the manager's effort response alongside the costs and benefits of each control instrument. Lambertsen [45] shows that heterogeneous beliefs can change how moral hazard affects the sensitivity of optimal compensation to outcomes. This analysis supports treating belief differences as part of the contract design problem. Optimal control choices depend on how incentives and monitoring affect managerial responses, objective project value, and the payoff the board receives.

Monitoring offers information that can support performance evaluation and resource allocation [12, 31]. Its capacity to improve decision quality depends on how information affects managerial actions and the economic consequences of those actions. Research on performance measure congruity provides a basis for distinguishing measured performance from the principal's objective [30]. Behavioral agency and innovation studies reinforce the importance of examining managerial judgment within the decision structure [20,27]. Research on complex business systems shows how coupled changes in bias, structural deviation, and regulatory intensity shape adaptive stability [46]. This systems perspective supports incorporating bias and control adjustment into a common analytical framework, while the present model specifies the objectives and choices of the board and manager. The present study brings these considerations into an agency model of business development decisions. By separating environmental

uncertainty from managerial overconfidence, the framework examines how biased beliefs change equilibrium effort and the optimal combination of incentive intensity and monitoring intensity.

3. METHODOLOGICAL APPROACH

3.1. Analytical Modeling Approach

Analytical modeling provides a framework for examining decision problems that involve delegated authority, incomplete information, and incentive design [5,8]. Explicit objectives and constraints allow researchers to trace how assumptions affect managerial choices and control outcomes. Business development decisions present these features because managers evaluate uncertain opportunities and boards select control instruments that influence resource commitment.

This study adopts an agency framework to represent the interaction between a board and a manager [3,4]. Delegation gives the manager discretion over development effort, while the board chooses incentive intensity and monitoring intensity. Managerial overconfidence enters the effort decision through an inflated assessment of opportunity quality. Separating subjective beliefs from objective project conditions allows the analysis to examine how biased judgment changes the board's optimal control choices.

3.2. Model Structure and Analytical Procedure

Three research traditions inform model construction. Agency theory supplies the delegation structure and the relationship between rewards and effort [3,8]. Management control research explains how incentives and monitoring influence managerial actions and performance evaluation [6]. Behavioral research motivates the distinction between perceived opportunity value and its objective counterpart [42,43]. Integration of these elements produces a decision problem in which the board anticipates the manager's response to control choices under biased beliefs.

Backward induction determines equilibrium choices. Given incentive intensity and monitoring intensity, the manager selects effort to maximize perceived utility. Substitution of this effort response into the board's payoff function establishes the control optimization problem. Optimality conditions characterize the board's choices, subject to parameter restrictions and feasible control levels. Comparative statics examine how changes in managerial overconfidence and environmental uncertainty affect effort and control choices. Numerical illustrations explore these relationships under illustrative parameter settings.

3.3. Scope and Assumptions

A single board and a single manager define the decision structure. Both actors have risk neutrality, which places expected payoffs, effort costs, and monitoring costs at the center of their objectives. Environmental uncertainty affects the productivity of development effort, while a separate bias parameter increases perceived opportunity quality. Prior research on executive hubris and corporate investment supports the use of inflated opportunity assessments to represent managerial overconfidence [41,43].

Quadratic effort and monitoring costs preserve tractability and represent increasing marginal costs. Parameter restrictions maintain diminishing marginal returns and define the conditions for interior choices. Feasible boundaries remain relevant when candidate solutions fall outside the permitted control range. The framework examines control choices for a development opportunity that the firm has committed to pursuing. Incentives influence additional managerial effort, while monitoring addresses evaluation errors associated with the existing commitment. Its scope covers a single decision episode, with learning and subsequent project revision as potential extensions.

3.4. Analytical Interpretation and Evaluation

Methodological evaluation rests on consistency among assumptions, objective functions, equilibrium conditions, and reported results [26]. Derivation establishes the manager's effort response and the board's associated optimization conditions. Claims about equilibrium existence, uniqueness, or directional effects require the relevant mathematical conditions. Where parameter interactions prevent a general sign determination, interpretation must state the restrictions supporting the result.

Numerical analysis complements the derivations by illustrating feasible equilibrium responses and the payoff consequences of alternative control choices. Selected parameter values represent hypothetical decision environments and serve an illustrative purpose. Interpretation distinguishes implications that follow from the model's structure from patterns that depend on particular parameter settings. Within these boundaries, the framework explains how managerial beliefs and environmental uncertainty shape control optimization in business development decisions.

4. THE MODEL

4.1. Economic Environment and Decision Structure

Business development decisions require firms to select opportunities, commit resources, and organize development activities under uncertain returns. An agency relationship represents this setting through two actors: a board that selects management control instruments and a manager who chooses development effort. Both actors maximize expected monetary payoffs. The firm has committed to pursuing the development opportunity. Effort represents the manager's additional development activity, while evaluation errors concern arrangements and obligations associated with the existing commitment.

Decision making follows two stages. At the first stage, the board chooses incentive intensity $\alpha \in [0,1]$ and monitoring intensity $m \geq 0$. At the second stage, the manager observes these choices and selects effort $b \geq 0$. Backward induction connects the manager's effort response with the board's control optimization problem.

Objective expected opportunity quality equals $\mu > 0$. The board uses this benchmark to evaluate expected returns and anticipates the manager's bias $\beta \geq 0$. Subjective opportunity quality equals $\mu + \beta$. This specification represents a divergence in beliefs about expected quality, while future outcomes remain uncertain. Table 1 defines the model's variables and parameters.

Table 1. Model Variables and Parameters

Symbol	Definition
$\mu > 0$	Objective expected opportunity quality
$\beta \geq 0$	Upward bias in the manager's opportunity assessment
$b \geq 0$	Managerial development effort
$\alpha \in [0,1]$	Manager's share of the contractual performance measure
$m \geq 0$	Monitoring intensity
$\gamma > 0$	Baseline curvature parameter governing diminishing effort returns
$\sigma \geq 0$	Productivity loss parameter associated with environmental uncertainty
$A = \gamma + \sigma$	Combined curvature parameter
$c > 0$	Manager's private effort cost parameter
$d > 0$	Sensitivity of evaluation error losses to managerial bias
$\eta > 0$	Effectiveness of monitoring in reducing evaluation error losses
$k > 0$	Monitoring cost parameter
$R(b)$	Objective expected contractual performance
$L(\beta, m)$	Expected evaluation error loss outside the compensation measure

Symbol	Definition
U_M	Manager's perceived expected utility
U_B	Board's objective expected payoff

4.2. Environmental Uncertainty and Managerial Bias

Environmental uncertainty and managerial overconfidence enter the model through separate parameters. Parameter σ captures the productivity loss associated with uncertain technological and market conditions. Higher values increase the curvature of the expected performance function and reduce the marginal return from development effort. Its interpretation concerns an expected productivity penalty; the formulation specifies expected payoffs without a separate probability distribution.

Managerial bias enters through β, which increases perceived opportunity quality from μ to $\mu + \beta$. A value of zero represents an unbiased assessment of expected quality. Positive values increase the return that the manager expects from development effort. Separation of these parameters distinguishes an environmental constraint on performance from a subjective distortion in opportunity evaluation.

4.3. Development Performance and Evaluation Error Losses

Expected contractual performance depends on opportunity quality and development effort. Monitoring addresses a separate loss that arises from errors in opportunity evaluation, partner assessment, or initiative structuring. Equation (1) defines both components:

$$R(b) = \mu b - \left(\frac{A}{2}\right) b^2, \quad L(\beta, m) = \frac{d\beta^2}{[2(1 + \eta m)]}, \quad A = \gamma + \sigma > 0. \tag{1}$$

Diminishing effort returns follow from $R^{''}(b) = -A < 0$. Greater effort raises expected performance when $b < \mu/A$ and lowers it when $b > \mu/A$. This threshold provides a benchmark for assessing effort relative to the level that maximizes contractual performance.

Evaluation error losses increase with managerial bias. The quadratic numerator represents increasing damage from larger assessment errors. Greater monitoring reduces these losses through verification, independent review, and assessment of development proposals. Marginal loss reduction declines as monitoring increases, capturing diminishing benefits from additional review.

Contractual performance determines managerial compensation, while the firm bears evaluation error losses outside that measure. Additive separation represents a development opportunity with an existing commitment whose evaluation losses remain independent of additional managerial effort. For example, verification may reduce errors concerning partner qualifications or existing contractual obligations, while performance rewards motivate development activity. The specification assumes that these verification activities leave effort productivity and the compensation measure unchanged. This arrangement gives incentives and monitoring distinct economic targets and permits identification of each response to managerial overconfidence.

4.4. Managerial Utility and Development Effort

Compensation gives the manager a share α of contractual performance. Perceived opportunity quality determines the manager's assessment of that reward, while effort creates a private quadratic cost. Equation (2) specifies perceived expected utility:

$$U_M(b;\, \alpha, \beta) = \alpha\left[(\mu + \beta)b - \left(\frac{A}{2}\right) b^2\right] - \left(\frac{c}{2}\right) b^2. \tag{2}$$

Strict concavity follows from

$$\partial^2 U_M / \partial b^2 = -(\alpha A + c) < 0.$$

For $\alpha > 0$, the unique optimal effort satisfies

$$\alpha(\mu + \beta) - (\alpha A + c)b = 0.$$

At $\alpha = 0$, the manager chooses zero effort.

Inflated opportunity assessments increase effort for a given incentive share. Higher effort relative to the unbiased case identifies the behavioral effect of overconfidence. Assessment of excessive effort requires comparison with an explicit objective benchmark, including the performance maximum μ/A.

Monitoring affects evaluation error losses outside the compensation measure. Its role in this formulation concerns decision quality, while the manager's effort response depends on incentives, perceived quality, and effort costs. The manager retains the subjective opportunity assessment after observing the control choices. Monitoring improves organizational evaluation procedures, while the effort decision follows the manager's existing belief. Participation assumes a reservation utility of zero; the option to choose zero effort yields utility of zero. Compensation consists of a performance share with a fixed transfer of zero.

4.5. The Board's Control Optimization Problem

Anticipating the effort response $b^*(\alpha, \beta)$, the board chooses incentives and monitoring to maximize its expected payoff:

$$\max U_B(\alpha, m;\ \beta) = (1 - \alpha)\left[\mu b * (\alpha, \beta) - \left(\frac{A}{2}\right)\left(b^*(\alpha, \beta)\right)^2\right] - \frac{d\beta^2}{[2(1+\eta m)]} - \left(\frac{k}{2}\right)m^2, \quad 0 \le \alpha \le 1, m \ge 0. \tag{3}$$

Retained contractual performance forms the first payoff component. Increasing the incentive share changes managerial effort and reduces the board's share of performance. Evaluation error losses and monitoring costs form the remaining components. Convex monitoring costs limit expenditure on review activities.

Joint selection places both instruments within a common board objective, while additive separation assigns each instrument a distinct optimization problem. Managerial bias affects the effort return that the manager anticipates and the evaluation losses that the firm bears. Opposing control responses can arise from this common source without an interaction in marginal benefits. This specification applies when monitoring addresses losses associated with an existing commitment and performance compensation governs additional effort. Verification that changes performance measurement, effort productivity, or managerial beliefs would require a linkage mechanism and a different optimization problem.

5. EQUILIBRIUM ANALYSIS

Backward induction determines the manager's development effort and the board's optimal control choices. Let $q = \mu + \beta$ and $A = \gamma + \sigma$. The analysis maintains $\mu > 0$, $\beta \ge 0$, $A > 0$, and $c, d, \eta, k > 0$. Incentives influence effort and the board's retained performance share, while monitoring reduces evaluation error losses.

5.1. Managerial Development Effort

Given the incentive share α, the manager maximizes perceived utility. The optimality condition is

$$\frac{\partial U_M}{\partial b} = \alpha q - (c + \alpha A)b = 0. \tag{4}$$

Strict concavity gives a unique effort response, including zero effort at $\alpha = 0$:

$$b^*(\alpha, \beta) = \frac{\alpha q}{c + \alpha A}. \tag{5}$$

For positive incentives, the response satisfies

$$\partial b^* / \partial \beta = \frac{\alpha}{c + \alpha A} > 0, \quad \partial b^* / \partial \alpha = \frac{cq}{(c + \alpha A)^2} > 0. \tag{6}$$

$$\partial b^* / \partial \sigma = \frac{-\alpha^2 q}{(c + \alpha A)^2} < 0, \quad \partial b^* / \partial m = 0. \tag{7}$$

Overconfidence raises effort under fixed incentives, while the productivity penalty associated with uncertainty reduces it. Monitoring changes evaluation error losses outside the compensation measure and leaves this effort response unchanged. A higher effort level than the unbiased response identifies expansion from biased beliefs; excessive effort requires comparison with an objective benchmark.

5.2. Optimal Incentive Intensity

Substitution of equation (5) into the board's objective separates its control problem into an incentive component F and a monitoring component G:

$$U_B(\alpha, m;\ \beta) = F(\alpha;\ q, A) - G(m;\ \beta), \tag{8}$$
$$F(\alpha;\ q, A) = (1 - \alpha)[\mu b^*(\alpha, \beta) - (A/2)(b^*(\alpha, \beta))^2],$$
$$G(m;\ \beta) = \frac{d\beta^2}{2(1 + \eta m)} + (k/2)m^2.$$

An effort transformation establishes existence and uniqueness of the incentive optimum. Solving equation (5) for the share needed to induce effort b gives

$$\alpha(b, q) = \frac{cb}{q - Ab},\quad 0 \le b \le \frac{q}{c + A}. \tag{9}$$

Define $R(b) = \mu b - Ab^2/2$ and $\hat{F}(b; q) = [1 - \alpha(b, q)]R(b)$. Small positive effort yields a positive incentive payoff, while $\alpha = 0$ and $\alpha = 1$ yield zero. Effort above μ/A cannot maximize this payoff: reducing it toward μ/A increases performance and reduces the required incentive share when performance is positive; negative performance yields a payoff below the feasible positive payoff. The optimum lies within $0 < b < min\{\mu/A, q/(c + A)\}$.

Within this interval, $R, R', \alpha_b,$ and α_{bb} are positive, and

$$\hat{F}_{bb} = -A(1 - \alpha) - 2\alpha_b(\mu - Ab) - \alpha_{bb}R(b) < 0, \tag{10}$$
$$\alpha_b = \frac{cq}{(q - Ab)^2},\quad \alpha_{bb} = \frac{2cAq}{(q - Ab)^3}.$$

Strict concavity on the relevant interval gives a unique optimal effort b^e and a unique incentive share $\alpha *$. Their defining conditions are

$$(1 - \alpha^*)(\mu - Ab^e) = \alpha_b(b^e, q)R(b^e), \tag{11}$$
$$\alpha^* = \frac{cb^e}{q - Ab^e},\quad b^e = \frac{\alpha * q}{c + \alpha^* A}.$$

Proposition 1. Optimal incentive intensity decreases with managerial overconfidence, while equilibrium development effort increases. For every finite $\beta \ge 0$, the equilibrium satisfies $0 < b^e < \mu/A$.

Proof. Write $F = qh(\alpha) - q^2 j(\alpha)$, where $h(\alpha) = \mu\alpha(1 - \alpha)/(c + A\alpha)$ and $j(\alpha) = A\alpha^2(1 - \alpha)/[2(c + A\alpha)^2]$. Let $\alpha_0 = [\sqrt{(c^2 + Ac)} - c]/A$. At an interior optimum, let $x = Ab^e/\mu$, with $0 < x < 1$. The incentive condition gives $c - 2c\alpha^* - A(\alpha^*)^2 = x[c - 3c\alpha^*/2 - A(\alpha^*)^2/2]$. The bracket on the right exceeds the expression on the left. A nonpositive bracket would imply $x \ge 1$, so both expressions must be positive. These conditions give $\alpha^* < \alpha_0\ and\ j'(\alpha^*) > 0$. At the optimum, $h' = qj'$, giving $F_{\alpha q} = -qj' < 0$. Equation (10) implies $F_{\alpha\alpha} < 0$ at the optimum. Implicit differentiation yields

$$\frac{d\alpha^*}{d\beta} = \frac{-F_{\alpha q}}{F_{\alpha\alpha}} < 0. \tag{12}$$

For the effort response, differentiating $\hat{F}_b$ with respect to q gives

$$\hat{F}_{bq} = \frac{cb(\mu - Ab)}{(q - Ab)^2} + \frac{c(q + Ab)R(b)}{(q - Ab)^3} > 0.$$
$$\frac{db^e}{d\beta} = \frac{-\hat{F}_{bq}}{\hat{F}_{bb}} > 0. \tag{13}$$

The bound $b^e < \mu/A$ follows from equation (11), whose right side is positive. The board reduces the incentive share as biased beliefs increase motivation. Effort rises, but the optimal share keeps it below the contractual performance maximum. This result concerns adjustment to biased motivation and does not establish substitution between incentives and monitoring.

5.3. Optimal Monitoring Intensity

Monitoring minimizes $G(m;\ \beta)$, the sum of evaluation error losses and review costs. Its optimality and curvature conditions are

$$G_m = km - \frac{d\eta\beta^2}{2(1+\eta m)^2} = 0, \tag{14}$$

$$G_{mm} = k + \frac{d\eta^2\beta^2}{(1+\eta m)^3} > 0.$$

At $\beta = 0$, monitoring provides zero loss reduction and $m^* = 0$. For $\beta > 0$, G_m starts below zero and increases without bound. A unique positive optimum satisfies

$$km^*(1+\eta m^*)^2 = \frac{d\eta\beta^2}{2}. \tag{15}$$

Proposition 2. Optimal monitoring intensity increases with managerial overconfidence for $\beta > 0$. Higher loss sensitivity raises monitoring, and higher monitoring costs reduce it.

Proof. Implicit differentiation of equation (15) gives

$$dm^* / d\beta = \frac{d\eta\beta}{k(1+\eta m^*)(1+3\eta m^*)} > 0, \tag{16}$$

$$dm^*/dd = \frac{\eta\beta^2}{2k(1+\eta m^*)(1+3\eta m^*)} > 0,$$

$$dm^*/dk = \frac{-m^*(1+\eta m^*)}{k(1+3\eta m^*)} < 0.$$

The right derivative of m^* with respect to β equals zero at $\beta = 0$. Greater bias raises the marginal benefit of review because it increases evaluation error losses. Monitoring reduces those losses without changing the manager's perceived quality or development effort. Its optimal level has zero sensitivity to σ under the maintained separation of payoff components.

5.4. Equilibrium Implications

Combining the unique incentive optimum with the unique monitoring optimum gives a unique equilibrium under the stated assumptions. Table 2 distinguishes effort responses under fixed controls from outcomes after the board adjusts incentives.

Table 2. Comparative Statics and Equilibrium Implications

Change	Optimal incentive share	Optimal monitoring	Effort implication
Higher β	Decreases	Increases for $\beta > 0$	Equilibrium effort increases but remains below μ/A
Higher d	Unchanged	Increases for $\beta > 0$	Equilibrium effort unchanged
Higher k	Unchanged	Decreases for $\beta > 0$	Equilibrium effort unchanged

Opposing responses of α^* and m^* reflect two consequences of the same bias parameter. Incentive adjustment changes the cost of inducing effort; monitoring limits losses outside the performance measure. Additive separation gives a zero-cross derivative between the instruments. The model supports changing control choices as bias grows, while a threshold between control regimes requires an additional criterion or interaction.

Performance interpretation requires both payoff components. Greater bias can improve the board's optimized contractual payoff through stronger motivation, while increasing the minimized sum of evaluation losses and monitoring costs. The net payoff response can have either sign. No claim of a universal decline follows from the separate control responses.

5.5. Numerical Illustration

An illustrative calculation sets $\mu = 2, \gamma = 1, \sigma = 1, c = 1, d = 0.5, \eta = 1,$ and $k = 1$. Overconfidence ranges from zero to four on 121 uniform grid points. Bisection solves equation (11) over the feasible effort interval and equation (15) over nonnegative monitoring, using 100 iterations for each

root. The incentive share follows from equation (9). Independent comparisons with a grid of 301 incentive shares at six bias values confirm the computed incentive optimum for those checks. These parameter choices describe hypothetical decision conditions.

Baseline values define an illustrative reference case. Unit values for the effort cost, monitoring effectiveness, and monitoring cost parameters establish reference scales for effort and review activity. Setting $\gamma = \sigma = 1$ gives equal contributions to the combined performance curvature $A = 2$, while $\mu = 2$ places the contractual performance maximum at one unit of effort. A loss coefficient of $d = 0.5$ sets the magnitude of evaluation losses relative to contractual performance. These choices support interpretation of the numerical comparisons and represent hypothetical conditions rather than empirical estimates.

At $\beta = 0$, the calculation gives the baseline incentive share used in the fixed incentive comparison. Table 3 reports selected equilibrium values and the corresponding board payoff.

Table 3. Illustrative Equilibrium Values

β	α^*	b^e	m^*	Board payoff
0	0.3172	0.3881	0.0000	0.4272
1	0.2850	0.5446	0.1797	0.3386
2	0.2500	0.6667	0.4656	-0.1240
3	0.2160	0.7542	0.7417	-0.8303
4	0.1861	0.8139	1.0000	-1.7143

Parameter sensitivity analysis varies each baseline parameter by 20 percent below and above its reference value, holding the remaining parameters constant. Overconfidence equals one throughout this comparison, giving baseline optimal incentives of 0.2850 and monitoring intensity of 0.1797. Proportional parameter changes permit comparison of control responses across different measurement scales.

Table 4 reports optimal incentive shares and monitoring intensities when each parameter varies by 20 percent below and above its baseline value. The comparison holds overconfidence at one and keeps all remaining parameters at their baseline values.

Table 4. Sensitivity of Optimal Controls to Parameter Changes

Parameter	Incentive share at −20%	Incentive share at +20%	Monitoring at −20%	Monitoring at +20%
μ	0.2764	0.2907	0.1797	0.1797
γ	0.2966	0.2744	0.1797	0.1797
σ	0.2966	0.2744	0.1797	0.1797
c	0.2602	0.3050	0.1797	0.1797
d	0.2850	0.2850	0.1510	0.2062
η	0.2850	0.2850	0.1577	0.1965
k	0.2850	0.2850	0.2125	0.1559

Effort cost produces the largest incentive response among the parameter changes examined. Higher effort cost increases the optimal performance share, while higher performance curvature reduces it. Equal changes in γ and σ produce identical responses because both parameters enter through their sum A. Monitoring responds to loss sensitivity, monitoring effectiveness, and monitoring cost. The largest monitoring response occurs for monitoring cost, followed by loss sensitivity. Zero responses across the

two control components follow from additive separation. These comparisons describe sensitivity near the reference case; parameter rankings can change under alternative reference values.

At β = 2, the board retains contractual performance of 0.6667 and incurs evaluation losses of 0.6823 and monitoring costs of 0.1084, producing a net payoff of −0.1240. The negative payoff reflects evaluation losses and control expenditure that exceed the return the board receives from development effort. Under the baseline parameters, optimized payoff crosses zero at an overconfidence level of approximately 1.7833. The existing commitment defines the economic interpretation of this result. Control adjustment improves the payoff within that commitment, while the available instruments cannot guarantee a positive return. A decision to cancel or withdraw would require an exit option in the model.

5.5.1 Development Effort

Figure 1 compares development effort under optimal incentive adjustment with effort under the incentive share optimal at zero overconfidence, using the contractual performance maximum as a benchmark.

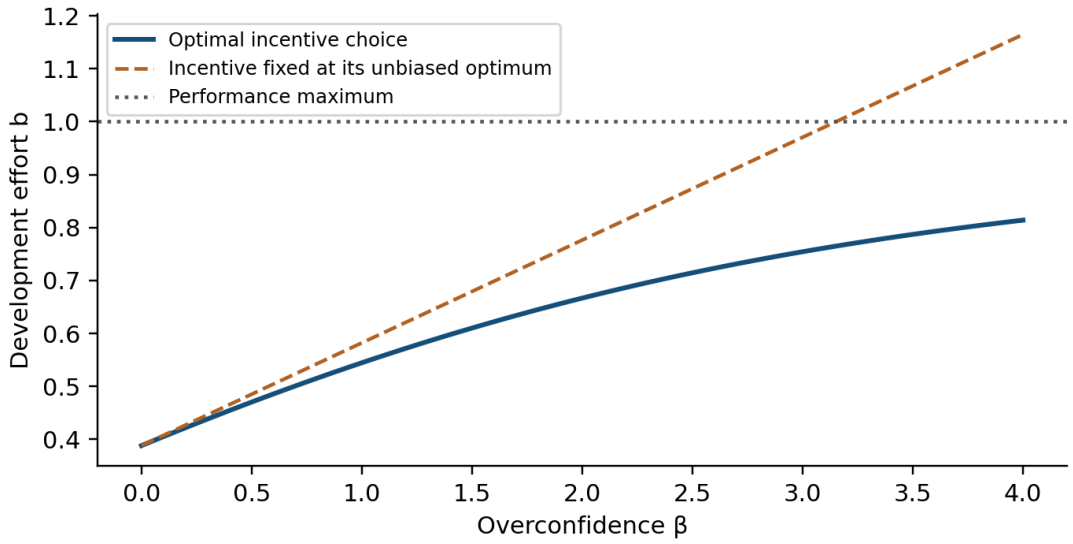


Figure 1. Development effort under fixed and optimal incentives

Figure 1 compares equilibrium effort with effort under the incentive share optimal at $\beta = 0$. The fixed share produces a larger expansion and crosses the performance maximum within the illustrated range. Optimal incentive adjustment keeps effort below that benchmark. Overconfidence can produce excessive effort under a fixed contract, while the board's optimal response prevents that outcome in this model.

5.5.2 Optimal Control Choices

The two panels in Figure 2 trace optimal incentive intensity and monitoring intensity as managerial overconfidence increases.

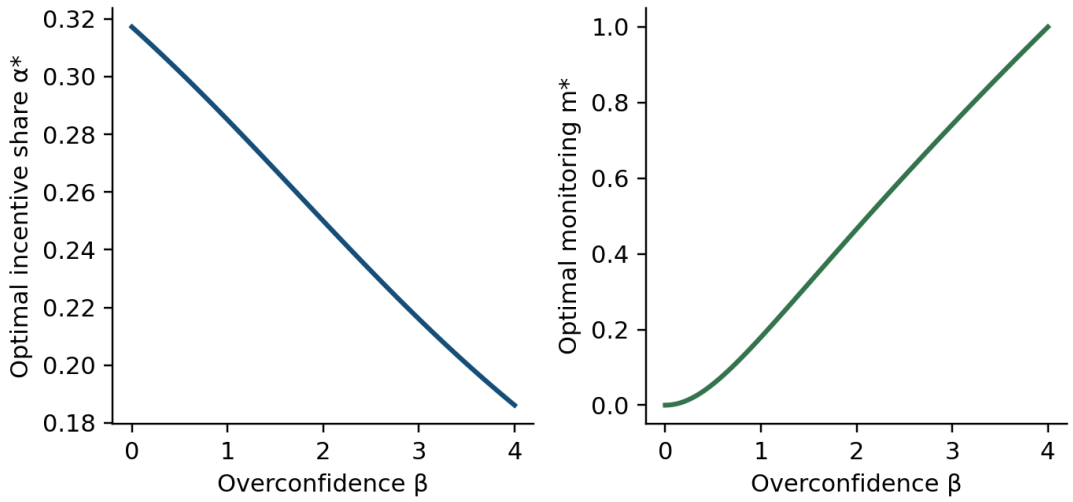


Figure 2. Incentive and monitoring responses to overconfidence

Figure 2 displays each instrument on its own scale. Incentive intensity declines and monitoring intensity rises over the illustrated range. Their levels have different units, so a crossing or numerical comparison would not identify control dominance. Separate responses follow from the analytical propositions.

5.5.3 Board Payoff

Payoff comparisons in Figure 3 assess the gains from adjusting both controls against configurations that fix the incentive share or exclude monitoring.

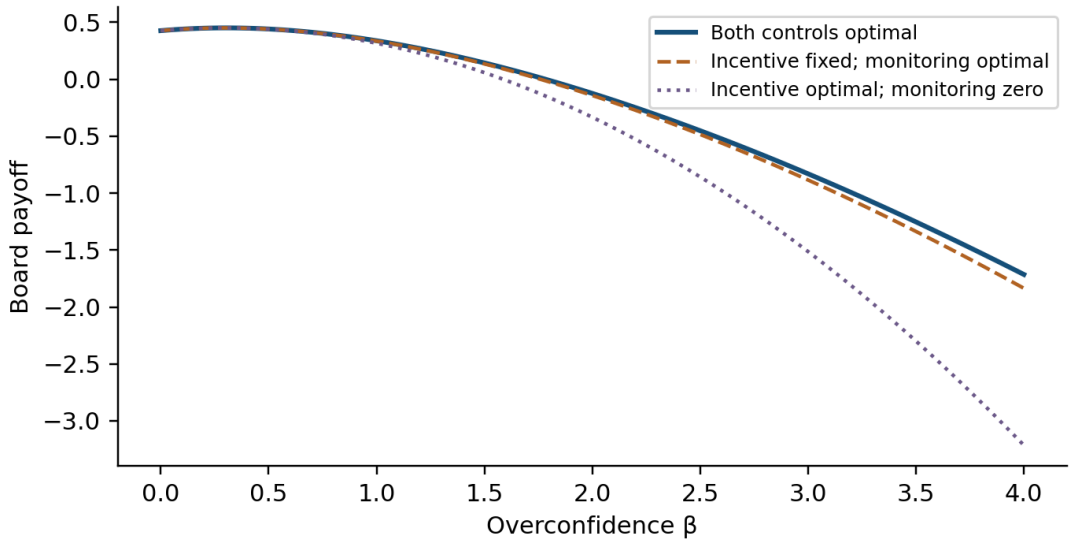


Figure 3. Payoff consequences of control adjustment

Figure 3 compares optimal choices for both instruments with two restricted configurations. One fixes the incentive share at its unbiased optimum and retains optimal monitoring. The other retains optimal incentives and sets monitoring to zero. The full optimum yields a payoff at least as high as either restricted configuration at each bias value. Payoff differences identify the gains from adjusting each instrument within the specified decision environment.

5.6 Compensation Structure and Binding Participation

Equilibrium analysis and numerical illustrations establish how incentives and monitoring respond to overconfidence under the baseline contract. Performance compensation motivates development effort

and determines the manager's reward. Choosing the incentive share requires the board to balance additional effort benefits against compensation costs. A fixed transfer could change this tradeoff by allowing the board to adjust compensation while preserving effort incentives. Examining this possibility helps distinguish the effects of managerial overconfidence from those of the compensation structure.

Introducing a fixed transfer allows the board to set compensation so that the manager evaluates expected utility as equal to reservation utility. This contract provides a basis for assessing whether the declining incentive share, increasing effort, effort bound, and monitoring response extend beyond the baseline compensation structure. Comparison of the results clarifies the contractual conditions supporting the two propositions and the economic rationale for the baseline restriction.

Let t denote a fixed payment from the firm to the manager. Perceived expected utility becomes

$$U_M = t + \alpha\left[qb - \frac{A}{2}b^2\right] - \frac{c}{2}b^2, \quad q = \mu + \beta. \tag{17}$$

The fixed transfer leaves the marginal return to effort unchanged, so equation (5) continues to determine the manager's effort response. When the transfer can take either sign, the board chooses the payment that equates perceived expected utility with zero reservation utility:

$$t = \frac{c}{2}b^2 - \alpha\left[qb - \frac{A}{2}b^2\right]. \tag{18}$$

Substitution into the board's objective gives

$$U_B = qb - \frac{A + c}{2}b^2 - \beta b(1 - \alpha) - \frac{d\beta^2}{2(1 + \eta m)} - \frac{k}{2}m^2. \tag{19}$$

For feasible effort and incentive choices, the contractual component satisfies

$$qb - \frac{A + c}{2}b^2 - \beta b(1 - \alpha) \le qb - \frac{A + c}{2}b^2 \le \frac{q^2}{2(A + c)}. \tag{20}$$

Full performance sharing eliminates the bias adjustment term and induces the effort that attains the upper bound. The optimal unrestricted contract satisfies

$$\alpha^* = 1, \quad b^e = \frac{\mu + \beta}{A + c}, \quad t^* = -\frac{(\mu + \beta)^2}{2(A + c)}. \tag{21}$$

The negative fixed transfer represents a payment from the manager to the firm in exchange for the full contractual performance payoff. Inflated expectations increase the payment that the manager accepts. Participation binds under the manager's subjective assessment, consistent with the beliefs governing effort.

These results clarify the scope of Proposition 1. Equilibrium effort increases with overconfidence under both compensation structures. Full performance sharing remains optimal under the unrestricted contract, while the baseline contract produces a declining incentive share. Effort under unrestricted transfers exceeds the contractual performance maximum when $\beta > \frac{\mu c}{A}$. Both the declining share and the effort bound depend on the compensation restriction. Proposition 2 retains its conclusions because the fixed transfer leaves evaluation error losses and monitoring costs unchanged. Optimal monitoring continues to satisfy equation (15) and increases with overconfidence for positive bias.

Employment arrangements that restrict fixed compensation to nonnegative payments provide a rationale for the baseline contract. Such arrangements permit salary and performance rewards while excluding an upfront payment from the manager to the firm. With zero reservation utility, performance compensation satisfies participation. Adding a positive fixed payment raises expenditure while leaving effort unchanged, so the board chooses a fixed payment of zero. The baseline results apply to this contract class, while the unrestricted transfer comparison identifies how the ability to extract perceived surplus changes incentive design.

Extending the analysis to contracts with binding participation clarifies the scope of the baseline findings. Both the declining incentive share and the effort bound depend on restrictions that prevent the board from using a negative fixed transfer to extract the surplus the manager expects. Greater overconfidence increases effort and monitoring across both contract classes. Compensation restrictions

define the boundary of the incentive result, while the monitoring result remains valid under the assumption that evaluation losses remain separate from compensation.

6. DISCUSSION AND MANAGEMENT CONTROL IMPLICATIONS

Managerial overconfidence affects control optimization through effort motivation and evaluation error losses. Inflated opportunity assessments increase the effort that managers supply under a given incentive contract. Optimal control responds through a lower incentive share and greater monitoring. These responses address separate consequences of biased judgment: incentives influence effort and reward allocation, while monitoring reduces losses outside the compensation measure. Their opposing trajectories reflect adjustment to a common behavioral condition.

6.1 Incentive Adjustment under Biased Motivation

Conventional agency problems concern the cost of inducing managerial effort. Overconfidence changes this problem because inflated expectations increase the returns that managers anticipate from development activity. A board that recognizes this motivation can induce effort with a smaller incentive share. Lower optimal incentive intensity reflects a change in the contract needed to motivate action.

Equilibrium effort increases as managerial overconfidence grows, despite the decline in incentive intensity. Under the baseline contract, the board's adjustment keeps effort below the level that maximizes objective contractual performance. This distinction separates expansion under biased beliefs from excessive effort. A fixed contract can induce effort beyond the performance maximum, while an optimal contract adjusts the reward share as beliefs change.

Incentive responsiveness remains positive throughout the model. Stronger overconfidence raises the marginal effort response to the incentive share under fixed control choices. The decline in optimal incentives follows from the board's payoff calculation, which balances effort benefits against the share of performance allocated to compensation. Claims that biased managers lose sensitivity to incentives would misrepresent this mechanism.

6.2 Monitoring and Organizational Evaluation Quality

Monitoring addresses evaluation errors that the contractual performance measure omits. Opportunity screening, partner assessment, and initiative structuring can create losses that remain outside the manager's reward calculation. Review activities reduce these losses and create a control benefit that incentive adjustment cannot reproduce within the specified payoff structure.

Greater overconfidence raises the marginal benefit of monitoring because the assumed evaluation losses increase with bias. Higher monitoring costs reduce the optimal level of review, while greater sensitivity of losses to bias increases it. These relationships locate monitoring within a decision problem that balances expected loss reduction against review expenditure.

Organizational evaluation quality differs from the manager's subjective opportunity assessment. Monitoring improves procedures and limits the consequences of evaluation errors, while the manager retains the belief that guides effort. The contribution concerns control of organizational losses under persistent bias. Cognitive correction would require a mechanism through which monitoring changes managerial beliefs.

6.3 Implications for Business Development Decisions

Business development combines effort devoted to opportunity pursuit with judgments about markets, partners, and organizational arrangements. A performance contract can reward development activity while omitting some consequences of those judgments. Distinguishing these dimensions helps explain why firms may need both motivational controls and evaluation procedures.

Practical application requires an assessment of what the compensation measure captures. Boards can examine whether rewards reflect development results, whether evaluation mistakes impose additional costs, and whether review procedures can reduce those costs. Potential procedures include independent assessments of partner capabilities, checks on commercial assumptions, and reviews of proposed resource obligations. Their relevance depends on the errors they address and the information they provide.

Resource commitment defines the scope of the model's application. The firm has committed to pursuing an opportunity, and control choices govern additional managerial effort and evaluation procedures. Negative optimized payoffs can arise when unavoidable evaluation losses and control costs exceed retained performance. Such outcomes indicate the limits of control adjustment within an existing commitment. Decisions about cancellation or withdrawal require an extension that includes an exit option.

6.4 Interpreting Changes in Control Choices

Declining incentives and increasing monitoring describe responses to managerial bias. Additive separation gives each instrument a distinct optimization problem. A change in monitoring cost affects the monitoring choice without changing optimal incentives, while a change in the effort cost parameter enters the incentive problem. These features define the scope of the control relationships.

Comparison of instrument levels requires attention to their units and economic roles. An incentive share measures reward allocation, whereas monitoring intensity measures review activity. A numerical crossing between their trajectories would lack a basis for identifying control dominance. Classification into low, intermediate, and high bias regimes would require thresholds that the current model does not establish.

Environmental uncertainty has a narrower role than managerial bias in this formulation. It increases the productivity penalty associated with development effort and reduces effort under fixed incentives. Optimal monitoring remains independent of this parameter because evaluation losses depend on bias and review intensity. A claim that uncertainty raises monitoring would require an additional link between uncertainty and the benefits of review.

6.5 Payoff Consequences and Decision Support

Payoff effects combine the motivational benefit of overconfidence with the costs of evaluation errors. Inflated expectations allow the board to obtain effort with a lower reward share and improve its optimized contractual payoff. Growing bias increases the minimum combined burden of evaluation losses and monitoring expenditure. The net payoff response depends on the balance between these effects.

Numerical comparisons illustrate the gains from adjusting each control instrument. Optimal choices for both instruments yield a payoff at least as high as configurations that fix incentives or exclude monitoring. This comparison follows from the available choice set and identifies the cost of imposing those restrictions. The magnitude of the gain depends on the illustrative parameter values.

Decision support can build on this structure through explicit objectives, feasible control choices, and transparent assumptions. Application would require estimates of effort costs, evaluation losses, and monitoring effectiveness. Sensitivity analysis could examine how uncertainty about those estimates changes recommended controls. Parameter uncertainty concerns the reliability of the decision support exercise, while environmental uncertainty concerns effort productivity within the model.

6.6 Limitations and Future Research

Several assumptions delimit the findings. A single board and a single manager represent delegated decision making, while expected monetary payoffs define their objectives. The board knows the manager's bias and the objective expected quality benchmark. Actual organizations may face uncertainty about both quantities, creating an estimation problem alongside control optimization.

Functional choices support tractability but constrain interpretation. Quadratic effort costs govern motivation, and a separate loss function links bias with evaluation errors. Monitoring acts on those losses without changing beliefs or effort. Alternative specifications could connect review activity with managerial learning, performance measurement, or development productivity. Each extension would require new derivations to establish its implications for optimal controls.

Losses remain independent of development effort because they concern arrangements associated with an existing commitment. Allowing losses to vary with effort, project scale, or the decision to proceed could create interactions between control instruments. An exit option would permit analysis of whether the firm should continue an opportunity when its optimized payoff falls below an alternative return.

Empirical research can assess the distinction between motivational effects and evaluation losses. Relevant settings include technology commercialization, market entry, and partnership development,

where rewards may capture some outcomes while omitting others. Studies could examine whether stronger managerial overconfidence accompanies lower incentive shares and greater review expenditure, while accounting for contract design, selection effects, and the information available to boards. Such evidence would assess the model's applicability and the conditions supporting its assumptions.

7. CONCLUSION

Business development decisions combine managerial effort with judgments about opportunities, partners, and resource commitments. This study develops an agency model to examine how managerial overconfidence shapes optimal incentives and monitoring. Separating contractual performance from evaluation error losses clarifies how control choices address distinct consequences of biased judgment.

The baseline model establishes that greater overconfidence reduces the optimal incentive share and increases development effort. Optimal incentive adjustment keeps effort below the level that maximizes objective contractual performance. Monitoring increases with overconfidence because larger evaluation losses raise the benefit of review. Its contribution concerns loss reduction, while managerial beliefs and effort remain unchanged by monitoring. Opposing control responses follow from separate optimization problems and a common source of behavioral distortion.

These findings contribute to decision analysis and management control research by distinguishing effort motivation from the organizational costs of evaluation errors. Inflated expectations can improve the board's contractual payoff through stronger motivation, while increasing evaluation losses and control expenditure. Net payoff effects depend on the balance between these consequences. Control optimization requires attention to what compensation measures capture and which losses review procedures can reduce.

Future research can introduce learning, uncertainty about managerial bias, interactions between effort and evaluation losses, and options to discontinue an opportunity. Empirical studies can assess whether incentive shares and review expenditure respond to overconfidence under the conditions specified by the model. Such extensions would establish the framework's applicability across business development settings.

Acknowledgements: The author thanks the anonymous reviewers for their thoughtful comments and valuable suggestions, which strengthened the model's economic justification, clarified the scope of the findings, and improved the numerical analysis.

Author Contributions: Yu-Min Wei was responsible for conceptualization, methodology, formal analysis, visualization, writing, review, and editing.

Declaration of Use of Artificial Intelligence: The author acknowledges the use of ChatGPT (OpenAI), accessed in October 2026, for language polishing. The author reviewed and revised all language revisions to ensure accuracy, clarity, and consistency with the intended meaning and remains responsible for the manuscript content.

Data Availability Statement: This study uses no external datasets. The article and supplementary materials provide the analytical derivations, code, and numerical results supporting the findings.

Funding Statement: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of Interest Disclosure: The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethics Approval Statement: Not applicable.

Consent to participate: Not applicable.

Consent for publication: Not applicable.

Permission to Reproduce Material: Not applicable.

Clinical Trial Registration: Not applicable.

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