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INDIVIDUAL CHOICE IN COMMON POOL RESOURCE ENVIRONMENTS: AN EXPERIMENTAL APPROACH

by

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I. Introduction

The traditional way to view the Common Pool Resource (CPR) appropriation problem faced by individuals is with the framework laid out in The Economic Theory of a Common Property Resource: The Fishery (Gordon 1954). In this framework, appropriators face the pressures from an open access resource and a competitive output market. These pressures lead appropriators to allocate factors of production, employed in using the CPR, in a socially sub-optimal manner. The appropriators over-employ inputs to the CPR from a social planner's point of view. In cases where CPR communities aggressively protect their resource from outside entrants, a limited-access model of CPR exploitation is more appropriate. Even in these cases, a model based on non-cooperative Nash type behavior predicts over employment of inputs to the CPR (Clark 1980). Mason, Sandler and Cornes (1988) showed that Nash conjectures are not consistent conjectural variations conjectures in the limited access CPR environment. Under the consistent conjectural variations hypothesis, the incentive structure faced by appropriators leads to the same behavior predicted by Gordon (1954) in the open access CPR.

All three of these models, based on appropriators equating marginal private benefits to marginal private costs (private rationality), predict input employment patterns in a CPR environment different from models based on social welfare maximizing (socially rational) appropriators[1]. This study investigates observed appropriator input employment in an experimental CPR environment[2]. The focus is on whether an appropriator's input employment

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[1] *In this study, the marginal private benefits are those defined using Nash conjectures and using consistent conjectural variations conjectures.*

[2] *This study reexamines the symmetric Nash design experiments described in Walker, Gardner and Ostrom (1990).*

in the CPR is consistent with any of the predictive models that assume privately rational appropriators or with the predictive model that assumes socially rational appropriators.

The experimental literature, as seen in Walker, Gardner and Ostrom (1990), finds sub-optimal CPR aggregate input employment levels in their limited access CPR experiments. Walker, Gardner and Ostrom (1990) also found that aggregate input employment, in many experiments, approximated aggregate Nash equilibrium levels. Notably, the Nash equilibrium was not played in any of their experiments; that the Nash equilibrium was not achieved leaves open the question as to what the subjects were doing on an individual level.

This study used the individual level data from the Walker, Gardner and Ostrom (1990) experiments along with the data from a set of forecasting experiments to investigate individual level input employment choices. The input employment choices made by the appropriators in these experiments were compared to the outcomes predicted by the competing models of human behavior to determine which model best characterized the appropriator's decision process. In general, this study finds that the subjects had experimental behavior consistent with the models based on private rationality.

The next section of this paper describes the experimental environment. Section III develops the behavioral predictions, given the experimental environment. Sections IV and V analyze the experimental results and section VI presents concluding comments.

II. The Experimental Environment

All of the experiments were conducted on the NovaNET computer network at Indiana University. The subjects were volunteers recruited from introductory microeconomics classes. They were told they would participate in a computerized experimental economic decision environment and that their experimental earnings would depend upon their own decisions as well as the decisions of their cohorts.

The subjects were checked in and were assigned to NovaNET terminals through which they received instructions and participated in the decision environment. Before participating in the experiment, the subjects read a set of computerized instructions that explained the specifics of their decision environment. The subjects were not permitted to communicate with each another after they were checked in. At the end of the experiment, the subjects were paid their earnings in cash, in private. In a subset of the experiments the subjects made one-period-ahead forecasts of their cohorts' input employment levels. For these subjects, a page of supplementary instructions was handed out and read aloud by the experiment monitor to be sure all of the subjects understood the forecasting procedure. The subjects were told to direct any questions to the experiment monitor.

The experiment was a multi-period game in which the subjects allocated an endowment of tokens between two experimental "markets". (The CPR production function, the breakdown of experiments run and the length of these experiments are reported in Table 1.) These tokens were generic productive inputs for two different production processes (market-1 and market-2). The productive process in market-1 yielded one unit of output valued at five cents for each token invested. The output of the productive process in market-2 (the CPR) was contingent upon the aggregate level of tokens invested in market-2. An appropriator's share of the production from market-2 was strictly proportional to his investment of tokens (employment of inputs) in the production process. Each output from market-2 was valued at one cent. An individual's payoff was the sum of his return from market-1 and market-2.

The subjects were informed of the specific parameters of the market-2 production function and they had access to a table of values that summarized the production function. A subject's information set also included a listing of personal earnings for each period from each market and the group token investment level in market-2. Their personal token investment and earnings history was accessible throughout the experiment.

The decision problem faced by the subjects in the CPR experiments was the choice of input employment levels. The decision environment is summarized as follows.

1. There are 8 potential appropriators.
2. The appropriators are each endowed with Y^o tokens that they can use in market-2.
3. They each use $Y_i \in [0, Y^o]$ tokens in market-2, leaving $(Y^o - Y_i)$ tokens to employ in market-1.
4. Market-1 has a constant marginal return to tokens of 5 cents.
5. Tokens (Y_i) employed in market-2 yields an output to the appropriator of Q_i such that, $Q_i = f(Y_i, Y^T)g(Y^T)$ where,
    - A. Y^T is the aggregate input level in the CPR.
    - B. $g(Y^T) = 23Y^T - .25(Y^T)^2$ is the aggregate market-2 output[3].
    - C. $f(Y_i, Y^T) = Y_i/Y^T$ determines appropriator i's proportion of the aggregate output.
6. The appropriator is paid 1 cent, the competitive output price for each unit of output from market-2.
7. An appropriator's payoff is $\pi(Y_i, Y^T) = 5(Y^o - Y_i) + (Y_i/Y^T)[23Y^T - 0.25(Y^T)^2]$ in each period.

The Experiment Treatments. The experiments were classified by three basic treatments. The first was experience level[4]. Subjects participated in experiments with cohorts of similar experience in the decision environment. New recruits participated in experiments with other inexperienced cohorts. These subjects were offered the opportunity to participate in another experiment with others who had been in at least one experiment. There was no

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[3] *The quadratic production function was chosen for 2 basic reasons: The first is that it has the general bell shape yield associated with biological systems. Second it is analytically convenient.*

[4] *Subject experience was controlled for because previous CPR experiments found significant experience effects.*

experienced group that was made up entirely of participants from a single inexperienced experiment.

The second treatment was endowment level. There were two different endowment levels used in the experiments. The first was 10 tokens. Since the 10-token experiments yielded average revenue equalizing and Nash best-response paths that were often constrained by the endowment level, a set of 25-token experiments was run. Subjects participating in the 25-token experiments were told that they would be paid one half of their experiment earnings prior to participating in the experiment. This adjustment in payoff structure was to equalize subject earnings between 10-token and 25-token experiments at the Nash equilibrium[5]. Subjects either participated in 10-token or 25-token experiments but not both.

The final treatment was forecasting. In a subset of the experiments the subjects were asked to forecast cohort market-2 token investment levels. In the 10-token experiments the subjects were not explicitly paid for their forecasts. This was to ensure there was no incentive distortion caused by an additional payoff mechanism, thus allowing a direct comparison with the Walker, Gardner and Ostrom (1990) experiments. In the 25-token experiments, a period was randomly selected at the end of the experiment and the subject whose forecast was closest to their actual cohort token investment level in that period was awarded an additional $3.00. This payoff scheme was selected because lump sum payoffs do not distort the Nash nor the social welfare incentive structures.

III. Predicted Solutions

Given the experimental environment and the two major theoretic frameworks (social welfare maximization and private rationality), benchmark models can be derived. These benchmarks can then be compared to the outcomes observed in the experiments. Private

[5] *Actual Nash equilibrium earnings in the 10-token experiments were 57% of those in the 25-token experiments. One half was a close and computationally simple approximation.*

rationality yields two competing models. The first is the Nash equilibrium model. The second, because Nash conjectures are not consistent conjectures in a CPR environment (Mason, Sandler and Cornes, 1988), is the consistent conjectures model that induces average revenue equalization between market-1 and market-2.

The Nash Model. When individuals act as Nash type agents, they strive to maximize their individual payoff function ($\pi(Y_i, Y^T)$) subject to their beliefs of the aggregate token investment in market-2 ($Y^T = \mathcal{Y}^T$). Thus, their token investment strategy in market-2 must satisfy the necessary first order condition:

$$\frac{d\pi(Y_i, Y^T)}{dY_i} = 18 - 0.5Y_i - 0.25\mathcal{Y}^T_{-i} = 0, \tag{3.1}$$

where $\mathcal{Y}^T_{-i} = \mathcal{Y}^T - Y_i$, and $\mathcal{Y}^T$ is <u>anticipated</u> market-2 aggregate token investment. Solving for Y_i yields agent i's best response function

$$Y_i^{BR} = \begin{cases} 0, \text{ if } Y_i < 0 \\ Y_i, \text{ if } Y_i \in [0, Y^o] \subset \mathcal{J}, \text{ where } Y_i = 36 - 0.5\mathcal{Y}^T_{-i}. \\ Y^o, \text{ if } Y_i > Y^o \end{cases} \tag{3.2}$$

Thus, Y_i maximizes appropriator i's profits when his belief of the aggregate market-2 token investment is consistent with the actual market-2 token investment.

Average Revenue Equalization. Under the consistent conjectural variations model the individual appropriators act as predicted by Gordon (1954). They employ inputs to equalize the average revenues between the two markets. Thus, they employ inputs such that

$$\frac{23\mathcal{Y}^T - 0.25(\mathcal{Y}^T)^2}{\mathcal{Y}^T} = 5 \text{ or } Y_i = 72 - \mathcal{Y}^T_{-i}. \tag{3.3}$$

Yielding the best-response function

$$Y_i^{BR} = \begin{cases} 0, \text{ if } Y_i < 0 \\ Y_i, \text{ if } Y_i \in [0, Y^o] \subset \mathcal{J}, \text{ where } Y_i = 72 - \mathcal{Y}^T_{-i}. \\ Y^o, \text{ if } Y_i > Y^o \end{cases} \tag{3.4}$$

Social Optimization. Under the paradigm of social welfare maximizing individuals all individuals act to maximize joint welfare ($\Sigma_{j=1}^{8}\pi(Y_j, Y^T)$); yielding the first order condition of

$$\frac{d\pi()}{dY_i} = 18 - 0.5\mathcal{Y}_{-i}^{T} - 0.5Y_i = 0. \tag{3.5}$$

Solving for the best-response function yields

$$Y_i^{BR} = \begin{cases} 0, \text{ if } Y_i < 0 \\ Y_i, \text{ if } Y_i \in [0, Y^o] \subset \mathcal{J}, \text{ where } Y_i = 36 - \mathcal{Y}_{-i}^{T}. \\ Y^o, \text{ if } Y_i > Y^o \end{cases} \tag{3.6}$$

The structure of the experimental environment yields specific individual market-2 token-investment predictions. Objective optimizing individuals must invest tokens into market-2 as predicted by their associated best-response function. Thus, subjects will invest tokens as predicted by their respective best-response functions. The validity of this assertion can be examined by comparing the predicted market-2 investments to the outcomes achieved by the subjects through their decision processes in the experiments.

IV. Results: Subject Type Classification

A broad summary of the results comparing predicted outcomes from the three benchmark models of appropriator behavior to actual subject market-2 investments reveal that, 141 (65.3%) of the 216 observed market-2 token investment paths were consistent with a path predicted by one of the three best response criteria. In all, 139 (64.4%) of the token investment paths were consistent with the underlying paradigm of private rationality and 2 (0.9%) of the token investment paths were consistent with the underlying paradigm of social welfare maximization.

Best Response Classifications. An appropriator's best-response function, in each of the three behavioral models, is a function of the appropriator's anticipated cohort market-2 token investment level. Thus, an appropriator must forecast his cohorts' market-2 token investment level to determine his best response. In the first level of analysis, the best-response paths were calculated using the assumption that the subjects could perfectly forecast cohort market-2 token investment levels. In the forecasting experiments, a second analysis was also used. Best-response paths were calculated using the subject's actual forecasts of cohort market-2 token investment levels. In the previously reported summary results, if the perfect forecast and actual-forecast classifications were in conflict for a particular subject, deference was given to the actual-forecast classifications.

To compare how closely appropriators came to investing tokens along their respective best-response paths, the sequences of best responses were calculated using the best-response functions described in equations (3.2), (3.4), and (3.6). These sequences were paired, period by period, with the observed token investment path of each of the appropriators. The Wilcoxon matched pairs test was used to determine whether the subjects' token investment paths were significantly different from any or all three of the best response paths at a significance level of $\alpha = 0.05$[6]. In cases where the best response paths were constrained at a corner for each of the periods, the Wilcoxon test would, by construct, always reject the hypothesis that two samples are drawn from the same underlying distribution. In these situations, the one tailed t-test is used because it is more robust about truncated data. In 21 cases the Wilcoxon test failed to reject two or more of the best response paths. In these cases the absolute proximity of the central tendency of the appropriator's actual token investment to the central tendency of the appropriator's predicted best response, and the number of agreements between the token-investment path and the best-response path were used to refine the rejection process[7].

Using this procedure, all of the subjects were sorted into one of four categories.

1) **Average Revenue Equalizing** type appropriators: subjects whose token investment patterns were not significantly different from the average revenue equalizing best response predictions.

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[6]*The Wilcoxon test assumes independence between observations. The experiments were designed such that experimental parameters were independent across periods. Input employment decisions are dependent on both the experimental parameters and subject forecasts. To the extent forecasts are dependent across periods, the assumption of independence is violated. The assumption of perfect one-period ahead forecasting assumes away time dynamic forecasts. Thus, independence is assumed.*

[7]*Thus, if, for example, the Wilcoxon test failed to reject that a particular investment path was significantly different from both the Nash and the average revenue equalization best response paths, then the theoretic path with the fewest absolute ties with the investment path and whose mean was farthest from the investment path's mean was rejected.*

2) **Nash** type appropriators: subjects whose token investment pattern was not significantly different from the Nash best response predictions.

3) **Social Welfare Maximizing** type appropriators: subjects whose token investment patterns were not significantly different from the social welfare maximizing best response predictions.

4) **Non-Assigned** appropriators: subjects whose token investment patterns were significantly different from the three previous.

Perfect Foresight. Perfect-foresight forecasts were assumed in order to generate best-response paths in all of the 27 experiments. The results of this classification procedure are reported in Table 2. Over all, 128 (59%) of the 216 subjects were classified as following one of the three perfect-foresight best-response paths. Of these 69 (32%) were classified as average revenue equalizers, 57 (26%) were classified as Nash type appropriators and 2 (1%) were classified as social welfare maximizers. The Nash model was the best predictor for the 88 subjects whose investment paths were significantly different from one of the benchmark models. That is, the average deviation between actual investments and benchmark best-response predictions was smallest for the Nash model. The observed tendency toward Nash type behavior in non-classified subjects coupled with only 1% of the subjects classified as social welfare maximizers, indicates private rationality dominates subject behavior.

In addition to support for privately rational behavior, Table 2 highlights an apparent token endowment effect. This is evidenced by the difference in subject type classifications between 10-token experiments and 25-token experiments. The 25-token experiments have higher proportions of subjects classified as following one of their best-response paths (Section V investigates this phenomena further). Of the subjects participating in the 10-token experiments, summarized in the first major column, 16 (12%) were average revenue equalizers and 33 (24%) were Nash type appropriators. Figure 1 plots the average per-period-deviation from the predicted best response for the subjects classified as Nash type appropriators and for the subjects classified as average revenue equalizers in the 10-token experiments. The reference line at '0' labeled BRP is the zero deviation path. Both the Nash type appropriators and the average revenue equalizers have average token-investment paths that closely track their associated best-response paths.

In the 25-token experiments, as reported in the second major column of Table 2, 63 (66%) of the subjects were classified as average revenue equalizers, 24 (30%) classified as Nash type agents and 2 (3%) classified as social welfare maximizing agents. Figure 2 traces the average deviations from best response path of the subjects classified as Nash type appropriators and as average revenue equalizers in the 25-token experiments. Here the BRP reference line is a credible description of central tendency. The apparent downward trend in both traces, particularly for the average-revenue-equalizers' path, is not consistent with the predictions of either model of behavior.

Forecasting Experiments. In a subset of the experiments, the subjects forecasted one-period-ahead cohort market-2 token investment levels. The subjects' best-response paths, generated using these forecasts, make it possible to compare the subjects' actual token-investment path to the predicted paths. Using the same classification technique as previously described, the subjects can be sorted as to their underlying type. The results of this process are reported in Table 3.

Overall, 66 (52%) of the 128 subjects invested tokens into market-2 consistent with one of the models of appropriator behavior. Of these, 36 (28%) were classified as average revenue equalizers, 28 (22%) as Nash appropriators and 2 (2%) as social welfare maximizers. Again, private rationality dominates social welfare maximization as descriptive of subject behavior. In the 10-token experiments, summarized in the major first column of Table 3, 8 (11%) were classified as average revenue equalizers and 21 (29%) as Nash type appropriators. In the 25-token experiments, as reported in the second major column of Table 3, 28 (50%) were classified as average revenue equalizers, 7 (11%) as Nash type agents and 2 (4%) as social welfare maximizers.

The perceived differences between the subject classification results in 25-token and 10-token experiments led to questions on the effects the different experimental treatments had on subject behavior.

V. Results: Treatment Effects on Subject Classification

These experiments had three distinct treatments: subject endowment, subject experience, and forecasting. Subject endowment level and subject experience level were treatments examined by Walker, Ostrom and Gardner at the aggregate level. They found that 25-token experiments tended to have higher market-2 token investment levels than 10-token experiments. They also found that experiments with experienced subjects tended to have higher market-2 token investment levels than experiments with inexperienced subjects.

The models assuming objective maximizing agents are mute on the effects of explicit forecasting or the effects of experience. Further, endowment levels should impact token investment levels only when the endowment constraint is binding. If the 10-token endowment proved binding, then the 25-token experiments should exhibit higher aggregate token investment levels. Subject types should not be impacted, since the best-response paths incorporate the subject's endowment constraint.

To test for significant treatment effects, the subject type results generated from the perfect-foresight best-response classification and reported in Table 2 were used. This data set was used because it was available for all the experiments. Proportions of subject type were pooled by experiment treatment type. Then the Z-test for the significance of difference between sample proportions was used on the target treatment, holding the other treatments constant.

Endowment Treatment. Table 4 reports the results of the test procedure on the endowment treatment. Each cell in the table reports the Z-value of the test with the associated p-value in parentheses. As reported in the first row of Table 4, the 10-token experiments have a significantly ($\alpha = 0.05$) lower proportion of average revenue equalizers than the 25-token experiments, across all treatment conditions. This is balanced, in the bottom row, by a significantly higher proportion of subjects following none of the best response paths. In fact, the 10-token experiments never report a higher proportion of subjects following a best-response path for any of the behavior types. The significant increase in average revenue equalizers in 25-token experiments over 10-token experiments is consistent with the observation of higher rent dissipation in 25-token experiments reported in Walker, Gardner and Ostrom (1990), but is inconsistent with the hypothesis that token endowment should not impact appropriator behavior.

It is possible that the subjects were "morally adverse" to investing all the way up to their endowment constraint. Since the constraint was frequently binding along the average revenue equalizing bench-mark path in the 10-token experiments, this "moral aversion" leads to actual investment paths significantly different from the benchmark. Thus, increasing the subjects endowment relieves the "moral" constraint.

Forecasting and Experience Treatment. Table 5 reports the results of the statistical tests examining the impact of forecasting on subject behavior. Table 6 reports the results of statistical tests examining the impact prior experience on subject behavior. These tests show that neither forecasting nor experience has significant impact on subject behavior. Thus, the only treatment with consistent and significant effects across experiment types is the endowment treatment.

VI. Concluding Comments

This study focused on the appropriation behavior of 216 subjects participating in 27 CPR experiments. It classified the subjects as following one of three behavioral models. Overall, 65.3% of the appropriators followed a token investment path attributable to one of the models of subject behavior. With 64.4% of the appropriators following token investment paths attributable to privately rational behavior and 0.9% following token investment paths attributable to social welfare maximizing behavior, privately rational behavior is the dominant behavior mode.

The observed heterogeneity of appropriator type helps to explain why neither the Nash equilibrium, the symmetric average revenue equalizing solution, nor the symmetric social welfare maximizing solution are ever achieved in the experimental CPR literature. The high proportion of privately rational agents explains why the experimental CPR literature reports appropriation levels well above the social optimum.

It is curious that token endowments have significant effects on subject-behavior classifications. Since payoffs were approximately normalized at the Nash equilibrium across the two endowment treatments, a pure income effect was controlled for. The result implies CPR appropriators are "more" privately rational the higher their resource endowment. An explanation is that subjects feeling some "moral" constraint against investing at their endowment limit, reserve their last token even when their best-response path indicates it should be employed in the CPR. This implies the marginal payoff associated with investing at 10 tokens is dominated by some disutility associated with investing at 10 tokens. Given a smooth Nash best-response path and investment levels near Nash equilibrium aggregate investment levels, the subject's marginal payoff from investing one more token is necessarily small. It would not take much "moral" marginal disutility to dominate the payoff structure at that point.

In the 25-token experiments where the "moral" constraint was lifted, 96% of the subjects followed investment paths not significantly different from one of their privately rational best-response paths. This is a clear indication of the descriptive strength of the paradigm of private rationality for subject behavior.

Table 1	Experiment Treatments and Parameters							
	Experiment Type							
	10-Token Experiments				25-Token Experiments			
Market-2 Payoff Function	$g(y) = 23Y^T - .25(Y^T)^2$				$g(y) = 23Y^T - .25(Y^T)^2$			
Number of experiments	17				10			
Number of Subjects	136				80			
	No Forecasts		Forecasts		No Forecasts		Forecasts	
Number of Experiments	8		9		3		7	
Number of Subjects	64		72		24		56	
	Experienced	In-Experienced	Experienced	In-Experienced	Experienced	In-Experienced	Experienced	In-Experienced
Number of Experiments	3	5	3	6	3	0	3	4
Periods per Experiment	30	20	30	20	20	0	20	20
Number of Subjects	24	40	24	48	24	0	24	32

Table 2	Number of Individuals Investing in a Way Not Significantly Different from One of their Best Response Functions Under the Perfect Foresight Assumption.							
	Experiment Type							
	10-Token Experiments				25-Token Experiments			
Average Revenue Equalizing Behavior	16 (11.7%)				53 (66.3%)			
Nash Behavior	33 (24.3%)				24 (30.0%)			
Social Welfare Maximizing Behavior	0 (0.0%)				2 (2.5%)			
None	87 (64.0%)				1 (1.2%)			
	No Forecasts		Forecasts		No Forecasts		Forecasts	
Average Revenue Equalizing Behavior	10 (15.6%)		6 (8.3%)		15 (62.5%)		38 (67.9%)	
Nash Behavior	19 (29.7%)		14 (19.4%)		8 (33.3%)		16 (28.6%)	
Social Welfare Maximizing Behavior	0 (0.0%)		0 (0.0%)		0 (0.0%)		2 (3.6%)	
None	35 (54.7%)		52 (72.2%)		1 (4.2%)		0 (0.0%)	
	Experienced	In-Experienced	Experienced	In-Experienced	Experienced	In-Experienced	Experienced	In-Experienced
Average Revenue Equalizing Behavior	6 (25.0%)	4 (10.0%)	2 (8.3%)	4 (8.3%)	15 (62.5%)	-	16 (66.7%)	22 (68.8%)
Nash Behavior	8 (33.3%)	11 (27.5%)	6 (25.0%)	8 (16.7%	8 (33.3)	-	7 (29.2%)	9 (28.1%)
Social Welfare Maximizing Behavior	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	-	1 (4.2%)	1 (3.1%)
None	10 (41.7%)	25 (62.5%)	16 (66.7%)	36 (75.0%)	1 (4.2%)	-	0 (0.0%)	0 (0.0%)

Table 3	Number of Individuals Investing in a Way Not Significantly Different from One of their Best Response Functions Using Actual Forecast Data.			
	Experiment Type			
	10-Token Experiments		25-Token Experiments	
Average Revenue Equalizing Behavior	8 (11.1%)		28 (50.0%)	
Nash Behavior	21 (29.2%)		7 (12.5%)	
Social Welfare Maximizing Behavior	0 (0.0%)		2 (3.6%)	
None	43 (59.7%)		19 (33.9%)	
	Inexperienced	Experienced	Inexperienced	Experienced
Average Revenue Equalizing Behavior	4 (8.3%)	4 (16.7%)	17 (53.1%)	11 (45.8%)
Nash Behavior	17 (35.4%)	4 (16.7%)	6 (18.8%)	1 (4.2%)
Social Welfare Maximizing Behavior	0 (0.0%)	0 (0.0%)	1 (3.1%)	1 (4.2%)
None	25 (56.3%)	16 (66.7%)	8 (25.0%)	11 (45.8%)

Table 4	Impact of Endowment on Subject Best Response Behavior. Z-test for Significance of Difference Between Two Independent Sample Proportions Comparing 10-token to 25-Token Experiments Under the Perfect Forecast Assumption. - Holding Other Experimental Treatments Constant -		
	Experiment Type		
Behavior Type	Experienced Forecasting	Inexperienced Forecasting	Experienced No Forecasting
Average Revenue Equalizing Behavior	-4.44 (0.00)	-5.71 (0.00)	-2.65 (0.01)
Nash Behavior	-0.31 (0.76)	-1.18 (0.24)	0.00 (1.00)
Social Welfare Maximizing Behavior	-0.97 (0.33)	-1.18 (0.24)	N/A
None	4.92 (0.00)	6.61 (0.00)	3.13 (0.00)

N/A denotes sample proportions equal at zero, so the Z-test is not defined.

Table 5	Impact of Forecasting on Subject Best Response Behavior. Z-test for Significance of Difference Between Two Independent Sample Proportions Comparing Forecasting to Non-Forecasting Experiments Under the Perfect Forecast Assumption. - Holding Other Experimental Treatments Constant -		
	Experiment Type		
Behavior Type	Experienced 10-Token	Experienced 25-Token	Inexperienced 10-Token
Average Revenue Equalizing Behavior	-1.48 (0.11)	0.29 (0.85)	-0.33 (0.74)
Nash Behavior	-0.61 (0.54)	-0.30 (0.76)	-1.25 (0.21)
Social Welfare Maximizing Behavior	N/A	0.97 (0.33)	N/A
None	1.74 (0.08)	N/A	1.22 (0.22)

Table 6	Impact of Experience on Subject Best Response Behavior. Z-test for Significance of Difference Between Two Independent Sample Proportions Comparing Esperienced to Inexperienced Experiments Under the Perfect Forecast Assumption. - Holding Other Experimental Treatments Constant -		
	Experiment Type		
Behavior Type	Forecasting 10-Token	Forecasting 25-Token	Non-Forecasting 10-Token
Average Revenue Equalizing Behavior	0.00 (1.00)	-0.16 (0.87)	1.60 (0.11)
Nash Behavior	0.81 (0.42)	0.08 (0.94)	0.42 (0.67)
Social Welfare Maximizing Behavior	N/A	0.20 (0.84)	N/A
None	-0.71 (0.48)	N/A	-1.63 (0.10)

N/A denotes sample proportions equal at zero, so the Z-test is not defined.

Figure 1

10-token Average Deviation from Best Response Path -Under Perfect Foresight

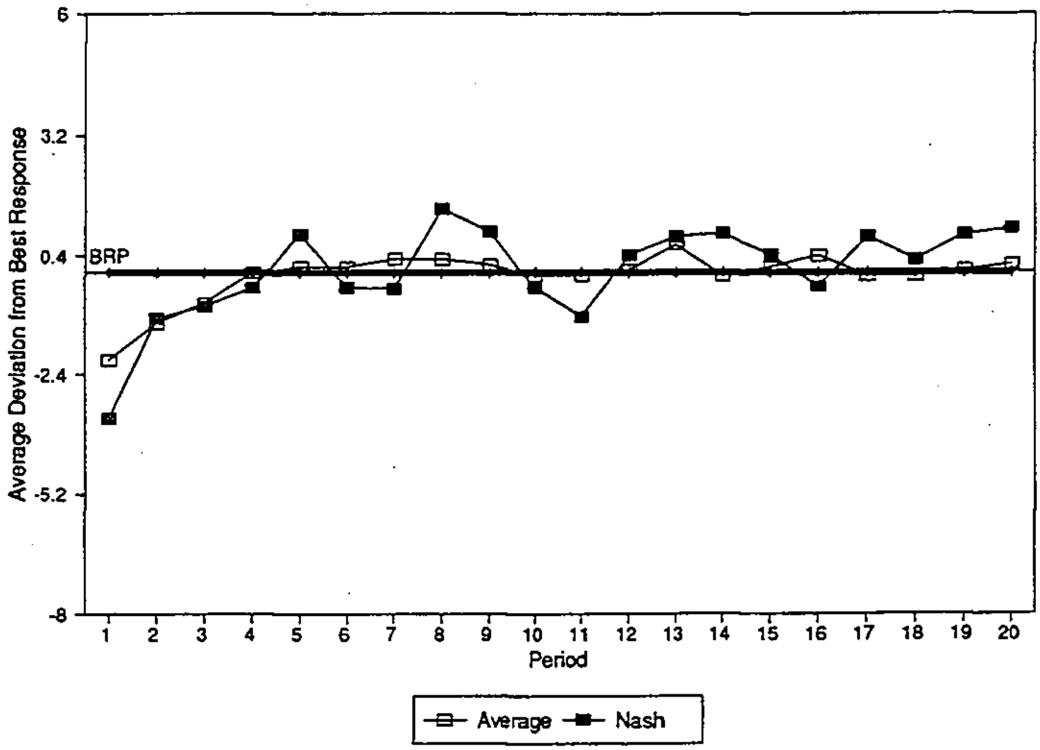
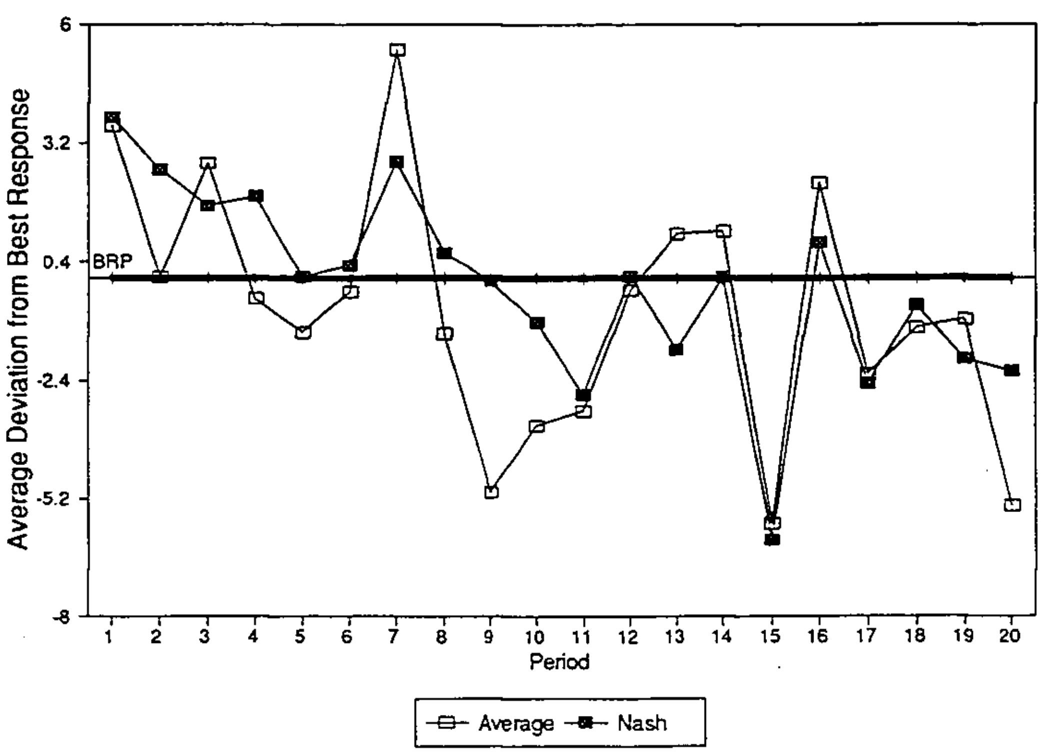


Figure 2

25-token Average Deviation from Best Response Path -Under Perfect Foresight



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