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The effect of noise in a performance measure on work motivation: A real effort laboratory experiment

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ABSTRACT

This paper reports the results of an individual real effort laboratory experiment where subjects are paid for measured performance. Measured performance equals actual performance plus noise. We compare a stable environment where the noise is small with a volatile environment where the noise is large. Subjects exert significantly more effort in the volatile environment than in the stable environment. This finding is in line with standard agency theory and contrasts the intuitive idea captured by a distinct element of expectancy theory that noisier performance measures would lower work motivation.

1. Introduction

The provision of appropriate incentives is the essence of economics. Because the interests of workers typically differ from those of their employer, a critical issue within labor economics–and personnel economics in particular–is how firms should shape compensation contracts to motivate employees to operate in the firm's interest (cf. Prendergast, 1999). A vast economic agency literature has developed in the past decades focusing on the design of optimal pay-for-performance schemes. One of the main issues this literature addresses is how responsive pay should be to performance, given the actual characteristics of the performance measure(s) used. Obviously the answer to this optimal contracting question depends on the underlying assumptions made about how agents respond to contracts that reward performance. Therefore, the validity of the prescriptions derived from agency theory crucially depends on the empirical relevance of key behavioral assumptions. One of these is how workers' motivation varies with the amount of noise in the performance measure employed. This paper empirically addresses this latter question head on.

Within agency theory two characteristics of performance measures have received widespread attention. The first one is "goal congruence", i.e. the alignment between the performance measure and organizational value. Because incongruent ("distorted") measures are predicted to invoke dysfunctional gaming responses that do not add value, they should receive a lower weight in performance pay.[1] The second characteristic is "noise"–i.e., the imprecision with which the performance measure reflects actual effort–and is the focus of this paper. Because noisier performance measures reflect employee effort less accurately agency theory prescribes that they should be weighed less in the employee's compensation scheme. In more prosaic terms: people should not be held accountable for factors they do not control (cf. Roberts, 2004).[2]

The dictum derived from agency theory that noisier performances measures should receive less weight in compensation follows from

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[1] See Baker (1992, 2002), Feltham and Xie (1994), Holmstrom and Milgrom (1991) and Datar et al. (2001) for multi-task agency models of distorted performance measures and Courty and Marschke (2004, 2008), Fehr and Schmidt (2004), Oosterbeek et al. (2006) and Sloof and Van Praag (2009) for empirical tests of actual gaming responses and distortions in performance measures.

[2] As Roberts (2004, p. 137) carefully points out, there is a subtlety in this principle. Good performance measures may make valuable use of variables the employee cannot control, in order to filter out some extraneous randomness (the "informativeness principle" of Holmstrom (1979)). For example, a company's total shareholder return (TSR) relative to an index (e.g., the S&P 500), is often regarded a less noisy performance measure for CEOs than the absolute value of the company's TSR, because it filters out business cycles effects. Thus, the CEO is not simply rewarded for a booming economy. Here we focus on true randomness that remains after all such filtering opportunities have been exhausted.

the insight that the optimal contract has to strike a balance between insuring the risk averse agent against (uncontrollable) risk and providing him with incentives to exert effort. The principal pays a risk premium to the agent that increases with the intensity of incentives, the degree of risk aversion of the agent, and the noise in the performance measure. This premium is traded off against the benefits of additional effort that stronger incentives generate. Noisier performance measures are less attractive for the principal, because they require higher risk premia for a given amount of incentives.

Apart from a higher required risk premium, however, in agency theory noise *per se* does not have a direct adverse effect on effort incentives.[3] (In this regard noise thus markedly differs from distortion.) In the often used linear version of the agency model, noise does not directly affect effort incentives at all; for a given incentive intensity, the incentive compatibility constraint is then independent of the amount of noise. In more general specifications noise may have a direct impact, but under the standard assumptions typically made about the agent's preferences, more noise always *strengthens* effort incentives (cf. Section 2).

This prediction is arguably counterintuitive: Why would an employee exert substantial effort when variations in the performance measure are largely beyond his control? Much more intuitive seems the common sense belief that more noise in the relationship between effort and measured performance demotivates employees to put forth effort. One reason why this has strong intuitive appeal is that in closely related settings governed by relative performance evaluation–i.e., in "tournaments" where employees compete for a fixed set of prizes–standard economic (tournament) theory formally predicts that employees reduce their effort levels when noise increases. In the words of Lazear (1995, p. 29): "If luck is the dominant factor in determining the outcome of the promotion decision, workers will not try very hard to win the promotion." Another possible reason is that people tend to look at decisions in a relative way. For example, most people are willing to spend an extra 15 min of travelling time to save 5 € on a 10 € purchase of say a new pen, but are unwilling to do so on a 500 € purchase of say a new suit (cf. Tversky and Kahneman, 1981). By analogy this suggests that the importance of effort for measured performance relative to the importance of noise plays a distinct role in deciding how much effort to exert.[4]

The common sense belief that noise works as a demotivator is captured within *expectancy theory*, which was developed by organizational psychologists (cf. Vroom, 1964) and is now one of the leading conceptual (non-formalized) theories of work motivation in the fields of management and organizational behavior. One of the key motivational drivers within this theory is the employee's *effort–performance expectancy*. The stronger the subjective perception that (more) effort leads to (better) performance, the more motivated an employee will be to put in effort. Now, a larger amount of noise in the performance measure implies that the relationship between effort and measured performance is weakened. Most probably, this also weakens the subjective perception of the relationship between effort and measured performance. Thus, the intuitive idea that a noisier performance measure *reduces* effort incentives is consistent with expectancy theory. Employees will be *less* motivated when their evaluation and rewards are based on measures they are less able to control. [5]

If noise indeed has a direct adverse effect on effort incentives just as intuition suggests, this may in principle overturn the key insight from agency theory that noisier measures should be weighed less in remuneration contracts. The principal may then prefer to set *stronger* incentives to compensate for the demotivational impact of higher noise. At the same time, however, she may still prefer lower incentives as to secure the employee's participation more cheaply. The overall net effect depends on how these two opposing forces cancel out; see Appendix B for a further discussion.

In this paper we empirically assess the relationship between noise and work motivation by means of a laboratory experiment. As Falk and Fehr (2003) and Falk and Heckman (2009) point out, a major advantage of lab experiments over naturally occuring field data is the high level of control and the possibility to implement truly exogenous ceteris paribus changes. Both papers carefully illustrate these advantages with experiments that address research questions at the heart of (empirical) labor economics, i.e. how to motivate workers to exert high effort. Translated to the specific question we are interested in, the experimental approach allows us to systematically control and vary the amount of noise in a performance measure while keeping the incentive contract (and everything else) fixed. It is hard to think of naturally occuring data for which the same holds true. Apart from the fact that the amount of noise is notoriously difficult to measure in the field, actual performance contracts are endogenously chosen and likely to vary with the noisiness of the performance measure used (this is at least what agency theory predicts). In the presence of such an empirical identification problem, testing the ceteris paribus consequences of performance noise on work motivation becomes very difficult. In contrast, controlled variation in a lab experiment does permit causal inferences and rules out confounding factors. Although lab experiments may have their own potentional limitations and objections, most of these can be circumvented by careful experimentation; see Falk and Fehr (2003) and Falk and Heckman (2009) for comprehensive arguments.

Since our research interest lies in the *direct* impact of noise in a performance measure on work motivation, our experiment is solely concerned with employees' behavior under an exogenously given incentive contract (i.e. the principal is absent). Subjects are confronted with an individual real effort task, i.e. adding three two-digit numbers. They are paid on the basis of their measured performance, with a given piece rate equal to about 5 eurocents per correct calculation, on top of their base salary. Noise enters the picture because, when calculating a subject's compensation, the number of correct calculations is not registered perfectly. In particular, there is a 50% chance that the subject is lucky and an amount of σ correct calculations is added to his actual number of correct calculations. Yet there is also an equal 50% probability that the subject is unlucky and an amount of σ is subtracted. We use σ as a treatment variable to represent different amounts of noise and consider both a *stable environment* in which σ is low ($\sigma = 10$) and a *volatile environment* in which σ is high ($\sigma = 180$).[6] Standard agency theory formally predicts effort levels to be (weakly)

[3] Of course, more noise will induce the principal to adapt the incentive intensity due to the larger required risk premium. This paper focuses on the agent's optimization problem and takes the incentive contract as given (cf. Section 2).

[4] A similar point is made in Azar (2006) regarding the importance of effort-based variable pay relative to the fixed salary component. He argues that relative thinking implies that "...a larger base salary may reduce effort because it makes the pay-for-performance bonus look smaller" (p. 5). Azar experimentally compares a low and a high fixed salary treatment while keeping the piece rate fixed. He finds no differences in the amounts of effort exerted, which is taken as evidence that relative thinking does not play a role for task performance. A plausible alternative explanation could be that the lack of behavioral variance is due to the negligible difference of about $2 between the two fixed salaries (which was done on purpose to avoid wealth effects). Another possibility is that gift exchange motivations work in the opposite direction, nullifying the effect of relative thinking.

[5] Perceived and actual control over measured performance may not be identical. For instance, a systematic upward bias in the level of perceived control may arise from the tendency that people overestimate their control (cf. Van den Steen, 2004). In Appendix B we briefly discuss an agency model in which the agent's subjective perception of the relationship between effort and performance differs from the actual relationship.

[6] These numbers are based on a pilot experiment in which subjects received a flat wage and were explicitly asked to put in sufficient effort. On average subjects made 176 correct calculations in the 40 min they were required to work (cf. Section 3).