Strategic Communication With A Myopically Loss Averse Investor

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Abstract: We study a dynamic communication model with a myopically loss averse investor as the information recipient. In a multi-period setting, the manager learns about the firm's fundamental value earlier than the investor and can report this additional information either truthfully or with a bias. We assume that the manager's communication strategy aims at optimizing the investor's perception of firm performance. Our model predicts that the manager will try to avoid downward price movements, which are disproportionally detrimental to the loss averse investor. In particular, the manager will claim stock values close to the investor's prior expectation to avoid immediate or future down movements. We examine the asset pricing implications of this communication strategy and find that strategic managerial behavior can reduce stock return volatility and cause stock price momentum.

Keywords: Strategic Information Transmission, Myopic Loss Aversion, Behavioral Economics, Communication, Momentum.

JEL: C73, D82, D83, G12, G14, G40

1. Introduction

The public dissemination of firm information influences investor behavior and stock market prices (see, e.g., Goldstein and Yang, 2019; Schneemeier, 2023), which in turn impact real economic activity. Therefore, strategic motives behind firms' communication to capital markets have drawn considerable interest across literature streams in accounting, economics, and finance. One central assumption at the very heart of the seminal theoretical works on strategic communication (Crawford and Sobel, 1982) and disclosure (Dye, 1985) – as well as subsequent work – is that information recipients are rational agents with rational beliefs, whose utility functions reflect risk aversion or risk neutrality. A long strand in behavioral economics, however, has challenged the ability of expected utility models to describe individual behavior in experimental (Allais, 1953) and empirical studies (Barber and Odean, 2000). In response, alternative descriptive models for decision making under risk have been developed (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992). One key feature of these models is loss aversion, i.e., individuals' disproportionate consideration of losses relative to gains. Using such non-standard investor preferences in a multi-period communication model yields novel implications, which have not yet been studied.

In this paper, we fill this research gap by examining a dynamic communication model with a myopically loss averse investor as the information recipient. Within a multi-period, discrete time setting, the fundamental value of the stock evolves randomly (Kremer et al., 2024) and is observed by the manager earlier than by the investor. The manager decides whether to report the firm value truthfully or to manipulate the investor's expectation within strict plausibility constraints. The central prediction from the model is that the manager's claimed information will be biased towards the investor's prior belief about the stock price, even if that implies deviations from the manager's private information. We study the asset pricing implications of the resulting communication strategy and find that such biased information provision reduces stock volatility and leads to stock price momentum. Lastly, we examine annual earnings forecasts as one example of managerial communication and document that our predictions are borne out in the data.

Specifically, we study a model with one investor and one manager in charge of a publicly listed firm. Akin to Shin (2003, 2006), we adopt a multi-period, discrete time model, where the firm's fundamental value develops in a binomial tree as proposed in the seminal option pricing model of Cox et al. (1979). The key innovation of our model lies within the investor's evaluation of stock performance. The investor in our model is myopically loss averse. Based on the longstanding experimental evidence on mental accounting (Kahneman and Tversky, 1984; Thaler, 1985) and loss aversion (Kahneman et al., 1990; Tversky and Kahneman, 1991), Benartzi and Thaler (1995) apply myopic loss aversion to accommodate the equity risk premium. Subsequent work shows that the underlying behavioral concepts can be employed to explain, for example, stock prices (Barberis and Huang, 2001; McQueen and Vorkink, 2004) as well as portfolio choice and imperfect diversification (Polkovnichenko, 2005; Dimmock and Kouwenberg, 2010). The investor's utility function in our model reflects both mental accounting and loss aversion. First, the investor separates the stock performance into different mental accounts despite the multi-period horizon. Prompted by the manager's public dissemination of information, the investor evaluates the stock price change since the last evaluation date, which we assume to occur once per year in line with Benartzi and Thaler (1995). Second, the investor's loss aversion implies that she dislikes stock price declines more than she likes stock price increases of the same magnitude. Inserting such non-standard investor preferences in a framework of managerial communication raises new strategic considerations for the manager. In line with models on catering and signalling (Baker and Wurgler, 2004; Baker et al., 2016), we assume that the manager cares about the investor's perception of stock performance, implying that the manager's utility also depends on short-term price changes (Kremer et al., 2024).

While the dynamics of the fundamental value in our model are common knowledge, we include information asymmetries between manager and investor with respect to price realizations. The manager observes the contemporaneous fundamental value at *evaluation* dates and chooses whether to communicate it accurately or with a bias. The investor lacks private information. Instead, she has to rely on public information about the firm value from the prior *intermediate* date, which arrives with a delay at the evaluation date. The economic intuition for this setup is simple: while there is verifiable historical information upon the release of audited financial statements, managers possess superior contemporaneous information through, for example, internal controlling and the order backlog. Moreover, the verifiable information from intermediate dates constrains the manager's ability to manipulate market prices. Since the investor knows the fundamental value implied by the public information about the firm from the last intermediate date and knows the underlying dynamics, she will only believe stock prices that could have plausibly emerged.

What is the optimal communication strategy of the manager? The manager can exploit the investor's loss aversion for an advantageous intertemporal utility exchange. The optimal strategy of the manager is then to claim information that implies a stock price as close to the investor's expectation as possible, even if that expectation does not comply with the manager's private information. The intuition is as follows. A myopically loss averse investor will incur disproportionally large utility losses if she observes a stock price decline between two evaluation dates. The manager will attempt to avoid communicating any information that implies a stock price decline between two evaluation dates. Therefore, the manager will exploit the investor's mental accounting such that losses are presented jointly with gains of the same magnitude at the same evaluation date (i.e., "grouping" losses with gains). If the manager observes an intermediate price decline, she will try to group it with subsequent gains. Conversely, the manager is willing to forego price increases to offset potential subsequent losses. In essence, the manager's role is to "edit" stock price changes such that the return pattern is most attractive to the investor (Thaler and Johnson, 1990).

Figure 1. Exemplary Binomial Tree and Communication Strategy
This figure shows the potential paths of the firm's fundamental value from t to $t + 2$ within our model. The path along the realized firm values, which in this example are realized through two initial firm value decreases and two subsequent firm value increases, are highlighted in red. The associated stock values claimed by the manager are depicted in blue. The intermediate dates $t_{0.5}$ and $t_{1.5}$, where the last public information about the firm value stems from, are shaded in grey.

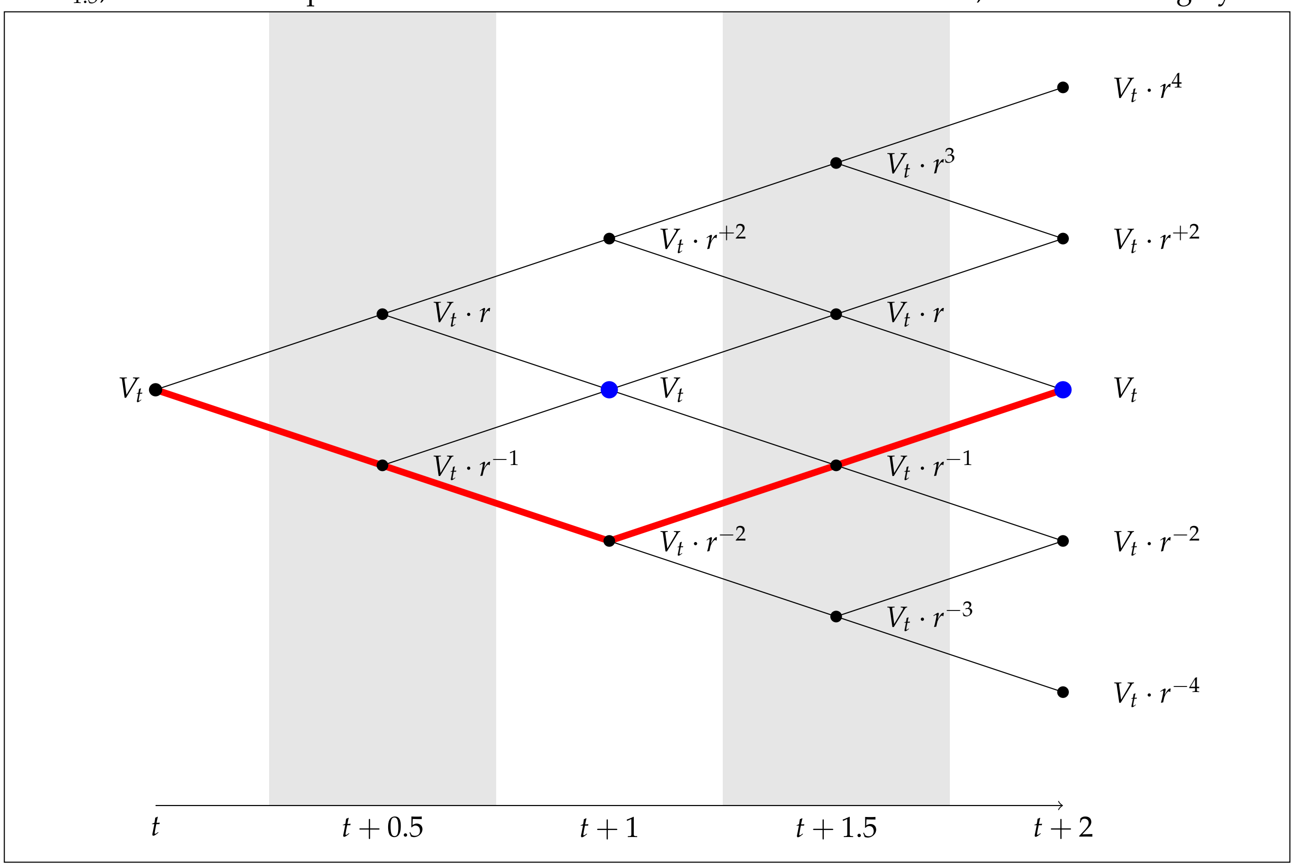


Figure 1 illustrates the communication strategy of the manager (blue dots) based on one specific development of the firm's fundamental value (red line). Starting from the fundamental value V_t in t, the firm value can either move upwards by factor r^{+1} with a probability of p or downwards by r^{-1} with a probability $(1-p)$. Prompted by the managerial claims at $t+1$ and $t+2$, the investor evaluates her investment. The investor, however, lacks contemporaneous information and instead relies on the public information from the previous intermediate dates ($t+0.5$ and $t+1.5$, shaded in grey). The manager also observes the contemporaneous project success ($t+1$ and $t+2$) and can choose to communicate the stock price accurately or share biased information. One exemplary fundamental value path is highlighted in red: the first two projects fail and the two subsequent projects succeed such that the firm's value in $t+2$ equals V_t. Here, accurate communication would be unattractive for a myopically loss averse investor as the utility loss due to the stock price decrease from t to $t+1$ exceeds the utility gain from the increase from $t+1$ to $t+2$. The manager can counteract this negative effect by claiming firm values of V_t in $t+1$ and $t+2$, respectively (as highlighted in blue). Hence, the manager employs a communication strategy that groups losses and gains together to the benefit of the investor.

We also study the asset pricing implications of the firm's optimal information provision. The biased information provision of managers reduces stock price volatility as also evident in Figure 1. This finding is particularly interesting as financial regulators seek to counteract excessive volatility in the stock market. Following the GameStop frenzy, the SEC has stated that "extreme stock price volatility has the potential to expose investors to rapid and severe losses and undermine market confidence"[1]. In our model, managerial communication in accordance with this regulatory goal emerges endogenously such that

[1] See the Jan. 29, 2021 Statement of Acting Chair Lee and Commissioners Peirce, Roisman, and Crenshaw.

regulatory constraints on firm communication might have unanticipated adverse affects. Our key finding is a positive autocorrelation between past and future stock returns akin to the widely documented and puzzling momentum effect (Jegadeesh and Titman, 1993; Carhart, 1997). Specifically, firms that have recently experienced stock price decreases are more likely to experience subsequent negative returns, whereas firms whose stocks have recently increased are more likely to display positive subsequent returns. The intuition for this implication is as follows. There will only be a negative stock return between two evaluation dates if the manager is unable to prevent this negative return via an upward biased claim. This situation can result from a previous overvaluation of the stock such that plausibility constraints prevent the manager from further increasing the degree of overvaluation. Consequently, negative realized returns indicate an overvaluation such that expected returns are comparably low. Similar arguments apply to positive stock returns.

Lastly, we document that our theoretical model matches existing and new empirical evidence. While the stock price dynamics feature stock price momentum, we derive two novel empirical predictions with respect to the interaction of managerial communication and stock prices. First, managerial overstatement in firm communication is more likely if the manager exhibited similarly biased communication in the last period. Second, managerial overstatement is more likely if the firm recently experienced a negative stock return. We focus on earnings forecasts as one example of managerial communication that is sufficiently quantifiable and verifiable to show that our predictions are borne out in the data. Analyses based on exogenous variation in past returns indicate that the effect is causal.

Our contribution to the literature is fourfold. First, we add to the literature on strategic information transmission, which goes back to Crawford and Sobel (1982). A multitude of theoretical and experimental work examines when and why individuals provide (in)accurate information in sender-receiver games (see, e.g., Okuno-Fujiwara et al., 1990; Dickhaut et al., 1995; Wang et al., 2010; Gneezy et al., 2018). Since our model features strategically biased communication, it adopts a key component of this stream of literature (see, e.g., Farrell and Rabin, 1996; Gneezy, 2005). Because we explicitly want to study the long-term implications of systematic biases in communicated firm information, we consider a new multi-period set-up. Motivated by the evidence from behavioral economics, we also introduce myopic loss aversion into a model of strategic communication. While we study the insertion of such non-standard receiver preferences in the specific setting of managerial communication, our results have implications beyond the corporate context.

Second, by explicitly considering managerial communication we also contribute to the stream of literature on voluntary disclosure, which goes back to Grossman and Hart (1980), Verrecchia (1983), and Dye (1985). Subsequent work has studied what firms disclose to their investors (see, e.g., Bond and Zeng, 2022; Schneemeier, 2023) and when they disclose (see, e.g., Acharya et al., 2011; Guttman et al., 2014) under a multitude of different assumptions. One central feature shared among these models is that investors are assumed to be risk neutral (see, e.g., Jung and Kwon, 1988; Einhorn and Ziv, 2008) or risk averse (see, e.g., Shin, 2003; Cheynel, 2013). A notable exception is the working paper by Huang et al. (2023), which inserts a loss averse investor in the framework of Dye (1985). Our approach differs in two main ways. First, because the empirical literature documents that voluntary disclosure is sticky, i.e., firms that disclose rarely cede their disclosures (Houston et al., 2010; Call et al., 2024), we study the information content of such firm proclamations instead of their timing. Second, we want to study long-term stock market implications of managerial communication such that we study a dynamic multi-period model instead of a static two-period model, allowing us to study the manager's intertemporal utility trade-off.

Third, we add to the extensive literature on the causes of stock price momentum. The puzzling return pattern has received continuous attention in the finance literature because momentum is perhaps the most pervasive stock market anomaly. Predicting subsequent returns based on past prices challenges even the weak form of Fama's (1970) efficient market hypothesis. Beyond rational explanations (Johnson, 2002; Hou et al., 2015), investor underreaction to novel firm information is the most common explanation for momentum (Barberis et al., 1998; Hong and Stein, 1999; Da et al., 2014). Our model features neither investor underreaction nor any autocorrelation of the underlying value process, yet stock price momentum emerges endogenously. Thus, we present a novel behavioral explanation for the momentum anomaly. Our paper relates to Shin (2006), who studies a joint model of asset prices and disclosures which yields momentum. The economic mechanism that causes momentum, however, differs as Shin (2006) presents a rational model where disclosure affects subsequent risks, while managers' communication causes momentum in our model.

Fourth, we extend the literature on myopic loss aversion. Developed by Benartzi and Thaler (1995) to explain the equity premium puzzle, myopic loss aversion combines mental accounting and loss aversion to describe human behavior more accurately. There is strong experimental evidence for behavior in line with myopic loss aversion (Gneezy and Potters, 1997; Thaler et al., 1997; Benartzi and Thaler, 1999; Zeisberger et al., 2012; Schwaiger et al., 2024), notably even among professional traders (Haigh and List, 2005) and in laboratory asset markets (Gneezy et al., 2003). Myopic loss aversion, however, has not yet been studied in a strategic communication model. By showing that such investor preferences can lead to momentum, our findings also provide a new angle on Docherty and Hurst (2018), who document that momentum profits are larger in markets with myopic investors.

2. A Model of Strategic Communication

2.1. Model Set-Up

We consider a dynamic model of managerial communication. Our model incorporates two participants: one manager of a publicly listed firm and one investor. Time is discrete, $t \in \{0, 0.5, 1, 1.5, ..., T\}$, i.e., each period has two dates. We consider a finite, multi-period set-up that runs until period T, which may be very far away from $t = 0$. We distinguish between evaluation dates ($t \in \{0, 1, 2, ..., T\}$), where the manager makes a claim about the firm's success and prompts an evaluation of the stock performance by the investor, and intermediate dates ($t \in \{0.5, 1.5, 2.5, ..., T - 0.5\}$). There is no public communication from the manager at intermediate dates such that the investor does not update her beliefs about the firm. When the investor is prompted to consider her investment at an evaluation date, she only has access to public information about the firm value from the preceding intermediate date. This bundling of voluntary firm communication with verifiable, backward-looking reporting is akin to the frequent practice of joint earnings forecasts and announcements (see, e.g., Baginski et al., 2023).

Firm Value Process. Let V_t be the value of the firm at time t. Between each date, the firm undertakes one independent and identical project, which succeeds with probability p and fails with probability $(1 - p)$. Each successful project leads to an increase in the firm value by a return factor $r > 1$, while the costs of a failed project decrease the firm value by the factor r^{-1}. The gross returns r are independently and identically distributed across time. Since one period consists of two dates, the firm value in $t + 1$, V_{t+1}, assumes a value $V_t * r^{+2}$ with probability p^2, a value V_t with probability $2 * p * (1 - p)$ and a value of $V_t * r^{-2}$ with probability $(1 - p)^2$. Thus, as depicted in Figure 2, which shows the possible developments of the fundamental value from t to $t+2$, the firm value moves in line with the seminal option pricing model of Cox et al. (1979) and similar to Shin (2003, 2006).

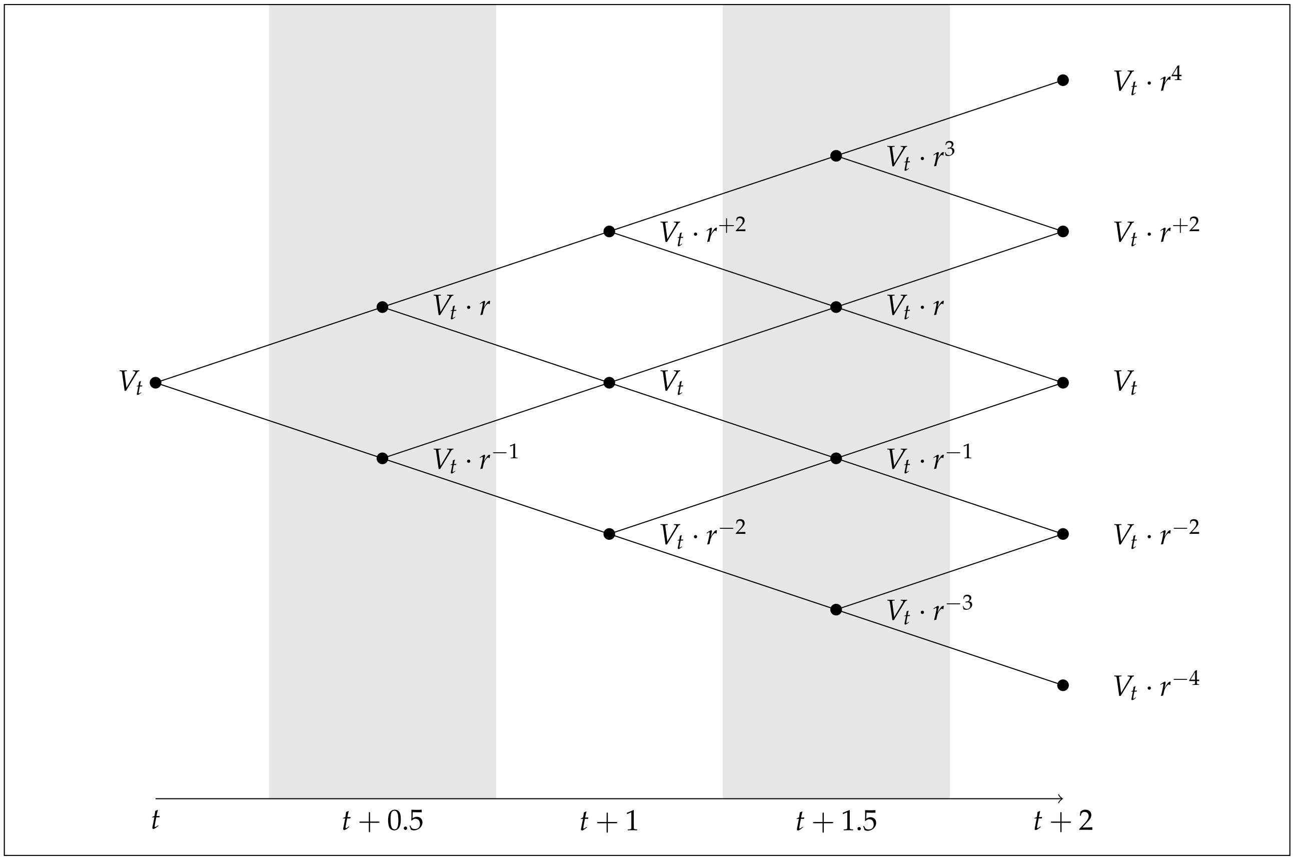
We define the two-step firm value path from t to $t+1$ as $\pi_t = (\pi_{t,0.5}, \pi_{t,1})$ with $\pi_{t,0.5} = V_{t+0.5}/V_t$ and $\pi_{t,1} = V_{t+1}/V_{t+0.5}$. The two-step firm value path π_t can thus assume the value pairs (r^{-1}, r^{-1}), (r^{-1}, r^{+1}), (r^{+1}, r^{-1}), and (r^{+1}, r^{+1}), reflecting the respective up and down movements in the binomial tree within one full period. The set of possible firm value paths π is called Π such that $\Pi = \{(\pi_{t,0.5}, \pi_{t,1}) \mid \pi_{t,0.5}, \pi_{t,1} \in \{r^{-1}, r^{+1}\}\}$.

A multi-period value path $\langle \pi_t \rangle_{t \in \mathbb{N}}$ (or $\langle \pi_t \rangle$ in short) is a sequence of one-period value paths. For a starting value V_0, such a multi-period value path $\langle \pi_t \rangle$ generates a multi-period firm value sequence $\langle V_t \rangle_{t \in \mathbb{N}}$ with $V_{t+1} = V_t \cdot \pi_{t,0.5} \cdot \pi_{t,1}$.

Information Asymmetries. Both manager and investor know exactly how the firm value process depends on the projects' success and failure. Thus, they are fully aware of the described stochastic process. There are, however, information asymmetries with respect to the realization of projects. While the manager knows the firm value at any point in time (i.e., both at intermediate and evaluation dates), the investor's information at evaluation dates stems from the last respective intermediate date. Thus, the investor has limited introspection into the intermediate development of the firm value: at an evaluation date (i.e., $t+1$, $t+2$, ...), the investor can only observe the firm value that was realized at the previous intermediate date (i.e., $t+0.5$, $t+1.5$, ...). We denote the firm value last observed by the investor as "limited introspection" firm value $L_t = V_{t-0.5}$.

This limited introspection of investors into the firm is akin to firm's annual financial reporting of earnings. Once a year, the firm has to release audited, and thus verified, financial statements. When the investor evaluates the stock performance at an evaluation

Figure 2. Fundamental Value Path
This figure shows the potential paths of the firm's fundamental value from t_0 to $t + 2$ within our model. The intermediate dates $t + 0.5$ and $t + 1.5$, where the last public information about the firm value stems from, are shaded in grey.



date upon the manager's claim in $t \in \{1, 2, ..., T\}$, her last verifiable information on the firm value arrives with delay from the previous intermediate date at $t \in \{0.5, 1.5, ..., T - 0.5\}$.

Managerial Claims. The manager can make use of her superior knowledge and claim at time $t \in \{1, 2, ..., T - 1\}$ which firm value has been realized through the most recent project. This claimed firm value is called C_t. The manager can truthfully reveal the firm's recent success or failure (i.e., the project success or failure before the evaluation date), but can also reveal a biased firm value based on strategic considerations. Our model thus allows the manager to distort her public claims in line with, for example, Einhorn and Ziv (2012).

Given the two-stage binomial structure of the firm value process (and everyone's knowledge about it), the manager will only claim values of C_t which are feasible, i.e., $C_t = L_t * r^{+1}$ or $C_t = L_t * r^{-1}$. Stated differently, the public information from the last intermediate date serves as a model-endogenous constraint of the manager's claims as the investor would recognize that larger deviations cannot be reconciled with the last publicly-available information. Since it is well-documented in the literature on firm disclosure that managers want to avoid litigation (Marinovic and Varas, 2016) and reputational damages due to excessively biased disclosure, we assume that the manager will abstain from any claim that does not satisfy the feasibility constraint.

For the last period $t = T$, we assume that all uncertainty about the firm value is resolved such that the investor is informed about the firm value V_T. Thus, it holds $C_T = V_T$. Note that we are interested in the implications of managers' strategic behavior at times $0 \ll t \ll T$ and neither in the influence of the assumed starting claim C_0 nor the forced behavior at the end of our model interval $t = T$.[2]

Based on the above considerations, the "limited introspection" firm value can be at most one r-step away from the previous firm value:

$$L_{t+1} = V_t \cdot \pi_{t,0.5}. \tag{1}$$

Similarly, the subsequent firm value will be within one r-step of the "limited introspection" firm value:

$$V_{t+1} = L_{t+1} \cdot \pi_{t,1}. \tag{2}$$

[2]As documented in the proof of Theorem 1, the special endgame situation in $t = T$ has no impact on optimal strategic behavior at any time $t < T$.

The State of Misrepresentation. If $C_t \neq V_t$, the manager has provided a biased estimate of the firm value. The state of misrepresentation at time t is called μ_t and is defined as $\mu_t = C_t / V_t$. Due the two-stage binomial structure, μ_t can only assume the values r^{-2}, r^0, or r^{+2}. If $\mu_t = r^{-2}$ the manager has claimed a firm value C_t that is lower than the true firm value V_t by a factor r^{-2}. If $\mu_t = r^0 = 1$, the manager has claimed the true firm value at time t. If $\mu_t = r^{+2}$, the claimed firm value C_t is higher than the true firm value V_t by a factor r^{+2}.

Price Impact of Managerial Claims. We assume that investors are naïve and do not anticipate any strategic motives of the manager. The motivation for this assumption is threefold. First, there is strong empirical evidence that investors incorporate managerial forecasts in their beliefs even if such forecasts are biased (Johnson et al., 2020; Baginski et al., 2023). Second, it appears inconsistent to assume that a myopically loss averse investor, who by assumption suffers from behavioral distortions, is able to infer managerial motives from a complex pattern of past prices and managerial claims. Third, experimental studies on strategic information transmission confirm that subjects fail to infer motives behind communicated information (even if such motives are substantially easier to infer than in our theoretical set-up as documented by Jin et al., 2021 and Montero and Sheth, 2021). Thus, we assume that investors take the firm value claims of the manager at face value. Since investors update their beliefs based on the managers' communicated information and trade accordingly, the price of the stock at time t will assume C_t and thus will fully reflect the manager's claimed firm value. Consequently, the stock will be undervalued ($C_t < V_t$) in mispresentation state $\mu_t = r^{-2}$, fairly valued ($C_t = V_t$) in misrepresentation state $\mu_t = r^0$, and overvalued ($C_t > V_t$) in misrepresentation state $\mu_t = r^{+2}$.

The Communication Strategy. A communication strategy of the manager S_t is a mapping $\mathbb{R}\ (V_{t-1}, C_{t-1}, \pi_{t-1}) \mapsto C_t$ which defines which firm value the manager will claim in time t if she is confronted with a firm value path π_{t-1}, a previous firm value V_{t-1}, and a previous managerial claim C_{t-1}. Inherently, we only consider feasible combinations of V_{t-1} and C_{t-1} as potential arguments for the managerial strategy, i.e., only combinations which $C_{t-1}/V_{t-1} = \mu_{t-1} \in \{r^{-2}, r^0, r^{+2}\}$. Note that the strategy in t does not directly depend on anything that happened before $t-1$. A feasible strategy satisfies

$$S_t(V_{t-1}, C_{t-1}, \pi_{t-1}) \in \{L_t r^{-1}, L_t r^{+1}\} = \{V_{t-1} \cdot \pi_{t-1,0.5} \cdot r^{-1}, V_{t-1} \cdot \pi_{t-1,0.5} \cdot r^{+1}\}. \tag{3}$$

A multi-period managerial strategy is a sequence $\langle S_t \rangle_{t \in \mathbb{N}}$. It is called feasible if each S_t in the sequence is feasible. For any managerial strategy $\langle S_t \rangle$, a starting firm value V_0, and a managerial claim C_0, a multi-period value path $\langle \pi_t \rangle$ generates a sequence of managerial claims $\langle C_t \rangle_{t \in \mathbb{N}}$, where $C_t = S_t(V_{t-1}, C_{t-1}, \pi_{t-1})$. This also leads to a sequence of misrepresentation states $\langle \mu_t \rangle_{t \in \mathbb{N}}$, where $\mu_t = C_t / V_t$.

Investor Utility. We assume that the investor has an additive separable utility function that myopically evaluates price changes between two evaluation dates $t-1$ and t. The overall utility induced by experiencing a price sequence $\langle C_t \rangle$ from time $t = a$ to $t = T$ (with $a > 0$) is thus given by

$$U_{t=a}^{T}(\langle C_t \rangle) = \sum_{t=a}^{T} u(C_t - C_{t-1}). \tag{4}$$

The investor is myopically loss averse. Thus, she evaluates her dollar change at each evaluation date t according to:

$$u(x) = \begin{cases} x & \text{for } x \geq 0 \\ \lambda x & \text{for } x < 0 \end{cases} \tag{5}$$

where $\lambda > 1$ defines the degree of loss aversion.

Manager Utility. We assume that the manager follows an investor perspective, i.e., she cares about the investor's utility. The expected managerial utility generated by employing a communication strategy $\langle S_t \rangle$ between times $t = a$ and $t = T$ (with $a > 0$) is called EU_a^T and is a function of $\langle S_t \rangle$, V_{a-1}, C_{a-1}, and π_{a-1}.[3]

For all $a < T$, the expected managerial utility can be recursively defined as a combination of the immediately realized utility IU_a^T and the expected future utility EFU_a^T:

$$EU_a^T(\langle S_t \rangle, V_{a-1}, C_{a-1}, \pi_{a-1}) = IU_a^T(\langle S_t \rangle, V_{a-1}, C_{a-1}, \pi_{a-1}) + EFU_a^T(\langle S_t \rangle, V_{a-1}, C_{a-1}, \pi_{a-1})$$

$$\text{with} \quad IU_a^T(\langle S_t \rangle, V_{a-1}, C_{a-1}, \pi_{a-1}) = u(C_a - C_{a-1}) = u(S_a(V_{a-1}, C_{a-1}, \pi_{a-1}) - C_{a-1})$$

$$\text{and} \quad EFU_a^T(\langle S_t \rangle, V_{a-1}, C_{a-1}, \pi_{a-1}) = \sum_{\pi_a} pr(\pi_a) EU_{a+1}^T(\langle S_t \rangle, V_a, C_a, \pi_a)$$

$$= \sum_{\pi_a} pr(\pi_a) EU_{a+1}^T(\langle S_t \rangle, V_{a-1} \cdot \pi_{a-1,0.5} \cdot \pi_{a-1,1}, S_a(V_{a-1}, C_{a-1}, \pi_{a-1}), \pi_a)). \quad (6)$$

For $a = T$, we know that $EFU_a^T = 0$. Since managers are forced to state the true value V_t in T,

$$EU_T^T(\langle S_t \rangle, V_{T-1}, C_{T-1}, \pi_{T-1}) = IU_T^T(\langle S_t \rangle, V_{T-1}, C_{T-1}, \pi_{T-1})$$

$$= u(C_T - C_{T-1}) = u(V_T - C_{T-1}). \quad (7)$$

A managerial strategy $\langle S_t \rangle$ is called optimal and denoted as $\langle S_t^{opt} \rangle$ if it generates the highest possible expected utility for the manager, that is,

$$EU_a^T(\langle S_t^{opt} \rangle, V_{a-1}, C_{a-1}, \pi_{a-1}) = max\{EU_a^T(\langle S_t \rangle, V_{a-1}, C_{a-1}, \pi_{a-1}) \mid \langle S_t \rangle \text{ is feasible}\}. \quad (8)$$

[3]Incorporating a discount rate into the manager's utility function does not affect the key insights derived in the following.

2.2. Discussion of Assumptions

Our model makes several simplifying assumptions for tractability. We discuss the most important assumptions in the following.

Biased Claims. The central choice of the manager in our model is the bias incorporated in her firm value claims. This focus is in line with the strategic information transmission literature, yet distinguishes our paper from large swaths of the voluntary disclosure literature, which mostly focuses on the decision whether to disclose and assumes that disclosure is inherently truthful (see, e.g., Grossman, 1981; Milgrom, 1981; Langberg and Sivaramakrishnan, 2008). A survey by Verrecchia (2001) points out that this common assumption of truthful disclosure is a weakness of the literature on voluntary disclosure. Einhorn and Ziv (2012) are a notable exception as they model the decision whether to guide and whether to bias the disclosure in a joint model.

Within our model, we focus on biased information in managerial communication for two reasons. First, the voluntary release of firm information such as earnings guidance is often viewed as sticky (Houston et al., 2010; Call et al., 2024). Thus, managers' leeway in the decision to guide is reduced. Second, there is strong empirical evidence for systematic biases in voluntarily provided firm information, with some evidence pointing towards intentionally conveyed biases (see, e.g., Johnson et al., 2020; Baginski et al., 2023; Lohmeier and Mohrschladt, 2024). Moreover, such intentionally distorted disclosures are treated as widely accepted in the literature on mandatory disclosure as evidenced by earnings management (Bartov, 1993; Roychowdhury, 2006). Altering our model such that the manager can choose whether to disclose verifiable information will yield qualitatively similar insights as the model presented here if the investor fails to unravel the strategic incentives of the manager.

Stock Mispricing. Our model rests on the assumption that the investor naïvely updates her beliefs about the firm based on the managerial claim and trades accordingly, even if this causes a deviation of fundamental firm value and stock price. Such stock mispricing is well-documented in the empirical asset pricing literature (Stambaugh and Yuan, 2017; Asness et al., 2019; Daniel et al., 2020) and is often ascribed to erroneous expectations of future firm performance (Seybert and Yang, 2012). Within our model, the manager induces mispricing in the stock market by providing biased information to the investor, which is in line with the strong stock price reactions around dates of corporate disclosures.

Such mispricing might be corrected if an arbitrageur recognizes the manager's strategic incentives and trades against any such over- or undervaluation of the stock. Incorporating an arbitrageur (or a group of arbitrageurs) in our model yields new insights. Dependent on the relative price impact of the arbitrageur and the investor, the stock price at the evaluation date will be set between the stock price implied by the managerial claim and the fundamental price (meaning that the stock price will move off the binomial tree). While complicating the model substantially, the main predictions of the model remain unchanged (although attenuated with respect to their effect size) as long as the myopically loss averse investor has any price impact. Given the strong evidence on the persistence of stock mispricing (Daniel et al., 2023) and the existence of limits to arbitrage (Shleifer and Vishny, 1997), this assumption seems reasonable – and we omit arbitrageurs for simplicity.

Investor Utility & Managerial Response. The main innovation of our model lies in the utility function of the investor, which reflects myopic loss aversion. Such investor behavior is well-founded by experimental and empirical evidence. This assumptions is also where our main model predictions stem from: the manager in our model faces incentives to provide biased information because the investor succumbs to mental accounting despite the multi-period setting. In combination with the investor's loss aversion, this myopia enables the manager to "edit" the stock price path so that it is most attractive for the investor.

Moreover, our model assumes that the manager recognizes the investor's myopic loss aversion and adjusts her optimal communication strategy accordingly. Such managerial responses to non-standard investor preferences are the core tenet of the catering literature in behavioral corporate finance (Malmendier, 2018), which has for example investigated how managers adjust their dividend policy to investors' reference point-dependent loss aversion (Baker et al., 2016). Following this stream of literature, our model presumes that investors fail to infer the manager's strategic incentives from past managerial claims. Our motivation for this assumption is twofold. First, despite the relative simplicity of our model, the patterns under which biased managerial communication emerges are quite complex (as documented in Section 3). Assuming that an otherwise "behavioral" investor is able to unravel such incentives from (directionally inconsistent) deceptions in past managerial claims over several periods is thematically inconsistent. Second, Jin et al. (2021) and Montero and Sheth (2021) document that information recipients in experimental studies on information transmission already fail to infer the sender's motives when bad news are omitted.[4] Extending our model by including the investor's learning about the manager's motives would also complicate our model considerably.

[4] Somewhat relatedly, Brown et al. (2012, 2013) provide accompanying field evidence for consumers' inability to correctly infer strategic motives of firms. Specifically, the authors show that movie studies systematically withhold low-quality movies from critics prior to the public release (so-called "cold-openings"), yet customers fail to unravel accurately that movies with a cold-opening are of lower quality.

3. Optimal Managerial Communication

3.1. Comparative Statics

In this section, we present the main comparative static result of our paper. Specifically, we present the optimal communication strategy a manager will follow in the face of a myopically loss averse investor, i.e., the strategy that maximizes the manager's expected utility (see Equation (6)) and thus fulfills the optimality condition in Equation (8). The formal proof of Theorem 1 is in the Appendix.

Theorem 1 (Optimal Information Provision). There exists a unique optimal managerial strategy $\langle S^{opt} \rangle$. It is given for each t with $0 < t < T$ as

$$S_t^{opt}(V_{t-1}, C_{t-1}, \pi_{t-1}) = C_t = \begin{cases} C_{t-1} \cdot r^{+2} & \text{if} \quad C_{t-1} < L_t \cdot r^{-1} \\ C_{t-1} \cdot r^{-2} & \text{if} \quad C_{t-1} > L_t \cdot r^{+1} \\ C_{t-1} & \text{otherwise.} \end{cases} \tag{9}$$

For $t = T$, $S_t^{opt}(V_{t-1}, C_{t-1}, \pi_{t-1}) = V_t$ must hold by assumption.

Hence, S_t^{opt} minimizes the extent of proposed firm value changes $\mid C_t - C_{t-1} \mid$ within the range of feasible managerial firm value claims, that is, the optimal managerial strategy only changes the claimed firm value C_t in cases where sticking to the previous claim is not possible (since C_{t-1} is not in the set $\{L_t r^{-1}, L_t r^{+1}\}$). Stated differently, the manager tries to stay as close as possible to the previously claimed stock price, matching the investor's prior belief.

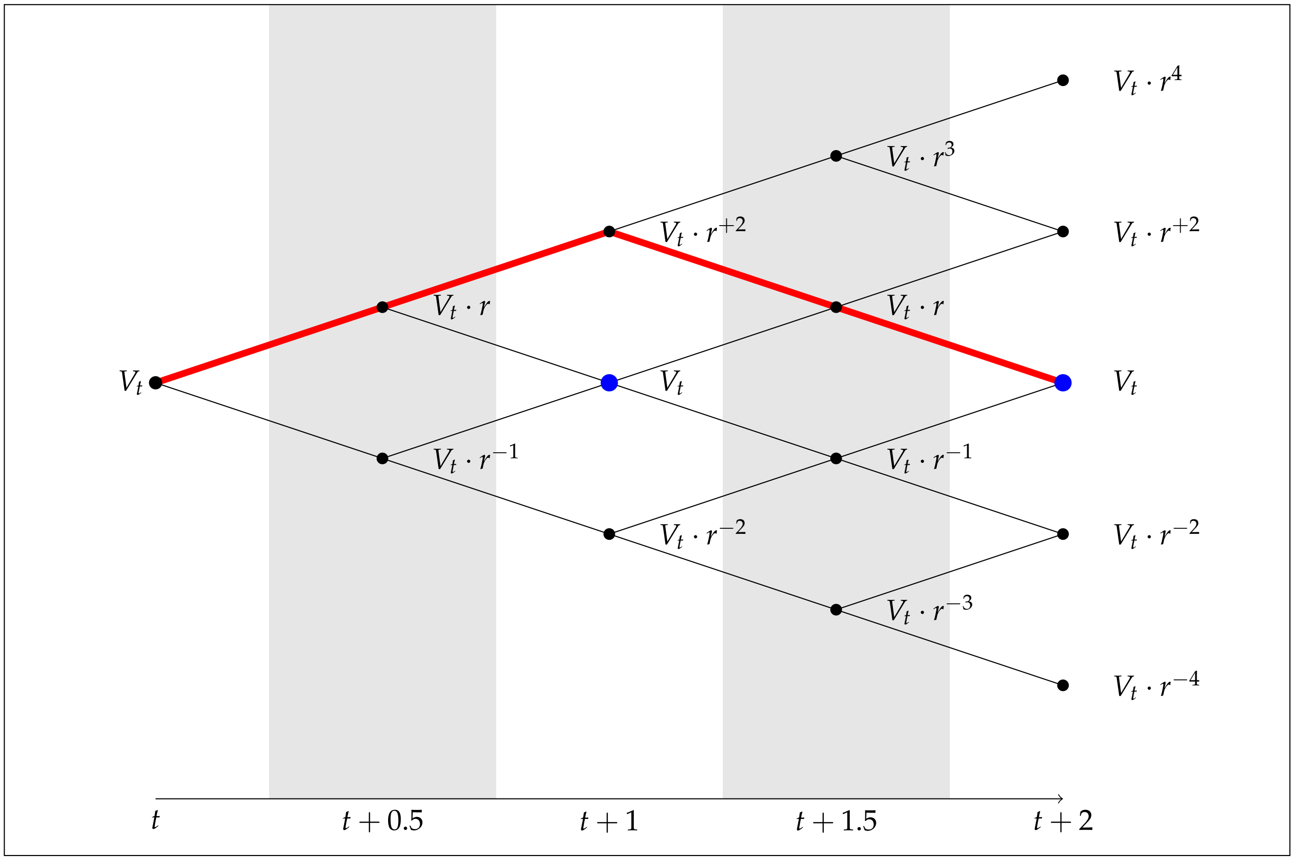
What is the rationale of this strategy? Stock price declines lead to disproportionally large utility losses for a myopically loss averse investor. Thus, the manager will also be disproportionally averse to provide any information that implies a decline in the stock price. To avoid such a utility loss, the manager might provide upward-biased information. Conversely, since the manager is aware of the stochastic firm value process, she anticipates down movements in the future. Hence, the manager might provide downward-biased information to build up a "buffer" for potential bad news in the future. Consequently, the manager will engage in smoothing the price path, which is a managerial strategy also documented in earnings management (see, e.g., Copeland, 1968; Baik et al., 2022) and dividend streams (see, e.g., Lintner, 1956; Leary and Michaely, 2011).

The role of the manager in our model is thus to communicate the stochastic stock price development in such a way that it is as attractive as possible for the myopically loss averse investor. This insight relates to the editing literature in experimental economics (Thaler, 1985; Thaler and Johnson, 1990): equivalent gambles can seem more or less attractive for human subjects dependent on the presentation. Specifically, the manager "edits" the stock prices through claims such that losses are integrated into gains where possible. This way, the manager presents the stochastic firm value process such that it generates the highest possible utility for the investor. While the resulting communication strategy of the manager implies intentionally deceptive forecasts, it is beneficial for the incumbent investor with myopic loss aversion.

3.2. Path Examples

Figure 3 illustrates the implications of Theorem 1 by means of a simple example. Specifically, the stock is initially fairly valued, i.e., there is no existing misstatement of the firm

Figure 3. Exemplary Binomial Tree and Communication Strategy – Initial Increase
This figure shows the potential paths of the firm's fundamental value from t to $t+2$ within our model. The path along the realized firm values, which in this example are realized through two initial firm value increases and two subsequent firm value decreases, are highlighted in red. The associated stock values claimed by the manager are depicted in blue. The intermediate dates $t+0.5$ and $t+1.5$, where the investor is able to observe the firm's fundamental value, are shaded in grey.



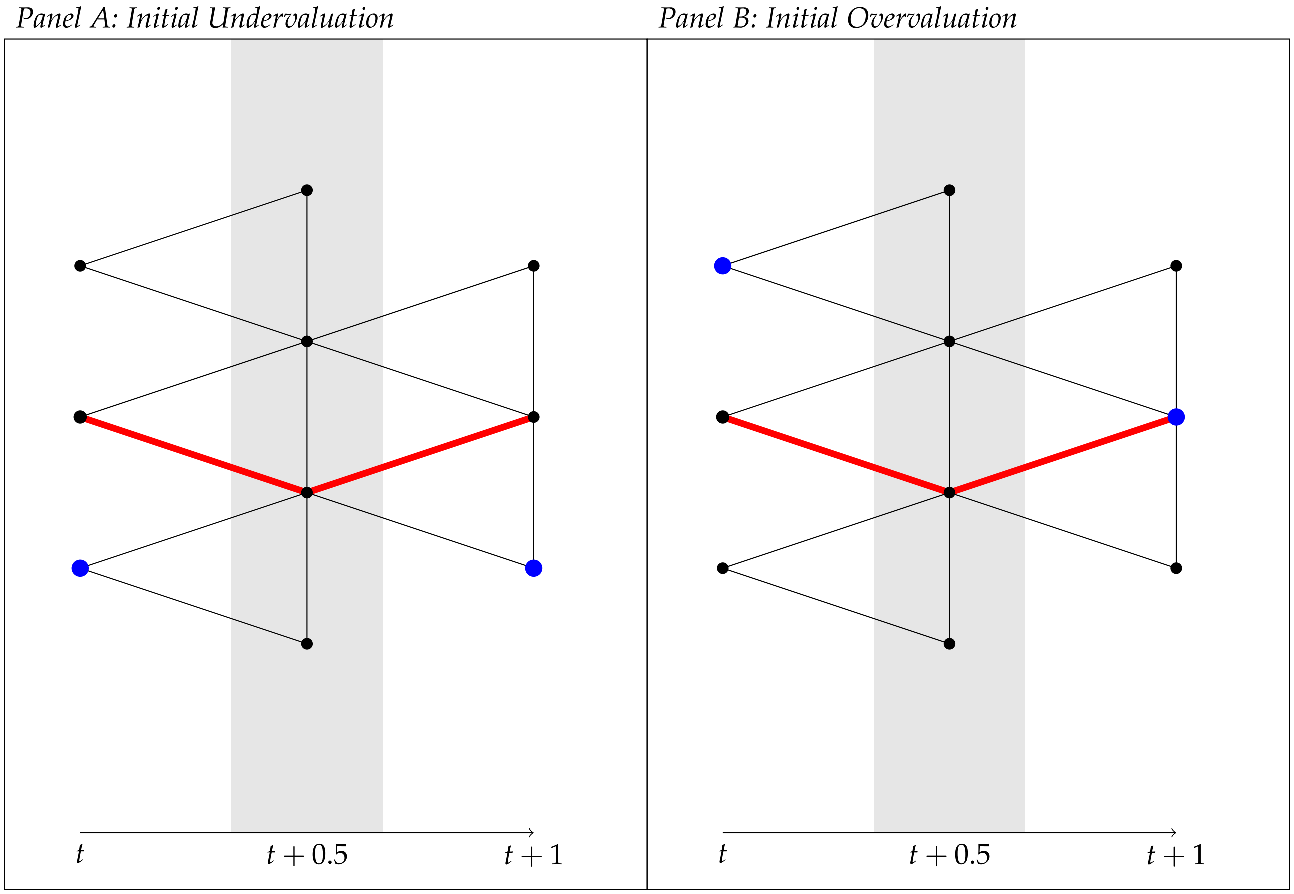
value in t. In $t+1$, both the manager and the investor are aware of the firm value in $t+0.5$. The success of the subsequent project in $t+1$ is, however, only known by the manager. In line with the optimal managerial strategy, the manager will claim that the second project failed to present a zero return between t and $t+1$ to the investor, while building a "buffer" for subsequent project failures. How will the subsequent development of the firm's fundamental value affect the manager's communication strategy? If the fundamental value increased from $t+1$ to $t+1.5$, the feasibility constraint would dictate that the manager can only claim a stock price of $V_t r^{+4}$ or $V_t r^{+2}$. Irrespective of the project success observed in

$t+2$, the manager would claim a value of $V_t r^{+2}$, which would imply undervaluation of the stock if the project from $t+1.5$ to $t+2$ succeeded and a fair valuation if the project failed. In the specific path depicted in Figure 3, however, two subsequent projects after $t+1$ failed. Then, the manager will claim a stock price of V_t, implying a second zero return. Hence, the manager will have communicated a constant fundamental value instead of an initial increase followed by a decrease, thus integrating losses and gains to smooth the stock's price path. Equation (5) combined with a loss aversion parameter $\lambda > 1$ directly shows that two zero returns imply a higher level of intertemporal utility than a positive and a negative price movement of the same magnitude.

The examples of firm value paths presented so far start with an initial alignment of the firm's fundamental value and the stock price claimed by the manager, i.e., the firm is fairly valued. As discussed before, however, mispricing arises endogenously within our model and in turn affects the subsequent communication strategy. Figure 4 depicts the optimal information provision in the face of a $\pi_t = (r^{-1}, r^{+1})$ firm value development if the firm is initially undervalued (Panel A) or overvalued (Panel B).

Panel A starts with a claimed value C_t that is lower than the fundamental firm value V_t such that the firm is initially undervalued ($\mu_t = r^{-2}$). The project undertaken from t to $t+0.5$ fails such that the firm's fundamental value declines. For the naïve investor, who believes that the firm value previously equaled the claimed stock price C_t, the observed firm value is plausible and could be explained with an intermediate project success. The manager privately observes that the subsequent project from $t+0.5$ to $t+1$ succeeds. The manager, however, indicates a subsequent stock price C_{t+1} below the firm value V_{t+1} to stay as close as possible to the investor's prior belief set in t. Hence, the fundamental firm value

Figure 4. Exemplary Binomial Tree and Communication Strategy – Initial Misrepresentation
This figure shows two potential paths of the firm's fundamental value from t to $t+1$ within our model. Panel A (Panel B) depicts the case where the firm's stock is initially undervalued (overvalued). Realized firm value paths are highlighted in red, while the associated stock values claimed by the manager are depicted in blue. The intermediate dates at $t+0.5$, where the last public information about the firm value stems from, are shaded in grey.



path allows the manager to preserve the undervaluation until $t+1$ as reserve for potential future losses.

Panel B shows the case where the claimed firm value C_t initially exceeds the firm value (V_t), implying an overvaluation. The initial project fails such that in $t+0.5$, the fundamental firm value $V_{t+0.5}$ is three r-steps below the previously claimed stock price C_t. Hence, at the evaluation date $t+1$, the investor recognizes that the previous managerial claim was excessively optimistic based on her limited introspection. After the subsequent project success from $t+0.5$ to $t+1$, the manager communicates the firm value accurately such that the firm is fairly priced in $t+1$.

4. Asset Pricing Implications of Optimal Communication

We next turn to the dynamics of the price process $\langle C_t \rangle$ generated by the optimal communication strategy of the manager. While the process of the true firm value $\langle V_t \rangle$ has no memory by assumption and moves upwards by a factor $\delta V_t = V_t / V_{t-1} = r^{+2}$ with probability p^2 (when path $\pi_{t-1} = (r^{+1}, r^{+1})$ is observed) and downwards by a factor $\delta V_t = V_t / V_{t-1} = r^{-2}$ with probability $(1-p)^2$ (when path $\pi_{t-1} = (r^{-1}, r^{-1})$ is observed), the dynamics of $\langle C_t \rangle$ are more complex. The probability to observe an up ($\delta C_t = C_t / C_{t-1} > 1$) or a down ($\delta C_t = C_t / C_{t-1} < 1$) movement at time t not only depends on the specific path π_{t-1} but also on the the optimal managerial strategy S_t^{opt} and, importantly, on the state of misrepresentation μ_{t-1} in the previous period.

We first recall that by the feasibility constraint μ_{t-1} can only assume the values r^{+2}, r^0, or r^{-2}. According to Theorem 1, the same holds for $\delta C_t = C_t / C_{t-1}$, and by assumption, it is also true for δV_t. As we are interested in the probabilities to observe the different realizations of these variables, we define

$$pr(\delta C_t) = \begin{pmatrix} pr(\delta C_t = r^{+2}) \\ pr(\delta C_t = r^0) \\ pr(\delta C_t = r^{-2}) \end{pmatrix} \tag{10}$$

as the probability vector for the three feasible price changes. For conditional probabilities, we use the common notation, e.g., $pr(\delta C_t = r^{+2} \mid \delta C_{t-1} = r^{+2})$ to refer to the probability to observe a positive price movement at time t, conditional on a positive price movement at time $t-1$. The notation $pr(\delta C_t \mid X)$ refers to the probability vector where the condition X is given for each component. Probability vectors $pr(\delta V_t)$ and $pr(\mu_t)$ are defined in the same way for the three possible changes of the true firm value and the three possible states of misrepresentation at time t.

Using this notation, we will show that the price process $\langle C_t \rangle$ is (1) less volatile than the underlying firm value process $\langle V_t \rangle$ and (2) prone to momentum, i.e., $\langle C_t \rangle$ features an increased probability to observe a positive (negative) return after a positive (negative) return in the previous period. Property (1) might look trivial given our intuitive characterization of the optimal managerial strategy as "always stay as close to the previously claimed value as feasible", but the price dynamics are more complex than it might look at first sight. In fact, there exist scenarios where changes in the stock price occur although the true firm value has not changed (e.g., when $\mu_{t-1} = r^{-2}$ and the path $\pi_{t-1} = (r^{+1}, r^{-1})$ is observed). So, we find it worthwhile to formally confirm this "smoothing property". Property (2) is the more interesting insight as it provides a new communication-based explanation for the occurrence of momentum in asset prices – optimal managerial communication generates stock price momentum even when there is no momentum in the underlying firm value process.

The distribution of δV_t is easily obtained as

$$pr(\delta V_t) = \begin{pmatrix} pr(\delta V_t = r^{+2}) \\ pr(\delta V_t = r^0) \\ pr(\delta V_t = r^{-2}) \end{pmatrix} = \begin{pmatrix} p^2 \\ 2p(1-p) \\ (1-p)^2 \end{pmatrix}. \tag{11}$$

The key challenge in determining $pr(\delta C_t)$ lies in the fact that it depends on assumptions about the probability vector $pr(\mu_{t-1})$, i.e., the likelihood that the manager has over-, under-, or correctly stated the firm value in the previous period.

To capture the dynamics of the distribution $pr(\mu_t)$ over time, we consider misrepresentation transition matrices M with $M \cdot pr(\mu_{t-1}) = pr(\mu_t)$. For each possible realization of π_{t-1}, they define how a given misrepresentation probability vector $pr(\mu_{t-1})$ is transformed into $pr(\mu_t)$ if the manager applies the optimal strategy S_t^{opt}.

These path-dependent transition matrices are given as:

$$M_{(r^{-1},r^{-1})} = \begin{pmatrix} 1 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{pmatrix}, \quad M_{(r^{-1},r^{+1})} = \begin{pmatrix} 0 & 0 & 0 \\ 1 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix},$$

$$M_{(r^{+1},r^{-1})} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 1 \\ 0 & 0 & 0 \end{pmatrix}, \quad M_{(r^{+1},r^{+1})} = \begin{pmatrix} 0 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 1 \end{pmatrix}. \tag{12}$$

Integrating the probabilities for the occurrence of the different paths π_{t-1}, we obtain

$$\begin{aligned} M &= (1-p)^2 M_{(r^{-1},r^{-1})} + (1-p)pM_{(r^{-1},r^{+1})} + p(1-p)M_{(r^{+1},r^{-1})} + p^2 M_{(r^{+1},r^{+1})} \\ &= \begin{pmatrix} (1-p) & (1-p)^2 & 0 \\ p & 2p(1-p) & (1-p) \\ 0 & p^2 & p \end{pmatrix}. \end{aligned} \tag{13}$$

In the same way, based on S_t^{opt}, we can derive the transition matrix

$$R = \begin{pmatrix} 0 & 0 & p \\ p & 1 & (1-p) \\ (1-p) & 0 & 0 \end{pmatrix} \tag{14}$$

that generates $pr(\delta C_t)$ based on $pr(\mu_{t-1})$, that is, $R \cdot pr(\mu_{t-1}) = pr(\delta C_t)$. Its columns indicate how likely each price movement is observed in the next period when being in a specific state of misrepresentation. The second column vector indicates, for instance, that there will be no price movement for sure at time t, if the firm value was fairly stated at time $t-1$.

Lemma 1. The probability vector

$$pr(\mu_t)^* = \frac{1}{(1-p)^3 + p(1-p) + p^3} \begin{pmatrix} (1-p)^3 \\ p(1-p) \\ p^3 \end{pmatrix} = \frac{1}{(1-p)^2 + p^2} \begin{pmatrix} (1-p)^3 \\ p(1-p) \\ p^3 \end{pmatrix} \tag{15}$$

is a fix vector of M, i.e., $M \cdot pr(\mu_t)^* = pr(\mu_t)^*$ and it further holds for any probability vector $pr(\mu_t)^*$:

$$\lim_{n \to \infty} M^n pr(\mu_t) = pr(\mu_t)^*. \tag{16}$$

The proof of Lemma 1 is in the Online Appendix.

Lemma 1 delivers important insights regarding the question which distribution $pr(\mu_{t-1})$ should be assumed at an arbitrary point of time unconditional on previous period price changes. $pr(\mu_t)^*$ is a steady state distribution of managerial misrepresentation and independent of the assumed starting state of misrepresentation.[5] For our analysis of $pr(\delta C_t)$, we can thus assume that the unconditional distribution of $pr(\mu_{t-1})$ is given as $pr(\mu_t)^*$, either since this canonical distribution is also assumed to be given at $t = 0$, or since we consider points of time t sufficiently far away from $t = 0$ to make the impact of the assumed starting distribution negligible.

Stock Price Volatility. Based on Equations (14) and (15), the unconditional price change vector $pr(\delta C_t)$ is given as

$$R \cdot pr(\mu_t)^* = \frac{1}{(1-p)^2 + p^2} \begin{pmatrix} p^4 \\ p(1-p)^3 + p(1-p) + (1-p)p^3 \\ (1-p)^4 \end{pmatrix}. \tag{17}$$

We note that

$$pr(\delta C_t = r^{+2}) = p^2 - \frac{p^2(1-p)^2}{(1-p)^2 + p^2} = pr(\delta V_t = r^{+2}) - \frac{p^2(1-p)^2}{(1-p)^2 + p^2} \tag{18}$$

and

$$pr(\delta C_t = r^{-2}) = (1-p)^2 - \frac{p^2(1-p)^2}{(1-p)^2 + p^2} = pr(\delta V_t = r^{-2}) - \frac{p^2(1-p)^2}{(1-p)^2 + p^2}. \tag{19}$$

Both the probability to observe a positive or a negative price change is thus $\frac{p^2(1-p)^2}{(1-p)^2+p^2}$ smaller than the probability to observe a respective change in the firm value. This directly implies that δC_t is less volatile than δV_t.

[5]The proof of Lemma 1 even demonstrates that this convergence occurs sufficiently fast and the Euclidian distance of $M^n pr(\mu_0)$ from $pr(\mu_t)^*$ shrinks exponentially at a rate of at least $\frac{1}{2^n}$.

Stock Price Momentum. To show that stock price momentum arises in our model, we first compare $pr(\delta C_t = r^{+2})$ to $pr(\delta C_t = r^{+2} \mid \delta C_{t-1} = r^{+2})$. According to Theorem 1, the optimal managerial strategy prescribes a price increase $\delta C_{t-1} = r^{+2}$ if and only if $C_{t-2} < V_{t-2} \cdot \pi_{t-2,0.5} \cdot r^{-1}$ and thus $\mu_{t-2} = \frac{C_{t-2}}{V_{t-2}} < \pi_{t-2,0.5} \cdot r^{-1}$. This can only happen for the case $\mu_{t-2} = r^{-2}$ and $\pi_{t-2,0.5} = r^{+1}$. In this case, with probability p, $\pi_{t-2,1}$ equals r^{+1} such that we end up with misrepresentation state $\mu_{t-1} = \frac{C_{t-1}}{V_{t-1}} = \frac{C_{t-2} \cdot r^{+2}}{V_{t-2} \cdot r^{+2}} = \mu_{t-2} = r^{-2}$. With probability $(1-p)$, $\pi_{t-2,1}$ equals r^{-1}, such that the misrepresentation state in $t-1$ is $\mu_{t-1} = \frac{C_{t-1}}{V_{t-1}} = \frac{C_{t-2} \cdot r^{+2}}{V_{t-2}} = \mu_{t-2} \cdot r^{+2} = r^0$. These considerations imply

$$pr(\delta C_t \mid \delta C_{t-1} = r^{+2}) = R \cdot pr(\mu_{t-1} \mid \delta C_{t-1} = r^{+2}) = R \begin{pmatrix} 0 \\ (1-p) \\ p \end{pmatrix} = \begin{pmatrix} p^2 \\ 1-p^2 \\ 0 \end{pmatrix}. \tag{20}$$

Comparing this probability vector with the unconditional probability vector in Equation (17) implies

$$pr(\delta C_t = r^{+2} \mid \delta C_{t-1} = r^{+2}) = pr(\delta C_t = r^{+2}) + \frac{(1-p)^2 p^2}{(1-p)^2 + p^2}. \tag{21}$$

The probability to observe a positive price change in t is thus comparably large after having observed a positive price change in $t-1$. Similarly, the probability of a negative return is comparably small after a positive return in the previous period.

An analogous result can be shown for downward movements. According to Theorem 1, the optimal managerial strategy prescribes a price decrease $\delta C_{t-1} = r^{-2}$ if and only if $C_{t-2} > V_{t-2} \cdot \pi_{t-2,0.5} \cdot r^{+1}$ and thus $\mu_{t-2} = \frac{C_{t-2}}{V_{t-2}} > \pi_{t-2,0.5} \cdot r^{+1}$. This can only happen for the case $\mu_{t-2} = r^{+2}$ and $\pi_{t-2,0.5} = r^{-1}$. In this case, with probability $(1-p)$, $\pi_{t-2,1}$ equals

r^{-1} such that we end up with misrepresentation state $\mu_{t-1} = \frac{C_{t-1}}{V_{t-1}} = \frac{C_{t-2} \cdot r^{-2}}{V_{t-2} \cdot r^{-2}} = \mu_{t-2} = r^{+2}$. With probability p, $\pi_{t-2,1}$ equals r^{+1}, such that the misrepresentation state in $t-1$ is $\mu_{t-1} = \frac{C_{t-1}}{V_{t-1}} = \frac{C_{t-2} \cdot r^{-2}}{V_{t-2}} = \mu_{t-2} \cdot r^{-2} = r^0$. These considerations imply

$$pr(\delta C_t \mid \delta C_{t-1} = r^{-2}) = R \cdot pr(\mu_{t-1} \mid \delta C_{t-1} = r^{-2}) = R \begin{pmatrix} (1-p) \\ p \\ 0 \end{pmatrix} = \begin{pmatrix} 0 \\ 1-(1-p)^2 \\ (1-p)^2 \end{pmatrix}. \tag{22}$$

Comparing this probability vector with the unconditional probability vector in Equation (17) implies

$$pr(\delta C_t = r^{-2} \mid \delta C_{t-1} = r^{-2}) = pr(\delta C_t = r^{-2}) + \frac{(1-p)^2 p^2}{(1-p)^2 + p^2}. \tag{23}$$

The probability to observe a negative price change in t is thus comparably large after having observed a negative price change in $t-1$. Similarly, the probability of a positive return is comparably small after a negative return in the previous period. These considerations result in Theorem 2.

Theorem 2 (Asset Pricing Implications). If a manager applies the optimal managerial strategy $\langle S_t^{opt} \rangle$, the resulting price process $\langle C_t \rangle$ is

(i) less volatile than the firm value process $\langle V_t \rangle$

(ii) exhibits momentum, that is,

$pr(\delta C_t = r^{+2} \mid \delta C_{t-1} = r^{+2}) > pr(\delta C_t = r^{+2})$ and

$pr(\delta C_t = r^{-2} \mid \delta C_{t-1} = r^{-2}) > pr(\delta C_t = r^{-2})$.

5. Some Empirical Evidence

Our model yields several empirical predictions with respect to (managerial) communication (Theorem 1) and its asset pricing implications (Theorem 2). The empirical literature already documents that the one implication of Theorem 2, i.e., stock price momentum, is borne out in reality (see, e.g., Jegadeesh and Titman, 1993; Carhart, 1997). Our model is also consistent with the findings of Docherty and Hurst (2018), who document that momentum profits are linked with investor myopia. Strategic communication with a myopically loss averse investor is, thus, a new behavioral contender to explain the emergence of momentum aside investor underreaction. The other implication of Theorem 2, i.e., that managerial communication reduces stock price volatility relative to the fundamental value process, is equally interesting as it carries important regulatory implications. In particular, regulators often seek to dampen excessive volatility in stock markets. The managerial communication strategy in our model is already in accordance with this aim of regulators. Testing this proposition empirically, however, requires a normative benchmark for stock price volatility, which we lack. Therefore, we do not test this prediction.

In contrast, Theorem 1 implies novel predictions with respect to firm communication, for which there is no direct evidence yet. In particular, we derive two testable hypotheses on the interaction of stock prices and firm communication. Then, we test these hypotheses based on one specific form of firm communication: managerial earnings forecasts.

5.1. Empirical Predictions

The optimal managerial strategy $\langle S_t^{opt} \rangle$ is a function of the last managerial claim, the corresponding actual fundamental value, and the fundamental development since this evaluation date. Because the fundamental price path is not observable, we cannot test Theorem 1 directly. Our model, however, allows us to derive empirical predictions with respect to the optimal managerial communication.

Theorem 1 states that the manager minimizes the extent of proposed firm value changes within her feasibility constraints. In particular, the manager tries to preserve any past misrepresentation of the firm value such that she is more likely to overstate the firm value if she overstated the firm value in the past, and vice versa. From these considerations, Hypothesis 1 immediately follows.

Hypothesis 1. *Managerial overstatement is more likely after an overstatement in the last period.*

Similarly, our model implies that a positively biased firm value claim ($C_t = V_t r^{+2}$) is more likely after the stock price declined in the last period ($C_{t-1} < C_{t-2}$). The intuition is as follows. The manager will only have conceded that the firm value has declined if the feasibility constraint has prevented her from counteracting this through a biased claim. Hence, the firm value must have been overstated in $t-2$. Given the positive correlation in managerial overstatement (see Hypothesis 1), overstatement is also comparably likely in t. Equivalent arguments apply to stock price increases.

Hypothesis 2. *Managerial overstatement is more likely after negative past stock returns.*

5.2. Data and Variables

Our theoretical model directly applies to firm communication with investors; it also pertains to many situations where information is provided to a myopically loss averse information recipient. To test Hypotheses 1 and 2, however, the communication must be quantifiable and verifiable. Therefore, we focus on one form of managerial communication in the following: annual earnings forecasts. Earnings forecasts influence investors' expectations and thus stock prices (Penman, 1980). Importantly, the veracity of such forecasts can be substantiated at the subsequent earnings announcement. Moreover, regulation on earnings forecasts yields sufficient leeway to managers to manipulate the forecasts such that prior work has already documented the influence of strategic motives of managers (see, e.g., Johnson et al., 2020; Baginski et al., 2023; Lohmeier and Mohrschladt, 2024).

Sources. We draw data on annual earnings forecasts from the I/B/E/S Guidance database for the sample period between February 2002 and December 2020. We focus on point and range forecasts of future earnings because we require them to be sufficiently precise to judge their accuracy. For range forecasts, we use the midpoint (see, e.g. Basi et al., 1976; Hassell and Jennings, 1986). We limit our analyses to the first annual earnings guidance within one year of the associated earnings announcement. Moreover, we require firms to be listed on the NYSE, AMEX, or NASDAQ, denomination in US Dollar (USD), and a stock price per share above 5 USD (measured at the month's end prior to the forecast date). We supplement the forecast data with accounting data from Compustat, stock data from CRSP, and analyst data from I/B/E/S. For our instrumental variable regressions, we draw mutual fund data from CRSP and Thomson Reuters (in conjunction with replication code provided by Wardlaw, 2020).

Dependent Variable. Our main variable of interest is *Overstatement*, which is a dummy variable equal to 1 if the manager's earnings forecast is higher than the ex-post earnings realization at the subsequent earnings announcement, and 0 otherwise.

Explanatory Variables. Last Overstatement is the one-year lag of *Overstatement*. If the manager did not communicate an earnings forecast in the previous year, *Last Overstatement* is missing. *Past Return* is the firm's stock performance in the previous 12 months ending in the month before the earnings forecast (in %).

Control Variables. We control for a number of firm-level determinants of managerial earnings forecasts. For brevity, we define these control variables only in Table A.1 in the Appendix. To ensure that no forward-looking information is included in our variables, we measure all firm-level information at the month's end preceding the forecast. Additionally, annual accounting data is updated each year in July such that sufficient time has passed since the fiscal year end for public dissemination (Fama and French, 1993). We winsorize all continuous variables at the 1% and 99%-level. Where indicated, we control for industry fixed effects at the two-digit granularity of the Standard Industry Classification (SIC). We report summary statistics on our sample in Table A.2 in the Appendix.

5.3. Results

Last Overstatement. We test Hypothesis 1 by regressing *Overstatement* on *Last Overstatement*.[6] The corresponding results are reported in Table 1. We present a battery of alternative specifications: univariate regressions (Column (1)), regressions including firm level controls (Column (2)), adding industry and year fixed effects (Column (3)), firm and year fixed effects (Column (4)), and industry $\times$ year fixed effects (Column (5)). Across all regressions, we observe a positive and statistically significant coefficient of *Last Overstatement*, implying that the effect of *Last Overstatement* is not subsumed by any other firm-level variable, time-invariant industry- or firm-specific characteristics, or even to time-varying industry-specific determinants.

[6] Using probit or logit regressions instead of a linear probability model does not alter any of our results.

Table 1. Managerial Misstatement and Past Misstatements
This table reports coefficient estimates from OLS regressions for the sample period from March 2002 to December 2020. The dependent variable is *Overstatement*, which is a dummy variable equal to 1 if the manager's earnings forecast exceeds the ex-post earnings realization, and 0 otherwise. The main explanatory variable is *Last Overstatement*, which is *Overstatement* lagged from the past year. Further explanatory variables are defined in Section 5.2. A constant term is included but not reported. The t-statistics, which are reported in parentheses, are calculated based on standard errors clustered by firm and year. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

	Dependent Variable: *Overstatement*				
	(1)	(2)	(3)	(4)	(5)
Last Overstatement	0.1948***	0.1670***	0.1563***	0.0251**	0.1572***
	(11.17)	(11.82)	(12.01)	(2.12)	(11.16)
Size		-0.0326***	-0.0329***	0.1027***	-0.0309***
		(-4.67)	(-4.60)	(4.41)	(-3.95)
BM		0.0673***	0.0470**	0.0932**	0.0432**
		(3.32)	(2.32)	(2.26)	(2.31)
Beta		0.0146	0.0220**	0.0016	0.0218**
		(1.28)	(2.32)	(0.11)	(2.14)
Horizon		0.0005***	0.0005***	0.0005***	0.0005***
		(4.34)	(4.33)	(3.85)	(4.15)
Profitability		0.0098	-0.0016	0.0191	-0.0008
		(0.52)	(-0.09)	(0.86)	(-0.04)
Loss		-0.0291	-0.0221	0.0204	-0.0167
		(-1.02)	(-0.86)	(0.38)	(-0.60)
Litigation		-0.0239*	-0.0448*	0.0933	-0.0511**
		(-1.86)	(-1.92)	(0.81)	(-2.13)
Analysts		0.0012	0.0011	0.0091***	0.0006
		(0.97)	(0.84)	(3.87)	(0.40)
Sentiment		0.1848***	0.1390*	0.1141*	0.2021**
		(3.77)	(1.83)	(1.90)	(2.12)
Year FE	No	No	Yes	Yes	No
Industry FE	No	No	Yes	No	No
Firm FE	No	No	No	Yes	No
Year $\times$ Industry FE	No	No	No	No	Yes
N	9,380	9,045	9,045	9,045	9,045
Adjusted R^2	0.0373	0.0641	0.0802	0.1346	0.1061

The economic effect size of *Last Overstatement*, however, varies notably. Without firm fixed effects the coefficient is between 0.16 and 0.19, pointing towards an economically large autocorrelation between past and current overstatement of earnings forecasts. The effect is diminished when we include firm fixed effects: an overstatement in the past year increases the likelihood of current overstatement by 2.5%. Thus, Table 1 provides evidence in support of Hypothesis 1, while highlighting that the effect of *Last Overstatement* is partially driven by time-invariant firm-specific characteristics such as, for example, managerial overconfidence or governance.

Past Return. Hypothesis 2 posits a negative relation between past stock returns and the likelihood of managerial overstatement. In our model, the last observable stock price before the managerial communication in t is realized in $t-1$. We argue that the underlying logic translates in reality to the most recent return observed by the manager, i.e., the *Past Return*. Therefore, we regress *Overstatement* on *Past Return* using the same specifications as before. Table 2 reports the corresponding results.

Across all columns, we observe a negative coefficient of *Past Return* in line with Hypothesis 2. The effect is statistically significant with t-values between -5.63 and -7.28. Importantly, the economic effect size is large. Focusing on Column (5), an increase in *Past Return* by one standard deviation increases the probability of *Overstatement* by 6.13 percentage

Table 2. Managerial Misstatement and Past Returns
This table reports coefficient estimates from OLS regressions for the sample period from March 2002 to December 2020. The dependent variable is *Overstatement*, which is a dummy variable equal to 1 if the manager's earnings forecast exceeds the ex-post earnings realization, and 0 otherwise. The main explanatory variable is *Past Return*, which is the firm's stock return over the prior 12 months starting at the month's end before the earnings forecast. Further explanatory variables are defined in Section 5.2. A constant term is included but not reported. The t-statistics, which are reported in parentheses, are calculated based on standard errors clustered by firm and year. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

	Dependent Variable: *Overstatement*				
	(1)	(2)	(3)	(4)	(5)
Past Return	-0.0016***	-0.0016***	-0.0016***	-0.0017***	-0.0014***
	(-7.28)	(-7.03)	(-6.63)	(-6.56)	(-5.63)
Controls	No	Yes	Yes	Yes	No
Year FE	No	No	Yes	Yes	No
Industry FE	No	No	Yes	No	No
Firm FE	No	No	No	Yes	No
Year $\times$ Industry FE	No	No	No	No	Yes
N	11,267	10,451	10,451	10,451	10,451
Adjusted R^2	0.0206	0.0524	0.0693	0.1484	0.0915

points ($= -0.0014 \times 43.81$), which corresponds to 12.24% ($= 0.06 \div 0.49$) of the dependent variable's standard deviation.

One natural concern for any regression that examines the effect of stock returns is that any concurrent firm policy will affect the stock returns. If this concurrent policy is correlated with the dependent variable, it results in an omitted variable bias and distorts the OLS coefficients. Thus, Edmans et al. (2012) propose an instrumental variable approach that identifies exogenous variation in stock prices by exploiting large redemptions from mutual funds that hold the stock. The argument runs as follows. If a mutual fund experiences large, sudden outflows, they will have to liquidate some of their positions such that they induce downward price pressure on their stock holdings. By focusing on the stock holdings of the mutual fund under pressure – instead of the actual fire sales of the fund (Coval and Stafford, 2007) – it is possible to identify variation in stock returns that is in principle orthogonal to fundamental information about the firm (Wardlaw, 2020). Thus, the price pressure induced by mutual funds fulfills the central exclusion criterion for an instrumental variable approach. A large stream of literature has adopted such price pressure as exogenous shock to stock prices (see, e.g., Zuo, 2016; Eckbo et al., 2018; Lohmeier and Schneider, 2024). We adopt two measures proposed by Wardlaw (2020) that are purged of any direct effects of returns: *Flow-to-Stock* and *Flow-to-Volume*. Both are defined in detail in Table A.1.

Table 3 reports the results of two instrumental variable regressions using *Flow-to-Stock* (Model I) and *Flow-to-Volume* (Model II) as respective instrument. Columns (1) and (3) display the first-stage regression results, where we regress *Past Return* on the respective measure of price pressure, the firm-specific control variables, and year and industry fixed effects. In both cases, we observe a statistically significant effect of price pressure on *Past Return*. Moreover, the Wald Statistic and first-stage F statistic are large and significant.

Table 3. Instrumentation of Past Returns via Mutual Fund Outflows
This table reports coefficient estimates from instrumental variable regressions for the sample period from March 2002 to December 2020. The odd-numbered columns display first-stage regressions of *Past Return* on two different instrumental variables, while the even-numbered columns report the second-stage regression results of *Overstatement* on the *Instrumented Past Return*. Models I and II use *Flow-to-Stock* and *Flow-to-Volume*, respectively, as instrumental variable, which are both measures of price pressure on the firm's stocks due to large mutual fund redemptions. All explanatory variables are defined in Section 5.2. A constant term is included but not reported. The t-statistics, which are reported in parentheses, are calculated based on standard errors clustered by firm and year. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Model	I		II	
Dep. Var.:	*Past Return*	*Overstatement*	*Past Return*	*Overstatement*
	(1)	(2)	(3)	(4)
Flow-to-Stock	-20.8001***			
	(-6.90)			
Flow-to-Volume			-311.8090***	
			(-6.38)	
Instrumented Past Return		-0.0044**		-0.0057**
		(-2.27)		(-2.18)
Controls	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Wald Statistic	7.95		7.58	
p-value	0.0000		0.000	
F Statistic	37.09		36.64	
p-value	0.0000		0.0000	
N	10,451		10,451	

Hence, we conclude that the relevance criterion for an instrumental variable holds. Given that the exclusion criterion is arguably fulfilled, both *Flow-to-Stock* and *Flow-to-Volume* are valid instruments. Columns (2) and (4) report the second-stage results of *Overstatement* on *Instrumented Past Return*. In both cases, we obtain statistically significant negative coefficients of *Instrumented Past Return*. The economic effect size is of similar magnitude as in Table 2. Focusing on Model I, a one standard deviation increase in *Instrumented Past Return* is associated with an increase in *Overstatement* by 9.11 percentage points ($= -0.0044 \times 20.72$), which is equal to 18.38% ($= 0.09 \div 0.49$) of *Overstatement*'s standard deviation. This finding implies that the effect of *Past Return* on strategic overstatement in managerial communication is likely causal, providing strong evidence for Hypothesis 2. Overall, our empirical analyses based on managerial earnings forecasts strongly support the empirical predictions of our model.

6. Conclusion

We study a dynamic model of managerial communication with a myopically loss averse investor as the information recipient. The manager observes fundamental value developments earlier than the investor and can claim a biased firm value, which the investor naïvely believes. The manager chooses a communication strategy to make the stock price pattern most attractive for the investor within the model-endogenous plausibility constraints.

Our main result is that the optimal communication will be systematically biased towards the investor's prior belief. The economic rationale of the manager is the following: she tries to aggregate losses with gains such that the return pattern is most attractive to the investor. Hence, she is willing to forego earlier price increases as cushion for subsequent decreases and tries to integrate stock price decreases into subsequent increases. We also examine the asset pricing implications of biased firm communication and find that it reduces stock return volatility and causes stock price momentum. This is particularly noteworthy because the fundamental price process does not exhibit momentum and the investors neither over- nor underreact to new information. Rather the communicated information is systematically biased itself. Finally, we argue and show that our model predictions are in line with existing and new empirical evidence.

Potential directions for additional research lie both within and outside of the scope of the literature on strategic firm communication. We study the impact of a myopically loss averse information recipient on the information content in firm communication. Future work could, for example, study settings where managers only control the timing of disclosures in such a multi-period model. Similarly, our model also directly applies to hedge funds, where managers exploit their discretion in reporting to avoid losses losses (Bollen and Pool, 2009) such that hedge fund returns are smoothed over time (Bollen and Pool, 2008). The mechanism we document also extends beyond the setting of financial markets and has potentially wider implications. Suppose that a politician acts as an information provider to her constituents. If the constituents are myopically loss averse, the politician is incentivized to provide a systematic bias towards the constituents' prior in the communicated information, leading to a slower diffusion of information. Similar mechanisms apply, for example, to the communication of central bankers.

Our results also have interesting regulatory implications. Maintaining stability in financial markets is a primary goal of financial regulators such that a multitude of instruments and policy measures have been introduced to reduce stock market volatility. Examples of these regulatory tools employed to mitigate excessive trading in the wake of the Great Financial Crisis include short-sale constraints (e.g. the SEC's Rule 201 in the United States), taxation of financial transactions (e.g. the Financial Transaction Tax in France), and leverage constraints (e.g. Basel III). Our model implies that managers themselves seek to reduce volatility trough strategic communication. Since such voluntary managerial communication itself is subject to regulation (e.g. "Regulation Fair Disclosure" in the United States), our results point towards unforeseen adverse consequences of limiting managers' strategic choices.

A. Appendix

A.1. Appendix: Proof of Theorem 1

The proof relies on the manager's trade-off between her immediate utility and her expected future utility (see decomposition of her total expected utility in Equation (6)). Regarding the expected future utility, the proof builds on the following Lemma. The proof for this Lemma is provided in the Online Appendix.

Lemma 2. For an optimal managerial strategy $\langle S_t^{opt} \rangle$ choosing the lower of the two feasible claims ($C_a = L_a r^{-1}$ instead of $C_a = L_a r^{+1}$) in time $t = a$ (with $0 < a < T$) generates a gain in expected future utility:

$$\sum_{\pi_a} pr(\pi_a)[EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, L_a r^{-1}, \pi_a) - EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, L_a r^{+1}, \pi_a)], \tag{A1}$$

that is higher than Λ_a and smaller than $\lambda \Lambda_a$ (with $\Lambda_a = L_a r^{+1} - L_a r^{-1}$).

At each point in time $t = a$ (with $0 < a < T$), the optimal strategy will choose the feasible claim (i.e., $C_a = L_a r^{+1}$ or $C_a = L_a r^{-1}$) that generates the higher sum of immediate utility IU_a^T and expected future utility EFU_a^T. We examine this choice separately for the following two cases: $C_{a-1} \leq L_a r^{-1}$ and $C_{a-1} \geq L_a r^{+1}$.

Case $\boldsymbol{C_{a-1} \leq L_a r^{-1}}$: Stating $C_a = L_a r^{+1}$ instead of $C_a = L_a r^{-1}$ results in an immediate utility gain of Λ_a (since C_a does not result in a loss compared to C_{a-1}). Based on Lemma 2, the expected future utility gain is larger than this immediate utility gain such that the manager will claim $L_a r^{-1}$, that is, her claim in $t = a$ will stay as close as possible to the previous claim C_{a-1}.

Case $C_{a-1} \geq L_a r^{+1}$: Stating $C_a = L_a r^{+1}$ instead of $C_a = L_a r^{-1}$ results in an immediate utility gain of $\lambda \Lambda_a$ (since C_a does not result in a gain compared to C_{a-1}). Based on Lemma 2, the expected future utility gain is smaller than this immediate utility gain such that the manager will claim $L_a r^{+1}$, that is, her claim in $t = a$ will stay as close as possible to the previous claim C_{a-1}.

Taking together our considerations on these two cases, the manager will always minimize $\mid C_a - C_{a-1} \mid$, that is, she will change the claimed firm value only (and to the smallest possible extent) if claiming $C_a = C_{a-1}$ is not feasible as C_a would be too low ($C_{a-1} < L_a r^{-1}$) or too high ($C_{a-1} > L_a r^{+1}$) given the publicly observable limited introspection value L_a.

A.2. Appendix: Empirical Analyses

Table A.1. Variable Definitions
In this table, we briefly introduce all variables used for our empirical analyses. All firm-level information is measured at the turn of the month prior to the managerial forecast. Annual accounting data is updated each year in July to ensure a sufficient time-lag since publication.

Variable	Variable Definition
Main Dependent Variable	
Overstatement	*Overstatement* is a dummy variable equal to 1 if the manager's earnings forecast is higher than the ex-post earnings realization announced at the associated subsequent earnings announcement, and 0 otherwise.
Main Explanatory Variables	
Last Overstatement	*Last Overstatement* is the one-year lag of *Overstatement*.
Past Return	*Past Return* is the firm's stock performance in the previous 12 months ending in the month before the earnings forecast (in %).
Control Variables	
Size	*Size* is the natural logarithm of the firm's stock market capitalization.

(Continued)

Variable	Variable Definition
BM	*BM* is the ratio of the firm's book value of equity to the market capitalization. Book value of equity is the shareholders' equity plus deferred taxes and investment tax credit minus book value of preferred stock.
Beta	*Beta* is the stock's market beta, which we estimate in line with Frazzini and Pedersen (2014).
Horizon	*Horizon* is the difference between the date the forecast is issued and the associated earnings announcement (measured in days).
Profitability	*Profitability* is the difference of the firm's revenues and the sum of costs of goods sold minus selling, general, and administrative expenses and interest expenses, standardized by the firm's book equity.
Loss	*Loss* is a dummy variable equal to 1 if *Profitability* is negative and 0 otherwise.
Litigation	*Litigation* is a dummy variable equal to 1 if the firm operates in a SIC industry that is exposed to increased litigation risk, and 0 otherwise. SIC codes 2833 to 2836, 3570 to 3577, 3600 to 3674, 5200 to 5961, and 7371 to 7379 are identified as industries with increased litigation risk.
Analysts	*Analysts* is the number of analysts that cover the firm, defined as all analysts that make an earnings forecast for the same fiscal year.
Sentiment	*Sentiment* is the Baker and Wurgler (2006) investor sentiment index obtained from Jeffrey Wurgler's website.
Instrumental Variables	

(Continued)

Variable	Variable Definition
Flow-to-Stock	*Flow-to-Stock* measures price pressure induced by mutual fund outflows (Wardlaw, 2020). We define large outflows at mutual funds as net dollar flows $F_{j,t}$ from fund j at time t that are larger than 5% of the fund's total assets at the prior quarter $TA_{j,t-1}$ (setting all other flows to zero). *Flow-to-Stock* is then determined by aggregating the price pressure exerted on stock i across all mutual funds, standardizing the $\text{SHARES}_{i,j,t-1}$ fund j holds in stock i at $t-1$ by stock i's total shares outstanding $SHROUT_{i,t-1}$. Then, *Flow-to-Stock* is defined as $\text{Flow-to-Stock}_{i,t} = (\sum_j^m \frac{\lvert F_{j,t}\rvert}{TA_{j,t-1}} \times \frac{\text{SHARES}_{i,j,t-1}}{\text{SHROUT}_{i,t-1}})$.
Flow-to-Volume	*Flow-to-Volume* measures price pressure induced by mutual fund outflows (Wardlaw, 2020). We define large outflows at mutual funds as net dollar flows $F_{j,t}$ from fund j at time t that are larger than 5% of the fund's total assets at the prior quarter $TA_{j,t-1}$ (setting all other flows to zero). *Flow-to-Volume* is then determined by aggregating the price pressure exerted on stock i across all mutual funds, standardizing the $\text{SHARES}_{i,j,t-1}$ fund j holds in stock i at $t-1$ by stock i's share volume $\text{SHARE\_VOL}_{i,t}$. Then, *Flow-to-Volume* is defined as: $\text{Flow-to-Volume}_{i,t} = (\sum_j^m \frac{\lvert F_{j,t}\rvert}{TA_{j,t-1}} \times \frac{\text{SHARES}_{i,j,t-1}}{\text{SHARE\_VOL}_{i,t}})$.

Table A.2. Summary Statistics
This table reports descriptive statistics for the variables used in our analyses. These statistics include sample mean, standard deviation, 25%-quantile (q.25), median, 75%-quantile (q.75), and the number of observations N. All variables are described in Section 5.2 in the main paper.

	Mean	Std.	q.25	Median	q.75	*N*
Overstatement	0.41	0.49	0.00	0.00	1.00	11,267
Last Overstatement	0.39	0.49	0.00	0.00	1.00	9,380
Past Return	18.98	43.81	-7.67	13.01	36.50	11,267
Size	21.44	1.64	20.24	21.29	22.50	11,267
BM	0.42	0.35	0.19	0.33	0.54	11,161
Beta	1.19	0.74	0.67	1.08	1.57	11,267
Horizon	314.20	76.16	288.00	359.00	364.00	11,267
Profitability	0.30	0.43	0.17	0.25	0.37	11,161
Loss	0.06	0.23	0.00	0.00	0.00	11,161
Litigation	0.32	0.47	0.00	0.00	1.00	11,267
Analysts	10.32	7.22	5.00	9.00	15.00	11,267
Sentiment	-0.21	0.31	-0.39	-0.25	-0.01	11,267

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Online Appendix for

"Strategic Communication With A Myopically Loss Averse Investor"

A. Proof of Lemma 1

The property $M \cdot pr(\mu_t)^* = pr(\mu_t)^*$ for

$$pr(\mu_t)^* = \frac{1}{(1-p)^3 + p(1-p) + p^3} \begin{pmatrix} (1-p)^3 \\ p(1-p) \\ p^3 \end{pmatrix} \tag{A1}$$

and

$$M = \begin{pmatrix} (1-p) & (1-p)^2 & 0 \\ p & 2p(1-p) & (1-p) \\ 0 & p^2 & p \end{pmatrix} \tag{A2}$$

is easily verified by applying matrix M to vector $pr(\mu_t)^*$. For the convergence proof, we first note that the transition matrix M has the three eigenvalues 0, $2p(1-p)$, and 1 and is thus similar to a Jordan matrix

$$J = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 2p(1-p) & 0 \\ 0 & 0 & 1 \end{pmatrix}, \tag{A3}$$

that is, there exists a matrix S such that $M = SJS^{-1}$. By Jordan decomposition, we obtain

$$S = \begin{pmatrix} \frac{(1-p)}{p} & \frac{-(1-p)}{p} & \frac{(1-p)^3}{p^3} \\ \frac{-1}{p} & \frac{1-2p}{p} & \frac{(1-p)}{p^2} \\ 1 & 1 & 1 \end{pmatrix} \tag{A4}$$

and thus

$$S^{-1} = \begin{pmatrix} \frac{p^2}{2(1-p)} & -\frac{p}{2} & \frac{(1-p)}{2} \\ -\frac{p^3}{q(1-q)} & \frac{qp-2p^3}{2q} & \frac{q(1+p)-2p^3}{2q} \\ \frac{p^3}{q} & \frac{p^3}{q} & \frac{p^3}{q} \end{pmatrix} \tag{A5}$$

with $q = p^2 + (1-p)^2$. For any $n \in \mathbb{N}$, we then have $M^n = SJ^nS^{-1}$ with

$$J^n = \begin{pmatrix} 0 & 0 & 0 \\ 0 & (2p(1-p))^n & 0 \\ 0 & 0 & 1 \end{pmatrix} \tag{A6}$$

and since $2p(1-p) < 1$, it holds

$$\lim_{n\to\infty} J^n = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix} \tag{A7}$$

and thus

$$\begin{aligned} \lim_{n\to\infty} M^n &= S \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix} S^{-1} = \begin{pmatrix} \frac{(1-p)^3}{p^3} \\ \frac{(1-p)}{p^2} \\ 1 \end{pmatrix} \begin{pmatrix} \frac{p^3}{q} & \frac{p^3}{q} & \frac{p^3}{q} \end{pmatrix} \\ &= \frac{1}{(1-p)^2 + p^2} \begin{pmatrix} (1-p)^3 & (1-p)^3 & (1-p)^3 \\ p(1-p) & p(1-p) & p(1-p) \\ p^3 & p^3 & p^3 \end{pmatrix}. \end{aligned} \tag{A8}$$

For any probability vector $pr(\mu_t)$, i.e., a vector with $pr(\mu_t = r^{+2}) + pr(\mu_t = r^0) + pr(\mu_t = r^{-2}) = 1$ it thus holds:

$$\lim_{n \to \infty} M^n pr(\mu_t) = pr(\mu_t)^*. \tag{A9}$$

B. Proof of Lemma 2

Let $\langle S_t^{opt} \rangle$ be an optimal managerial disclosure strategy and $C_a^{opt} = S_a^{opt}(V_{a-1}, C_{a-1}, \pi_{a-1})$ for given values V_{a-1}, C_{a-1}, π_{a-1} at a point in time $t = a$ with $0 < a < T$. From V_{a-1} and π_{a-1}, the limited introspection value $L_a = V_{a-1} \cdot \pi_{a-1,0.5}$ is obtained and as L_a can be observed by the investor in $t = a$, C_a^{opt} has to be in $\{L_a r^{-1}, L_a r^{+1}\}$ for S_a^{opt} to be a feasible strategy.

For the proof of this Lemma, we will repeatedly use the following "linear-loss-aversion property". Based on the investor's piecewise linear utility function with loss aversion parameter $\lambda > 1$, it generally holds for any real A, B, and C with $B < C$:

- $u(A - B) - u(A - C) = \lambda(C - B)$ for $A \leq B < C$

  since both $(A - B)$ and $(A - C)$ are evaluated with $u(x) = \lambda x$
- $u(A - B) - u(A - C) = (C - B)$ for $B < C \leq A$

  since both $(A - B)$ and $(A - C)$ are evaluated with $u(x) = x$
- $(C - B) < u(A - B) - u(A - C) < \lambda(C - B)$ for $B < A < C$

  since $(A - B)$ is evaluated with $u(x) = x$ and $(A - C)$ with $u(x) = \lambda x$.

$t = a = T - 1$. We start by considering the special case $t = a = T - 1$ to cover potential endgame considerations. The expected future utility in $t = T - 1$ solely stems from the immediate utility obtained in $t = T$. Since managers are forced by our model set-up to reveal the truthful value ($C_T = V_T$), the gain in expected future utility from claiming $C_a = L_a r^{-1}$ instead of $C_a = L_a r^{+1}$ is given by

$$\sum_{\pi_a} pr(\pi_a)[EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, L_a r^{-1}, \pi_a) - EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, L_a r^{+1}, \pi_a)]$$

$$= \sum_{\pi_{T-1}} pr(\pi_{T-1})[EU_T^T(\langle S_t^{opt} \rangle, V_{T-1}, L_{T-1}r^{-1}, \pi_{T-1}) - EU_T^T(\langle S_t^{opt} \rangle, V_{T-1}, L_{T-1}r^{+1}, \pi_{T-1})]$$

$$= \sum_{\pi_{T-1}} pr(\pi_{T-1})[u(V_T - L_{T-1}r^{-1}) - u(V_T - L_{T-1}r^{+1})]. \tag{A10}$$

The linear-loss-aversion property (with $A = V_T$, $B = L_{T-1}r^{-1}$, and $C = L_{T-1}r^{+1}$) immediately gives

$$L_{T-1}r^{+1} - L_{T-1}r^{-1} \leq \sum_{\pi_{T-1}} pr(\pi_{T-1})[u(V_T - L_{T-1}r^{-1}) - u(V_T - L_{T-1}r^{+1})] \leq \lambda(L_{T-1}r^{+1} - L_{T-1}r^{-1}). \tag{A11}$$

To see that the ordering is strict, it suffices to show that for some $\pi_{T-1} \in \Pi_{T-1}$, we have $V_T \leq L_{T-1}r^{-1}$, and for some other $\pi_{T-1} \in \Pi_{T-1}$, we have $L_{T-1}r^{+1} \leq V_T$. The former is given for $\pi_{T-1} = (r^{-1}, r^{-1})$ as we have $V_T = V_{T-1}r^{-1}r^{-1} \leq L_{T-1}r^{-1}$. The latter is given for $\pi_{T-1} = (r^{+1}, r^{+1})$ as we have $L_{T-1}r^{+1} \leq V_{T-1}r^{+1}r^{+1} = V_T$. It thus holds:

$$\Lambda_a < \sum_{\pi_{T-1}} pr(\pi_{T-1})[u(V_T - L_{T-1}r^{-1}) - u(V_T - L_{T-1}r^{+1})] < \lambda\Lambda_a. \tag{A12}$$

$\boldsymbol{t = a < T - 1}$. We now consider the standard case where $t = a < T - 1$. Here we have to distinguish two cases (for the two different values of $\pi_{a-1,1}$).

Case 1: $V_a = L_a r^{-1}$

Case 2: $V_a = L_a r^{+1}$

For both cases, we show that the gain in expected future utility

$$\sum_{\pi_a} pr(\pi_a)[EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, L_a r^{-1}, \pi_a) - EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, L_a r^{+1}, \pi_a)] \tag{A13}$$

a) is larger than $\Lambda_a = L_a r^{+1} - L_a r^{-1}$ and

b) is smaller than $\lambda\Lambda_a = \lambda(L_a r^{+1} - L_a r^{-1})$.

In the following, we show that the conditions *a)* and *b)* hold for both *Case 1* and *Case 2*.

Combination 1a). In this combination, it holds that $V_a = L_a r^{-1}$ and the two feasible options for the manager are $C_a = V_a$ or $C_a = V_a r^{+2}$. We have to show that

$$\sum_{\pi_a} pr(\pi_a)[EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, L_a r^{-1}, \pi_a) - EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, L_a r^{+1}, \pi_a)] > \Lambda_a, \tag{A14}$$

which in this case becomes

$$\sum_{\pi_a} pr(\pi_a)[EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a, \pi_a) - EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a r^{+2}, \pi_a)] > \Lambda_a. \tag{A15}$$

To show that this property holds true, we define a mimicking strategy $\langle \widetilde{S^{opt}_t} \rangle$. This mimicking strategy corresponds to $\langle S^{opt}_t \rangle$ for all $t > a+1$. In $t = a+1$, $\langle \widetilde{S^{opt}_t} \rangle$ results in the claim that the optimal strategy would prescribe if the argument C_a would equal $V_a r^{+2}$.

By definition, when comparing $EU^T_{a+1}(\langle \widetilde{S^{opt}_t} \rangle, V_a, V_a, \pi_a)$ and $EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a r^{+2}, \pi_a)$, we note that in this case, $\langle \widetilde{S^{opt}_t} \rangle$ and $\langle S^{opt}_t \rangle$ generate identical sequences of subsequent claims $C_{a+1}, C_{a+2}, \ldots$. Hence, there are no utility differences for periods $t > a+1$ and any utility differences stem from the immediate utility in period $t = a+1$. More formally:

$$\begin{aligned}
&EU^T_{a+1}(\langle \widetilde{S^{opt}_t} \rangle, V_a, V_a, \pi_a) - EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a r^{+2}, \pi_a) \\
&\quad = IU^T_{a+1}(\langle \widetilde{S^{opt}_t} \rangle, V_a, V_a, \pi_a) - IU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a r^{+2}, \pi_a) \\
&\quad = u(\widetilde{S^{opt}_{a+1}}(V_a, V_a, \pi_a) - V_a) - u(S^{opt}_{a+1}(V_a, V_a r^{+2}, \pi_a) - V_a r^{+2}) \\
&\quad = u(S^{opt}_{a+1}(V_a, V_a r^{+2}, \pi_a) - V_a) - u(S^{opt}_{a+1}(V_a, V_a r^{+2}, \pi_a) - V_a r^{+2}).
\end{aligned} \tag{A16}$$

For $\pi_a = (r^{-1}, r^{-1})$, the limited introspection value L_{a+1} is $V_a r^{-1}$ and $S^{opt}_{a+1}(V_a, V_a r^{+2}, \pi_a)$ has to be in $\{V_a r^{-2}, V_a\}$. We thus have the ordering $S^{opt}_{a+1}(V_a, V_a r^{+2}, \pi_a) \leq V_a < V_a r^{+2}$ such that the linear-loss-aversion property implies

$$u(S^{opt}_{a+1}(V_a, V_a r^{+2}, \pi_a) - V_a) - u(S^{opt}_{a+1}(V_a, V_a r^{+2}, \pi_a) - V_a r^{+2}) > V_a r^{+2} - V_a. \tag{A17}$$

For all $\pi_a \neq (r^{-1}, r^{-1})$, the linear-loss-aversion property gives

$$u(S^{opt}_{a+1}(V_a, V_a r^{+2}, \pi_a) - V_a) - u(S^{opt}_{a+1}(V_a, V_a r^{+2}, \pi_a) - V_a r^{+2}) \geq V_a r^{+2} - V_a. \tag{A18}$$

Based on these two inequalities and the optimality of $\langle S^{opt}_t \rangle$ (in comparison to $\widetilde{\langle S^{opt}_t \rangle}$), we conclude

$$\begin{aligned}
&\sum_{\pi_a} pr(\pi_a)[EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, L_a r^{-1}, \pi_a) - EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, L_a r^{+1}, \pi_a)] \\
=&\sum_{\pi_a} pr(\pi_a)[EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a, \pi_a) - EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a r^{+2}, \pi_a)] \\
\geq&\sum_{\pi_a} pr(\pi_a)[EU^T_{a+1}(\widetilde{\langle S^{opt}_t \rangle}, V_a, V_a, \pi_a) - EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a r^{+2}, \pi_a)] \\
>&V_a r^{+2} - V_a = L_a r^{+1} - L_a r^{-1} = \Lambda_a
\end{aligned} \tag{A19}$$

as proposed by the Lemma.

Combination 2a). In this combination, it holds that $V_a = L_a r^{+1}$ and the two feasible options for the manager are $C_a = V_a r^{-2}$ or $C_a = V_a$. We have to show that

$$\sum_{\pi_a} pr(\pi_a)[EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, L_a r^{-1}, \pi_a) - EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, L_a r^{+1}, \pi_a)] > \Lambda_a, \tag{A20}$$

which in this case becomes

$$\sum_{\pi_a} pr(\pi_a)[EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a r^{-2}, \pi_a) - EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a, \pi_a)] > \Lambda_a. \tag{A21}$$

For the path $\pi_a = (r^{-1}, r^{-1})$, it holds that $L_{a+1} = V_a r^{-1}$ and any feasible strategy can thus only claim $C_{a+1} = V_a r^{-2}$ or $C_{a+1} = V_a$. We have to distinguish the two cases:

$$\text{(i)} \quad S^{opt}_{a+1}(V_a, V_a, (r^{-1}, r^{-1})) = V_a r^{-2} \text{ and}$$

$$\text{(ii)} \quad S^{opt}_{a+1}(V_a, V_a, (r^{-1}, r^{-1})) = V_a. \tag{A22}$$

Combination 2a), Case (i). In this case, it holds that $S^{opt}_{a+1}(V_a, V_a, (r^{-1}, r^{-1})) = V_a r^{-2}$. Again, we consider a mimicking strategy $\langle \widetilde{S^{opt}_t} \rangle$. It corresponds to $\langle S^{opt}_t \rangle$ for all $t > a+1$. For $t = a+1$, $\langle \widetilde{S^{opt}_t} \rangle$ results in the claim that the optimal strategy would prescribe if the argument C_a would equal V_a.

By definition, when comparing $EU^T_{a+1}(\langle \widetilde{S^{opt}_t} \rangle, V_a, V_a r^{-2}, \pi_a)$ and $EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a, \pi_a)$, we note that in this case, $\langle \widetilde{S^{opt}_t} \rangle$ and $\langle S^{opt}_t \rangle$ generate identical sequences of subsequent claims $C_{a+1}, C_{a+2}, ...$ Hence there are no utility differences for periods $t > a+1$ and any utility differences stem from the immediate utility in period $t = a+1$. More formally:

$$\begin{aligned}
&EU^T_{a+1}(\langle \widetilde{S^{opt}_t} \rangle, V_a, V_a r^{-2}, \pi_a) - EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a, \pi_a) \\
&\quad = IU^T_{a+1}(\langle \widetilde{S^{opt}_t} \rangle, V_a, V_a r^{-2}, \pi_a) - IU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a, \pi_a) \\
&\quad = u(\widetilde{S^{opt}_{a+1}}(V_a, V_a r^{-2}, \pi_a) - V_a r^{-2}) - u(S^{opt}_{a+1}(V_a, V_a, \pi_a) - V_a) \\
&\quad = u(S^{opt}_{a+1}(V_a, V_a, \pi_a) - V_a r^{-2}) - u(S^{opt}_{a+1}(V_a, V_a, \pi_a) - V_a).
\end{aligned} \tag{A23}$$

For $\pi_a = (r^{-1}, r^{-1})$, the limited introspection value L_{a+1} is $V_a r^{-1}$ and for this case (i), $S^{opt}_{a+1}(V_a, V_a, (r^{-1}, r^{-1}))$ equals $V_a r^{-2}$. We thus have the ordering $S^{opt}_{a+1}(V_a, V_a, \pi_a) \leq V_a r^{-2} < V_a$ such that the linear-loss-aversion property implies

$$u(S^{opt}_{a+1}(V_a, V_a, \pi_a) - V_a r^{-2}) - u(S^{opt}_{a+1}(V_a, V_a, \pi_a) - V_a) > V_a - V_a r^{-2}. \tag{A24}$$

For all $\pi_a \neq (r^{-1}, r^{-1})$, the linear-loss-aversion property gives

$$u(S^{opt}_{a+1}(V_a, V_a, \pi_a) - V_a r^{-2}) - u(S^{opt}_{a+1}(V_a, V_a, \pi_a) - V_a) \geq V_a - V_a r^{-2}. \tag{A25}$$

Based on these two inequalities and the optimality of $\langle S^{opt}_t \rangle$ (in comparison to $\langle \widetilde{S^{opt}_t} \rangle$), we conclude

$$\begin{aligned}
&\sum_{\pi_a} pr(\pi_a)[EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, L_a r^{-1}, \pi_a) - EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, L_a r^{+1}, \pi_a)] \\
=&\sum_{\pi_a} pr(\pi_a)[EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a r^{-2}, \pi_a) - EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a, \pi_a)] \\
\geq&\sum_{\pi_a} pr(\pi_a)[EU^T_{a+1}(\langle \widetilde{S^{opt}_t} \rangle, V_a, V_a r^{-2}, \pi_a) - EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a, \pi_a)] \\
>&V_a - V_a r^{-2} = L_a r^{+1} - L_a r^{-1} = \Lambda_a
\end{aligned} \tag{A26}$$

as proposed by the Lemma.

Combination 2a), Case (ii). In this case, it holds that $S^{opt}_{a+1}(V_a, V_a, (r^{-1}, r^{-1})) = V_a$. Here, we consider an alternative strategy $\langle \widehat{S^{opt}_t} \rangle$ that is only partly a mimicking strategy. As before, it corresponds to $\langle S^{opt}_t \rangle$ for all $t > a+1$. For $t = a+1$ and $\pi_a \neq (r^{-1}, r^{-1})$, $\langle \widehat{S^{opt}_t} \rangle$ results in the claim that the optimal strategy would prescribe if the argument C_a would equal V_a. For $t = a+1$ and $\pi_a = (r^{-1}, r^{-1})$, $\widehat{S^{opt}_{a+1}}(V_a, V_a r^{-2}, \pi_a)$ equals $V_a r^{-2}$.

For $\pi_a \neq (r^{-1}, r^{-1})$, this proof of Case (ii) is equivalent to the proof of Case (i) and results in

$$EU_{a+1}^T(\langle \widehat{S_t^{opt}} \rangle, V_a, V_a r^{-2}, \pi_a) - EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, V_a, \pi_a) \geq V_a - V_a r^{-2}. \tag{A27}$$

A new argument is utilized to show

$$EU_{a+1}^T(\langle \widehat{S_t^{opt}} \rangle, V_a, V_a r^{-2}, \pi_a) - EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, V_a, \pi_a) > V_a - V_a r^{-2} \tag{A28}$$

for $\pi_a = (r^{-1}, r^{-1})$. Based on $\widehat{S_{a+1}^{opt}}(V_a, V_a r^{-2}, \pi_a) = V_a r^{-2}$ and $S_{a+1}^{opt}(V_a, V_a, \pi_a) = V_a$, both strategies generate no immediate utility in $a+1$ and the difference between the two terms $EU_{a+1}^T(\langle \widehat{S_t^{opt}} \rangle, V_a, V_a r^{-2}, \pi_a)$ and $EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, V_a, \pi_a)$ only stems from the difference in expected future utility. To conclude that this difference is larger than $V_a - V_a r^{-2}$, we can rely on the already proven parts of Lemma 2. In the case $a = T-2$, the strict inequality follows from the endgame considerations. For $a < T-2$, we note that $V_{a+1} = V_a r^{-2} = L_{a+1} r^{-1}$ such that the situation is equivalent to Condition 1a), looking at period $t = a+1$ instead of $t = a$.

Based on these two inequalities and the optimality of $\langle S_t^{opt} \rangle$ (in comparison to $\langle \widehat{S_t^{opt}} \rangle$), we conclude

$$\begin{aligned}
&\sum_{\pi_a} pr(\pi_a)[EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, L_a r^{-1}, \pi_a) - EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, L_a r^{+1}, \pi_a)] \\
=&\sum_{\pi_a} pr(\pi_a)[EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, V_a r^{-2}, \pi_a) - EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, V_a, \pi_a)] \\
\geq&\sum_{\pi_a} pr(\pi_a)[EU_{a+1}^T(\langle \widehat{S_t^{opt}} \rangle, V_a, V_a r^{-2}, \pi_a) - EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, V_a, \pi_a)] \\
>&V_a - V_a r^{-2} = L_a r^{+1} - L_a r^{-1} = \Lambda_a.
\end{aligned} \tag{A29}$$

as proposed by the Lemma.

Combination 2b). In this combination, it holds that $V_a = L_a r^{+1}$ and the two feasible options for the manager are $C_a = V_a r^{-2}$ or $C_a = V_a$. We have to show that

$$\sum_{\pi_a} pr(\pi_a)[EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, L_a r^{-1}, \pi_a) - EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, L_a r^{+1}, \pi_a)] < \lambda \Lambda_a, \tag{A30}$$

which in this case becomes

$$\sum_{\pi_a} pr(\pi_a)[EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a r^{-2}, \pi_a) - EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a, \pi_a)] < \lambda \Lambda_a. \tag{A31}$$

To show that this property holds true, we define a mimicking strategy $\langle \widetilde{S^{opt}_t} \rangle$. This mimicking strategy corresponds to $\langle S^{opt}_t \rangle$ for all $t > a+1$. In $t = a+1$, $\langle \widetilde{S^{opt}_t} \rangle$ results in the claim that the optimal strategy would prescribe if the argument C_a would equal $V_a r^{-2}$.

By definition, when comparing $EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a r^{-2}, \pi_a)$ and $EU^T_{a+1}(\langle \widetilde{S^{opt}_t} \rangle, V_a, V_a, \pi_a)$, we note that in this case, $\langle S^{opt}_t \rangle$ and $\langle \widetilde{S^{opt}_t} \rangle$ generate identical sequences of subsequent claims $C_{a+1}, C_{a+2}, \ldots$. Hence, there are no utility differences for periods $t > a+1$ and any utility differences stem from the immediate utility in period $t = a+1$. More formally:

$$\begin{aligned}
&EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a r^{-2}, \pi_a) - EU^T_{a+1}(\langle \widetilde{S^{opt}_t} \rangle, V_a, V_a, \pi_a) \\
&\quad = IU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a r^{-2}, \pi_a) - IU^T_{a+1}(\langle \widetilde{S^{opt}_t} \rangle, V_a, V_a, \pi_a) \\
&\quad = u(S^{opt}_{a+1}(V_a, V_a r^{-2}, \pi_a) - V_a r^{-2}) - u(\widetilde{S^{opt}_{a+1}}(V_a, V_a, \pi_a) - V_a) \\
&\quad = u(S^{opt}_{a+1}(V_a, V_a r^{-2}, \pi_a) - V_a r^{-2}) - u(S^{opt}_{a+1}(V_a, V_a r^{-2}, \pi_a) - V_a).
\end{aligned} \tag{A32}$$

For $\pi_a = (r^{+1}, r^{+1})$, the limited introspection value L_{a+1} is $V_a r^{+1}$ and $S^{opt}_{a+1}(V_a, V_a r^{-2}, \pi_a)$ has to be in $\{V_a, V_a r^{+2}\}$. We thus have the ordering $V_a r^{-2} < V_a \leq S^{opt}_{a+1}(V_a, V_a r^{-2}, \pi_a)$ such that the linear-loss-aversion property implies

$$u(S_{a+1}^{opt}(V_a, V_a r^{-2}, \pi_a) - V_a r^{-2}) - u(S_{a+1}^{opt}(V_a, V_a r^{-2}, \pi_a) - V_a) < \lambda(V_a - V_a r^{-2}). \quad \text{(A33)}$$

For all $\pi_a \neq (r^{+1}, r^{+1})$, the linear-loss-aversion property gives

$$u(S_{a+1}^{opt}(V_a, V_a r^{-2}, \pi_a) - V_a r^{-2}) - u(S_{a+1}^{opt}(V_a, V_a r^{-2}, \pi_a) - V_a) \leq \lambda(V_a - V_a r^{-2}). \quad \text{(A34)}$$

Based on these two inequalities and the optimality of $\langle S_t^{opt} \rangle$ (in comparison to $\widetilde{\langle S_t^{opt} \rangle}$), we conclude

$$\begin{aligned}
&\sum_{\pi_a} pr(\pi_a)[EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, L_a r^{-1}, \pi_a) - EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, L_a r^{+1}, \pi_a)] \\
=&\sum_{\pi_a} pr(\pi_a)[EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, V_a r^{-2}, \pi_a) - EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, V_a, \pi_a)] \\
\leq&\sum_{\pi_a} pr(\pi_a)[EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, V_a r^{-2}, \pi_a) - EU_{a+1}^T(\widetilde{\langle S_t^{opt} \rangle}, V_a, V_a, \pi_a)] \\
<&\lambda(V_a - V_a r^{-2}) = \lambda(L_a r^{+1} - L_a r^{-1}) = \lambda \Lambda_a \qquad \text{(A35)}
\end{aligned}$$

as proposed by the Lemma.

Combination 1b). In this combination, it holds $V_a = L_a r^{-1}$ and the two feasible options for the manager are $C_a = V_a$ or $C_a = V_a r^{+2}$. We have to show that

$$\sum_{\pi_a} pr(\pi_a)[EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, L_a r^{-1}, \pi_a) - EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, L_a r^{+1}, \pi_a)] < \lambda \Lambda_a, \quad \text{(A36)}$$

which in this case becomes

$$\sum_{\pi_a} pr(\pi_a)[EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, V_a, \pi_a) - EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, V_a r^{+2}, \pi_a)] < \lambda \Lambda_a. \quad \text{(A37)}$$

For the path $\pi_a = (r^{+1}, r^{+1})$, it holds that $L_{a+1} = V_a r^{+1}$ and any feasible strategy can thus only claim $C_{a+1} = V_a$ or $C_{a+1} = V_a r^{+2}$. We have to distinguish the two cases:

$$\begin{aligned} &\text{(i)} \quad S^{opt}_{a+1}(V_a, V_a, (r^{+1}, r^{+1})) = V_a r^{+2} \text{ and} \\ &\text{(ii)} \quad S^{opt}_{a+1}(V_a, V_a, (r^{+1}, r^{+1})) = V_a. \end{aligned} \tag{A38}$$

Combination 1b), Case (i). In this case, it holds that $S^{opt}_t(V_a, V_a, (r^{+1}, r^{+1})) = V_a r^{+2}$. Again, we consider a mimicking strategy $\langle \widetilde{S^{opt}_t} \rangle$. It corresponds to $\langle S^{opt}_t \rangle$ for all $t > a + 1$. For $t = a + 1$, $\langle \widetilde{S^{opt}_t} \rangle$ results in the claim that the optimal strategy would prescribe if the argument C_a would equal V_a.

By definition, when comparing $EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a, \pi_a)$ and $EU^T_{a+1}(\langle \widetilde{S^{opt}_t} \rangle, V_a, V_a r^{+2}, \pi_a)$, we note that in this case, $\langle S^{opt}_t \rangle$ and $\langle \widetilde{S^{opt}_t} \rangle$ generate identical sequences of subsequent claims $C_{a+1}, C_{a+2}, \ldots$. Hence there are no utility differences for periods $t > a + 1$ and any utility differences have to stem from the immediate utility in period $t = a + 1$. More formally:

$$\begin{aligned} &EU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a, \pi_a) - EU^T_{a+1}(\langle \widetilde{S^{opt}_t} \rangle, V_a, V_a r^{+2}, \pi_a) \\ &\quad = IU^T_{a+1}(\langle S^{opt}_t \rangle, V_a, V_a, \pi_a) - IU^T_{a+1}(\langle \widetilde{S^{opt}_t} \rangle, V_a, V_a r^{+2}, \pi_a) \\ &\quad = u(S^{opt}_{a+1}(V_a, V_a, \pi_a) - V_a) - u(\widetilde{S^{opt}_{a+1}}(V_a, V_a r^{+2}, \pi_a) - V_a r^{+2}) \\ &\quad = u(S^{opt}_{a+1}(V_a, V_a, \pi_a) - V_a) - u(S^{opt}_{a+1}(V_a, V_a, \pi_a) - V_a r^{+2}). \end{aligned} \tag{A39}$$

For $\pi_a = (r^{+1}, r^{+1})$, the limited introspection value L_{a+1} is $V_a r^{+1}$ and for this case (i), $S^{opt}_{a+1}(V_a, V_a(r^{+1}, r^{+1}))$ equals $V_a r^{+2}$. We thus have the ordering $V_a < V_a r^{+2} \leq S^{opt}_{a+1}(V_a, V_a, \pi_a)$

such that the linear-loss-aversion property implies

$$u(S_{a+1}^{opt}(V_a, V_a, \pi_a) - V_a) - u(S_{a+1}^{opt}(V_a, V_a, \pi_a) - V_a r^{+2}) < \lambda(V_a r^{+2} - V_a). \tag{A40}$$

For all $\pi_a \neq (r^{+1}, r^{+1})$, the linear-loss-aversion property gives

$$u(S_{a+1}^{opt}(V_a, V_a, \pi_a) - V_a) - u(S_{a+1}^{opt}(V_a, V_a, \pi_a) - V_a r^{+2}) \leq \lambda(V_a r^{+2} - V_a). \tag{A41}$$

Based on these two inequalities and the optimality of $\langle S_t^{opt} \rangle$ (in comparison to $\langle \widetilde{S_t^{opt}} \rangle$), we conclude

$$\begin{aligned}
&\sum_{\pi_a} pr(\pi_a)[EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, L_a r^{-1}, \pi_a) - EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, L_a r^{+1}, \pi_a)] \\
=&\sum_{\pi_a} pr(\pi_a)[EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, V_a, \pi_a) - EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, V_a r^{+2}, \pi_a)] \\
\leq&\sum_{\pi_a} pr(\pi_a)[EU_{a+1}^T(\langle S_t^{opt} \rangle, V_a, V_a, \pi_a) - EU_{a+1}^T(\langle \widetilde{S_t^{opt}} \rangle, V_a, V_a r^{+2}, \pi_a)] \\
<&\lambda(V_a r^{+2} - V_a) = \lambda(L_a r^{+1} - L_a r^{-1}) = \lambda \Lambda_a.
\end{aligned} \tag{A42}$$

as proposed by the Lemma.

Combination 1b), Case (ii). In this case, it holds that $S_{a+1}^{opt}(V_a, V_a, (r^{+1}, r^{+1})) = V_a$. Here, we consider an alternative strategy $\langle \widehat{S_t^{opt}} \rangle$ that is only partly a mimicking strategy. As before, it corresponds to $\langle S_t^{opt} \rangle$ for all $t > a+1$. For $t = a+1$ and $\pi_a \neq (r^{+1}, r^{+1})$, $\langle \widehat{S_t^{opt}} \rangle$ results in the claim that the optimal strategy would prescribe if the argument C_a would equal V_a. For $t = a+1$ and $\pi_a = (r^{+1}, r^{+1})$, $\widehat{S_{a+1}^{opt}}(V_a, V_a r^{+2}, \pi_a)$ equals $V_a r^{+2}$.

For $\pi_a \neq (r^{+1}, r^{+1})$, this proof of Case (ii) is equivalent to the proof of Case (i) and results in

$$EU_{a+1}^T(\langle S_t^{opt}\rangle, V_a, V_a, \pi_a) - EU_{a+1}^T(\langle \widehat{S_t^{opt}}\rangle, V_a, V_a r^{+2}, \pi_a) \leq \lambda(V_a r^{+2} - V_a). \tag{A43}$$

The same argument as in Case (ii) of Combination 2a) is utilized to show

$$EU_{a+1}^T(\langle S_t^{opt}\rangle, V_a, V_a, \pi_a) - EU_{a+1}^T(\langle \widehat{S_t^{opt}}\rangle, V_a, V_a r^{+2}, \pi_a) < \lambda(V_a r^{+2} - V_a) \tag{A44}$$

for $\pi_a = (r^{+1}, r^{+1})$. Based on $\widehat{S_{a+1}^{opt}}(V_a, V_a r^{+2}, \pi_a) = V_a r^{+2}$ and $S_{a+1}^{opt}(V_a, V_a, \pi_a) = V_a$, both strategies generate no immediate utility in $a+1$ and the difference between the two terms $EU_{a+1}^T(\langle S_t^{opt}\rangle, V_a, V_a, \pi_a))$ and $EU_{a+1}^T(\langle \widehat{S_t^{opt}}\rangle, V_a, V_a r^{+2}, \pi_a))$ only stems from the difference in expected future utility. To conclude that this difference is smaller than $\lambda(V_a r^{+2} - V_a)$, we can rely on the already proven parts of Lemma 2. In the case $a = T-2$, the strict inequality follows from the endgame considerations. For $a < T-2$, we note that $V_{a+1} = V_a r^{+2} = L_{a+1} r^{+1}$ such that the situation is equivalent to Condition 2b), looking at period $t = a+1$ instead of $t = a$.

Based on these two inequalities and the optimality of $\langle S_t^{opt}\rangle$ (in comparison to $\langle \widehat{S_t^{opt}}\rangle$), we conclude

$$\begin{aligned}
&\sum_{\pi_a} pr(\pi_a)[EU_{a+1}^T(\langle S_t^{opt}\rangle, V_a, L_a r^{-1}, \pi_a) - EU_{a+1}^T(\langle S_t^{opt}\rangle, V_a, L_a r^{+1}, \pi_a)] \\
=&\sum_{\pi_a} pr(\pi_a)[EU_{a+1}^T(\langle S_t^{opt}\rangle, V_a, V_a, \pi_a) - EU_{a+1}^T(\langle S_t^{opt}\rangle, V_a, V_a r^{+2}, \pi_a)] \\
\leq&\sum_{\pi_a} pr(\pi_a)[EU_{a+1}^T(\langle S_t^{opt}\rangle, V_a, V_a, \pi_a) - EU_{a+1}^T(\langle \widehat{S_t^{opt}}\rangle, V_a, V_a r^{+2}, \pi_a)] \\
<&\lambda(V_a r^{+2} - V_a) = \lambda(L_a r^{+1} - L_a r^{-1}) = \lambda\Lambda_a
\end{aligned} \tag{A45}$$

as proposed by the Lemma.