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The Effect of Financial Incentives and Task-specific Cognitive Abilities on Task Performance

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Abstract

We extend evidence on the interaction between financial incentives and cognitive abilities by focusing on the effect of task-specific abilities. In a memory-intensive task situated in an accounting context, the effect of accounting education on performance is stronger under financial incentives as compared to flat rate pay. Subjects with more accounting education respond stronger to financial incentives. Hence using incentives efficiently may involve targeting them at high-ability individuals. More generally, taking into account the incentive-ability interaction seems important when interpreting observed behavior in cognitively demanding lab and field economic environments.

Keywords: Financial incentives, Cognitive ability, Performance, Experiment

JEL classification: C81; C91; C93; D83

1. Introduction

Economists widely believe that, absent strategic considerations such as agency problems, financial incentives represent the dominant and effective stimulator of human productive activities. In cognitively demanding tasks, however, even if incentives and other motivational factors sufficiently induce effort, both financial and cognitive resources may be wasted for individuals lacking cognitive abilities (or skills, or capital) to perform the task. This prediction has been expressed only informally in Camerer and Hogarth's (1999) capital-labor-production framework and by others.[1] Furthermore, empirical tests are sparse, and – likely due to the complexity of measuring cognitive effort duration (other than as a direct correlate of cognitive production) let alone effort intensity – they have examined only the reduced-form relationship between incentives, abilities and performance. Nevertheless, even this relationship has important implications for designing efficient incentive schemes in firms, experimental settings and elsewhere, as well as for interpreting observed (variance of) behavior in cognitively demanding lab and field economic environments.

Broadly in line with the above prediction, two between-subject experimental studies document a positive interaction between incentives and abilities. In an accounting task, Awasthi and Pratt (1990) find that incentives (rewarding correct choice) improve performance compared to flat rate pay only for subjects with high perceptual differentiation. Similarly, Palacios-Huerta (2003) reports that raising incentives (piece-rate and tournament) improves performance in a Monty Hall Three Door task only for subjects with superior schooling outcomes (but this effect could be partly due to intra-group communication).[2]

We extend the above evidence by focusing on the interaction between incentives and more *task-specific*, as opposed to domain-general, cognitive abilities. Their role in cognitive production is central to Camerer and Hogarth's capital-labor-production framework and has been extensively studied in cognitive science and behavioral decision research (see, e.g., Anderson, 2000, and Bonner and Sprinkle, 2002, for reviews). Moreover, unlike in the above two choice tasks, our

[1] See, e.g., Awasthi and Pratt (1990), Libby and Lipe (1992), Libby and Luft (1993), and Wilcox (1993).
[2] Rydval and Ortmann (2004) review the papers in more detail. They also illustrate that both abilities and incentives are important for performance in an IQ test, but they lack an independent measure of ability that would enable them to study the incentive-ability interaction.

performance measure allows us to study the incentive-ability interaction in a more continuous fashion. Last, we pay closer attention to motivational issues and the role of effort input.

We use a dataset from Libby and Lipe (1992; henceforth LL). In the experiment, 117 accounting and auditing students performed a task called free recall. They were presented with 28 sentence-long accounting expressions used in auditing a company's internal control system. At their own pace, subjects memorized the items, then completed a brief demographic questionnaire, and finally recalled (typed in) the items in any order.

Subjects were randomly assigned into three treatments. The $FLAT treatment featured a $2 participation fee. The incentivized treatments in addition featured combined piece-rate and tournament incentives, namely, $0.1 per correctly recalled item and $5 if among the best five performers in the treatment. The incentives were announced prior to memorizing in the $MEMO treatment, but only prior to recalling in the $RECALL treatment.[3] LL's main finding is that performance – the number of correctly recalled items – is significantly higher (by about two items on average) in $MEMO and $RECALL compared to $FLAT. Performance also varies considerably across subjects, the reasons for which we analyze below.

Subjects reported their attained accounting credits (henceforth education; on average about 20 credits) and auditing job experience (henceforth experience; on average about three months for the third of subjects with experience).[4] LL interpret the variables as proxies for task-specific cognitive ability, potentially reflecting subjects' differential familiarity with the memorized items. The proxies do not vary across the treatments but vary substantially across subjects and are only weakly correlated with each other. Noting a significant correlation between education and performance in $RECALL,[5] LL speculate that the impact of incentives on performance may depend on subjects' accounting knowledge. We analyze this hypothesis in more detail.

[3] LL labeled the treatments FLAT, ENCODING and RETRIEVAL, respectively.
[4] Subjects also reported the number of auditing credits but this variable does not vary across subjects.
[5] LL also report a significant correlation between performance and auditing grades in $RECALL, but the grades are not available for further analysis.

2. Results and discussion

In Column 1 of Table 1, we first replicate the average incentive treatment effect reported by LL.[6] Column 2 then shows that the effect remains about the same after accounting for the significant positive effect of education and experience. There is also a significant negative interaction (i.e., substitution) effect between education and experience.[7]

Column 3 suggests, however, that the incentive treatment effect in fact stems from a significant interaction between incentives and education. Performance on average improves by about a quarter of an item with each additional accounting credit in $FLAT, but by about 50 percent more in the incentivized $RECALL and $MEMO treatments (note the results are remarkably similar in $RECALL and $MEMO despite the differential timing of incentives). The effect of experience – about three items per each additional month – as well as the education-experience interaction effect remain about the same as in column 2 and do not differ across the treatments. The incentive treatment dummies are individually and jointly highly insignificant and hence are omitted. In sum, what seems to drive the incentive treatment effect reported by LL is that incentives better foster performance of subjects with more education. To illustrate, the average performance of subjects with above-median education is 10.2 items in $FLAT versus 13.6 items in $RECALL and $MEMO (combined), whereas the figures are 9.6 and 10.7 items, respectively, for the remaining subjects with lower education.

We next examine whether our findings are affected by motivational problems, which may involve quite a different incentive-ability interaction than the one portrayed above. In general, subjects in $FLAT could lack intrinsic motivation to perform, while the motivation of subjects in $MEMO and $RECALL could be "crowded out" by the piece-rate or tournament incentives (in the sense of Deci et al., 1999, or Gneezy and Rustichini, 2000) or by the delayed announcement of the incentives in $RECALL. We observe the following. First, in the bottom decile of performance with one to four recalled items, five subjects come from $FLAT, three from $RECALL and five from $MEMO, so low performance is not overly specific to any treatment. Second, low performance does not seem to arise from (initial) motivational problems, since only

[6] For reasons that remain unclear, we are unable to exactly replicate the results for $FLAT and $RECALL, but the discrepancy is negligible.

[7] However, for all the reported regressions, log-linear "production function" specifications that would more naturally accommodate the education-experience interaction perform much worse in terms of statistical significance and fit.

two bottom-decile performers come from the bottom decile of memorizing time (which was unobtrusively measured).[8] Third, the bottom-decile performers on average have only slightly lower education and experience compared to the remaining subjects. Most importantly, column 4 shows that our results change rather little when excluding the eight worst performers with just one or two recalled items; the incentive-education interaction becomes even larger and more significant.[9]

As a second robustness check, we examine whether including memorizing time, i.e., initial effort duration input, affects our results. This is not an attempt to estimate a formal capital-labor-production model, since we observe neither other effort inputs (their duration and intensity) such as recalling effort,[10] nor other likely relevant cognitive ability inputs such as short-term memory. Furthermore, since memorizing time is endogenous to recall performance, we use only the residual variation therein, after removing the effect of incentives, education and experience.[11] In an unreported background estimation, we find that memorizing time is higher in $MEMO and decreases with more education and experience.[12] This may simply mean that more education and experience facilitates faster reading and memorizing of the items. In any case, column 5 shows that the residuals from the background estimation have a significant positive impact on performance. Most importantly, comparing vis-à-vis column 3, our results are virtually intact, and the incentive-education interaction is slightly smaller but still highly significant.

3. Conclusions

In line with the previous two studies, we find a positive incentive-ability interaction, in our case for a more task-specific form of cognitive ability. All three studies suggest that using incentives efficiently may involve targeting them at high-ability individuals. The findings may naturally be specific to the production settings, incentive schemes and cognitive ability proxies, among other

[8] Two subjects took only about a minute and 10 subjects took between two to three minutes to memorize, yet their average performance reached almost seven items.
[9] Excluding all bottom-decile performers yields similar findings. In all the robustness checks, the preferred model specification is the one in column 3.
[10] Recall time was measured, but this seems to be a direct correlate or byproduct of performance and furthermore is likely confounded by differences in subjects' typing speed.
[11] Still, the residual variation could subsume various forms of unobserved heterogeneity.
[12] The decrease is faster in $MEMO but not significantly so. The regressors are jointly significant at the 5% level. We exclude six "outliers", namely, two (four) subjects with markedly low (high) memorizing times. Their inclusion weakens the background estimation results but not the results in column 5.

things. Also, the studies do not address whether low-ability individuals waste cognitive resources, since effort is insufficiently observed.

More generally, studying the incentive-ability interaction falls short of testing the capital-labor-production framework. As acknowledged in its various informal accounts, disciplining the framework requires identifying relevant cognitive, non-cognitive (personality) and motivational constructs, and structural relationships among them. For a specific task, there are likely numerous fixed and variable effort and ability inputs, augmentable to various extents by incentives. Further, not only objective abilities but also their subjective (self-perceived) counterparts may affect effort and performance.

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Table 1: Regressions of recall performance on incentive treatment dummies and cognitive ability proxies.[a]

REGRESSOR	(1)	(2)	(3)	(4)	(5)
intercept	9.805*** (0.651)	2.913 (2.911)	4.483 (2.812)	6.367** (2.481)	4.319* (2.441)
$RECALL	1.800 (1.113)	2.083* (1.072)			
$MEMO	2.537** (1.216)	2.530** (1.236)			
Education		0.323** (0.136)	0.244* (0.135)	0.171 (0.120)	0.260** (0.116)
Education * $RECALL			0.115** (0.051)	0.135*** (0.050)	0.090** (0.045)
Education * $MEMO			0.119** (0.059)	0.177*** (0.053)	0.106** (0.048)
Experience		3.248** (1.326)	3.345*** (1.284)	2.469** (1.219)	3.377*** (1.010)
Education * Experience		-0.137** (0.061)	-0.141** (0.058)	-0.111** (0.055)	-0.141*** (0.046)
Memorizing time residuals					0.022*** (0.0027)
Joint significance	*	**	**	***	***
# observations in $FLAT,$RECALL,$MEMO	41,38,38	41,38,38	41,38,38	40,35,34	41,37,33

[a] OLS estimates with heteroskedasticity-robust standard errors in parentheses. *,**, and *** denote significance at the 10%, 5% and 1% level, respectively.