The Impact of Financial Histories on Individuals and Societies: A Laboratory Study

Xu Jiang, Radhika Lunawat and Brian Shapiro

Working Paper

The Impact of Financial Histories on Individuals and Societies: A Laboratory Study

Xu Jiang[1]

Radhika Lunawat[2]

Brian Shapiro[3]

July 30, 2013

The authors thank John Dickhaut and Judy Rayburn for their ideas, inspiration, and encouragement in the early stages of this research, and gratefully acknowledge research funding from the Carlson School of Management Department of Accounting. The University of Minnesota Institutional Review Board granted human subjects approval for this study (IRB Tracking Number 0605S87086).

[1] Fuqua School of Business, Duke University, 100 Fuqua Drive, Durham, NC 27708; e-mail: xu.jiang@duke.edu.
[2] The Paul Merage School of Business, University of California-Irvine, Irvine, CA 92697-3125; e-mail: rlunawat@uci.edu.
[3] Opus College of Business, University of St. Thomas, 2115 Summit Avenue, Mail # MCH 316, St. Paul, MN 55105-1096; e-mail: bpshapiro@stthomas.edu.

Abstract

This paper studies how successive generations of laboratory societies organize themselves when given reports of financial transactions from previous generations. We define an increase in societal organization as a reduction in the entropy of the distribution of amounts sent and returned by successive generations of players in the Investment Game. Our entropy analysis of data from Berg, J., Dickhaut, J., and McCabe, K. (1995. Trust, Reciprocity, and Social History. *Games and Economic Behavior,* **10**, 122-142) indicate that the provision of a financial history reduced the entropy of the amounts sent by Investors, amounts returned by Stewards, and the amounts in the joint Investor/Steward distribution. We then gathered new data over five societal generations to test the predictive power of our hypothesis that financial histories provide a basis for developing societal order. Participants in Session I (the first generation) received no financial history, whereas participants in the subsequent Sessions II-V received a report that summarized the financial history of the immediately preceding session. The amounts sent by Investors and returned by Stewards increased over the five sessions and produced greater overall societal wealth, but entropy declined significantly only in the amounts sent by Investors. The concluding section discusses the implications of our results and identifies opportunities for future research.

The Impact of Financial Histories on Individuals and Societies: A Laboratory Study

Despite the proliferation of measurement and reporting practices, little is known about their impact on society at large. The purpose of this paper is to document how a prevalent public disclosure practice, the reporting of financial history, influences how laboratory societies organize themselves over time. We develop the idea that individuals and organizations may use information not only to draw inferences, but also to restructure their environment. In particular, we hypothesize that successive generations of individuals in laboratory societies will increasingly organize themselves over time when they receive reports of financial transactions undertaken by the preceding generation.

Theories of how communication influences how societies organize themselves (e.g., Giddens, 1984; Habermas, 1979; Luhmann, 1986; Leydesdorff, 2001) provide a basis for our hypothesis. In these theories, societal organization is an emergent property of the norm-governed behavior of individual actors, and can be mediated through various coordination and communications systems. For example, information systems that aggregate and report the actions of individuals from a preceding generation can help organize the actions of individuals in a successive generation if individuals interpret the information as an indicator of the expected behavioral norms in their society. In this manner, the information resources that individuals use to produce and reproduce their social systems are the product of social interaction among individuals in preceding generations (cf. Berg, Dickhaut, and McCabe, 1995, pp. 132-133; Giddens, 1984; Latour, 1993).

We operationally define an increase in organization as a reduction in the entropy (disorder or variance) in the amounts invested and returned by Investors and Stewards across successive generations of players in an Investment Game setting. In an Investment Game, an

Investor receives $10 from the experimenter and then decides how much of the $10 ($0-$10) to send to the Steward. The amount sent to the Steward then triples ($0-$30). Finally, the Steward decides how much of the tripled sum to send back to the Investor. In our experiment, each societal generation consists of a new set of Investor/Steward pairs. Following Berg et al. (1995), we introduce financial history by providing each successive generation with a summary of the amounts invested and returned by players in the preceding generation. Unlike Berg et al. (1995), we introduce the Shannon-Weaver measure of entropy to assess whether the introduction of financial transaction history reduces entropy in the distribution of amounts invested and returned across generations of players. This entropy measure provides a formal way to assess the overall amount of order or dispersion in societal outcomes.

The relatively simple and widely used Investment Game setting has several attractive features for investigating the evolution of societal organization. The game is played only once, Investors and Stewards are anonymously paired, and anonymity ensures that the experimenter cannot match the identities of specific individuals to the dollar amounts sent and returned. These procedures control for alternative explanations of behavior including repeated game reputation effects, contractual precommitments, punishment threats, and experimenter demand effects. In addition, in the Investment Game and its numerous variations (e.g., the gift exchange game, the peasant-dictator game, and the moonlighting game), many players invest and return nonzero amounts, contrary to the assumption of pure monetary self-interest (Berg et al., 1995; Camerer and Fehr, 2002; Dickhaut and McCabe, 1997; Dickhaut and Rustichini, 2002). Finally, in the Investment Game setting, substantial variation exists across the actions of different players. We hypothesize that the introduction of financial transaction histories will reduce this variation by mediating what individuals expect of others and what others expect of them, and that over successive generations of laboratory societies the actions of individuals will on average converge toward the emerging norms of expected behavior.

Our study contributes to the prior investment game literature in three ways. First, it applies our entropy metric to the Berg et al. (1995) data. Second, it attempts to replicate the entropy results in a new and independent study. Third, it ascertains whether the introduction of financial history has an incremental effect across multiple generations of the investment game.

The remainder of the paper is organized as follows. The first section describes the Investment Game, develops our measure of entropy, and states our hypotheses. The second and third sections present the experiment's method and results, respectively. The fourth section discusses the implications of our results and identifies opportunities for future research.

Theory and Hypotheses

Below we describe the Investment Game and develop our hypotheses about entropy reduction and societal organization.

Investment Game Structure

The investment game is played as follows. In stage one, the subjects in Rooms A and B are each given \$10 as a show-up fee. Subjects in Room A (Investors) are given an additional \$10[1] and must decide how much of their \$10 to send to an anonymous counterpart in Room B. We denote this amount by M_a. The amount sent is then tripled, resulting in a total return of $3M_a$. In stage two, a counterpart in Room B (the Steward) is given the tripled money. The counterpart Steward must decide how much money to return, which is denoted $k_b(3M_a)$. The Investor chooses the strategy M_a in {0, 1, 2…, 10}, while the Steward chooses the strategy

$$k_b\colon \{0, 3, \ldots, 30) \rightarrow \{0, 1, \ldots, 30\},$$

which satisfies $0 \leq k_b(3M_a) \leq 3M_a$.

These strategies result in the payoffs

$$P_a(M_a, k_b) = \$10 - M_a + k_b(3M_a)$$

and

$$P_b(M_a, k_b) = 3M_a - k_b(3M_a).$$

A subject's initial wealth is denoted W_i. If subjects have strictly increasing indirect utility function for wealth, given by $V_i(W_i + P_i(M_a, k_b))$ for i = a, b, and each subject, i, maximizes $V_i(\cdot)$, then Stewards have a dominant strategy to keep all the money, that is, $k_b(3M_a) = 0$ for all M_a. If Investors infer their counterpart's dominant strategy, then they should send nothing, i.e., $M_a = 0$. If these results obtain, societal entropy will already be zero or close to zero, even in the absence of information about the actions of individuals in a preceding laboratory society.

Hypotheses

One hypothesis for the investment game is that subjects will make decisions consistent with the subgame perfect prediction,

$$N_0: M_a = 0 \quad \text{for all a.}$$

If for some reason Investors send a positive amount (i.e., $M_a > 0$), then the dominant strategy for Stewards is as follows:

$$N_1: \text{If } M_a > 0, \text{ then } k_b(3M_a) = 0 \quad \text{for all b.}$$

Past research in the Investment Game has found, however, that some investors trust stewards and that some stewards are trustworthy. Consistent with these prior results, our hypotheses for the No History condition (first generation of players) in our Investment Game are as follows:

H1. Investors will send nonzero amounts to Stewards ($M_a > 0$ for some a).

H2. Stewards who receive nonzero amounts will return nonzero amounts to Investors ($k_b(3M_a) > 0$ for some b).

Impact of financial history. The question next arises as to how much variation exists across individual behavior, and whether a simple information system that merely aggregates and reports the actions of individuals from a previous generation will reduce that variation in a successive generation. To address this question, our experimental design employs multiple generations of players. All generations except the first receive a financial history of transactions made by the immediately preceding generation. Sociological research suggests that communication across generations can significantly influence behavior in subsequent generations (e.g., Giddens, 1984; Habermas, 1979; Luhmann, 1986; Leydesdorff, 2001). In our setting, a financial history summarizing the transactions of a preceding generation provides a basis for individuals to assess the dispositions, intentions, and trustworthiness of players in a subsequent Investment Game (cf. Kramer, 1999, p. 575). For example, Investors might use the past transaction data to identify investments that are likely to yield a positive return, and Stewards might infer the reasonableness of the amount invested by their Investor partners as well as the amount they are expected to return to the Investors. Alternatively, Investors and Stewards might more simply select amounts based on their conformity with perceived central tendencies in the past data.

Using entropy to measure the impact of financial history. To assess the impact of financial history on players' behavior, we measure the change in entropy of the amounts invested and returned by Investors and Stewards. The term entropy first arose in statistical mechanics to reflect the status of a particle system. Decreases in entropy reflect less movement in the particle and less uncertainty about its location. In a social setting, the amount of entropy reflects the amount of uncertainty about individuals' behavior. An increase in entropy means that the behavior of individuals is more uncertain, while a decrease in entropy means that the behavior is less uncertain or more orderly.

The engineering and information theory literatures have widely used the entropy concept (e.g., see Cover and Thomas, 1991). Sims (1998, 2003, 2005) introduced Shannon's entropy concept into economics and defined the informativeness of information signals as the change in entropy between prior and posterior distributions. The Shannon entropy measure has since been used to model price stickiness (Sims, 1998), flexible information acquisition (Yang, 2012), and general equilibrium (Mackowiak and Wiederholt, 2009). Following the prior economics literature, we use Shannon's entropy to measure the uncertainty of individuals' behavior.

More formally, we use the following entropy definition to measure the amount of order in our laboratory societies. Let p_i denote the probability of the ith element being drawn from a distribution of n discrete outcomes. Entropy is defined by

$$- \quad \Sigma \; p_i \; \log_2(p_i).$$

As an example, consider a binary outcome such as the flip of a coin. A fair coin has entropy equal to 1, and a biased coin with a 0.75 probability of heads has entropy equal to 0.81. The entropy metric indicates that the biased coin has more order than the fair coin.[2]

Entropy metric applied to the Berg et al. (1995) data. To illustrate how the entropy metric can be applied and to establish continuity with the prior literature, we now perform an entropy analysis of the Berg et al. (1995) data. The Berg et al. (1995) study had two treatments, "no history" and "social history." The social history treatment included a report summarizing the decisions in the no history treatment. Below, we re-label their "social history" treatment as "financial history" to conform to the labels we use in our experiments. We compare the entropy metrics across the Berg et al. (1995) no history and financial history treatments, separately for the investor, steward, and joint data sets.

For the Investors, $\text{Entropy}_{\text{No History}} = 3.141$ and $\text{Entropy}_{\text{Financial History}} = 2.876$. We used a bootstrapping technique to determine whether the observed Entropy reduction of 0.265 is statistically significant. The null hypothesis for this test is that the amounts invested were chosen randomly. We generated 10,000 measures of differences in entropy under this assumption. Based on this bootstrapped distribution, the observed reduction in entropy is significant ($p < .02$, one-tailed).

Since the maximum amounts returned by stewards were constrained by the tripled amounts sent by investors, we converted the amounts returned into percentages of the maximum amount that could be returned. Under this measure, more trustworthy stewards returned a higher percentage. More specifically, we analyzed the entropy in the distributions of the amounts returned by Stewards, in deciles of percentage of amounts received from Investors. For these Steward distributions, $\text{Entropy}_{\text{No History}} = 3.086$ and $\text{Entropy}_{\text{Financial History}} = 2.709$. We again used a bootstrapping technique to determine whether the observed Entropy difference of 0. 377 is statistically significant. The null hypothesis for this test is that the returned amounts were chosen randomly. We generated 10,000 measures of differences in entropy under this assumption. Based on this bootstrapped distribution, the observed reduction in entropy is significant ($p < .0001$, one-tailed).

Finally, the Berg et al. (1995) no history and financial history data as a whole tended to cluster on outcome pairs. We examine the joint densities of Investor and Steward behavior to test whether the observed clustering is statistically significant. This test must take into account that the No History condition has a smaller sample size than the Financial History condition. Ceteris paribus, smaller sample sizes yield smaller maximum levels of entropy.[3] The entropy formula for the No History condition is

$$-\Sigma\Sigma\ (f_{i,j}/32)\ \mathrm{Log}_2\ (f_{i,j}/32)$$

where $f_{i,j}$ denotes the frequency in category "i,j." For example, "3,2" denotes 3 dollars invested and 2 returned by the steward. A similar formula applies to the Financial History condition, with 28 possible observations. The calculated entropies are 4.688 and 4.227 for the No History and Financial History conditions, respectively, for an overall decrease in entropy of 0.461 across the two conditions. To test for significance, we created 10,000 draws of the difference between entropies under the assumption that in both settings the observations were just as likely to fall in one category as any other. This test indicates that the 0.461 reduction in entropy is marginally significant at the .055 level (one-tailed).

In sum, the Berg et al. (1995) data indicate that the introduction of financial history significantly reduced entropy in the distributions of amounts sent and amounts returned, and marginally reduced entropy in the joint distributions. The results from the Berg et al. (1995) single-generation financial history treatment are, however, preliminary and to our knowledge have not been replicated in subsequent studies. More specifically, our analysis of the Berg et al. (1995) data leave two unanswered questions: (1) Can the entropy reduction results be independently replicated in a new study? (2) Do financial histories have an incremental effect over subsequent generations? To provide answers, we gathered new data over five societal generations to test the predictive power of our hypothesis that financial histories provide a basis for developing order in societies. Participants in Session I (the first generation) received no financial history, whereas participants in Sessions II-V (the subsequent four generations) received a report summarizing the financial history of the immediately preceding session.

Based on our preceding discussion of social theory, and consistent with our entropy analyses of the Berg et al. (1995) data, the following hypotheses predict that the distributions of amounts invested, returned, and the joint distributions will exhibit more order (less entropy) across generations of players:

H3. Financial transaction histories will produce more order (less entropy) in the Investor distributions across generations.

H4. Financial transaction histories will produce more order (less entropy) in the Steward distributions across generations.

H5. Financial transaction histories will produce more order (less entropy) in the joint Investor/Steward distributions across generations.

Method

Subjects

Subjects were recruited from the subject pool in CIRANO Research Center, Montreal, Canada. Subjects received $10 for showing up. Subjects also could earn up to an additional $30, depending on their decisions and the decisions of their anonymous partner. Subjects were told to report directly to either Room A or Room B. Room A subjects served as Investors, and Room B subjects served as Stewards. A monitor was randomly chosen in each room after 10 subjects arrived. Monitors received $5, in addition to their $10 show-up fee.

Five sessions were run. Each session consisted of nine pairs of subjects and two monitors. The first session was the "No History" condition, in which subjects did not receive any financial history from a previous experimental session. The other four sessions received a financial history from the immediately preceding experimental session. The Appendix provides the instructions for both investors and stewards, for both the non-history and history conditions. Table 1 summarizes the results for each of the nine pairs of subjects in each session.

Materials

Each subject was given a consent form and set of instructions. The consent form emphasized that (a) participation in the experiment will not affect participants' relationship with the University or affect their course grades, (b) participation is voluntary, (c) all data will remain confidential, and (d) compensation consists of a payment for showing up plus or minus amounts sent and received to anonymous counterparts in the experiment. The instructions were read aloud by the experimenter.

Procedures

The appendix provides the instructions, including the procedures taken to assure anonymity and confidentiality. Each subject performed the following steps:

A. Subjects were randomly assigned to report directly to either Room A or Room B. One subject in each room was randomly selected to serve as a monitor (called Monitor A or Monitor B, for Room A and Room B, respectively). Monitors verified that the experimenters followed the experimental instructions.

B. Subjects read the consent form, were asked questions about the form, were given an opportunity to ask questions about the form, and then signed the form if they wished to participate in the experiment.

C. An experimenter in Room A read the experimental instructions out loud in Room A, and another experimenter in Room B read the instructions out loud in Room B. Subjects in both rooms were given hard copies of the instructions and were asked to read along silently. Toward the end of the instructions, a summary financial history was given to all but the first generation of players.

D. One at a time, Room A subjects (Investors) were called to a private area in Room A, were randomly given an envelope containing $10, open the envelope, and decided whether to send all, some, or none of $10 to their Room B counterparts (Stewards). Room A subjects put the amount of money they wish to send in an envelope and pocketed the rest. Room A subjects also pocketed a specially marked key to be used later.

E. After all Room A subjects performed step D, the Room A monitor took the envelopes to a recorder who was located in a hallway. The recorder recorded the amount sent and tripled the investment. The Room B monitor was then called to bring the envelopes to Room B, and Monitor A returned to Room B.

F. One at a time, Room B subjects were called to a private area in Room B, were randomly given an envelope, opened the envelope, decided how much money to send back to their counterpart in Room A, left that amount of money in the envelope, and pocketed the rest. Afterward, each Room B subject was paid a $10 show-up fee and was asked to leave the building.

G. The Room B monitor took the envelopes to the recorder in the hallway. At this time the amounts sent back were recorded. The Room A monitor was called to put the envelopes into mailboxes marked with letters corresponding to letters on the envelopes.

H. One at a time, Room A subjects went to Room C and opened the mailbox with a lettered key corresponding to the letter on mailbox. After opening the appropriate mailbox, Room A subjects took out the envelope, removed the money, and dropped the key in a box. Afterward, Room A subjects were paid their $10 show-up fee and were then asked to leave the building.

I. The monitors were paid $15 for their participation.

Results

Amounts Invested and Returned

Participants in Session I have no history, while participants in Sessions II-V have financial history because they have access to the results of prior sessions. H1 predicted that investors would send nonzero amounts to stewards. The average amount invested ranged from $4.67 in Session I to $7.00 in Session V (Table 1), with an overall average of $5.45. One-sided Wilcoxon rank-sum tests indicate that in all five sessions, the amounts invested differed significantly from zero with a one-sided p-value < 0.023. These results support H1.

[Insert Table 1 about here]

H2 predicted that stewards who receive nonzero amounts will return nonzero amounts. Therefore, in order to test H2 we removed observations where the stewards received $0. The average amounts returned by stewards who received nonzero amounts increased monotonically from $4.29 in session I (no history) to $9.38 in Session V (financial history), with an overall average of $7.04 (Table 1). Excluding cases where stewards received $0, one-sided Wilcoxon rank-sum tests for amounts sent yielded one-sided p-values < 0.023 for all sessions other than session I. In Session I, the Wilcoxon rank-sum test yielded a one-sided p-value of 0.174. The latter results may be attributed to the relatively large number of Stewards who received positive amounts but returned $0 in Session I. Overall, the results support H2.

Although we did not predict the effect of financial history on amounts sent and returned, we did observe a successive increase in the amounts sent in three of the four financial history conditions, and a successive increase in the amounts returned by Stewards in all four of the financial history conditions. This pattern of results indicates that financial histories can have a beneficial effect on societies, regardless of their impact on entropy.

Influence of Financial History on Entropy

Investor behavior. H3 predicted that the introduction of financial history would reduce the entropy of amounts sent by investors. Panel A of Table 2 lists the number of investors, by amount invested and experimental session. Figure 1 displays histograms of the amounts invested, by experimental session. A visual inspection of Figure 1 indicates that the introduction of a financial history reduced the variance in the amounts invested across the experimental sessions, where the amounts in Session I are more dispersed than in Session V. More formally, $\text{Entropy}_{\text{session I}} = 2.503$ and $\text{Entropy}_{\text{session V}} = 1.406$, indicating a reduction in entropy of 1.098. We used a bootstrapping technique to determine whether this Entropy reduction of 1.098 is statistically significant. The null hypothesis for this test is that the investment amounts are chosen randomly. We generated 10,000 measures of differences in entropy under this assumption. Figure 2 displays the bootstrapping results. Based on the bootstrapped distribution, the observed reduction in entropy is statistically significant ($p < .01$, one-tailed). These results support H3, and are consistent with our entropy analysis of the Berg et al. (1995) data.

[Insert Table 2, Figure 1, and Figure 2 about here]

Steward behavior. Since the maximum amounts returned by stewards were constrained by the tripled amounts sent by investors, we analyzed the entropy in the distributions of the amounts returned by Stewards, in deciles of percentage of amounts received from Investors. Panel B of Table 2 lists the number of stewards who returned, by deciles of percentages of amounts received from investors and experimental session. The average amounts returned by stewards as a percentage of amounts received from Sessions I - V are 23.8%, 36.6%, 41.45%, 43.1% and 41.25%, respectively. Figure 3 shows histograms of the amounts returned in deciles of amounts received, for each of the five sessions. Unlike the Investor distributions in Figure 1, the Steward distributions in Figure 3 do not reveal a trend toward less variance across the five sessions.

[Insert Figure 3 about here]

More formally, $Entropy_{session\ I}$ = 1.379 and $Entropy_{session\ V}$ = 2.156, indicating a trend toward more entropy (less order). We again used a bootstrapping technique to determine whether the observed Entropy difference of 0. 777 is statistically significant. The null hypothesis for this test is that the returned amounts are chosen randomly. We generated 10,000 measures of differences in entropy under this assumption. Figure 4 displays the bootstrapping results. Based on this bootstrapped distribution, session V has a higher rather than lower entropy than Session I (one-tailed $p > 0.5$), contrary to H4. [4] This result also is contrary to our entropy analysis of the Berg et al. (1995) Steward distributions. We conjecture that our result may be attributed to how Session I exhibited more frequent zero amounts returned. The subsequent greater dispersion in the amounts returned by Stewards in Sessions II – V resulted in an increase in entropy, but it also indicates that a financial history yielded more trustworthy stewards. Consistent with this interpretation, Berg et al. (1995, p. 132) speculated (citing Coleman, 1990) that the provision of a financial history might enable Stewards to more easily identify with other investment game participants, and thus trigger internalized social norms of trustworthiness.

Joint test of investor/steward behavior. We now examine the joint densities of Investor and Steward behavior to test whether the observed clustering is statistically significant. Since each session has the same sample size of 9, the effect of sample size on the entropy metric does not arise in our setting. The entropy formula is as follows:

$$-\Sigma\Sigma\ (f_{i,j}/N)\ Log_2\ (f_{i,j}/N)$$

where $f_{i,j}$ denotes the frequency in category "i,j." For example, "3,2" denotes 3 dollars invested and 2 returned by the steward and N represents the number of sample observations. Under this metric, $Entropy_{session\ I} = 2.948$ and $Entropy_{session\ V} = 2.750$. We used a bootstrapping technique to determine whether the observed Entropy reduction of 0.198 in the joint Investor/Steward distributions from Session I to Session V is statistically significant. We created 10,000 draws of the difference between entropies under the assumption that in both settings the observations were just as likely to fall in one category as any other. This test indicates that the 0.198 reduction in entropy is not significant at conventional levels (one-tailed $p > 0.4$). This result does not support H5, and is contrary to the marginally significant reduction in entropy we observed in the Berg et al. (1995) joint distributions.

General Discussion

This paper investigates whether the provision of financial transaction history will enable successive generations of a laboratory society to increasingly organize themselves over time. We operationally defined an increase in organization as a reduction in entropy of the distributions of amounts invested and returned in an investment game. We used the Berg et al. (1995) data to show that a report summarizing the financial transactions of a previous experimental session significantly reduced entropy in the amounts sent by Investors and returned by Stewards. In addition, the reduction in entropy of the joint distribution of amounts invested and returned in the Berg et al. (1995) study was marginally significant. Our analysis of the Berg et al. (1995) data, however, left two unanswered questions. First, can the entropy reduction results be independently replicated in a new study? Second, do financial histories have an incremental effect over subsequent generations? To provide answers, we gathered new data over five societal generations to test the predictive power of our hypothesis that financial histories provide a basis for developing societal order.

If we assume that all agents are myopically self-interested and believe that all other agents are similarly self-interested, then each Investor and Steward should "take the money and run", leaving no role for financial history in the evolution of society. In order for financial history to play a role, the assumption of myopic self-interest needs to be relaxed. For example, if each Investor is myopically self-interested but believes that his or her partner might not be, then a financial history of past Investor-Steward behavior can tell Investors something about the likely amount returned for each amount invested. Thus, financial histories also can influence the amounts invested, and can influence the amounts returned if Stewards are not myopically self-interested. For example, even though there are no contracts and there is no reputation building in the Investment Game, past transaction data can give Stewards a basis to infer and mimic expected or acceptable behavior.

Consistent with the prior investment game literature, our bootstrap analyses indicate that in all five sessions the distributions of amounts sent by Investors differed significantly from zero. Similarly, in four of five sessions the distributions of amounts returned by Stewards differed significantly from zero. The entropy in the amounts sent by Investors declined significantly from Session I to Session V, but the entropy did not decline significantly in the distributions of the amounts returned by Stewards and in the joint Investor/Steward distributions. In contrast, our entropy analyses of the Berg et al. (1995) data comparing their no history and financial history conditions yielded significant entropy reductions in the Investor and Steward distributions, and a marginally significant entropy reduction in the joint Investor/Steward distributions. This pattern of results across the two studies indicates that more research is needed to document the effects of financial history across a variety of conditions.

Furthermore, entropy reduction is only one of several possible social outcomes that could be mediated by financial histories. For example, as we observed in our data, financial histories can yield more disperse but also more trustworthy Stewardship distributions in an Investment Game setting, and the increase in Stewardship trustworthiness might in turn yield more trusting Investors in subsequent generations. Ultimately, these iterative effects could yield greater overall social wealth, despite lower entropy in the amounts returned by Stewards. More research is needed, however, to test the robustness of financial histories' mediating effects across a variety of social settings. For example, variations of the single-period Investment Game could be used to test the effects of financial history when Investors and Stewards participate in multiple sessions and are allowed to communicate with one another (cf. Charness et al., 2011).

Finally, the provision of financial histories can be a conscious strategy that societal agents use to structure their economic and social environments. But financial histories, like other measurement systems, also can have unintended on organizations and societies (Cyert and March, 1992; Burchell, Clubb, Hopwood, Hughes, and Nahapiet, 1980; Thompson, 1967). While the effects of financial histories might in some circumstances be mediated by the conscious strategies of individual agents (cf. Berg et al., 1995, p. 134), financial histories also can structure the behavior of subsequent generations without requiring agents to be consciously aware of these effects (cf. Giddens, 1984). More research is needed to ascertain the extent to which the effect of financial history is mediated by conscious versus unconscious individual perceptions and decision strategies.

References

Berg, J., Dickhaut, J., and McCabe, K. (1995). Trust, Reciprocity, and Social History. *Games and Economic Behavior,* 10, 122-142.

Burchell, S., Clubb., C., Hopwood, A.G. , Hughes, J., and Nahapiet, J. (1980). The Roles of Accounting in Organizations and Society. *Accounting, Organizations and Society*, 5, 5-27.

Camerer, C.F., and Fehr, E. (2002). Measuring Social Norms and Preferences Using Experimental Games: A Guide for Social Scientists. Forthcoming in Henrich, Boyd, Bowles, Camerer, Fehr, Gintis, and McElreath, *Foundations of Human Sociality: Experimental and Ethnographic Evidence from 15 Small-Scale Societies.*

Charness, G., Du, N., and Yang, C. (2011). Trust and trustworthiness reputations in an investment game. *Games and Economic Behavior*, 72, 361-375.

Coleman, J. (1990). *Foundations of Social Choice Theory*. Cambridge, MA: Harvard University Press.

Cover, T. M. and Thomas, J.A. (1991). *Elements of Information Theory*. New York, NY: Wiley-Interscience.

Cyert, R., and March, J. (1992). *A Behavioral Theory of the Firm* (2nd ed.). Oxford, UK: Basil Blackwell.

Dickhaut, J., and McCabe, K. A. (1997). The Behavioral Foundations of Stewardship Accounting and a Proposed Program of Research: What is Accountability? *Behavioral Research in Accounting*, 9, 60-87.

Dickhaut, J., and Rustichini, A. (2002). Trust and the Investment Game. *Encyclopedia of Cognitive Science* (forthcoming).

Fehr, E., and Falk, A. (2001). Psychological Foundations of Incentives. *Working Paper No. 95, Institute for Empirical Research in Economics, University of Zurich.*

Giddens, A. (1984). *The Constitution of Society.* Cambridge: Polity Press.

Habermas, J. (1979). *Communication and the Evolution of Society* (trans. T. McCarthy). Boston.

Kramer, R. M. (1999). Trust and Distrust in Organizations: Emerging Perspectives, Enduring Questions. *Annual Review of Psychology*, 50, 569-598.

Latour, B. (1993). *We have Never Been Modern*. Harvard, MA: Harvard University Press.

Leydesdorff, L. (2001). *A Sociological Theory of Communication: The Self-Organization of the Knowledge-Based Society.* Universal Publishers.

Luhmann, N. (1986). The Autopoiesis of Social Systems. In Felix Geyer and Johannes van der Zouwen (Eds.), *Sociocybernetic Paradoxes*, pp. 172-192. Sage: London.

Mackowiak, B. and Wiederholt, M. (2009). Optimal Sticky Prices under Rational Inattention. *American Economic Review*, 99(3): 769–803.

Sims, C.A. (1998). Stickiness. *Carnegie-Rochester Conference Series on Public Policy*, 49(1): 317–356

Sims, C. A. (2003). Implications of Rational Inattention. *Journal of Monetary Economics*, 50(3): 665 – 690.

Sims, C. A. (2005). Rational Inattention: A Research Agenda. *Deutsche Bundesbank Research Centre Discussion Paper Series 1: Economic Studies*, 2005:34.

Thompson, J.D. (1967). *Organizations in Action: Social Science Bases of Administrative Theory.* New York: McGraw-Hill.

Yang M. (2012). Coordination with Rational Inattention. *Duke University Working Paper*.

Table 1. Amounts sent and returned, by experimental session. Investor averages include $0 amounts invested. Steward averages exclude observations where $0 was received.

Session I			Session II		
Subject Pair	Sent	Returned	Subject Pair	Sent	Returned
A	6	0	A	6	9
B	5	10	B	2	1
C	0	0	C	0	0
D	5	0	D	6	3
E	4	0	E	10	12
F	4	4	F	4	5
G	8	16	G	2	1
H	0	0	H	10	5
I	10	0	I	5	15
Averages:	$4.67	$4.29	Averages:	$5.00	$6.38

Session III			Session IV		
Subject Pair	Sent	Returned	Subject Pair	Sent	Returned
A	0	0	A	10	0
B	5	8	B	5	8
C	5	10	C	0	0
D	1	1	D	5	10
E	4	5	E	3	0
F	4	0	F	10	21
G	5	8	G	5	15
H	7	7	H	6	5
I	10	15	I	10	8
Averages:	$4.56	$6.75	Averages:	$6.00	$8.38

Session V		
Subject Pair	Sent	Returned
A	5	0
B	5	3
C	5	10
D	10	13
E	10	15
F	*	*
G	6	9
H	10	20
I	5	5
Averages:	$7.00	$9.38
* Missing data		

Table 2. Number of investors by amounts sent and returned, by experimental session.

Panel A. Number of investors, by experimental session and amount sent.

Amounts Sent	Session I	Session II	Session III	Session IV	Session V
0	2	1	1	1	0
1	0	0	1	0	0
2	0	2	0	0	0
3	0	0	0	1	0
4	2	1	2	0	0
5	2	1	3	3	4
6	1	2	0	1	1
7	0	0	1	0	0
8	1	0	0	0	0
9	0	0	0	0	0
10	1	2	1	3	3
Entropy	2.503	2.503	2.419	2.113	1.406

Panel B. Number of stewards, by experimental session and amounts returned in deciles of percentage of amounts received from investors. Observations where investors sent $0 are excluded.

Deciles of Percentage	Session I	Session II	Session III	Session IV	Session V
0	4	0	1	2	1
(0%,10%]	0	0	0	0	0
(10%,20%]	0	4	0	0	1
(20%,30%]	0	0	0	2	0
(30%,40%]	1	1	2	0	1
(40%, 50%]	0	2	2	0	3
(50%, 60%]	0	0	2	1	0
(60%, 70%]	2	0	1	2	2
(70%, 80%]	0	0	0	0	0
(80%, 90%]	0	0	0	0	0
(90%, 100%]	0	1	0	1	0
Entropy	1.379	1.750	2.250	2.250	2.156

Figure 1. Amounts invested in each of the five sessions.

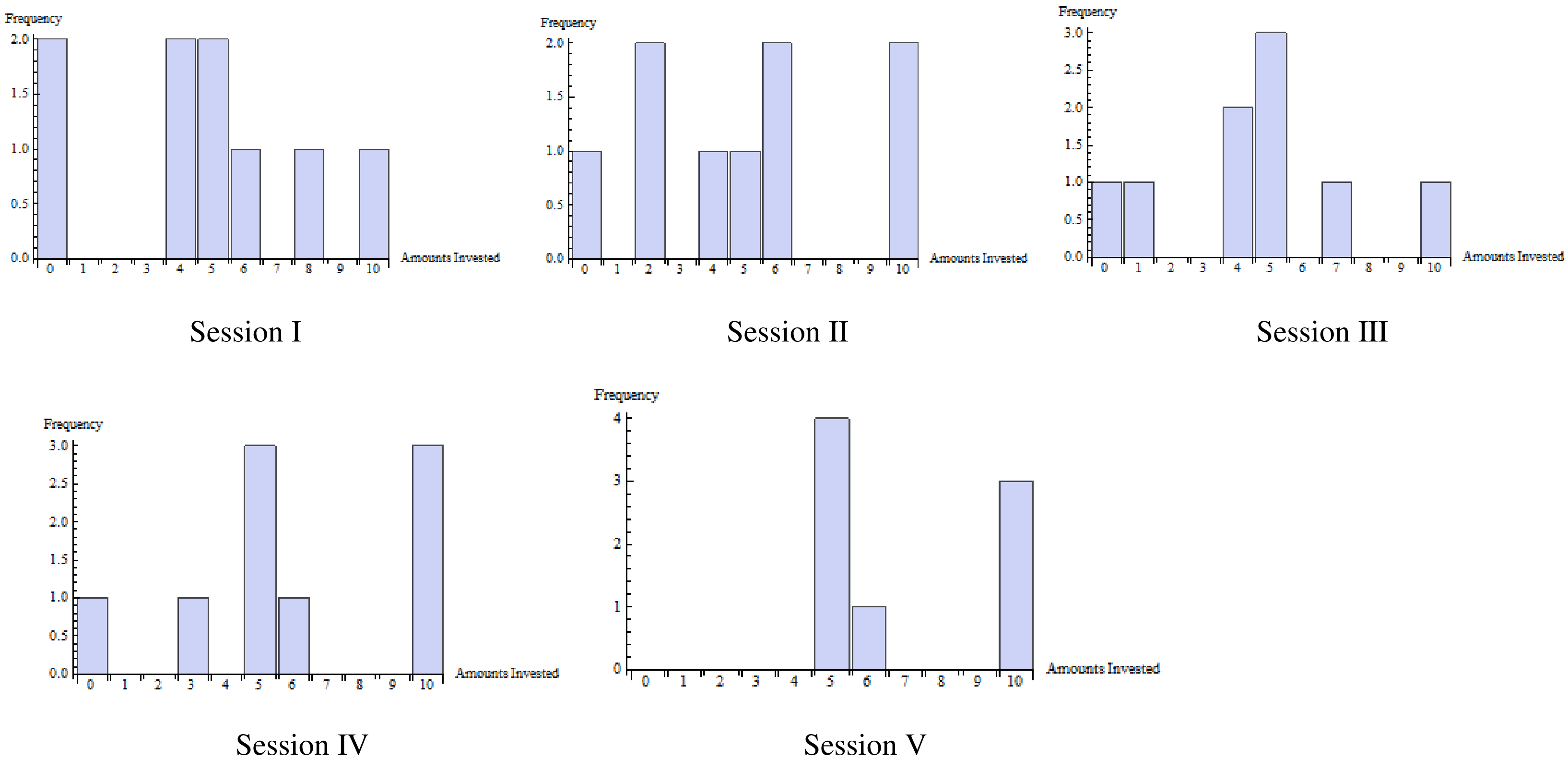


Figure 2. Bootstrapped distribution for amounts invested between session I and session V.

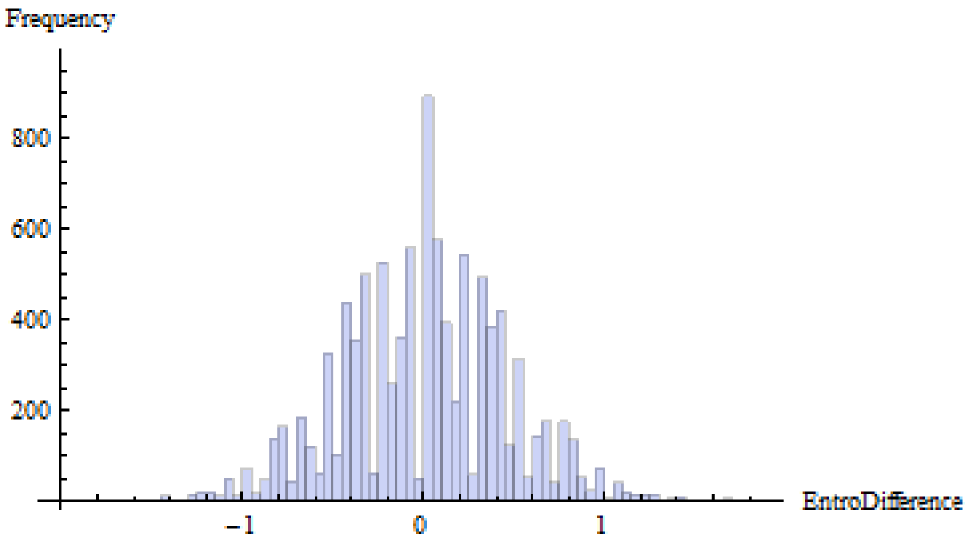
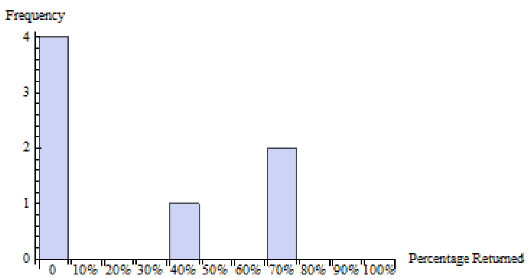
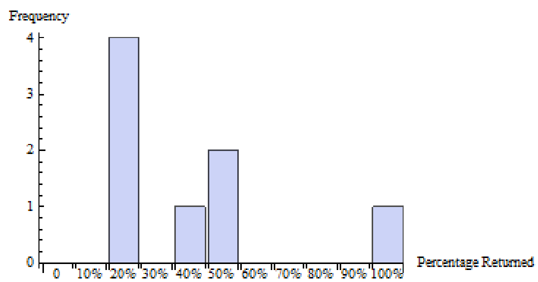


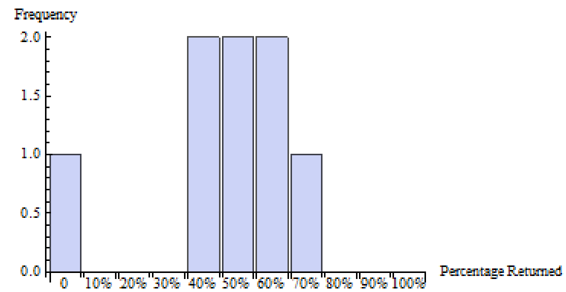
Figure 3. Amounts returned in each of the five sessions, in deciles of the percentage of amounts received.



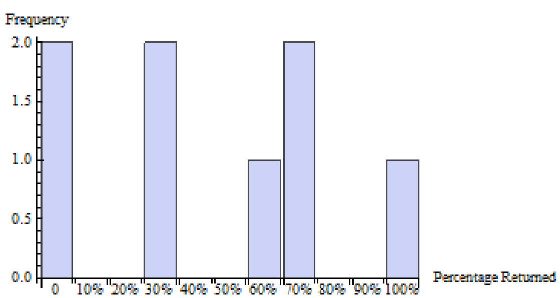
Session I



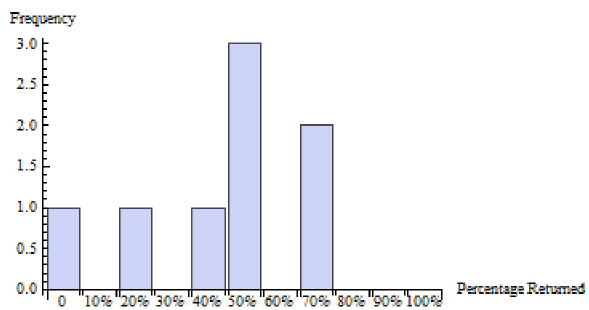
Session II



Session III



Session IV



Session V

Figure 4. Bootstrapped distribution for percentage amounts returned between session I and session V.

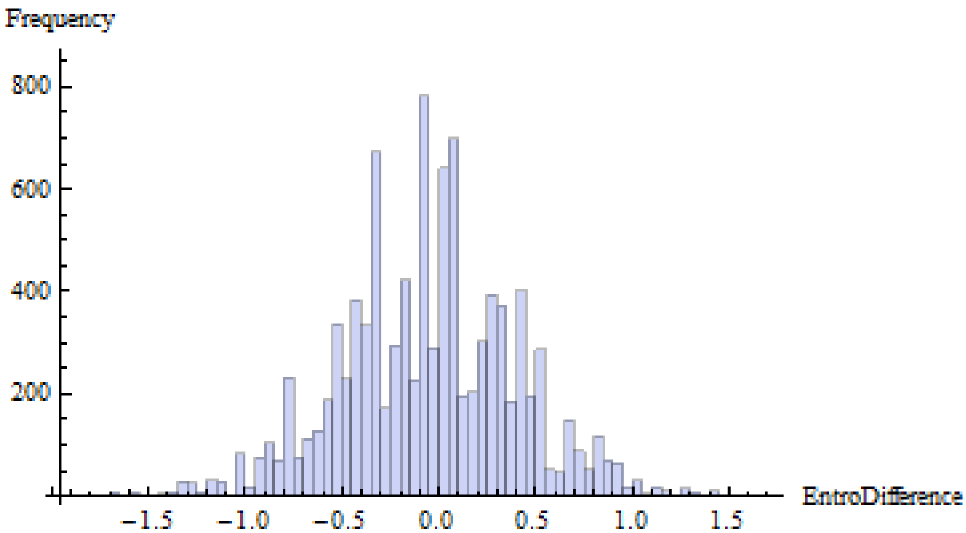
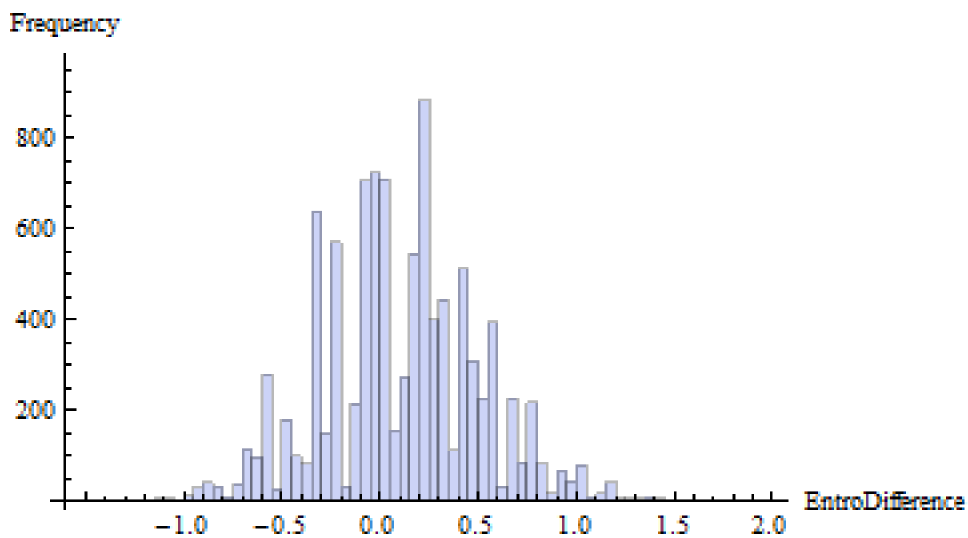


Figure 5. Bootstrapped distribution for the joint behavior between session I and session V.



Appendix

Instructions for Room A

You have been asked to participate in a decision making study. I will read these instructions out loud. Please do not talk among yourselves. If you have any questions, please raise your hand. I will then answer your questions individually.

Overview

In this experiment each of you will be paired with a different participant who is in another room. You will not be told who these people are either during or after the experiment. **This is Room A.** Other participants are in Room B. You will notice that there are other people in the same room with you who are also participating in this experiment. You will not be paired with any of these people.

One participant in Room A will be called Monitor A, and one participant in Room B will be called Monitor B. Monitor A and Monitor B will be randomly chosen before the experiment begins. The monitors will be in charge of the envelopes as explained below. The monitors also will verify that the instructions have been followed. Monitors will be given $15 at the end of the experiment.

Each participant in Room B who is not a monitor will be given $10 for showing up on time and participating until the end of the experiment. Each participant in Room A will receive $10 in an envelope. Each Room A participant will then have the opportunity to send some, all, or none of the $10 to a participant in Room B. Each dollar sent to Room B will be tripled. For example, if a participant in Room A sends an envelope containing $2, he or she will keep the remaining $8 and the envelope will contain $6 when it reaches Room B. If a participant in Room A sends an envelope containing $9, he or she will keep the remaining $1 and the envelope will contain $27 when it reaches Room B. The participant in Room B will then decide how much money to send back to the participant in Room A.

[For the financial history treatment we added the following paragraph: Each of you has received a report summarizing the decisions of subjects who participated in a previous experiment. Please check the last page of the instructions to be sure you have this sheet.]

Confidentiality

This experiment is designed so that no one, including the experimenters and monitors, will know the decisions of any individual participants in Room A or Room B. Since your decision is private, we ask that you do not tell anyone your decision either during or after the experiment.

How the Experiment is Run

Room A participant decisions. The experiment is conducted as follows. Twelve large unmarked envelopes have been placed in a box in Room A. Each of these envelopes contains 10 one dollar bills, a smaller inner envelope, and a key in a sealed envelope marked “KEY”. The inner envelope and key are both marked with the same letter of the alphabet. The Room A monitor will randomly select and hand each participant in Room A an unmarked envelope from the box. Each Room A participant will perform the following steps:

1. Privately open the unmarked envelope. The participant who opens the envelope will be the only person who knows which letter of the alphabet was in the envelope.
2. Leave the envelope marked “KEY” unopened until instructed to open it later in the experiment.
3. Privately decide how many dollar bills to put into the inner envelope, and then put those dollar bills in the inner envelope.
4. Privately pocket any remaining dollar bills and pocket the unopened envelope marked “KEY”.
5. Privately put the inner envelope back inside the large unmarked envelope.
6. Raise his or her hand. When Monitor A comes by, return the unmarked envelope to the box marked “return the envelopes here”.

Recording and processing of Room A envelopes. As soon as all Room A envelopes have been put into the return box, Monitor A will transport the box to a recorder who is sitting in the hallway. With Monitor A observing, the recorder will perform the following steps:

1. Take all unmarked envelopes out of the box.
2. Take an inner envelope out of an unmarked envelope, one at a time.
3. On a blank sheet of paper, record the letter that is printed on the envelope and the amount of money in the envelope.
4. Triple the amount of money in the inner envelope, place the inner envelope back into the unmarked outer envelope, and place the unmarked outer envelope back in the box.
5. After all of the envelopes have been processed in this manner, the recorder will signal Monitor B to come to the recorder’s desk. Once Monitor B has arrived, Monitor A will be asked to return to Room A.

Room B participant decisions. Monitor B will carry the box of envelopes to Room B. Monitor B then will randomly select and hand each participant in Room B an unmarked envelope from the box. Each Room B participant will perform the following steps:

1. Decide how many dollar bills to leave in the inner envelope.
2. Pocket any remaining dollar bills.
3. Place the inner envelope in the unmarked outer envelope.
4. Raise his or her hand. When Monitor B comes by, return the outer envelope to the box marked “return envelopes here”.
5. Gather his or her belongings, receive his or her $10 compensation for participating in the experiment, and be asked to leave the building.

Recording and processing of Room B envelopes. After all envelopes in Room B are returned to the box marked "return the envelopes here" and all Room B participants have been asked to leave the building, Monitor B will transport the box to the recorder in the hallway. With Monitor B observing, the recorder will perform the following steps:

1. Take all unmarked envelopes out of the box.
2. Take an inner envelope out of an unmarked envelope, one at a time.
3. Record on a blank sheet of paper the letter on the envelope and the amount of money in the envelope.
4. Place the inner envelope in the box.
5. After all of the envelopes have been processed in this manner, the recorder will then signal Monitor A to come to the recorder's desk.

Once Monitor A has arrived, Monitor B will return to Room B. When Monitor A arrives, Monitor A and the recorder will carry the box of envelopes to room C. Room C contains locking boxes with identifying letters. The letters correspond to the letters on the inner envelopes. While the recorder observes, Monitor A will place each inner envelope in the box with the corresponding letter. All of the boxes will then be locked. The recorder will then return to the hallway and Monitor A will return to Room A.

Room A participants privately open the returned envelopes. Monitor A will then point to one participant in Room A at a time to proceed to Room C. When called to go to Room C, each Room A participant will perform the following steps:

1. Gather all of his her belongings since he or she will be asked to leave the building when done.
2. Enter Room C alone.
3. Open the envelope marked "KEY". Inside this envelope is a lettered key which will open the locked box with the corresponding letter. The inner envelope in the box is the same envelope that Room A participant started with.
4. Go to the appropriate locked box, open it, take out the envelope, and remove the money.
5. Return the empty envelope to the box.
6. Lock the box.
7. Return the key to the envelope marked "KEY".
8. Drop the envelope marked "KEY" in the box just outside the door in the hallway and be asked to leave the building.

Conclusion of experiment. After everyone in Room A has left, the experiment is over and the two monitors will be paid $15 for their participation.

Note about Dollar Bills. We will use e-dollars for this experiment. At the end of the experiment, your e-dollars will be converted into real dollars at a faceless teller. The conversion rate is one dollar for one e-dollar bill.

Instructions for Room B

You have been asked to participate in a decision making study. I will read these instructions out loud. Please do not talk among yourselves. If you have any questions, please raise your hand. I will then answer your questions individually.

Overview

In this experiment each of you will be paired with a different participant who is in another room. You will not be told who these people are either during or after the experiment. **This is Room B.** Other participants are in Room A. You will notice that there are other people in the same room with you who are also participating in this experiment. You will not be paired with any of these people.

One participant in Room A will be called Monitor A, and one participant in Room B will be called Monitor B. Monitor A and Monitor B will be randomly chosen before the experiment begins. The monitors will be in charge of the envelopes as explained below. The monitors also will verify that the instructions have been followed. Monitors will be given $15 at the end of the experiment.

Each participant in Room B who is not a monitor will be given $10 for showing up on time and participating until the end of the experiment. Each participant in Room A will receive $10 in an envelope. Each Room A participant will then have the opportunity to send some, all, or none of the $10 to a participant in Room B. Each dollar sent to Room B will be tripled. For example, if a participant in Room A sends an envelope containing $2, he or she will keep the remaining $8 and the envelope will contain $6 when it reaches Room B. If a participant in Room A sends an envelope containing $9, he or she will keep the remaining $1 and the envelope will contain $27 when it reaches Room B. The participant in Room B will then decide how much money to send back to the participant in Room A.

[For the financial history treatment we added the following paragraph: Each of you has received a report summarizing the decisions of subjects who participated in a previous experiment. Please check the last page of the instructions to be sure you have this sheet.]

Confidentiality

This experiment is designed so that no one, including the experimenters and monitors, will know the decisions of any individual participants in Room A or Room B. Since your decision is private, we ask that you do not tell anyone your decision either during or after the experiment.

How the Experiment is Run

Room A participant decisions. The experiment is conducted as follows. Twelve large unmarked envelopes have been placed in a box in Room A. Each of these envelopes contains 10 one dollar bills, a smaller inner envelope, and a key in a sealed envelope marked "KEY". The inner envelope and key are both marked with the same letter of the alphabet. The Room A monitor will randomly select and hand each participant in Room A an unmarked envelope from the box. Each Room A participant will perform the following steps:

1. Privately open the unmarked envelope. The participant who opens the envelope will be the only person who knows which letter of the alphabet was in the envelope.
2. Leave the envelope marked "KEY" unopened until instructed to open it later in the experiment.
3. Privately decide how many dollar bills to put into the inner envelope, and then put those dollar bills in the inner envelope.
4. Privately pocket any remaining dollar bills and pocket the unopened envelope marked "KEY".
5. Privately put the inner envelope back inside the large unmarked envelope.
6. Raise his or her hand. When Monitor A comes by, return the unmarked envelope to the box marked "return the envelopes here".

Recording and processing of Room A envelopes. As soon as all Room A envelopes have been put into the return box, Monitor A will transport the box to a recorder who is sitting in the hallway. With Monitor A observing, the recorder will perform the following steps:

1. Take all unmarked envelopes out of the box.
2. Take an inner envelope out of an unmarked envelope, one at a time.
3. On a blank sheet of paper, record the letter that is printed on the envelope and the amount of money in the envelope.
4. Triple the amount of money in the inner envelope, place the inner envelope back into the unmarked outer envelope, and place the unmarked outer envelope back in the box.
5. After all of the envelopes have been processed in this manner, the recorder will signal Monitor B to come to the recorder's desk. Once Monitor B has arrived, Monitor A will be asked to return to Room A.

Room B participant decisions. Monitor B will carry the box of envelopes to Room B. Monitor B then will randomly select and hand each participant in Room B an unmarked envelope from the box. Each Room B participant will perform the following steps:

1. Decide how many dollar bills to leave in the inner envelope.
2. Pocket any remaining dollar bills.
3. Place the inner envelope in the unmarked outer envelope.
4. Raise his or her hand. When Monitor B comes by, return the outer envelope to the box marked "return envelopes here".
5. Gather his or her belongings, receive his or her $10 compensation for participating in the experiment, and be asked to leave the building.

Recording and processing of Room B envelopes. After all envelopes in Room B are returned to the box marked “return the envelopes here” and all Room B participants have been asked to leave the building, Monitor B will transport the box to the recorder in the hallway. With Monitor B observing, the recorder will perform the following steps:

1. Take all unmarked envelopes out of the box.
2. Take an inner envelope out of an unmarked envelope, one at a time.
3. Record on a blank sheet of paper the letter on the envelope and the amount of money in the envelope.
4. Place the inner envelope in the box.
5. After all of the envelopes have been processed in this manner, the recorder will then signal Monitor A to come to the recorder’s desk.

Once Monitor A has arrived, Monitor B will return to Room B. When Monitor A arrives, Monitor A and the recorder will carry the box of envelopes to room C. Room C contains locking boxes with identifying letters. The letters correspond to the letters on the inner envelopes. While the recorder observes, Monitor A will place each inner envelope in the box with the corresponding letter. All of the boxes will then be locked. The recorder will then return to the hallway and Monitor A will return to Room A.

Room A participants privately open the returned envelopes. Monitor A will then point to one participant in Room A at a time to proceed to Room C. When called to go to Room C, each Room A participant will perform the following steps:

1. Gather all of his her belongings since he or she will be asked to leave the building when done.
2. Enter Room C alone.
3. Open the envelope marked “KEY”. Inside this envelope is a lettered key which will open the locked box with the corresponding letter. The inner envelope in the box is the same envelope that Room A participant started with.
4. Go to the appropriate locked box, open it, take out the envelope, and remove the money.
5. Return the empty envelope to the box.
6. Lock the box.
7. Return the key to the envelope marked “KEY”.
8. Drop the envelope marked “KEY” in the box just outside the door in the hallway and be asked to leave the building.

Conclusion of experiment. After everyone in Room A has left, the experiment is over and the two monitors will be paid $15 for their participation.

Note about Dollar Bills. We will use e-dollars for this experiment. At the end of the experiment, your e-dollars will be converted into real dollars at a faceless teller. The conversion rate is one dollar for one e-dollar.

Footnotes

[1] In the investment games reported in Berg et al. (1995), all subjects were given a $10 show-up fee. Subjects in Room B pocketed their show-up fee. Unlike in our experiment, the Berg et al. (1995) subjects in Room A did not receive an additional $10 and instead decided how much of their $10 show-up fee to send to their anonymous counterpart in Room B.

[2] Entropy also varies with the number of possible outcomes. For example, a fair die has entropy equal to 2.58 and thus has less order than a fair coin. Accordingly, our entropy metric takes sample size into account.

[3] Specifically, in the No History condition there are at most 32 distinct observations. This means the maximum level of entropy will be $-\text{Log}_2(1/32) = 5.0$. In contrast, if there were only 28 observations, the maximum entropy would be $-\text{Log}_2(1/28) = 4.8$.

[4] Pairwise entropy differences between Sessions II - V are not significant at conventional levels.