# Belief Elicitation When More Than Money Matters: Controlling for "Control"

## *Online Appendix* *


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## Heterogeneous effects

In this section, we examine possible heterogeneous effects of control motivations. In particular, we explore whether control motives affect reported beliefs to different degrees depending on the confidence level $\mu$. Goodie (2003), Goodie and Young (2007), and Heath and Tversky (1991) provide some evidence that people with greater confidence in their performance exhibit a greater bias towards betting on themselves.[1]

We first consider the theoretical predictions our model makes. The model is built on the premise that a subject reaps control benefits upon being paid for a successful performance. Hence, there is an intuitive sense that distortions brought about by a manipulation of control motives, such as in our experiment, should be increasing in a subject's perceived likelihood of success.


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[1] This is true of Heath and Tversky's first three experiments but not their fourth.

Recall that optimal reported beliefs are $p_1^* = \mu(1 + C_H) + N(\mu)$ and $p_2^* = \mu + \frac{N(\mu)}{C_H+1}$. Thus,

$$\begin{aligned}\frac{dp_1^*}{d\mu} &= (1 + C_H) + N'(\mu) \\ \frac{dp_2^*}{d\mu} &= 1 + \frac{N'(\mu)}{C_H + 1}\end{aligned}$$

With the minimal assumptions we have made on $N$ so far, namely $N(\mu) \geq 0$, it is possible that $\frac{dp_i^*}{d\mu} < 0$. That is, people with lower beliefs could make higher reports. Clearly, making an inflated report for self-regard/signalling reasons does not make much sense if high reports indicate low beliefs. Indeed, a fully articulated signalling model would start with assumptions to ensure that higher types make higher reports. Accordingly, let us now assume that $(1 + C_H) > -N'(\mu)$. The model then predicts that $\frac{dp_1^*}{d\mu}, \frac{dp_2^*}{d\mu} > 0$.

This prediction is of limited interest, obtaining even if people have no control or signalling objectives ($C_H = 0 \equiv N$). A more interesting prediction comes from examining $p_1^* - p_2^*$. The difference $p_1^* - p_2^*$ comes from the control motivation in Treatment 1. We have that

$$\frac{d(p_1^* - p_2^*)}{d\mu} = C_H(1 + \frac{N'(\mu)}{C_H + 1}) > 0$$

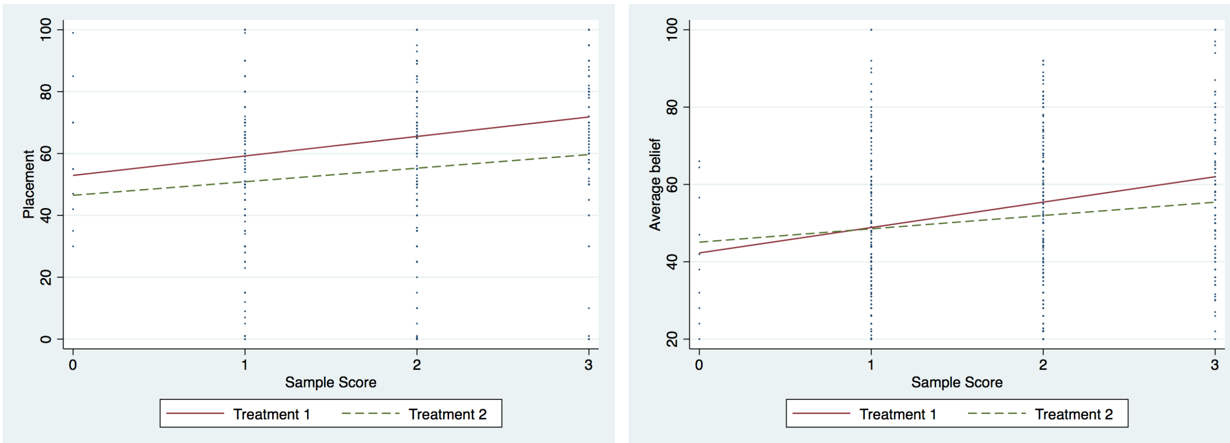
Thus, the model predicts that the distortion due to control is increasing in beliefs.

We now turn to our data. Using subjects' performance as an estimator for confidence levels would lead to obvious endogeneity problems when testing whether $p_1 - p_2$ is increasing in $\mu$. We instead use the score obtained on the sample questions as a proxy for confidence. This score is a strong predictor (p-values $\sim 0.000$ in OLS regressions) of both performance and reported confidence for both parts of the experiment (i.e., the quiz and the 5-question questionnaire that followed). This suggests that performance in the sample questions is both a valuable signal for future performance and an information seemingly used by subjects to determine their confidence level.

Equipped with this proxy for confidence, we set to explore its impact on the distance between reported probabilities in the two treatments. Figure 1 plots Placement and Average Belief against Sample Score and, in addition, presents two separate regression lines for the two treatments, including only subjects for whom the elicitation is incentive compatible. The plots suggest that the degree of the distortion is slightly increasing in confidence. However, the slope coefficients are not statistically different from one another (p-value = 0.455 for placement and p-value = 0.114 for average belief).

Figure 1: Heterogeneous effects

(a) Placement (b) Average beliefs




We further explore the relationship between confidence $\mu$ and treatment differences with a set of regressions which include the interaction variable *Treatment-1* $\times$ *Sample Score*. The results are presented in Table 1 and 2 for placement and average beliefs respectively. In both tables, models E-G are OLS regressions. Model H is a semi-structural estimation imposing a model restriction that derives from assuming the presence of control motives. More specifically, as highlighted by Proposition 1, $C_H > 0$ implies $p_1^* > p_2^*$ for all $\mu$. In accordance with this restriction, we run a constrained regression imposing that the intercept estimated for treatment 1 must lie weakly above the intercept for treatment 2. The estimation is reported under Model H. If treatment differences are indeed increasing in confidence, we should observe a larger treatment effect as the sample score (and therefore $\mu$) increases. Hence our estimation for the coefficient of the interaction term should be positive and significant in regressions where we separately control for Treatment and Sample Score (models G and H). In Table 2, we do find some evidence that control motives increase in confidence as shown by the statistically significant coefficients on the interaction term of Model G and H. Although the coefficient is positive, the effect is no longer significant in Table 1.

Another approach is to explore the decomposed effect of the treatment across the 5 questions. We pre-registered this analysis as exploratory as we did not expect to have enough power to detect a treatment effect given the expected large variance of beliefs for

Table 1: Heterogeneous effect - The effect of confidence on placement

| | Placement<br>Model E | Placement<br>Model F | Placement<br>Model G | Placement<br>Model H |
|---|---|---|---|---|
| Treatment 1 | -1.460 | | 6.747 | 6.747 |
| | (0.698) | | (0.180) | (0.180) |
| Sample Score | | $2.858^{**}$ | $4.501^{**}$ | $4.501^{**}$ |
| | | (0.037) | (0.015) | |
| Treat.1 X Sample Score | $6.253^{***}$ | $4.911^{***}$ | 1.777 | 1.777 |
| | (0.000) | (0.000) | (0.485) | (0.485) |
| Gender: Male | 1.190 | 0.838 | 0.749 | 0.749 |
| | (0.559) | (0.680) | (0.713) | (0.713) |
| Gender: Other | 1.801 | 2.846 | 2.099 | 2.099 |
| | (0.915) | (0.866) | (0.901) | (0.901) |
| Munich | -1.019 | -1.359 | -1.416 | -1.416 |
| | (0.621) | (0.509) | (0.491) | (0.491) |
| Constant | $55.71^{***}$ | $51.50^{***}$ | $48.51^{***}$ | $48.51^{***}$ |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| N | 536 | 536 | 536 | 536 |
| $R^2$ | 0.0688 | 0.0762 | 0.0794 | 0.0794 |

NOTES: The dependent variable is placement (the reported belief that own performance in the quiz is above the median). Models E-G are OLS regressions. Model H is a semi-structural estimation imposing the model's restriction that Treatment 1 > 0. The regression includes major dummies. $P$-values in parentheses. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.

each individual question. The approach consists in cheking whether the treatment effect is larger for questions perceived as easy compared to questions seen as difficult. The mean reported probabilities of answering each of the 5 questions are: $q_1 = 48.73$, $q_2 = 52.19$, $q_3 = 64.13$, $q_4 = 42.39$ and $q_5 = 56.39$, so the questions perceived to be the easiest are $q_3$ and $q_5$, while the hardest are $q_1$ and $q_4$.

We then compute the average belief, $p_D$, for the two questions perceived as most difficult, and, separately, the average belief, $p_E$, for the two questions perceived as easiest. We evaluate whether the treatment dummy is statistically linked to the difference, $p_D - p_E$, in an OLS regression which includes the standard controls. The sign of the treatment coefficient is

Table 2: Heterogeneous effect - The effect of confidence on average belief

| | Avg Belief | Avg Belief | Avg Belief | Avg Belief |
|---|---|---|---|---|
| | Model E | Model F | Model G | Model H |
| Treatment 1 | -9.445*** | | -4.064 | 0 |
| | (0.002) | | (0.313) | (.) |
| Sample Score | | 3.941*** | 2.951** | 3.941*** |
| | | (0.000) | (0.046) | (0.000) |
| Treat.1 X Sample Score | 6.837*** | 2.015** | 3.903* | 2.015** |
| | (0.000) | (0.013) | (0.056) | (0.013) |
| Gender: Male | 3.637** | 3.295** | 3.348** | 3.295** |
| | (0.026) | (0.044) | (0.040) | (0.044) |
| Gender: Other | 17.37 | 17.12 | 17.57 | 17.12 |
| | (0.200) | (0.205) | (0.194) | (0.205) |
| Munich | -2.682 | -2.976* | -2.942* | -2.976* |
| | (0.104) | (0.071) | (0.075) | (0.071) |
| Constant | 45.58*** | 39.06*** | 40.86*** | 39.06*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| N | 536 | 536 | 536 | 536 |
| $R^2$ | 0.0815 | 0.0867 | 0.0885 | 0.0867 |

NOTES: The dependent variable is average belief (the average reported belief that the previewed questions will be answered correctly). Models E-G are OLS regressions. Model H is a semi-structural estimation imposing the model's restriction that Treatment 1 > 0. The regression includes major dummies. $P$-values in parentheses. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.

positive, so running against the hypothesis that confidence boosts control motives, and not significant (p-value = 0.85).

All things considered, we find only slightly suggestive evidence that control motives are increasing in confidence levels interspersed among non-significant results of mixed direction. One must still keep in mind that this is an "out of sample" prediction of our model (it was not built to yield this prediction), that the data is in line with the prediction (and, importantly, does not reject it), and that the sample size of the experiment was intended for the more basic test of $\bar{p}_1 > \bar{p}_2$.

Note that our prediction that more confident individuals inflate more for control reasons is unrelated to the Kruger and Dunning (1999) *unskilled and unaware* effect, which maintains that unskilled people are especially overconfident in their beliefs, as this effect is about people's actual beliefs, not their reports of these beliefs. Moreover, control is not implicated in the Kruger and Dunning experiments, which elicit beliefs in an unincentivized manner.

# References


[1] Goodie, A. S. (2003) The effects of control on betting: paradoxical betting on items of high confidence with low value. J Exp Psychol Learn Mem Cogn: 29, 598-610.

[2] Goodie, Adam and Diana Young (2007), "The skill element in decision making under uncertainty: Control or competence?," Judgment and Decision Making, 2(3), pp. 189-203.

[3] Heath, Chip and Amos Tversky, (1991) "Preference and Belief: Ambiguity and Competence in Choice under Uncertainty," Journal of Risk and Uncertainty, 4, 5-28.

[4] Kruger, Justin and David Dunning (1999), "Unskilled and unaware of it: How difficulties in recognizing one's own incompetence lead to inflated self-assessments," Journal of Personality and Social Psychology, 77, 1121–34.