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Remuneração dos Gestores e Timing do IPO: Uma Abordagem de Opções Reais

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Managerial Compensation and IPO Timing: A Real Options Approach

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Resumo

Esta dissertação desenvolve um modelo de opções reais para analisar o *timing* de uma oferta pública inicial, num contexto em que gestores e acionistas podem discordar sobre o momento ótimo para listar a empresa em bolsa. A questão central é perceber se a compensação do gestor pode ser desenhada de forma a alinhar os seus incentivos com os dos acionistas. O principal resultado é que um contrato simples de partilha de valor, no qual o gestor recebe uma fração fixa do valor operacional pós-IPO, consegue alinhar a sua decisão com o momento ótimo dos acionistas. Este bónus não depende do valor operacional corrente e dos parâmetros do processo subjacente, pelo que o contrato pode ser definido no início da relação e não precisa de ser renegociado.

O modelo é depois estendido em duas direções. Na primeira, os investidores externos valorizam as ações do IPO acima do valor fundamental, antecipando o IPO. Na segunda, o gestor é impaciente, pelo que tem maior incentivo para listar mais cedo. Em ambos os casos, o mesmo tipo de contrato continua a alinhar a decisão de *timing*, sendo apenas necessário ajustar o nível do bónus à fonte específica de desalinhamento.

Em termos de *welfare*, sob sentimento de mercado, os *payoffs* de ambos os agentes internos permanecem inalterados relativamente ao modelo base, resultado que decorre da forma como o exercício ótimo é determinado em modelos de opções reais, sendo reforçado pela estrutura linear do contrato e pelo facto de o sentimento afetar apenas as receitas do IPO. Tal não significa que mercados favoráveis sejam irrelevantes para os emitentes na prática, uma vez que o modelo abstrai de vários canais através dos quais estes podem ter efeito. Sob impaciência do gestor, o custo de listar mais cedo reflete-se no *welfare* do gestor, enquanto o dos acionistas permanece inalterado.

Palavras-chave: *timing* do IPO; opções reais; teoria da agência; remuneração executiva; impaciência do gestor; sentimento de mercado

Classificação JEL: G32; G34; D86; J33

Abstract

This dissertation develops a real options model of IPO timing in which managers and shareholders may disagree about when to go public, and asks whether compensation can align their incentives. The central result is that, under the model's assumptions, a simple value-sharing contract, in which the manager receives a fixed fraction of the post-IPO operating value, can align his timing decision with the shareholders' threshold. In the base model, this bonus does not depend on the current operating value or the underlying parameters, so the contract can be set at the outset and need not be renegotiated later.

The model is then extended in two directions. In the first case, outside investors value IPO shares above their fundamental value, bringing the IPO forward. In the second, the manager is impatient and is eager to list early. In both cases, the same contract still aligns the timing decision, with only the bonus level adjusting to the misalignment.

Turning to welfare, under market sentiment, the model implies that both insider payoffs are unchanged relative to the base model, a consequence of how optimal exercise is determined in the model, reinforced by the linear contract and by sentiment entering only through the IPO proceeds. This does not mean that favorable markets are irrelevant to issuers in practice, since the model abstracts from several channels through which they matter. Under managerial impatience, listing early imposes a cost on the manager's welfare, leaving shareholders unaffected.

Keywords: IPO timing; real options; agency theory; executive compensation; managerial impatience; market sentiment

JEL Classification: G32; G34; D86; J33

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1 Introduction

A substantial part of the literature has examined the factors that influence the timing of an initial public offering (IPO), showing that firms tend to cluster their decisions in periods of high valuations and optimistic investor sentiment, suggesting that this decision is inherently strategic. This intuition is naturally captured by a real options approach, in which the IPO is treated as an option that the firm exercises when economic conditions are sufficiently favorable, allowing the optimal timing to arise endogenously from the dynamics of the firm's cash flows and the opportunity cost of waiting.

However, an important aspect of the IPO decision remains relatively unexplored, namely the presence of agency conflicts within a firm. In practice, the decision to go public is rarely made by a single agent, as shareholders and managers often have different incentives and preferences regarding the timing of the IPO. While shareholders aim to maximize firm value, managers may be influenced by private benefits, career concerns, or differences in time horizons, leading to divergent preferences over IPO timing and, ultimately, a suboptimal listing decision.

Despite the growing literature on both real options and executive compensation, these two strands have rarely been combined to study the IPO timing problem. This dissertation addresses this gap by asking the following research question: How should a shareholder design a value-sharing contract so that a manager chooses the shareholder-optimal IPO timing when the IPO decision is an irreversible real option?

The analysis builds on two existing frameworks. Bustamante (2012) provides a rigorous real options model of IPO timing, but treats the manager and shareholders as a single entity, abstracting from agency conflicts. Cardoso and Pereira (2015) designs an optimal compensation contract that aligns the investment timing of a self-interested manager with shareholders' preferences in a real options setting, but does not apply their framework to the IPO decision specifically. This dissertation combines the two by adopting the real options structure of Bustamante (2012) and the compensation design methodology of Cardoso and Pereira (2015), applying them jointly to the IPO timing problem.

The base model shows that introducing a simple value-sharing contract, consisting of a fixed fraction of post-IPO operating value, is sufficient to align the IPO timing decisions of both parties under the assumptions. Importantly, the optimal value-sharing bonus does not depend on the current operating value or on the parameters of the underlying process, meaning that it can be agreed upon at the outset without requiring renegotiation as market conditions evolve. Building on this foundation, two independent extensions further develop the framework. First, under market sentiment, outside investors hold optimistic beliefs and are willing to pay above fundamental value.

Despite this external distortion, the optimal contract continues to align incentives and, within the assumptions, the welfare of both insiders remains unchanged relative to the base case. Second, under managerial impatience, managers discount future payoffs at a higher rate than shareholders do (Grenadier and Wang, 2005). Although the contract still aligns IPO timing decisions, the payoff consequences become asymmetric: the manager's welfare declines as impatience increases, while shareholders remain unaffected.

The remainder of the dissertation is organized as follows. Section 2 reviews the relevant literature. Section 3 presents the base model and derives the optimal contract. Section 4 extends the framework to incorporate market sentiment. Section 5 introduces managerial impatience. Section 6 concludes by discussing the main results, limitations, and directions for future research. Mathematical proofs are collected in the Appendix.

2 Literature Review

2.1 Motives and Costs of Going Public

The decision to go public is one of the most studied topics in corporate finance, reflecting the complexity of a transaction that simultaneously affects the firm's capital structure, ownership, and long-term strategic positioning. Understanding why and when firms choose to conduct an IPO is therefore central to the study of investment policy and financial markets.

The literature identifies several reasons for going public, with access to external financing being one of the most common. Pagano et al. (1998) study a large sample of Italian firms and find that companies tend to go public after periods of high growth and investment, often to rebalance their capital structure. Similarly, Chemmanur et al. (2010) find that capital expenditures are significantly related to the probability of going public, consistent with the view that firms also use the IPO as financing for investment opportunities that they could not otherwise fund.

Beyond financing, IPOs serve other strategic purposes. A common motive is the desire to create publicly traded shares that can be used as acquisition currency in stock-based deals, making it easier to grow through mergers and acquisitions (Zingales, 1995; Brau et al., 2003). Going public also provides founders and early investors with a natural exit route, allowing them to partially liquidate their holdings while the firm continues to operate (Black and Gilson, 1998). The increased visibility and analyst coverage that come with a public listing can improve external monitoring and strengthen the firm's reputation with customers, suppliers, and employees (Pagano et al., 1998; Maksimovic and Pichler, 2001). In practice, the decision to go public is rarely driven by a single motive, as it reflects the simultaneous pursuit of several of these objectives.

At the same time, the decision to go public carries significant costs and risks. Direct transaction costs, including underwriting, legal, and registration fees, can represent around 7% of IPO proceeds in the United States (Ritter, 1987), making the IPO one of the most expensive corporate transactions. A central source of additional costs is the information asymmetry between issuers and investors. Leland and Pyle (1977) argue that this asymmetry is a fundamental friction shaping financing decisions, as firms with better prospects may struggle to credibly communicate their quality to the market. Rock (1986) shows that new shares are systematically offered below their fundamental value as a way to compensate uninformed investors for the risk of participating alongside better-informed ones. Loughran and Ritter (2004) document that the magnitude of underpricing has varied substantially over time, rising sharply during the hot market of the late 1990s, and argue that this variation reflects changes in the composition of issuers and in the bargaining power between firms and underwriters.

Public listing also requires extensive disclosure of financial and strategic information, which can reduce confidentiality and weaken a firm's competitive position. Yosha (1995) shows that these disclosure costs are particularly relevant for firms with sensitive proprietary information. Brau and Fawcett (2006) further report that managers view the loss of autonomy after listing as an important concern, suggesting that the decision to go public involves not only financial considerations but also a significant change in the way the firm is governed and monitored.

More broadly, these costs and frictions imply that the timing of an IPO may have important consequences for firm value and for the distribution of gains between different stakeholders. In particular, the presence of uncertainty, asymmetric information, and changes in governance structure suggests that managers and shareholders may not always evaluate the benefits of going public in the same way.

2.2 IPO Timing, Market Conditions, and Waves

Even after a company decides to go public, determining the optimal timing of the IPO is not straightforward. Empirical evidence consistently shows that IPO activity is cyclical, with periods of intense issuance followed by intervals in which market entry becomes substantially more limited. Ritter (1991) further shows that firms going public during hot markets tend to underperform in subsequent years, suggesting that issuers may strategically exploit temporary investor optimism rather than simply signal stronger fundamentals. Lowry (2003) shows that IPO volume is jointly driven by financing needs and investor sentiment, linking aggregate issuance activity to broader macroeconomic and market conditions. In a similar way, Helwege and Liang (2004) compare firms that go public in hot and cold markets and find that the two differ mainly in the number of issuers rather than in their fundamentals, concluding that hot markets are best explained by greater investor optimism. At a broader level, Baker and Wurgler (2006) show that investor sentiment has measurable effects on asset prices, with the strongest impact on young, hard-to-value firms, the kind that typically come to market through an IPO. Taken together, these empirical regularities suggest that IPO timing is endogenous and strategically determined, providing the main empirical motivation for modeling the listing decision as an optimization problem.

On the theoretical side, Ljungqvist et al. (2006) formalizes the role of investor optimism by modeling hot markets as periods in which a segment of investors holds overly optimistic beliefs about firm value. Their framework shows that rational insiders may accelerate IPO timing in order to exploit temporary sentiment-driven overvaluation. This mechanism directly motivates the market sentiment extension developed in this dissertation, in which outside investors value IPO shares above their fundamental value, and insiders strategically respond to this pricing distortion. In a closely related contribution, Derrien (2005) models how investor sentiment can push IPO prices above fundamental value, showing that strong sentiment-driven demand from individual investors leads to high offer prices, large initial returns, and poor long-run performance. In parallel, Pástor and Veronesi (2005) develop a rational equilibrium framework in which IPO waves arise endogenously from variation in the cost of capital, providing an alternative explanation for issuance clustering that does not rely on behavioral assumptions.

However, these models generally treat the firm as a unified decision maker. A single agent determines the optimal IPO threshold, while the possibility that managers and shareholders may prefer different listing timings is abstracted away. This omission is economically important, since in practice the listing decision is typically made by managers whose incentives may not be perfectly aligned with shareholders'. Therefore, while the existing IPO timing literature provides strong motivation for modeling the listing decision as a strategic timing problem, it leaves open the question of how internal agency conflicts may affect it.

2.3 The Real Options Approach to IPO Timing

The real options framework, introduced by Myers (1977) and formalized by Dixit and Pindyck (1994), provides the theoretical foundation for analyzing IPO timing. The central idea is that investment opportunities resemble financial call options: their holder has the right, but not the obligation, to commit capital when conditions are favorable. Dixit and Pindyck (1994) show that the value of waiting can be substantial even under moderate uncertainty, and that the optimal exercise threshold lies strictly above the zero-NPV level. This framework is well-suited to the IPO context because it allows the optimal timing to arise endogenously from cash flow dynamics and market conditions.

Several authors have applied real options analysis specifically to IPO timing. Benninga et al. (2005) derive conditions under which going public is optimal by trading off private benefits of control against diversification gains. Draho (2000) confirms the option-like nature of the listing decision by showing that firms time their offerings relative to market benchmarks.

However, the most directly relevant contribution for this dissertation is Bustamante (2012), who embeds IPO timing in a real options framework with asymmetric information and signaling. In her model, firms differ in quality and use the timing of the IPO, the fraction of shares offered, and underpricing as signals to outside investors. This dissertation builds on the core structure of her framework, particularly the link between IPO proceeds and the exercise of a growth option, as well as the role of the growth factor θ in capturing the resulting increase in future value. However, the present model abstracts from the signaling dimension in order to focus on a different source of distortion. Specifically, asymmetric information between the firm and the market is replaced in the base model by full information and pricing at fundamental value, allowing the analysis to isolate the agency conflict between the manager and shareholders.

2.4 Agency Conflicts and IPO Timing

A key simplification in the Bustamante (2012) model is the assumption that the manager and the shareholders act as a single entity. This allows the analysis to focus entirely on the information asymmetry between the firm and the market, but it sets aside a dimension of the problem that is equally important in practice. The separation of ownership and control, long recognized as a defining feature of the modern corporation, gives rise to agency costs that can distort a wide range of corporate decisions. Jensen and Meckling (1976) argue that whenever managers do not bear the full consequences of their decisions, they will tend to act in ways that benefit themselves rather than shareholders. In the context of an IPO, this tension is particularly sharp because the manager controls the timing of the transaction, which determines how much value each party receives, and the two parties may have very different views on when that transaction should take place.

The direction of the conflict is not always the same, and this asymmetry is central to understanding IPO timing distortions. On one hand, a manager who values the autonomy and private benefits of running a private firm may want to delay the IPO beyond what shareholders would find optimal, since going public brings scrutiny, accountability, and a loss of control (Shleifer and Vishny, 1997). On the other hand, a manager who holds a significant equity stake or faces career concerns may prefer to list sooner, converting his position into liquid wealth even at the cost of a lower long-run valuation (Brau and Fawcett, 2006). Related evidence is provided by Lerner (1994), who shows that venture-backed biotech firms are significantly more likely to go public when market valuations are high. This evidence is consistent with the idea that some insiders may prefer earlier listing when market conditions are favorable, although it does not directly identify an agency conflict between managers and shareholders.

These opposing tendencies show that the agency conflict over IPO timing can push the manager toward either a later or an earlier listing than shareholders would choose. The framework developed in this dissertation is designed to accommodate both directions, since the value-sharing contract realigns the manager's threshold with the shareholders' regardless of the direction of the underlying distortion. What remains is to specify how such a contract should be structured.

2.5 Compensation Design in a Real Options Setting

The question of how to design a compensation contract that induces a manager to exercise an investment option at the shareholders' preferred threshold has attracted considerable attention in the real options literature. More broadly, the corporate finance literature shows that managerial compensation is a central mechanism through which shareholders can shape managerial decisions. Jensen and Murphy (1990) show that how managers are paid directly affects their behavior, and that poorly designed incentive structures can generate systematic distortions in investment and financing decisions. Similarly, Bebchuk and Fried (2003) argue that compensation packages may reflect managerial influence rather than shareholder interests, highlighting the need for a contract-theoretic approach to incentive alignment.

Within the real options literature, Grenadier and Wang (2005) show that a manager facing private information and moral hazard may delay exercise relative to the shareholder-optimal threshold, and that this distortion can be corrected by linking compensation to project cash flows at exercise. Nishihara and Shibata (2008) show that combining monitoring with performance-sensitive pay can substantially reduce efficiency losses arising from moral hazard. Hori and Osano (2013) further show that restricted stock may dominate options when the main concern is investment timing rather than average performance, providing further support for a linear compensation structure in this setting.

The most closely related paper is Cardoso and Pereira (2015). Their model considers a firm in an idle state that transitions to an active state upon investment, and derives a value-sharing bonus that is independent of the current value of the state variable, the risk-free rate, and the volatility. This state-independence property, which this dissertation also obtains and extends to the IPO context, makes the contract practically implementable without requiring continuous renegotiation.

The model of Cardoso and Pereira (2015) differs from the setting of this dissertation in two aspects. First, their framework applies to a generic real option and does not study the IPO decision specifically. Second, their model assumes the firm begins in an idle state with no pre-investment cash flows, whereas a firm contemplating an IPO is typically already operational. The models of IPO timing, such as Bustamante (2012), treat the firm as a single decision maker and abstract from the conflict between managers and shareholders, while the models of compensation design in real options, such as Cardoso and Pereira (2015) and Grenadier and Wang (2005), address that conflict but not in the IPO context. This dissertation sits at the intersection of the two, extending value-sharing compensation to an IPO timing setting in which the firm is already operational, and the listing decision is delegated to a manager whose incentives may differ from those of shareholders.

3 The Base Model

3.1 Setup and Assumptions

Consider a private firm with assets in place and a growth option to invest. The firm is owned by shareholders who hire a manager to run it, and an agency conflict arises because the two parties may have different preferences regarding the optimal timing of the IPO. The model abstracts from signaling and asymmetric information between the firm and the market, focusing instead on the design of an optimal compensation contract that aligns the manager's timing decision with that of the shareholders.

The firm's assets in place generate operating cash flows whose present value is summarized by the state variable X_t, which follows a geometric Brownian motion (GBM) under the risk-neutral measure:

$$dX = \mu X \, dt + \sigma X \, dZ, \tag{3.1}$$

where $\mu = r - \delta, r > 0$ is the risk-free rate, $\delta > 0$ is the opportunity cost of deferring investment (convenience yield), $\sigma > 0$ is the instantaneous volatility, and dZ is the increment of a standard Wiener process. There are no time restrictions on exercising the option, so the option to conduct the IPO is perpetual.

The Compensation Contract

The manager receives a fixed wage $W > 0$ and participates in the firm's operating value through a value-sharing bonus:

- Before the IPO, he receives a fraction $\phi_i \in]0, 1[$ of the pre-IPO operating value X.
- After the IPO, he receives a fraction $\phi_a \in]0, 1[$ of the post-IPO scaled operating value θX, where $\theta > 1$ is the growth factor by which the firm's operating value increases upon exercise of the growth option.

Both ϕ_i and ϕ_a are fractions of the firm's operating value X, not fractions of the equity stake or the IPO proceeds, as the manager does not hold equity and does not benefit from capital gains or IPO proceeds. The shareholders design ϕ_a to align the manager's IPO timing decision with their own, as derived below.

The fixed wage W is the same before and after the IPO. This is a deliberate simplification that isolates ϕ_a as the sole instrument through which shareholders influence the manager's timing decision. It is also economically plausible, since fixed wages are typically set by long-term employment contracts and are not renegotiated at the moment of a corporate event such as an IPO.

In this dissertation the firm is already operational before the IPO, so that the manager actively manages the operating value X prior to listing. As a consequence, the pre-IPO share $\phi_i > 0$ is a novel feature of this model that plays an important role in determining the optimal ϕ_a^* and the conditions under which the manager accepts the contract.

In addition, the manager incurs effort costs $E_i > 0$ pre-IPO and $E_a > E_i$ post-IPO, with increment $\Delta E = E_a - E_i > 0$ reflecting the higher disutility of running an active, listed firm. This effort increment, together with the manager's positive compensation gain from the IPO discussed below, ensures that the manager's exercise threshold is positive and economically meaningful.

For consistency, the effort costs E_i and E_a, the wage W, and the investment cost K introduced below are all expressed in present-value terms, in the same units as X.

The Growth Option and IPO Financing

The firm has a growth option that escalates the firm's operating value by a factor $\theta > 1$ upon exercise, reflecting the expansion of productive capacity following Bustamante (2012). At the IPO, the firm issues a fraction $q \in]0, 1[$ of its post-IPO equity to outside investors, generating proceeds:

$$P = q\left[(1 - \phi_a)\theta X - W\right]. \tag{3.2}$$

These proceeds finance the investment cost $K > 0$. Following Bustamante (2012), the firm operates a residual dividend policy and holds no cash, so any excess $P - K \geq 0$ is distributed to the original shareholders with the remaining fraction $(1 - q)$ of the post-IPO firm being retained by them. The fraction q is treated as exogenous and the financing constraint $P \geq K$ is assumed satisfied at the optimal threshold. This requires q to exceed a minimum level q_{min}, which is characterized explicitly in equation (3.35) once the optimal contract and trigger have been derived.

3.2 Payoff Functions

The manager's payoff from the IPO is the gain in compensation minus the increase in effort costs:

$$\Pi^M(X) = (\phi_a\theta X - E_a + W) - (\phi_i X - E_i + W) = \phi_a\theta X - \phi_i X - (E_a - E_i). \tag{3.3}$$

The shareholders' payoff from the IPO is derived from three distinct components. The value of the fraction retained by the original shareholders after the IPO is:

$$S_a(X) = (1-q)\left[(1-\phi_a)\theta X - W\right]. \tag{3.4}$$

The value of the shareholders' position before the IPO is:

$$S_i(X) = (1-\phi_i)X - W. \tag{3.5}$$

The proceeds received by the firm from issuing fraction q to outside investors are:

$$P(X) = q\left[(1-\phi_a)\theta X - W\right]. \tag{3.6}$$

It is important to note that $S_a(X)$ and $P(X)$ together reconstruct the full post-IPO firm value net of managerial compensation:

$$S_a(X) + P(X) = (1-\phi_a)\theta X - W, \tag{3.7}$$

since together $(1-q)$ and q account for the entire post-IPO firm value, split between original and new shareholders. Including P in full and subtracting K is therefore equivalent to including only the excess $P - K$, but makes the derivation more transparent. The net payoff for the shareholders is therefore

$$\begin{aligned}\Pi^S(X) &= S_a(X) - S_i(X) + P(X) - K \\ &= \left[(1-\phi_a)\theta X - W\right] - \left[(1-\phi_i)X - W\right] - K \\ &= (1-\phi_a)\theta X - W - (1-\phi_i)X + W - K \\ &= (1-\phi_a)\theta X - (1-\phi_i)X - K, \end{aligned} \tag{3.8}$$

where the second line uses $S_a + P = (1-\phi_a)\theta X - W$ established above, and the fixed wage W cancels because it is paid at the same level before and after the IPO. It therefore affects the level of post-IPO firm value and the financing constraint, but not the incremental payoff from listing. Note also that q drops out of the final expression, confirming that the shareholders' net payoff depends only on the compensation contract ϕ_a and the investment cost K, independently of the equity issuance size. This result is consistent with Bustamante (2012), whose value matching condition takes the same form.

Remark 3.1 (Role of the Fixed Wage)**.** *Although W cancels from both the shareholders' and the manager's net payoffs, it is not redundant in the model. It enters the post-IPO firm value* $(1-\phi_a)\theta X - W$, *which determines both the IPO proceeds P and the value retained by original shareholders S_a. Therefore, a higher fixed wage reduces the net proceeds available to cover the investment cost K, which in turn raises the minimum share fraction q_{min} required to satisfy the financing constraint. This is verified numerically in Section 3.7.*

3.3 The Shareholders' Problem

Before the IPO, the shareholders hold a contingent claim on the firm's operating value. Following the standard real options approach of Dixit and Pindyck (1994) and Bustamante (2012), the shareholders' value function $F^S(X)$ must satisfy the following ordinary differential equation (ODE):

$$\frac{1}{2}\sigma^2 X^2 F^{S\prime\prime}(X) + \mu X F^{S\prime}(X) - rF^S(X) = 0. \tag{3.9}$$

The general solution to equation (3.9) is:

$$F^S(X) = A_1 X^{\beta_1} + A_2 X^{\beta_2}, \tag{3.10}$$

where $\beta_1 > 1$ and $\beta_2 < 0$ are the positive and negative roots of the fundamental quadratic $Q(\beta) = 0$:

$$Q(\beta) = \frac{1}{2}\sigma^2\beta(\beta - 1) + \mu\beta - r = 0, \tag{3.11}$$

given by:

$$\beta_1 = \frac{1}{2} - \frac{\mu}{\sigma^2} + \sqrt{\left(\frac{\mu}{\sigma^2} - \frac{1}{2}\right)^2 + \frac{2r}{\sigma^2}} > 1, \tag{3.12}$$

$$\beta_2 = \frac{1}{2} - \frac{\mu}{\sigma^2} - \sqrt{\left(\frac{\mu}{\sigma^2} - \frac{1}{2}\right)^2 + \frac{2r}{\sigma^2}} < 0. \tag{3.13}$$

The shareholders choose the value threshold X_S^* to maximize their option value, subject to the following boundary conditions:

Absorbing barrier:

$$F^S(0) = 0. \tag{3.14}$$

Value matching condition:

$$F^S(X_S^*) = (1 - \phi_a)\theta X_S^* - (1 - \phi_i)X_S^* - K. \tag{3.15}$$

Smooth pasting condition:

$$F^{S\prime}(X_S^*) = (1-\phi_a)\theta - (1-\phi_i). \tag{3.16}$$

The absorbing barrier condition (3.14) requires that the option is worthless when the operating value is zero. Since $\beta_2 < 0$, the term $A_2 X^{\beta_2} \to \infty$ as $X \to 0$, which would violate this condition. Therefore, we must set $A_2 = 0$, and the solution reduces to:

$$F^S(X) = A_1^S X^{\beta_1}. \tag{3.17}$$

Applying the value matching condition (3.15) and smooth pasting condition (3.16), we solve for A_1^S and the optimal threshold X_S^*. From the smooth pasting condition:

$$A_1^S \beta_1 \left(X_S^*\right)^{\beta_1 - 1} = (1-\phi_a)\theta - (1-\phi_i). \tag{3.18}$$

Combining with the value matching condition yields the optimal IPO threshold for the shareholders:

$$X_S^* = \frac{\beta_1}{\beta_1 - 1} \cdot \frac{K}{(1-\phi_a)\theta - (1-\phi_i)}, \tag{3.19}$$

and the constant:

$$A_1^S = [(1-\phi_a)\theta - (1-\phi_i)] \cdot \frac{1}{\beta_1} \left(X_S^*\right)^{1-\beta_1}. \tag{3.20}$$

The complete expression for the shareholders' value function is therefore:

$$F^S(X) = \begin{cases} [(1-\phi_a)\theta X_S^* - (1-\phi_i)X_S^* - K] \left(\dfrac{X}{X_S^*}\right)^{\beta_1} & \text{if } X < X_S^*, \\ (1-\phi_a)\theta X - (1-\phi_i)X - K & \text{if } X \geq X_S^*. \end{cases} \tag{3.21}$$

3.4 The Manager's Problem

Since the manager holds a contingent claim on the firm's operating value, the manager's value function $F^M(X)$ must satisfy the same ODE as the shareholders in equation (3.9):

$$\frac{1}{2}\sigma^2 X^2 F^{M\prime\prime}(X) + \mu X F^{M\prime}(X) - r F^M(X) = 0. \tag{3.22}$$

By the same reasoning as above, the general solution reduces to:

$$F^M(X) = A_1^M X^{\beta_1}, \tag{3.23}$$

after imposing the absorbing barrier $F^M(0) = 0$.

The manager chooses the value threshold X_M^* to maximize his own value function, subject to the boundary conditions:

Value matching condition:

$$F^M(X_M^*) = \phi_a \theta X_M^* - \phi_i X_M^* - (E_a - E_i). \tag{3.24}$$

Smooth pasting condition:

$$F^{M\prime}(X_M^*) = \phi_a \theta - \phi_i. \tag{3.25}$$

Equation (3.24) is the value matching condition for the manager, where the net gain at the IPO is the increment in value-based compensation minus the increment in effort costs $\Delta E = E_a - E_i$. Applying the same procedure as we did for the shareholders, the optimal IPO threshold for the manager is:

$$X_M^* = \frac{\beta_1}{\beta_1 - 1} \cdot \frac{E_a - E_i}{\phi_a \theta - \phi_i}, \tag{3.26}$$

and the constant:

$$A_1^M = (\phi_a \theta - \phi_i) \cdot \frac{1}{\beta_1} \left(X_M^*\right)^{1-\beta_1}. \tag{3.27}$$

The complete manager's value function expression is:

$$F^M(X) = \begin{cases} \left[\phi_a \theta X_M^* - \phi_i X_M^* - (E_a - E_i)\right] \left(\dfrac{X}{X_M^*}\right)^{\beta_1} & \text{if } X < X_M^*, \\ \phi_a \theta X - \phi_i X - (E_a - E_i) & \text{if } X \geq X_M^*. \end{cases} \tag{3.28}$$

Note that X_M^* depends directly on both ϕ_a and ϕ_i, reflecting that the manager's decision is sensitive to the entire compensation structure, including both the pre-IPO and post-IPO value-sharing bonus.

The structure of the two triggers imposes necessary conditions on the compensation parameters. For X_S^* to be well-defined and positive, the denominator of equation (3.19) must be positive, which requires:

$$(1 - \phi_a)\theta - (1 - \phi_i) > 0, \tag{3.29}$$

ensuring that the shareholders' net payoff is increasing in X, so that waiting for a higher threshold is always optimal rather than listing immediately. Similarly, for X_M^* to be well-defined and positive, the denominator of equation (3.26) must be positive, requiring:

$$\phi_a \theta - \phi_i > 0, \tag{3.30}$$

ensuring that the manager's net compensation gain from the IPO is positive. Both conditions are assumed to hold throughout the model to ensure that the triggers are well-defined and positive.

3.5 The Optimal Compensation Scheme

The shareholders' objective is to design a value-sharing bonus ϕ_a such that the manager's individually optimal IPO threshold coincides with their own. The alignment condition is therefore:

$$X_M^* = X_S^*. \tag{3.31}$$

Proposition 3.1 (Optimal Value-Sharing Bonus). *The fraction of post-IPO operating value that the manager should receive to align his IPO timing decision with that of shareholders is:*

$$\phi_a^* = \frac{E_i + K\phi_i + E_a(\theta + \phi_i - 1) - E_i(\theta + \phi_i)}{(E_a - E_i + K)\,\theta}. \tag{3.32}$$

Under this contract, both agents exercise the growth option at the unique optimal threshold:

$$X^* = \frac{\beta_1}{\beta_1 - 1} \cdot \frac{E_a - E_i + K}{\theta - 1}. \tag{3.33}$$

Proof. Set $X_M^* = X_S^*$ using equations (3.19) and (3.26) and solve for ϕ_a. Substituting back yields X^* as in equation (3.33). See Appendix A.1 for the full derivation. ☐

A natural question is whether the manager always finds the optimal contract acceptable. Because the manager receives a fraction ϕ_i of the operating value X before the IPO and a fraction ϕ_a^* of the scaled operating value θX afterwards, his compensation gain from going public, measured per unit of operating value, is $\phi_a^* \theta - \phi_i$. Substituting the optimal bonus from equation (3.32), this gain simplifies to $\Delta E(\theta - 1)/(\Delta E + K)$, which is strictly positive for any $\theta > 1$ and any positive effort increment. The manager is therefore always better off in value terms under the aligned contract, so no separate acceptability restriction needs to be imposed. Notably, this holds even when the optimal post-IPO fraction ϕ_a^* is lower than the pre-IPO fraction ϕ_i, since the scaling effect of θ more than compensates for the smaller fraction.

Corollary 3.1 (Independence of the Optimal Contract). *The optimal contract ϕ_a^* is independent of the state variable X, the risk-free rate r, the drift μ, and the volatility σ.*

The independence result in Corollary 3.1 has an important economic interpretation. Even though the model assumes full information, the agency conflict between shareholders and managers creates a wedge between their individually optimal IPO timings. The optimal compensation scheme in Proposition 3.1 eliminates this wedge through a simple, state-independent contract that does not require monitoring of the state variable X. Consequently, renegotiation of the contract is not required as the operating value process evolves over time.

It is important to note that this independence result applies specifically to the parameters of the GBM process. In the extensions, the optimal contract depends on market sentiment θ_{opt} and managerial impatience n_m. The nature and contractibility of these parameters are discussed in each extension separately.

Corollary 3.2 (Insider Payoffs under the Optimal Contract). *Under the optimal contract ϕ_a^*, evaluated at the aligned trigger X^*, the shareholders' and the manager's payoffs are:*

$$\Pi^S(X^*) = \frac{K}{\beta_1 - 1}, \qquad \Pi^M(X^*) = \frac{\Delta E}{\beta_1 - 1}. \tag{3.34}$$

Proof. See Appendix A.2. □

Each insider's payoff is the net value created by the IPO, capitalized by the option multiplier $1/(\beta_1 - 1)$ that reflects the value of optimally timing the exercise. The shareholders' payoff scales with the investment cost K that the IPO finances, while the manager's payoff scales with the effort increment ΔE that he must be compensated for. That the payoffs take this closed form is a direct consequence of how optimal exercise is determined in real options models, where the smooth pasting condition ties the value extracted at the optimum to the structural parameters of the problem. Neither payoff depends on the operating value X or on the parameters of the underlying process, consistent with the independence of the optimal contract established in Corollary 3.1. These payoffs serve as the benchmark against which the welfare effects of the two extensions are assessed.

Remark 3.2 (Financing Constraint). *After deriving the optimal contract ϕ_a^* and the aligned trigger X^*, the financing constraint can be characterized explicitly. The constraint $P \geq K$ is satisfied at the optimal threshold whenever q exceeds the lower bound:*

$$q \geq q_{min} = \frac{K}{(1 - \phi_a^*)\,\theta\,X^* - W}, \tag{3.35}$$

which is determined by feasibility rather than optimization. This treatment is analogous to Bustamante (2012), who also treats q as exogenous in her basic model. The focus of this dissertation is the design of the compensation contract ϕ_a that aligns the IPO timing decisions of the manager and the shareholders. By contrast, the optimal choice of the issuance fraction is a separate problem that is left outside the model in order to keep the analysis tractable. Within the payoff structure adopted here, q drops out of the shareholders' net payoff, indicating that the agency problem studied in this dissertation does not depend on the equity issuance size.

3.6 Comparative Statics

From equation (3.32), the following comparative statics hold:

$$\frac{\partial \phi_a^*}{\partial E_a} > 0, \qquad \frac{\partial \phi_a^*}{\partial E_i} < 0, \qquad \frac{\partial \phi_a^*}{\partial K} < 0, \qquad \frac{\partial \phi_a^*}{\partial \phi_i} > 0. \tag{3.36}$$

Proof. See Appendix A.3. □

The optimal value-sharing bonus is increasing in E_a, since a higher post-IPO effort disutility makes the IPO less attractive to the manager and requires a larger bonus to induce him to exercise. It is decreasing in E_i, as a more costly pre-IPO period makes the manager more willing to exercise the option to escape the current effort, so shareholders need a smaller bonus to align him. It is also decreasing in K, because a higher investment cost raises the shareholders' trigger proportionally more than the manager's, which reduces the bonus needed to align them. Finally, it increases with ϕ_i, since a higher pre-IPO value-sharing bonus leaves the manager better off before the IPO and therefore requires a larger post-IPO bonus to make the transition worthwhile.

3.7 Numerical Example

To illustrate the main findings of the base model, the numerical example combines parameter values from Cardoso and Pereira (2015) and Bustamante (2012). Following Cardoso and Pereira (2015), the risk-free rate is set to $r = 0.05$, volatility to $\sigma = 0.20$, and drift to $\mu = 0.02$. The effort costs are set to $E_i = 15$ before the IPO and $E_a = 65$ after the IPO, implying an effort increment of $\Delta E = 50$ and a ratio $E_a/E_i \approx 4.3$. This calibration captures the assumption that managing a publicly listed firm is substantially more demanding than managing a private firm, due to additional responsibilities related to investor relations, regulatory compliance, and public reporting. The ratio $\Delta E/K = 50/200 = 0.25$ implies that the incremental effort cost represents one quarter of the investment cost. This value is chosen for illustrative purposes rather than estimated from data.

From Bustamante (2012), the calibration adopts the growth factor $\theta = 1.875$, corresponding to the good-type firm's growth option. The fraction of shares issued is set to $q = 0.25$, consistent with the representative issuance fraction used in Bustamante (2012) and with the 20–25% range observed in US IPO data. The pre-IPO value-sharing bonus $\phi_i = 0.15$ has no direct counterpart in either Cardoso and Pereira (2015) or Bustamante (2012), since it arises from this dissertation's departure from the idle-state assumption. It is therefore introduced as an illustrative value that captures a meaningful pre-IPO value-sharing arrangement between shareholders and the manager. The full calibration is presented in Table 3.1.

Parameter	**Description**	**Value**
r	Risk-free rate	0.05
μ	Drift $(r - \delta)$	0.02
σ	Cash flow volatility	0.20
θ	Growth option scaling factor	1.875
K	Investment cost	200
W	Fixed wage	50
E_i	Pre-IPO effort cost	15
E_a	Post-IPO effort cost	65
ϕ_i	Pre-IPO value-sharing bonus	0.15
q	Fraction of shares issued at IPO	0.25

Table 3.1: Base Case Parameters. Parameter values used throughout the base model analysis.

The base case results are presented in Table 3.2.

Output	**Description**	**Value**
β_1	Positive root of fundamental quadratic	1.5811
ΔE	Effort increment	50
ϕ_a^*	Optimal value-sharing bonus	0.1733
ϕ_i	Pre-IPO value-sharing bonus	0.1500
X^*	Optimal IPO trigger	777.36

Table 3.2: Base Case Results. Optimal contract ϕ_a^* and IPO trigger X^* computed at the base case parameter values.

The base case satisfies all model assumptions. The optimal contract yields $\phi_a^* = 17.33\%$ and the financing constraint is satisfied, since the minimum share fraction required to cover K at the optimal threshold is $q_{min} = 0.1732$, which is below the issued fraction $q = 0.25$. The proceeds are therefore sufficient to finance the investment at the optimal trigger.

Table 3.3 illustrates the consequences of deviating from the optimal contract. When $\phi_a < \phi_a^*$, the manager is under-compensated and delays the IPO beyond the shareholders' preferred timing. When $\phi_a > \phi_a^*$, the manager is over-compensated and conducts the IPO too early. Only at $\phi_a = \phi_a^*$ are the two triggers perfectly aligned.

ϕ_a	X_S^*	X_M^*	$X_M^* - X_S^*$	Outcome
0.1133	669.7	2178.8	$+1509.1$	Manager lists too late
0.1733	777.36	777.36	0.0	**Aligned ✓**
0.2333	926.1	473.3	-452.8	Manager lists too early

Table 3.3: Misalignment Analysis. IPO triggers under individual optimization (X_S^* for shareholders, X_M^* for manager) and under the aligned contract (X^*), at base case parameter values.

Figure 3.1 illustrates how the IPO triggers vary with the post-IPO value-sharing bonus ϕ_a. The shareholders' trigger X_S^* increases with ϕ_a, since a larger managerial share reduces the portion of post-IPO cash flows retained by shareholders and therefore requires a higher value level to justify listing. By contrast, the manager's trigger X_M^* decreases with ϕ_a, because a higher value-sharing bonus makes the IPO more attractive to the manager at lower value levels. The two curves intersect at ϕ_a^*, where both parties choose the same IPO threshold, yielding the aligned trigger X^*.

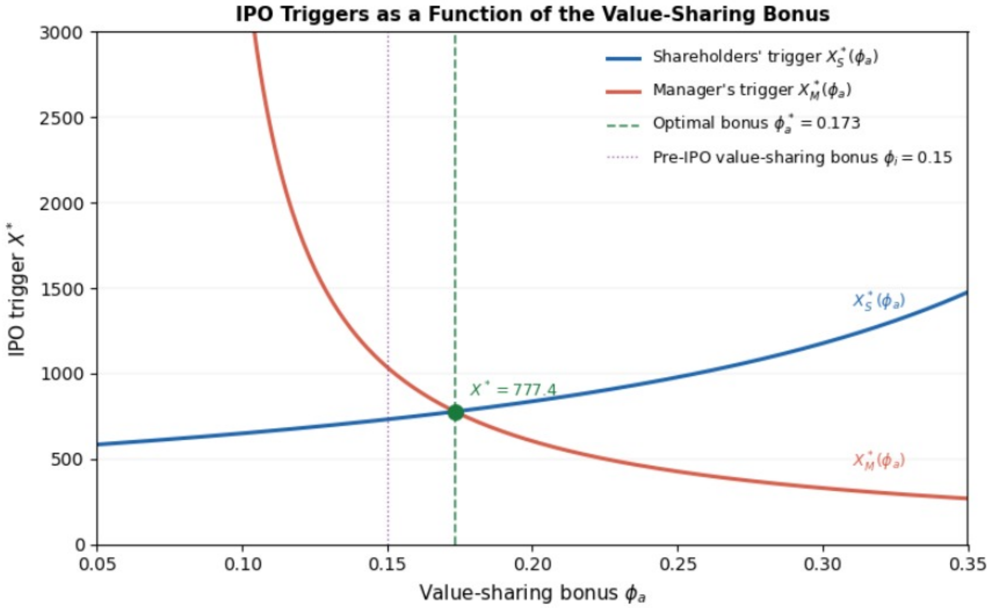

Figure 3.1: IPO Triggers as a Function of the Value-Sharing Bonus in the Base Model. The upward-sloping curve labeled $X_S^*(\phi_a)$ shows the shareholders' trigger and the downward-sloping curve labeled $X_M^*(\phi_a)$ shows the manager's trigger. The vertical dashed line marks the optimal value-sharing bonus $\phi_a^* = 0.1733$ at which the two triggers coincide; the intersection point is annotated at $X^* = 777.36$. The dotted vertical line marks $\phi_i = 0.15$. All other parameters are held at base case values.

Figure 3.2 illustrates the comparative statics of ϕ_a^* with respect to the key parameters. The dotted line in each panel marks the base case value of ϕ_a^*.

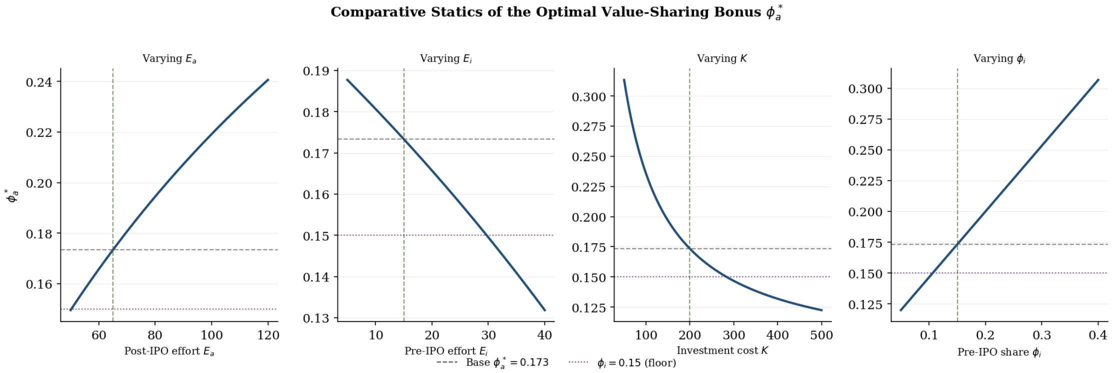

Figure 3.2: Comparative Statics of the Optimal Value-Sharing Bonus in the Base Model. Each panel varies one parameter while holding all others at their base case values. The solid curve shows ϕ_a^* as a function of the varied parameter. The vertical dashed line marks the base case value of the varied parameter.

4 Extension 1: Market Sentiment

4.1 Motivation and Setup

This extension introduces market sentiment by relaxing the fair-pricing assumption of the base model for outside investors, while preserving full information between the manager and shareholders. Whereas the base model assumes that IPO shares are priced at the firm's fundamental value, this extension allows outside investors to hold optimistic beliefs about post-IPO growth prospects and therefore to pay above fundamental value. This departure does not introduce asymmetric information between the manager and the shareholders, since both insiders observe the true growth factor θ and understand that outside investors value the IPO using more optimistic beliefs. The wedge introduced in this extension is therefore behavioral rather than informational, arising from a difference in beliefs between outsiders and insiders rather than from any private information held by one insider relative to the other.

Formally, outside investors' optimistic belief is captured by a parameter $\theta_{opt} > \theta$, which represents the growth factor they use when pricing IPO shares. The parameter θ_{opt} affects only IPO proceeds, as it determines the price new investors pay at issuance. By contrast, the value retained by the original shareholders is based on the true growth factor θ, and the manager's value-sharing compensation remains tied to the true post-IPO operating value θX rather than to the optimistic valuation $\theta_{opt} X$ used in the IPO pricing.

Assumption 4.1 (Market Sentiment). *Outside investors hold an optimistic view of the firm's post-IPO growth prospects, as reflected in $\theta_{opt} > \theta$, which reflects their willingness to pay above the firm's fundamental value at the IPO. The manager and shareholders observe the market's optimistic valuation and factor it into their optimal IPO timing. The IPO proceeds are therefore:*

$$P_{opt}(X) = q\left[(1-\phi_a)\theta_{opt}X - W\right] > q\left[(1-\phi_a)\theta X - W\right] = P(X). \tag{4.1}$$

Remark 4.1. *This formulation follows Ljungqvist et al. (2006), who model hot markets as periods in which a segment of investors holds overly optimistic beliefs about post-IPO firm value, while insiders know the fundamental value and strategically time the IPO to exploit the resulting pricing window. The parameter $\theta_{opt} > \theta$ formalizes this mechanism, since outside investors value IPO shares above fundamental value, while the true growth factor that materializes after the IPO remains θ. The empirical motivation for this assumption comes from Ritter (1991), who documents long-run underperformance of hot market IPOs, consistent with issuers timing their offerings during periods of temporary investor optimism, and from Lowry (2003), who shows that investor sentiment is a significant driver of aggregate IPO volume.*

4.2 Payoff Functions

The manager's payoff is unchanged from the base model:

$$\Pi^M(X) = (\phi_a \theta X - E_a + W) - (\phi_i X - E_i + W) = \phi_a \theta X - \phi_i X - (E_a - E_i). \quad (4.2)$$

The shareholders' payoff now incorporates the optimistic proceeds P_{opt}:

$$\Pi^S_{opt}(X) = S_a(X) - S_i(X) + P_{opt}(X) - K, \quad (4.3)$$

where $S_a(X) = (1-q)[(1-\phi_a)\theta X - W]$ and $S_i(X) = (1-\phi_i)X - W$ are unchanged. Combining these expressions and collecting terms in X yields:

$$\Pi^S_{opt}(X) = (1-\phi_a)\theta X - (1-\phi_i)X - K + q(\theta_{opt} - \theta)(1-\phi_a)X. \quad (4.4)$$

The additional term $q(\theta_{opt} - \theta)(1-\phi_a)X > 0$ captures the sentiment premium. Note that this premium is proportional to $(1-\phi_a)$, because the higher the manager's value-sharing bonus, the smaller the share of the sentiment premium captured by shareholders. Within the model, this premium increases the attractiveness of the IPO for shareholders, leading them to prefer an earlier IPO threshold.

4.3 The Shareholders' Problem

The shareholders' value function $F^S_{opt}(X)$ satisfies the same ODE as in the base model, equation (3.9). Applying the value matching and smooth pasting conditions with the updated payoff yields the optimal IPO threshold:

$$X^*_S(\theta_{opt}) = \frac{\beta_1}{\beta_1 - 1} \cdot \frac{K}{(1-\phi_a)\theta - (1-\phi_i) + q(\theta_{opt} - \theta)(1-\phi_a)}, \quad (4.5)$$

For a given value-sharing bonus ϕ_a, the denominator is larger than in the base model by the sentiment premium term $q(\theta_{opt} - \theta)(1-\phi_a) > 0$. It follows that $X^*_S(\theta_{opt}) < X^*_S$, meaning that shareholders prefer to conduct the IPO earlier when outside investors price the issue using the optimistic growth factor $\theta_{opt} > \theta$.

4.4 The Manager's Problem

Since the manager's payoff is unaffected by θ_{opt}, the ODE in equation (3.22), together with the value matching and smooth pasting conditions that determine his optimal threshold, are identical to those of the base model. His optimal trigger therefore remains:

$$X_M^* = \frac{\beta_1}{\beta_1 - 1} \cdot \frac{E_a - E_i}{\phi_a \theta - \phi_i}. \tag{4.6}$$

This result highlights the key agency conflict introduced by market sentiment. The shareholders' threshold falls with θ_{opt}, while the manager's threshold remains unaffected, widening the misalignment between the two agents. The relevant question is therefore whether the value-sharing contract can be recalibrated to restore alignment under this additional source of distortion.

4.5 The Optimal Compensation Scheme

Proposition 4.1 (Optimal Value-Sharing Bonus with Market Sentiment). *The fraction of post-IPO operating value that aligns the manager's and shareholders' optimal IPO timing under market sentiment is obtained by setting $X_M^* = X_S^*(\theta_{opt})$ and solving for ϕ_a, which yields:*

$$\phi_a^*(\theta_{opt}) = \frac{-(E_a - E_i)\left(1 + (-1+q)\theta - q\theta_{opt}\right) + (E_a - E_i + K)\phi_i}{K\theta + E_i(-1+q)\theta - E_i q \theta_{opt} + E_a(\theta - q\theta + q\theta_{opt})}. \tag{4.7}$$

Defining $N_0 = E_i + K\phi_i + E_a(\theta + \phi_i - 1) - E_i(\theta + \phi_i)$ as the base model numerator, $D_0 = (E_a - E_i + K)\theta$ as the base model denominator, and $\Delta E = E_a - E_i$, equation (4.7) simplifies to:

$$\phi_a^*(\theta_{opt}) = \frac{N_0 + q(\theta_{opt} - \theta)\Delta E}{D_0 + q(\theta_{opt} - \theta)\Delta E} > \phi_a^* \quad \textit{for } \theta_{opt} > \theta. \tag{4.8}$$

Under this contract, both agents exercise the growth option at the unique optimal threshold:

$$X^*(\theta_{opt}) = \frac{\beta_1}{\beta_1 - 1} \cdot \frac{D_0 + q(\theta_{opt} - \theta)\Delta E}{\theta(\theta - 1) + q(\theta_{opt} - \theta)(\theta - \phi_i)} < X^* \quad \textit{for } \theta_{opt} > \theta. \tag{4.9}$$

Proof. Set $X_M^* = X_S^*(\theta_{opt})$ using equations (4.5) and (4.6) and solve for ϕ_a. Substituting back yields $X^*(\theta_{opt})$ as in (4.9). □

Corollary 4.1 (Consistency with Base Model). *When $\theta_{opt} = \theta$, the sentiment premium vanishes and the optimal contract reduces exactly to the base model result:*

$$\phi_a^*(\theta_{opt})\big|_{\theta_{opt}=\theta} = \phi_a^*, \qquad X^*(\theta_{opt})\big|_{\theta_{opt}=\theta} = X^*. \tag{4.10}$$

Corollary 4.2 (Double Invariance of Payoffs and Non-Identification of q)**.** *Under the optimal contract $\phi_a^*(\theta_{opt})$, both the shareholders' and the manager's payoffs at the IPO are independent of the level of market sentiment θ_{opt} and the fraction of shares issued q, and coincide with the base model payoffs of Corollary 3.2:*

$$\Pi_{opt}^S(X^*) = \frac{K}{\beta_1 - 1}, \qquad \Pi_{opt}^M(X^*) = \frac{\Delta E}{\beta_1 - 1}. \tag{4.11}$$

Proof. See Appendix A.4. □

As established for the base model in Corollary 3.2, these payoffs follow from the way optimal exercise is determined under the contract, and two implications are worth noting here. First, within the model's assumptions, market sentiment does not change the payoff of either agent under the optimal contract. Despite bringing the IPO forward, the adjustment in the value-sharing bonus offsets the sentiment premium in the insiders' payoff expressions, leaving both the manager and the shareholders with the same payoffs as in the base model. For the shareholders, the sentiment premium received from optimistic investors is offset by the higher value-sharing bonus that must be offered to the manager. For the manager, although the optimal value-sharing bonus $\phi_a^*(\theta_{opt})$ rises with sentiment and the aligned trigger $X^*(\theta_{opt})$ falls, the product $(\phi_a^*\theta - \phi_i) \cdot X^*$ remains constant across all levels of sentiment, because the trigger was constructed precisely so that the manager's own optimality condition is satisfied, and therefore his payoff $\Pi^M = (\phi_a^*\theta - \phi_i)X^* - \Delta E$ is invariant. This should not be interpreted as saying that hot markets never benefit issuers in practice, as there are many channels through which market conditions may affect issuer welfare that this model deliberately abstracts from, such as reduced underpricing, relaxed financing constraints, and broader investor demand.

Second, although q appears in both $\phi_a^*(\theta_{opt})$ and $X_S^*(\theta_{opt})$, influencing the timing of the IPO and the required compensation, it has no effect on the value that shareholders ultimately receive. This non-identification result is not a general property but depends on two specific features of the model. First, the compensation contract is linear in the operating value, which means that when the optimal contract and trigger are substituted into the payoff expressions, q is absorbed by the shareholders' optimal conditions and cancels out exactly, as shown in Appendix A.4. Second, the result requires that the financing constraint $P \geq K$ be satisfied, so that q enters the payoff only through the proceeds, not through a binding constraint that would change the optimal threshold. When the financing constraint is violated, no viable contract exists, and the invariance result does not apply. Since shareholders are indifferent to q, the model does not produce an optimal endogenous choice of q, but only a lower bound:

$$q \geq q_{min}(\theta_{opt}) = \frac{K}{(1 - \phi_a^*(\theta_{opt}))\, \theta_{opt}\, X^*(\theta_{opt}) - W}, \tag{4.12}$$

Note that $q_{min}(\theta_{opt})$ depends on θ_{opt} because the proceeds are valued by outside investors at the optimistic price θ_{opt}, whereas in the base model the corresponding lower bound uses the true growth factor θ.

4.6 Comparative Statics

Proposition 4.2 (Effect of Market Sentiment on the Optimal Contract). *The optimal value-sharing bonus is increasing in market sentiment:*

$$\frac{\partial \phi_a^*(\theta_{opt})}{\partial \theta_{opt}} > 0. \tag{4.13}$$

The optimal IPO trigger is decreasing in market sentiment:

$$\frac{\partial X^*(\theta_{opt})}{\partial \theta_{opt}} < 0. \tag{4.14}$$

Proof. See Appendix A.5. □

The intuition is that as market sentiment increases, shareholders want to conduct the IPO earlier to exploit the premium paid by new investors. However, the manager's payoff is tied to the true growth factor θ and is unaffected by θ_{opt}. His preferred threshold, therefore, remains unchanged, and without additional compensation, he would not exercise earlier. To induce the manager to align with the shareholders' preferred earlier timing, shareholders must offer a higher value-sharing bonus.

One aspect of this extension deserves clarification, namely the observability and contractibility of θ_{opt}. The level of market optimism is observable at the time of the IPO, since both the manager and the shareholders observe the price that outside investors are willing to pay. This presumes that both insiders have an accurate intuition about the overpricing, in the sense that they recognize the extent to which the price paid by outside investors exceeds the firm's fundamental value implied by the true growth factor θ. However, θ_{opt} is not known at the outset of the relationship, when the contract is signed, because the IPO occurs in the future and market sentiment fluctuates over time.

4.7 Numerical Example

Table 4.1 presents the parameters used to illustrate this extension, which are identical to the base case.

Parameter	Description	Value
r	Risk-free rate	0.05
μ	Drift ($r - \delta$)	0.02
σ	Cash flow volatility	0.20
θ	True growth factor	1.875
K	Investment cost	200
W	Fixed wage	50
E_i	Pre-IPO effort cost	15
E_a	Post-IPO effort cost	65
ϕ_i	Pre-IPO value-sharing bonus	0.15
q	Fraction of shares issued at IPO	0.25

Table 4.1: Parameters for the Market Sentiment Extension. Parameters held constant across all sentiment levels; only θ_{opt} varies.

Table 4.2 shows how the optimal contract and IPO trigger respond to increasing levels of market sentiment θ_{opt}.

θ_{opt}	$\phi_a^*(\theta_{opt})$	$\Delta\phi_a^*$	$X^*(\theta_{opt})$	ΔX^*	$q_{min}(\theta_{opt})$
1.875 (base)	0.1733	—	777.36	—	0.1732
2.075	0.1777	+0.0044	742.47	-34.89	0.1644
2.375	0.1842	+0.0109	696.22	-81.14	0.1540
2.875	0.1948	+0.0215	631.97	-145.39	0.1415
3.875	0.2152	+0.0419	536.68	-240.68	0.1264

Table 4.2: Optimal Contract and IPO Trigger under Market Sentiment. The column $q_{min}(\theta_{opt})$ reports the minimum share fraction required to satisfy the financing constraint $P \geq K$ at the optimal threshold. Since $q = 0.25 > q_{min}(\theta_{opt})$ for all levels of sentiment considered, the financing constraint is satisfied throughout.

As market sentiment increases from $\theta_{opt} = \theta = 1.875$ to $\theta_{opt} = 3.875$, the optimal value-sharing bonus rises from 17.33% to 21.52% and the optimal IPO trigger falls from 777.36 to 536.68, a reduction of approximately 31%, consistent with the monotone relationships established in Proposition 4.2. The last column of Table 4.2 reports the minimum share fraction $q_{min}(\theta_{opt})$

required to satisfy the financing constraint at each level of sentiment. As θ_{opt} increases, outside investors pay a higher price per share, so a smaller fraction of equity needs to be issued to raise the same K. Consequently $q_{min}(\theta_{opt})$ falls monotonically from 0.1732 at the base case to 0.1264 at $\theta_{opt} = 3.875$. Since $q = 0.25 > q_{min}(\theta_{opt})$ for all levels of sentiment considered, the financing constraint is satisfied throughout.

In Figure 4.1, the left panel shows that $\phi_a^*(\theta_{opt})$ rises as market sentiment increases, with the pre-IPO operating value share $\phi_i = 0.15$ shown as a dotted line for reference. The right panel shows the corresponding reduction of the optimal IPO trigger as sentiment grows, consistent with Proposition 4.2.

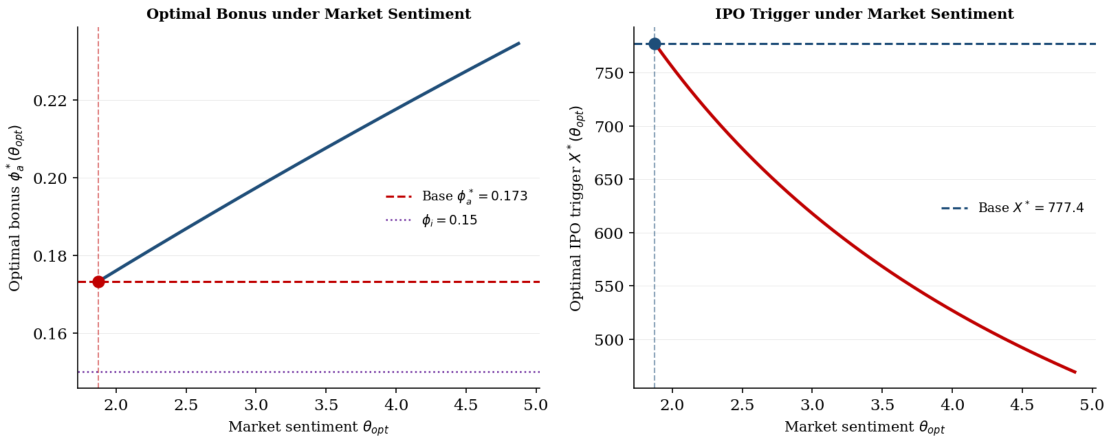

Figure 4.1: Optimal Contract and IPO Trigger under Market Sentiment. The left panel plots $\phi_a^*(\theta_{opt})$ and the right panel plots $X^*(\theta_{opt})$, both as functions of market sentiment $\theta_{opt} \geq \theta = 1.875$. All other parameters are held at base case values. The dotted horizontal line marks $\phi_i = 0.15$ (left) and the base case trigger (right).

Figure 4.2 illustrates the mechanism underlying these results. The curve labeled $X_M^*(\phi_a)$ plots the manager's optimal threshold, which is decreasing in ϕ_a: as the value-sharing bonus increases, the IPO becomes more attractive to the manager and he is willing to exercise at a lower value level. Importantly, this curve does not depend on θ_{opt}, since the manager's payoff is tied to the true growth factor θ and not to the market's optimistic valuation, as established in Section 4.2. Each curve labeled $X_S^*(\phi_a, \theta_{opt})$ plots the shareholders' optimal threshold for a different level of sentiment. As θ_{opt} rises, the shareholders' curves shift downward and to the right, as the sentiment premium makes the IPO more valuable to shareholders, so they are willing to exercise at progressively lower value levels for any given ϕ_a. For each level of θ_{opt}, the optimal contract is found at the intersection of the corresponding shareholders' curve with the manager's curve. As sentiment increases, these intersections move to the right and downward, which is precisely what drives the increase in $\phi_a^*(\theta_{opt})$ and the decrease in $X^*(\theta_{opt})$ documented in Table 4.2. The base case corresponds to $\theta_{opt} = \theta = 1.875$, at which point the two curves intersect at $\phi_a^* = 0.1733$ and $X^* = 777.36$.

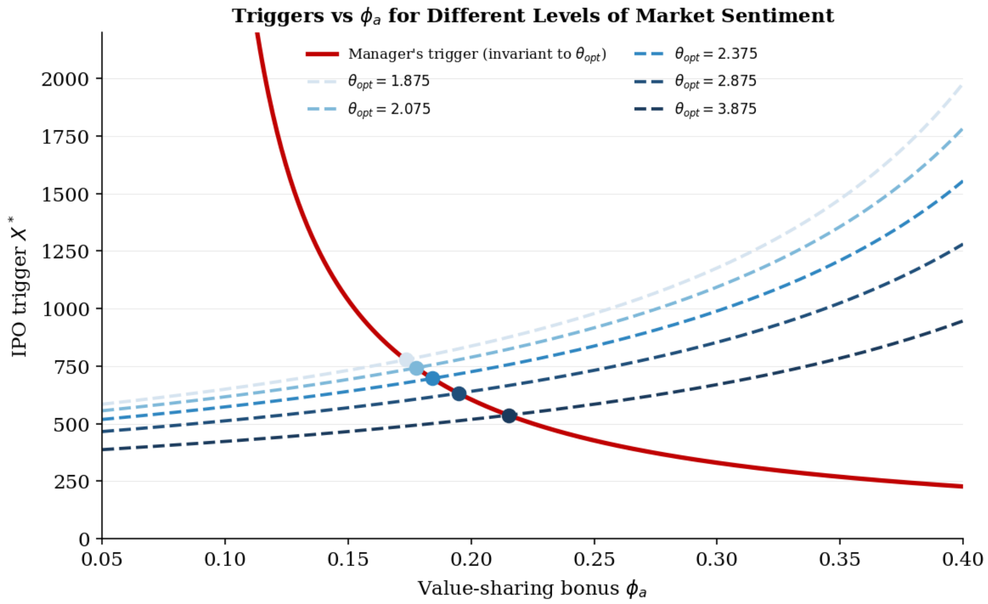

Figure 4.2: IPO Triggers as a Function of the Value-Sharing Bonus under Market Sentiment. The solid curve labeled $X_M^*(\phi_a)$ shows the manager's trigger, which does not depend on θ_{opt}. The dashed curves show the shareholders' trigger $X_S^*(\phi_a, \theta_{opt})$ each labeled directly on the figure. Higher sentiment shifts the shareholders' curve downward and to the right. All other parameters are held at base case values.

5 Extension 2: Managerial Impatience

5.1 Motivation and Setup

In the base model, the manager and the shareholders share the same discount rate r. This is a convenient simplification, but it may not hold in practice. As noted by Cardoso and Pereira (2015), managers may be more impatient than shareholders for several reasons: they have a large share of their human capital tied to the firm, face career concerns, and tend to have shorter effective horizons than diversified institutional investors. Following Grenadier and Wang (2005) and Cardoso and Pereira (2015), we capture this by assuming the manager discounts future payoffs at a rate $r + n_m$, where $n_m \geq 0$ measures the degree of managerial impatience, while the shareholders continue to discount at the base rate r.

When $n_m > 0$, the manager and shareholders value future payoffs differently, creating a new source of misalignment over IPO timing that is entirely separate from the classic agency conflict in the base model. The central question is whether the same contract is sufficient to correct this additional wedge, or whether a new instrument becomes necessary. This extension builds directly on the base model and is independent of the market sentiment extension.

Assumption 5.1 (Managerial Impatience)**.** *The manager discounts future payoffs at rate $r + n_m$, where $n_m \geq 0$. The shareholders continue to discount at the base rate r. The manager's and shareholders' fundamental quadratic roots are therefore:*

$$\gamma_1^M = \frac{1}{2} - \frac{\mu}{\sigma^2} + \sqrt{\left(\frac{\mu}{\sigma^2} - \frac{1}{2}\right)^2 + \frac{2(r+n_m)}{\sigma^2}}, \qquad \beta_1^S = \frac{1}{2} - \frac{\mu}{\sigma^2} + \sqrt{\left(\frac{\mu}{\sigma^2} - \frac{1}{2}\right)^2 + \frac{2r}{\sigma^2}}, \tag{5.1}$$

where $\mu = r - \delta$. Since $n_m \geq 0$, we have $\gamma_1^M \geq \beta_1^S$, with equality when $n_m = 0$.

5.2 The Effect of Managerial Impatience on IPO Triggers

The payoff functions are unchanged from the base model, but since the two parties now discount at different rates, they solve different equations resulting in different triggers.

The manager's optimal trigger now reflects his higher discount rate:

$$X_M^*(n_m) = \frac{\gamma_1^M}{\gamma_1^M - 1} \cdot \frac{E_a - E_i}{\phi_a \theta - \phi_i}, \tag{5.2}$$

while the shareholders' trigger remains as in the base model:

$$X_S^* = \frac{\beta_1^S}{\beta_1^S - 1} \cdot \frac{K}{(1-\phi_a)\theta - (1-\phi_i)}. \tag{5.3}$$

Since $\gamma_1^M \geq \beta_1^S$ and the multiplier $\gamma/(\gamma-1)$ is strictly decreasing in γ for $\gamma > 1$, a higher n_m implies a lower multiplier $\gamma_1^M/(\gamma_1^M - 1)$ and therefore a lower manager's trigger.

Proposition 5.1 (Effect of Managerial Impatience on the Manager's Trigger). *A more impatient manager has a lower optimal IPO threshold and therefore wants to conduct the IPO earlier:*

$$\frac{\partial X_M^*(n_m)}{\partial n_m} < 0. \tag{5.4}$$

Proof. Since γ_1^M is increasing in n_m and the multiplier $\gamma_1^M/(\gamma_1^M - 1)$ is strictly decreasing in γ_1^M for $\gamma_1^M > 1$, it follows that $X_M^*(n_m)$ is decreasing in n_m. □

A higher discount rate reduces the present value of continuing to wait, making earlier exercise more attractive. An impatient manager therefore wants to go public before the shareholders' optimal trigger point, creating a new agency conflict introduced by managerial impatience.

5.3 The Optimal Compensation Scheme

Proposition 5.2 (Optimal Value-Sharing Bonus under Managerial Impatience). *Define* $A(n_m) = \gamma_1^M/(\gamma_1^M - 1)$ *and* $B = \beta_1^S/(\beta_1^S - 1)$. *The fraction of post-IPO operating value that aligns the manager's and shareholders' IPO triggers is obtained by setting* $X_M^*(n_m) = X_S^*$ *and solving for* ϕ_a, *which yields:*

$$\phi_a^*(n_m) = \frac{A(n_m) \cdot \Delta E \cdot (\theta - 1 + \phi_i) + B \cdot K \cdot \phi_i}{\theta \left[A(n_m) \cdot \Delta E + B \cdot K\right]}, \tag{5.5}$$

where $\Delta E = E_a - E_i$. *Under this contract, both agents exercise the growth option at the unique aligned threshold:*

$$X^*(n_m) = \frac{A(n_m) \cdot \Delta E + B \cdot K}{\theta - 1}. \tag{5.6}$$

Proof. See Appendix A.6. □

The compact form of $X^*(n_m)$ helps clarify the economic mechanism behind the impatience extension. The numerator $A(n_m) \cdot \Delta E + B \cdot K$ is a weighted sum of two components. The first, $A(n_m) \cdot \Delta E$, reflects the manager's incremental effort cost scaled by his impatience multiplier, while the second, $B \cdot K$, reflects the shareholders' investment cost scaled by their fixed multiplier.

The denominator $\theta - 1$ represents the net growth factor at the IPO. The threshold, therefore, rises when costs increase and falls when the firm's growth potential is higher. As the manager becomes more impatient, $A(n_m)$ decreases, reducing the weight on his effort cost in the numerator and lowering the threshold. Economically, the IPO occurs earlier because the manager places less value on waiting. Shareholders respond by reducing the value-sharing bonus, which partially offsets the manager's incentive to exercise early. In equilibrium, however, both ϕ_a^* and X^* fall together. This result is consistent with Cardoso and Pereira (2015), who show that higher managerial impatience calls for a lower value-sharing rule.

Corollary 5.1 (Consistency with Base Model). *When $n_m = 0$, we have $\gamma_1^M = \beta_1^S = \beta_1$ and therefore $A = B = \beta_1/(\beta_1 - 1)$. Equation* (5.6) *then reduces to:*

$$X^*(0) = \frac{(\beta_1/(\beta_1 - 1)) \cdot (\Delta E + K)}{\theta - 1} = \frac{\beta_1}{\beta_1 - 1} \cdot \frac{E_a - E_i + K}{\theta - 1} = X^*, \tag{5.7}$$

recovering exactly the base model aligned threshold. Similarly, $\phi_a^*(0) = \phi_a^*$.

Remark 5.1 (No New Instrument Required). *As established by Cardoso and Pereira (2015), the same contract structure as in the base model remains sufficient to align the two parties under managerial impatience, within the model's assumptions. The value-sharing bonus ϕ_a alone absorbs the misalignment introduced by managerial impatience, with the only change being that ϕ_a^* and X^* now depend on n_m through the term $A(n_m)$. This should be understood as a property of the optimal contract within the present framework rather than a general prescription.*

As in the base model, the only restriction on q is the financing constraint, which requires q to satisfy the lower bound:

$$q \geq q_{min}(n_m) = \frac{K}{(1 - \phi_a^*(n_m))\,\theta\, X^*(n_m) - W}, \tag{5.8}$$

which is determined by feasibility rather than optimization. Note that $q_{min}(n_m)$ depends on n_m because both the optimal value-sharing bonus and the optimal trigger vary with the manager's discount rate, affecting the proceeds available at the IPO.

A distinctive feature of this extension is that the optimal value-sharing bonus $\phi_a^*(n_m)$ is strictly decreasing in the manager's impatience parameter n_m. For sufficiently high levels of impatience, the optimal bonus falls below the pre-IPO fraction ϕ_i. This does not signal that the manager is worse off, as it has a clear economic interpretation. When the manager places less value on waiting, he is willing to accept a lower operating value share in exchange for the earlier IPO timing that the aligned contract implements. The reduction therefore reflects the manager's own preference for earlier exercise rather than an externally imposed reduction in compensation.

A related question concerns the observability and contractibility of n_m. Unlike market sentiment θ_{opt}, managerial impatience n_m is a relatively stable characteristic of the manager that reflects his time preferences and career horizon. While n_m is not directly observable, it differs fundamentally from θ_{opt} in that it is an intrinsic property of the manager rather than a fluctuating market condition. In practice, a manager's degree of impatience can be approximated using observable proxies such as career history, age relative to retirement, investment decision track record, and the structure of prior compensation arrangements. These signals are naturally revealed during the hiring and negotiation process, making n_m assessable, at least approximately, before the contract is signed. The assumption that n_m is contractible is admittedly strong, and the extension should be understood as characterizing the properties of the optimal contract conditional on n_m being known rather than as a literal prescription.

5.4 Comparative Statics

Proposition 5.3 (Effect of Managerial Impatience on the Optimal Contract)**.** *The optimal value-sharing bonus is decreasing in managerial impatience:*

$$\frac{\partial \phi_a^*(n_m)}{\partial n_m} < 0, \tag{5.9}$$

and the optimal IPO trigger is also decreasing in managerial impatience:

$$\frac{\partial X^*(n_m)}{\partial n_m} < 0. \tag{5.10}$$

Proof. See Appendix A.7. □

5.5 Shareholders' Value under Managerial Impatience

Corollary 5.2 (Invariance of Shareholders' Value)**.** *Under the optimal contract $\phi_a^*(n_m)$, the value that shareholders receive at the moment of the IPO is:*

$$\Pi^S(n_m) = (1 - \phi_a^*(n_m))\,\theta\,X^*(n_m) - (1 - \phi_i)\,X^*(n_m) - K = \frac{K}{\beta_1^S - 1}, \tag{5.11}$$

which is independent of n_m.

Corollary 5.2 establishes that, under the optimal contract $\phi_a^*(n_m)$, shareholders are indifferent to the degree of managerial impatience. This is an equilibrium result that depends critically on shareholders adjusting the value-sharing bonus optimally in response to n_m. For any level of impatience, the contract is recalibrated so that both triggers coincide, and this recalibration happens to leave the shareholders' payoff unchanged at $K/(\beta_1^S - 1)$. Outside of the optimal contracting equilibrium, shareholders would not be indifferent, as a suboptimal contract would expose them to the distortion introduced by the manager's impatience.

The cost of impatience is therefore borne by the manager alone. Evaluated at the aligned trigger, his payoff is:

$$\Pi^M(n_m) = \frac{\Delta E}{\gamma_1^M - 1}, \tag{5.12}$$

which is strictly decreasing in n_m, since a more impatient manager has a higher effective discount rate and therefore a larger γ_1^M. Comparing with the benchmark payoffs of Corollary 3.2, the shareholders retain their base model value $K/(\beta_1^S - 1) = K/(\beta_1 - 1)$, whereas the manager's payoff falls from the base model level $\Delta E/(\beta_1 - 1)$ to $\Delta E/(\gamma_1^M - 1)$, since $\gamma_1^M > \beta_1$ whenever $n_m > 0$. The welfare cost of impatience is thus borne entirely by the manager, in contrast to the market sentiment extension, where both insiders retained their base model payoffs. This asymmetry is a specific property of the model's structure and should be understood as such rather than as a general claim about how shareholders fare when managers are impatient in practice.

5.6 Numerical Example

Table 5.1 presents the base case parameters, identical to those of the previous extensions.

Parameter	Description	Value
r	Base discount rate	0.05
μ	Drift ($r - \delta$)	0.02
σ	Cash flow volatility	0.20
θ	Growth factor upon IPO	1.875
K	Investment cost	200
W	Fixed wage	50
E_i	Pre-IPO effort cost	15
E_a	Post-IPO effort cost	65
ϕ_i	Pre-IPO value-sharing bonus	0.15

Table 5.1: Parameters for the Managerial Impatience Extension. Parameters held constant across all impatience levels; only n_m varies.

Table 5.2 shows how the optimal contract and IPO trigger respond to increasing levels of managerial impatience n_m.

n_m	γ_1^M	$\phi_a^*(n_m)$	$\Delta\phi_a^*$	$X^*(n_m)$	ΔX^*	$q_{min}(n_m)$
0.00 (base)	1.5811	0.1733	—	777.36	—	0.1732
0.01	1.7321	0.1633	-0.0100	757.09	-20.27	0.1758
0.02	1.8708	0.1569	-0.0164	744.65	-32.71	0.1774
0.03	2.0000	0.1524	-0.0209	736.17	-41.19	0.1786
0.05	2.2361	0.1465	-0.0268	725.26	-52.10	0.1801
0.08	2.5495	0.1413	-0.0320	715.91	-61.45	0.1814
0.10	2.7386	0.1390	-0.0343	711.90	-65.46	0.1819

Table 5.2: Optimal Contract and IPO Trigger under Managerial Impatience. The table reports the optimal value-sharing bonus $\phi_a^*(n_m)$, the aligned IPO trigger $X^*(n_m)$, and the minimum feasible equity fraction $q_{min}(n_m)$ for varying levels of managerial impatience. All other parameters are held at base case values.

As managerial impatience increases from $n_m = 0$ to $n_m = 0.10$, the optimal value-sharing bonus falls from 17.33% to 13.90%, and the optimal IPO trigger falls from 777.36 to 711.90, a reduction of approximately 8%. The effects on the trigger are relatively modest compared to the sentiment extension, though the direction is the same: greater impatience brings the IPO forward. The more notable effect is on the bonus. Since the manager is already inclined to exercise early, shareholders have no reason to offer a higher bonus to bring him forward. Rather, they lower the bonus to contain his eagerness and prevent excessively early exercise. This illustrates that the value-sharing bonus works in both directions, attracting the manager toward the IPO in the base model while restraining him here, being consistent with the conclusions of Cardoso and Pereira (2015).

Although q does not appear in the payoff expressions of this extension, as it cancels algebraically as in the base model, the financing constraint $P \geq K$ still requires $q \geq q_{min}(n_m)$ as given in equation (5.8). As n_m increases, both ϕ_a^* and X^* fall, which slightly reduces the denominator and raises $q_{min}(n_m)$, as reported in Table 5.2. The financing constraint is satisfied for all levels of impatience considered, provided q exceeds the corresponding minimum.

Figure 5.1 illustrates these results. Both panels show decreasing relationships, confirming the comparative statics. The left panel shows the value-sharing bonus falling as n_m rises, while the right panel shows the corresponding compression of the IPO trigger.

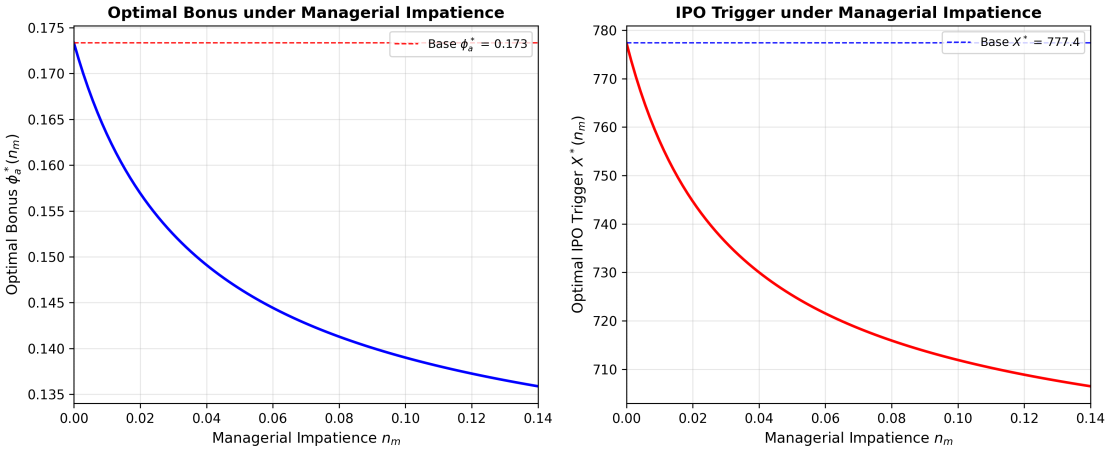

Figure 5.1: Optimal Contract and IPO Trigger under Managerial Impatience. The left panel plots $\phi_a^*(n_m)$ and the right panel plots $X^*(n_m)$, both as functions of the impatience parameter $n_m \geq 0$. All other parameters are held at base case values. The dotted horizontal lines mark the base case values in both panels.

Figure 5.2 shows the mechanism behind these results. The curve labeled $X_S^*(\phi_a)$ does not move with n_m, since the shareholders' discount rate is unaffected. The curves labeled $X_M^*(\phi_a, n_m)$ shift downward as n_m increases: for any given ϕ_a, a more impatient manager is willing to go public at a lower value level. The equilibrium for each level of impatience is found at the intersection of the corresponding manager's curve with the shareholders' fixed curve. As n_m rises, these intersections move to the left and downward, producing the pattern of decreasing ϕ_a^* and decreasing X^* reported in Table 5.2.

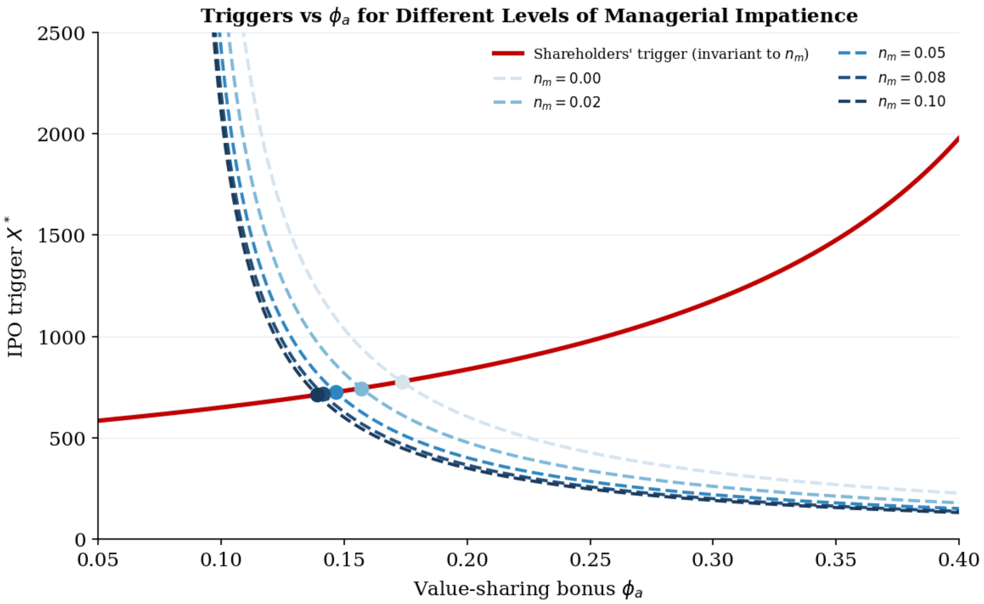

Figure 5.2: IPO Triggers as a Function of the Value-Sharing Bonus under Managerial Impatience. The solid curve labeled $X_S^*(\phi_a)$ shows the shareholders' trigger, which does not depend on n_m. The dashed curves show the manager's trigger $X_M^*(\phi_a, n_m)$ for several levels of impatience. Higher impatience shifts the manager's curve downward. All other parameters are held at base case values.

Figure 5.3 illustrates the welfare consequences of managerial impatience. The shareholders' payoff remains constant at $K/(\beta_1^S - 1) = 344.15$ regardless of the degree of impatience, consistent with the earlier invariance result. The manager's payoff, by contrast, declines steadily as n_m rises, from 86.04 at $n_m = 0$ to 28.76 at $n_m = 0.10$. Under the optimal contract, the cost of impatience is borne by the manager, who accepts a lower present value in exchange for earlier exercise.

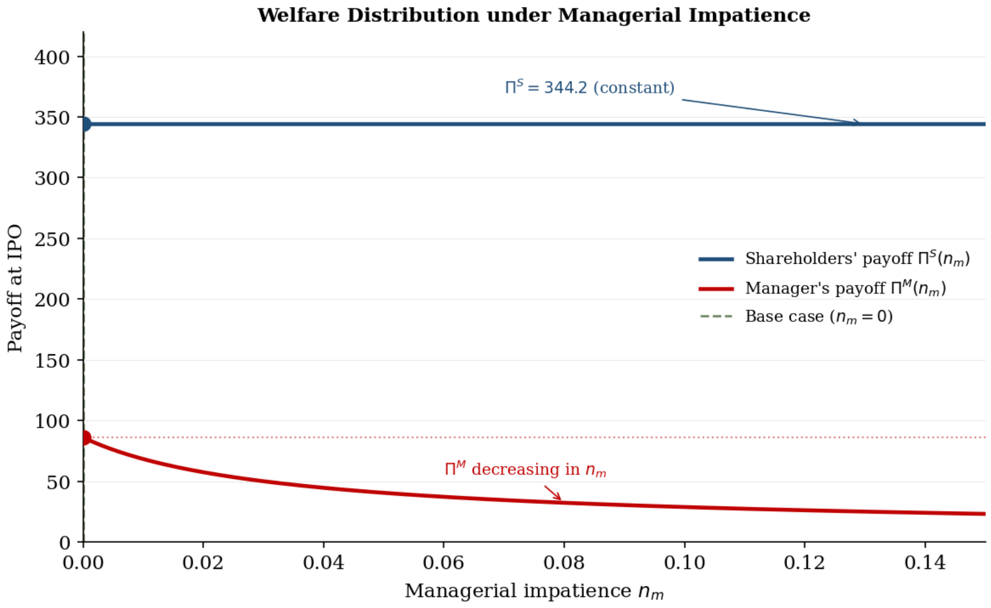

Figure 5.3: Welfare Distribution under Managerial Impatience. The constant curve labeled $\Pi^S(n_m)$ shows the shareholders' payoff and the declining curve labeled $\Pi^M(n_m)$ shows the manager's payoff, both evaluated at the aligned trigger as functions of n_m. The dotted horizontal lines mark the base-case payoffs for $n_m = 0$. All other parameters are held at base case values.

5.7 Comparison with the Market Sentiment Extension

Comparing the two extensions reveals an instructive contrast in how the value-sharing bonus adjusts to different sources of misalignment. Under market sentiment, shareholders raise the bonus to bring a reluctant manager forward, since his own valuation is unaffected by outside investors' optimism. Under managerial impatience, the adjustment reverses. The manager is already inclined to exercise early, so shareholders lower the bonus to restrain him rather than to draw him forward. In both cases, the optimal trigger falls relative to the base model, and the IPO occurs earlier, yet the contractual adjustment that supports this outcome operates in opposite directions. This illustrates that the bonus can either accelerate or delay the manager's decision, depending on the nature of the misalignment.

The welfare implications, derived earlier for each extension, also differ. Under market sentiment, the optimal contract leaves both parties better off than in the base model, whereas under managerial impatience, the manager alone bears the cost of his eagerness to list. In both cases, however, the basic contract structure remains unchanged, with only the level of the value-sharing bonus adjusting to the source of misalignment.

6 Conclusion

6.1 Concluding Remarks and Contributions

This dissertation develops a real options model of IPO timing in the presence of agency conflicts between managers and shareholders, focusing on how compensation design shapes the optimal listing decision. By combining the frameworks of Bustamante (2012) and Cardoso and Pereira (2015), the analysis offers theoretical insights relevant to both the real options literature on investment timing, which has largely abstracted from agency conflicts, and the executive compensation literature, where the specific setting of IPO timing has received limited attention. The contribution is conceptual rather than empirical, and the conclusions are best understood as properties of a deliberately simplified model rather than as established features of IPO markets.

The central result is that a simple value-sharing contract, under which the manager receives a fixed fraction of the post-IPO operating value, is sufficient to align the IPO timing decisions of both parties within the model's assumptions. In the base model, the optimal bonus does not depend on the current operating value, the risk-free rate, the drift, or the volatility of the underlying process. This implies that the contract can be agreed upon at the outset without requiring renegotiation. In the two extensions, the optimal bonus does depend on the new parameter, but they differ in an important way. Market sentiment fluctuates and cannot be fixed in the contract in advance. In contrast, managerial impatience is a relatively stable characteristic of managers and may, in principle, be approximated at the outset using observable proxies. However, treating it as precisely contractible remains a strong assumption.

The performance of the contract can be assessed along two distinct dimensions. The first is timing alignment, meaning that the contract induces the manager to exercise the IPO option at the same threshold that shareholders would choose. This is the property that the value-sharing bonus is designed to deliver, and it holds across the base model and both extensions under the maintained assumptions. The second is welfare protection, meaning the extent to which each party is protected from the distortion that motivates the contract. These two properties do not necessarily coincide. A contract may align the timing decision without preserving the welfare of both parties, because the distribution of payoffs depends on the source of the distortion rather than on timing alignment alone.

The two extensions illustrate this distinction. Under market sentiment, the model predicts a double-invariance result, whereby the optimal contract leaves both insiders' welfare unchanged relative to the base model despite bringing the IPO forward. It does not imply that market sentiment is irrelevant to issuing firms in practice, since the model deliberately abstracts from the channels through which favorable market conditions may genuinely benefit issuers. Under managerial impatience, by contrast, the welfare consequences are asymmetric, since the manager's payoff declines as his impatience grows, while the shareholders' welfare is preserved under the optimal contract. Taken together, these patterns suggest that, within the model, the IPO timing can be aligned in both cases, but welfare is symmetrically protected only when the distortion originates outside the firm rather than from the manager's own preferences.

6.2 Limitations and Future Research

Despite its contributions, the analysis is subject to several limitations, each of which points to a direction for future research. The model abstracts throughout from asymmetric information and signaling between the firm and the market, which are central to Bustamante (2012). In her framework, firms have private information about their quality and use IPO timing, the fraction of shares issued, and underpricing to signal that quality to less informed outside investors. In the present model, by contrast, there is no private information to convey, all parties know the true growth factor θ, and even the optimism of outside investors in the market sentiment extension reflects a difference in beliefs rather than an informational asymmetry. While this simplification isolates the agency conflict between the manager and shareholders, it sets aside important features of real IPO markets, including signaling considerations, adverse selection among issuers, and the systematic underpricing that is observed empirically. Allowing informational frictions would enrich the model considerably and could interact with the incentive structure in non-trivial ways.

The compensation contract is deliberately parsimonious, combining a fixed wage with linear value-sharing rules before and after the IPO. This structure keeps the mechanism transparent, but it also abstracts from several features of executive compensation observed in practice. Real-world pay packages often include stock options, restricted equity with vesting schedules, and performance-contingent bonuses, each of which could affect the manager's timing incentives through channels not captured by the present framework. Extending the model to richer contractual forms would therefore be a natural direction for future research.

A related simplification concerns the fraction of equity sold at the IPO, which is treated as exogenous throughout. Allowing this fraction to be endogenously chosen, jointly with the value-sharing bonus, would more directly connect the financing decision to the incentive problem and could alter the structure of the optimal contract.

A further limitation is that the option to go public is treated as perpetual and unconstrained by external factors. In reality, firms frequently face binding financing constraints and limited market windows, driven by investor expectations or the availability of favorable conditions. Incorporating constraints that actually bind, rather than assuming they hold slack, would bring the model closer to the conditions firms face in reality.

Finally, the analysis is theoretical and does not provide direct empirical tests of the model's predictions. Future research could examine the relationship between managerial compensation and IPO timing using real data, such as compensation arrangements disclosed in IPO prospectuses. This would enable testing whether the model's predictions about incentive alignment and payoff allocation are reflected in observed executive pay patterns around IPO events.

A Mathematical Proofs

A.1 Proof of the Optimal Value-Sharing Bonus

This is the proof of Proposition 3.1 in Section 3.

The alignment condition requires $X_M^* = X_S^*$. Using the trigger expressions in equations (3.19) and (3.26):

$$\frac{\beta_1}{\beta_1 - 1} \cdot \frac{E_a - E_i}{\phi_a \theta - \phi_i} = \frac{\beta_1}{\beta_1 - 1} \cdot \frac{K}{(1 - \phi_a)\theta - (1 - \phi_i)}. \tag{A.1}$$

The common factor $\beta_1/(\beta_1 - 1) > 0$ cancels from both sides, leaving:

$$\frac{\Delta E}{\phi_a \theta - \phi_i} = \frac{K}{(1 - \phi_a)\theta - (1 - \phi_i)}, \tag{A.2}$$

where $\Delta E = E_a - E_i$. Cross-multiplying:

$$\Delta E \left[(1 - \phi_a)\theta - (1 - \phi_i)\right] = K \left[\phi_a \theta - \phi_i\right]. \tag{A.3}$$

Expanding the left-hand side and collecting all terms in ϕ_a on the right-hand side:

$$\Delta E(\theta - 1 + \phi_i) + K\phi_i = \phi_a \theta(\Delta E + K). \tag{A.4}$$

Solving for ϕ_a and substituting $\Delta E = E_a - E_i$ gives the optimal contract:

$$\phi_a^* = \frac{E_i + K\phi_i + E_a(\theta + \phi_i - 1) - E_i(\theta + \phi_i)}{(E_a - E_i + K)\,\theta}, \tag{A.5}$$

which is equation (3.32). To obtain the aligned trigger, substitute ϕ_a^* back into the manager's threshold. The denominator of X_M^* becomes:

$$\begin{aligned} \phi_a^* \theta - \phi_i &= \frac{\Delta E(\theta - 1 + \phi_i) + K\phi_i}{\Delta E + K} - \phi_i \\ &= \frac{\Delta E(\theta - 1 + \phi_i) + K\phi_i - \phi_i(\Delta E + K)}{\Delta E + K} \\ &= \frac{\Delta E(\theta - 1)}{\Delta E + K}. \end{aligned} \tag{A.6}$$

Substituting back into X_M^*:

$$X^* = \frac{\beta_1}{\beta_1 - 1} \cdot \Delta E \cdot \frac{\Delta E + K}{\Delta E(\theta - 1)} = \frac{\beta_1}{\beta_1 - 1} \cdot \frac{E_a - E_i + K}{\theta - 1}, \tag{A.7}$$

which is equation (3.33). Substituting ϕ_a^* into the shareholders' threshold X_S^* yields the same expression, confirming that both agents exercise at the common trigger X^*. ☐

A.2 Proof of Insider Payoffs under the Optimal Contract

This is the proof of Corollary 3.2 in Section 3.

Consider first the shareholders. Their value function before the IPO satisfies $F^S(X) = C(X/X^*)^{\beta_1}$ for $X < X^*$, where the payoff at exercise is $\Pi^S(X^*) = [(1 - \phi_a^*)\theta - (1 - \phi_i)]\, X^* - K$. Let $\mathcal{A} = (1 - \phi_a^*)\theta - (1 - \phi_i)$ denote the bracket coefficient. The value matching condition gives $C = \mathcal{A}X^* - K$, and the smooth pasting condition gives $C\beta_1/X^* = \mathcal{A}$, so that $C = \mathcal{A}X^*/\beta_1$. Equating the two expressions for C:

$$\frac{\mathcal{A}X^*}{\beta_1} = \mathcal{A}X^* - K \implies \mathcal{A}X^* = \frac{\beta_1}{\beta_1 - 1} K. \tag{A.8}$$

The shareholders' payoff at the optimal trigger is therefore:

$$\Pi^S(X^*) = \mathcal{A}X^* - K = \frac{\beta_1}{\beta_1 - 1} K - K = \frac{K}{\beta_1 - 1}. \tag{A.9}$$

For the manager, the same argument applies with payoff at exercise $\Pi^M(X^*) = (\phi_a^*\theta - \phi_i)X^* - \Delta E$. Writing $\mathcal{B} = \phi_a^*\theta - \phi_i$, the value matching and smooth pasting conditions give $\mathcal{B}X^* = \beta_1 \Delta E/(\beta_1 - 1)$, since the manager's net gain at exercise is ΔE rather than K. Hence:

$$\Pi^M(X^*) = \mathcal{B}X^* - \Delta E = \frac{\beta_1}{\beta_1 - 1} \Delta E - \Delta E = \frac{\Delta E}{\beta_1 - 1}. \tag{A.10}$$

Both payoffs are independent of X and of the parameters of the underlying process. ☐

A.3 Proof of Comparative Statics of the Base Model

This is the proof of comparative statics in Section 3.

Write $\phi_a^* = N_0/D_0$ where $N_0 = E_i + K\phi_i + E_a(\theta + \phi_i - 1) - E_i(\theta + \phi_i)$ and $D_0 = (\Delta E + K)\theta$.

$\partial\phi_a^*/\partial E_a > 0$: Note first that N_0 can be rewritten as $N_0 = \Delta E(\theta + \phi_i - 1) + K\phi_i$, which follows from collecting terms in E_a and E_i. We have $\partial N_0/\partial E_a = \theta + \phi_i - 1$ and $\partial D_0/\partial E_a = \theta$. The numerator of $\partial\phi_a^*/\partial E_a$ is:

$$\begin{aligned}(\theta + \phi_i - 1)D_0 - \theta N_0 &= (\theta + \phi_i - 1)(\Delta E + K)\theta - \theta[\Delta E(\theta + \phi_i - 1) + K\phi_i] \\ &= \theta(\theta + \phi_i - 1)K - \theta K\phi_i = \theta K(\theta - 1).\end{aligned} \tag{A.11}$$

Therefore:

$$\frac{\partial\phi_a^*}{\partial E_a} = \frac{\theta K(\theta - 1)}{D_0^2} = \frac{K(\theta - 1)}{\theta(\Delta E + K)^2} > 0, \tag{A.12}$$

since $K > 0$ and $\theta > 1$.

$\partial\phi_a^*/\partial E_i < 0$: From $N_0 = E_i + K\phi_i + E_a(\theta + \phi_i - 1) - E_i(\theta + \phi_i)$, we have $\partial N_0/\partial E_i = 1 - (\theta + \phi_i) = -(\theta + \phi_i - 1) = -\partial N_0/\partial E_a$. From $D_0 = (\Delta E + K)\theta = (E_a - E_i + K)\theta$, we have $\partial D_0/\partial E_i = -\theta = -\partial D_0/\partial E_a$. Since both partial derivatives are exactly the negatives of those with respect to E_a, it follows that $\partial\phi_a^*/\partial E_i = -\partial\phi_a^*/\partial E_a < 0$.

$\partial\phi_a^*/\partial K < 0$: We have $\partial N_0/\partial K = \phi_i$ and $\partial D_0/\partial K = \theta$. Therefore:

$$\frac{\partial\phi_a^*}{\partial K} = \frac{\phi_i D_0 - \theta N_0}{D_0^2} = \frac{\phi_i - \theta\phi_a^*}{D_0}. \tag{A.13}$$

Since $\theta\phi_a^* - \phi_i = \Delta E(\theta - 1)/(\Delta E + K) > 0$, it follows that $\phi_i - \theta\phi_a^* < 0$ and therefore $\partial\phi_a^*/\partial K < 0$. A higher investment cost raises the shareholders' trigger proportionally more than the manager's, so a lower value-sharing bonus is needed to align them at the new threshold.

$\partial\phi_a^*/\partial\phi_i > 0$: We have $\partial N_0/\partial\phi_i = K + \Delta E$ and $\partial D_0/\partial\phi_i = 0$. Therefore:

$$\frac{\partial\phi_a^*}{\partial\phi_i} = \frac{K + \Delta E}{D_0} = \frac{1}{\theta} > 0. \quad \square \tag{A.14}$$

A.4 Proof of Invariance of Shareholders' Value under Market Sentiment

This is the proof of the Invariance Corollary in Section 4.

The shareholders' payoff at the aligned trigger $X^*(\theta_{opt})$ is:

$$\Pi_{opt}^S = [(1 - \phi_a^*)\theta + q(\theta_{opt} - \theta)(1 - \phi_a^*) - (1 - \phi_i)]\, X^*(\theta_{opt}) - K, \tag{A.15}$$

where the $q(\theta_{opt} - \theta)$ term captures the additional proceeds from selling at the sentiment-inflated price.

From the shareholders' value matching and smooth pasting conditions at $X^*(\theta_{opt})$, let $\mathcal{A} =$

$(1-\phi_a^*)\theta - (1-\phi_i) + q(\theta_{opt} - \theta)(1-\phi_a^*)$ denote the bracket coefficient. The shareholders' value function satisfies $F^S(X) = C(X/X^*)^{\beta_1}$ for $X < X^*$. The value matching condition gives $C = \mathcal{A}X^* - K$, and the smooth pasting condition gives $C\beta_1/X^* = \mathcal{A}$, so that $C = \mathcal{A}X^*/\beta_1$. Equating the two expressions for C:

$$\frac{\mathcal{A}X^*}{\beta_1} = \mathcal{A}X^* - K \implies K = \mathcal{A}X^* \cdot \frac{\beta_1 - 1}{\beta_1} \implies \mathcal{A}X^*(\theta_{opt}) = \frac{\beta_1}{\beta_1 - 1} \cdot K. \tag{A.16}$$

Substituting into the shareholders' payoff expression:

$$\Pi^S_{opt} = \frac{\beta_1}{\beta_1 - 1} \cdot K - K = K\left(\frac{\beta_1}{\beta_1 - 1} - 1\right) = K \cdot \frac{\beta_1 - (\beta_1 - 1)}{\beta_1 - 1} = \frac{K}{\beta_1 - 1}. \tag{A.17}$$

The terms q, θ_{opt}, and $X^*(\theta_{opt})$ all cancel, confirming $\Pi^S_{opt} = K/(\beta_1 - 1)$ independently of market sentiment.

For the manager's payoff, note that the manager's payoff function and ODE are identical to those of the base model, since his compensation is tied to the true growth factor θ and not to θ_{opt}. The manager's smooth pasting condition at the aligned trigger $X^*(\theta_{opt})$ therefore gives:

$$(\phi_a^*(\theta_{opt})\,\theta - \phi_i)\,X^*(\theta_{opt}) = \frac{\beta_1}{\beta_1 - 1} \cdot \Delta E. \tag{A.18}$$

Although both $\phi_a^*(\theta_{opt})$ and $X^*(\theta_{opt})$ individually depend on θ_{opt}, their combination $(\phi_a^*\theta - \phi_i) \cdot X^*$ is constant because X^* was constructed precisely so that $X_M^*(\phi_a^*) = X^*$, and the manager's trigger condition does not involve θ_{opt} or q. The manager's payoff at the aligned trigger is therefore:

$$\Pi^M_{opt} = (\phi_a^*\theta - \phi_i)\,X^*(\theta_{opt}) - \Delta E = \frac{\beta_1}{\beta_1 - 1} \cdot \Delta E - \Delta E = \Delta E\left(\frac{\beta_1}{\beta_1 - 1} - 1\right) = \frac{\Delta E}{\beta_1 - 1}, \tag{A.19}$$

which is independent of θ_{opt} and q. $\square$

A.5 Proof of Comparative Statics under Market Sentiment

This is the proof of Proposition 4.2 in Section 4.

Step 1: $\partial\phi_a^*(\theta_{opt})/\partial\theta_{opt} > 0$.

From equation (4.8), let $\epsilon = q(\theta_{opt} - \theta)\Delta E \geq 0$. Then $\phi_a^* = (N_0 + \epsilon)/(D_0 + \epsilon)$. Differentiating with respect to ϵ:

$$\frac{\partial\phi_a^*}{\partial\epsilon} = \frac{D_0 - N_0}{(D_0 + \epsilon)^2}. \tag{A.20}$$

Since $\phi_a^* = N_0/D_0 < 1$, we have $N_0 < D_0$, so $D_0 - N_0 > 0$. Since $\partial\epsilon/\partial\theta_{opt} = q\Delta E > 0$, by the chain rule $\partial\phi_a^*/\partial\theta_{opt} > 0$.

Step 2: $\partial X^*(\theta_{opt})/\partial\theta_{opt} < 0$**.**

From equation (4.9), define num $= D_0 + \epsilon$ and den $= \theta(\theta-1) + q(\theta_{opt}-\theta)(\theta-\phi_i)$, so that $X^* = B \cdot \text{num}/\text{den}$. Differentiating with respect to θ_{opt}:

$$\frac{\partial X^*}{\partial\theta_{opt}} = B \cdot \frac{\frac{\partial \text{num}}{\partial\theta_{opt}} \cdot \text{den} - \text{num} \cdot \frac{\partial \text{den}}{\partial\theta_{opt}}}{\text{den}^2} = B \cdot \frac{q\Delta E \cdot \text{den} - \text{num} \cdot q(\theta - \phi_i)}{\text{den}^2}. \tag{A.21}$$

Since $B > 0$ and $\text{den}^2 > 0$, the sign is determined by the numerator $q[\Delta E \cdot \text{den} - \text{num} \cdot (\theta - \phi_i)]$. Expanding num $= D_0 + \epsilon = (\Delta E + K)\theta + q(\theta_{opt} - \theta)\Delta E$ and den $= \theta(\theta-1) + q(\theta_{opt} - \theta)(\theta - \phi_i)$:

$$\begin{aligned}\Delta E \cdot \text{den} - \text{num} \cdot (\theta - \phi_i) = \Delta E \left[\theta(\theta-1) + q(\theta_{opt}-\theta)(\theta-\phi_i)\right] \\ - \left[(\Delta E + K)\theta + q(\theta_{opt}-\theta)\Delta E\right](\theta - \phi_i).\end{aligned} \tag{A.22}$$

The two terms involving $q(\theta_{opt} - \theta)\Delta E(\theta - \phi_i)$ cancel, leaving:

$$\begin{aligned}\Delta E \cdot \text{den} - \text{num} \cdot (\theta - \phi_i) &= \Delta E\,\theta(\theta-1) - (\Delta E + K)\theta(\theta - \phi_i) \\ &= \theta\left[\Delta E(\theta - 1) - (\Delta E + K)(\theta - \phi_i)\right] \\ &= \theta\left[\Delta E(\phi_i - 1) - K(\theta - \phi_i)\right] \\ &= -\theta\left[(1 - \phi_i)\Delta E + K(\theta - \phi_i)\right].\end{aligned} \tag{A.23}$$

Both terms in the bracket are strictly positive: $(1 - \phi_i) > 0$ since $\phi_i \in]0, 1[$ by construction, and $(\theta - \phi_i) > 0$ since $\theta > 1 > \phi_i$. The numerator is therefore strictly negative, unconditionally, without requiring any additional restriction on the parameters. Hence $\partial X^*/\partial\theta_{opt} < 0$. □

A.6 Proof of the Optimal Contract under Managerial Impatience

This is the proof of Proposition 5.2 in Section 5.

Setting $X_M^*(n_m) = X_S^*$ using equations (5.2) and (5.3):

$$A(n_m) \cdot \frac{\Delta E}{\phi_a\theta - \phi_i} = B \cdot \frac{K}{(1-\phi_a)\theta - (1 - \phi_i)}. \tag{A.24}$$

Cross-multiplying:

$$A(n_m) \cdot \Delta E \cdot [(1-\phi_a)\theta - (1-\phi_i)] = B \cdot K \cdot [\phi_a\theta - \phi_i]\,. \tag{A.25}$$

Expanding:

$$A\Delta E(\theta - 1 - \phi_a\theta + \phi_i) = BK(\phi_a\theta - \phi_i). \tag{A.26}$$

Collecting terms in ϕ_a:

$$A\Delta E(\theta - 1 + \phi_i) - A\Delta E\phi_a\theta = BK\phi_a\theta - BK\phi_i. \tag{A.27}$$

$$A\Delta E(\theta - 1 + \phi_i) + BK\phi_i = \phi_a\theta\,[A\Delta E + BK]\,. \tag{A.28}$$

Solving for ϕ_a gives equation (5.5). To derive $X^*(n_m)$, substitute $\phi_a^*(n_m)$ into $X_M^*(n_m) = A(n_m) \cdot \Delta E/(\phi_a^*\theta - \phi_i)$ and simplify the denominator:

$$\begin{aligned}\phi_a^*\theta - \phi_i &= \frac{A\Delta E(\theta - 1 + \phi_i) + BK\phi_i}{A\Delta E + BK} - \phi_i \\ &= \frac{A\Delta E(\theta - 1 + \phi_i) + BK\phi_i - \phi_i(A\Delta E + BK)}{A\Delta E + BK} \\ &= \frac{A\Delta E(\theta - 1)}{A\Delta E + BK}.\end{aligned} \tag{A.29}$$

Substituting back:

$$X^*(n_m) = A\Delta E \cdot \frac{A\Delta E + BK}{A\Delta E(\theta - 1)} = \frac{A(n_m) \cdot \Delta E + B \cdot K}{\theta - 1}, \tag{A.30}$$

which is equation (5.6). □

A.7 Proof of Comparative Statics under Managerial Impatience

This is the proof of Proposition 5.3 in Section 5.

Step 1: $\partial X^*(n_m)/\partial n_m < 0$.

From equation (5.6), $X^*(n_m) = [A(n_m)\Delta E + BK]/(\theta - 1)$. Since $\theta - 1 > 0$ is fixed, it suffices to show $\partial A/\partial n_m < 0$. We have $A(n_m) = \gamma_1^M/(\gamma_1^M - 1)$ where $\gamma_1^M > 1$ is increasing in n_m. The function $f(x) = x/(x-1)$ satisfies $f'(x) = -1/(x-1)^2 < 0$ for all $x > 1$, so A is decreasing in γ_1^M and therefore in n_m.

Step 2: $\partial \phi_a^*(n_m)/\partial n_m < 0$.

Write $\phi_a^* = [A\Delta E(\theta - 1 + \phi_i) + BK\phi_i]/[\theta(A\Delta E + BK)]$. Let $u = A\Delta E(\theta - 1 + \phi_i) + BK\phi_i$ and $v = \theta(A\Delta E + BK)$. Then:

$$\frac{\partial \phi_a^*}{\partial A} = \frac{u'v - uv'}{v^2}, \tag{A.31}$$

where $u' = \Delta E(\theta - 1 + \phi_i)$ and $v' = \theta\Delta E$. The numerator $u'v - uv'$ equals:

$$\Delta E(\theta - 1 + \phi_i) \cdot \theta(A\Delta E + BK) - [A\Delta E(\theta - 1 + \phi_i) + BK\phi_i] \cdot \theta\Delta E. \tag{A.32}$$

Expanding and canceling the $A(\Delta E)^2(\theta - 1 + \phi_i)\theta$ terms:

$$= \theta\Delta E \cdot BK(\theta - 1 + \phi_i) - \theta\Delta E \cdot BK\phi_i = \theta\Delta E \cdot BK(\theta - 1) > 0. \tag{A.33}$$

Since $\partial\phi_a^*/\partial A > 0$ and $\partial A/\partial n_m < 0$, it follows that $\partial\phi_a^*/\partial n_m < 0$. □

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