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The Economic Impact of Envy: Evidence from a Multi-Period Game with Attacks and Insurance

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Abstract

We report results from a multi-period game designed to stimulate feelings of envy. There are a number of important features of our game that distinguish it from previous games used to examine envy. A unique and important feature of our design is that it addresses the two negative effects of envy: the wasteful expenditure of resources in an attempt to harm others and the wasteful use of resources by those envied in an attempt to protect themselves. We find that as wasteful as attacks are, spending on protection against attacks, while individually rational, results in even more waste. Players purchase insurance at twice the rate of attacks. Our multiperiod game permits us to examine how subjects' behaviour motivated by envy or the threat of envious actions changes over time. We report evidence consistent with players learning that envious feelings are wasteful and are less satisfying than the foregone monetary rewards.

Keywords: anti-social preferences, envy, insurance
JEL Classifications: C91, D003, D6

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The Economic Impact of Envy: Evidence from a Multi-Period Game with Attacks and Insurance

1. Introduction

Envy is a destructive force.[1] Envy may lead to individuals expending resources in unproductive, from society's perspective, efforts to damage the envied (Smith and Kim, 2007; van de Ven et al, 2009). Envy's destructive nature is, however, not limited to the negative actions taken by the envious. Envy can also result in the use of resources by the envied to protect themselves from these harmful acts, drawing resources away from productive, social welfare-enhancing, uses.[2]

A number of authors advance models that incorporate envy (or more broadly defined anti-social preferences, see Mui, 1995, Fehr and Schmidt, 1999, Bolton and Ockenfels, 2000, and Charness and Rabin, 2002).[3] A common feature of these general models is that dividual derives negative utility when her payoff or well-being is less than the payoff or well-being of other individuals. Evidence of supportive of this assumption is offered by results from a number of experimental studies. In the Power-To-Take Game, the second mover in the game prefers to destroy much if not all of his earnings rather than permit the first mover from taking it (Bosman and van Winden, 2002, Bosman et al., 2006, and Albert and Mertins, 2008). Using the Money Burning Game Zizzo and Oswald (2001) and Zizzo (2003) find significant evidence that subjects will pay to burn the money of other players. Abbink and Sadrieh (2009) and Abbink and Herrmann (2011) find that players playing the Joy-of-Destruction Game are willing to destroy other players' endowments, especially if they can act anonymously. Beckman et al. (2002) measure the role of positional bias. They find that: (a) when income positions are known in an

[1] Envy may also be a constructive force (e.g., Grolleau et al. 2009). It can compel the envious to strive harder in hopes of attaining the status of those who are advantaged.

[2] Protecting one's self from envy involves expenses and efforts taken to hide and/or protect one's wealth (see Schoeck, 1969).

[3] These models also incorporate pro-social preferences. Sobel (2005) provides an overview of these models.

income allocation, a Pareto improving income allocation faces opposing votes if it does not benefit everybody: non-beneficiaries oppose Pareto improvements especially when the recipient is in a relatively high income position. Saijo and Nakamura (1995) and Cason et al. (2002) report evidence of spiteful behaviour in public goods games. In all of these studies, with the exception of Abbink and Sadrieh (2009) and Saijo and Nakumura (1995), the subjects play either single-shot games or independent, repeated one-shot games.

In this paper we report results from a multi-period game designed to stimulate destructive envy and to measure the cost to a society with members who act on these feelings.[4] There are a number of important features of our game that, while individually not unique, in total distinguish it from previous games used to examine envy or anti-social preferences. First, players differ by type (rich and poor) and by their cumulative wealth. The rich have larger per period endowments and higher expected returns from investing than do the poor. Second, players play in groups of ten and a player that decides to take action can select any one of the other nine players as the focus of this action.[5] This choice can vary from period to period. Third, when deciding whether or not to take some action, each player has complete information regarding all players' previous period's earnings, all players' cumulative earnings, and own payoff possibilities for any action decision made.[6] Fourth, the game is designed so that the relative

[4] In this paper our focus is on the characteristics of the attacker and the issue of insurance buying. A separate paper addresses the issue of the characteristics of those targeted for attacks (see Grossman and Komai, 2012).
[5] A feature of many games is that players do not choose who will be the focus of their actions. Play is in fixed pairs or, if in groups, an action may have an impact (not necessarily equally) on all members of the group. Players may only select their primary targets.
[6] For many games, the decisions are often one-shot or independent repeated play, one-shot decisions. In our game, cumulative history can be important.

earnings at each decision making point differ (i.e. player X's cumulative earnings relative to player Y's cumulative earnings can vary from period to period).[7]

The final two features of our game's design are of particular interest. First, as a multi-period game, our players can adapt and learn, adjusting their strategies over time as they become more experienced. The play of players in the first m periods may differ dramatically from their play in the last n periods. A fairly standard result from multi-period VCM games is that players' behaviour changes with time; contribution levels decline over time as players suffer either donor fatigue, adapt to the play of the other players, or learn to free-ride. We allow for the possibility that our players too can learn, possibly that acting on envious feelings is wasteful and is less satisfying than the foregone monetary rewards or, alternatively, that acting on envious feelings provides them some non-monetary benefits which exceed any foregone monetary rewards.

Second, our design is unique in that it addresses the two negative effects of envy. On-the-one-hand, envy may manifest as the wasteful (i.e. unproductive from a societal perspective) expenditure of resources by persons in an attempt to harm others: expenditures that reduce the overall well-being of society as a whole. In our design, envious players can, by paying a portion of their endowments, attempt to inflict harm upon other, envied players of their choosing. On-the-other-hand, targets of envious actions may be keenly aware that destructive actions may be directed at them. Knowing that one may be a target of envious actions can lead a person to expend resources to protect (i.e. insure) against such harm. Such expenditures are wasteful, reducing the overall well-being of society. Our game includes an insurance option that players can purchase (at the cost of reduced savings or investments) to indemnify themselves against losses arising from envious actions taken against them by others.

[7] Even in many multi-period games, often earnings are determined by a random draw from among all periods and players do not know the earnings histories of other players. So in any period, the current period's decision is independent of past earnings and the total ve earnings of players are unknown and irrelevant.

2. The Experiment

Sixteen sessions were conducted in the Saint Cloud State University Economics Research and Teaching Laboratory. Players are recruited by email and by posters displayed around campus. Participation is on a first-come, first-served basis.[8] There are ten players per session and no player participates in more than one session. There is no show-up fee. Players are randomly assigned to partitioned computer stations and are instructed not to communicate with one another. General instructions are read aloud with experiment specific instructions provided on-line. Sessions last between 90 and 120 minutes.

Players are instructed to log on to the experiment site at which time the program randomly assigns each with an ID number (1 – 10) and a type (A or B). Instructions (for periods 1 – 30) are then provided (for both As and Bs) and players read them at their own speed.[9] Players are informed that after 30 periods the game will change and that new instructions will be provided. After all players have finished reading the instructions they play a practice period followed by an additional opportunity to ask questions.[10] Play then begins.

The first 30 periods are comprised of a repeated play investment/savings game with earnings from each period accumulating. Players can either invest or save their endowments. Per period endowments are $0.30 for Type A players and $0.15 for Type B players. If the endowment is saved, the amount is added to the player's accumulated earnings account. Alternatively, a player can invest her endowments. The probability that an investment will have

[8] The email list is comprised of persons who have expressed an interest in participating by e-mailing a sign-up e-mail address after being informed of the opportunity in large lecture classes. Posters are placed around campus and in dormitories. We attempt to run gender balanced sessions (i.e. the notices indicated that the first five men and five women will participate) but women did not volunteer as frequently as did men. If less than five women show, after waiting a reasonable length of time, a session is filled with the surplus men.

[9] Players are informed that if they have any questions to raise their hands and an experimenter will come and answer their question(s) privately.

[10] Throughout the session, players make their decisions at their own pace. However, play does not move from one period to the next until all players have finished.

a positive payoff is 50%, regardless of player type. If their investment is successful, Type A players realize a gain of $0.30 (for total period earnings of $0.60); if their investment is unsuccessful, they realize a net loss of $0.15 (for total period earnings of $0.15). If their investment is successful, Type B players realize a gain of $0.11 (for total period earnings of $0.26); if their investment is unsuccessful, they realize a net loss of $0.05 (for total period earnings of $0.10). For Type A players, the expected earnings per period is $0.375 (a 25% expected rate of return); for Type B players, the expected earnings per period is $0.18 (a 20% expected rate of return). The differences in endowments and expected investment payoffs are intended to create an obvious and significant gap between the cumulative earnings of the As and Bs before the second stage of the experiment.

Investment outcomes are determined by players selecting from one of ten playing cards arrayed on their computer screens. Five of the cards have a W on their backs, indicating a positive payoff for the investments, and five have an X on their backs, indicating a negative payoff for the investments. A card is selected and that card is turned over. Subsequently the remaining nine cards are turned over too.

At the end of each period, players are provided a summary of their and every other players' earnings for that period and their and every other players' cumulative earnings through that period (see Table 1 for a sample).

New on-line instructions are provided after period 30. As before, players read them at their own speed and are told to raise a hand if they had any questions. The endowments and the investment and savings features all remained the same. Players are now permitted to attempt to do harm to another player of their choice and well as to insure themselves against harm by another player. A player can attack only one player per period (but more than one player can attack a given player) and insurance protects a player against all attacks in a given period. Attempting to harm another and insurance against being harmed by another each costs $0.05. If, for example, player 1 pays to harm player 2 and player 2 had not paid to insure himself against harm, then player 2 loses $0.20; if player 2 has purchased insurance, he loses nothing. It is important to note that attacks are anonymous; the player attacked is not informed of the identity of his attacker(s). The $0.05 paid to attack another and/or the $0.05 paid for insurance reduces the amount of the endowment to be saved or invested.[11] At the end of each period, players see a table that summarizes the round: if they bought insurance, if they choose to attack another, if they saved or invested, the outcome if they invested, and if they were attacked by another player (see Table 2). They would next see the period earnings and cumulative earnings table (Table 1). Finally, Table 3 details the earnings per period depending on the saving/investing choice, the decision to attack another, the decision to purchase insurance, and whether or not one is attacked. The second part of the session lasts for 60 periods.

4. Results: Periods 1 – 30

We only briefly discuss the results from the first 30 periods. This part of the experiment is intended to create and reinforce the differences between the Type A and Type B players. In these periods players can only save and invest. On average players invest 85.1% of the time. Type B players invest at a marginally higher rate than Type A players, 87.6% vs. 82.5% (means test t-statistic = 1.69, p-value = 0.09).[12] By period 30, the differences between the Type A and Type B players is evident. In period 30, the mean cumulative earnings of Type A players are more than twice the mean cumulative earnings of Type B players ($11.39 vs. $5.38).

5. Results: Periods 31 – 90

[11] Expected rates of return remained unchanged.
[12] The unit of measurement is the individual player

5.1 Investment Rates

Beginning in period 31 players can attack others and insure against attacks. The mean investment rate for all players increases modestly, from 85.1% to 87.1% (paired means test t-statistic = 1.47, p-value = 0.14, two-tailed test). Type B players still invest at a higher rate than Type A players (88.2% vs. 86.0%, respectively), but the difference is not significant (means test t-statistic = 0.69, p-value = 0.49, two-tailed test). The increase is greater for Type A players than Type B players (from 82.5% to 86.0% and from 87.6% to 88.2%, respectively). Only the increase for Type A players is significant (Type A: paired means test t-statistic = 2.94, p-value = 0.004, two-tailed test; Type B: paired means test t-statistic = 0.24, p-value = 0.81, two-tailed test).

5.2 Who Attacks?

5.2.1 Summary Statistics

We find a fair degree of homogeneity in the willingness of individual players to attack another both within and between types. Table 4 reports the percentage of players by how many times they attack any other player during the last 60 periods. On average, Type A players attack 15.2 times; Type A players attack 14.1 times.[13] A majority of players of both types attack others relatively infrequently. Sixty-three percent (53%) of Type A (B) players attack another player in ten or fewer periods. Small subsets of players of both types are frequent attackers; 15% (5%) of Type A (B) players attack another player in more than 50 periods. A Wilcoxon two sample test cannot reject the null hypothesis of no difference in the distribution of the number of attacks by player type (p-value = 0.26).

A small number of players of each type are responsible for a disproportionate share of all attacks. The ten most frequent attackers of each type account for 34.0% of all attacks by Type B

[13] The unit of measurement is the individual. A means test cannot reject the null hypothesis that the rate of attacking is equal across player type ($p < 0.69$).

players and 38.6% of all attacks by Type A players. The 50% least frequent attackers of each type account for 10.1% of all attacks by Type B players and 3.3% of all attacks by Type A players.

5.3.2 Regression Results

In this section we consider, using regression analysis, the factors that result in a player choosing to attack another player. Our dependent variable is Attacks_{it} (= 1 if player i attacks another player in period t). We estimate two models. In Model 1 we include player type (Type = 1 if type A), if the player was attacked in the previous period (was Attacked_{it-1} = 1 if yes), and player's cumulative earnings by type (Cumulative Earnings A_{it-1} and Cumulative Earnings B_{it-1}). A simple reading of the models of social preferences suggests a Type B player should be the type to attack most frequently: all of the Type A players and possibly some of the other Type B players have higher earnings. Having previously been attacked might incline a player to attack in retaliation. Such attacks are, however, difficult to understand since the person attacked does not know the identity of his attacker so the attacked cannot know to whom he should direct his retaliation. The cumulative earnings variables control for players' income, allowing us to determine if attacking is a normal or inferior good.

In Model 2 we include player characteristics including Male (= 1 if yes), Economic Classes (= number of economics classes taken), Caucasian (=1 if yes), and GPA (= player's self-reported grade point average). Finally, in both models we control for the period (Period). See Table 5 for definitions of all regression variables. The regressions are probit with random effects and clustering at the session level.[14]

Table 6 reports the regression results. Since a log likelihood ratio test rejects the null hypothesis that the coefficients for the player characteristics variables are jointly equal to zero,

[14] We estimate our regression models using STATA 11.2 and GLLAMM (Rabe-Hesketh et al. 2005).

we focus our discussion on Model 2.[15] After controlling for player characteristics, we find that Type A players are significantly more likely to attack another player. Being attacked in the prior period increases the probability a player will attack in the current period by approximately 14%t; this is consistent with the retaliation hypothesis. For both type players, attacking is an inferior good; the likelihood of attacking declines the greater is a player's cumulative earnings. A $1 increase in cumulative earnings reduces the probability of attacking by approximately 1.5% and 3.3% for A and B players, respectively.[16]

We find that male players are more likely to attack another player than are female players. An extra economics class taken increases the probability of attacking another by about 12% and players with a higher, self-reported, grade point average are more likely to attack another. Being a Caucasian reduces the probability of attacking another. Finally, we find that attacks decline significantly and continuously over time, by 2.6% per period.

5.4 Who Buys Insurance?

5.4.1 Summary Statistics

On average, players purchase insurance 44% of the time. Not surprisingly, being the most frequent target of attacks, type A players buy insurance at a significantly higher rate than do type B players; the average Type A player purchases insurance in 34 of the 60 periods (57%), the average Type B player purchases insurance in 19 of the 60 periods (32%).[17] Table 7 reports the percentage of players by type and by how many times they purchase insurance over the last 60 periods. Twenty-one (46) percent of Type A (B) players purchase insurance in 10 or fewer periods. A (large) small subset of all players are purchasers; 34% (6%) of Type A (B) players

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[15] $\chi^2(4) = 985.8$, p-value = 0.000 .

[16] We are able to reject the null hypothesis that the coefficients of Cumulative Earnings A_{it-1} and Cumulative Earnings B_{it-1} are equal ($\chi^2(1) = 6.06$, $p < 0.014$).

[17] The unit of measurement is the individual. A means test rejects the null hypothesis that the rate of insurance buying is equal across player type ($p < 0.001$).

attack another player in more than 50 periods. A Wilcoxon two sample test rejects the null hypothesis of no difference in the distribution of the number of insurance purchases by player type (p-value = 0.000).

5.4.2 Regression Results

In this section we consider, using regression analysis, the factors that result in a player choosing to purchase insurance. Our dependent variable is Buys Insurance_{it} (= 1 if player i buys insurance in period t). We estimate two models. In Model 1 we include player type (Type = 1 if type A), if the player was attacked in the previous period (was Attacked_{it-1} = 1 if yes), and player's cumulative earnings by type (Cumulative Earnings A_{it-1} and Cumulative Earnings B_{it-1}). A simple reading of the models of social preferences suggests that Type A players should be the most frequent target for attacks and therefore the more likely to demand insurance: a Type A player has higher earnings than all of the Type B players and possibly some of the other Type A players. Having previously been attacked might incline a player to fear of further attacks resulting in an increased probability of purchasing insurance. The cumulative earnings variables control for players' income allowing us to determine if insurance is a normal or inferior good.

In Model 2 we include player characteristics including Male (= 1 if yes), Economic Classes (= number of economics classes taken), Caucasian (=1 if yes), and GPA (= player's self-reported grade point average). Finally, in both models we control for the period (Period). See Table 5 for definitions of all regression variables. The regressions are probit with random effects and clustering on the session.

Table 8 reports regression results for who buys insurance. Since a log likelihood ratio test rejects the null hypothesis that the coefficients for the player characteristics variables are jointly equal to zero, we focus our discussion on Model 2.[18] After controlling for player characteristics, we find no difference in the probability of buying insurance by player type. Being attacked in the prior period has a large impact on the probability a player will purchase insurance in the current period; the probability of buying insurance increase by 86%. For both type players, insurance is an inferior good; the likelihood of buy insurance declines the greater is a player's cumulative earnings. A $1 increase in cumulative earnings reduces the probability of buying insurance by approximately 12% (37%) for A (B) players.[19]

Male players are more likely than female players to gamble that they will not be attacked. Males are 49% less likely than females to purchase insurance. This is consistent with studies that show males to be less risk averse than females.[20] Taking an additional economics class increases the probability of buying insurance by approximately 12%. Caucasian players are significantly more likely (27%) to purchase insurance than are non-Caucasian players. The more academically successful (self-reported) students have a higher probability of buying insurance, by approximately 20% for each one-half grade point. Finally, other things equal, insurance buying increases approximately 2.7% per period.

5.5 Changes in Behaviour over Time

Our multi-period game permits us to examine how subjects' behaviour motivated by envy or the threat of envious actions changes over time. In Table 9 we report how players' willingness to attack others changes with time. We (crudely) categorize players as one of three types: *No to Mild Envy* (attack another two or fewer times in a ten-period span); *Moderate Envy* (attack another three to seven times in a ten-period span); and *High to Extreme Envy* (attack

[18] $\chi^2(4) = 798.3$, p-value = 0.000 .
[19] We are able to reject the null hypothesis that the coefficients of Cumulative Earnings A_{it-1} and Cumulative Earnings B_{it-1} are equal ($\chi^2(1) = 23.9$, $p < 0.001$).
[20] See, for example, Eckel and Grossman (2008a and 2008b).

another eight or more times in a ten-period span). We find that there is a steady increase in players classified as *No to Mild ASP* and a steady decline in players classified as either *Moderate ASP* or *High to Extreme ASP*. By the final ten-period span, approximately 80% of all players were attacking other players two or fewer times. The pattern observed is consistent with the conclusion that players learn that attacking others is wasteful and self-destructive.

In Table 10 we report how players' insurance buying behaviour changes with time. We (crudely) categorize players as one of three types: *Risk Takers and Mildly Risk Averse* (purchase insurance two or fewer times in a ten-period span); *Moderately Risk Averse* (purchase insurance three to seven times in a ten-period span); and *Highly to Extremely Risk Averse* (purchase insurance eight or more times in a ten-period span). For Type B players, there is a steady increase in players classified as *Risk Takers and Mildly Risk Averse* and a (somewhat) steady decline in players classified as either *Moderately Risk Averse* or *Highly to Extremely Risk Averse*. For Type A players, there is an increase in players classified as *Risk Takers and Mildly Risk Averse* and a decline in players classified as *Moderately Risk Averse*. But for players classified as *Highly to Extremely Risk Averse*, the numbers are stable. The pattern observed is consistent with the conclusion that players (Bs more than As) decreasingly feel the need to buy insurance, reflecting the decline in attacks across time.

To better test how our subjects' behaviour changes over time, we conduct regression analysis that models the convergence process of the attack (insurance buying) rate. Here the unit of analysis is the session average number of attacks (purchases of insurance) in each decision period. The model of convergence is motivated by Ashenfelter et al. (1992) and employed by Noussair et al. (1995) and Eckel and Grossman (2005). This model is designed to address questions about the initial attack (insurance buying) rate within a particular session, the decay in the attack (insurance buying) rate within the session, and the asymptotic level of the attack (insurance buying) rate. The model's basic estimating equation is given by

$$y_{it} = \beta_{1i}D_i(1/t) + \beta_2((t\text{-}1)/t) + u. \qquad (1)$$

The subscripts i and t denote the particular session and the particular decision period in the experiment, respectively. The dependent variable, y_{it}, is the attack (insurance buying) rate in session i in period t. The dummy variable D_i takes a value of 1 for session i and 0 otherwise. The origin of the convergence process for session i is given by β_{1i}. β_2 is the asymptote for the dependent variable. We use this technique to estimate the asymptotic level of the attack (insurance buying) rate.[21] For the insurance regression, we estimated the basic model and a second model controlling for the attack rate in period t-1 for the session. Table 11 suppresses the session starting points and reports only the convergence values (and the coefficient for the attack rate in period t-1).

The results reported for the attack rate regression indicate that the convergence point for the attack rate is 22 percent. This is approximately half the average attack rate of 45.6 percent in period 31 (the first period players could attack or buy insurance). This result is consistent with the pattern reported in Table 10. For the insurance buying regression (not controlling for the attack rate in period t-1), the convergence rate is 43 percent, only 10 percentage points lower than the average insurance buying rate of 53 percent in period 31. The results reported in Table 7 suggests that the decision to purchase insurance in any given period is driven strongly by whether or not a subject was attacked in the previous period. To control for this factor and its

[21] As Noussair et al. note, "analysis of the data ... encounters some classical problems that exist in the analysis of almost all data produced in experimental markets ... a convergence process that is not understood theoretically [and] this means that serial correlation is present, and heteroscedasticity may be present" (472). The method of correction employed is Kmenta's (1986) cross-sectionally heteroskedastic and time-wise autoregressive model (see pages 618-622).

effect on the convergence rate, we reestimate the convergence model controlling for the attack rate in period t-1. The new convergence rate is now 35 percent, almost 20 percentage points lower than the average insurance buying rate in period 31. These results offer strong evidence that the behaviour of our subjects changes over time. Subjects become significantly less likely to act on their envious feelings, and thereby wasting fewer resources, and, in response to the reduction in the number of attacks, purchase insurance at a reduced rate, further reducing the amount of resources wasted.

5.6 The economic cost of envy

People acting on their envious feelings harm not only the target of these actions but society as a whole. Scarce resources are wasted in attempts to harm others and in attempts to protect against such harm. This results in both a slowing of individuals' wealth accumulation and the growth of the overall economy.

In our experiment, resources that could have been saved or invested are wasted attacking others or buying insurance. Figure 1 illustrates the potential and actual growth paths for earnings for both player types.[22] For both player types, the actual and predicted growth paths are virtually identical for the first 30 periods. With period 31, and the possibility to act on anti-social preferences, the growth paths begin to diverge. By period 90, potential average earnings for Types A and B are $32.73 and $15.88, respectively; actual average earnings are $29.06 and $12.70, respectively. In total, anti-social preferences result in actual earnings approximately 18% smaller than potential earnings.

6. Discussion and Conclusion

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[22] Calculations of potential earnings reflect average investment rates for each player type and assume no attacks or insurance purchases. Expected potential earnings per period for a type A player = $0.364 = 0.849*[0.5*0.60 + 0.5*0.15] + 0.151*0.30; for a type B player = $0.176 = 0.880*[0.5*0.26 + 0.5*0.10] + 0.120*0.15.

Theoretical as well as experimental evidence indicate that envy can be a powerful sentiment with significant behavioural implications. The envious may hurt the envied and the envied may hold back from success and/or may spend resources to protect themselves against hostile behaviour. The behavioural implications of envy suggest that policies regarding taxation, redistribution, work place, market place, etc. could be affected by envy considerations. Building a body of evidence on envy related behaviour can prove to be generally useful since it allows us to somewhat measure the scale and possibly identify the likely envy related behaviour which can be useful for policy makers who would like to minimize the harm caused by destructive envy or to harness envy related behaviour into constructive as opposed to destructive ways.

Using a money burning design, we conduct an experiment that helps address some relevant aspects of envy driven behaviour which are not addressed previously (at least not experimentally). Consistent with other studies, we find strong evidence of destructive envy related behaviour which happened 25% of the time in spite of both a significant monetary cost to the envious party and no guarantee of success. More importantly, our results suggest that existing theories of (anti)social preferences are inadequate to explain the diversity in envious behaviour observed in our study. Simple inequality aversion fails to explain much of our findings. While the less wealthy do exhibit envy of the wealthier, we find evidence that both class and one's position within one's own class driving behaviour. We find strong evidence of within class envy: the rich targeting the rich and the poor targeting the poor. Within the rich community, the target of envy is usually a wealthier subject whose wealth is close to that of the attacker; the attacker may possibly be trying to improve his/her relative ranking. Within the poor community, the target of envy is usually a poorer subject whose wealth is close to the attacker; the attacker may possibly be trying to preserve his/her relative ranking.

A unique observation of our study is that worse than the envy itself is the fear of envy: the resources spent to protect oneself from envy are twice as much as the resources spent on envious attacks. Considerably more resources are expended on protecting one's self from envious actions that the resources expend on envious acts. Overall anti-social preferences incur substantial costs both through the spending of resources on costly attacks and on protection against them: on average earnings are 18% less than they could be in the absence of envy related behaviour.

To end on a positive note, our results suggest that, while feelings of envy may be universal, acting on those feelings is not. While many of our subjects may have feelings of envy, only a small subset consistently acts on those feelings. There is also evidence that not acting on envious feelings can be learned. We observe a steady decline in envy related behaviour over time which has the flow on effect of reducing the spending of resources to protection against envious acts.

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Figure 1: Potential and Actual Earnings Growth Paths by Player Type

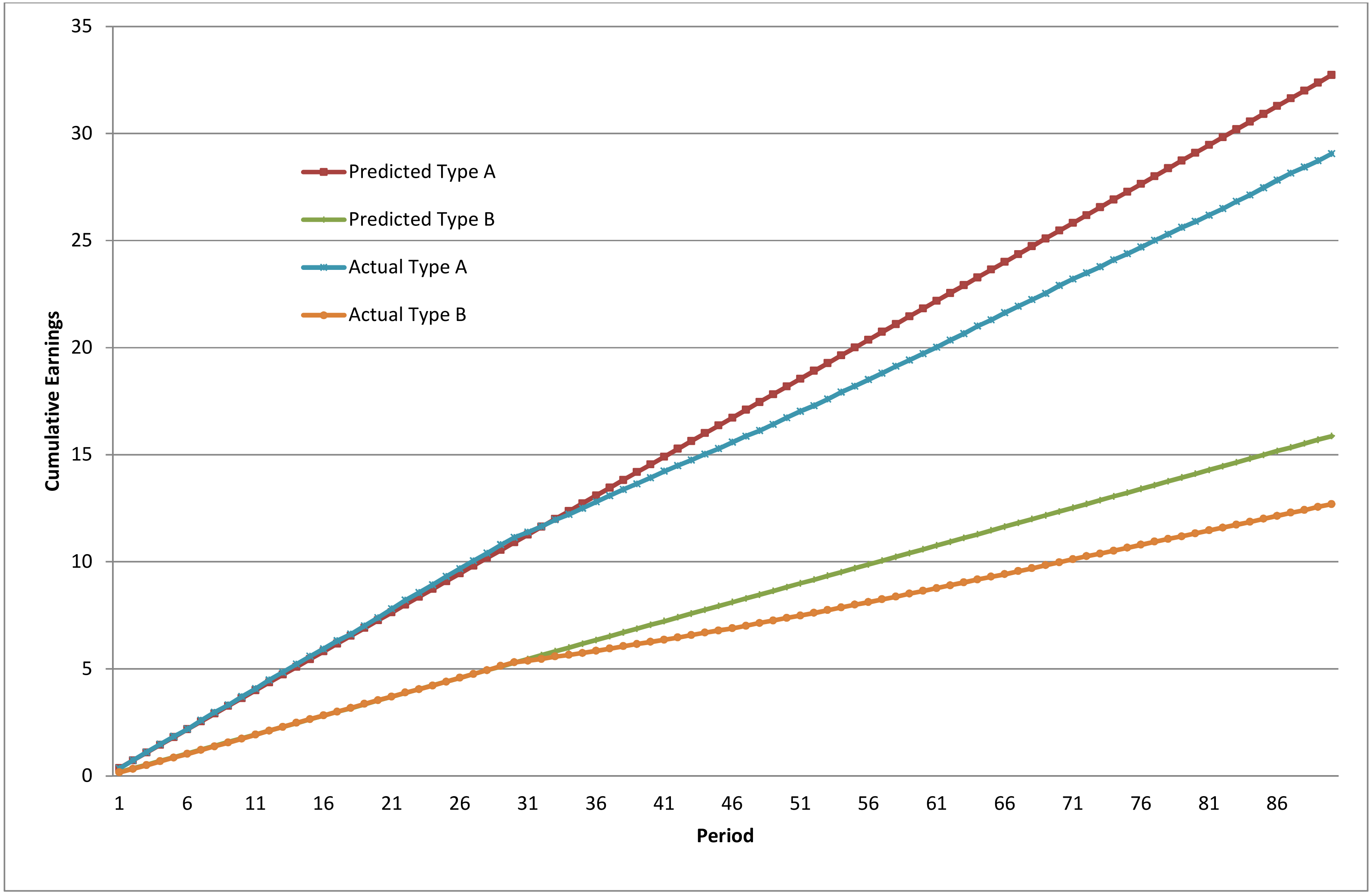

Table 1: End of Period Display

Player ID	Type	Earnings*	Cumulative Earnings*
1	B	10	157.0
2	A	60	420.0
3	A	60	495.0
4	A	60	420.0
5	A	15	465.0
6	A	60	405.0
7	B	26	212.0
8	B	26	190.0
9	B	10	153.0
10	B	10	121.0

* - Earnings reported in cents.

Table 2: Stage Two Summary of Decisions and Outcomes Display

Continue

Stage Two - Round 1 : Your Result

You are : Player 1
Insured : No
You Attacked : No one
Choice : Invest
Result : Lost
Attacked by other player: No

Earnings : 15.0 cents

Please wait. You will redirect automatically to the next screen!!
The server is computing earnings for the other players.

Table 3: Possible Outcomes and Earnings for Periods 31 to 90

Type	Save/Invest	Win	Harm	Insure	Attacked	Earnings	Type	Save/Invest	Win	Harm	Insure	Attacked	Earnings
A	Save	…	No	No	No	$0.30	**B**	Save	…	No	No	No	$0.15
A	Save	…	Yes	No	No	$0.25	**B**	Save	…	Yes	No	No	$0.10
A	Save	…	No	No	Yes	$0.10	**B**	Save	…	No	No	Yes	($0.05)
A	Save	…	Yes	No	Yes	$0.05	**B**	Save	…	Yes	No	Yes	($0.10)
A	Save	…	No	Yes	No	$0.20	**B**	Save	…	No	Yes	No	$0.10
A	Save	…	Yes	Yes	No	$0.20	**B**	Save	…	Yes	Yes	No	$0.05
A	Save	…	No	Yes	Yes	$0.20	**B**	Save	…	No	Yes	Yes	$0.10
A	Save	…	Yes	Yes	Yes	$0.20	**B**	Save	…	Yes	Yes	Yes	$0.05
A	Invest	No	No	No	No	$0.15	**B**	Invest	No	No	No	No	$0.10
A	Invest	No	Yes	No	No	$0.125	**B**	Invest	No	Yes	No	No	$0.067
A	Invest	No	No	No	Yes	($0.05)	**B**	Invest	No	No	No	Yes	($0.10)
A	Invest	No	Yes	No	Yes	($0.075)	**B**	Invest	No	Yes	No	Yes	($0.133)
A	Invest	No	No	Yes	No	$0.125	**B**	Invest	No	No	Yes	No	$0.07
A	Invest	No	Yes	Yes	No	$0.10	**B**	Invest	No	Yes	Yes	No	$0.034
A	Invest	No	No	Yes	Yes	$0.13	**B**	Invest	No	No	Yes	Yes	$0.067
A	Invest	No	Yes	Yes	Yes	$0.10	**B**	Invest	No	Yes	Yes	Yes	$0.034
A	Invest	Yes	No	No	No	$0.60	**B**	Invest	Yes	No	No	No	$0.26
A	Invest	Yes	Yes	No	No	$0.50	**B**	Invest	Yes	Yes	No	No	$0.173
A	Invest	Yes	No	No	Yes	$0.40	**B**	Invest	Yes	No	No	Yes	$0.06
A	Invest	Yes	Yes	No	Yes	$0.30	**B**	Invest	Yes	Yes	No	Yes	($0.027)
A	Invest	Yes	No	Yes	No	$0.50	**B**	Invest	Yes	No	Yes	No	$0.17
A	Invest	Yes	Yes	Yes	No	$0.40	**B**	Invest	Yes	Yes	Yes	No	$0.087
A	Invest	Yes	No	Yes	Yes	$0.50	**B**	Invest	Yes	No	Yes	Yes	$0.173
A	Invest	Yes	Yes	Yes	Yes	$0.40	**B**	Invest	Yes	Yes	Yes	Yes	$0.087

Table 4: Frequency of Attacking

Number of Times a Player Attacked Another Player	Percent by type	
	Type A	Type B
0	28.8%	16.3%
1 – 5	22.5%	23.8%
6 – 10	11.3%	12.5%
11 – 15	5.0%	11.3%
16 – 20	5.0%	8.8%
20 – 25	1.3%	8.8%
26 – 30	6.3%	3.8%
31 – 35	1.3%	5.0%
36 – 40	1.3%	1.3%
41 – 45	2.5%	3.8%
46 – 50	3.8%	1.3%
51 – 55	2.5%	1.3%
56 – 60	8.8%	2.5%
Average number of attacks (as a percentage of periods)	15.2 (25.4%)	14.1 (23.5%)

Table 5: Definition of Regression Variables

Dependent Variables	Definition
$Attacker_{it}$	= 1if player i was an attacker in period t, 0 otherwise
Buys $Insurance_{it}$	= 1 if player i bought insurance in period t, 0 otherwise
Independent Variables	**Definition**
Type	=1 if is type A, 0 otherwise
$WasAttacked_{it-1}$	= 1 if player i was attacked by any other player j (j≠i) in period t-1, 0 otherwise
Cumulative Earnings A_{it-1}	= player i's cumulative earnings in period t-1 if player i is type A
Cumulative Earnings B_{it-1}	= player i's cumulative earnings in period t-1 if player i is type B
$Male_i$	= 1 if player i is male, 0 otherwise
Economics $Classes_i$	= number of economics classes player i has taken
$Caucasian_i$	= 1 if player i is Caucasian, 0 otherwise
GPA_i	= player i's self-reported grade point average (0 = < 2.00; 1 = 2.00 – 2.49; 2 = 2.50 – 2.99; 3 = 3.00 – 3.49; 4 = ≥ 3.50)
Period	= period number (t = 31, …, 90)

Table 6: Who Attacks[+]

Variable	Marginal Probability Effect (Std. Err.)	
	Model 1	Model 2
Type	0.057 (0.124)	0.478*** (0.091)
$\text{WasAttacked}_{it-1}$	0.180*** (0.065)	0.139** (0.069)
Cumulative Earnings A_{it-1}	-0.022*** (0.005)	-0.015*** (0.006)
Cumulative Earnings B_{it-1}	-0.049*** (0.012)	-0.033*** (0.013)
Male	…	1.046*** (0.065)
Economics Classes	…	0.123*** (0.017)
Caucasian	…	-0.361*** (0.071)
GPA	…	0.181*** (0.034)
Period	-0.025*** (0.004)	-0.026*** (0.004)
Constant	0.918*** (0.266)	-0.943* (0.258)
L.L.R.	-3039	-3022
N **Individuals** *Sessions*	9600 **160** *16*	

+ Random effects with clustering by session.
*** - Significant at 1% level
** - Significant at 5% level
* - Significant at 10% level

Table 7: Frequency of Insurance Purchases

Number of times a player purchased insurance	Percent by type	
	Type A	Type B
0	6.3%	16.3%
1 – 5	11.3%	23.8%
6 – 10	3.8%	12.5%
11 – 15	5.0%	11.3%
16 – 20	6.3%	8.8%
20 – 25	1.3%	8.8%
26 – 30	8.8%	3.8%
31 – 35	10.0%	5.0%
36 – 40	3.8%	1.3%
41 – 45	5.0%	3.8%
46 – 50	3.8%	1.3%
51 – 55	5.0%	1.3%
56 – 60	5.0%	2.5%
Average number of insurance purchases (as a percentage of periods)	34.1 (56.8%)	19.0 (31.6%)

Table 8: Determinants of Who Buys Insurance[+]

Variable	Marginal Probability Effect (Std. Err.)	
	Model 1	Model 2
Type	0.635 (0.417)	-0.126 (0.397)
Cumulative Earnings A_{it-1}	-0.131*** (0.028)	-0.119*** (0.032)
Cumulative Earnings B_{it-1}	-0.392*** (0.068)	-0.365*** (0.073)
Was Attacked t-1	0.806*** (0.086)	0.860*** (0.086)
Male		-0.494*** (0.068)
Econ Classes		0.117*** (0.018)
Caucasian		0.265** (0.107)
GPA		0.203*** (0.058)
Period	0.031*** (0.007)	0.027*** (0.008)
Constant	0.475* (0.276)	0.432 (0.337)
L.L.R.	-3856	-3810
N **Individuals** *Sessions*	9600 **160** *16*	

+ Random effects with clustering by session.
*** - Significant at 1% level
** - Significant at 5% level
* - Significant at 10% level

Table 9: Changes in Anti-Social Preferences (ASP) over Time

	No to Mild ASP[a]		Moderate ASP[b]		High to Extreme ASP[c]	
Periods	Type A	Type B	Type A	Type B	Type A	Type B
31-40	53.8%	41.3%	23.8%	32.5%	22.5%	26.3%
41-50	65.0%	51.3%	12.5%	33.8%	22.5%	15.0%
51-60	68.8%	73.8%	13.8%	15.0%	17.5%	11.3%
61-70	72.5%	73.8%	11.3%	15.0%	16.3%	11.3%
71-80	73.8%	82.5%	11.3%	13.8%	15.0%	3.8%
81-90	80.0%	78.8%	7.5%	15.0%	12.5%	6.3%

a - attack another two or fewer times in a ten-period span.
b - attack another three to seven times in a ten-period span.
c - attack another eight or more times in a ten-period span.

Table 10: Changes in Insurance Buying Behaviour over Time

	Risk Takers to Mildly Risk Averse[a]		Moderately Risk Averse[b]		Highly to Extremely Risk Averse[c]	
Periods	Type A	Type B	Type A	Type B	Type A	Type B
31-40	21.3%	36.3%	31.3%	43.8%	47.5%	20.0%
41-50	26.3%	47.5%	25.0%	32.5%	48.8%	20.0%
51-60	32.5%	60.0%	17.5%	22.5%	50.0%	17.5%
61-70	36.3%	65.0%	13.8%	16.3%	50.0%	18.8%
71-80	35.0%	68.8%	27.5%	12.5%	37.5%	18.8%
81-90	41.3%	62.5%	16.3%	30.0%	42.5%	7.5%

a - attack another two or fewer times in a ten-period span.
b - attack another three to seven times in a ten-period span.
c - attack another eight or more times in a ten-period span.

Table 11: Convergence Points for Attacking and Insurance Buying Rates

	Coefficient (t-statistic)		
	Attack Rate	Insurance Buying	
		(1)	(2)
Attack Rate$_{t-1}$			0.320 (10.59)
Convergence point *(Standard Error)*	0.223 (8.93)	0.429 (15.17)	0.348 (16.26)
Wald χ^2 **(p-value)**	90.5 (0.000)	61.74 (0.000)	197.33 (0.000)
N **(Groups)** ***Time Periods***	960 (16) *60*		

Note: Estimated starting points for each session are suppressed.