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Target Ambiguity and Ratchet Effect*

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Prior literature documents that the subordinate has an incentive to reduce the effort level when current performance affects future target performance, which is known as the ratchet effect. The ratchet literature, however, assumes that the superior can discern the true (desired) level of target performance in the short run, and it does not explicitly explain how the ratchet effect varies along the process of identifying the true target performance. This study analytically investigates the impact of *target ambiguity* on the magnitude of the ratchet effect. The analysis shows stronger ratchet effect when the superior possesses limited prior knowledge about the indubitable target performance. With higher ambiguity that the superior faces in setting target performance, the superior must depend largely on the subordinate's actual performance. As a consequence, the subordinate becomes more reluctant to exert effort for the best level of current performance because it will influence the future standard to be substantially tough. It also shows that the subordinate's effort reduction following a highly ambiguous performance target can be alleviated when the subordinate actively participates in the target setting process and when performance measures are adequately noisy.

Keywords: target ambiguity, ratchet effect, participation, measurement noise

I. Introduction

As performance targets are widely utilized in performance evaluation systems, prior research explores the implications of target performance in incentive contracts. A set of studies empirically document that when the subordinate's actual performance revises the target performance in the following period (target-setting practice known as the ratchet principle),

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the subordinate has a dysfunctional incentive to reduce their productivity in early periods so as to avoid taking responsibility for higher targets in the future (effort reduction known as the ratchet effect). Murphy (2001) shows that earnings are likely to be smoothed when companies are using internally determined standards. Leone and Rock (2002) document that budgets (asymmetrically) ratchet as positive earnings innovations tend to be permanent and that such asymmetric adoption of earnings surprises into budgets discourages managers from manipulating income-increasing discretionary accruals. Bouwens and Kroos (2011) investigate real effort reduction instead of earnings management in relation to budget ratcheting and find that retail store managers with favorable sales performance in the first three quarters shirk in the final quarter and, as a consequence, easily meet the next year's sales target.

The ratchet effect hinges on three performance concepts: target, actual, and true levels of performance. In the ratcheting literature, target performance is generally treated as a threshold performance level that triggers bonus compensation. This target performance provides the subordinate with a constructive incentive to exert over the threshold level of effort. Because better performance can result in a less attainable future target performance with target ratcheting, the subordinate also has a destructive incentive not to give the best level of effort for maximal performance. I name this best achievable performance level 'true' performance in this paper. The superior has difficulty in identifying true performance because output performance is affected not only by input resources (such as subordinate efforts) but also by market conditions and production functions that are obscure and/or unpredictable to the superior. To determine the target performance that matches the target effort level, the superior must deal with the uncertain nature of output realization due to market externality and production technology. If the superior has a lack of understanding about the effort-to-performance relation and thereby the target performance level becomes ambiguous to her, the threshold target can deviate far from the best attainable performance level. Hence, the subordinate may take advantage of the large slack, which creates more room for the subordinate to shirk from achieving maximal performance. I assume such target ambiguity that the superior confronts as an important factor that substantiates the ratchet principle and hence escalates the ratchet effect.

Most prior studies, however, have not illuminated the role of target ambiguity in incentive

contracts while assuming that the superior can discern the true level of target performance easily and quickly. Also, they do not explicitly explain how the ratchet effect aggravates or lessens along the process of identifying the true performance. As it overlooks the learning procedure to resolve target ambiguity, prior research can provide only limited insights regarding what factors facilitate the use of past performance in setting targets. To provide better comprehension around target and incentive, I explore circumstances in which the benefit of ratcheting targets exceeds the resultant cost from the subordinate's shirking based on the target ambiguity concept.

Developing a simple model in the Bayesian framework, this study analytically shows that ratchet effect increases with the degree of ambiguity in identifying target performance. It also shows that ratchet effect diminishes when there are mechanisms to hinder the superior from the intensive adoption of past performance on future targets. The analysis shows that effort reduction declines (1) by the subordinate's active participation in the target setting process and (2) by the use of noisy performance measures.

This study contributes to prior research in several facets. First, based on the target ambiguity notion as a critical reason for the ratchet principle, I seek potential mechanisms or conditions that can alleviate the effort reduction incentive while past performance is being used to identify the true level of target performance. Second, the literature does not explicitly provide a causal linkage between target performance and target effort level. It simply proxies the target level of effort with target performance (Murphy, 2001) or target bonus (Indjejikian and Nanda, 2002), but does not provide details of how the effort translates to performance and what fundamentally drives the inter-temporal effort allocation incentive in their *incentive zone* graphs.[1)] To incorporate 'effort' into the picture, I develop an analytical model using the Bayesian approach as it fits well with the ratcheting practice. The model captures the obscure relation between target effort and target performance in that several economic conditions (such as target ambiguity, target-setting styles, and measurement noise) are incorporated into the incentive zone. Third, prior literature does not fully explain how the ratchet effect comes

1) See page 251 in Murphy (2001) and page 797 in Indjejikian and Nanda (2002).

to an end. Indjejikian and Nanda (2002) find that there is persistency in receiving an above-target bonus because firms usually update performance targets only partially based on past performance. They see that budgetary slacks causing the ratchet effect cannot exist in the following period insofar as the target is fully updated based on current performance. Similarly, Bouwens and Kroos (2011) consider whether target performances are met consecutively over two-year periods to test the ratchet effect. As described in our model section, however, I believe the true level of target performance cannot be identified readily from the previous period's performance. Instead, the analysis suggests that it requires a multi-year learning process to identify the true level of target performance as a mapping of target effort while mitigating target ambiguity.

II. The Model

Target performance is widely used in incentive contracts as a benchmark to evaluate the subordinate's performance. Theoretical studies in labor economics literature suggest that more challenging targets motivate subordinates to become more productive, and that the ideal strategy to maximize the firm's value is raising a target as close as possible to the subordinate's maximal capability (Stedry and Kay, 1966; Rockness, 1977; Chow, 1983). In order to set an optimal level of target performance, the superior needs to understand how subordinates' effort relates to performance outcome. The superior possesses limited knowledge about the subordinate's capability, the productivity of technology, and their interactive effects; hence, the ambiguous cause-effect relation can hinder the superior from identifying the appropriate target performance.

The literature has sought to find effective methods to identify appropriate levels of target performance given the limited information. Some have examined the use of past performance. Berliner (1976) and Weitzman (1980) discuss that the superior can view actual performance in any period as the revealed minimal level of the subordinate's capability, and they may use this information to determine targets for the following period. Milgrom and Roberts (1992) argue that the superior can benefit ex post if she uses information about the subordinate's

past performance to revise targets in multi-period contracts. Such a procedure that sets the target based on past performance is known as the ratchet principle.

The ratchet principle naturally gives rise to the subordinate's dynamic incentive in multiple periods because the subordinate may improve their net benefits by inter-temporally allocating effort. When the ratchet principle is being implemented, subordinates have a strong incentive to reduce their productivity in early periods so as to avoid taking responsibility for higher targets in the future, which is known as the ratchet effect (Weitzman, 1980; Holmstrom, 1982; Chow et al., 1991). I construct the following model and develop propositions around the ratchet effect and target ambiguity as follows.

A risk-neutral principal hires a risk-neutral and effort-averse agent to operate a firm for two periods.[2] Assume that the agent has a convex cost (disutility) function of effort: $c = \frac{1}{2}ke^2$ where e is the agent effort and k is a positive constant. The principal sets target performance levels for two periods, T_1 and T_2, and provides a bonus when the agent's performance exceeds the target each period. That is, she writes a compensation contract for the agent as follows:

$$\begin{cases} s + (x_p - T_p) & \text{if } x_p > T_p \\ s + 0 & \text{otherwise} \end{cases}$$

where s ensures the reservation wage, x is the agent's real performance observed by the principal, and $p \in \{1, 2\}$ indicates periods.

Presume that the agent's performance is stochastic due to the incompletely known production function and the unpredictable external economic conditions. I assume that the stochastic nature of the agent's performance, X, follows a normal distribution where its mean value shifts proportionally to the agent's actual effort level e and its variance has a constant value independent of the effort: $X \sim N[\theta(e), \sigma^2]$. Define θ_0 as the mean level of base performance when $e = 0$, so the expected performance given a certain effort level becomes $\theta = \theta_0 + e$ where $e \geq 0$. For example, if the principal sets a target level of agent effort e_T for a period, she projects that the agent's performance will follow a normal distribution with mean

2) This study examines the agent's incentive in relation to the target setting mechanisms; thus the agent's risk attitude in incentive contracts is out of its scope.

$\theta_T = \theta_0 + e_T$ and variance σ^2, expecting the agent puts in the target level of effort e_T during the period.

It is important for the principal to understand the relation between the agent's effort and his performance so as to set an appropriate level of target performance as well as to provide a fair amount of contingent compensation. However, the principal must disentangle two puzzles to discern this relationship: the mean value of target performance distribution θ_T and the agent's actual effort e_p, which is unobservable by the principal and hence possibly different from e_T. To address the first concern, I adopt the Bayesian approach. The principal has a prior belief on θ_T which is distributed by $N(\mu_T, \tau^2)$ and keeps adjusting her belief (the posterior expectation from the target effort e_T) as new performance observations arrive. Thus, the principal sets the initial target performance via the expected performance (prior mean) conditioned on the target effort level: $T_1 = E_{prior}[E(X|e_T)] = E_{prior}[\theta_T] = \mu_T$. As the principal observes the agent's performance at the end of period 1, the principal adjusts the second period's target T_2 using Bayesian analysis (posterior distribution). Assuming that the principal intends the same target level of agent effort e_T for the two periods, the prior distribution for period 1 and the posterior distribution for period 2 can be written as follows:

$$f_1(x): N\left(T_1 = \mu_T, \quad \sigma^2_{prior} = \tau^2\right),$$

$$f_2(x): N\left(T_2 = \frac{\sigma^2}{\tau^2+\sigma^2}\mu_T + \frac{\tau^2}{\tau^2+\sigma^2}x_1, \quad \sigma^2_{posterior} = \frac{\tau^2\sigma^2}{\tau^2+\sigma^2}\right).$$

The second period target T_2 (posterior mean target performance) that increases with the first period's performance is the cause of the ratchet effect.[3] The timeline of the Bayesian update of the target is presented in the figure below.

The second puzzle is that the principal cannot perfectly disentangle the two components of actual performance to set T_2 (at stage D in Figure 1): one which is determined by the production technology and incompletely understood by the principal and the other which

3) The two-period model can be easily extended to a multi-period model without changing our insights on agent incentive for the first (preceding) period.

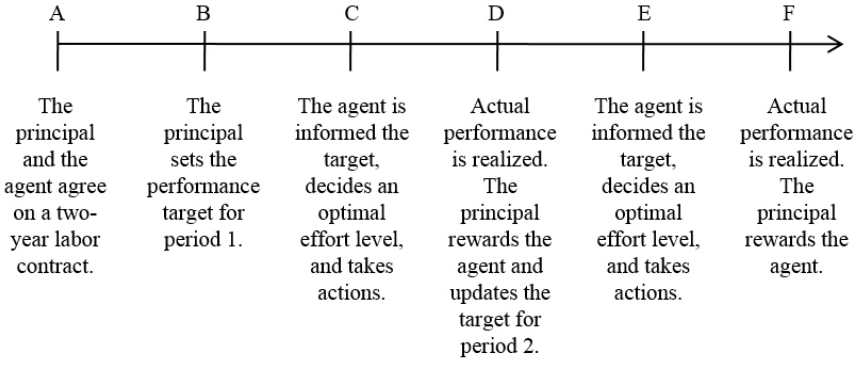

Figure 1. The Time Line for Target Setting

is the mean shift causes by the agent's effort. By denoting y as the performance that would have been realized if the agent had put in the target level of effort, the actual performance in period 1 provided with a certain effort level e_1 becomes $x_1 = y_1 + (e_1 - e_T)$. Then, only the first term's y_1 should be used to reach the posterior mean given the target effort in the second period. Suppose the agent put in an amount of effort higher than the target effort in the first period, $e_1 > e_T$. If the principal can identify the actual performance and hence completely disentangle the second term (mean shift by the differential effort), she will use only y_1 to revise the second period's target performance T_2. However, if the principal can discern the impact of differential effort $(e_p - e_T)$ only partially, y_1 will be overvalued and the influence of production technology will be overstated. Let's define ρ as the extent to which the principal captures the differential effort correctly. Then, the principal decomposes the actual performance into two factors $\hat{x}_1 = y_1 + (1-\rho)(e_1 - e_T)$, for $0 \le \rho < 1$, to develop the second period's target T_2 at $\frac{\sigma^2}{\tau^2+\sigma^2}\mu_T + \frac{\tau^2}{\tau^2+\sigma^2}\hat{x}_1$. Therefore, the degree of overstating the influence of production technology depends on how correctly the principal understands the impact of the agent's differential effort on the actual performance. Thus, the agent must cope with a higher level of target performance when the principal has limited information about the agent's effort. In short, the agent's expected utility over the two periods is:

$$E(U) = \left[s + \int_{T_1}^{\infty} (x_1 - T_1) f_1(x_1) dx_1 - \frac{1}{2} k e_1^2 \right] + \left[s + \int_{T_2}^{\infty} (x_2 - T_2) f_2(x_2) dx_2 - \frac{1}{2} k e_2^2 \right]$$

$$= \left[s + \int_{T_1-(e_1-e_T)}^{\infty} \left(y_1 + (e_1 - e_T) - T_1 \right) f_1(y_1) dy_1 - \frac{1}{2} k e_1^2 \right]$$

$$+ \left[s + \int_{T_2-(e_2-e_T)}^{\infty} \left(y_1 + (e_2 - e_T) - T_2 \right) f_2(y_2) dy_2 - \frac{1}{2} k e_2^2 \right]$$

where $T_1 = \mu_T$ and $T_2 = \frac{\sigma^2}{\tau^2+\sigma^2}\mu_T + \frac{\tau^2}{\tau^2+\sigma^2}\left(y_1 + (1-\rho)(e_1 - e_T) \right)$. The optimal effort level in the first period is determined as in the following first order condition (*FOC*).

$$FOC : \frac{\partial E(U)}{\partial e_1} = \int_{T_1-(e_1-e_T)}^{\infty} f_1(y_1) dy_1 - (1-\rho)\frac{\tau^2}{\tau^2+\sigma^2} \int_{T_2-(e_2-e_T)}^{\infty} f_2(y_2) dy_2 - k e_1$$

$$= 1 - F_1\left(T_1 - e_1 + e_T \right) - (1-\rho)\frac{\tau^2}{\tau^2+\sigma^2}\left[1 - F_2\left(T_2 - e_2 + e_T \right) \right] - k e_1$$

$$= \left[\frac{1}{2} + \frac{1}{\sqrt{\pi}} \int_0^{\frac{e_1-e_T}{\sigma\sqrt{2}}} \exp(-t^2) dt \right].$$

$$-(1-\rho)\frac{\sigma_{post}^2}{\sigma^2}\left[\frac{1}{2} + \frac{1}{\sqrt{\pi}} \int_0^{\frac{e_1-e_T}{\sigma_{post}\sqrt{2}}} \exp(-t^2) dt \right] - k e_1 = 0.$$

The first (second) term represents the incremental utility (disutility) from exerting effort in the first period. These two terms indicate the trade-off between rewards from better current performance and future losses from the assignment of higher targets. The agent's decision for e_1 balances the net utility from the multi-period compensation concern and the disutility from exercising effort (the third term). Thus, the traditional incentive zone must contract as shown in Figure 2 due to the negative impact of current efforts on future evaluation.

The ratchet effect can be visualized when the incentive zone falls below the performance

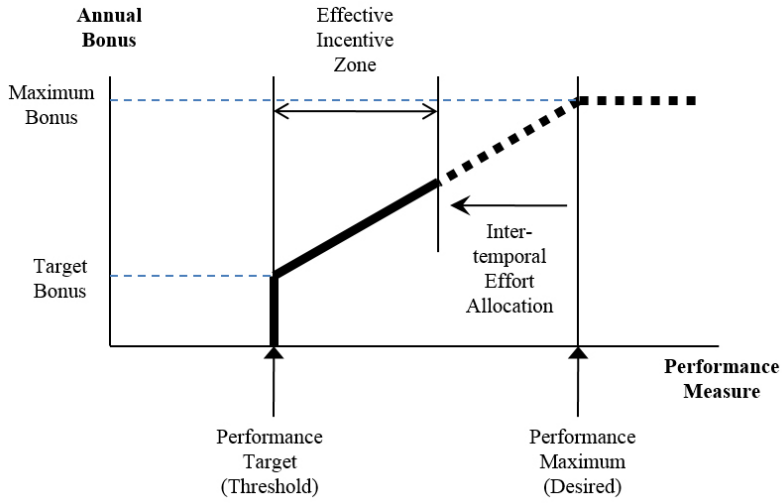

Figure 2. Annual Bonus Plan with Target Ratcheting

level desired by the principal upon the agent's earnest effort. In addition, the first order condition reveals that the agent's optimal effort decision in the first period (at stage D in Figure 1) depends on three key parameters: τ (variance of the principal's prior belief on target, i.e., target ambiguity at stage B in Figure 1), ρ (the principal's capability of discerning the differential effort, for example, communication between the principal and the agent at stage D in Figure 1), and σ (measurement noise throughout the contract period).[4] The implication of these parameters is translated into Propositions 1 through 4 in the next section.

III. Target Ambiguity and Ratchet Effect

The fundamental reason for the ratchet principle is that the superior has incomplete knowledge about the true capability and productivity of resources along with an uncertain

4) The first order condition cannot be solved algebraically because of the nonlinearity of the Gauss error function. Instead, I show numerical examples in the Appendix to demonstrate the impact of each parameter on the agent's effort decision.

environment. The superior is likely to assign greater weight on past performance information which is readily available. Stiglitz (1975), Keren et al. (1983), and Chow et al. (1991) explain that repeated observations of a subordinate's performance may enable the superior to make increasingly accurate assessments of the subordinate's private information or performance capability. When the true target performance is more ambiguous — i.e., when τ becomes higher in our analytical model, the superior had better revise her prior belief on the target by weighting the realized performance more. Consequently, the subordinate conjectures that his actual performance in the current period will have a nontrivial impact on the future target performance, leading to a stronger ratchet effect. The numerical example presented in Panel A in the Appendix confirms our intuition that the magnitude of effort reduction increases with target ambiguity (represented by τ), and the effort reduction problem is aggravated when the principal has greater difficulty in distinguishing the effort component from the technology component (when ρ decreases).[5)]

I contrast participative target setting methods with non-participative (formula-based) ones to apply the target ambiguity concept. Targets are often set through interactions between the superior and the subordinate who is evaluated against the target (Murphy, 2001). One of the reasons that the superior embraces the subordinate in the target decision process is to enhance target accuracy (Nouri and Parker, 1998; Anderson et al., 2010). On the one hand, when the superior has imprecise information on how the performance target should be set for the subordinate who is equipped with a certain level of production capability, she is likely to seek communication with the subordinate.[6)] On the other hand, the superior would need neither additional performance observation nor the subordinate's opinion about

5) The target ambiguity measure — the variance term, — can be viewed as the distance between the performance threshold and the performance maximum in Figure 1. The larger the variance (interval) is, the larger the effort reduction that exists.

6) In contrast to prior literature approaching the ratchet effect from information asymmetry between the superior and the subordinate, it is irrelevant to our study whether or not the subordinate has private knowledge about his capability or technology. What really matters in our target ambiguity view is simply the fact that the superior has imperfect information and relies on past performance to set a more appropriate target (not to reduce the information gap between the superior and the subordinate).

the target if her prior belief was very strong via sufficient past observations, the deterministic nature of operations, or available direct monitoring. The superior may simply develop and use fixed target formulas that are subject less to realized performance but more to accumulated past performance data. Then, because the current performance data constitute one of the data points utilized in the formula, the current performance data can influence the target performance in a non-negotiable way with small weight. Consequently, subordinates predict or simulate targets straightforwardly by using the formula and have only a small degree of need, if any, to meditate on the trade-off between current performance improvement and less demanding standards in the following period.[7)]

Thus, the ratchet effect can be influenced by target ambiguity — the use of either a participative target decision or a formula-based target decision. If the target formula has been already established (low τ), the superior will give less consideration to target ratcheting, and the ratchet effect does not materialize. Targets being set through communication between the superior and the subordinate, on the other hand, imply high target ambiguity (high τ). The subordinate will be concerned about the possibility of the radical adjustment of future targets via newly arriving performance observation.[8)]

Proposition 1: *The ratchet effect is greater if targets are more ambiguous to be determined.*

If active interaction between the superior and the subordinate is available in the target-setting process, subordinates can try to prevent a sharp increase in the target performance

7) Indjejikian and Nanda (2002) provide empirical analysis that firms do not commit to ratchet standards (targets) to better motivate their executives. Their finding is analogous to our target setting procedure using fixed formulas in that there is little flexibility of target adjustment via past performance.

8) There are few empirical studies on the ratchet effect pertaining to the detailed target−setting process, especially the difficulty in determining the optimal level of targets. Lee and Plummer (2007) and Bouwens and Kroos (2011) document evidence of ratchet effects focusing on the budget/target setting process; however, their research sites set the target at the level of past performance (budget spending and sales revenues in the previous year) but neither provide further insights into various functional forms of target performance nor diverse levels of target ambiguity.

level by explaining to their supervisor that the realized high performance is not caused by their capabilities but by exceptionally favorable situations. The subordinate can decompose x into permanent innovation in technology and temporal components (e.g., abnormal excessive effort) and explain this to the superior. For example, in the context of Leone and Rock (2002), the subordinate can help his superior discern the permanent innovation from transitory surprises mingled in his past performance. Subordinates can even express their opinions on targets and deliver their voice through participation. Thus, I expect that the subordinate's concern about radical and oversensitive target ratcheting can be mitigated through participative target setting process because the subordinate can effectively communicate with and inform the superior of any temporary noise components that have little to do with the true target performance.

I interpret the parameter ρ in the model as active interaction between the supervisor and the subordinate. The superior is likely to recognize the effort and technology components (higher values of ρ) when informed subordinates voice their opinions and provide details about the factors affecting their current performance. The numerical example presented in Panel B in the Appendix indicates that the magnitude of effort reduction decreases with the superior's ability to associate the future target with only the relevant portion of the current performance.

Proposition 2: *Subordinates' influence on target determination mitigates the ratchet effect.*

Another interesting question regarding the ratchet effect is whether performance noise can affect the subordinate's dynamic incentive. The main purpose of adopting the ratchet principle is for the superior to use more information to induce the subordinate's maximum effort level. However, if the information is not precise in inferring the true target (θ), there is no benefit of revising the prior belief according to the newly arriving noisy information. Therefore, the noise of performance measures can be a crucial factor in developing target performance.

I suspect that the precision of performance measures is associated with the scope of performance measures: whether a measure is used uniquely for a specific subordinate (unique

measures) or commonly for numerous subordinates (common measures). It is reported that common measures usually receive significantly greater weight than unique measures (Slovic and MacPhillamy, 1974), subordinates' effort levels are higher under a relative performance evaluation (RPE) contract than under a non-RPE contract (Frederickson, 1992), and financial performance improves following the implementation of an incentive plan with relative performance measures (Matsumura and Shin, 2006). They suggest that using common measures (which is analogous to relative performance evaluation) may hinder subordinates from their inter-temporal effort allocation to maximize the net benefits — the rewards from current performance at the cost of increased future target performance. However, the literature has not considered the target ratcheting practice in the RPE (or common measurement) setting. In fact, the inter-temporal effort allocation incentive can still exist in the RPE practice, and the effort reduction issue may even be exacerbated with the use of common measures when the target performance is revised independently for each subordinate. That is, a subordinate may want to slow down his current working pace, endure an unfavorable evaluation compared to other subordinates but lower his future target standard, and enjoy favorable evaluation results against other subordinates in future periods.

The different degree of information asymmetry between unique and common measures can affect the ratchet effect, too. In order to set performance targets, the superior requires comprehensive knowledge about an individual subordinate's capability, production technology, general market factors, and their compounding effects on the subordinate's performance. For instance, the parent company must understand the subsidiary's key operations, comparative strategic advantages, industry characteristics, regulations, and so on, to set its target profit. When the superior observes performance results from many subordinates with the use of common measures, her knowledge about common technology and noisy market conditions can be factored out; hence, individual subordinates may have greater difficulty in voicing their favorable opinions about their own performance results. On the other hand, unique measures entail a larger degree of freedom for each subordinate in explaining the factors influencing the current performance outputs and expressing opinions on the appropriate future target level, or even persuading the superior to set targets at attainable levels.

Provided with deficient information pertinent to unique measures, the superior would

recognize greater noise imbedded in those measures (higher σ in the model) and reduce her reliance on the noisy measures in discerning the target performance (she might still use them to conjecture the subordinate's effort level as in the typical agency models). As a result, the subordinate will be under less pressure to exert his best efforts and the ratchet effect will diminish with unique measures due to its noisiness.

Proposition 3: *Measurement noise mitigates the ratchet effect.*

Furthermore, the numerical example presented in Panel C in the Appendix suggests that the subordinate puts in a higher level of effort as measurement noise increases and, furthermore, the increase in effort is more substantial when the ρ value is low (less interactive environment). In other words, measurement noise works only for the target setting circumstance when the subordinate's participation is trivial. Figure 3 graphically shows this complementary relationship.

Thus, the mitigation effect by measurement noise is greater when the subordinate's participation in the target decision is limited.

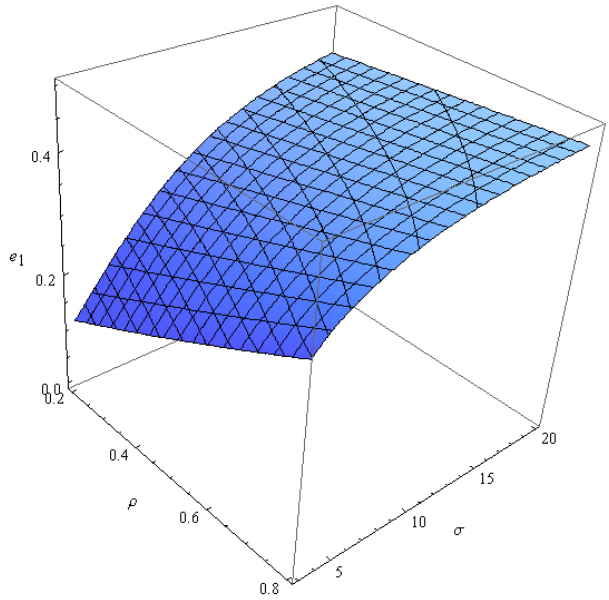

Figure 3. The Subordinate's Incentive with Target Influence and Measurement Noise

Proposition 4: *Measurement noise mitigates the ratchet effect to a substantively large degree when subordinates' influence on the target determination is restricted.*

I note that the traditional agency model's emphasis on the utilization of more precise and less noisy measures is not valid in ratchet setting because the principle wants to identify the true target rather than the agent's action. Another study that departs from the traditional agency perspectives is that of Feltham et al. (2006). They argue that more information is not always preferred in dynamic agency relationships since less information may be a commitment device that ameliorates negative incentives such as the ratchet effect. Laffont and Martimort (2002) also suggest that under a multi-period agency model, firm value is higher if a superior can commit in advance to adopt targets that do not incorporate information about subordinates' past performance.

IV. Concluding Remark

This research analytically examines the implication of target ambiguity on the subordinate's effort allocation over multiple periods. Prior literature documents that the subordinate has incentive to reduce the effort level when current performance affects future target performance, which is known as the ratchet effect. The literature, however, has not completely explored important issues regarding the ratchet effect, such as why target ratcheting is implemented despite its negative influence on subordinates' incentive, what circumstances facilitate the use of past performance in setting performance standards, which level of target performance should be considered when the superior possesses limited information for determining the true level of target performance, and how the true target performance can be unveiled through the repetition of performance evaluation.

Developing a model in the Bayesian framework, I propose that the subordinate's effort reduction incentive is greater when there is a higher level of ambiguity in determining target performance. I also propose two conditions that alleviate the effort reduction incentive caused by target ratcheting: the subordinate's participation in the target setting process and the use

of noisy performance measures. They hinder superiors from the intensive adoption of past performance to the future target, and hence, reduce the effort reduction incentive. These mechanisms play a more significant role with greater target ambiguity, suggesting a trade-off from using past performance in target setting: resolving the dubious nature of performance targets versus amplifying the effort reduction incentive.

This study provides future research directions. For instance, researchers need to approach the ratchet effect in the long-term perspective to examine how the effort reduction incentive comes to an end along with target ambiguity. The reduced form of incentive zone can be investigated in the similar vein. Future research can also explore implications of target ambiguity on asymmetric target ratcheting or potentially nonlinear relationship between the incentive scheme and the performance measurement traits such as target ambiguity and measurement noise. It may be also interesting to empirically examine the annual profile of target ambiguity and whether the ratchet effect gradually diminishes when a performance measure is being used repeatedly.

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APPENDIX
Numerical Examples on First Order Condition

Panel A – Hypothesis 2, Section 2
Target Ambiguity (τ) on Effort Decision

τ	σ	e_T	e_1		
			$\rho = 0.2$	$\rho = 0.5$	$\rho = 0.8$
1	8	1	2.1936	2.2136	2.2358
2	8	1	2.0811	2.1415	2.2050
4	8	1	1.7801	1.9466	2.1237
8	8	1	1.2190	1.5743	1.9650
16	8	1	N.A.	1.2248	1.8130
32	8	1	N.A.	1.0656	1.7429
64	8	1	N.A.	1.0171	1.7215
128	8	1	N.A.	1.0043	1.7158

Panel B – Hypothesis 3, Section 2
Subordinate Influence (ρ) on Effort Decision

	σ	e_T	e_1		
			$\tau = 1$	$\tau = 8$	$\tau = 16$
0.0	8	1	2.1775	1.0027	N.A.
0.1	8	1	2.1856	1.1072	N.A.
0.2	8	1	2.1933	1.2187	N.A.
0.3	8	1	2.1988	1.3336	N.A.
0.4	8	1	2.2064	1.4521	1.0441
0.5	8	1	2.2136	1.5743	1.2248
0.6	8	1	2.2203	1.7004	1.4129
0.7	8	1	2.2273	1.8306	1.6088
0.8	8	1	2.2342	1.9650	1.8130
0.9	8	1	2.2411	2.1053	2.0258
1.0	8	1	2.2489	2.2489	2.2489

Panel C – Hypothesis 4, Section 2
Measurement Noise (σ) on Effort Decision

σ	e_T	τ	e_1		
			ρ = 0.2	ρ = 0.5	ρ = 0.8
1	1	8 / 16	N.A. / N.A.	1.0784 / 1.0198	N.A. / N.A.
2	1	8 / 16	N.A. / N.A.	1.0998 / 1.0276	2.5114 / 2.4665
4	1	8 / 16	N.A. / N.A.	1.2566 / 1.0740	2.0085 / 1.9157
8	1	8 / 16	1.2190 / N.A.	1.5740 / 1.2248	1.9650 / 1.8130
16	1	8 / 16	1.7266 / 1.2091	1.8672 / 1.5345	2.0119 / 1.8749
32	1	8 / 16	1.9438 / 1.7025	1.9843 / 1.8322	2.0251 / 1.9638
64	1	8 / 16	1.9978 / 1.9245	2.0082 / 1.9623	2.0186 / 2.0002
128	1	8 / 16	2.0083 / 1.9865	2.0083 / 1.9963	2.0083 / 2.0061

Panel D – Additional Tests, Section 6
Initial Target Effort (e_T) on Effort Decision

τ	ρ	σ	e_T	e_1
8	0.5	8	1.0	1.5740
8	0.5	8	1.1	1.5592
8	0.5	8	1.2	1.5439
8	0.5	8	1.3	1.5296
8	0.5	8	1.4	1.5148
8	0.5	8	1.5	1.5000
8	0.5	8	1.6	N.A.
8	0.5	8	1.7	N.A.
8	0.5	8	1.8	N.A.

Definition of Variables

τ : Variance of the superior's prior belief on performance target

σ : Variance of the performance measure

e_T : The target level of effort assumed by the superior

e_1 : The subordinate's actual effort in period 1

ρ : The superior's knowledge on the subordinate's differential effort