

Investment Game

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Investments: benefits and incentives.

In economic environments, an investment is an advance payment to earn future productive returns and benefits. The agent who makes the investment must however have the appropriate incentives. For instance, a company involved in scientific research is willing to pay for the costs of the research only if there is a reasonable certainty that adequate benefits and profits may be reaped in the future. This might not be the case if competitors are allowed to copy the new design at no cost. Patents are a way to guarantee such a return.

When prospects of future benefits are not reasonably large and reasonably certain to the person making the advance payment, then the potential investor may decide that the investment is not convenient; then, the productive potential of the investment is lost. This outcome is inefficient, since the total amount of resources available falls short of the full potential.

One way of overcoming this inefficiency is the institution of complete, binding irrevocable contracts. The contract has to be binding, or it has no power; it has to be complete, or the uncertain outcome in some event might destroy the incentive to invest. And it must be irrevocable: the person who makes the advance payment in the form of investment is, after the fact, in an unfavorable bargaining position, since the payment is made.

Clearly, as beneficial as they are, contracts with such stringent requirements are hard to realize, and when they can they are typically costly and complex. In many informal or infrequent interactions a contract is either not feasible or not convenient. A second way to insure the appropriate investment in repeated situations is building a reputation through the threat of future sanctions. An informal agreement to return something to the investor is credible if the situation is going to be repeated. The investor may threaten to stop the investment in future periods. The promise of future benefits, and the threat of their loss, may induce the trustee to honor his dues today.

But when contracts are impossible, and the exchange is not repeated, investments are likely to be inefficient. The loss may be considerable. Yet often in real exchanges we observe investments even when these two solutions are unavailable, and it is crucial to understand why investment still occurs. Recent research in experimental economics addresses - this issue precisely.

The investment game is an effective tool used in this research. This is a simple game, specifically designed for a laboratory environment. Its aim is to investigate if observable investment occurs if agents cannot write binding contracts and cannot create reputations.

The effectiveness of trust

The investment game is a tool to study how widespread and effective trust is in social interactions. Consider any situation in which one agent is giving another the power to make a decision that affects the utility of both. Trust occurs if, in pursuing an outcome that is potentially favorable to the two players, one of the two puts himself willingly in a situation of vulnerability. It is far from clear whether trust has any effect in economic interactions between selfish agents. It is also far from clear how different factors may affect trust if it does exist. The investment game allows a controlled study of the effectiveness and nature of trust in economic interactions.

The structure of the Investment Game

Two players move in sequence. Player 1 has an initial monetary endowment A . Player 1 decides the amount x of A to transfer to Player 2. The transfer x is a productive investment; it increases by a multiple, R , (larger than one), before reaching Player 2. Then, Player 2 decides how much, a , of Rx to return to Player 1. Player 1 leaves with $A - x + a$ and Player 2 leaves with $Rx - a$. Thus if Player 1 has an initial 10\$ and decides to transfer 5\$, Player 2 would receive 15\$. If Player 2 decides to return 8\$ dollars out of the \$15, the final payoff of the players is 13\$ and 7\$ respectively.

Several features of the game deserve comment. First, there is no possibility of writing binding contracts so that Player 2 cannot be penalized for not sending something back to Player 1. Second there is no role for reputation formation, at least as long as the game is played only once, and the subjects are never going to meet again. Similarly the threat of a zero transfer in future periods, which might be very effective in situations where this game is repeated by the same subjects in the same role is ineffective. Given the assumption that each subject prefers more money to less we know that the second player should not return any of the Rx that he was sent. Given Player 1 knows that Player 2 follows the same principles of behavior as Player 1, then Player 1 knows he will receive nothing back, thus Player 1 will send nothing. In summary, the investment game is a strategic situation in which no investment should occur under standard economic modeling assumptions.

This conclusion is true even for very large R is, which is the paradox highlighted by the investment game. If the first player rationally decides to make no initial transfer the two players completely forgo the potential benefits of the productive technology represented by R : The total amount they receive is A , rather than RA , which would be technically feasible. It is clear that if they could sign binding and irrevocable contracts before the beginning of the game, then the rational course of action would prescribe a transfer equal to the total amount A by the first player. This choice would maximize the total amount available to them, and they could bargain on its final allocation.

Experimental evidence

The original experiment implementing this game was run with very tight experimental controls: see Berg, J., Dickhaut, J. and McCabe, K., (1995). Two features were crucial. First, the anonymity from the experimenter as well as subject's anonymity from each other was guaranteed. Second, each subject was matched with only one other subject. The values chosen for the parameters were $A=10\$$ and $R=3$.

While the prediction of the sub-game perfect equilibrium is a zero transfer of the first player and a zero amount returned, the average amount sent was \$5.16, and the average amount returned was \$4.66. Very few subjects among the first movers sent zero (2 over 32). The amount sent was highly variable, hardly different in a statistical sense from that obtained from a uniform distribution over the different possible transfers. Many among the second movers who had received an amount of one dollar or more (over 10 possible) returned less than one dollar (12 over 28). But 11 of the same 29 subjects returned more than they had received. It has become customary to call Player 1's behavior trusting behavior and player 2's positive reciprocity.

This finding leads to the conclusion that new assumptions about individual behavior need to be incorporated in modeling activities in industrial organization such as the modeling of asymmetric information to better explain observed phenomena. Several different games, with similar design, have given the same experimental outcomes.

Related games

The basic features of the investment game are that the first mover has to make a decision that is costly to him, but potentially beneficial for both players. The benefits to the first mover however come only after a similar costly decision for Player 2: so Player 1 has no way to insure that he will get some of the benefits. On the contrary, purely selfish motivations of the second player would imply that the first mover cannot derive any benefit from his payment; he should not make any positive transfer. The same dilemma can be found in several related games that have been tested. The fundamental result that an advance positive payment of Player 1 is made is confirmed (with some important exceptions). Now we review some of these variations.

The Gift Exchange game

Like the trust game, the gift exchange game two players move sequentially. Player 1 has to propose a wage w , in a given interval. Player 2 can accept or refuse. If he refuses, both players get a zero payoff. If he accepts, he has to choose a costly effort e . Then the game is over, and the first player gets a payoff $R e - w$, while the second gets $w - c(e)$, where c is a convex. The transfer, or investment, in the investment game is replaced by the commitment of the first player to pay a wage w , irrespective of the effort of the second player; the return payment is replaced by the effort e and its cost $c(e)$ to the second player. The opportunity for both players is represented by the productive factor R .

Like the investment game, a rational selfish first player should anticipate a minimum effort of the second player, and should promise a minimum wage. With minimum wage, effort, and cost of zero effort all equal to zero, both players get zero equilibrium payoff, even if $Re - c(e)$ achievable (and hence divisible to each) with a feasible effort e .

Experimental evidence. This game was introduced and tested in Fehr, Kirchgeister, and Riedl, (1993, 1998); see also Charness (1996, 2000). In contrast to the equilibrium prediction of minimum effort and minimum wage (the market clearing levels of the competitive labor market), the observations in the experiment were consistent with a fair wage hypothesis. This hypothesis can be formulated in three different parts: The effort level is increasing in the wage; the average wage is higher than the market clearing level, and the average effort is higher than the minimum. These outcomes persist after replications of the same one-shot game.

The Moonlighting Game

In the investment game Player 1 can only transfer positive amounts of money to Player 2. In the moonlighting game, both players begin with a positive endowment. Player 1 can give an amount g or take away an amount t from the second player. The amount increases by a multiple R , an amount taken away is simply transferred to Player 1. Player 2 can then return money or take money away from the first player: an amount b given back costs b to Player 2 while the punishment in the form of an amount p taken away costs $3p$. Since Player 1 is a moonlighter, his activity cannot be legally enforced. The game allows the study of positive and negative reciprocity.

Experimental evidence. The moonlighting game was introduced and tested in one-shot experiments by Abbink, Irlenbusch, and Renner, (1999). They found that three quarters of subjects transfer a positive amount g ; on average, this transfers induces a positive return b . Finally, an amount taken away t is heavily punished with a positive p . So retribution is stronger and more effective than reciprocity. Player 2 is also allowed to propose a non-binding contract. These contracts increased trust but did not encourage reciprocity.

The Peasant-Dictator Game

In the Peasant-Dictator game Player 1 is a peasant, and Player 2, a dictator. The peasant decides the amount of investment k he makes out of an available amount W . The investment produces income $(1+r)k$. Then the second player (the "dictator") moves: he can impose a tax on the income produced, and the amount $t(1+r)k$ goes to him, and $(1-t)(1+r)k$ returns to the peasant, and is added to $W-k$.

Two treatments are possible: first the dictator can commit to a level of taxes before the peasant decides, or does not commit. A slightly different but economically equivalent formulation is one in which the dictator announces the level of taxes before the investment. In one treatment he is committed to the announcement made; in the other he

is not. When the announcement has no binding force, and the rational choice for the dictator for any level of investment is to tax the entire amount produced. In the second case the dictator knows that a tax level too high will induce the peasant to make no investment.

While phrased differently, the peasant and dictator game with no commitment is equivalent to the trust game: the amount invested by the peasant in the Peasant Dictator Game is equivalent to the transfer made by Player 1 in the investment game, and the amount left after taxation corresponds to the amount returned by Player 2 in the investment game. The specific parameters of Berg et al are matched by a rate of return $R=2$ in the Peasant-Dictator game, and W equal to the initial endowment of the first mover. A possibly important difference in the description of the game is the nature of the amount decided by the first mover. In the instructions reported for the Peasant-Dictator game the amount is described as an investment, while in the Investment game is described as a transfer from the first to the second mover.

Experimental evidence. The game was introduced and tested in Van Huyck, Battalio and Walters, (1995). The game with commitment played by rational selfish individuals would have an outcome where positive investment is made, while in the game without commitment the peasant would not invest anything. The emphasis in Van Huyck *et alii*, (1995) is on the difference in behavior between the commitment and no-commitment game. The qualitative results of Van Huyck *et alii*, (1995) correspond to the prediction of the game theoretical analysis of the game, which anticipates a zero level of investment. In the experiment when no commitment is possible the average investment, and aggregate earnings are lower

There is no direct comparison available in either paper between the results in the Berg *et alii*, (1995) paper and in the Van Huyck *et alii*, (1995) paper. From the evidence available it is not clear that the level of trust in the Peasant-Dictator game experiment is lower than that found in the Investment game although in both games there is a positive level of investment without available commitments.

Reciprocal behavior and its reasons

The results we have reported have prompted a set of natural questions: What is the reason for such behavior? Why in particular do we observe the deviation from the predictions based on the assumptions of selfish and rational behavior that are supported in different contexts? Are these deviations robust and meaningful? Important elements to answer these questions can be found in the different manipulations of the basic game that have been tested over the past years.

Manipulations

Social History. In a variation of their main experiment, Berg *et alii* (1995) show subjects a report on the outcome of the same experiment run a few months earlier in the same

university. The report showed for each level of transfer the number of subjects who had chosen that transfer, the average amount returned and the average profit (average amount returned minus average amount sent). The behavior in the two treatments (with and without seeing a social history) is different, and statistically significant at the 6% level suggesting an increase in the correlation between the amount that is sent and amount sent back.

Induced strategic reasoning. Boeing, Fitzgerald and Ortman, (2000), ask whether informing subjects of the theoretical logic of subgame perfection makes them perform more consistently with the theory. They modify the way in which information is presented to participants and, through a questionnaire, prompt strategic reasoning. None of the various treatments led to a significant reduction of the amounts invested. Their results suggest that the findings by Berg *et alii* (1995) are robust to changes in information presentation and to the strategic reasoning cues.

Mood Induction. A large literature in psychology has shown that mood and emotions can affect altruism, defined as the propensity to help unknown people with no material reward. The common finding is that good mood increases altruism. A review of these findings and their methodology is in Lewis and Haviland-Jones, (2000), and Gilbert, Fiske, and Lindzey, (1998): in particular see Isen, (2000) and Zajonc, (1998). An illuminating review of the main hypothesis and explanations is in Carlson, Charlin, and Miller, (1988).

The effect of mood on reciprocity however is not clear. An experimental analysis of this question is in Kirchgeister, Rigotti and Rustichini, (2001). The experiment is based on the investment game. Before the game, however, subjects in the role of Player 2 undergo a mood induction phase. There are two treatments: to a first treatment group a ‘sad’ movie was shown (a five minutes sequence out of Schindler’s List); to a second treatment group, a ‘happy’ movie (a five minutes sequence out of the movie ‘City Lights’).

The mood induction was effective. The behavior of players in the two different moods is significantly different. The return transfer of ‘happy’ (‘sad’) subjects was relatively insensitive (sensitive) to the original investment x . happy subjects replied with an amount higher than the sad ones, while high ‘happy’ x replied with lower a than ‘sad’ subjects.

Personal and social interactions The original investment game captures what can be called direct reciprocity. However, in various social exchanges reciprocity may not directly be the subject who first makes the investment, but other members of a group. Subjects are called indirectly reciprocal if they are willing to reciprocate even if the originator of the transfer is not the target of the reciprocity, but rather belongs to the same group. Buchan *et alii* (2001) devise and test a variation of the original trust game to examine the extent to which subjects are willing to trust for the benefit of a group or a community.

The original design is called the direct condition. In the group condition a sender A transfers money to responder B, and sender C transfers money to responder D. The

money is multiplied by three, as in the original Berg *et alii* (1995) experiment. Responder B can then return some proportion of her wealth to sender C, while responder D can return some proportion of his wealth to sender A. In the society condition sender A sends money to responder B, while responder D receives money from a different, randomly chosen, sender in Sender A's room. Responder D then returns some proportion of his wealth to sender A, while responder B returns some proportion of her wealth to a randomly chosen sender in Sender A's room. Subjects are said to engage in indirect trust by sending money, even when they are not the recipients of potential reciprocation.

Over a total amount normalized to 1000, the mean amounts sent were 782.14 units in the direct condition, 488.64 units in the group condition, and 505.46 units in the society condition. Thus, even in the society condition where there is no potential for personally benefiting from reciprocation, the amounts sent far exceed the equilibrium prediction. But the trust of the subjects is significantly and negatively influenced as the reciprocation becomes more indirect. The coefficients for both the group and society conditions are negative and significantly different from the direct condition: so there are significantly lower levels of trust as one moves from the direct to the indirect reciprocity. Similar results hold for the second mover.

There is strong evidence of reciprocity even when the reciprocation is indirect. The mean proportions returned (fraction of the money returned over the total amount available to the two players after the productive investment) are .319 in the direct condition, .114 in the group condition, and .130 in the society condition. Also similar to the situation for the amount sent, as the target of reciprocation becomes less direct subjects' propensities to reciprocate are significantly and negatively influenced. As in the analysis of amount sent the coefficients for both the group and society conditions are significantly different from the direct condition.. Thus, as with the levels of trust displayed, we see lower levels of reciprocation as we move from the direct to the indirect reciprocity conditions. For both the amount sent and the amounts returned, there was no significant difference between the group and society conditions.

Choice of partner Eckel and Wilson (2000) design a variation of the trust game to study the partners people choose in investment enterprises. In their design subjects are allowed to choose between two games. These two games could be slightly different, or even perfectly identical, but both are trust games. The games had a marker represented by an icon, a stylized image of a face, which could appear to be friendly, unfriendly, or neutral. The first mover was first choosing the icon (hence the game), and then made the first move in a trust game. The second mover could then observe the game chosen (including the icon) and the first move of the sender. Eckel and Wilson interpret the choice of icon as the choice of the type of partner that the first mover would like to meet. This interpretation may not necessarily be the same made by subjects in real experiments: the choice of an angry icon might be interpreted by both players as a signal that the first mover would be angry at a lack of reciprocation of the second player. The result they find is that people choose partners who appear to be most trustworthy. A choice of the neutral icon is usually followed by a more trusting choice of investment.

There are some of the counter-intuitive results: for instance, a choice of angry icon is followed by a high level of trusting behavior; and reciprocation by the second player is higher when the icon chosen by the first was angry. Both results might be more easily explained on the basis of the interpretation of the choice of icon as a signal sent to the second mover..

Different Factors affecting behavior

Gender. One dimension of analysis of the trust game is the study of different behavior of players of different genders in the trust game. It is known from previous studies that there are significant gender differences in behavior of subjects. For instance, in the dictator game Bolton and Katok (1995) and Eckel and Grossman (1998) find that women give more than men. The difference was significant in the second paper. Andreoni and Vesterlund (1998) compare differences in gender behavior in dictator games for different monetary values of the tokens to be divided. They find that women give more overall and are more likely to divide tokens evenly despite changes in monetary value, while men become less generous as the value of their tokens increases.

For the trust game Croson and Buchan (1999) examine this issue in a study extending over four different countries. The design of the experiment is the same as in Berg *et alii* (1994).

Male and female send approximately the same amount as first movers. But female are more reciprocal. The proportion of money returned grows by approximately by one third per each dollar, and the effect of gender is to increase this factor by approximately one eighth. In Croson and Buchan (1999) the gender of the opponent is unknown. Buchan, Solnick and Croson (2001) vary the information that subjects have about the gender of the opponent. When subjects know the gender of the opponent, the gender difference in observed trust and reciprocity becomes more apparent: males send more than females to all types of subjects when males are first movers. Subjects of all genders send more to males than to females; and male subjects send significantly more to other males than to females.

Culture and Environment: International studies. The trust game has been tested in different countries, thus providing a test of the possible importance of cultural and social factors. A first study is in Bond and Kwang-Kuo Hwang, (1996), who found evidence of face-saving behavior among subjects, a fact that makes even more desirable the use of double-blind procedures.

A more systematic study is in Buchan *et alii* (2001b) who used the design to test trusting behavior in direct and indirect matching to test for differences in behavior in four different countries. The study involved students from China (Beijing), Korea (Seoul) and Japan (Osaka) and United States (Madison, Wisconsin).

The differences in the level of trust were significant and sizeable. Japanese and Korean subjects extended significantly less trust than did American subjects. Also the amounts

sent by American and Chinese subjects significantly differed from the amounts sent by Japanese and Korean subjects.

Expectations. Morrison and Rutstrom (2000) study the effect that beliefs have over the behavior. They use a discrete version of the TG, so the first mover can only send or not send, and the second can only choose between returning and not returning.

They focus on is the prior belief that the second mover has that the first will send money. A second mover is surprised if he was expecting no money sent, yet he receives a transfer. Their main finding is that a surprised second mover is less likely to return the money.

The Need for new theories

How can we now give a unified explanation of these different phenomena? Probably the most widely used approach is to attempt to adjust standard theories of preferences to address the trust issue. Such an approach would introduce additional arguments to the utility function and then ask if observed data can be accounted for. The most typical assumption is to say that the individual's preferences are defined on their own and other people's payoffs. This is the approach systematically investigated in Fehr and Schmidt, (1999). Such approach to the problem would imply that other aspects of traditional analysis can continue as they always have. There is no doubt that this approach will continue to provide useful insights.

Rather than view trust as something to be built into existent models, it is plausible a more complete understanding of trust could arise as a more general aim to trace behavioral regularities in strategic situations back to structures and functions of the brain. McCabe et. al. have recently begun to examine the behavior of subjects in multiple person settings using functional magnetic resonance imaging. They are able to show definitively different brain activation for trusting players when they play against other humans versus play against computers. Their examination is a first step in attempting to unravel the anatomical underpinnings of the trust phenomenon. A major factor to still be determined is how activation varies as a function of the level of observed trust. A potential hint at how to address this question is the working paper by Smith *et alii*(2001). Their study finds that relatively more brain activation can be traced to ventromedial (dorsomedial) areas depending on the presence of ambiguous (risky) stimulus comparisons. The ventromedial area corresponds to areas that are evoked in the presence of emotional factors while the dorsomedial evokes areas that are traditionally associated with computation,

As we have noted levels of trust are not independent of factors like social history, gender differences, and culture differences. The results in Kirchgeister et alii (2001) show that the observation of a payoff irrelevant and informationally vacuous sequence out of a movie can alter in a systematic way the behavior, suggesting that mood and emotion enter in the way behavior and reciprocity is regulated. This in turn suggests the following conjecture: The same ventro-medial area that is related to emotional factors in

conjunction with ambiguous stimuli may also be associated with moral based emotional choice which is sensitized by such things as seeing Schindler's List and observing social history. Furthermore this area would be differentially activated due to gender and cultural differences.

Brain imaging is one of the tools that can be used in this research, but only one of the many available. Together with others which belong to the standard tool kit of cognitive neuroscience, like neuro-physiological and lesions research, it can provide the basis for formulating and testing functional hypotheses. For example it is now safe to state that the brain structures involved in implicit learning are different from those involved in explicit learning (see Curran (1995) for a review of this evidence.) The location of a function **in itself** has of course a limited interest from the point of view of economic applications. Nevertheless, the location of function supports an analysis and a detailed knowledge of the specific ways in which the human decision process is organized and implemented. Accordingly, it forms the foundation for a structural explanation of behavior. This explanation enhances but need not necessarily replace the static features of optimality. A less traditional approach to examining the behavior is argue that trust is the consequence of different neuronal structures being activated in the presence of other parties and that what needs to be comprehended is just how such structures perform and interrelate to begin to have a complete description of how trust is accommodated. The approach is a broader one and does not necessarily presume any well-defined preference structure can govern what is perceived to be trusting behavior. The neuronal interplay is simply too probabilistic and to some extent accidental to ever hope to be accommodated by a well-defined set of ordered preferences.

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