

# Transparency, Efficiency and the Distribution of Economic Welfare in Pass-Through Investment Trust Games\*

Thomas A. Rietz<sup>†</sup>  
Roman M. Sheremeta<sup>‡</sup>  
Timothy W. Shields<sup>†,‡</sup>  
Vernon L. Smith<sup>§</sup>

May, 2011

## Abstract

We design an experiment to examine welfare and behavior in a multi-level trust game representing a pass through investment in an intermediated market. In a repeated game, an Investor invests via an Intermediary who lends to a Borrower. A pre-experiment one-shot version of the game serves as a baseline and to type each subject. We alter the transparency of exchanges between non-adjacent parties. We find transparency of the exchanges between the investor and intermediary does not significantly affect welfare. However, transparency regarding exchanges between the intermediary and borrower promotes trust on the part of the investor, increasing welfare. Further, this has asymmetric effects: borrowers and intermediaries achieve greater welfare benefits than investors. We discuss implications for what specific aspects of financial market transparency may facilitate more efficiency.

*JEL Classifications:* C72, C91, D72, G14, G21

*Keywords:* financial intermediation, financial market transparency, pass through securities, multi-level trust games, experiments

---

\* The authors would like to thank and dedicate this paper to John Dickhaut who brought us together as researchers, inspired our thinking in this area and worked with us in designing the game studied in this paper.

<sup>†</sup> Henry B. Tippie College of Business, University of Iowa, Iowa City, Iowa 52242-1000, U.S.A.

<sup>‡</sup> Argyros School of Business and Economics, Chapman University, One University Drive, Orange, CA 92866, U.S.A.

<sup>§</sup> Economic Science Institute, Chapman University, One University Drive, Orange, CA 92866, U.S.A

## **Transparency, Efficiency and the Distribution of Economic Welfare in Pass-Through Investment Trust Games**

Berg, Dickhaut and McCabe (1995) investigate trust and reciprocity in a two-player investment trust game. Since then, the game has been studied extensively. Ostrom and Walker (2005), among others, review the literature and identify that social distance, communication and reputation all affect the degree of trust and reciprocity. The primary focus is on one-to-one trust and reciprocity behavior.

In reality, many situations require multiple levels of trust. For example, when a person invests in a bond fund, he or she trusts the fund manager not to misrepresent the bonds in the fund. The fund manager, in turn, must trust the bond issuers. Alternatively, consider collateralized debt obligations (CDOs). In the home mortgage market, institutional arrangements emerged in which mortgages were originated by one firm (e.g., Country Wide), sold to an investment banker that assembled them into large packages, and issued Mortgage Backed Securities (a kind of CDO) that were in turn sold to investors. Investors trusted the originators to perform due diligence in evaluating the risk of borrowers, and security issuers to provide adequate data trails and loan servicing arrangements. This chain required multiple levels of trust to justify investment. As the recent financial crisis shows, the breakdown of these serial trust relations can have drastic implications.

Financial market crises frequently prompt calls for reform that include greater transparency. For example, in a letter to the G20 on June 16, 2010, President Obama states: “We should support efforts to enhance transparency and increase disclosure by our large financial

institutions.” He further asks for: “More transparency and disclosure to promote market integrity and reduce market manipulation.” (Obama, 2010). Transparency is often one of the goals of regulation ranging from current calls for reform to the Sarbanes-Oxley Act and the Securities and Exchange Act. One of the stated goals of the Securities and Exchange Commission is: “a far more active, efficient, and transparent capital market that facilitates the capital formation so important to our nation's economy.”<sup>1</sup> However, it is difficult to draw clear conclusions about the effects of transparency alone in naturally occurring environments. Usually, regulation promoting transparency is tied to other reforms and occurs during a time of other changes to the economy (e.g., the Securities and Exchange Act). Here, using a multi-level trust game, we study transparency in a controlled investment/trust environment to isolate its effects.

The conventional two-player trust game is commonly interpreted as an investment game. An investor (the first player) invests money with a trustee (the second player) who employs it productively and chooses how much, if any, to return to the investor. Because each player is involved in each transaction and, hence, observes the play of all players, the game is completely transparent. Our game extends this to include a financial intermediary, creating a three-player trust game by adding a third player (the intermediary). This allows us to control transparency by changing whether each player can observe the play of all others or only observe transactions involving the player directly.

In our game, the three players move sequentially. The first player (the investor) initiates the process by sending money (any portion of his endowment) to the second player (the

---

<sup>1</sup> <http://www.sec.gov/about/whatwedo.shtml#corpfin>, accessed 10/27/2010.

intermediary) with the amount being tripled. One can interpret the tripled amount as the case where the intermediary creates value through the intermediation process (e.g., through pooling investments, diversification and increased liquidity). The intermediary then decides how much of the tripled amount to loan to the third player (the borrower), with the amount being tripled again. This can be interpreted as putting the money to productive resource use. The borrower chooses how much to return to the intermediary who, in turn, chooses how much to return to the investor. This effectively creates an intermediated market, generating gains from specialization and trade from two interactions based on trust and reciprocity.

Our game is repeated, but we use an independent one-shot pre-experiment version to type the behavior of each subject in his or her role and for comparison with the repeated version. In the one-shot setting, we find that transparency has little effect. However, in the repeated setting, transparency of exchanges between the intermediary and borrower increase efficiency and payoffs to all parties. Transparency of exchanges between the investor and intermediary has no significant effect upon efficiency. Only transparency in respect to the borrower and intermediary exchanges matters. Transparency regarding the exchanges between the other parties does not. Further, we find that it is the transparency, and not the specific exchanges, that increases welfare. Last, we find that benefits are asymmetric. The borrowers and intermediaries benefit more than the investors from the ability of investors to view the borrower/intermediary transactions.

The elements of our three-player trust game can be found in the existing literature. First, our three-player trust game is related to the three-player centipede game with a binary choice space (Rapoport et al., 2003; Murphy et al., 2004) and continuous choice space (Sheremeta and Zhang,

2010). Second, multi-level trust has been studied in evolutionary literature. For example, Greiner and Levati (2005) use a variant of a trust game in order to implement a cyclical network of indirect reciprocity where the first individual may help the second, the second help the third, and so on until the last, who in turn may help the first. As in a two-player trust game, the authors find that pure indirect reciprocity enables mutual trust in the multi-player environment.<sup>2</sup> Finally, the three-player trust game is related to a 3-person ultimatum game by Buchner et al. (2004). While related, none of this research studies a direct, multi-level trust game that corresponds to pass through securities nor varies transparency in such games.

In the next section, we lay out our experiment. Then, we discuss our results in Section II and follow with discussion in Section III.

## **I Experimental Environment, Design and Procedures**

### **A Three-Player Trust Game**

We implement the three-player linear trust game shown in Figure 1. In the first stage, the investor sends some portion,  $s_1$ , of his endowment of 10 experimental dollars to an intermediary. The amount sent triples on the way. Then, the intermediary sends some amount,  $s_2$ , to a

---

<sup>2</sup> There are several other studies in the literature that investigate direct and indirect trust and reciprocity in a two-player trust game (Wedekind and Milinski, 2000; Dufwenberg et al., 2001; Guth et al., 2001; Seinen and Schram, 2006). By allowing receivers to reciprocate towards the other donors, Dufwenberg et al. (2001) find that indirect reciprocity induces insignificantly smaller donations than direct reciprocity and that receivers are more rewarding in the case of indirect reciprocity. Guth et al. (2001) find that indirect reward reduces significantly mutual cooperation compared to the direct reward. In the same line of research, Seinen and Schram (2006) and Wedekind and Milinski (2000) provide experimental evidence on indirect reciprocity in a “repeated helping game” developed by Nowak and Sigmund (1998). In this game, donors decide whether or not to provide costly help to the recipients they are matched with, based on information about the recipient’s behavior in encounters with third parties.

borrower. The amount again triples. The borrower sends back some amount,  $r_3$ , to the intermediary. Finally, the intermediary sends back an amount,  $r_2$ , to the investor.

## **B Experimental Design and Procedures**

We design four treatments as given in Table I to study how the level of transparency affects trust and reciprocity. In each treatment, the investor is endowed with 10 experimental dollars and the game proceeds according to the rules described here.

In the baseline treatment No-T (stands for “no transparency”), parties can only observe their bilateral interactions, i.e. the investor cannot see the interactions between the intermediary and the borrower, and the borrower cannot see the interactions between the intermediary and the investor. In the Borrower-T treatment, the interactions between the intermediary and the investor are transparent to the borrower. In the Investor-T treatment, the interactions between the borrower and intermediary are transparent to the investor. Finally, in the Full-T treatment there is “full” transparency, so all parties can see the interactions of all pairs.

The experiment was conducted at Chapman University at the Economic Science Institute. Subjects were recruited from a standard subject pool consisting primarily of undergraduate students. Subjects interacted with each other anonymously over a local computer network. The experiment was programmed and conducted using z-Tree (Fischbacher, 2007). The computers were placed within individual cubicles in such a way that all subjects could only view their own computer screen.

At the beginning of each session, subjects were given the instructions for the one-shot three-player trust game. An experimenter read the instructions aloud while each subject followed along with their own copy of the instructions.<sup>3</sup> All subjects were randomly assigned to a specific role, designated generically as player 1, player 2, or player 3 to avoid any value-laden terminology. Player 1 was endowed with 10 experimental dollars. In the first stage, player 1 made a decision on how much to send to player 2 (any integer between 0 and 10) and how much to keep. Each dollar sent by player 1 was tripled. In the second stage, player 2 made a decision on how much to send to player 3. The amount sent by player 2 was also tripled. In the third stage, player 3 made a decision on how much to return to player 2 and how much to keep. Finally, in the fourth stage, player 2 made a decision on how much to return to player 1 and how much to keep. All subjects were told that player 1, player 2, and player 3 can send some, all, or none of the amount available to them.

After all subjects completed the one-shot experiment, an experimenter announced a second part of the experiment that lasted for 10 periods. No indication of this second part had been given before subjects participated in the first part of the experiment to avoid any potential super-game strategies. The subjects also had not been told that the experiment would end after the first part. In the second part of the experiment, all subjects remained in the same role assignments (i.e., player 1, 2, or 3) as in the first part of the experiment. However, they were randomly re-grouped with other subjects who were in different roles to form a completely new three-player group. Subjects stayed in their newly formed groups for all 10 periods of the second part of the

---

<sup>3</sup> The instructions, available in Appendix I, explain the structure of the game in detail.

experiment. It was commonly known that the new pairings would last for 10 periods and that the experiment would end at that time. Each period corresponded to the three-player trust game and it proceeded in exactly the same way as the first part of the experiment. This procedure allowed subjects to participate in a single play of the game, without knowledge of a second 10-period repeat play version of the same stage game, as implemented by Burnham et al (2000) in their trust games. Hence, in one sitting, data are obtained from both single play and repeat play versions of the same game. We use the decisions in the single play version to type the playing characteristics of every subject for subsequent analysis.

After completing both parts of the experiment, subjects were paid for the decisions they made in the one-shot three-player trust game in the first part of the experiment. Also, subjects were paid for one randomly selected play of the 10 decision periods in the second part of the experiment. The earnings were paid privately in cash (US dollars) and each experimental session lasted for about 50 minutes. Experimental dollars were converted to US dollars at a rate of 2 experimental dollars to one US dollar. The average experimental earnings, including a \$7 participation fee, were \$23.15, ranging from a low of \$8 to a high of \$79. No subject participated more than once, and no subject had prior experience with a similar experimental environment.



## II Results

### A Efficiency and Payoffs in a One-Shot Trust Game

**Table II** reports average amounts sent and/or returned by parties and the efficiency in each treatment. Efficiency is measured as the sum of all three payoffs in the group divided by the maximum possible payoff of 90 experimental dollars. Reported Kruskal-Wallis test statistics measure whether there are significant differences across treatments. Panel A in the top part of **Table II** indicates that treatments have little effect in the single-shot games.

Table III reports regression results that examine the effect of transparency upon efficiency and payoffs. Payoffs are the amounts earned by each person after all players have sent and/or returned. In each column we report the coefficient estimates and robust errors for the investors' choices ( $s_1$ ), the intermediaries' ( $s_2$  and  $r_2$ ), and the borrowers' ( $r_3$ ). The independent variables are dummy-variables for Investor-T and Borrower-T treatments. Examining the data from the one-shot three-player trust game (first period), we find no difference in individual behavior and no differences in efficiency across treatments.<sup>4</sup> There is also no apparent difference in distribution of individual decisions across treatments. This leads to our first result:

**Result 1:** Transparency does not change aggregate behavior nor efficiency significantly in a one-shot multi-level trust game.

---

<sup>4</sup> In the one-shot game (first period), all individual observations are independent. So, we also performed a standard Wilcoxon Rank-Sum test and found no significant difference in decisions made by player 1, 2, or 3, and no difference in efficiency.

### 3.2. Efficiency and Payoffs in a Repeated Trust Game

In contrast to the results in the one-shot game, there are significant differences in behavior across treatments in repeated games (Panel B and C of **Table II**). Treatments with investor and full transparency result in higher amounts sent, amounts returned and efficiencies. Players of all types tended to have higher payoffs. Table IV reports regression results that examine the effect of transparency upon efficiency and payoffs over time for the repeated game. In each column, we report the coefficient estimates and robust standard errors for the player's choices.<sup>5</sup> In addition to the aforementioned dummy-variables for Investor-T and Borrower-T treatments, we include an inverse period variable (1/Period) to control for learning (i.e, 1/2, 1/3, 1/4, . . . , 1/11). As shown in regression (1) of Table IV, transparency affects efficiency in the repeated game. In particular, giving the investor full information about the transactions between the intermediary and borrower significantly increases efficiency. In contrast, giving the borrower full information about the investor and intermediary interactions, if anything, decreases efficiency.<sup>6</sup>

**Result 2.** Providing transparency to the investor (i.e., allowing the investor to see the exchange between the intermediary and the borrower) increases efficiency, while providing

---

<sup>5</sup> The robust specification allows for heteroskedasticity using Huber-White standard errors. Clustering by group, or running panel models by group, replicate the treatment effects since each group of subjects only participates in one treatment. That is, variance within and across matched groups of subjects can replicate exactly the within and across treatment variance.

<sup>6</sup> A median regression yields comparable results (coefficient values and statistical significance) albeit the Inverse of Period variable coefficient becomes marginally significant in addition to the Investor-T variable. Results available upon request.

transparency to the borrower (i.e., allowing the borrower to see the exchange between the investor and intermediary) has no significant effect on average efficiency.

Beyond the overall welfare measure, we examine profits of each player in regression (2). The treatment variable Investor-T is positive for all parties, albeit insignificant for the borrower. Shown in **Table II**, payoffs for the investor increase with full information (in respect to the investor), increasing 14 percent on average. When the investor had transparency, in the Investor-T and Full-T treatments, the average payoffs for the intermediary increased 21 percent and average payoffs increased 14 percent for the borrower. As a result, everyone benefits from investor having transparency. In contrast to the investor, when the borrower had full information, denoted by the treatment variable Borrower-T, his payoff did not change significantly (if anything, it decreased). Interestingly, the borrower fared worse in the Borrower-T than in the No-T treatment, where the average payoffs dropped from 18.3 to 13.6.

**Result 3.** Providing transparency to the investor increases payoffs to all players, while providing transparency to the borrower does not change payoffs significantly.

Similar to estimation results for payoffs, regression (3) in Table IV reports multivariate regression results for the effect of transparency upon each agent's proportion of payoffs (individual payoff as a fraction of the total payoff) over time for the repeated game. The estimation results indicate that giving the investor information increases the intermediary's and

borrower's proportions of total payoff (see coefficient for Investor-T), and it decreases the investor's proportion of payoff. Thus, while transparency for investor increases payoffs to all parties, the borrowers and intermediaries benefit by relatively more than the investors (who actually have the increased information sets). As before, no significant effect comes for the treatment dummy-variable Borrower-T.

**Result 4.** Providing transparency to the investor shifts the distribution of payoffs towards intermediaries and borrowers, while providing transparency to the borrower does not change the distribution of payoffs.

Interestingly, the intermediary's and borrower's proportions increase over time, while investor's proportion decreases, indicating significant learning.

### **3.3. Determinants of Behavior in a Repeated Trust Game**

The gains from exchange, and hence payoffs and efficiency, are driven by the (multiplied) amounts sent, not the amounts returned. So in order to generate economic surplus, transparency has to affect the amounts sent by the investor and intermediary; while the amounts returned by the borrower and intermediary distribute the surplus and provide the reciprocity needed to encourage future efficiency through higher future amounts sent. To measure these effects, we examine the individual behavior of the players and the determinants that influence such behavior.

Table V reports the regression results that examine behavior over time (periods 3-11) in the ten-period repeated game. We use simultaneous equation estimation procedures to control for endogeneity. In each column we report the coefficient estimates and robust standard errors for the players' choices. In addition to the aforementioned variables Investor-T, Borrower-T, and Inverse Period, we include the independent variable IType, which is the amount sent or returned in the pre-experiment one-shot game. While the investor and borrower have a singular value for IType, the intermediary has one representing the amount sent to the borrower (used in regression (2)) and another representing the amount sent back to the investor (used in regression (4)). In this procedure, we are combining and extending techniques developed in two previous papers. Rigdon, et al, (2007) identified the IType of each subject in an extensive form trust game in the first period of a twenty period repeated game, and found this variable highly significant in explaining subsequent behavior in the different treatment conditions they studied. By following Burnham et al. (2000) in observing decisions in a pre-experiment single play version, followed by a repeat play version, we are able to measure IType before subjects know they are going to participate in a repeated version of the same game.<sup>7</sup> Thus, we test whether this independent IType measure persists as a predictive procedure for subject behavior in a repeated version of the same stage game.

In addition, we include independent variables representing the observable choices in the current period: S1, S2, R3, and S1Vis which is S1 when visible to the borrower. Also we include

---

<sup>7</sup> Burnham et al. (2000) did not measure IType; their purpose was simply to compare single play with repeat play using data obtained from subjects in the same session. See Houser's (2003) examination and discussion of types for dynamic decision making.

variables representing the prior period's observable choices: LagS1, LagS2, LagR3, LagR2, and LagS1Vis, LagS2Vis, LagR3Vis and LagR2Vis which are last period's choices when observable to the appropriate player.

As per the regressions (1) – (4) in Table V note the treatment variable Investor-T is only significant for the investor's choice in regression (1), affecting the amount sent; the critical behavior needed to facilitate any efficiency at all. On average investors send about 26 percent more when investor has full transparency, an average of 6.8 in the Full-T and Investor-T treatments versus 5.4 in the No-T and Borrower-T treatments. Interestingly the amounts of the transparent choices, captured by LagS2Vis and LagR3Vis, are not significant in predicting how much of the endowment is put at risk, only the fact the choices were transparent matters. Also the past amounts sent by the investor, LagS1, and returned directly to the investor, LagR3, are predictive.

We observe that the IType coefficient is significant in all of these regressions, confirming the methodological value of our pre-experiment measurement of a person's characteristic willingness to trust. This is important in separating out a source of variation that enables better estimation of treatment and other effects.<sup>8</sup>

Examining the intermediary's sending choice; the treatment effects are insignificant in regression (2). The treatment effect is captured by the amount sent by the investor, S1. Also notice that in all treatments all amounts sent and returned were visible to the intermediary. In all treatments the intermediary sent on average 1.8 times the amount received by the investor except

---

<sup>8</sup> Further, because IType is a constant across all observations from a single player in each regression, it also serves as an effective player fixed effect.

for in the No-T treatment where the average was 1.9. The last period amounts directly received by the intermediary were germane. The intermediary's sending type determined in the one-shot game was predictive, but the amount sent in the prior round was not.

Symmetric to the investor, transparency differed for the borrower across treatments. In regression (3) we see treatment effects are not significant. The average amount returned was 1.5 times the amount sent by the intermediary in all treatments, except for the No-T treatment, where the average was 1.3. Again the amounts of the transparent choices, captured by  $LagS1Vis$  and  $LagR2Vis$  are not significant in predicting how much is returned, only the fact the choices were transparent mattered. What was sent by the intermediary,  $S2$ , what was sent last period,  $LagS2$ , and what the borrower sent back last period,  $LagS3$ , were predictive in addition to the behavior of the borrower in the one-shot game.

Finally we return to the intermediary in regression (4) to examine the amount returned to the investor. The amount sent by the investor,  $S1$ , and the amount returned by the borrower,  $R3$ , increase the amount returned to the investor, whereas the amount sent to the borrower decreased it. The amount sent by the investor last period,  $LagS1$ , and returned by the borrower,  $LagR3$ , also are predictive, as is the amount returned by the intermediary last period,  $LagR2$ . Again, the intermediary type behavior is marked significantly by her choice in the one-shot game. As with the intermediary's sending decision, the treatment dummies  $Investor-T$  and  $Borrower-T$  do not load, as we argue the treatment effects are captured by  $S1$  and  $R3$  where transparency differs over treatments. The average amount returned to the investor was 0.55 times the amount returned by the borrower in the No-T and  $Investor-T$  treatments, increased to 0.57 in the  $Full-T$

treatment, but decreased 0.48 in the Borrower-T treatment, where the borrower was not privy to the amount returned to the investor.

In summary, the multivariate results show that:

- (1) Players typed as trusting and/or reciprocating in the one-shot setting tend to continue that behavior in the repeated setting. There is also significant persistence in investor and borrower behavior across rounds in the repeated setting.
- (2) Investor transparency increases the initial investments and overall efficiency as a result.
- (3) More investment creates more lending and more lending creates more return to the intermediary and investor.
- (4) History matters in a complex and interesting way. Intermediaries seem to learn through time while all subjects appear affected by how other subjects treated them in the prior period. Specifically, learning through time reduces the willingness of intermediaries to make loans, while good prior returns increases the amounts investors invest.

The history effect creates an interesting, but complex, dynamic relationship. In particular, the coefficients on LagR3 in regressions (2) and (4) suggest that, if borrowers do not pay back intermediaries, subsequent loans and returns to investors fall. Then, the coefficient on LagR2 in regression (1) suggests that investors will invest less in subsequent periods. This dynamic would drive down efficiency and economic welfare. On the other hand, higher loan repayment rates would drive the opposite dynamic outcomes.



### **III Discussion and Extensions**

We design an experiment to examine welfare and behavior in a multi-level investment trust game. In the scenario an Investor invests via an Intermediary who lends to a Borrower in a repeated game. We alter the transparency of exchanges between non-adjacent parties. We find that transparency does not change aggregate behavior nor efficiency in a one-shot multi-level trust game. However, in repeated multi-level trust games, transparency matters. Providing transparency to the investor (i.e., allowing the investor to see the exchange between the intermediary and the borrower) increases efficiency and payoffs to all players, while providing transparency to the borrower (i.e., allowing the borrower to see the exchange between the investor and intermediary) does not change efficiency and payoffs. Providing transparency to the investor also shifts the distribution of payoffs towards intermediaries and borrowers, while providing transparency to the borrower does not change the distribution of payoffs.

We introduce and test the ability of a one-shot game to measure the trust characteristics of subjects and to predict trusting behavior in a subsequent repeated version of the same stage game. This procedure may have value in other applications not yet explored.

Overall, our findings indicate that in the multi-level trust game transparency can matter, improving outcomes in financial markets and economic welfare. On the other hand, only one side of transparency matters. For financial markets this implies that not all forms of transparency are equal in their ability to improve market outcomes. In the analog pass through securities market (the collateralized, home mortgage debt obligation market we discussed in the introduction), the ability to verify the credit worthiness of borrowers would seem to be the most

important aspect of transparency. In addition, transparency affects welfare asymmetrically. When transparency matters, it is borrowers and intermediaries benefit more than investors in relative terms. If the policy goal of the government is to make home ownership (and borrowing in general) more accessible, then investor transparency (allowing investors to see the transactions between intermediaries and the ultimate borrowers) can facilitate this while shifting economic welfare toward the ultimate borrowers.

There are several obvious extensions to our research. First, trust relationship may involve even higher orders and our game would be easy to generalize to three or more levels. Second, trust may be circular instead of linear as we have in our game. It would be simple to design a game where either the borrower gave back money both to the investor and intermediary or, alternatively to the investor with the investor paying the intermediary (Sheremeta and Zhang, 2010). Finally, calls for reform often include reporting standards and oversight bodies. One could easily add a monitoring agent to replace direct transparency in our setup up. One could also report prior aggregate outcomes (as in the original Berg, Dickhaut and McCabe, 1995, paper) or current aggregate information. Of course, all may interact with transparency and help us inform policy with respect to transparency, reporting and oversight in financial markets.

## References

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

- Buchner, S., Gonzalez, L.G., Guth, W., and Levati, M.V., 2004, Incentive Contracts versus Trust in Three-player Ultimatum Games: An Experimental Study, *European Journal of Political Economy* 20, 673-694.
- Burnham, T., K. McCabe and V. Smith, 2000, Friend-or-Foe Intentionality Priming in an Extensive Form Trust Game, *Journal of Economic Behavior and Organization* 43, 57-73.
- Dufwenberg, M., Gneezy, U., Güth, W., Van Demme, E., 2001, Direct versus Indirect Reciprocity: An Experiment, *Homo Economicus* 18, 19-30.
- Greiner, B., and Levati, V.M., 2005, Indirect Reciprocity in Cyclical Networks: An Experimental Study. *Journal of Economic Psychology* 26, 711-731.
- Guth, W., Königstein, M., Marchand, N., and Nehring, K., 2001, Trust and Reciprocity in the Investment Game with Indirect Reward, *Homo Economicus* 18, 241–262.
- Houser, D., 2003, Classification of Types for Dynamic Decision Makers, In L. Nadel, ed. *Encyclopedia of Cognitive Science*, vol. ?? , 1020-1026 (London: Nature Publishing Group).
- Nowak, M.A., and Sigmund, K., 1998, The Dynamics of Indirect Reciprocity, *Journal of Theoretical Biology* 194, 561–574.
- Obama, B., 2010, Letter to G-20, June 16, 2010, Accessed on 9/30/2010 at: [http://www.whitehouse.gov/sites/default/files/rss\\_viewer/president\\_obama\\_letter\\_to\\_g-20\\_061610.pdf](http://www.whitehouse.gov/sites/default/files/rss_viewer/president_obama_letter_to_g-20_061610.pdf)
- Rapoport, A., Stein, W. E., Parco, J. E., and Nicholas, T. E., 2003, Equilibrium Play and Adaptive Learning in a Three-player Centipede Game, *Games and Economic Behavior* 43, 239–65.
- Rigdon, M., K. McCabe and V. Smith, 2007, Sustaining Cooperation in Trust Games, *Economic Journal* 117, 991-1007.
- Seinen, I., and Schram, A., 2006, Social Status and Group Norms: Indirect Reciprocity in a Repeated Helping Experiment, *European Economic Review* 50, 581-602.
- Sheremeta, R.M., & Zhang, J. 2010, Multi-Level Trust Game with “Insider” Communication, McMaster University, Working Paper.
- Wedekind, C., and Milinski, M., 2000, Cooperation Through Image Scoring in Humans, *Science* 288, 850–852.
- Wichman, H., 1972, Effects of Isolation and Communication on Cooperation in a Two-player Game, In L. S. Wrightsman, J. O'Connor, and N. J. Baker (Eds.), *Cooperation and Competition: Readings on Mixed-Motive Games*, 197-206. (Belmont, CA: Brooks/Cole Publishing Company).

## Tables and Figures

**Table I: Summary of Treatments**

Treatment	Players Observing Additional Information	Transparency About Transactions of:	Number of Subjects
No-T	None	None	48
Borrower-T	Borrower	Investor and Intermediary	48
Investor-T	Investor	Intermediary and Borrower	48
Full-T	Investor and Borrower	All Players	48

**Table II: Average Statistics by Treatment**

	Full Transparency	Borrower Transparency	Investor Transparency	No Transparency	Kruskal-Wallis test Statistic <i>P-Value</i> (3 d.o.f.)
<i>Panel A: Amounts Sent and Returned in One-Shot Games</i>					
Player 1	6.9	7.0	6.9	7.6	2.109
Amount Sent	(1.7)	(2.4)	(2.0)	(2.5)	<i>0.5501</i>
Player 2	12.9	11.6	14.1	16.5	2.903
Amount Sent	(5.9)	(6.8)	(8.5)	(8.0)	<i>0.4068</i>
Player 3	9.6	8.1	11.8	11.3	0.428
Amount Returned	(10.9)	(9.0)	(17.3)	(13.5)	<i>0.9343</i>
Player 2	3.9	2.8	5.0	5.1	1.753
Amount Returned	(4.6)	(4.7)	(9.0)	(6.5)	<i>0.6252</i>
Efficiency	0.55 (0.15)	0.52 (0.19)	0.58 (0.22)	0.65 (0.22)	2.665 <i>0.4462</i>
<i>Panel B: Amounts Sent and Returned in Repeated Games</i>					
Player 1	6.7	5.1	6.9	5.7	21.473***
Amount Sent	(3.5)	(4.1)	(3.7)	(4.2)	<i>0.0001</i>
Player 2	11.9	9.2	12.2	11.0	7.148*
Amount Sent	(10.7)	(10.2)	(12.3)	(11.5)	<i>0.0673</i>
Player 3	17.8	13.8	18.2	14.8	7.404*
Amount Returned	(20.3)	(19.8)	(23.7)	(20.9)	<i>0.0601</i>
Player 2	10.6	6.7	10.2	8.0	19.477***
Amount Returned	(10.1)	(9.5)	(10.7)	(9.1)	<i>0.0002</i>
Efficiency	0.52 (0.29)	0.43 (0.30)	0.54 (0.33)	0.48 (0.33)	39.296*** <i>0.0001</i>
<i>Panel C: Average Payoff by Player Type in Repeated Games</i>					
Investor	13.93	11.58	13.28	12.27	8.294*
Payoff	(7.98)	(7.40)	(8.57)	(6.52)	<i>0.0403</i>
Intermediary	15.23	13.36	16.57	12.96	12.916**
Payoff	(8.88)	(11.61)	(12.60)	(12.29)	<i>0.0048</i>
Borrower	18.00	13.63	18.36	18.29	8.138*
Payoff	(15.11)	(14.77)	(18.78)	(19.74)	<i>0.0433</i>

Standard deviations are in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Table III:** Regressions on Efficiency and Payoffs in One-Shot Games

<i>Variables</i>	Efficiency	Payoff Investor	Payoff Intermediary	Payoff Borrower
Investor-T	-0.021 (0.049)	0.938 (1.400)	-0.250 (2.220)	-2.562 (4.170)
Borrower-T	-0.076 (0.049)	-1.375 (1.400)	1.062 (2.220)	-6.562 (4.170)
Constant	0.624*** (0.046)	7.281*** (1.213)	13.188*** (1.923)	35.656*** (3.612)
Observations	64	64	64	64
R-squared	0.041	0.023	0.004	0.045

Standard errors in parentheses.

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

**Table IV:** Efficiency, Payoffs and Distribution of Payoffs in Repeated Games (Periods 2-11)

<i>Variables</i>	(1) Efficiency	(2) Regressions on Payoffs to:			(3) Regression on Share of Payoffs to:		
		Investor	Intermediary	Borrower	Investor	Intermediary	Borrower
Inverse Period	0.084 (0.090)	-4.342* (2.473)	-0.388 (3.702)	12.301** (5.564)	-0.501*** (0.098)	0.123* (0.063)	0.378*** (0.072)
Investor-T	0.074*** (0.025)	1.678*** (0.606)	2.741*** (0.907)	2.225 (1.363)	-0.093*** (0.024)	0.063*** (0.015)	0.030* (0.018)
Borrower-T	-0.033 (0.025)	-0.022 (0.606)	-0.472 (0.907)	-2.513* (1.363)	-0.005 (0.024)	0.011 (0.015)	-0.007 (0.018)
Constant	0.456*** (0.030)	12.816*** (0.724)	13.474*** (1.084)	14.728*** (1.630)	0.573*** (0.029)	0.232*** (0.018)	0.195*** (0.021)
Observations	640	640	640	640	640	640	640
R-squared	0.017	0.017	0.015	0.017	0.060	0.032	0.045

Standard errors in parentheses.

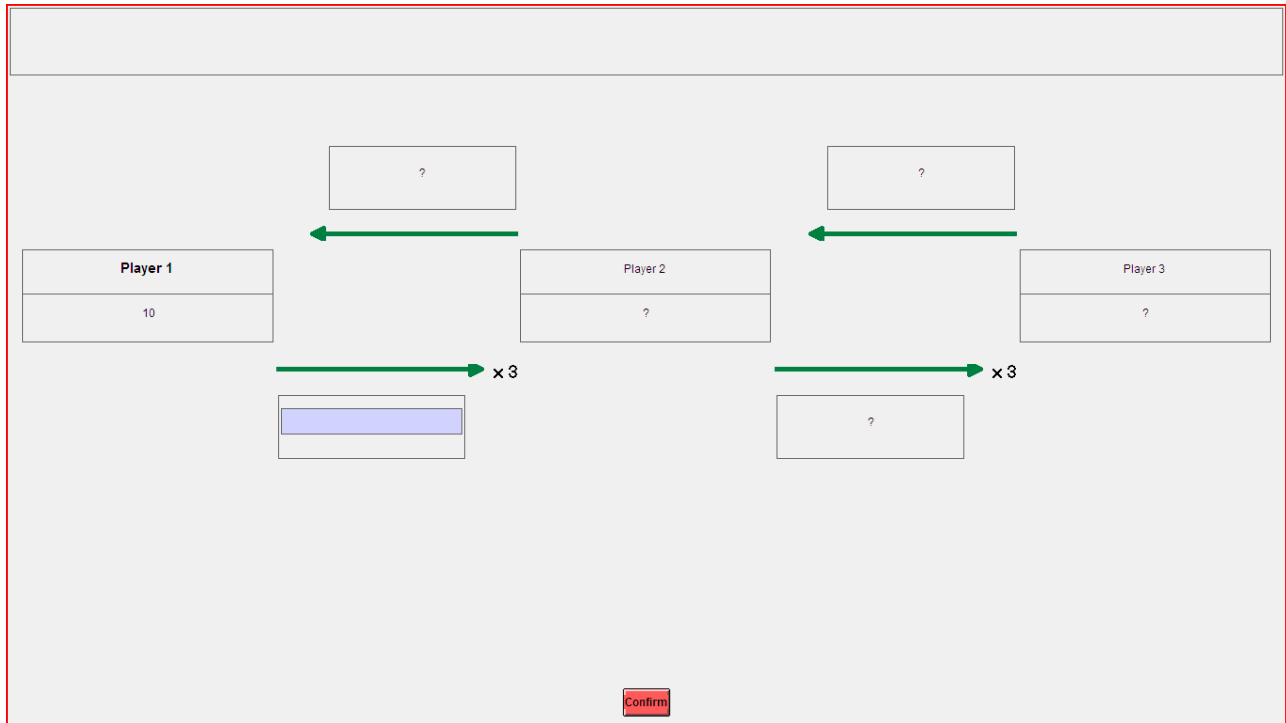
\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

**Table V:** Regression of Amounts Sent and Returned in Repeated-Setting using History Variables (Periods 3-11)

Variable	Regression Number			
	(1) S1	(2) S2	(3) R3	(4) R2
Inverse Period	2.574 (1.630)	7.129** (3.236)	7.295 (4.668)	3.490* (1.969)
Investor-T	0.928*** (0.323)	-0.207 (0.493)	0.460 (0.699)	0.363 (0.298)
Borrower-T	-0.145 (0.245)	-0.108 (0.493)	1.601 (1.186)	0.284 (0.294)
Itype	0.124** (0.060)	0.112*** (0.034)	0.075** (0.029)	0.083*** (0.024)
<i>Current period's observable choices</i>				
S1		1.419*** (0.082)		0.826*** (0.061)
S2			1.331*** (0.053)	-0.327*** (0.036)
R3				0.451*** (0.018)
S1Vis			-0.019 (0.192)	
<i>Prior period's observable choices</i>				
LagS1	0.354*** (0.052)	-0.310** (0.122)		-0.431*** (0.074)
LagS2		-0.174** (0.069)	-0.289*** (0.082)	0.181*** (0.042)
LagR3		0.456*** (0.045)	0.393*** (0.051)	-0.272*** (0.030)
LagR2	0.160*** (0.023)	-0.147** (0.073)		0.589*** (0.044)
LagS1Vis			-0.284 (0.213)	
LagS2Vis	-0.025 (0.041)			
LagR3Vis	0.004 (0.024)			
LagR2Vis			0.107 (0.090)	
Constant	0.748 (0.560)	-2.529*** (0.945)	-4.054*** (1.096)	-1.362*** (0.485)
Observations	576	576	576	576
R-squared	0.483	0.750	0.859	0.884

Robust standard errors in parentheses.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1



**Figure 1:** Three-Player Trust Game Screen Shot from the Experiment

## Supplementary Appendix

### INSTRUCTIONS (*Example of the No-Transparency Treatment*)

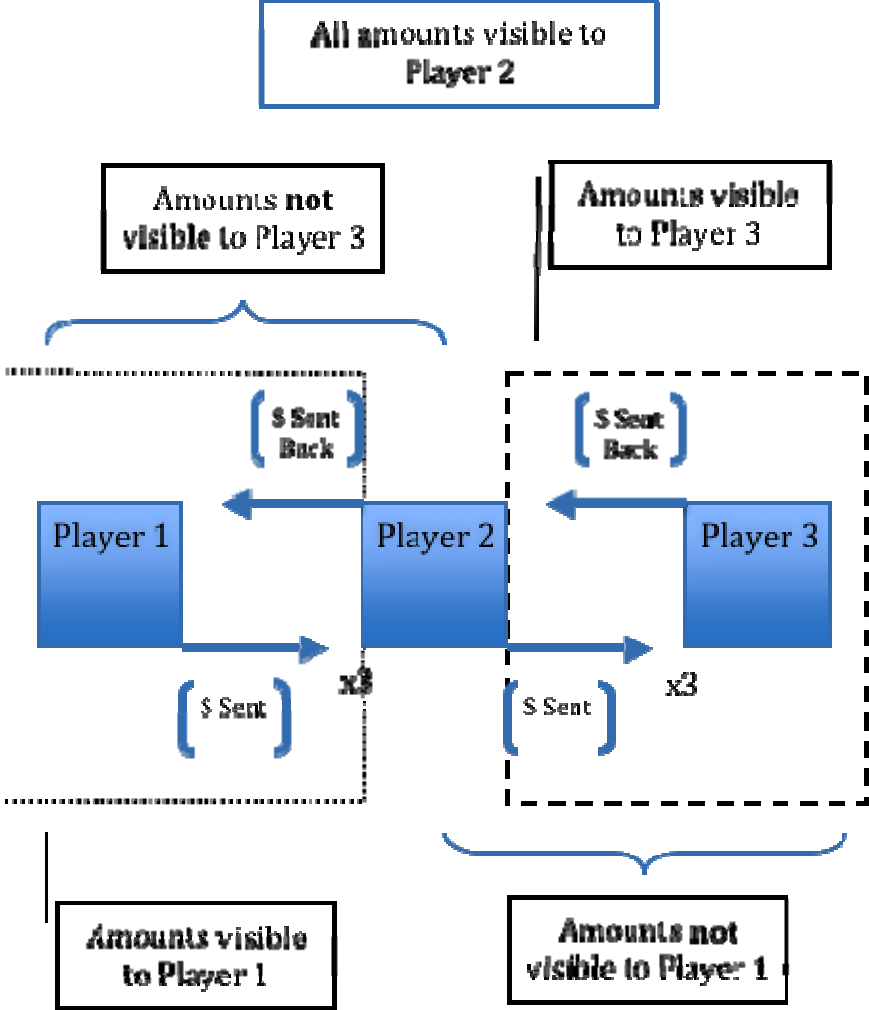
This is an experiment in the economics of decision-making. Various research agencies have provided funds for this research. The currency used in the experiment is experimental dollars, and they will be converted to U.S. Dollars at a rate of 2 experimental dollars to 1 dollar. At the end of experiment your earnings will be paid to you in private and in cash. It is very important that you remain silent and do not look at other people's work. If you have any questions, or need assistance of any kind, please raise your hand and an experimenter will come to you. If you talk, laugh, exclaim out loud, etc., you will be asked to leave and you will not be paid. We expect and appreciate your cooperation.

The 24 participants in today's experiment will be randomly assigned into 8 three-player groups. In addition to the group assignment each participant will also be randomly assigned to a specific type in the group, designated as Player 1, Player 2, or Player 3. You and the other two participants in your group will make choices that will determine your payoffs. The experiment consists of four decision stages.

In stage 1, Player 1 receives \$10 and then decides how many dollars to send to Player 2. The amount sent by Player 1 is multiplied by 3. In stage 2, Player 2 decides how many dollars to send



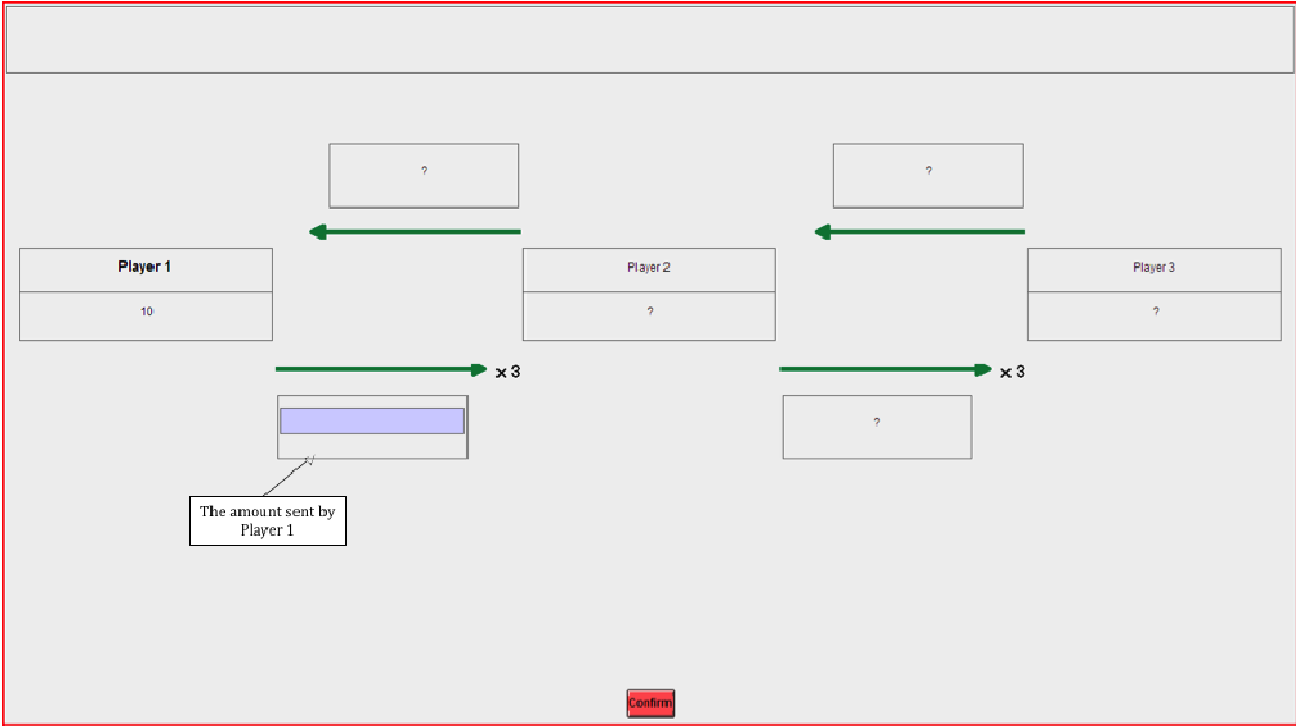
to Player 3. The amount sent by Player 2 is multiplied by 3. In stage 3, Player 3 decides how many dollars to send back to Player 2. Finally, in stage 4, Player 2 decides how many dollars to send back to Player 1. Not all amounts are visible to all Players as shown in the following diagram:



Next we describe in details the decisions made by all players in each stage of the experiment.

Stage 1: Player 1 receives \$10 and then decides how many dollars to send to Player 2 (any integer between 0 and 10). Player 1 enters the amount sent to Player 2 in the box labeled “The amount sent by Player 1” below. The amount sent by Player 1 is multiplied by 3. Any amount that is not sent is automatically allocated to Player 1’s account.

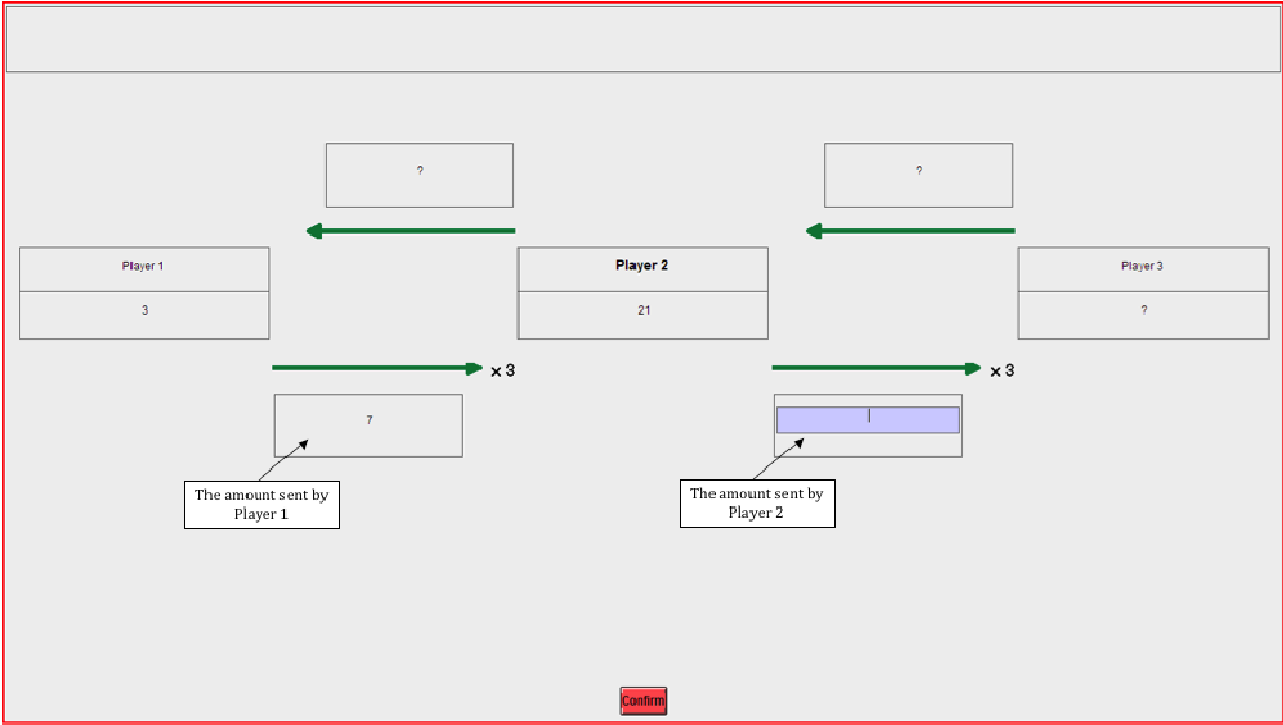
After making this decision, Player 1 will only learn the decision made Player 2 in stage 4. However, Player 1 will not learn the decisions made by Player 2 in stage 2 and Player 3 in stage 3.



Decision Screen for Player 1 in Stage 1

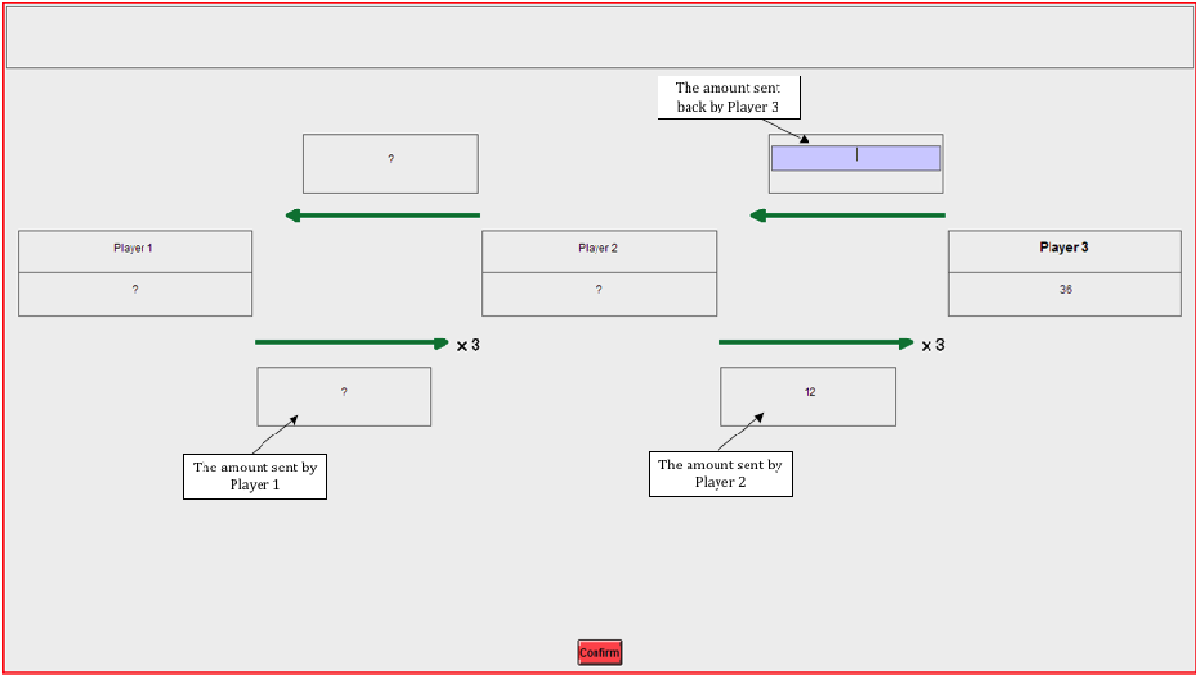
Stage 2: After learning the amount sent by Player 1 in stage 1, Player 2 decides how many dollars to send to Player 3 (any integer between 0 and the amount available in Player 2’s account at that time). Player 2 enters the amount sent to Player 3 in the box labeled “The amount sent by Player 2” below. The amount sent by Player 2 is multiplied by 3. Any amount that is not sent is automatically allocated to Player 2’s account.

Player 2 will learn all the decisions made by all players in all stages.



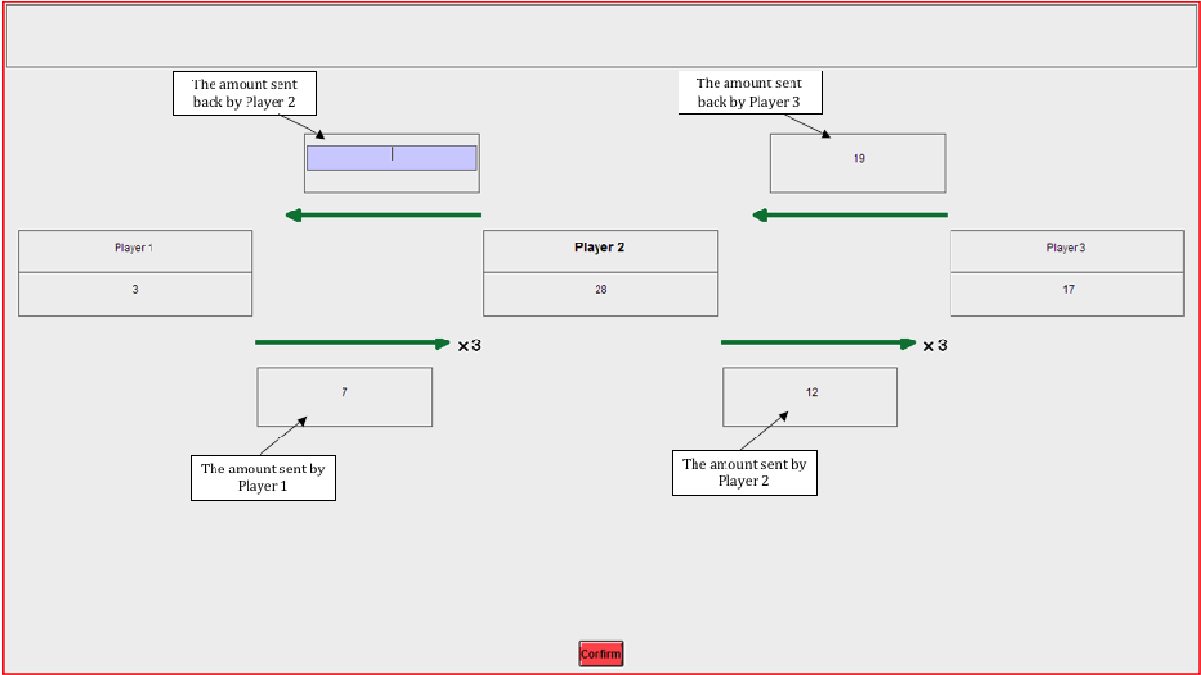
Decision Screen for Player 2 in Stage 2

Stage 3: After learning the amount sent by Player 2 in stage 2, Player 3 decides how many dollars to send back to Player 2 (any integer between 0 and the amount available in Player 3's account at that time). Player 3 enters the amount sent back to Player 2 in the box labeled "The amount sent back by Player 3" below. The amount sent back by Player 3 is NOT multiplied. Any amount that is not sent is automatically allocated to Player 3's account. Before making this decision, Player 3 will only learn the decision made by Player 2 in stage 2. However, Player 3 will not learn the decisions made by Player 1 in stage 1 and Player 2 in stage 4.



Decision Screen for Player 3 in Stage 3

Stage 4: After learning the amount sent back by Player 3 in stage 3, Player 2 decides how many dollars to send back to Player 1 (any integer between 0 and the amount available in Player 2’s account at that time). Player 2 enters the amount sent back to Player 1 in the box labeled “The amount sent back by Player 2” below. The amount sent back by Player 2 is NOT multiplied. Any amount that is not sent is automatically allocated to Player 2’s account.



Decision Screen for Player 2 in Stage 4

Finally, at the end of the Stage 4 the total earnings are reported to each person. Please record the decisions and your earnings on your record sheet under the appropriate heading.

## SUMMARY

The computer will assign you and two other participants to a three-player group, consisting of Player 1, Player 2, and Player 3. In stage 1, Player 1 receives \$10 and then decides how many dollars to send to Player 2. The amount sent by Player 1 is multiplied by 3. In stage 2, Player 2 decides how many dollars to send to Player 3. The amount sent by Player 2 is multiplied by 3. In stage 3, Player 3 decides how many dollars to send back to Player 2. Finally, in stage 4, Player 2 decides how many dollars to send back to Player 1.

After making the first decision, Player 1 will only learn the decision made Player 2 in stage 4. However, Player 1 will not learn the decisions made by Player 2 in stage 2 and Player 3 in stage 3. Player 2 will learn all the decisions made by all players in all stages. Before making a decision, Player 3 will only learn the decision made by Player 2 in stage 2. However, Player 3 will not learn the decisions made by Player 1 in stage 1 and Player 2 in stage 4.

At the end of Stage 4 the total earnings are reported to each person. This experiment is now over and your earnings will be part of the total you will be paid.

## EXAMPLE

Consider a hypothetical example:

Stage 1: Player 1 sends \$7 to Player 2

Stage 2: Player 2 sends \$12 to Player 3

Stage 3: Player 3 sends back \$19 to Player 2

Stage 4: Player 2 sends back \$16 to Player 1

In stage 1, Player 1 sends \$7 to Player 2 and keeps \$3 ( $\$10 - \$7 = \$3$ ). The amount received by Player 2 is \$21 ( $\$7 \times 3 = \$21$ ). At the end of stage 1, Player 2 learns the decision made by Player 1.

In stage 2, Player 2 sends \$12 to Player 3 and keeps \$9 ( $\$21 - \$12 = \$9$ ). The amount received by Player 3 is \$36 ( $\$12 \times 3 = \$36$ ). At the end of stage 2, Player 3 learns the decision made by Player 2.

In stage 3, Player 3 sends back \$19 to Player 2 and keeps \$17 ( $\$36 - \$19 = \$17$ ). The amount received by Player 2 is \$19. However, Player 2 also has an additional \$9 which was kept in stage 2, for a total of \$28 ( $\$19 + \$9 = \$28$ ). At the end of stage 3, Player 2 learns the decision made by Player 3.

In stage 4, Player 2 sends back \$16 to Player 1 and keeps \$12 ( $\$28 - \$16 = \$12$ ). However, Player 1 also has an additional \$3 which was kept in stage 1, for a total of \$19 ( $\$16 + \$3 = \$19$ ). At the end of stage 4, Player 1 learns the decision made by Player 2.

As the result, the total earnings for each player are:

Player 1 earns \$19

Player 2 earns \$12

Player 3 earns \$17

#### QUIZ #1

A hypothetical example:

Stage 1: Player 1 sends \$2 to Player 2

Stage 2: Player 2 sends \$0 to Player 3

Stage 3: Player 3 sends back \$0 to Player 2

Stage 4: Player 2 sends back \$0 to Player 1

What are the total earnings for each player?

Player 1 earns \_\_\_\_?

Player 2 earns \_\_\_\_?

Player 3 earns \_\_\_\_?



## QUIZ #2

A hypothetical example:

Stage 1: Player 1 sends \$9 to Player 2

Stage 2: Player 2 sends \$25 to Player 3

Stage 3: Player 3 sends back \$50 to Player 2

Stage 4: Player 2 sends back \$15 to Player 1

What are the total earnings for each player?

Player 1 earns \_\_\_\_?

Player 2 earns \_\_\_\_?

Player 3 earns \_\_\_\_?

*(The following distributed after subjects played the one-shot game)*

### INSTRUCTIONS - 10 MORE REPLICATIONS

This experiment consists of 10 decision-making periods. The rules for each period are exactly the same as the rules for the previous experiment. In all 10 periods of the experiment you will remain the same type of player as in the previous experiment. However, at the beginning of the first period, you will be randomly rematched with two other players of the other types to form a new three-player group. You will remain with this new three-player group for all 10 periods of the experiment.

During each period, you and the other two participants in your group will make choices as in the previous experiment that will determine your payoffs. Please record the decisions and your earnings in each period on your record sheet under the appropriate heading.

We will randomly choose 1 of the 10 periods for actual payment using a die roll using a ten-sided die with numbers from 1 to 10. Your final earnings for these experiments consist of: (1) your show up fee, (2) earnings from the first experiment and (3) your earnings from the randomly selected period in the second experiment. Note that after this 10-period experiment there will be no further experiments and your earnings will be paid to you in private and in cash.

## **Economic Science Institute Working Papers**

### **2011**

**11-02** Corgnet, B., Kujal, P. and Porter, D. The Effect of Reliability, Content and Timing of Public Announcements on Asset Trading Behavior.

**11-01** Corgnet, B., Kujal, P. and Porter, D. Reaction to Public Information in Markets: How Much Does Ambiguity Matter?

### **2010**

**10-22** Mago, S., Sheremeta, R., and Yates, A. Best-of-Three Contests: Experimental Evidence.

**10-21** Kimbrough, E. and Sheremeta, R. Make Him an Offer He Can't Refuse: Avoiding Conflicts Through Side Payments.

**10-20** Savikhim, A. and Sheremeta, R. Visibility of Contributions and Cost of Inflation: An Experiment on Public Goods.

**10-19** Sheremeta, R. and Shields, T. Do Investors Trust or Simply Gamble?

**10-18** Deck, C. and Sheremeta, R. Fight or Flight? Defending Against Sequential Attacks in the Game of Siege.

**10-17** Deck, C., Lin, S. and Porter, D. Affecting Policy by Manipulating Prediction Markets: Experimental Evidence.

**10-16** Deck, C. and Kimbrough, E. Can Markets Save Lives? An Experimental Investigation of a Market for Organ Donations.

**10-15** Deck, C., Lee, J. and Reyes, J. Personality and the Consistency of Risk Taking Behavior: Experimental Evidence.

**10-14** Deck, C. and Nikiforakis, N. Perfect and Imperfect Real-Time Monitoring in a Minimum-Effort Game.

**10-13** Deck, C. and Gu, J. Price Increasing Competition? Experimental Evidence.

**10-12** Kovenock, D., Roberson, B., and Sheremeta, R. The Attack and Defense of Weakest-Link Networks.

**10-11** Wilson, B., Jaworski, T., Schurter, K. and Smyth, A. An Experimental Economic History of Whalers' Rules of Capture.

**10-10** DeScioli, P. and Wilson, B. Mine and Thine: The Territorial Foundations of Human Property.

**10-09** Cason, T., Masters, W. and Sheremeta, R. Entry into Winner-Take-All and Proportional-Prize Contests: An Experimental Study.

**10-08** Savikhin, A. and Sheremeta, R. Simultaneous Decision-Making in Competitive and Cooperative Environments.

**10-07** Chowdhury, S. and Sheremeta, R. A generalized Tullock contest.

**10-06** Chowdhury, S. and Sheremeta, R. The Equivalence of Contests.

**10-05** Shields, T. Do Analysts Tell the Truth? Do Shareholders Listen? An Experimental Study of Analysts' Forecasts and Shareholder Reaction.

**10-04** Lin, S. and Rassenti, S. Are Under- and Over-reaction the Same Matter? A Price Inertia based Account.

**10-03** Lin, S. Gradual Information Diffusion and Asset Price Momentum.

**10-02** Gjerstad, S. and Smith, V. Household expenditure cycles and economic cycles, 1920 – 2010.

**10-01** Dickhaut, J., Lin, S., Porter, D. and Smith, V. Durability, Re-trading and Market Performance.

## **2009**

**09-11** Hazlett, T., Porter, D., Smith, V. Radio Spectrum and the Disruptive Clarity OF Ronald Coase.

**09-10** Sheremeta, R. Expenditures and Information Disclosure in Two-Stage Political Contests.

**09-09** Sheremeta, R. and Zhang, J. Can Groups Solve the Problem of Over-Bidding in Contests?

**09-08** Sheremeta, R. and Zhang, J. Multi-Level Trust Game with "Insider" Communication.

**09-07** Price, C. and Sheremeta, R. Endowment Effects in Contests.

**09-06** Cason, T., Savikhin, A. and Sheremeta, R. Cooperation Spillovers in Coordination Games.

**09-05** Sheremeta, R. Contest Design: An Experimental Investigation.

**09-04** Sheremeta, R. Experimental Comparison of Multi-Stage and One-Stage Contests.

**09-03** Smith, A., Skarbek, D., and Wilson, B. Anarchy, Groups, and Conflict: An Experiment on the Emergence of Protective Associations.

**09-02** Jaworski, T. and Wilson, B. Go West Young Man: Self-selection and Endogenous Property Rights.

**09-01** Gjerstad, S. Housing Market Price Tier Movements in an Expansion and Collapse.

## **2008**

**08-10** Dickhaut, J., Houser, D., Aimone, J., Tila, D. and Johnson, C. High Stakes Behavior with Low Payoffs: Inducing Preferences with Holt-Laury Gambles.

**08-09** Stecher, J., Shields, T. and Dickhaut, J. Generating Ambiguity in the Laboratory.

**08-08** Stecher, J., Lunawat, R., Pronin, K. and Dickhaut, J. Decision Making and Trade without Probabilities.

**08-07** Dickhaut, J., Lungu, O., Smith, V., Xin, B. and Rustichini, A. A Neuronal Mechanism of Choice.

**08-06** Anctil, R., Dickhaut, J., Johnson, K., and Kanodia, C. Does Information Transparency Decrease Coordination Failure?

**08-05** Tila, D. and Porter, D. Group Prediction in Information Markets With and Without Trading Information and Price Manipulation Incentives.

**08-04** Caginalp, G., Hao, L., Porter, D. and Smith, V. Asset Market Reactions to News: An Experimental Study.

**08-03** Thomas, C. and Wilson, B. Horizontal Product Differentiation in Auctions and Multilateral Negotiations.

**08-02** Oprea, R., Wilson, B. and Zillante, A. War of Attrition: Evidence from a Laboratory Experiment on Market Exit.

**08-01** Oprea, R., Porter, D., Hibbert, C., Hanson, R. and Tila, D. Can Manipulators Mislead Prediction Market Observers?