Payoff Calculator Data: An Inexpensive Window into Decision Making

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April 2016

Barcelona GSE Working Paper Series

Working Paper nº 903

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April 26, 2016

Abstract: Payoff calculators provide a source of information about subjects' decision making process that is cheap, frequently available, and rarely used. We study data from an experiment designed to look at a difficult coordination problem. The experiments were *not* designed to study payoff calculator use; the payoff calculator was included as a tool for helping subjects to understand the payoffs. Our goal is to show that data about payoff calculator usage can yield useful insights about subjects' decision making. The main issue in the game is whether players will successful coordinate, and, if so, whether they coordinate at an efficient equilibrium or a safe one. We find that initial searches using the calculator have predictive power for the total surplus and probability of coordinating for a pair in the long run. Specifically, searches consistent with the efficient equilibrium reduce total surplus and the probability of coordinating. These conclusions remain true after controlling for a pair's initial outcomes, indicating that the data about calculator searches has predictive power beyond the pairs' initial outcomes.

Keywords: Coordination, Experiments, Organizations, Asymmetric Information

JEL Classification Codes: C92, D23, J31, L23, M52

Acknowledgements: The authors thank the NSF (SES-0214310), the Spanish Ministry of Economics and Competitiveness (Grant: ECO2014-59302-P) and the *Generalitat de Catalunya* (Grant: 2014 SGR 510) for funding this research. We thank Joe Stinn for his work as a research assistant.

1. Introduction: As behavioral economists, experimental economists are interested not just in what decisions subjects make but also the processes underlying these decisions. This has led to a large number of studies looking at the process of decision making using various tools such as fMRI, eye-tracking, content analysis for experiments with communication, mouselab, the effects of hormones, reaction times, and facereading. These tools can be difficult and expensive to implement, and typically require experimenters to design their experiment around the gathering of process information.

The purpose of this note is to evaluate the usefulness of a type of process information that is commonly gathered but little noted: subjects' searches using a payoff calculator. Implementing a payoff calculator is cheap and easy. Many experiments already include payoff calculators and it is trivial to record subjects' searches using the payoff calculator. There is little reason to believe inclusion of a payoff calculator has large effects on subjects' choices given its non-intrusive nature (although presumably it reduces noise due to confusion).[1] These features make payoff calculators a good source of cheap process analysis as a supplement to experiments designed for other purposes.

The preceding assumes that something useful can be learned from looking at payoff calculator searches. As proof of concept, we look at data from a series of coordination game experiments. These experiments were run as part of the experimental design of Brandts and Cooper (2016; henceforth "BC16"), a study comparing centralized and decentralized management structures. The games being played are complicated coordination games with multiple asymmetric equilibria. The payoff calculator was included as a tool to help subject understand the relatively complex environment. We did not design the experiments with the use of payoff calculator search data in mind. This matches how we think most experimenters will use payoff calculator data, as a useful supplement gathered in the process of studying other issues.

Our main results focus on the initial calculator searches made before any play takes place. These searches provide a window into subjects' initial thoughts about the games before they have any feedback about outcomes. It is difficult to achieve coordination in these games, and often pairs coordinate at a safe equilibrium rather than the efficient equilibrium. Most searches are consistent with subjects considering one of these approaches, often in isolation. Initial searches consistent with the efficient equilibrium significantly reduce the total surplus earned by pairs in the long run. This stems from a significantly lower probability of successful coordination. Intuitively, it is harder to coordinate at the efficient equilibrium than the safe equilibrium. When pairs initially aim at this outcome, they tend to fail leading to lower payoffs. Searches consistent with a subject's own best equilibrium (which is distinct from the safe and efficient equilibria) increase the probability of successful coordination, but do not increase total surplus due to moving play away from the efficient equilibrium towards the safe equilibrium.

These conclusions are unaffected by controls for the pairs' initial outcomes, indicating the initial calculator searches capture something about a pairs' initial thought processes that is not reflected in the initial outcome. We do not interpret our results as the calculator searches "causing" some long run outcomes to be more likely. Rather, we think the searches illuminate what subjects are initially thinking about how to play the game. These initial thoughts play an important role in long run outcomes.

[1] Requate and Waichman (2011) study whether adding a payoff calculator affects subjects' choices in a Cournot oligopoly experiment. They find that it does not unless a best-response option is added.

The broader point is that gathering the calculator data cost us nothing – it was pure chance that the programmer on this particular project wrote the software in a way that saved all of the data from the payoff calculator – but provides useful insights beyond the data about outcomes. Process is a subject of great interest to experimenters. Why not take more advantage of a cheap source of useful data?

2. Experimental Design and Procedures: The data in this paper is drawn from BC16. To save space, we only include a synopsis of the main features of the design – see BC16 for details.

The Game: The decentralization game was originally designed to study tradeoffs between centralized and decentralized management of a firm's divisions. This version, from our Decentralization treatments, is played by two players (Divisions 1 and 2), and starts with nature randomly choosing a state of the world $G \in \{1,2,3,4,5\}$. Draws are iid with each state equally likely. *Both players know the drawn value of G.* As standard nomenclature, we refer to states of the world by the game induced (e.g. Game 1 for G = 1). (In the original application this is interpreted as a taste shock that *temporarily* shifts tastes for *both* divisions' customers.) The divisions observe G and simultaneously choose a product type from the space $T_i \in \{1,2,3,4,5\}$. Payoff functions for the two divisions are given below with $k_4 > k_2 > k_3$.

$$\pi_{D1} = k_1 - k_2|T_1 - 5| - k_3|T_1 - G| - k_4|T_1 - T_2| \quad \textbf{(Eq. 1a)}$$

$$\pi_{D2} = k_1 - k_2|T_2 - 1| - k_3|T_2 - G| - k_4|T_1 - T_2| \quad \textbf{(Eq. 1b)}$$

To understand what the subjects face, consider the three game tables shown in Table 1. These represent the divisions' payoff tables for Games 1, 3, and 5 subject to $k_1 = 54$, $k_2 = 7$, $k_3 = 4$, and $k_4 = 14$. Division 1 corresponds to the row player, Division 2 to the column player.

The five games induced by the five possible states of the world are all coordination games with five pure strategy Nash equilibria: (R1,C1), (R2, C2), … (R5,C5). We refer to these as Equilibrium 1, Equilibrium 2, etc. In each of the five games there is a tension similar to BOS, since Division 1 prefers Equilibrium 5 with Equilibrium 1 being his least preferred equilibrium, while for Division 2 it is the other way around.

Surplus (i.e. the sum of players' payoffs) is maximized by choosing the equilibrium that is equivalent to the state of the world (i.e. Equilibrium 1 if G = 1, Equilibrium 2 if G = 2, etc.). We refer to this as the "efficient" equilibrium. The efficient equilibrium is procedurally fair (equalizes expected payoffs under the veil of ignorance about the state of the world), but yields asymmetric payoffs in each state of the world except G = 3.

There are many pure strategy equilibria that lead to lower payoffs than the efficient equilibrium. Notably, always playing Equilibrium 3 provides a relatively easy way to coordinate and achieve equal payoffs since Equilibrium 3 yields the same payoff to both players regardless of the state of the world. Moreover this is safe in the sense that 3 is the maximin strategy for all values of G. We therefore refer to the equilibrium where 3 is played for all value of G as the "safe" equilibrium. Except for G = 3, the safe equilibrium does not maximize total surplus. Achieving maximum surplus relies critically on the ability of players to not just coordinate on an equilibrium, but to coordinate on the efficient equilibrium. This is the important difference between the decentralization game and BOS games: there is an obvious equilibrium that is fair. The decentralization game is designed to confront subjects with a very difficult coordination problem. Not only is it hard to reach any coordination equilibrium, it is particularly difficult to coordinate on the non-obvious efficient equilibrium even though it is procedurally fair and leads to higher payoffs.

Table 1: Stage Game Payoffs

Note: Each cell contains the payoffs for D1 (π_{D1}) and D2 (π_{D2}).

Game 1

	C1	C2	C3	C4	C5
R1	26, 54	12, 29	-2, 4	-16, -21	-30,-46
R2	15, 40	29, 43	15, 18	1, -7	-13, -32
R3	4, 26	18, 29	32, 32	18, 7	4, -18
R4	-7, 12	7, 15	21, 18	35, 21	21, -4
R5	-18, -2	-4, 1	10, 4	24, 7	38, 10

Game 3

	C1	C2	C3	C4	C5
R1	18, 46	4, 29	-10,12	-24, -13	-38, -38
R2	15, 32	29, 43	15, 26	1, 1	-13, -24
R3	12, 18	26, 29	40, 40	26, 15	12, -10
R4	1,4	15, 15	29,26	43,29	29, 4
R5	-10,-10	4,1	18,12	32, 15	46, 18

Game 5

	C1	C2	C3	C4	C5
R1	10, 38	-4, 21	-18, 4	-32,-13	-46,-30
R2	7, 24	21, 35	7, 18	-7, 1	-21,-16
R3	4, 10	18, 21	32, 32	18, 15	4, -2
R4	1,-4	15, 7	29, 18	43, 29	29, 12
R5	-2,-18	12,-7	26,4	40, 15	54, 26

Design and Procedures: This study uses data from two of the treatments in BC16.[2] For both treatments we set $k_1 = 54$, $k_2 = 7$, and $k_4 = 14$. The only difference between the two treatments is the value of k_3. This parameter measures "state losses," losses due to choosing a product type different from the current state of the world (i.e. the current game). We set $k_3 = 4$ in the Low State Losses treatment and $k_3 = 6$ for the High State Losses treatment.

Subjects are assigned a role (D1 or D2) at the beginning of the session. These roles remain constant throughout the session. Subjects are matched into pairs consisting of a D1 and D2 at the beginning of the session, and pairings are fixed throughout the session. Each pair plays the decentralization game, as described above, for 18 rounds.

[2] The full design of BC16 includes eight different treatments. Our goal is to have a short simple paper, so we did not use the five treatments that have communication and/or an active third player because of the high degree of complexity involved. The final treatment uses a strangers matching rather than a partners matching. Our primary focus is on what (if any) equilibrium emerges for a fixed pair, so the strangers matching treatment doesn't fit. It is worth noting that the subjects in the CM role (when active participants rather than passive) use the payoff calculator more than twice as frequently as subjects in the division role. If calculator use is a symptom of deliberative thinking, the CMs deliberate about the game a far more than the divisions do.

Both treatments include subjects in a third "central manager" (CM) role. These subjects receive the sum of the payoffs from the two divisions. They make no decisions and are included to maintain parallelism with other treatments where CMs play an active role. The CMs will be ignored from this point forward (and are not included in any data that we report including counts of the number of subjects).

There are three sessions for each treatment with 18 active participants in each session. This yields 54 subjects per treatment. Since subjects are in fixed pairs, there are 27 independent observations in each treatment.

The payoff calculator is always available when subjects make a decision. They can enter a state of the world and decisions for each of the divisions. The calculator returns a payoff for each of the players. They can use the calculator as many times as they want in each round. Subjects are given printed copies of payoff tables for all five games along with a detailed description of how the payoffs work. The payoff calculator is intended as a supplement to the payoff tables.

The sessions were run at the LINEEX lab at the University of Valencia, with participants being undergraduate students from the university. The payoffs are denominated in Experimental Currency Units, with 1 ECU = 0.2 €. Participants are paid for all rounds. Including a 5€ show-up fee average pay is about 20€ with sessions lasting around an hour.

3. Results: Table 2 summarizes outcomes from the two treatments. The data has been split into data from early rounds (Rounds 1 – 6) and late rounds (Round 7 – 18). The first three columns summarize individual choices. "Efficient" refers to play consistent with the efficient equilibrium (T_i = G), "Safe" refers to play of $T_i = 3$ consistent with the safe equilibrium, and "Own Best" refers to play consistent with the equilibrium that is best for the player (5 for D1, 1 for D2). These categories are not mutually exclusive so the percentages can add up to more than 100%. The right three columns summarize outcomes for pairs, giving the frequency that pairs coordinate on *any* equilibrium ("Coordinate), coordinate on the efficient equilibrium ("Efficient"), or coordinate on the safe equilibrium ("Safe").

Table 2a: Outcomes by Treatment, Rounds 1 - 6

	Individual Choice			Group Outcome		
	Efficient	Safe	Own Best	Coordinate	Efficient	Safe
Low State Losses	36.7%	48.5%	14.8%	36.4%	18.5%	25.9%
High State Losses	47.8%	49.1%	16.0%	38.3%	22.8%	27.8%

Table 2b: Outcomes by Treatment, Rounds 7 - 18

	Individual Choice			Group Outcome		
	Efficient	Safe	Own Best	Coordinate	Efficient	Safe
Low State Losses	35.2%	63.3%	8.8%	68.5%	25.3%	52.2%
High State Losses	64.2%	43.5%	16.5%	58.0%	46.6%	27.2%

Achieving coordination is difficult. Coordination only emerges gradually and even in the later rounds coordination rates never approach 100%. When coordination emerges it is generally at the safe equilibrium with low state losses and at the efficient equilibrium with high state losses. The intuition behind this difference is straight forward. It is more costly to make a choice that diverges from the state of the world with high state losses, so the expected payoff gain from playing the efficient equilibrium is larger (12 ECUs with high state losses vs. 8 ECUs with low state losses). This naturally leads to more play of the efficient equilibrium.

Use of the payoff calculator is common but not universal. 69% of subjects use the calculator at least once and subjects average 10.0 searches across the eighteen rounds (14.6 searches subject to ever using the calculator). Table 3 breaks down use of the payoff calculator by treatment and time period – Rounds 1 – 6 versus Rounds 7 – 18. Each cell reports the average number of searches per round and, in parentheses, the probability of making at least one search in a round.

Table 3: Searches per Round (Probability of Searching per Round)

	All Rounds	Rounds 1 - 6	Rounds 7 - 18
Low State Losses	0.49 (12.1%)	0.87 (23.5%)	0.30 (6.5%)
High State Losses	0.63 (15.9%)	1.25 (29.3%)	0.31 (9.3%)

As we would expect, the number of searches is higher in early rounds (Rounds 1 – 6) than later rounds, with the difference being statistically significant ($t = 4.55$; $p < .01$). There are more searches with high state losses in Rounds 1 – 6, but this difference is not statistically significant ($t = 0.78$; $p > .10$).

Table 4: Frequency by Search Type per Round, Rounds 1 - 6 (Probability per Round)

	Efficient	Safe	Own Best
Low State Losses	0.23 (12.3%)	0.26 (13.9%)	0.15 (8.0%)
High State Losses	0.41 (18.5%)	0.42 (17.6%)	0.21 (7.7%)

Table 4 breaks down the frequency per round of making different types of calculator searches in Rounds 1 – 6. The labels are analogous to those we used for describing subjects' choices, and are based solely on what was entered into the payoff calculator for the subject's *own* strategy. "Efficient" refers to searching the strategy consistent with the surplus maximizing equilibrium ($T_i = G$), "Safe" refers to searching $T_i = 3$ consistent with the safe equilibrium, and "Own Best" refers to searching the strategy consistent with the equilibrium that is best for the player (5 for D1, 1 for D2). These are the three most common types of searches. Each cell reports the average number of searches per round and, in parentheses, the probability of making at least one search of the specified type in a round.

To take a closer look at what types of searches are made in Rounds 1 - 6, we limit ourselves to data with Games 2 and 4. With this restriction the three categories defined above are distinct from each other as well as from searches for the equilibrium consistent with the other player's best equilibrium ("Other Best"). For periods where subjects use the calculator, they tend to look at two specific approaches to the game, play consistent with the efficient or safe equilibrium (85% of all periods where a search is conducted). Often times nothing else is searched. In periods where a search is made, 25% only look at

Efficient (T_i = G), 28% only look at Safe (T_i = 3), and 15% look at Efficient and Safe but nothing else. Calculator searches are not random, as subjects are looking at very specific approaches to the game.

Table 5: Choices by Search Type, Rounds 1 - 6

Search Type		Choice Type: Efficient	Choice Type: Safe	Choice Type: Own Best
	All Observations	42%	48%	15%
	Efficient	70%	45%	23%
	Safe	40%	73%	15%
	Own Best	49%	25%	55%

Table 5 summarizes the choices made by subjects as a function of what they search *in the current period*. The data set is limited to Rounds 1 – 6 when searches are frequent. The rows show whether subjects made at least one search of the indicated sort in the current period. For example, the row labeled "Safe" gives data from subjects who *at least once* in the current period made a search using the payoff calculator where they entered a strategy of T_i = 3 for themselves. The columns give their probability of making each type of choice. Note that the categories of choices are not mutually exclusive, so the probabilities can and do add up to more than 100%. As a point of comparison, the first row gives the probability of making each type of choice across all observations in Rounds 1 – 6, regardless of what if any calculator search was made in the current round. There is an obvious correlation between what people search in the current period and what they choose. Note that there is a high degree of endogeneity, as both searches and choices are heavily influenced by past outcomes.

We now turn to the central question of this note. Does data about subjects' calculator searches give us any useful information about the long term outcomes for a pair? Does information about the calculator searches predict the total surplus for a pair? Does this information predict what if any equilibrium a pair converges to? Does the data about calculator searchers add anything to our ability to predict anything beyond the early outcomes for the pair?

We focus on the calculator searches made prior to the first round of play. Initial searches provide a window into the thought processes of subjects prior to gaining any experience. These searches cannot be affected by past outcomes as they are made prior to any outcomes being realized. We limit our attention to the three most common types of searches as described above.

Table 6 looks at the relationship between early calculator searches and the pair's total surplus, defined as the sum of payoffs for the two divisions. For each type of search, the data is broken down into pairs who did not make that type of search in Round 1 and pairs who had at least one calculator search of that type in Round 1. The first column reports average surplus over Rounds 2 – 18, all rounds except the round in which the initial search was made. The second column looks at long run outcomes by reporting average surplus over Rounds 13 – 18, the final third of the experiment. To give a sense of scale, the standard deviation of a pair's average total surplus across Rounds 2 - 18 is 9.8 and the standard deviation of average total surplus across Rounds 13 - 18 is 12.6. Searches consistent with the efficient equilibrium decrease total surplus while the other two types of searches raise total surplus (only in the long run for searches consistent with the Safe equilibrium).

Table 6: Period 1 Searches and Total Surplus

Type of Period 1 Search		Average Total Surplus Periods 2 - 18	Average Total Surplus Periods 13 - 18
Searches, Efficient	No	57.9	61.9
	Yes	55.3	60.6
Searches, Safe	No	57.1	60.5
	Yes	56.6	62.8
Searches, Own Best	No	56.4	61.1
	Yes	58.4	62.3

It is risky to read too much into the results shown in Table 6 since this does not account for the number of searches being made in Round 1, the possibility that pairs make more than one type of search in Round 1, or the fact the pairs aren't all playing the same game in Round 1. The OLS regressions reported in Table 7 account for all of these issues. There are 54 observations in each regression, one per pair. The dependent variable in Models 1 and 2 (Models 3 and 4) is the pair's average total surplus across Rounds 2 – 18 (Rounds 13 – 18). All regressions include controls for the game played in Round 1. These are not reported to save space, but full regression output is available from the authors upon request. All regressions include a dummy for the High State Loss treatment. Robust standard errors are reported in parentheses.

Table 7: Effects of Early Calculator Searches on Total Surplus

Dependent Variable	Average Total Surplus Rounds 2 - 18		Average Total Surplus Rounds 13 - 18	
	Model 1	Model 2	Model 3	Model 4
Searches, Efficient	-1.383** (0.633)	-1.266* (0.723)	-2.575*** (0.795)	-2.476*** (0.791)
Searches, Safe	0.777 (0.608)	0.596 (0.733)	1.635* (0.909)	1.479 (0.889)
Searches, Own Best	1.072 (0.927)	1.229 (0.906)	1.384 (0.946)	1.612* (0.920)
High State Losses	-3.257 (2.935)	-3.454 (2.939)	-1.470 (3.698)	-1.643 (3.744)
Coordinate Safe Equilibrium		5.255 (4.089)		5.290 (4.524)
Coordinate Efficient Equilibrium		0.395 (4.255)		1.966 (5.923)

Note: All regressions include 54 observations. Robust standard errors are reported in parentheses. Three (***), two (**), and one (*) stars indicate statistical significance at the 1%, 5%, and 10% levels respectively.

The variables of interest in Model 1 are the number of each type of calculator search made by the pair *prior to Round 1*. Initial searches consistent with the efficient equilibrium have a significant and negative effect on total surplus. Model 2 adds in controls for the pair's outcome in Round 1 – specifically, did the pair coordinate at either the safe equilibrium or the efficient equilibrium. While the magnitude of the former is large, neither estimate is statistically significant. The impact on the estimated effect of "Efficient" searches is minimal. Data about the calculator searches in Round 1 provides predictive power about total surpluses beyond what we learn by knowing the Round 1 outcomes.

We might expect the effect of initial calculator searches to weaken in later rounds. In fact, judging by the results of Models 3 and 4, the opposite is true. The effect of "Efficient" searches remains negative, but the magnitude of the effect is increased (comparing Rounds 13 – 18 to Rounds 2 – 18) as well as the statistical significance. The signs of the estimates for "Safe" and "Own Best" searches remain positive, but the magnitudes increase and both variables reach weak significance in one of the regressions. As with Model 2, Model 4 indicates that the Round 1 calculator searches have predictive power even after controlling for the pair's outcome in Round 1.

Result 1: Initial searches consistent with the efficient equilibrium reduce surplus, especially in the long run. Round 1 calculator searches by a pair have predictive power beyond the outcomes for Round 1.

Underlying any effects on total surplus must be effects on pairs' outcomes. Table 8 looks at outcomes in the long run, reporting data from Rounds 13 – 18. For each type of initial search, the data is broken down into pairs who did not make that type of search in Round 1 and pairs who had at least one calculator search of that type in Round 1. The first column reports the frequency of coordinating at any equilibrium. "Efficient" searches decrease the probability of coordinating successfully while "Safe" and "Own Best" searches increase the probability of coordination. The next two columns report the frequency of coordinating at the efficient and safe equilibria respectively. The most notable feature of these two columns is the strong effect of "Own Best" searches, moving pairs from the efficient equilibrium towards the safe equilibrium.

Table 8: Period 1 Searches and Total Surplus

Type of Period 1 Search		Coordinate	Efficient	Safe
Searches, Efficient	No	69.2%	40.4%	39.4%
	Yes	62.7%	35.7%	41.2%
Searches, Safe	No	65.1%	38.4%	36.3%
	Yes	69.0%	38.9%	46.0%
Searches, Own Best	No	64.2%	42.3%	35.8%
	Yes	74.4%	26.9%	53.8%

For the same reason described in our introduction of Table 7, the results reported in Table 8 must be taken with a grain of salt. The regressions reported in Table 9 put our discussion on firmer ground from a statistical point of view. These are probits where the dependent variable is a dummy for whether the pair coordinated in the current round. All regressions include controls for the game being played.[3] These are not reported to save space, but full regression output is available from the authors upon request. All four models include a control for the round. This is always positive and significant, consistent with pairs becoming more coordinated over time. Models 1 and 2 use data from Rounds 2 – 18 (918 observations) while Models 3 and 4 only use observations from Rounds 13 – 18 (324 observations). Standard errors,

[3] To limit the number of independent variables, the regressions in Table 9 do not include controls for the game played in Round 1 (unlike Table 7). Adding these controls does not affect our conclusions.

reported in parentheses, are corrected for clustering at the pair level. We report marginal effects rather than parameter estimates.

Table 9: Effects of Early Calculator Searches on Coordination

Time Period Included in Data Set	Rounds 2 - 18		Rounds 13 - 18	
	Model 1	Model 2	Model 3	Model 4
Round	0.024*** (0.004)	0.024*** (0.004)	0.028** (0.014)	0.028** (0.013)
Searches, Efficient	-0.043** (0.022)	-0.042* (0.024)	-0.095*** (0.032)	-0.093*** (0.035)
Searches, Safe	0.028 (0.020)	0.024 (0.024)	0.045 (0.030)	0.041 (0.034)
Searches, Own Best	0.051** (0.020)	0.057*** (0.020)	0.088*** (0.032)	0.093*** (0.033)
High State Losses	-0.074 (0.067)	-0.078 (0.066)	-0.105 (0.079)	-0.111 (0.077)
Coordinate Safe Equilibrium		0.030 (0.098)		0.017 (0.126)
Coordinate Efficient Equilibrium		0.117 (0.094)		0.110 (0.103)

Note: Standard errors corrected for clustering at the pair level are reported in parentheses. Three (***), two (**), and one (*) stars indicate statistical significance at the 1%, 5%, and 10% levels respectively.

Once again, the variables of interest are the number of each type of calculator search made by the pair *prior to Round 1*. Initial searches consistent with the efficient equilibrium have a significant and negative effect on the probability of coordinating in all four regressions. Rather than attenuating with experience, the effect of the initial searches gets stronger over time both in terms of the magnitude of the effect and the statistical significance. As in Table 7, Models 2 and 4 show that the Round 1 calculator searches have predictive power even after controlling for the pair's outcome in Round 1.

Result 2: Initial searches consistent with the efficient equilibrium reduce the probability of coordinating, especially in the long run.

The negative effect on coordination from initial searches consistent with the efficient equilibrium, especially in the long run, provides an explanation for the negative effect on total surplus documented in Table 7. What is puzzling is that initial searches consistent with the own best equilibrium have a strong positive effect on the probability of coordination but only a weak positive effect on total surplus. To understand these differing effects, recall that surplus depends both on whether a pair coordinates and where it coordinates. Looking at Table 8, searches consistent with the efficient equilibrium reduce the probability of coordinating but have little effect on where coordination takes place. Searches consistent with the own best equilibrium increase the probability of coordinating and make it more likely that coordination takes place at the safe equilibrium rather than the efficient equilibrium. Because total surplus, by definition, is higher on average for the efficient equilibrium, the latter effect partially offsets the former. The net effect is a weakly positive effect on total surplus.

Table 10: Effects of Early Calculator Searches on Outcomes

Outcome	No Coordination		Efficient Equilibrium	
	Model 1	Model 2	Model 1	Model 2
Round	-0.091 (0.106)	-0.093 (0.106)	0.072 (0.103)	0.072 (0.102)
Searches, Efficient	0.575*** (0.217)	0.576** (0.229)	0.138 (0.200)	0.137 (0.210)
Searches, Safe	-0.372* (0.222)	-0.363 (0.232)	-0.152 (0.177)	-0.183 (0.188)
Searches, Own Best	-0.618*** (0.178)	-0.650*** (0.195)	-0.755*** (0.225)	-0.713*** (0.233)
High State Losses	2.034*** (0.592)	2.060*** (0.600)	2.836*** (0.724)	2.853*** (0.727)
Coordinate Safe Equilibrium		-0.547 (0.616)		0.125 (0.715)
Coordinate Efficient Equilibrium		-0.130 (0.725)		0.034 (0.759)

Note: The base category is coordination at the safe equilibrium. Standard errors corrected for clustering at the pair level are reported in parentheses. Three (***), two (**), and one (*) stars indicate statistical significance at the 1%, 5%, and 10% levels respectively.

The preceding observations are supported by the results of the multinomial logits shown in Table 10. The dataset is taken from Rounds 13 – 18. Observations with Game 3 are excluded since play of the safe equilibrium and efficient equilibrium are not distinct, leaving 258 observations. The base category is play of the safe equilibrium. We include three other categories: (1) No coordination; (2) Coordination at the efficient equilibrium; and (3) Coordination at neither the safe nor the efficient equilibrium. Parameter estimates for the final category are not reported to save space – none of the types of initial calculator search have a significant effect for this category. Both models include controls for the game played in the current period. To save space, these are not reported but full regression output is available from the authors upon request. Models 1 and 2 differ in whether or not we include controls for the pair's outcome in Round 1. Note that a multinomial logit generates a set of parameter estimates for each outcome. Table 10 reports the estimates for two outcomes for two models, *not the results of four separate models*.

The results for no coordination mirror those reported in Table 9. Searches consistent with the efficient (own best) equilibrium make non-coordination more (less) likely. The critical point is that searches consistent with the efficient equilibrium do *not* have an effect on the likelihood of the efficient equilibrium relative to the safe equilibrium. Searches consistent with the own best equilibrium significantly shift play away from the efficient equilibrium towards the safe equilibrium. Thus, the multinomial logits in Table 10 pick up the countervailing effect that we described using Table 8. This effect is robust to controls for the pair's initial outcome.

Result 3: Initial searches consistent with the own best equilibrium reduce the probability of coordinating as well as the likelihood of coordinating at the efficient equilibrium. Together these effects yield a weak positive effect on total surplus in the long run.

4. Conclusions: The primary purpose of this note is examine the value of looking at usage of a payoff calculator as a cheap and easily available source of information about subjects' decision making processes. The payoff calculator was used frequently, especially in early rounds. Usage is consistent with subjects considering a few sensible approached to the game – play of either the safe or the efficient equilibrium. Initial searches consistent with the efficient equilibrium have a negative effect on the long run probability of coordinating and, by extension, total surplus in the long run. Intuitively, there is a reason why the safe equilibrium is called safe. Shooting for the efficient equilibrium increases the probability that no equilibrium emerges. Failure to coordinate is a far worse outcome than settling for the safe equilibrium, and leads to low total surplus. By contrast, searches consistent with the safe equilibrium have little effect on surplus and coordination. Searches consistent with the own best equilibrium lead to increased coordination but not increased surplus due to a shift from the efficient equilibrium towards the safe equilibrium.

We don't think the calculator searches "cause" good or bad outcomes. Rather, the initial calculator searches are indicative of how subjects initially think about the game. Going for the efficient equilibrium is the clever thing to do, but trying to be too clever can backfire!

Critically, our conclusions about the effects of initial searches are not affected by controlling for initial outcomes for the pair. This indicates that the initial searches provide predictive power beyond what can be learned from the pairs' initial outcomes.

We are not arguing that payoff calculators are the best possible source of information. We would have learned more about subjects' deliberations from an eye tracker or mouse-lab. Instead, the payoff calculator is a valuable supplement for studies *not* intended to focus on process. It is non-intrusive from a subject's point of view, experiments don't need to be designed around it, and many experiments are already gathering this data without using it. Given that it costs virtually nothing to gather data about payoff calculator usage, why not use it?

Bibliography

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