DISCRETE GOODS WITH MULTIPLE ATTRIBUTES: AN EXPERIMENTAL STUDY

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Abstract: We conduct an experimental game designed loosely on the choice between a defined benefits and flexible benefits compensation packages. The "goods" chosen are discrete and have multiple attributes that affect the payoff function. We are interested in studying the degree to which these complications affect optimal choices. Essentially, subjects are asked to solve a complex linear programming problem. We identify a priori some heuristics that subjects might use. Eighty subjects participated in this individual-choice experiment. The main results are that (a) the relative tradeoff between the multiple attributes is a significant treatment variable and (b) the majority of experimental subjects adopt heuristics that approximate the optimal solution to a complex linear programming problem. Further, the subjects rarely choose a fixed payoff option with a known payoff and low decision cost, even when the fixed payoff is 80% of the maximum possible under the decision-making task.

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I. Introduction

As of FY97, the U.S. Navy encountered, for the first time in its history, problems meeting recruitment and retention goals. This problem has persisted in more recent years, and has very real consequences for the readiness of the force over the next twenty years. In an effort to address these issues, the Navy has recently instituted pecuniary incentives, which include numerous enlistment and reenlistment incentives. While effective, offering and or increasing pecuniary incentives can be prohibitively costly, even if offered to a select group of military personnel. But pecuniary incentives are only part of the overall military compensation package. Compensation is comprised of pecuniary benefits like salary and bonuses, and of non-pecuniary benefits such as dental and health care. A potential cost-effective tool to induce enlistment and increase retention is a flexible benefits package.

Under such a scheme, the employer (Navy) chooses the level of compensation and the employee (a sailor) chooses the mix of salary and benefits in his/her compensation package. Primarily because of institutional constraints, the Navy has typically ignored this option.[1] It is possible that under a flexible compensation the employee may perceive that the value of his benefits package has increased, giving rise to greater job satisfaction (White 1983). Greater job satisfaction may increase employee tenure. Additionally, the labor supply pool from which the employer can draw may

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[1] The existing benefits package provided to military personnel by the Department of Defense (DoD) is a standardized, relatively inflexible benefits package. Currently, the military is prohibited from offering non-standardized packages to specific groups. With an inflexible package, targeting benefits to increase enlistment and retention may not be a strategy favored either by the employer or the employee. Relative to using pecuniary incentives, the employer's relative labor cost are likely to be greater, as the employer must offer all individuals the identical enhanced-benefits package.

increase if perspective employees place a greater relative value on a flexible compensation package.[2]

From the employee's point of view, an optimal combination is one that (a) is the most preferred by the employee, given the available choices and (b) extracts the total value of the employer-defined package. In general, benefits are offered to the employee in discrete units, i.e., units cannot be subdivided. Also, each discrete unit has multiple attributes. These two factors (discreteness, multiple attributes) complicate the employee's choice[3] and may cause him/her to choose a sub-optimal combination. The discreteness of the benefits may prevent the employee from extracting the total value of the employer-defined compensation package. The complexity of the employee's decision is compounded by the fact that each discrete benefit has multiple attributes. Too many options may push the limits of the employee's computational abilities, and this, too, may cause or contribute to a sub-optimal choice

The prevention or elimination of sub-optimal choices is important for policy. Dissatisfaction with the choice is likely to reduce job satisfaction and job tenure. If the objective of the employer is to encourage enlistment and retention while controlling costs, it is critical that the employer offers a sufficient number of discrete benefits and per-benefit attributes without (inadvertently) inducing too much complexity.

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[2] While a flexible compensation scheme may decrease the employer's labor cost, it could increase other costs. Offering a large number of benefit combinations would likely impose substantial monitoring and administrative costs on the employer. Further, employees may attribute very little added value beyond the *kth* option (Bucci and Grant 1995). The employer, therefore, has an incentive to offer just enough options and associated attributes such that the marginal cost of offering an additional option is just equal to its marginal benefit. Under a flexible scheme, the employee can choose from a variety of combinations, as long as the combinations do not exceed the employer-defined value of the total benefit package.

[3] These two factors also complicate the employer's decision on what combinations to offer to the employee. In this project, we focus mainly on the employee's decision-making task.

The objective of this study is to examine how individuals make choices when faced with discrete multi-attribute goods. Laboratory methods are utilized to obtain controlled experimental data and test specific hypotheses. The main results are that (a) the relative tradeoff between the attributes is a significant treatment variable and (b) the majority of experimental subjects adopt heuristics that approximate the optimal solution to a complex linear programming problem. Further, the subjects rarely choose a fixed payoff option with a known payoff and low decision cost, even when the fixed payoff is 80% of the maximum possible under the decision-making task.

II. Methodology

According to neo-classical theory, the consumer chooses an optimal basket, or alternatively, makes an optimal choice if the following two conditions are satisfied. First, the *marginal utility* of the last dollar spent on each item in the basket is equal across all items. Second, the consumer spends all his/her income. This theory has two important assumptions: (a) the consumer has no computational or cognitive limits and (b) goods are continuous, i.e., they are infinitely divisible.

In contrast, many decision scientists believed that individuals do in fact have computational or cognitive limits, and that these limits affect an individual's choices. They argue that individuals adopt simplifying techniques when faced with complex decisions. Simon (1955) drew a distinction between substantive and procedural rationality. While some decisions may appear to be sub-optimal when viewed through the lens of neo-classical theory, they are actually the result of an efficient application of decision resources. Smith and Walker (1993) focused explicitly on the tradeoff between decision costs and decision rewards in the context of laboratory market experiments. The individual who equates the *marginal decision cost* with the *marginal decision reward* is making an optimal choice, but in some contexts, that choice differs from the optimal choice implied by neo-classical theory.

This difference of opinion is especially critical when the neo-classical continuity assumption does not hold, i.e., where the object of the choice is a discrete good with multiple attributes. As mentioned above, both the discreteness and the multiple-attribute characteristic complicate the individual's decision-making task. These two factors may also interact, which adds to the complexity. Thus (some) decision theorists would argue that an individual would take account of this complexity by developing a decision-making heuristic, while (most) neo-classical theorists would argue that this added complexity would have little, if any, impact on the individual's ability to make an optimal choice.

There are three strands of research that address decision-making in complex settings (see von Winterfeldt and Edwards, 1986). The first is investigates of the individual assignment of values for commodities with multiple attributes. This strand is largely normative, as the researcher constructs a decision aid to facilitate the "correct" decision. The second strand studies whether individuals are capable of making payoff-maximizing decisions in the presence of multiple attributes. The third is looks at whether or not individuals are able to consistently make payoff-maximizing decisions with multidimensional decisions and meeting multiple constraints. The second and third strands are more positive as they assess the ability of individuals from observations of unaided behavior.

III. The Model

This research reports an experiment that explores individual decision-making over a stylized discrete multi-attribute good. The relationship between this stylized good and a flexible benefits package is discussed below. For simplicity, the individual decision-maker is referred to as the "subject," as human decision-makers participate as the experimental subjects. The subject chooses units of the stylized good, subject to a constraint, and s/he receives a financial reward that varies with his/her choices.

III.A. The cell selection game

A unit of the stylized good is represented as a cell in an $n \times m$ matrix. Thus the subject's choice set consists of $n \times m$ units of the good. The good is discrete in the sense that the subject cannot choose "part" of a cell; the decision to choose a particular cell is an all or none proposition.

Each cell has three attributes: the *cell payoff*, the *cell weight* and the *cell value*. The cell weight and cell payoff are fixed, i.e., they are the same for each cell in the matrix. The cell value is a numeric value that varies with each cell. Any time a subject selects a cell, his/her reward is:

$$\begin{array}{l}\text{Reward from}\\ \text{selecting cell } i\end{array} = \text{Cell Payoff} + (\text{Cell Weight} \times \text{Cell Value}_i)\,. \tag{1}$$

The subject's reward from selecting k cells is the sum of the rewards from each of the cells that s/he selects:

$$\begin{array}{l}\text{Reward from}\\ \text{selecting } k \text{ cells}\end{array} = \sum_{i=1}^{k} [\text{Cell Payoff} + (\text{Cell Weight} \times \text{Cell Value}_i)] \tag{2a}$$

$$= k \times \text{Cell Payoff} + [\text{Cell Weight} \times \sum_{i=1}^{k} \text{Cell Value}_i]\,. \tag{2b}$$

Obviously, if there are no constraints on the subject's choices, his/her total reward will be maximized if s/he selects all the cells in the matrix, i.e., $k = n \times m$.

Each subject has a *value limit* that constrains his/her choices. The subject can continue to select cells as long as the sum of the cell payoffs from the selected cells does not exceed the value limit. If the subject selects k cells, then this restriction is expressed formally as:

$$\sum_{i=1}^{k} \text{Cell Value}_i \leq \text{Value Limit} \tag{3}$$

For simplicity, the "available budget" will refer to the difference between the value limit and the sum of k cell values that have been selected:

$$\begin{array}{l}\text{Available budget} \\ \text{after selecting } k \text{ cells}\end{array} = \text{Value Limit} - \sum_{i=1}^{k} \text{Cell Value}_i \tag{4}$$

Thus the decision-making task facing the profit-maximizing subject is a constrained optimization problem where equation (2a) or (2b) is the objective function and equation (3) is the constraint. In that sense, the task is analogous to optimization in neo-classical consumer theory.[4] But the good is discrete, not continuous, and so neo-classical theory is not directly applicable. In effect, the subject must solve the integer-programming problem commonly called the "knapsack problem" (Greenberg, 1971). While this type of problem may be intuitively simple, the process of identifying the optimal solution can be extraordinarily complex and typically requires a computerized algorithm. In this experiment, the optimal solution to any given decision matrix is

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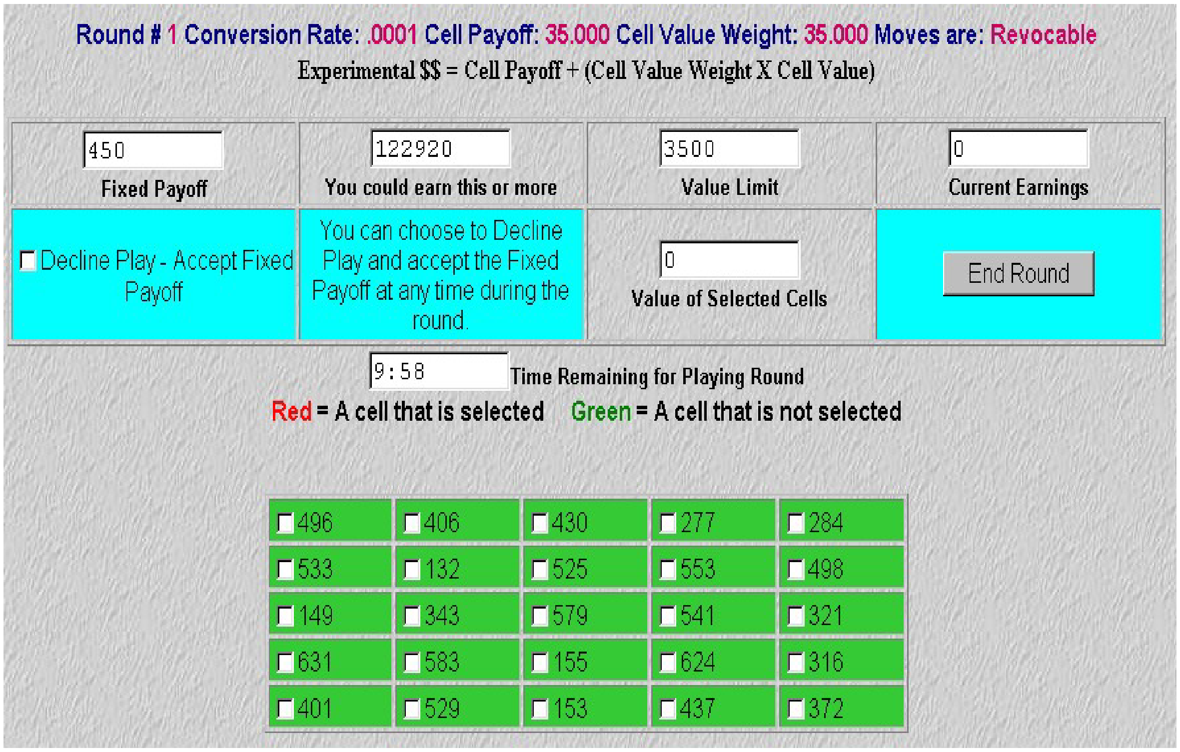
[4] The collection of cells that the subject selects is analogous to the market basket, and the value limit is analogous to the budget constraint

computed with the branch-and-bound method.[5] Of course, the subject does not have such an algorithm at his/her disposal.

A sample view of how this problem is presented to the experimental subject is provided in Figure 1.



Round # 1 Conversion Rate: .0001 Cell Payoff: 35.000 Cell Value Weight: 35.000 Moves are: Revocable

Experimental $$ = Cell Payoff + (Cell Value Weight X Cell Value)

450	122920	3500	0
Fixed Payoff	You could earn this or more	Value Limit	Current Earnings
☐ Decline Play - Accept Fixed Payoff	You can choose to Decline Play and accept the Fixed Payoff at any time during the round.	0 Value of Selected Cells	End Round

9:58 Time Remaining for Playing Round

Red = A cell that is selected Green = A cell that is not selected

☐ 496	☐ 406	☐ 430	☐ 277	☐ 284
☐ 533	☐ 132	☐ 525	☐ 553	☐ 498
☐ 149	☐ 343	☐ 579	☐ 541	☐ 321
☐ 631	☐ 583	☐ 155	☐ 624	☐ 316
☐ 401	☐ 529	☐ 153	☐ 437	☐ 372

Figure 1. Subject Screen Display

III.B. The fixed payoff option

As an alternative to selecting cells, the subject may choose a *fixed payoff*. That is, instead of "playing the game" where s/he is rewarded for selecting cells, the subject can

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[5] See Garfinkel and Nemhauser (1972) or Parker and Rardin (1988). The branch-and-bound algorithm is part of the computer interface used to conduct this experiment. The solutions obtained by this algorithm were also checked against an exhaustive search algorithm.

“opt out” and receive the fixed payoff as the reward. To aid in the decision on whether to earn reward by selecting cells or to take the fixed payoff, the subject is informed (via the computerized subject interface) as to the maximum amount s/he could earn in from selecting cells. While the subject is not guaranteed that s/he will earn this maximum amount, s/he has a benchmark by which to gauge his/her decision to play or take the fixed payoff. The motive for including this alternative reward is discussed below in section III.C. The subject’s incentives regarding the fixed payoff vs. selecting cells in this are discussed further below in section IV.B.

III.C. Relation to benefits packages

This model is designed as a simplified version of a flexible benefits package. Here is how the model corresponds to (a simplified version of) the naturally occurring world:

1. The $n \times m$ matrix represents the available benefits offered by the employer.
2. Each cell in the matrix represents a component of the package, such as medical, dental and childcare policies.
3. The cells that the subject selects represent the package chosen an employee.
4. The cell value represents dollar value of coverage for each policy.
5. The cell weight represents the monetary value that the employee places on each $1 of coverage.
6. The cell payoff represents the value that the employee places on having a particular type of coverage, independent of the amount of coverage.
7. The total reward in equation (2) represents the monetary value that the employee places on the package s/he has selected.
8. The value limit represents the total amount of coverage that the employer is willing to offer the employee; it is the employee’s benefits “budget.”

9. The fixed payment option represents the monetary value the employee places on an alternative non-flexible benefits package

The constraint shown in equation (3) implies that in this simplified world, the employee pays \$1 for \$1 worth of coverage, i.e., each unit of cell value counts as one unit against the value limit. This might appear "unrealistic" in that there would be no reason to buy insurance in such a world. But note that if the cell weight is greater than one, then the employee is implicitly purchasing coverage at a discount. For example, if the cell weight is 1.2, then the economic cost of buying \$1 of insurance is \$0.83.[6]

Also, if the subject chooses the fixed payment option, s/he avoids the subjective costs associated with the decision-making task while still receiving a positive reward. In this simplified world, that choice is analogous to accepting a fixed benefits package. The employee receives a benefit, but his/her actions have no effect on the value of the package, or its composition

IV. The Experiment

IV.A. Design overview

The experiment is a four-cell, 2×2 design with the cell payoff and fixed payoff option as the treatment variables. The cell payoff is either 20 or 100. Holding the cell weight constant, the higher the cell payoff the less the relative contribution of the cell value to the reward from selecting a given cell (see equation (2) above). The fixed payoff is either 80% or 50% of the maximum possible reward from selecting cells. For example, if the fixed payoff percentage is 80% and the maximum possible reward from selecting

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[6] The subject receives a reward of 1.2 per unit of cell value. Thus to get a reward of 100 from selecting a cell (ignoring the cell payoff for the moment), the cell value would have be 100 / 1.2 = 83.33.

cells is 2450, then the fixed payment option has a reward of 2032.[7] The lower the fixed payment percentage, the higher the opportunity cost of foregoing the option to select cells.

The experiment is designed to examine (a) how the subject's choice of cells are affected when the reward from selecting a cell is relatively more or less determined by the cell value versus the cell payoff (with the cell weight held constant) and (b) how the subject's decision to select cells versus taking the fixed payoff is affected by the size of the fixed payoff relative to the maximum possible reward from selecting cells. In the context of benefits packages, item (a) corresponds to an employee's choice between just having a particular benefit in the package (a cell's reward is determined primarily by the cell payoff) versus the amount of the coverage (a cell's reward is determined primarily by the cell value). Item (b) corresponds to the choice between a fixed package and a flexible one. Typically, but not always, fixed benefits are less that those under a flexible package. Of course, a flexible package requires that the beneficiary incur subjective costs of identifying the preferred package. Thus if the subjective costs are high, an employee might choose the fixed package with lower total benefit if the difference between benefits is relatively small.

Tables 1 and 2 show the experimental parameters. For simplicity, the four cells of the experimental design are referred to collectively as "sessions" and individually as sessions S1, S2, S3 and S4.[8] Table 1 shows those parameters that are varied across sessions, and Table 2 shows those that are held constant across sessions.

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[7] This example is actually round 1 and 2 of session S1.

[8] This same terminology is used with the subjects, although the session numbers that the subject enters into the computerized subject interface are 17, 18, 19 and 20, respectively (section IV.D. below describes the computerized interface).

IV.B. Parameters varied across sessions

The four sessions shown in Table 1 correspond to the four cells of the experimental design. Session S1 has a cell payoff of 20 and fixed payoff percentage of 80%, S2 has 100 and 80%, S3 has 20 and 50%, and S4 has 100 and 50%. As noted above, the fixed payoff is a percentage of the maximum possible earnings from selecting cells.

Table 1. Experimental Parameters Varied Across Sessions

	Session			
Parameter	S1	S2	S3	S4
Cell Payoff	20	100	20	100
Fixed Payoff Percentage	80%	80%	50%	50%
Number of Rounds	9	8	10	11
Fixed Deduction (US$)	$17.00	$18.00	$20.00	$27.00

Each session is a series of decision-making tasks or "rounds" where the given cell payoff/fixed payoff percentage combination applies to each round. Each round, the subject sees a different decision matrix, and has the option of selecting cells for payoff or choosing the fixed payoff. For example, in session S1, the subject views a total of eight different decision matrices, one in each round. In each of those eight rounds, the cell payoff is 20 and the fixed payoff is 80% of the maximum possible earnings from selecting cells in the respective decision matrix.

Table 1 shows that each session has a different number of rounds. The number of rounds per session is varied to mitigate the possibility that subjects alter their behavior in anticipation of the end of a session. Previous research has identified "end of experiment" or "end of sequence" effects. One common control is a randomized ending point (see Davis and Holt, 1998).[9]

Each subject completes all four sessions, i.e., each subject completes 8 + 9 + 10 + 11 = 38 rounds. To control for order effects, a subject completes the four sessions in one of four random sequences. There are eighty subjects that participate in the experiment, and approximately an equal number are assigned to each sequence. Twenty-one subjects receive the sequence S4-S1-S2-S3, twenty receive the sequence S1-S3-S4-S2, nineteen receive the sequence S3-S2-S1-S4 and twenty receive the sequence S2- S4-S3-S1**.**

Table 1 also shows a "fixed deduction" that varies with each session. At the end of each session, a deduction is subtracted from the subject's earnings. This deduction is explained to the subject as part of the instructions (section IV.D. below), and the amount of the deduction is revealed to the subject as s/he begins each session. This deduction is designed to maintain salient incentives between selecting cells and choosing the fixed payoff option.[10] Alternative methods of maintaining these incentives include a variety of combinations of the parameters shown in both Tables 1 and 2. But (in the authors' opinion) such combinations of parameters have prohibitive drawbacks. For example, small cell weights and cell payoffs (values like 0.00001) can be used, but a subject might then interpret equation (2) as essentially zero, irrespective of the cell value. Similarly, large upper and lower bounds for cell values (like numbers in the 1000's) significantly

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[9] The computer program is restarted at the beginning of each session, and the experimental instructions inform subjects that they will complete multiple sessions (see section IV.D. below and Appendices 3 and 7). If all sessions have the same number of rounds, subjects night very well anticipate the last round of a session, which could in turn introduce uncontrolled variation.

[10] Typically, subjects earn $10-$20 for participation in a two-hour session. Without the fixed deduction, a subject in this experiment would earn around $60 even if s/he simply choose the fixed payoff each round. Even though s/he could earn an additional $5-$10 selecting cells, s/he might very well immediately opt for fixed payoff, regardless of the potential reward from selecting cells, as the former has both a substantially lower time cost and substantially lower decision cost than the latter.

increase the difficulty of making an optimum or near optimum choice, as does a large dimension matrix. Small dimension matrices trivialize the problem (e.g., the optimum choice is a single cell), as does a small range between the upper and lower bounds of cell values. And very small conversion rates are difficult for subjects to internalize, and the corresponding marginal gain from a choice is unacceptably small.[11] These considerations resulted in the parameters shown in Tables 1 (above) and 2 (below).

IV.C. Parameters constant across sessions

Table 2 shows the parameters that are identical in each of the four sessions. All decision matrices that the subject sees are 5×5, i.e., they are square matrices with five rows and five column. This dimensionality is chosen as it has a sufficiently rich optimal solution. Both the combination and location of cells that comprise the optimal solution vary considerably each round. At the same time, the identification of the (near) optimal solution is sufficiently difficult but not excessive.[12] Square matrices are chosen to assist the subject in comparing individual cells.

Table 2. Experimental Parameters Constant Across Sessions

	Cell Values						
Matrix Dimensions	Lower Bound	Upper Bound	Cell Weight	Value Limit	Revocable Moves?	Seconds per round	Conversion Rate
5×5	100	1000	1.2	2000	Yes	240	0.001

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[11] Even with the conversion rate used here, an additional $E1 is worth one-tenth of one U.S. penny. The authors feel that this is the lowest reasonable rate.

[12] Based on pre-testing, 4×4 or smaller matrices often have trivial or easily identifiable solutions, and 6×6 or larger matrices have excessively burdensome solutions. In both cases, the results are scientifically uninteresting: In the first, the experimental data are not sufficiently diverse, and in the second, the subject has a very strong incentive to opt for the fixed payoff simply to avoid high decision costs.

Each of the twenty-five cells of a given matrix is populated with a cell value. The lower bound for each cell value is 100 and the upper bound is 1000, i.e., the cell values range from 100 to 1000. The computerized experimenter interface randomly populates the individual cells (section IV.D. below). This range is chosen so that the variety of choices is sufficiently rich, with the computational difficulty significant but not overwhelming. That is, the subject can develop a useful but nontrivial heuristic for deciding which cells to select, and the associated mental calculations are manageable

The cell weight is fixed at 1.2 in all rounds of all four sessions. Thus according to Tables 1 and 2 and equation (2), the subject's reward from selecting a cell is 20 + ($1.2 \times$Cell Value) in sessions S1 and S3, and 100 + ($1.2 \times$Cell Value) in sessions S2 and S4. If the cell value is 350 (midpoint of the cell value range), then the cell value comprises 95% of the reward in S1 and S3, and 81% in S2 and S4. If the cell value is 100 (minimum of the cell value range), the respective percentages are 86% and 54%, and if the cell value is 600 (maximum of cell value range) then the respective percentages are 97% and 88%.

The value limit is also constant across all rounds of all four sessions. In any given round, the subject may continue to select cells as long as the sum of the cell values that have been selected does not exceed 2000. This value is chosen in conjunction with, and for similar reasons as, the matrix size and cell value range.

The computerized experimenter interface gives the experimenter the option whether or not to allow the subject revocable moves. In this experiment, that option is set to "Yes." That is, the subject can select and then "deselect" a cell by clicking the cell a second time, even after selecting other cells; cells can be selected and deselected as many times as the clock allows (see next paragraph). One of the research questions of interest is the degree with which the subject searches prior to making his/her final decision for the round. Also, the subject has to opportunity to try different heuristics within the course of a round.

The subject is given four minutes (240 seconds) per round to make his/her decisions. Each round, the subject mouse-clicks either an "accept fixed payoff" button to take the fixed payoff, or an "end round" button to indicated that s/he is done selecting cells. If the subject does click one of these two buttons before time expires, the subject's reward for that round is zero.[13] This time limit is based on pre-testing. In the experiment, the eighty subjects collectively completed 3040 rounds. Only 23 (0.8%) had a zero payoff, i.e., ended before subjects clicked one of the two buttons.[14]

The subject's rewards are expressed in "experimental dollars" or E$, which are converted into U.S dollars or US$ at the rate of E$1 = US$0.001. For example, E$15,210 = US$15.21. The computer interface (section IV.D. below) automatically converts the subject's experimental rewards into U.S. currency at the end of each session. As described below in section IV.D., the subject records his/her US$ earnings from the screen onto a paper record sheet, and then subtracts the fixed deduction for the given session. This conversion rate is chosen in conjunction with the other parameters, so as to

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[13] The time remaining in the round is shown on the subject's screen. Also, the "zero payoff" was reiterated in the instructions that the subject receives.

[14] The maximum number of times this occurs for any one subject is twice; there are three such instances (subjects 5404, 7407 and 7323). Only one of those three had two zero payoffs in the same session (7407, S3). Other summary data on the zero payoffs: Five of the zero payoffs are in S1, seven in S2, four in S3 and seven in S4. Thus 61% (14/23) occur when the cell payoff is 100. Fifty-seven percent (13/23) occur in either rounds 1, 2 or 3. By random-order sequence, four zero payoffs occur in the first random sequence, five in the second sequence, six in the third, and eight in the fourth.

yield an expected payout in the fifteen to twenty dollars (US) range for the subject's participation in a (roughly) two-hour period.

IV.D. Procedure

The experiment is a computerized web-based application installed at the Mississippi Experimental Research Laboratory (MERLab) on the University of Mississippi campus. This facility is a state-of-the-art computer laboratory with private computer carrels. The computerized application is comprised of an experimenter interface and a subject interface. Both utilize Microsoft Explorer v5.0; the subject interface includes computerized instructions.

The subjects are recruited from undergraduate business courses at the University of Mississippi. Participation by the subject involved two visits to the laboratory, which are referred to as Part I and Part II. Part I is instructional training that lasts approximately one-and-a-half hours. Part II is the data-collection period, and lasts approximately two hours. The subject is paid his/her earning from both parts upon completion of Part II.[15] Each subject is paid a $6 participation fee, independent of his/her decisions, for each part.

The training in Part I familiarize the subject with the computerized interface, record keeping, and the sequence of events (multiple sessions, fixed deductions, etc.). The decisions from Part II are used in the data analysis. A summary is provided in this subsection.

Upon arrival, the subject is assigned a subject number, given a printed earnings record, and seated at one of the private carrels. The subject completes computerized instructions that are part of the interface, and then completes two practice rounds with

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[15] This payment schedule is explicitly explained to subjects when they are recruited.

2×2 matrices. After finishing, the subject raises his/her hand, and is approached by an experimenter. S/He is queried for questions or clarification regarding the decision-making task, and, after all questions are answered, is presented with some brief additional printed instructions and a consent form.[16]

Once the subject has read the additional instructions and signed the consent form, s/he again raises his/her hand to indicate that s/he is ready to proceed. An experimenter writes the first session number and corresponding fixed deduction the subject's printed record sheet. While the experimenter watches, the subject restarts the computerized interface and enters the session number and subject number. The subject then proceeds through all rounds of the given session. After completing the session, the subject again raises his/her hand, receives another session number and fixed deduction, and restarts the program as the experimenter watches. This process continues until all Part I sessions are completed. After the final Part I session, the subject totals his/her earnings on the record sheet, signs up for Part II (a least one day later, and no more than seven), and is excused.

Upon returning for Part II, the subject is again seated at a private computer carrel and given his/her record sheet from Part I. The subject uses the same subject number in Part II as in Part I. As before, the subject completes the computerized instructions and then completes two practice rounds with 2×2 matrices. After finishing, the subject raises his/her hand, and an experimenter provides him/her with a session number and fixed deduction. As an experimenter watches, the subject restarts the computerized interface and enters the session number and subject number. After completing the session, the

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[16] The subjects are explicitly recruited for participation in two parts, with each part on a separate day. The consent form explicitly refers to Parts I and II, so consent is not solicited when the subject returns for Part II. However, after reviewing the instructions and before starting the first session of Part II, the subject is reminded that s/he signed a consent form during his/her previous visit.

subject raises his/her hand, and receives another session number and fixed deduction. This process continues until all sessions of Part II are completed.

Upon completion of the final session of Part II, the subject is privately paid his/her cash earnings from both Parts I and II and is excused. In this experiment, cash earnings in Part I average \$14.35, with a low of about \$4 and a high of about \$25. In Part II, the average is \$20.67, with a low of about \$3 and a high of about \$28. (These figures are exclusive of the participation fees.)

V. Heuristics

V.A. Overview

The fact that the subject faces the integer-programming problem described in section III is more than a computational curiosity. Given the complexity of the problem, it is extremely unlikely that an untrained decision-maker (like a typical experimental subject) could solve a problem usually reserved for a computerized algorithm. More likely, a subject will develop heuristics or "rules of thumb" to simplify the decision-making task. The effectiveness of a particular heuristic can be evaluated relative to a benchmark (i.e., the optimal solution) or relative to other heuristics.

Here, the experimental design varies the cell payoff across sessions while holding the cell weight and value limit constant (see Tables 1 and 2). Three heuristics stand out because of their simplicity. Each of the three has both a "simple" version and a more sophisticated "advanced" version. Below, the simple heuristics are denoted with an "S" subscript, and the advanced heuristics are denoted with an "A" subscript. The payoff to each heuristic is computed using the thirty-eight matrices viewed by the subject. Where appropriate, a trial-and-error is used to determine the choices (the choices were made by the authors using a Microsoft Excel spreadsheet). These choices are meant to be representative. In most cases, there are alternative choices that also conform to the given heuristic rule. (The decision matrices from all 38 rounds, and the choices for each heuristic are in an Appendix 1.**)** Before presenting the payoffs, the individual heuristics are discussed.

V.B. Individual heuristics

Under the *High Numbers* heuristic, the subject concentrates on cell values in the 700-1000 range. This rule will result in three or fewer cells being selected. To the extent that it involves the fewest computations, this heuristic has the lowest decision cost. The simple and advanced versions of this heuristic are indicated by H_S and H_A, respectively:

1. H_S. Select the highest remaining cell value until the value limit prohibits further selection.
2. H_A. Select three cells that (nearly) exhaust the value limit, focusing on cell values in the 800-1000 range, but also selecting outside this range

In all thirty-eight rounds, heuristic H_S results in the selection of two cells, both in the 800-1000 range. This heuristic often leaves a considerable available budget, but not enough to select the highest remaining cell value. Heuristic H_A typically results in the selection of two cells in the 800-1000 range and one in the 100-300 range. As heuristic H_A selects one more cell than heuristic H_S, and often does a much better job of exhausting the value limit, H_A should yield significantly higher average profit than H_S. Thus one would expect heuristic H_S to be rarely, if ever, used.

Under the *Middle Numbers* heuristic, the subject concentrates on cell values in the 400-699 range. This rule will result in four or five cells being selected. The simple and advanced versions of this heuristic are indicated by M_S and M_A, respectively:

3. M_S. Select four cells in the 400-699 range that (nearly) exhausts the value limit.

4. M_A. Select five cells that (nearly) exhaust the value limit, focusing on cell values in the 400-699 range, but also selecting outside this range

Under heuristic M_S, the average cell value will be around 500, which is close to the midpoint (550) of both the entire cell value range (100-1000) and this middle range (400-699). Heuristic M_A selects one more cell than does heuristic M_S. So if both rules approximately equally exhaust the value limit, then M_A should yield a slightly higher profit: E$10-20 more in S1 and S3, and E$90-100 more in S2 and S4. (Recall the cell payoff is E$20 in S1 and S3, and E$100 in S2 and S4). But M_A almost always results in a wider range of cell values, so it involves a more complex choice and thus a higher decision cost. Thus one might expect the two heuristics to be used equally as often in S1 and S3, where the expected profit difference is relatively small, and M_A to be used more often in S2 and S4

Under the *Low Numbers* heuristic, the subject concentrates on cell values in the 100-399 range. This strategy will result in six or more cells being selected, and usually seven or more.[17] To that extent that it involves the most computations, this heuristic has the highest decision cost. The simple and advanced versions of this heuristic are indicated by L_S and L_A, respectively:

5. L_S. Select the lowest remaining cell value until the value limit prohibits further selection.

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[17] The one exception is round 5 of S4, where the optimal solution is only five cells.

6. L_A. Select six or more cells that (nearly) exhaust the value limit, focusing on cells in the 100-399 range, but also selecting outside this range

Heuristic L_S often leaves a considerable available budget, but not enough to select the lowest remaining cell value (although the remaining budget is usually considerably less than under heuristic H_S). Heuristic L_A does a better job of exhausting the value limit, and in thirty-four of the thirty-eight rounds, both heuristics select the same number of cells[18], so L_A should yield higher average profit than L_S. Thus one would expect heuristic L_A to be used more often.

V.C. Relation to optimal solution

Heuristic L_A is also intriguing because it mimics is a simple algorithm based on equations (2b) and (3). As noted in section III.C above, the subject knows the maximum amount s/he can earn from selecting cells. Substituting this maximum possible earnings for "the earnings from selecting *k* cells" on the right hand side of (2b), treating equation (3) as an equality so that the value limit can be substituted for the sum of the cell payoffs in (2b), and then solving for *k* yields:

$$k' = \begin{array}{c}\text{Optimal}\\ \text{number of}\\ \text{cells to select}\end{array} = \frac{\text{Max Possible Earnings} - (\text{Cell Weight} \times \text{Value Limit})}{\text{Cell Payoff}} \qquad (5)$$

Thus the subject can identify the optimal number of cells to select (under the assumption that some combination of cell values can exactly meet the value limit).

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[18] In rounds 2 and 6 of S1, L_S selects 8 cells and L_A selects 7. In round 1 of S3, L_S selects 9 cells and L_A selects 8, and in round 2 of S3, L_S selects 7 cells and L_A selects 6.

In all but three of the 38 rounds, heuristic L_A selects the same number of cells as the optimal solution.[19] Additionally, the trial-and-error solution identified using heuristic L_A yields the optimal solution in 34% (13/38) of the rounds.[20] Even where L_A does not yield the optimal solution, it results in reward very close to the maximum possible, as shown in Table 3 below.

V.D. Relative payoffs

Table 3 summarizes the reward to these six heuristics, as a percentage of the maximum possible (i.e., optimal) reward. The heuristics are divided into "simple" and "advanced" categories. The numbers in Table 3 are computed as follows. For each of the heuristics, the per-round reward is summed over all rounds in the session. This sum is then divided by the sum of the maximum possible per-round earnings in the session. Letting Z_j denote the reward to heuristic Z in round j of a given session, this can be expressed formally as:

$$\text{Reward to Heuristic}\,Z\text{ in Session S}i = \frac{\sum_{j=1}^{\text{Final Round in S}i} \text{Reward to } Z_j}{\sum_{j=1}^{\text{Final Round in S}i} \text{Max Possible Reward}_j}, \; i = 1,\ldots,4 \qquad (6)$$

The four-session average earnings of each heuristic is shown as the column average in Table 3.

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[19] The exceptions are round 2 and round 6 of S, where L_A selects 7 and the optimal number is 8, and round 2 of S3, where L_A selects 6 and the optimal number is 7.

[20] Rounds 5 and 9 of S1, rounds 1, 4, 5, and 8 of S2, rounds 1, 5 and 6 of S3, and rounds 1, 6, 9, and 10 of S4.

Table 3. Rewards to Heuristics as a Percent of the Maximum Possible Reward

Session	Simple Heuristics			Advanced Heuristics		
	High H_S	Middle M_S	Low L_S	High H_A	Middle M_A	Low L_A
S1	90.8%	97.2%	88.8%	96.4%	98.1%	99.7%
S2	80.0%	89.9%	92.8%	86.6%	93.1%	99.9%
S3	90.9%	97.6%	92.1%	96.6%	93.1%	99.9%
S4	79.1%	88.4%	99.8%	85.2%	91.5%	99.8%
Column Average	85.5%	93.3%	93.4%	91.2%	95.3%	99.8%

Note: Calculations based on data shown in Appendix 2.

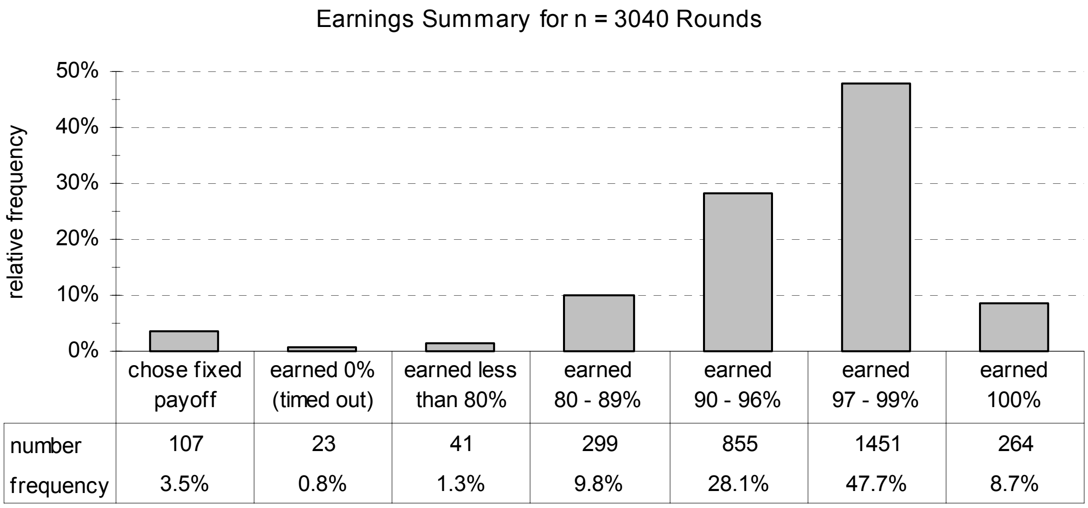
The most obvious result from Table 3 is the clear dominance of heuristic L_A. This heuristic yields over 99% of the maximum possible earnings in all four sessions. This is not surprising, given the above discussion regarding this heuristic's approximation of the optimal solution. The other two advanced heuristics H_A and M_A also do reasonably well, averaging 91% and 95%, respectively, but their performance varies across treatments: in S1 and S3, they earn over 95% but in S2 and S4 they earn considerable less. This is especially true of heuristic H_A which only earns about 86% in S2 and S4.

A few other observations are worth mentioning. First, the simple heuristics do fairly well, but not as well as the corresponding advanced heuristic. This is to be expected, as the advanced versions are typically better at exhausting the value limit. Second, among the simple heuristics, M_S earns the most in S1 and S3 when the cell payoff is 20, while L_S does best in S2 and S4 where the cell payoff is 100. This contrasts with the advanced category, where the best heuristic (L_A) is independent of the cell payoff. Finally, the High Number heuristics H_S and H_A are generally the least profitable, even though they have the lowest decision costs.

VI. Results

VI.A. Summary

Figure 2 summarizes the outcomes over the 3040 rounds completed by the eighty subjects in Part II (data collection) of the experiment. In those rounds where the subjects choose to "play the game" and select cells, earnings are expressed as a percentage of the maximum possible reward for the respective round. This measure is used so that outcomes from different rounds are comparable.[21]



	chose fixed payoff	earned 0% (timed out)	earned less than 80%	earned 80 - 89%	earned 90 - 96%	earned 97 - 99%	earned 100%
number	107	23	41	299	855	1451	264
frequency	3.5%	0.8%	1.3%	9.8%	28.1%	47.7%	8.7%

Note: Earnings expressed as percentage of maximum possible reward

Figure 2. Histogram of Outcomes Across all Four Sessions

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[21] Recall that the maximum possible reward varies across rounds; see Appendix 2.

The data shown in Figure 2 yield three observations. First, subjects predominantly opt to “play the game” as the means to earning a reward. The fixed payoff option is rarely chosen, occurring in only 3.5% (107/3040) of the rounds. Analysis of the data (not shown in Figure 2) reveals that the fixed payoff choice is confined to less than a third of the subjects (24/80). By session, the fixed payoff was chosen 47 times in S1 by ten different subjects, 46 times in S2 by eighteen different subjects, 10 times in S3 by six different subjects, and 4 times in S4 by three different subjects. Further discussion of the fixed payoff option by session is presented below.

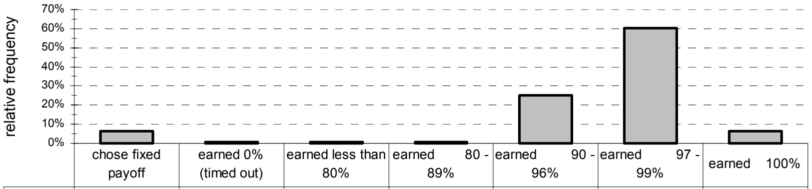
Second, the three-minute time limit per round is not binding. In less than 1% (23/3040) of the rounds do subjects “time out,” i.e., fail to either choose the fixed payoff option or click the “end round’ button when finished selecting cells. Inspection of the data indicates that twenty different subjects “time out” across all four sessions. Three of those subjects time out twice, two of them in two separate sessions and one of them twice in the same session (S2). By session, time outs occur five times in S1, seven times in S2 (by six different subjects), four times in S3 and seven times in S4.

Third, when subjects choose to play the game, they do quite well. In almost half (47.7%) of the 3040 rounds earnings are in the 97-99% range, and in 84.5% (= 28.1% + 47.7% + 8.7%) of the rounds earnings are 90% or more of the maximum possible. Additionally, inspection of the data (not shown in Figure 2) reveals that low earnings are confined to a subset of subjects. The 339 rounds with earnings less than 90% are confined to less than half of the subjects (38/80), and 208 of those rounds are confined to fourteen of the eighty of the subjects. The 41 rounds with earnings below 80% are confined to six subjects, and two subjects account for 32 of those 41 rounds.

Even though subjects consistently earn over 90% of the maximum possible, there are differences across treatments. These differences are illustrated in Figure 3, which show outcomes by session. First, compare sessions S1 and S3 (Figures 3a and 3c, respectively) with S2 and S4 (Figure 4b and 4d, respectively). In sessions S1 and S3, where the cell payoff is 20, subjects earn 97-99% of the maximum possible in over 60% of the rounds, and rarely earn less that 90% of the maximum. This contrasts with sessions S2 and S4, where the cell payoff is 100. There, subjects earn in the 97-99% range in only about 30% of the rounds, and earn less than 90% in about 15-20% of the rounds. Curiously, subjects are able to earn 100% the maximum possible more often in S2 and S4, than in S1 and S3 (9.8% and 13.1% vs. 6.3% and 5.1% of the rounds).

But overall, when the cell payoff is 20, earnings tend to be higher and less disperse than when the cell payoff is 100. When cell payoff is relatively low, then the cell value is more important in determining the reward from selecting a particular cell. Perhaps this makes subjects concentrate relatively more on the cell value, and thus more closely approximate the optimal solution. Further discussion on subjects' strategies is presented below in section VI.D**.**

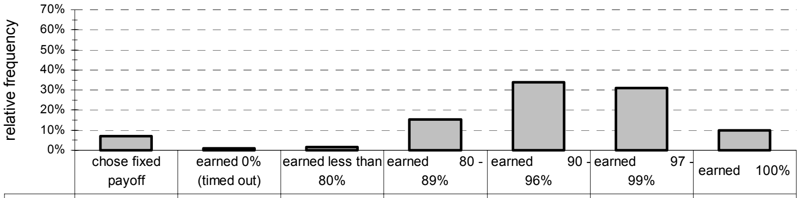
Figure 3a. Session S1 (n=720) fixed option = 80%, cell payoff = 20



	chose fixed payoff	earned 0% (timed out)	earned less than 80%	earned 80 - 89%	earned 90 - 96%	earned 97 - 99%	earned 100%
number	47	5	4	5	181	433	45
frequency	6.5%	0.7%	0.6%	0.7%	25.1%	60.1%	6.3%

Note: Earnings expressed as percentage of maximum possible reward

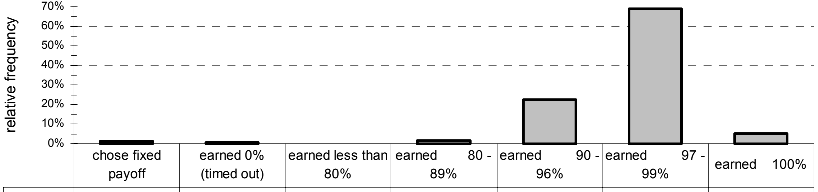
Figure 3b. Session S2 (n=640), fixed option = 80%, cell payoff = 100



	chose fixed payoff	earned 0% (timed out)	earned less than 80%	earned 80 - 89%	earned 90 - 96%	earned 97 - 99%	earned 100%
number	46	7	11	99	216	198	63
frequency	7.2%	1.1%	1.7%	15.5%	33.8%	30.9%	9.8%

Note: Earnings expressed as percentage of maximum possible reward

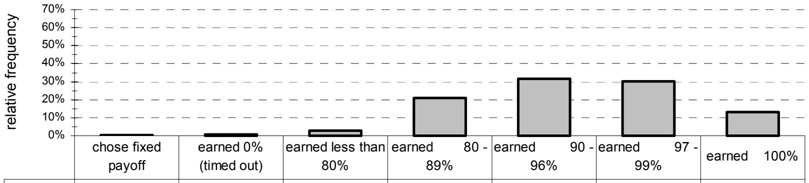
Figure 3c. Session S3 (n=800), fixed option = 50%, cell payoff =20



	chose fixed payoff	earned 0% (timed out)	earned less than 80%	earned 80 - 89%	earned 90 - 96%	earned 97 - 99%	earned 100%
number	10	4	0	12	180	553	41
frequency	1.3%	0.5%	0.0%	1.5%	22.5%	69.1%	5.1%

Note: Earnings expressed as percentage of maximum possible reward

Figure 3d. Session S4 (n=880), fixed option = 50%, cell payoff = 100



	chose fixed payoff	earned 0% (timed out)	earned less than 80%	earned 80 - 89%	earned 90 - 96%	earned 97 - 99%	earned 100%
number	4	7	26	183	278	267	115
frequency	0.5%	0.8%	3.0%	20.8%	31.6%	30.3%	13.1%

Note: Earnings expressed as percentage of maximum possible reward

Figure 3. Histograms of Outcomes by Session

VI.B. Fixed effects model

Three fixed effects (or dummy variable) regressions are outlined in Table 4. All three regressions use the same fixed effects model, but use different dependent variables: Earnings Ratio, Cell Ratio and Search Ratio. Generically, theses dependent variables are referred to as Y:

$$\begin{aligned} Y = \beta_0 + \beta_F \text{Fixed} + \beta_T \text{Timeout} + \sum_{i=2}^{4} \beta_{Si} \text{Session}_i \\ + \sum_{j=2}^{11} \beta_{Rj} \text{Round}_j + \sum_{k=2}^{80} \beta_{\text{Sub}k} \text{Subject}_k + \varepsilon \end{aligned} \tag{7}$$

The Earnings Ratio measures the subject's per-round earnings. The question of interest is how well the subject does relative to the optimal solution, so earnings are expressed as a percentage of the maximum possible in the given round of the given session. This normalization controls for the variation in the maximum possible earnings across the 38 total rounds that each subject completes. Thus the Earnings Ratio is one measure of how well the subject does relative to the optimal solution.

The Cell Ratio measures the number of cells in the subject's final choice each round. This variable is a count of the number of cells that the subject has selected as part of his/her final choice when s/he clicks the "end round" button. Again, the question of interest is how well the subject does relative to the optimal solution, so this variable is expressed as a percentage of the number of cells in the optimal solution for the given round. This normalization also controls for the variation in the optimal number of cells per round across the 38 total rounds that each subject completes. This variable is a second measure of how well the subject does each round, relative to the optimal solution.

Table 4. Fixed Effects Regression Models

$$Y = \beta_0 + \beta_F \text{Fixed} + \beta_T \text{Timeout} + \sum_{i=2}^{4} \beta_{Si} \text{Session}_i + \sum_{j=2}^{11} \beta_{Rj} \text{Round}_j + \sum_{k=2}^{80} \beta_{\text{Sub}k} \text{Subject}_k + \varepsilon$$

Variable	Definition
Dependent Y	
Earnings Ratio	Subject's per-round earnings, as a percent of the maximum possible in the round
Cell Ratio	Number of cells in subject's final per-round choice, as a percent of the number of cells in the round's optimal solution
Search Ratio	Total number of cells subject selects per round (including those not part of subject's final choice), as a ratio of the number of cells in subject's final choice for the round
Fixed Effects	
Fixed	= 1 if subject chooses the fixed payoff option in the round = 0 otherwise
Timeout	= 1 if time expires before subject is finished in the round = 0 otherwise
Session_i $i = 2, \ldots, 4$	= 1 if Y observation from session Si = 0 otherwise
Round_j $j = 2, \ldots, 11$	= 1 if Y observation from round Rj = 0 otherwise
Subject_k $k = 2, \ldots, 80$	= 1 if Y observation from subject Sub$k$ = 0 otherwise

Note: There are n = 3040 observations of each dependent variable. There are 107 instances where Fixed = 1 and 23 instances where Timeout = 1.

The Search Ratio measures the search activity of the subject while controlling for the heuristic used by the subject. The numerator of this ratio is a count of all cells that the subject selects during the course of a round, including those that the subject subsequently deselects, i.e., those that are not part of the subject's final choice. Recall that with the revocable choice option (Table 2 above), the subject is able to search out and try different combinations of cells before clicking the "end round" button. The denominator of Search Ratio is the count of the number of cells in the subject's final choice in the round. Recall from section V that the subject's heuristic can be categorized according to the number of cells that in the subject's final choice. Thus this measure normalizes search activity so that it is comparable across subjects, as the following example illustrates.

Consider two subjects who both have three cells in their final selection, so both are using a High Numbers heuristic (see section V.B. above). Suppose that the second subject selects and then deselects two additional cells in the process of making his/her final choice, i.e., s/he searches a total of five cells while the first subject only searches three. The first subject has a Search Ratio of 3/3 = 1.0, and the second has a ratio of 5/3 = 1.67. The subject who searches more has a higher Search Ratio. Now consider a third subject who has five cells in his/her final choice and does not deselect any cells during the round. This subject, who uses a Medium Numbers heuristic, has a Search Ratio of 5/5 = 1.0. Thus according to the this measure of search activity, the first and third subjects search an equal amount, after accounting for the different heuristics they use, and the second subject searches more.

The ninety-four independent variables are fixed effects dummy variables, as shown in Table 4. The Fixed and Timeout variables control for those rounds where, respectively, the subject chooses the fixed payoff option or time expires before the subject is finished (i.e., before s/he clicks either the "accept fixed payoff" button or the "end round" button). If Fixed = 1, then the Earning Ration equals the amount of the fixed payoff (divided by the maximum possible for the round) and both Cell Ratio and Search Ratio equal zero. When and Timeout = 1, all three dependent variables have a value of zero.

The three Session dummy variables control for individual session effects, and are used to test for the effect of the experimental treatments outlined in Table 1 above. The ten Round variables control for individual round effects. These variables are used to test for variation over time, such as learning. The seventy-nine Subject_k dummy variables control for a variety of subject-specific effects, including (but not limited to) risk aversion.[22]

VI.C. Regression results

Table 5 presents the hypothesis tests from the fixed effects regressions. (The entire regression outputs are shown in Appendix 3.) The models seem to fit the data fairly well, with adjusted R^2's of 0.85, 0.77 and 0.49 for the Earnings Ratio, Cell Ratio and Search Ratio, respectively. There is strong evidence of a session (or treatment) effect in the Earnings Ratio and the Cell Ratio, as both those p-values are less than 0.01; there is marginal evidence of a session effect in the Search Ratio (p = .087). There does not appear to be a round effect in the Earnings Ratio (p = .260), but there are significant round effects in both the Cell Ratio and Search Ratio (both p-values < .05). As one might

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[22] A dummy variable for session sequence is not included as the order of sessions is varied across subject with one of four random sequences (section IV.B.) in order to control for sequence effects.

expect, there are strong subject effects in all three ratios. The session and round effects (or lack thereof) are discussed in the remainder of this subsection; the subject effects are discussed in the following subjection.

Table 5. Hypotheses Tests from Fixed Effects Regressions

Test	Dependent Variable Earnings Ratio	 Cell Ratio	 Search Ratio
Overall Model H0: $\beta_{S2} = \ldots = \beta_{Sub80} = 0$	$R^2_{Adj} = 0.85$ F = 196.9 p < .001	$R^2_{Adj} = 0.\ 77$ F = 111.2 p < .001	$R^2_{Adj} = 0.\ 49$ F = 29.7 p < .001
Session Effect H0: $\beta_{S2} = \beta_{S3} = \beta_{S4} = 0$	F = 174.0 p < .001	F = 5.07 p = .002	F = 2.19 p = .087
Round Effect H0: $\beta_{R2} = \ldots = \beta_{R11} = 0$	F = 1.24 p = .260	F = 4.37 p < .001	F = 2.13 p = .020
Subject Effect H0: $\beta_{Sub2} = \ldots = \beta_{Sub80} = 0$	F = 28.1 p < .001	F = 70.9 p < .001	F = 13.6 p < .001

Note: n = 3040 for each regression. See Appendix 3 for further detail.

Figure 4 plots the estimated values of each of the dependent variables by round. These estimates are obtained using the estimated models (see Appendix 3). In each case, Fixed, Timeout and Subject_k, $k = 2, \ldots, 80$ are all set equal to zero, and Session_i and Round_j are set equal to 1, as appropriate, for the corresponding session and round.

The estimated Earnings Ratio per round is shown in Figure 4a. The nature of the treatment effects is apparent. Sessions S1 and S3 are virtually identical, and S2 and S4 are substantially less, although all four sessions have estimates are reasonably close to 1.0 (or 100%). This is consistent with the histograms shown in Figure 2. Figure 4a and the significant session effect for the Earnings Ratio (Table 5) are further evidence that a lower cell payoff, and thus a relatively higher importance of cell value, results in higher earnings. Figure 4a also indicates that S4 has lower earnings than S2. In S4, the fixed payoff was 50% of the maximum possible, while in S2 it is 80%. Recall from Figure 2 that in S2, the fixed payment option is chosen in 7.2% of the rounds, while in S4 it is chosen in only chosen in 0.5% of the rounds. One interpretation is that 80% fixed payment option provides a cushion in those rounds where the subject does (relatively) poorly, but the 50% option does not. However, no such effect is apparent in the comparison of S1 and S3, which have 80% and 50% fixed payment options, respectively.

Figure 4a. Estimated Earnings Ratio per Round

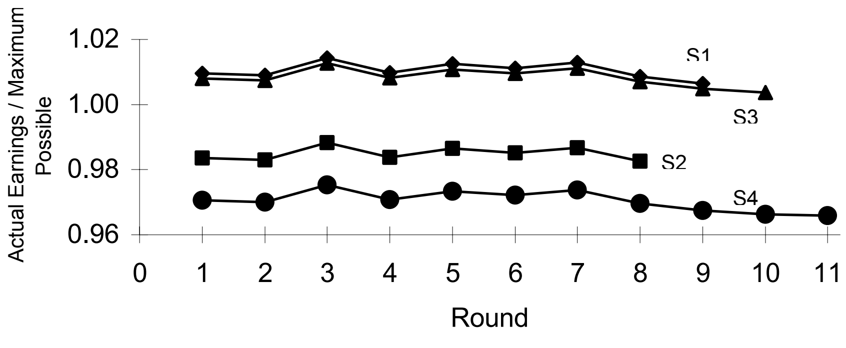
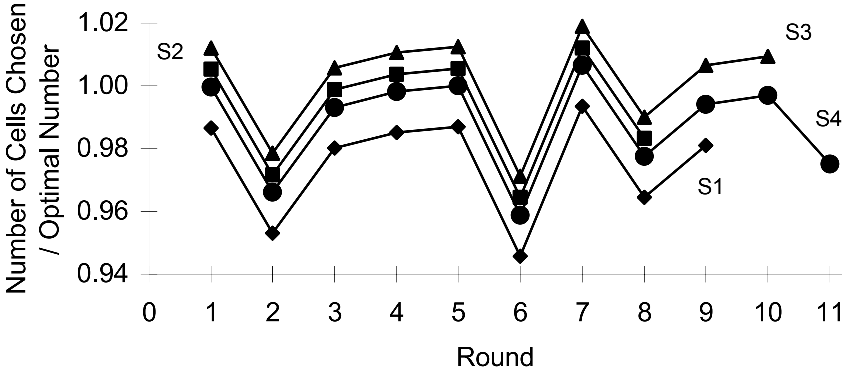


Figure 4b shows the estimated Cell Ratio per round. There are two observations to be made. First, S3 and S1 are somewhat dissimilar, which is different from the similarity shown in Figure 4a. In particular, S3 has the highest estimated Cell Ratio, and

S1 the lowest. Furthermore, S2 and S4 are very similar, which is also different from Figure 4a, although S2 still has a (slightly) higher estimate than S4. This is somewhat paradoxical: the session that is furthest from the optimal solution in terms of cells (S1 in Figure 4b) is the closest to the optimal solution in terms of earnings (S1 in Figure 4a). While all four session have estimates fairly close to 1.0 (or 100%), recall from Table 5 that session effect for the Cell Ratio is significant with a p-value = .002.

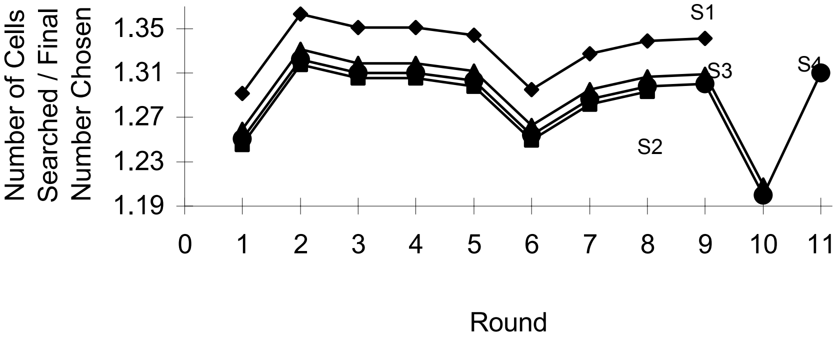
Figure 4b. Estimated Cell Ratio per Round



The second observation regarding Figure 4b is the unusual decrease in round 6, which account (at least in part) for the significant round effect shown in Table 5. While there is variation across all rounds, including decreases in rounds 2 and 8, round 6 is the only one that stands out as exceptional. One possible explanation is a “training effect.” Recall that in Part I of the experiment, subjects complete four instructional training sessions, and that each of those sessions lasts five rounds. Perhaps the subjects incorrectly anticipate that round 5 is also the final round in Part II of the experiment. Why subjects systematically choose fewer cells when confronted with an unexpected round, however, remains an open question. However, with the exception of the round 6 decrease, the estimated Cell Ratio is fairly constant across rounds, which indicates the absence learning effect. This suggests that the training was otherwise effective in preparing the subject for the data sessions (there is also no evidence of learning in Figure 4a). Whatever the origin or cause of the round 6 decrease, note that it is of no apparent consequence with respect to earnings, as there is no corresponding increase or decrease in the Earnings Ratio shown in Figure 4a.

The estimated Search Ratio is shown in Figure 4c. Recall that Table 5 indicates a marginal session effect for this ratio (p-value = .087). Inspection of Figure 4c suggests that this is due to a difference between S1 and the other three sessions, with more search activity in S1. The estimated search activity is essentially the same in S2, S3 and S4. But there is some search occurring in all sessions, as the average estimated Search Ratio is in the 1.3 range, i.e., greater than 1. The significant round effect (p = .020 in Table 5) is apparently due to the decreases in rounds 6 and 10, rather than a steady increase or decrease across rounds. As with the Cell Ratio, the origin or cause of these decreases remains a mystery.

Figure 4c. Search Ratio per Round



VI.D. Observed heuristics

In all three fixed effects regressions, highly significant subject effects are observed (Table 5). To investigate the variation across subjects, each subjects' decisions are categorized according to the heuristics discussed in section V. Specifically, the number of rounds each session that the subject chose 3 cells or less, 4 or 5 cells, and 6 or more cells in his/her final decision are tabulated. Based on the number of times the subject employed the given choice, the subject is then categorized as using a High Numbers, Medium Numbers or Low Numbers heuristic, respectively, in each of the four sessions. In five separate instances, a subject's decision is labeled Unable to Categorize.[23] Then a designation is assigned to the subject across all for sessions. If the subject receives a High Numbers designation in all four session, then s/he is categorized as High Numbers across all four sessions. The same rule is used to for the Medium and Low categorizations across all sessions. If the subject is categorized as using different heuristics in different sessions, then s/he is categorized as using a Mixed heuristic across session.[24] (The details are shown in an Appendix 4).

Table 6 shows the results of the categorization. There is indeed substantial variation across subjects. One regularity is the frequent use of the Low Numbers heuristic and the infrequent use of the High Numbers heuristic, both when heuristics are identified as "by individual session" or "across session." Approximately half (51%) of the subjects use the Low Numbers heuristic in all four sessions, and over 60% use this heuristic in the individual sessions. (Some of the subjects in the "by individual session"

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[23] In S1, subject 68 chooses the fixed payoff in all nine rounds and subject 79 chooses the fixed payoff in eight rounds. In S2, subject 47 chooses the fixed payoff in seven of the eight rounds. In S3 subject 50, and in S4 subject 49 appears to employ all three heuristics.

[24] Some assignments were somewhat arbitrary, but these were few in number. For this reason, no formal statistical analysis is performed on the data in Table 6. The interested reader is directed to Appendix 4.

Low Numbers row are categorized as Mixed across all four sessions.) By contrast, the corresponding percentages are 5% and about 10% for the Low Numbers heuristic. In general, the frequency with which each heuristic is observed corresponds with the profitability of the respective heuristic as shown in above in Table 3: the Low Numbers heuristic is the most profitable, Medium Numbers the second most profitable, and High Numbers is the least profitable. Most subjects (72%) do not vary their strategy across sessions, but a significant minority (28%) does employ more than one heuristic across sessions and are thus categorized as Mixed. Overall, subjects appear able to employ a heuristic or heuristics that approximates the optimal solution.

Table 6. *Ex Post* Categorization of Subject Heuristics

Heuristic	Across Sessions	By Individual Session			
		S1	S2	S3	S4
High Numbers (chooses 3 cells or less)	5% (4/80)	10% (8/80)	10% (8/80)	14% (11/80)	9% (7/80)
Medium Numbers (chooses 4 or 5 cells)	16% (13/80)	26% (21/80)	28% (22/80)	25% (20/80)	29% (22/80)
Low Numbers (chooses 6 or more cells)	51% (41/80)	61% (49/80)	61% (49/80)	60% (48/80)	63% (50/80)
Mixed (uses multiple strategies)	28% (22/80)	n/a	n/a	n/a	n/a
Unable to Categorize	n/a	3% (2/80)	1% (1/80)	1% (1/80)	1% (1/80)
Column Total	100% (80/80)	100% (80/80)	100% (80/80)	100% (80/80)	100% (80/80)

(Note to table is at top of next page)

Note: Subjects who receive the High, Medium or Low designation in the Across Sessions column are identified as using that heuristic in each of the four sessions. Of the 23 subjects who use the Mixed strategy, 6 use a combination of Low/Medium, 13 use Medium/High, 2 use Low/High, and 1 uses Low/Medium/High. In the Unable to Categorize row, the subjects who could not be categorized were different in each session, i.e., these are five separate subjects. See text and Appendix 4).

VII. Conclusion

This research utilizes the laboratory methods of experimental economics to examine individual decision-making over discrete multi-attribute goods. One example of such goods in the naturally occurring world is a flexible compensation or benefits package. Historically, the U.S. Navy has not offered such packages to its personnel. To the extent that such flexible packages increase employee satisfaction, they could potentially be used to induce enlistment and increase retention.

But decision-making in such a setting is complex, so increasing decision cost might offset the gains from increased flexibility. This research investigates, in a stylized environment, whether individuals can solve heuristically a challenging discrete multi-attribute goods problem. Analytically, the problem is a linear programming problem that requires sophisticated solution methods. The research also investigates if individuals prefer the decision problem to a “fixed payoff” option with a known payoff and a very low decision cost. One can think of this fixed payoff option as an alternative, defined benefits package.

There are two main results. First, the relative tradeoff between the attributes of the discrete good is a significant treatment variable. The discrete good has two attributes; one that is fixed across choices and one that varies across choices. When variable attribute has relatively more weight in the overall reward function, subjects earn a higher reward on average. One hypothesis is that that with greater weight on the variable attribute, subjects focus on the "essence of the problem" and develop heuristics that closely approximate the optimal solution. Overall, subjects do quite well, as most of the eighty subjects consistently earn 90% of the maximum possible reward. Further analysis reveals the majority of experimental subjects adopt heuristics that approximate the optimal solution to the complex linear programming problem.

Second, subjects rarely choose a fixed payoff option with a known payoff and low decision cost, even when the fixed payoff is 80% of the maximum possible under the decision-making task. This suggests that the subjects place a high implicit valuation on the flexibility in making choices, and that they appear confident in their ability to exceed the fixed payoff.

Collectively, the results suggest that individuals (at least, financially motivated experimental subjects) can indeed handle difficult decision-making tasks like those involving discrete multi-attribute goods. And these individuals systematically reveal a preference for the task, as they rarely opt for a fixed payoff option. This indicates that a flexible benefits package may be strongly preferred to a defined benefits package. Future research will reveal the limits of this preference, and the degree to which these results extrapolate to other populations, especially with regard to recruitment and retention of U.S. Navy personnel.

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Appendix 1. Matrices and Heuristics

Decision matrices viewed by subject

Session S1

Round 1

736	798	141	967	573
581	113	473	885	791
622	785	877	151	148
361	834	812	956	634
372	739	437	428	522

Round 2

369	848	304	196	190
661	843	726	1000	193
684	631	983	709	820
338	988	320	114	356
352	921	581	618	141

Round 3

366	462	469	287	916
444	351	472	268	335
371	245	742	626	807
955	247	394	173	441
983	683	670	513	361

Round 4

928	605	590	563	150
669	726	925	517	320
666	923	488	418	982
486	852	711	465	155
188	120	553	343	452

Round 5

429	667	556	779	167
541	588	452	637	195
240	241	197	850	399
527	946	806	117	216
332	690	514	290	100

Round 6

584	273	735	462	186
692	712	937	516	631
590	509	578	543	253
845	422	181	287	936
174	235	783	397	188

Round 7

500	707	812	407	630
346	331	368	140	780
886	181	312	535	936
776	128	533	286	398
346	391	329	879	589

Round 8

173	932	298	593	844
672	659	995	932	706
469	413	218	585	750
965	234	126	466	998
203	532	411	863	406

Round 9

546	589	305	434	301
472	834	658	373	627
726	587	541	364	427
261	485	713	235	889
481	559	899	577	531

Session S2

Round 1

807	393	889	727	559
145	976	475	462	466
567	825	211	115	196
782	708	960	251	349
821	916	818	248	679

Round 2

865	392	891	628	333
549	795	650	939	334
269	296	437	566	261
908	503	451	398	413
436	313	875	882	102

Round 3

769	831	406	634	987
858	768	740	962	670
351	494	381	319	640
733	170	820	947	913
465	470	237	203	618

Round 4

321	321	624	688	498
875	441	289	911	543
168	458	171	309	793
495	574	907	956	852
785	344	200	862	445

Round 5

276	190	993	778	109
394	285	525	903	237
472	724	104	841	440
238	555	484	259	270
658	265	360	198	983

Round 6

886	125	506	287	483
624	846	600	429	616
757	806	824	617	145
231	813	608	410	593
332	400	283	576	286

Round 7

967	826	115	362	828
941	991	406	459	379
994	333	724	604	439
856	257	199	380	461
469	726	199	366	858

Round 8

469	682	511	354	786
753	565	915	432	623
694	301	355	113	646
466	625	701	365	342
956	774	902	987	558

Session S3

Round 1

919	969	625	384	390
952	108	828	472	167
689	959	136	560	468
113	166	149	761	616
696	364	608	506	788

Round 2

623	750	163	266	744
687	725	324	313	699
828	758	956	934	796
476	273	839	332	784
818	797	298	331	378

Round 3

843	599	226	483	443
748	420	155	269	537
907	284	671	546	593
301	622	856	977	707
421	668	677	793	134

Round 4

684	795	749	982	387
910	423	557	356	817
407	471	256	657	257
206	774	351	376	370
483	493	179	868	166

Round 5

545	222	846	387	719
508	395	599	641	785
639	785	647	638	333
127	665	271	791	595
387	968	913	744	559

Round 6

609	567	224	186	403
354	625	689	654	731
475	519	238	733	292
416	129	278	496	140
976	440	438	479	898

Round 7

139	289	517	585	152
513	522	414	665	348
766	882	325	179	966
780	846	827	741	395
841	470	590	332	684

Round 8

427	481	643	459	574
433	656	171	626	449
394	318	140	359	102
293	718	238	854	326
291	632	322	909	247

Round 9

681	217	866	711	297
984	613	188	457	759
381	647	455	852	910
317	650	841	490	296
892	725	342	853	985

Round 10

970	241	148	368	580
885	679	556	972	126
571	652	149	112	746
686	869	438	686	383
511	431	507	653	984

Session S4

Round 1

161	462	462	393	304
663	446	649	107	959
397	285	595	806	270
351	889	757	930	476
715	236	211	370	427

Round 2

393	910	949	643	159
983	128	521	597	242
622	814	752	516	190
574	748	458	685	146
221	320	309	790	592

Round 3

962	309	851	664	247
304	866	842	975	324
412	162	998	479	648
902	220	315	151	429
533	969	697	891	577

Round 4

927	781	427	491	825
593	617	475	241	740
965	501	429	975	327
789	141	669	348	812
465	135	262	153	884

Round 5

986	551	755	924	765
344	897	907	851	609
517	616	238	801	248
923	480	797	800	381
932	838	701	527	522

Round 6

906	987	893	933	147
880	503	622	145	914
446	802	876	843	990
970	378	829	306	336
553	171	792	348	586

Round 7

409	628	515	458	628
292	872	357	813	695
281	179	851	826	626
217	280	377	648	153
645	671	978	421	857

Round 8

153	872	803	859	647
236	151	133	289	190
385	908	223	304	950
493	316	703	556	445
481	147	337	658	413

Round 9

136	326	592	289	493
902	599	439	391	843
545	140	233	482	617
467	834	761	768	793
939	523	299	207	365

Round 10

164	670	248	365	980
662	245	550	479	184
553	917	130	563	803
720	433	774	104	140
417	834	857	700	970

Round 11

1000	971	343	732	282
721	726	128	849	194
720	898	392	178	662
262	215	913	837	168
257	236	316	832	661

Appendix 2. Heuristics

See section V of text for description of heuristics.

S1 Round 1	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	7	3	5	7	7
payoff	2348	2475	2197	2460	2499	2535	2540
cell value sum	1923	1996	1714	2000	1999	1996	2000
remaining value limit	77	4	286	0	1	4	0
	967	573	428	967	622	634	437
	956	522	372	885	437	437	428
		473	361	148	428	372	372
		428	151		361	151	361
			148		151	148	148
			141			141	141
			113			113	113

S1 Round 2	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	8	3	5	7	8
payoff	2426	2468	2315	2458	2495	2532	2553
cell value sum	1988	1990	1796	1998	1996	1993	1994
remaining value limit	12	10	204	2	4	7	6
	1000	684	338	988	581	631	356
	988	581	320	820	369	338	352
		369	304	190	356	304	338
		356	196		352	196	304
			193		338	193	196
			190			190	193
			141			141	141
			114				114

S1 Round 3	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	7	3	5	7	7
payoff	2366	2478	2427	2452	2494	2535	2540
cell value sum	1938	1998	1906	1993	1995	1996	2000
remaining value limit	62	2	94	7	5	4	0
	983	626	351	983	513	441	371
	955	469	335	742	394	335	361
		462	287	268	371	287	335
		441	268		366	268	268
			247		351	247	247
			245			245	245
			173			173	173

S1 Round 4	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	7	3	5	7	7
payoff	2332	2476	2173	2447	2498	2533	2540
cell value sum	1910	1997	1694	1989	1998	1994	2000
remaining value limit	90	3	306	11	2	6	0
	982	563	418	982	465	488	517
	928	517	343	852	452	418	452
		465	320	155	418	343	418
		452	188		343	320	188
			155		320	155	155
			150			150	150
			120			120	120

S1 Round 5	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	9	3	5	9	9
payoff	2195	2475	2296	2452	2490	2580	2580
cell value sum	1796	1996	1763	1993	1992	2000	2000
remaining value limit	204	4	237	7	8	0	0
	946	588	290	946	527	527	527
	850	527	241	806	514	241	241
		452	240	241	452	240	240
		429	216		399	216	216
			197			197	197
			195			195	195
			167			167	167
			117			117	117
			100			100	100

S1 Round 6	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	8	3	5	7	8
payoff	2288	2468	2292	2450	2496	2540	2560
cell value sum	1873	1990	1777	1992	1997	2000	2000
remaining value limit	127	10	223	8	3	0	0
	937	543	287	936	578	783	397
	936	516	273	783	462	253	287
		509	253	273	397	235	273
		422	235		287	188	253
			188		273	186	235
			186			181	188
			181			174	186
			174				181

S1 Round 7	H_S	M_S	L_S	H_A	M_A	L_A	Optimal1	Optimal2
number of cells	2	4	7	3	5	7	7	7
payoff	2226	2470	2188	2455	2496	2534	2540	2540
cell value sum	1822	1992	1707	1996	1997	1995	2000	2000
remaining value limit	178	8	293	4	3	5	0	0
	936	589	331	936	500	391	500	407
	886	535	329	879	407	368	391	398
		500	312	181	398	329	331	329
		368	286		346	312	329	312
			181		346	286	181	286
			140			181	140	140
			128			128	128	128

S1 Round 8	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	7	3	5	7	7
payoff	2432	2479	2130	2458	2493	2533	2538
cell value sum	1993	1999	1658	1998	1994	1994	1998
remaining value limit	7	1	342	2	6	6	2
	998	585	406	932	466	532	466
	995	532	298	863	413	413	406
		469	234	203	411	298	298
		413	218		406	234	234
			203		298	218	218
			173			173	203
			126			126	173

S1 Round 9	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	6	3	5	6	6
payoff	2186	2476	2327	2453	2500	2516	2516
cell value sum	1788	1997	1839	1994	2000	1997	1997
remaining value limit	212	3	161	6	0	3	3
	899	559	373	899	531	531	531
	889	485	364	834	427	364	364
		481	305	261	373	305	305
		472	301		364	301	301
			261		305	261	261
			235			235	235

S2 Round 1	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	8	3	5	8	8
payoff	2523	2793	3090	2689	2892	3188	3188
cell value sum	1936	1994	1908	1991	1993	1990	1990
remaining value limit	64	6	92	9	7	10	10
	976	567	393	960	679	475	475
	960	559	349	916	466	349	349
		475	251	115	349	251	251
		393	248		251	248	248
			211		248	211	211
			196			196	196
			145			145	145
			115			115	115

S2 Round 2	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	7	3	5	7	7
payoff	2416	2794	2990	2694	2898	3084	3092
cell value sum	1847	1995	1908	1995	1998	1987	1993
remaining value limit	153	5	92	5	2	13	7
	939	628	334	939	451	413	398
	908	503	333	795	437	333	334
		451	313	261	436	313	333
		413	296		413	296	296
			269		261	269	269
			261			261	261
			102			102	102

S2 Round 3	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	6	3	5	6	6
payoff	2539	2786	2593	2688	2883	2982	2983
cell value sum	1949	1988	1661	1990	1986	1985	1986
remaining value limit	51	12	339	10	14	15	14
	987	670	381	962	470	494	470
	962	618	351	858	465	381	406
		381	319	170	381	351	351
		319	237		351	319	319
			203		319	237	237
			170			203	203

S2 Round 4	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	7	3	5	7	7
payoff	2440	2793	2835	2699	2896	3089	3089
cell value sum	1867	1994	1779	1999	1997	1991	1991
remaining value limit	133	6	221	1	3	9	9
	956	543	321	956	458	498	498
	911	498	321	875	445	344	344
		495	309	168	441	321	321
		458	289		344	289	289
			200		309	200	200
			171			171	171
			168			168	168

S2 Round 5	H_S	M_S	L_S	H_A	M_A	L_A	Optimal1	Optimal2
number of cells	2	4	9	3	5	9	9	9
payoff	2571	2790	3144	2700	2894	3293	3299	3299
cell value sum	1976	1992	1870	2000	1995	1994	1999	1999
remaining value limit	24	8	130	0	5	6	1	1
	993	555	270	993	525	394	360	394
	983	525	265	903	440	265	276	270
		472	259	104	394	259	265	259
		440	238		360	238	259	238
			237		276	237	238	237
			198			198	198	198
			190			190	190	190
			109			109	109	109
			104			104	104	104

S2 Round 6	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	7	3	5	7	7
payoff	2278	2793	2727	2689	2889	3094	3100
cell value sum	1732	1994	1689	1991	1991	1995	2000
remaining value limit	268	6	311	9	9	5	0
	886	576	332	846	506	593	429
	846	506	287	813	483	332	400
		483	286	332	429	286	332
		429	283		287	283	286
			231		286	231	283
			145			145	145
			125			125	125

S2 Round 7	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	7	3	5	7	7
payoff	2582	2792	2897	2698	2899	3096	3100
cell value sum	1985	1993	1831	1998	1999	1997	2000
remaining value limit	15	7	169	2	1	3	0
	994	604	366	941	459	459	380
	991	469	362	858	439	406	379
		461	333	199	406	362	366
		459	257		362	257	362
			199		333	199	199
			199			199	199
			115			115	115

S2 Round 8	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	6	3	5	6	6
payoff	2532	2799	2796	2681	2893	2999	2999
cell value sum	1943	1999	1830	1984	1994	1999	1999
remaining value limit	57	1	170	16	6	1	1
	987	565	355	956	511	511	511
	956	558	354	915	432	365	365
		511	342	113	355	355	355
		365	301		354	354	354
			113		342	301	301
						113	113

S3 Round 1	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	9	3	5	8	8
payoff	2354	2480	2552	2449	2496	2560	2560
cell value sum	1928	2000	1977	1991	1997	2000	2000
remaining value limit	72	0	23	9	3	0	0
	969	608	390	959	506	689	689
	959	560	384	919	472	472	472
		468	364	113	468	167	167
		364	167		384	166	166
			166		167	149	149
			149			136	136
			136			113	113
			113			108	108
			108				

S3 Round 2	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	7	3	5	6	7
payoff	2308	2478	2502	2458	2499	2520	2524
cell value sum	1890	1998	1968	1998	1999	2000	1987
remaining value limit	110	2	32	2	1	0	13
	956	699	331	839	699	687	332
	934	623	324	828	332	313	331
		378	313	331	331	298	324
		298	298		324	273	298
			273		313	266	273
			266			163	266
			163				163

S3 Round 3	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	7	3	5	7	7
payoff	2301	2479	2287	2447	2494	2529	2533
cell value sum	1884	1999	1789	1989	1995	1991	1994
remaining value limit	116	1	211	11	5	9	6
	977	599	420	907	546	622	483
	907	537	301	856	443	301	443
		443	284	226	421	284	284
		420	269		301	269	269
			226		284	226	226
			155			155	155
			134			134	134

S3 Round 4	H_S	M_S	L_S	H_A	M_A	L_A	Optimal1	Optimal2
number of cells	2	4	7	3	5	7	7	7
payoff	2310	2478	2265	2459	2496	2529	2540	2540
cell value sum	1892	1998	1771	1999	1997	1991	2000	2000
remaining value limit	108	2	229	1	3	9	0	0
	982	657	356	817	471	557	376	471
	910	483	351	795	407	370	370	370
		471	257	387	387	257	356	351
		387	256		376	256	257	257
			206		356	206	256	206
			179			179	206	179
			166			166	179	166

S3 Round 5	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	6	3	5	6	6
payoff	2297	2479	2192	2448	2499	2516	2516
cell value sum	1881	1999	1727	1990	1999	1997	1997
remaining value limit	119	1	273	10	1	3	3
	968	559	387	913	559	595	595
	913	545	387	744	395	395	395
		508	333	333	387	387	387
		387	271		387	271	271
			222		271	222	222
			127			127	127

S3 Round 6	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	8	3	5	8	8
payoff	2289	2479	2369	2459	2499	2547	2547
cell value sum	1874	1999	1841	1999	1999	1989	1989
remaining value limit	126	1	159	1	1	11	11
	976	567	354	976	475	440	440
	898	519	292	731	440	354	354
		475	278	292	438	278	278
		438	238		354	238	238
			224		292	224	224
			186			186	186
			140			140	140
			129			129	129

S3 Round 7	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	7	3	5	7	7
payoff	2258	2469	2257	2449	2494	2535	2539
cell value sum	1848	1991	1764	1991	1995	1996	1999
remaining value limit	152	9	236	9	5	4	1
	966	590	348	966	513	517	513
	882	517	332	846	414	395	395
		470	325	179	395	325	332
		414	289		348	289	289
			179		325	179	179
			152			152	152
			139			139	139

S3 Round 8	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	8	3	5	8	8
payoff	2156	2479	2320	2460	2493	2550	2560
cell value sum	1763	1999	1800	2000	1994	1992	2000
remaining value limit	237	1	200	0	6	8	0
	909	626	318	718	449	481	359
	854	574	293	656	433	322	326
		481	291	626	427	291	318
		318	247		359	247	293
			238		326	238	291
			171			171	171
			140			140	140
			102			102	102

S3 Round 9	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	6	3	5	6	6
payoff	2403	2480	2108	2448	2500	2515	2518
cell value sum	1969	2000	1657	1990	2000	1996	1998
remaining value limit	31	0	343	10	0	4	2
	985	711	342	910	490	681	490
	984	490	317	892	457	317	381
		457	297	188	455	297	317
		342	296		381	296	297
			217		217	217	296
			188			188	217

S3 Round 10	H_S	M_S	L_S	H_A	M_A	L_A	Optimal1	Optimal2
number of cells	2	4	8	3	5	7	7	7
payoff	2387	2480	2510	2454	2500	2536	2540	2540
cell value sum	1956	2000	1958	1995	2000	1997	2000	2000
remaining value limit	44	0	42	5	0	3	0	0
	984	679	431	885	507	571	653	571
	972	507	383	869	438	431	571	511
		431	368	241	431	368	241	383
		383	241		383	241	149	149
			149		241	148	148	148
			148			126	126	126
			126			112	112	112
			112					

S4 Round 1	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	8	3	5	8	8
payoff	2467	2794	3110	2695	2889	3189	3189
cell value sum	1889	1995	1925	1996	1991	1991	1991
remaining value limit	111	5	75	4	9	9	9
	959	595	351	959	462	370	370
	930	476	304	930	462	351	351
		462	285	107	393	285	285
		462	270		370	270	270
			236		304	236	236
			211			211	211
			161			161	161
			107			107	107

S4 Round 2	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	8	3	5	8	8
payoff	2518	2793	2858	2696	2895	3198	3200
cell value sum	1932	1994	1715	1997	1996	1998	2000
remaining value limit	68	6	285	3	4	2	0
	983	622	320	814	516	592	521
	949	521	309	790	458	320	393
		458	242	393	393	242	242
		393	221		320	221	221
			190		309	190	190
			159			159	159
			146			146	146
			128			128	128

S4 Round 3	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	7	3	5	7	7
payoff	2568	2800	2750	2688	2892	3090	3098
cell value sum	1973	2000	1708	1990	1993	1992	1998
remaining value limit	27	0	292	10	7	8	2
	998	664	315	962	533	479	429
	975	533	309	866	429	429	412
		479	304	162	412	304	315
		324	247		315	247	309
			220		304	220	220
			162			162	162
			151			151	151

S4 Round 4	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	7	3	5	7	7
payoff	2528	2798	2628	2692	2895	3099	3100
cell value sum	1940	1998	1607	1993	1996	1999	2000
remaining value limit	60	2	393	7	4	1	0
	975	593	348	927	465	740	593
	965	501	327	825	429	327	475
		475	262	241	427	262	262
		429	241		348	241	241
			153		327	153	153
			141			141	141
			135			135	135

S4 Round 5	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	5	3	5	5	5
payoff	2502	2796	2529	2695	2893	2896	2900
cell value sum	1918	1997	1691	1996	1994	1997	2000
remaining value limit	82	3	309	4	6	3	0
	986	609	480	897	551	616	616
	932	527	381	851	480	551	517
		480	344	248	381	344	381
		381	248		344	248	248
			238		238	238	238

S4 Round 6	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	7	3	5	7	7
payoff	2572	2788	2897	2693	2887	3098	3098
cell value sum	1977	1990	1831	1994	1989	1998	1998
remaining value limit	23	10	169	6	11	2	2
	990	586	378	933	553	503	503
	987	553	348	914	446	378	378
		503	336	147	348	348	348
		348	306		336	306	306
			171		306	171	171
			147			147	147
			145			145	145

S4 Round 7

number of cells	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
payoff	2	4	7	3	5	7	7
cell value sum	2420	2795	2811	2700	2893	3092	3100
remaining value limit	1850	1996	1759	2000	1994	1993	2000
	150	4	241	0	6	7	0
	978	695	357	857	515	357	458
	872	515	292	851	421	292	421
		409	281	292	409	280	292
		377	280		357	217	280
			217		292	179	217
			179			153	179
			153				153

S4 Round 8	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	9	3	5	9	9
payoff	2430	2795	3091	2689	2900	3293	3300
cell value sum	1858	1996	1826	1991	2000	1994	2000
remaining value limit	142	4	174	9	0	6	0
	950	658	304	950	493	445	385
	908	556	289	908	481	316	316
		445	236	133	385	236	289
		337	223		337	223	236
			190		304	190	190
			153			153	153
			151			151	151
			147			147	147
			133			133	133

S4 Round 9	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	8	3	5	8	8
payoff	2409	2800	3194	2693	2886	3194	3194
cell value sum	1841	2000	1995	1994	1988	1995	1995
remaining value limit	159	0	5	6	12	5	5
	939	545	365	902	467	365	365
	902	523	326	793	439	326	326
		493	299	299	391	299	299
		439	289		365	289	289
			233		326	233	233
			207			207	207
			140			140	140
			136			136	136

S4 Round 10	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	9	3	5	9	9
payoff	2540	2799	3296	2689	2898	3296	3296
cell value sum	1950	1999	1997	1991	1998	1997	1997
remaining value limit	50	1	3	9	2	3	3
	980	553	417	970	553	417	417
	970	550	365	917	479	365	365
		479	248	104	417	248	248
		417	245		365	245	245
			184		184	184	184
			164			164	164
			140			140	140
			130			130	130
			104			104	104

S4 Round 11	H_S	M_S	L_S	H_A	M_A	L_A	Optimal
number of cells	2	4	9	3	5	9	9
payoff	2566	2796	3204	2696	2893	3277	3300
cell value sum	1971	1997	1920	1997	1994	1981	2000
remaining value limit	30	3	80	3	6	19	0
	1000	662	282	971	661	343	316
	971	661	262	898	392	262	282
		392	257	128	343	257	262
		282	236		316	236	257
			215		282	215	215
			194			194	194
			178			178	178
			168			168	168
			128			128	128

Appendix 3. SAS Regression Output

Table A3-1. “Earnings Ratio” Regression Output

Analysis of Variance

Source	Degrees of freedom	Sum of Squares	Mean Square	F statistic, p-value	R^2, Adjusted R^2
Model	94	29.39607	0.31272	196.89	0. 8627
Error	2945	4.67763	0.00159	<.0001	0. 8583
Corrected Total	3039	34.07370			

Root MSE	Dependent Mean	Coefficient of Variation
0.03985	0.94678	4.20940

Parameter	Estimated coefficient	Standard Error	t-statistic	p-value
β_0	1.00954	0.00692	145.80	<.0001
β_F	-0.18580	0.00434	-42.78	<.0001
β_T	-0.95534	0.00847	-112.73	<.0001
β_{S2}	-0.02598	0.00219	**-11.88**	<.0001
β_{S3}	-0.00162	0.00209	-0.78	0.4368
β_{S4}	-0.03900	0.00209	-18.66	<.0001
β_{R2}	-0.00049	0.00315	-0.16	0.8762
β_{R3}	0.00482	0.00315	1.53	0.1261
β_{R4}	0.00025	0.00315	0.08	0.9361
β_{R5}	0.00291	0.00315	0.92	0.3560
β_{R6}	0.00166	0.00315	0.53	0.5989
β_{R7}	0.00328	0.00315	1.04	0.2977
β_{R8}	-0.00086	0.00315	-0.27	0.7845
β_{R9}	-0.00310	0.00343	-0.90	0.3671
β_{R10}	-0.00430	0.00393	-1.09	0.2747
β_{R11}	-0.00468	0.00514	-0.91	0.3629
β_{Sub2}	-0.00460	0.00915	-0.50	0.6147
β_{Sub3}	-0.01758	0.00914	-1.92	0.0547
β_{Sub4}	-0.10625	0.00914	-11.62	<.0001
β_{Sub5}	-0.06743	0.00914	-7.37	<.0001
β_{Sub6}	0.00300	0.00914	0.33	0.7432
β_{Sub7}	0.00220	0.00914	0.24	0.8099
β_{Sub8}	-0.04853	0.00915	-5.31	<.0001
β_{Sub9}	-0.00162	0.00919	-0.18	0.8604
β_{Sub10}	-0.01669	0.00914	-1.83	0.0681

β_{Sub11}	0.00146	0.00914	0.16	0.8732
β_{Sub12}	-0.01443	0.00914	-1.58	0.1147
β_{Sub13}	-0.00805	0.00915	-0.88	0.3790
β_{Sub14}	0.00034	0.00914	0.04	0.9705
β_{Sub15}	0.00202	0.00914	0.22	0.8249
β_{Sub16}	-0.06677	0.00915	-7.30	<.0001
β_{Sub17}	0.00255	0.00914	0.28	0.7803
β_{Sub18}	0.00052	0.00914	0.06	0.9543
β_{Sub19}	-0.00154	0.00914	-0.17	0.8664
β_{Sub20}	-0.02482	0.00915	-2.71	0.0067
β_{Sub21}	-0.01463	0.00914	-1.60	0.1097
β_{Sub22}	-0.04169	0.00914	-4.56	<.0001
β_{Sub23}	0.00131	0.00914	0.14	0.8858
β_{Sub24}	-0.06703	0.00915	-7.32	<.0001
β_{Sub25}	-0.01982	0.00914	-2.17	0.0303
β_{Sub26}	0.00241	0.00915	0.26	0.7924
β_{Sub27}	-0.00012	0.00914	-0.01	0.9894
β_{Sub28}	-0.00463	0.00914	-0.51	0.6126
β_{Sub29}	-0.01299	0.00914	-1.42	0.1553
β_{Sub30}	0.00032	0.00915	0.03	0.9721
β_{Sub31}	0.00124	0.00914	0.14	0.8924
β_{Sub32}	-0.01606	0.00914	-1.76	0.0791
β_{Sub33}	-0.01606	0.00914	-1.76	0.0791
β_{Sub34}	0.00083	0.00914	0.09	0.9273
β_{Sub35}	-0.05040	0.00914	-5.51	<.0001
β_{Sub36}	-0.04548	0.00919	-4.95	<.0001
β_{Sub37}	-0.01384	0.00914	-1.51	0.1302
β_{Sub38}	-0.15961	0.00923	-17.29	<.0001
β_{Sub39}	-0.07873	0.00915	-8.61	<.0001
β_{Sub40}	-0.04876	0.00915	-5.33	<.0001
β_{Sub41}	-0.05821	0.00915	-6.36	<.0001
β_{Sub42}	-0.01527	0.00914	-1.67	0.0951
β_{Sub43}	-0.03517	0.00914	-3.85	0.0001
β_{Sub44}	-0.08057	0.00914	-8.81	<.0001
β_{Sub45}	-0.05476	0.00914	-5.99	<.0001
β_{Sub46}	-0.01899	0.00920	-2.06	0.0391
β_{Sub47}	-0.04525	0.00918	-4.93	<.0001
β_{Sub48}	-0.07498	0.00914	-8.20	<.0001
β_{Sub49}	-0.04983	0.00916	-5.44	<.0001
β_{Sub50}	-0.04265	0.00915	-4.66	<.0001
β_{Sub51}	-0.02987	0.00914	-3.27	0.0011

β_{Sub52}	-0.04831	0.00915	-5.28	<.0001
β_{Sub53}	-0.03883	0.00914	-4.25	<.0001
β_{Sub54}	-0.05887	0.00915	-6.44	<.0001
β_{Sub55}	-0.05698	0.00915	-6.23	<.0001
β_{Sub56}	-0.12341	0.00915	-13.48	<.0001
β_{Sub57}	-0.02504	0.00914	-2.74	0.0062
β_{Sub58}	-0.02333	0.00914	-2.55	0.0108
β_{Sub59}	-0.07089	0.00915	-7.75	<.0001
β_{Sub60}	-0.04356	0.00915	-4.76	<.0001
β_{Sub61}	-0.01255	0.00915	-1.37	0.1701
β_{Sub62}	0.00437	0.00914	0.48	0.6328
β_{Sub63}	-0.07072	0.00914	-7.73	<.0001
β_{Sub64}	-0.04792	0.00914	-5.24	<.0001
β_{Sub65}	-0.00466	0.00915	-0.51	0.6102
β_{Sub66}	-0.04716	0.00915	-5.15	<.0001
β_{Sub67}	-0.02097	0.00914	-2.29	0.0219
β_{Sub68}	-0.05869	0.00925	-6.35	<.0001
β_{Sub69}	-0.01337	0.00914	-1.46	0.1436
β_{Sub70}	-0.02974	0.00914	-3.25	0.0012
β_{Sub71}	-0.00639	0.00918	-0.70	0.4865
β_{Sub72}	-0.05416	0.00915	-5.92	<.0001
β_{Sub73}	-0.01995	0.00914	-2.18	0.0292
β_{Sub74}	-0.00809	0.00915	-0.88	0.3766
β_{Sub75}	-0.00544	0.00914	-0.60	0.5517
β_{Sub76}	-0.14933	0.00914	-16.33	<.0001
β_{Sub77}	-0.00866	0.00915	-0.95	0.3440
β_{Sub78}	-0.00009	0.00915	-0.01	0.9924
β_{Sub79}	-0.02579	0.00920	-2.80	0.0051
β_{Sub80}	-0.07020	0.00914	-7.68	<.0001

F tests for restrictions

Test	Source	d.f.	Mean Square	F-statistic, p-value
H_0: $\beta_{S2} = \beta_{S3} = \beta_{S4} = 0$	Numerator	3	0.27632	173.97
	Denominator	2945	0.00159	<.0001
H_0: $\beta_{R2} = \beta_{R3} = \ldots = \beta_{R11} = 0$	Numerator	10	0.00197	1.24
	Denominator	2945	0.00159	.2598
H_0: $\beta_{Sub2} = \beta_{Sub3} = \ldots = \beta_{Sub80} = 0$	Numerator	79	0.04468	28.13
	Denominator	2945	0.00159	<.0001

Table A3-2. “Cells Ratio” Regression Output

	Analysis of Variance				
Source	Degrees of freedom	Sum of Squares	Mean Square	F statistic, p-value	R^2, Adjusted R^2
Model	94	175.59962	1.86808	111.23	0. 7802
Error	2945	49.46135	0.01680	<.0001	0. 7732
Corrected Total	3039	225.06098			

Root MSE	Dependent Mean	Coefficient of Variation
0.12960	0.77029	16.82437

Parameter	Estimated coefficient	Standard Error	t-statistic	p-value
β_0	0.98658	0.02252	43.82	<.0001
β_F	-0.73903	0.01412	-52.33	<.0001
β_T	-0.74120	0.02756	-26.90	<.0001
β_{S2}	0.01868	0.00711	2.63	0.0086
β_{S3}	0.02552	0.00679	3.76	0.0002
β_{S4}	0.01304	0.00680	1.92	0.0552
β_{R2}	-0.03354	0.01025	-3.27	0.0011
β_{R3}	-0.00647	0.01025	-0.63	0.5278
β_{R4}	-0.00152	0.01025	-0.15	0.8824
β_{R5}	0.00032	0.01025	**0.03**	0.9754
β_{R6}	-0.04079	0.01025	-3.98	<.0001
β_{R7}	0.00688	0.01025	0.67	0.5020
β_{R8}	-0.02201	0.01025	-2.15	0.0318
β_{R9}	-0.00559	0.01117	-0.50	0.6166
β_{R10}	-0.00268	0.01279	-0.21	0.8341
β_{R11}	-0.02447	0.01671	-1.46	0.1431
β_{Sub2}	-0.00650	0.02974	-0.22	0.8271
β_{Sub3}	-0.11372	0.02973	-3.82	0.0001
β_{Sub4}	-0.49691	0.02973	-16.71	<.0001
β_{Sub5}	-0.37532	0.02973	-12.62	<.0001
β_{Sub6}	-0.01728	0.02973	-0.58	0.5611
β_{Sub7}	-0.03091	0.02973	-1.04	0.2986
β_{Sub8}	-0.30138	0.02974	-10.13	<.0001
β_{Sub9}	-0.04755	0.02989	-1.59	0.1117
β_{Sub10}	-0.18749	0.02973	-6.31	<.0001
β_{Sub11}	-0.03295	0.02973	-1.11	0.2679
β_{Sub12}	-0.10563	0.02973	-3.55	0.0004
β_{Sub13}	-0.07323	0.02974	-2.46	0.0139

β_{Sub14}	-0.00705	0.02973	-0.24	0.8126
β_{Sub15}	0.00386	0.02973	0.13	0.8966
β_{Sub16}	-0.48510	0.02976	-16.30	<.0001
β_{Sub17}	0.00799	0.02973	0.27	0.7882
β_{Sub18}	-0.01331	0.02973	-0.45	0.6543
β_{Sub19}	-0.04026	0.02973	-1.35	0.1758
β_{Sub20}	-0.25267	0.02974	-8.50	<.0001
β_{Sub21}	-0.09202	0.02973	-3.09	0.0020
β_{Sub22}	-0.29933	0.02973	-10.07	<.0001
β_{Sub23}	0.00094	0.02973	0.03	0.9748
β_{Sub24}	-0.49006	0.02977	-16.46	<.0001
β_{Sub25}	0.00668	0.02973	0.22	0.8222
β_{Sub26}	0.00739	0.02974	0.25	0.8037
β_{Sub27}	0.00423	0.02973	0.14	0.8869
β_{Sub28}	-0.07116	0.02973	-2.39	0.0168
β_{Sub29}	-0.09352	0.02973	-3.15	0.0017
β_{Sub30}	-0.02545	0.02974	-0.86	0.3922
β_{Sub31}	0.01128	0.02973	0.38	0.7045
β_{Sub32}	-0.04442	0.02973	-1.49	0.1352
β_{Sub33}	-0.08720	0.02973	-2.93	0.0034
β_{Sub34}	-0.00851	0.02973	-0.29	0.7747
β_{Sub35}	-0.33328	0.02973	-11.21	<.0001
β_{Sub36}	-0.06105	0.02988	-2.04	0.0411
β_{Sub37}	-0.08179	0.02973	-2.75	0.0060
β_{Sub38}	-0.51129	0.03001	-17.04	<.0001
β_{Sub39}	-0.56407	0.02974	-18.97	<.0001
β_{Sub40}	-0.38198	0.02976	-12.83	<.0001
β_{Sub41}	-0.40053	0.02974	-13.47	<.0001
β_{Sub42}	-0.03195	0.02973	-1.07	0.2826
β_{Sub43}	-0.26181	0.02973	-8.81	<.0001
β_{Sub44}	-0.52629	0.02973	-17.70	<.0001
β_{Sub45}	-0.37717	0.02973	-12.69	<.0001
β_{Sub46}	-0.15307	0.02992	-5.12	<.0001
β_{Sub47}	-0.35972	0.02984	-12.05	<.0001
β_{Sub48}	-0.52536	0.02973	-17.67	<.0001
β_{Sub49}	-0.36149	0.02979	-12.13	<.0001
β_{Sub50}	-0.29675	0.02975	-9.97	<.0001
β_{Sub51}	-0.19177	0.02973	-6.45	<.0001
β_{Sub52}	-0.32640	0.02974	-10.98	<.0001
β_{Sub53}	-0.24212	0.02973	-8.14	<.0001
β_{Sub54}	-0.43681	0.02974	-14.69	<.0001

β_{Sub55}	-0.42566	0.02975	-14.31	<.0001
β_{Sub56}	-0.31313	0.02977	-10.52	<.0001
β_{Sub57}	-0.16086	0.02973	-5.41	<.0001
β_{Sub58}	-0.01848	0.02973	-0.62	0.5342
β_{Sub59}	-0.44831	0.02974	-15.07	<.0001
β_{Sub60}	-0.05462	0.02977	-1.83	0.0666
β_{Sub61}	-0.06947	0.02974	-2.34	0.0196
β_{Sub62}	0.01420	0.02973	0.48	0.6329
β_{Sub63}	-0.47403	0.02973	-15.94	<.0001
β_{Sub64}	-0.30214	0.02973	-10.16	<.0001
β_{Sub65}	-0.03033	0.02974	-1.02	0.3079
β_{Sub66}	-0.20925	0.02977	-7.03	<.0001
β_{Sub67}	-0.13523	0.02973	-4.55	<.0001
β_{Sub68}	-0.33648	0.03006	-11.19	<.0001
β_{Sub69}	-0.04872	0.02973	-1.64	0.1014
β_{Sub70}	-0.20952	0.02973	-7.05	<.0001
β_{Sub71}	-0.05711	0.02984	-1.91	0.0558
β_{Sub72}	-0.37149	0.02974	-12.49	<.0001
β_{Sub73}	-0.05728	0.02973	-1.93	0.0541
β_{Sub74}	-0.08635	0.02977	-2.90	0.0037
β_{Sub75}	-0.03382	0.02973	-1.14	0.2554
β_{Sub76}	-0.27223	0.02973	-9.16	<.0001
β_{Sub77}	-0.06862	0.02974	-2.31	0.0211
β_{Sub78}	-0.03224	0.02974	-1.08	0.2784
β_{Sub79}	-0.12421	0.02992	-4.15	<.0001
β_{Sub80}	-0.50557	0.02973	-17.00	<.0001

F tests for restrictions

Test	Source	d.f.	Mean Square	F-statistic, p-value
H_0: $\beta_{S2} = \beta_{S3} = \beta_{S4} = 0$	Numerator	3	0.08518	5.07
	Denominator	2945	0.01680	.0017
H_0: $\beta_{R2} = \beta_{R3} = \ldots = \beta_{R11} = 0$	Numerator	10	0.07332	4.37
	Denominator	2945	0.01680	<.0001
H_0: $\beta_{Sub2} = \beta_{Sub3} = \ldots = \beta_{Sub80} = 0$	Numerator	79	1.19040	70.88
	Denominator	2945	0.01680	<.0001

Table A3-3. “Search Ratio” Regression Output

Analysis of Variance

Source	Degrees of freedom	Sum of Squares	Mean Square	F statistic, p-value	R^2, Adjusted R^2
Model	94	377.10067	4.01171	29.72	0. 4869
Error	2945	397.46246	0.13496	<.0001	0.4705
Corrected Total	3039	774.56313			

Root MSE	Dependent Mean	Coefficient of Variation
0.36737	1.29599	28.34678

Parameter	Estimated coefficient	Standard Error	t-statistic	p-value
β_0	1.29131	0.06383	20.23	<.0001
β_F	-1.28863	0.04004	-32.19	<.0001
β_T	-1.47913	0.07812	-18.93	<.0001
β_{S2}	-0.04566	0.02016	-2.27	0.0236
β_{S3}	-0.03217	0.01923	-1.67	0.0945
β_{S4}	-0.04096	0.01927	-2.13	0.0336
β_{R2}	0.07200	0.02906	2.48	0.0133
β_{R3}	0.05952	0.02905	2.05	0.0405
β_{R4}	0.05967	0.02905	2.05	0.0400
β_{R5}	0.05248	0.02905	1.81	0.0709
β_{R6}	0.00374	0.02905	0.13	0.8976
β_{R7}	0.03586	0.02906	1.23	0.2172
β_{R8}	0.04768	0.02905	1.64	0.1008
β_{R9}	0.04962	0.03165	1.57	0.1171
β_{R10}	-0.05033	0.03626	-1.39	0.1653
β_{R11}	0.05949	0.04736	1.26	0.2092
β_{Sub2}	0.01130	0.08431	0.13	0.8934
β_{Sub3}	0.12236	0.08428	1.45	0.1467
β_{Sub4}	-0.29905	0.08428	-3.55	0.0004
β_{Sub5}	0.25297	0.08429	3.00	0.0027
β_{Sub6}	0.03876	0.08428	0.46	0.6456
β_{Sub7}	0.04571	0.08428	0.54	0.5876
β_{Sub8}	0.64274	0.08431	7.62	<.0001
β_{Sub9}	-0.11023	0.08473	-1.30	0.1934
β_{Sub10}	0.03397	0.08428	0.40	0.6869
β_{Sub11}	0.24727	0.08428	2.93	0.0034
β_{Sub12}	0.31818	0.08428	3.78	0.0002
β_{Sub13}	0.21618	0.08431	2.56	0.0104

β_{Sub14}	0.06169	0.08428	0.73	0.4643
β_{Sub15}	-0.02679	0.08428	-0.32	0.7506
β_{Sub16}	0.41792	0.08437	4.95	<.0001
β_{Sub17}	0.05781	0.08428	0.69	0.4928
β_{Sub18}	0.02602	0.08428	0.31	0.7575
β_{Sub19}	0.00352	0.08428	0.04	0.9667
β_{Sub20}	0.15734	0.08431	1.87	0.0621
β_{Sub21}	0.10840	0.08429	1.29	0.1985
β_{Sub22}	0.21687	0.08428	2.57	0.0101
β_{Sub23}	-0.07578	0.08428	-0.90	0.3686
β_{Sub24}	0.89070	0.08438	10.56	<.0001
β_{Sub25}	-0.29466	0.08428	-3.50	0.0005
β_{Sub26}	-0.13298	0.08431	-1.58	0.1148
β_{Sub27}	-0.05430	0.08428	-0.64	0.5194
β_{Sub28}	0.10951	0.08428	1.30	0.1939
β_{Sub29}	-0.01683	0.08428	-0.20	0.8417
β_{Sub30}	0.07327	0.08431	0.87	0.3849
β_{Sub31}	-0.05504	0.08428	-0.65	0.5137
β_{Sub32}	-0.00689	0.08428	-0.08	0.9348
β_{Sub33}	-0.04206	0.08428	-0.50	0.6178
β_{Sub34}	-0.13633	0.08428	-1.62	0.1059
β_{Sub35}	-0.05842	0.08428	-0.69	0.4883
β_{Sub36}	-0.23829	0.08470	-2.81	0.0049
β_{Sub37}	-0.12220	0.08429	-1.45	0.1472
β_{Sub38}	-0.12339	0.08507	-1.45	0.1470
β_{Sub39}	-0.19872	0.08431	-2.36	0.0185
β_{Sub40}	-0.02286	0.08437	-0.27	0.7864
β_{Sub41}	-0.28386	0.08431	-3.37	0.0008
β_{Sub42}	-0.03509	0.08428	-0.42	0.6772
β_{Sub43}	0.28091	0.08429	3.33	0.0009
β_{Sub44}	0.32113	0.08428	3.81	0.0001
β_{Sub45}	0.04700	0.08428	0.56	0.5771
β_{Sub46}	-0.00923	0.08481	-0.11	0.9133
β_{Sub47}	0.11815	0.08460	1.40	0.1626
β_{Sub48}	0.55020	0.08428	6.53	<.0001
β_{Sub49}	-0.21941	0.08445	-2.60	0.0094
β_{Sub50}	-0.02134	0.08434	-0.25	0.8002
β_{Sub51}	0.43853	0.08428	5.20	<.0001
β_{Sub52}	0.19041	0.08431	2.26	0.0240
β_{Sub53}	0.14544	0.08428	1.73	0.0845
β_{Sub54}	0.25449	0.08431	3.02	0.0026

β_{Sub55}	0.16164	0.08433	1.92	0.0554
β_{Sub56}	-0.20344	0.08439	-2.41	0.0160
β_{Sub57}	0.13168	0.08428	1.56	0.1183
β_{Sub58}	-0.23638	0.08428	-2.80	0.0051
β_{Sub59}	0.11707	0.08431	1.39	0.1651
β_{Sub60}	-0.07769	0.08439	-0.92	0.3573
β_{Sub61}	0.06869	0.08431	0.81	0.4153
β_{Sub62}	-0.10931	0.08428	-1.30	0.1947
β_{Sub63}	0.19218	0.08428	2.28	0.0227
β_{Sub64}	0.04537	0.08428	0.54	0.5904
β_{Sub65}	-0.06985	0.08431	-0.83	0.4074
β_{Sub66}	-0.14807	0.08438	-1.75	0.0794
β_{Sub67}	-0.01817	0.08428	-0.22	0.8293
β_{Sub68}	0.37324	0.08522	4.38	<.0001
β_{Sub69}	-0.16954	0.08428	-2.01	0.0444
β_{Sub70}	-0.18176	0.08428	-2.16	0.0311
β_{Sub71}	-0.13713	0.08460	-1.62	0.1052
β_{Sub72}	-0.13674	0.08431	-1.62	0.1049
β_{Sub73}	-0.08734	0.08428	-1.04	0.3001
β_{Sub74}	0.31555	0.08438	3.74	0.0002
β_{Sub75}	0.20048	0.08428	2.38	0.0174
β_{Sub76}	-0.13044	0.08428	-1.55	0.1218
β_{Sub77}	0.19852	0.08431	2.35	0.0186
β_{Sub78}	0.05173	0.08431	0.61	0.5395
β_{Sub79}	-0.18193	0.08481	-2.15	0.0320
β_{Sub80}	0.49569	0.08428	5.88	<.0001

F tests for restrictions

Test	Source	d.f.	Mean Square	F-statistic, p-value
H$_0$: $\beta_{S2} = \beta_{S3} = \beta_{S4} = 0$	Numerator	3	0.29544	2.19
	Denominator	2945	0. 13496	. 0873
H$_0$: $\beta_{R2} = \beta_{R3} = \ldots = \beta_{R11} = 0$	Numerator	10	0. 28732	2.13
	Denominator	2945	0. 13496	0.0195
H$_0$: $\beta_{Sub2} = \beta_{Sub3} = \ldots = \beta_{Sub80} = 0$	Numerator	79	1.83400	13.59
	Denominator	2945	0. 13496	<.0001

Appendix 4. *Ex Post* Subject Heuristics

Table Key.

Columns under “No. of Cells Chosen” heading are as follows: “≤ 3” indicates the number of rounds in the given session in which the subject chooses three or few cells, “4 or 5” indicates the number of rounds where s/he chooses four or five cells, and “≥ 6” indicates the number of rounds in which s/he chooses six or more cells.

Columns under “fixed” and “time” headings indicate the number of rounds in the given session where, respectively, the subject chooses the fixed payoff option or time expires before s/he makes a final decision.

Heuristic labels correspond to the definitions given in section V of the text.

		No. of Cells Chosen						
Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
1	S1	0	0	9			Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
2	S1	0	1	7		1	Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
3	S1	0	0	9			Low	Mixed
	S2	0	1	7			Low	
	S3	4	5	1			Med	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
4	S1	9	0	0			High	Mixed
	S2	7	1	0			High	
	S3	0	9	1			Med	
	S4	7	4	0			High	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
5	S1	1	7	1			Med	Med
	S2	2	5	1			Med	
	S3	1	5	4			Med	
	S4	4	6	0	1		Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
6	S1	0	0	9			Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
7	S1	2	0	7			Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
8	S1	0	3	6			Low	Mixed
	S2	1	4	3			Med	
	S3	2	4	4			Med	
	S4	4	3	3		1	High	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
9	S1	0	0	1	8		Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
10	S1	0	5	4			Med	Mixed
	S2	0	1	7			Low	
	S3	2	7	1			Med	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
11	S1	0	2	7			Low	Low
	S2	0	0	8			Low	
	S3	0	1	9			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
12	S1	0	1	8			Low	Low
	S2	0	2	6			Low	
	S3	0	1	9			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
13	S1	0	2	7			Low	Low
	S2	0	1	7			Low	
	S3	0	1	8		1	Low	
	S4	0	2	9			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
14	S1	0	0	9			Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
15	S1	0	0	9			Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
16	S1	4	4	0	1		Med	Mixed
	S2	5	1	0	2		High	
	S3	7	2	0		1	High	
	S4	7	4	0			High	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
17	S1	0	0	9			Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
18	S1	0	1	8			Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
19	S1	0	0	9			Low	Low
	S2	0	0	8			Low	
	S3	0	5	5			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
20	S1	1	0	8			Low	Mixed
	S2	6	0	0	2		High	
	S3	6	4	0			High	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
21	S1	0	1	8			Low	Low
	S2	0	2	5	1		Low	
	S3	0	2	8			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
22	S1	0	6	3			Med	Med
	S2	0	7	1			Med	
	S3	0	9	1			Med	
	S4	0	6	5			Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
23	S1	0	0	9			Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
24	S1	9	0	0			High	Mixed
	S2	2	4	1		1	Med	
	S3	10	0	0			High	
	S4	2	8	0		1	Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
25	S1	0	0	9			Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
26	S1	0	0	8		1	Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
27	S1	0	0	9			Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
28	S1	0	3	6			Low	Low
	S2	0	0	8			Low	
	S3	0	1	9			Low	
	S4	0	2	9			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
29	S1	0	1	8			Low	Low
	S2	0	2	6			Low	
	S3	0	4	6			Low	
	S4	0	2	9			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
30	S1	0	1	8			Low	Low
	S2	0	1	7			Low	
	S3	0	0	10			Low	
	S4	0	1	9		1	Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
31	S1	0	0	9			Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
32	S1	1	1	7			Low	Low
	S2	0	1	7			Low	
	S3	0	0	10			Low	
	S4	0	2	9			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
33	S1	0	5	4			Med	Mixed
	S2	0	1	7			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
34	S1	0	0	9			Low	Low
	S2	0	1	7			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
35	S1	1	5	3			Med	Med
	S2	1	5	2			Med	
	S3	3	5	2			Med	
	S4	4	4	3			Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
36	S1	0	0	4	5		Low	Low
	S2	0	0	6	2		Low	
	S3	0	0	10			Low	
	S4	0	0	10	1		Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
37	S1	0	0	8	1		Low	Low
	S2	0	1	7			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
38	S1	4	0	0	5		High	High
	S2	3	0	0	5		High	
	S3	7	1	1	1		High	
	S4	10	1	0			High	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
39	S1	9	0	0			High	High
	S2	8	0	0			High	
	S3	10	0	0			High	
	S4	10	0	0		1	High	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
40	S1	1	8	0			Med	Med
	S2	1	4	0	3		Med	
	S3	4	6	0			Med	
	S4	2	5	3		1	Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
41	S1	1	6	2			Med	Med
	S2	0	6	0	2		Med	
	S3	2	8	0			Med	
	S4	3	7	1			Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
42	S1	0	2	7			Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
43	S1	1	4	4			Med	Med
	S2	0	2	5	1		Med	
	S3	0	7	3			Med	
	S4	2	3	6			Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
44	S1	6	3	0			High	High
	S2	6	2	0			High	
	S3	6	4	0			High	
	S4	6	5	0			High	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
45	S1	0	9	0			Med	Med
	S2	1	7	0			Med	
	S3	0	10	0			Med	
	S4	1	9	1			Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
46	S1	0	2	4			Low	Mixed
	S2	0	2	1	3		Med	
	S3	0	1	8	5		Low	
	S4	0	1	10	1		Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
47	S1	2	5	2			Med	Med
	S2	1	0	0	7		Unable	
	S3	0	8	2			Med	
	S4	5	4	2			Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
48	S1	7	1	1			High	High
	S2	5	3	0			High	
	S3	9	0	1			High	
	S4	9	2	0			High	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
49	S1	4	3	0	2		High	Mixed
	S2	0	1	4	3		Low	
	S3	6	3	1			High	
	S4	4	3	4			Unable	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
50	S1	3	1	5			Low	Mixed
	S2	0	5	0	3		Med	
	S3	3	3	4			Unable	
	S4	1	7	3			Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
51	S1	0	1	8			Low	Mixed
	S2	1	4	3			Med	
	S3	0	3	7			Low	
	S4	0	5	6			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
52	S1	1	7	0		1	Med	Med
	S2	0	8	0			Med	
	S3	0	5	5			Med	
	S4	0	10	1			Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
53	S1	0	3	6			Low	Mixed
	S2	0	4	4			Med	
	S3	0	6	4			Med	
	S4	0	8	3			Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
54	S1	2	7	0			Med	Mixed
	S2	1	5	0		2	Med	
	S3	6	4	0			High	
	S4	3	7	1			Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
55	S1	3	6	0			Med	Mixed
	S2	2	3	0		3	Med	
	S3	6	3	1			High	
	S4	4	5	2			Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
56	S1	2	3	4			Med	Mixed
	S2	3	5	0	2		Med	
	S3	0	2	6	2		Low	
	S4	1	6	2			Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
57	S1	0	5	4			Med	Mixed
	S2	0	3	5			Low	
	S3	1	2	7			Low	
	S4	0	2	9			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
58	S1	0	1	8			Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	3	8			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
59	S1	2	6	0		1	Med	Med
	S2	2	5	1			Med	
	S3	5	4	1			Med	
	S4	3	8	0			Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
60	S1	0	1	8			Low	Low
	S2	0	0	8			Low	
	S3	0	0	6	4		Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
61	S1	1	1	6		1	Low	Low
	S2	0	0	8			Low	
	S3	0	1	9			Low	
	S4	0	2	9			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
62	S1	0	0	9			Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
63	S1	0	9	0			Med	Med
	S2	4	4	0			Med	
	S3	4	6	0			Med	
	S4	2	9	0			Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
64	S1	3	5	1			Med	Mixed
	S2	0	3	5			Low	
	S3	1	6	3			Med	
	S4	1	6	4			Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
65	S1	0	0	9			Low	Low
	S2	0	0	6	2		Low	
	S3	0	1	9			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
66	S1	3	5	1			Med	Mixed
	S2	0	0	7		1	Low	
	S3	0	0	9		1	Low	
	S4	4	2	5			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
67	S1	0	3	6			Low	Low
	S2	0	1	7			Low	
	S3	0	2	8			Low	
	S4	0	3	8			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
68	S1	0	0	0	9		Unable	Med
	S2	1	3	2	2		Med	
	S3	1	7	1	1		Med	
	S4	2	7	2			Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
69	S1	0	1	8			Low	Low
	S2	1	0	7			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
70	S1	0	4	5			Low	Mixed
	S2	0	3	5			Low	
	S3	3	6	1			Med	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
71	S1	0	0	4	5		Low	Low
	S2	0	0	6	2		Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
72	S1	1	6	2			Med	Med
	S2	1	5	0		2	Med	
	S3	0	10	0			Med	
	S4	0	10	1			Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
73	S1	0	0	9			Low	Low
	S2	0	3	5			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
74	S1	0	3	6			Low	Low
	S2	0	0	6		2	Low	
	S3	0	2	8			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
75	S1	0	0	9			Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
76	S1	0	4	5			Low	Mixed
	S2	0	8	0			Med	
	S3	0	3	7			Low	
	S4	0	11	0			Med	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
77	S1	0	2	7			Low	Low
	S2	0	1	7			Low	
	S3	0	0	9		1	Low	
	S4	0	1	10			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
78	S1	0	1	8			Low	Low
	S2	0	0	8			Low	
	S3	0	0	10			Low	
	S4	0	1	9		1	Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
79	S1	0	0	1	8		Unable	Low
	S2	0	3	5			Low	
	S3	0	1	8	1		Low	
	S4	0	2	9			Low	

Subject		≤ 3	4 or 5	≥ 6	fixed	time	Heuristic	Overall
80	S1	7	2	0			High	Mixed
	S2	3	5	0			High	
	S3	7	3	0			High	
	S4	5	6	0			Med	