Correction to McKelvey and Page, "Public and Private Information: An Experimental Study of Information Pooling", *Econometrica*, Nov. 1990

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Abstract

The above mentioned article (McKelvery and Page 1990) errs in calculating the consequences of myopic-rational responses to the payoffs used in the experiments it describes. This invalidates the article's proof that myopic responses are a non-myopic Bayes-Nash equilibrium. Thus we lack game-theoretical predictions to compare with the experimental results.

Headnote: Correction to McKelvey and Page

Keywords: consensus, common knowledge, information pooling, Bayesian learning.

Claims

In their article (McKelvery and Page 1990), McKelvey and Page note that

> In previous experimental work, ... [researchers] investigated how individuals use public information to augment their original private information, and whether in doing so, a rational expectations equilibrium is attained. ... [But either] the inference processes are complicated because of the enormous number of potential interactions among the individuals, and the optimal inference processes are not analyzed. ... [or] the inference process is analyzed but the working assumption is not altogether satisfactory.

In contrast,

> We compare the predictions of a [game-] theoretical model of a common knowledge inference process with actual behavior. ... The experiment is designed so that, under certain behavioral assumptions, truthful reporting of current private information is a Bayes-Nash equilibrium, and the equilibrium path leads to a common knowledge equilibrium characterized by complete pooling of information.

More specifically, they use a "lottery version of a [quadratic] proper scoring rule" so that "an individual's probability of winning a lottery is .. maximized by [honest] reporting". That is, they try to make honest reports of posterior beliefs be optimal myopic responses, i.e., maximizing one-period payoffs.

Assuming honest reporting,

> By direct calculation we find that for the experiment the refinement process terminates in three periods ($T = 3$) and that at the beginning of the third period if all the players are fully rational Bayesian, each has obtained the pooled information. Moreover there is complete pooling by the third period if the subjects are constrained to report in even hundredths as in the table of Appendix A.

Finally, they show that, given the above results, myopic responses are a non-myopic equilibrium, reasoning that

> by departing from truthful reporting j might be able to change j's information sets in [periods] $3, 4, 5$, or 6. But in doing so j could only make things worse for j, since j's information sets for these rounds were already fully refined under truthful reporting.

Errors

There are two major errors in this analysis[1].

First, McKelvey and Page's quadratic proper scoring rule payoff table, Table A, has payoff values rounded to only three significant digits, inducing several regions of linear payoffs. For example, the payoffs given for the reports $.02, .04, .06, .08$ are all linear. For linear scoring rules and linear utilities (from lottery payoffs), it is always optimal to report some end of the linear range. For example, if one's posterior was .051, one's unique optimal (myopic) response would be .08, not the nearest possible ("honest") report of .06.

Second, even if we assume subjects always (honestly) reported the nearest allowed posterior value, I find that my exact computations disagree with McKelvey and Page's "direct calculation" that honest reports induce complete "pooling" after two announcements.

Assuming that subjects honestly report to the nearest even hundredth (and round up when equa-distant), and rounding announcements to the nearest hundredth (as McKelvey and Page apparently did), allows me to reproduce Tables II and III, and the optimal reports in Figure 1. I find that while in all states the four and further announcements induce no information partition changes, in some states the third announcement does change some information partitions. For example, if the three subjects observe $(0, 9, 10)$ successes out

[1] The paper also contains a clerical error. On page 1327, formulas like

$$\rho(\omega) = (.5)(.6^{y_1+y_2+y_3})(.4^{30-y_1-y_2-y_3})$$

are missing a combinatorial term, and should instead read:

$$\rho(\omega) = (.5)(\frac{10!10!10!}{y_1!y_2!y_2!(10-y_1)!(10-y_2)!(10-y_3)!})(.6^{y_1+y_2+y_3})(.4^{30-y_1-y_2-y_3})$$

of 11, then their sequence of rounded reports is: $(.02, .96, .98), (.92, .96, .96), (.92, .92, .96), (.96, .96, .96)$

If "pooling" means all participants have an information partition identical to the partition which would result from being directly told all private information, then I find that 8.24% of the prior weight is in states where pooling never occurs. If, however, "pooling" means only that the rounded reports of all participants are identical to those they would make if they had been told all private information, then pooling does occur in all states. However, in some states this kind of pooling only occurs after three, not two, announcements.

McKelvey and Page's proof that myopic responses are a Bayes-Nash equilibrium crucially depends on the assumption that it is common knowledge at every period that in equilibrium pooling will occur by the third period. Since for no state is this common knowledge in the first period, there may be incentives to deviate from the proposed equilibrium. Thus we no longer know any Bayes-Nash equilibria to this game.

Conclusion

McKelvey and Page mistakenly calculated that myopic rational responses implies information pooling after two announcements in all states, given the payoff table they employed in their experiment. The mistook the consequences of both the rounding of their payoff values, and of their choice of a coarse array of possible posterior reports.

Though McKelvey and Page observed clear differences between theory and experiment, they concluded that a "rough approximation" of theory seems "borne out in the experimental evidence". However, the errors in their analysis imply that we no longer have a game theoretic prediction of behavior in this environment, and so we cannot draw such conclusions.

References

McKelvery, R., and T. Page (1990): "Public and Private Information: An Experimental Study of Information Pooling," *Econometrica*, 58(6), 1321–1339.