FOLLOW THE FIRST FOLLOWER: DONATIONS TO CHARITY AND PRO-SOCIAL BEHAVIOUR

By

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To the late Dougal and Irene Lovett

Thank you.

ABSTRACT

Leadership is present in wide variety of human interactions from organisational hierarchy to online charitable fundraising. Consequently, the subject has been studied in a multitude of fields from biology to history. In behavioural economics, the existence of leadership has been tested experimentally as a potential solution to social dilemmas with varying success. However, the majority of previous experimental studies have examined only one form of leadership where leadership where only one group member can exhibit it. In psychological research, there is an evolving interest in the concept of shared leadership, where leadership is shared among multiple group members. Likewise, Derek Sivers (2010) emphasised the importance of a first follower, who is a person who acts directly after the leader and makes the leader's actions more credible. This thesis tests the impact of first followership on solving social dilemmas and examines further the topic of shared leadership.

Chapter 2 studies whether the introduction of a first follower increases total investment in a linear public good game both theoretically and experimentally. Four investment sequences are considered including two new additions to the literature: the First Follower game and the Two Leader game. The already established Leader game and Sequential game are implemented as control treatments. The First Follower game has three investment stages; in the first stage, a leader invests, in the second stage a first follower invests and the rest of the group simultaneously invest in the third stage. The Two Leader game has only two investment stages; in the first stage, two leaders simultaneously invest in the first stage and then the rest of the group simultaneously invest in the second stage. The four investment sequences are ranked according to their expected total investment. No one investment sequence is always found to be superior, and thus the ranking is dependent on the strategic behaviour of early movers, namely leaders and first followers. In the experiment, the First Follower game had the highest total invested in the public good and Two Leader, the second highest. These results suggest that shared leadership or first followership may be superior to a one leader structure. Specifically, in the First Follower game,

leaders set a better example by investing significantly more than leaders in other treatments, and first followers exhibit higher levels of reciprocity than later followers. All investment sequences were imposed exogenously to create a simple initial testing ground for introducing the first follower.

Chapter 3 expands on the endogenous leadership literature by comparing the efficiency of a game with two investment stages, a two-day treatment to a game with three investment stages, a three-day treatment. Using a novel experimental design, each group member chooses what investment stage they would like to invest during. Therefore, the number of group members investing on day one, equivalent to leaders, is unrestricted, hence one can also explore how many group members are willing to lead. Willingness to lead is greater in both treatments than observed in previous studies. Nevertheless, the proportion of leaders is significantly higher in the three-day treatment, this result leads to significantly higher total investment in the three-day treatment. Leader investment and total investment in these treatments, where there is endogeneity over the timing of investment choices is compared to the treatments from Chapter 2 where timing is exogenously imposed. Endogenous leaders are found not to invest significantly more than exogenous leaders, and similarly there is no significant difference in total investment. Nevertheless, the treatments with three investment stages, namely three-day and First Follower, have the highest levels of leader investment and overall total investment.

Chapter 4 extends the design of Corazzini, Cotton and Valbonesi (2015) to consider a real-time environment; this adjustment makes the game more akin to real world crowdfunding and competitive lobbying (Austen-Smith and Wright, 1992). Like Chapter 3, individuals choose when they would like to invest rather than a set exogenous investment sequence imposed on them as in Chapter 2. Two treatments are executed, a multiple public good treatment with four identical threshold public goods and another with only one threshold public good. It is hypothesised that the real-time environment increase efficiency in reaching a threshold in the presence of multiple threshold public goods. The experimental evidence implies otherwise; the multiple public good treatment leads to significantly lower levels of efficiency stemming from the inefficiency caused by group members investing in multiple projects when only one project can be fully funded.

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Finally, I dedicate this thesis to my grandparents, the late Irene and Dougal Lovett who both, sadly, passed away during the completion of this thesis. They were the best grandparents I could have wished for, they cared for me deeply and had unwavering faith in me.

DECLARATION

An earlier version of Chapter 2 of this thesis was presented at the research seminar of the School of Economics at the University of Kent on 18th February 2015. It was also presented at the Public Economic Theory (PET) 2015 conference on 3rd July 2015 at the University of Luxembourg.

An earlier version of Chapter 3 was presented at the Economic and Psychology Perspectives on Social Issues using an Experimental Approach hosted at the University of Kent on 20th April 2016. It was also presented as during research seminar of the School of Economics at the University of Kent on 10th May 2016.

The main results from Chapters 2, 3 and 4 of the originally submitted version of this thesis were presented at the Department for Transport on 14th November 2016.

CHAPTER 1

LEADERSHIP IN SOCIAL DILEMMAS

1.1 Social Dilemmas

In a social dilemma the strategy that maximises individual payoff differs from the strategy that maximises the group's payoff (Dawes 1980). Consequently, individuals face a dilemma of whether to choose what is best for them or best for the group. Optimal provision of public goods is a prime example of a social dilemma. Public goods such as flood defences and freely available online learning courses are both non-excludable and non-rivalrous. Non-excludability means individuals cannot be excluded from consuming the good even if they did not pay. This characteristic causes free rider problems whereby individuals have an incentive to not invest as they can take advantage of the investments of others. If individuals are self-interested and choose to free ride, there will be a lower provision of public goods than what is socially optimal. Non-rivalry means consumption of the good does not reduce the amount available for others. This characteristic further encourages free-riding as there is no competition among consumers for the good (e.g. Olson 1971).

1.1.1 Charitable Donation and Crowd-funding

A common example of public goods is charitable donations. Charitable donations can be viewed as being beneficial to society at a cost to the individual. For example, the ALS Ice Bucket Challenge campaign led to the discovery of a new gene in ALS research at the expense of individuals suffering icy water being thrown over them (Landers 2016). Recently, there has been an emergence of online collective action to help fund projects known as crowd-funding which is the process of collecting small investments from a large populace. Similar to public goods there is an incentive to not invest to the project and free ride on others investments foregoing the risk of the project not being funded.

1.1.2 Linear Public Good Games

Despite the incentive to free-ride, many individuals donate to charity and ever increasingly crowdfund projects. To understand this persistent existence of prosocial behaviour, social dilemmas have been studied extensively using experiments. There are two key questions in the existing experimental literature; firstly, is efficiency in social dilemmas as low as theory would predict and secondly, what institutions or interventions increase efficiency.

The linear public good game is the most commonly studied social dilemma and is a simplified version of the social dilemma involved in public good provision. In the standard linear public good game, individuals are placed into groups, given an endowment and decide independently how much of that endowment to invest in a public good. Any endowment not invested, is automatically placed into a private account which benefits only the individual. Once all group members have made their investment decisions, the total investment to the public good is multiplied by some factor, and the payoff is split equally among all group members regardless of the amount they invested. The return on each token invested to the public good, the marginal per capita return (MPCR), is typically calculated such that there is a selfish incentive to invest zero, but it is Pareto optimal if everyone invests his or her endowment.

It is beyond the scope of this research to review all the literature on linear public good games, but a summary of the main results is useful. In a survey of the public goods literature, Ledyard (1995) found that individuals initially invest between 40-60% of their endowment. This is higher than the Nash equilibrium of zero, however when the game is repeated, investments decline and converge towards the Nash equilibrium. Andreoni (1995) proposed the initial high levels of investment was due to confusion or kindness of individuals. The superseding theory is that differences in initial investment are due to heterogeneity in innate cooperativeness and individual beliefs of how much others will invest (Fischbacher and Gächter 2010). During the course of the experiment as individuals discover other group members free riding they update their beliefs and reduce their investments accordingly.

Some studies have changed the payoff calculation by changing underlying parameters such as the group size and the MPCR (Issac and Walker 1988; Xu et al. 2013). If the return remains constant but the number of group members benefitting from the public good increases, this reduces the MPCR. Issac and

Walker (1988) found that higher MPCR leads to significantly higher total investment, and that increasing the number of group members reduces investments if the total return remains stable.

What about changes which do not alter the payoff calculation? The following institutions and interventions have been found to significantly increase total investment: communication between players (Koukoumelis, Levati and Weisser 2012; Kumakawa 2013), priming cooperation (Drouvelis, Metcalfe and Powdthavee 2015), punishment (Fehr and Gächter 2000), partner design (Zelmer 2003) and disclosing investments without anonymity (Rege and Telle 2004; Martinsson, Pham-Khanh and Villegas-Palacio 2013).

An institution of relevance to my work is the introduction of a threshold. Issac, Schmidtz and Walker (1989) hypothesised that the implementation of a provision point will increase total investment. The individuals benefit from the public good only if the total investment surpasses a pre-specified level i.e. threshold or provision point. With a provision point, there is no longer a dominant strategy to invest zero. Instead, there exists a range of Nash equilibria in some of which, the provision point is reached. This intervention, therefore, makes the game a problem of coordination as opposed to a cooperation problem. The Pareto efficient equilibrium remains to be where all group members invest their entire endowment.

1.2 Leadership in linear public good games

This research is concerned with the intervention of leadership to encourage public good investment. Economics is not alone in examining the impact of leadership; it has been studied extensively in other social sciences including psychology, anthropology and sociology. Consequently, there are a multitude of ways to define a leader but for consistency with the existing experimental economics literature[1], a leader in this research will be defined as a group member

[1] Note there has also been a movement towards leadership by words; here the main considerations are leading by actions or as frequently referred to leading by example.

who invests first and does not know of any other group member's investment prior to making their investment decision. It is important to gain a fuller understanding of how the behaviour of early movers impact on follower behaviour, as this determines group outcomes. Leaders are the core of most organisations and leadership style and changes in leadership can affect the entire organisation (Meyer 1975; Agbim 2013). Seeking donations sequentially is institutionalised in modern charity which can be seen on online charitable fundraising and crowdfunding platforms. There is the opportunity for leadership to emerge in these contexts (Shapely 1998; Romano and Yildrim 2001). As noted by Schwerhoff (2016) there is also leadership present in climate change negotiations at the international level. Clearly, the policy implications of leadership research are far-reaching.

Previous economics literature has highlighted many distinct reasons why leadership should increase public good investment. By making their decision first, leaders can restrict the possible outcomes for later movers. Varian (1994) hypothesised that the introduction of a leader lowers public good provision compared to a simultaneous game, as the leader will free ride on the second mover's investment. Varian (1994) however considered only a two-person group in a quasi-linear setting. Similarly, older theoretical literature on charitable donations (e.g. Roberts 1984; Warr 1982) theorised many individuals are motivated by altruism leading to a 'crowding out' of donations. In this instance, the more others donate the less you will donate.

If the leader has superior information about the quality of the public good, their presence is theorised to increase public good investment (Hermalin 1998). In this asymmetric information scenario, leaders can signal the quality through their investment. A large investment by the leader can make the followers believe the public good is of high quality inducing them to invest more. Further to this, the asymmetric knowledge of the quality may help the charity to increase donations. Specifically, for a high-quality charity, it is hypothesised by Vesterlund (2003) a situation where only the leader knows the quality is superior to one where all group members are informed. The positive effect of a leader and asymmetric information is consistent with experimental results in Potters, Sefton and Vesterlund (2007). The leader's investment also needs to be credible to effectively raise investment (Komai and Stegeman, 2010; Andreoni 1998). For Andreoni (1998) to be credible the leader must sacrifice a large amount of their endowment to the public good. Komai and Stegeman (2010) mention exerted effort by the leader as a factor to their credibility but implicate that multiple leaders could restore credibility. One would expect leaders to desire to be viewed credible, to give them higher influence over the followers.

Hermalin (1998) coins the process by which a first mover invests a positive amount to the public good, *'leading by example'*. By not free riding, the leader sets a good example for the rest of the group and the possible creation of a social norm[2]. This is opposed to *'leading by sacrifice'*, also in Hermalin (1998), where the leader rewards their team for good behaviour, for example leaving early on a Friday if they exceed their target performance level. Leading by example is considered to be more effective than leading by sacrifice as the leader directly inputs to the public good. Nevertheless, the aim of the leader remains the same which is to increase the followers' investments, since their payoff is increasing in the level of other group members.

Charities tend to seek donations sequentially (Andreoni 1998; Vesterlund 2003; Romano and Yildrim 2001), this behaviour is not logical if fundraisers expect crowding out to occur. Instead, knowledge of previous donations significantly increases the amounted donated by the current individual this effect is known as 'crowding in' (Frey and Meier 2004; Shang and Croson 2009; Alpizar, Carlsson and Johansson-Stenman 2008). This behaviour is also referred to as reciprocity or conditional cooperation and its existence has become the predominant reason why leadership should make a significant difference. Fischbacher, Gächter and Fehr (2001) classified participants as either conditional co-operators, hump-shaped, free riders or others[3] based on their reaction function to hypothetical average previous investments. Around 50% of subjects were classified as conditional co-operators, these individuals invest

[2] Property rights, contracts and concepts of justice are all commonplace examples of social norms.
[3] Free riding individuals will invest zero regardless of what the others invest. Hump shaped individuals will exhibit positive reciprocity at lower levels of previous investment but then negative reciprocity during higher levels of previous investment.

more the more they observe others investing. Incorporating the existence of follower reciprocation, Cartwright and Patel (2010) hypothesise that leaders willingness to invest a positive amount is increasing in the proportion of conditionally co-operative followers. Figuières, Masclet and Willinger (2012) uncover positive reciprocity in their fully sequential public good game treatments. Interestingly, the level of conditional cooperation decreases the later the stage the individual invests during. Importantly, the investments of previous movers must be observable to other individuals for leadership[4] to raise investment (Figuières, Masclet and Willinger 2012; Reinstein and Riener 2012).

The initial leadership public good experiments imposed leadership exogenously however the imposition has a questionable impact on total investment. Moxnes and van der Heijden (2003) and Güth et al. (2007) both found it to have a positive impact, however other studies have found it not to have a significant change to total investment (Gächter et al. 2012; Gächter and Renner 2014; Potters, Sefton and Vesterlund 2007). Nevertheless a common result is that leaders tend to invest a larger proportion of their endowment than those that follow them (Gächter and Renner 2014) meaning that they will earn less than followers[5].

Later experiments considered self-selection of leaders, commonly referred to as voluntary or endogenous leadership (Arbak and Villeval 2013; Cappelen et al. 2015; Rivas and Sutter 2011; Haigner and Wakolbinger 2010). The majority of the endogenous leadership studies have found voluntary leaders invest more than their exogenous counterparts, but why would an endogenous leader have a stronger motive to invest more? Cartwright and Patel (2010) theorises that strategists[6] would invest a positive amount if they are early in the sequence and there is a sufficient level of conditional cooperation exhibited by followers. There is good reason to suspect that conditional cooperation would be present given the field evidence on charitable giving (Alpizar, Carlsson and

[4] Considering the other direction, with observability the leader may also be avoiding the social stigma involved with a zero or low level investment (Linardi and McConnell, 2011).
[5] There are some rare instances in previous experiments where leaders do earn more on average than followers: the high-status treatment in Eckel, Fatas and Wilson (2010), exogenous leaders with the power to exclude others in Güth et al., (2007).
[6] Strategists are individuals who are motivated by their own individual payoff.

Johansson-Stenman 2008; Frey and Meier 2004; Shang and Croson 2009) and the correlation between leader and follower investments observed in public good experiments (Levati, Sutter and van der Heijden 2007; Figuières, Masclet and Willinger 2012). One would imagine leaders in endogenous games would be more cooperatively inclined than the average group member because more cooperatively inclined individuals are willing to nominate for leadership (Préget, Nguyen-Van and Willinger 2016; Gächter et al. 2012). This stems from their optimism of the level of investments they expect from others. Arbak and Villeval (2013) also suggest that altruistic individuals would also be more willing to lead because they expect their payoff sacrifice will increase total investment. Being the leader would also increase an individual's social image if they viewed the role as prestigious. Compatible with this theory, total investment is higher if the leader's level of generosity, determined pre-game, is announced alongside their investment level (Arbak and Villeval 2011). Willingness to serve as leader may also act as a signal to others that the individual is willing to sacrifice their own payoff hence followers are more inclined to reciprocate (Potters, Sefton and Vesterlund 2005; Haigner and Wakolbinger 2010).

Leadership is also stated as a potential solution to coordination problems (Ledyard 1995) and subsequently tested in experiments. Efficiency is greater when investments are made sequentially rather than simultaneously in a threshold public good experiment (Coats, Gronberg and Grosskopf, 2009; Bracha, Menietti and Vesterlund 2011; Erev and Rapoport 1990). This is however not true when full refunds are available (Coats, Gronberg and Grosskopf 2009), where individuals will receive their investment back if the threshold is not reached. The sequential investment structure does not solve the entire efficiency problem, as payoffs are still significantly below the Pareto efficient level (e.g. Dorsey 1992; Coats, Gronberg and Grosskopf 2009).

1.3 The contribution of this thesis

The majority of the previous literature considered only one form of leadership whereby leadership is given to only one group member. There is a growing interest in the concept of shared leadership in psychological studies (Wang, Waldman and Zhen 2014; Carson, Tesluk and Marrone 2007); this concept suggests that multiple individuals can exhibit leadership. Wang, Waldman and Zhang (2014) found that shared leadership increased team effectiveness. Derek Sivers (2010) coined the 'first follower effect' which is the critical importance of the second person to act in the group, they decide whether to follow the leader. Gächter and Renner (2014) observed that leaders initially shape accepted social norms and follower beliefs. However, as the game is repeated the reactions of followers in previous rounds become more influential to the current level of follower investments. These observations indicate that an exogenous investment sequence with one leader may not be the most effective investment sequence despite being the most frequently studied.

Chapter 2 explores the impact of imposing first followership as means to solve social dilemmas. Four different investment sequences are considered: the First Follower game and the Two Leader game are two new additions to the literature and the two control treatments are the Leader game and the Sequential game[7]. The First Follower game has three investment stages, a leader invests, then a first follower invests before the rest of the group invests simultaneously. The Two Leader game has two investment stages; two leaders invest simultaneously then the rest of the group invests simultaneously. It is argued that this Two Leader game captures the idea of shared leadership by allowing more than one group member to invest first. It is shown theoretically that the First Follower game can lead to the highest total investment. This structure encourages the leader to set a 'better' example as well as the additional benefit of an extra shot of a good example by the first follower. In addition, two observations of the same level investment can help confirm the social norm. The First Follower game had the highest total investment in the experiment and Two Leader the second highest, implying that the dominant form of leadership studied previously may underestimate the influence of leadership.

[7] The Leader game has two investment stages; one person invests then the rest of the group simultaneously invests. In the Sequential game, everyone invests during a different investment stage and therefore investments are made in a chain.

The investment structures in Chapter 2 are imposed exogenously; this was to create a simple 'testing ground' for the new structures. There is not a consistent method of implementing leadership endogenously in the existing literature. One method involves a nomination stage, where any group member can nominate themselves for leadership. Among the nominees, one is selected to be the leader (Arbak and Villeval 2013; Cappelen et al. 2015). In the second method, the first person to invest within a time period is selected as leader. If no one chooses to invest within that time period, the game reverts to the simultaneous game (Rivas and Sutter 2011; Préget, Nguyen-Van and Willinger 2016). The third method involves unanimous acceptance of one individual to the leadership role (Güth et al. 2007; Levati, Sutter and van der Heijden 2007). The fourth method involves asking one group member if they would like to invest first or last (Haigner and Wakolbinger 2010). A common factor across all methods is that only one leader is imposed, even if there is more than one person willing to lead.

How many individuals are willing to lead? Arbak and Villeval (2013) find that 25% of individuals are willing to serve as leader which is not much higher than the 21.1% found by Cappelen et al. (2015) in their no compensation treatment and not much lower than the 28% willing to move first in Haigner and Wakolbinger (2010). In Cappelen et al. (2015) the proportion of willingness to lead increases to 64.6% if the leader is compensated a medium amount and to 93.3% if a high level of compensation. Rivas and Sutter (2011) find the average frequency a subject is the leader is 3.88 out of a possible 16 rounds. Willingness to lead diminishes as the game is repeated (Arbak and Villeval 2013). Given that 68.75% of experienced players in Centorrino and Concina (2013) are willing to pay to be the leader suggests that being the leader is viewed as a superior role.

So how does endogenous leadership fare against exogenously imposed leadership? Rivas and Sutter (2011) concludes that voluntary leadership decreases the difference between leaders' and followers' investments. Groups with voluntary leaders have 50% higher total investment than the fully simultaneous game but 80% higher than groups with exogenous leaders. Haigner and Wakolbinger (2010) finds endogenous leader groups to have 84% higher investment compared to simultaneous groups and 31% higher than exogenous leader groups. Dannenberg (2015) concludes that although exogenous leadership leads to 49% more investment than a simultaneous investment order, endogenous leadership is more impactful at 181% higher. Centorrino and Concina (2013) also find that endogenous leaders invest more than exogenous leaders. There are however some exceptions, Arbak and Villeval (2013) find followers investments are more responsive to exogenous leaders and Potters, Sefton and Vesterlund (2005) find that a sequential order of investment increases total investment if the order is determined exogenously. Notably, none of the above literature consider more than one leader per group. To my knowledge there is one paper which allows for multiple leaders, Vyrastekova and Garikipati (2008), however in this study the individuals can be both leaders and followers within a single round of investment decisions.

Chapter 3 focuses on endogenous leaders in public good games. The first research question of this chapter stems from the following result of Chapter 2, that the First Follower game, which had three investment stages, and leads to the highest public good provision. Therefore, in the second experiment, it is examined whether three investment stages, a three-day treatment, leads to a higher level of total investment than two stages, a two-day treatment. The second experiment does not impose the number of individuals investing during each stage. Therefore, one can also uncover how many individuals are willing to invest during the first stage, i.e. be a leader. The investment structures were imposed exogenously during the first experiment; therefore it is of interest to uncover whether this effect is present if imposed endogenously.

The average total investment to the public good was significantly higher in the three-day treatment compared to the two-day treatment. A prominent cause of the increase is due to the significantly higher proportion of 'leaders', individuals choosing to invest on day one. Nevertheless, there was no significant difference in leader investment between treatments; the average follower investment was also similar between treatments. The existence of at least one first follower, someone investing on day two in the three-day treatment leads to significantly higher total investment, reinforcing the result of beneficial first followership from Chapter Two.

In Chapter 4 leadership is studied in a non-linear public good game, namely the threshold public good game. As briefly discussed above, there has been an increasing popularity in crowdfunding and with it an increasing number of projects vying for funding. Extending from the third chapter, another element of individual choice is added, *where* they will choose to invest. The reward structure of crowdfunding is similar to threshold public good games (Boudreau et al. 2015; Mak et al. 2015), the project creator must first reach their target before investors receive any beneficial return from crowdfunding projects. In a recent experimental paper, Corazzini, Cotton and Valbonesi (2015) found that the success of reaching the threshold is significantly lower when there are four public goods rather than one public good. This is a crucial result given the huge range of choice in crowdfunding projects currently available. Investments will also be sequential in this third experiments, and thus one can also investigate the impact of early mover actions on overall efficiency.

Chapter 4 expands on the research of Corazzini, Cotton and Valbonesi (2015) by extending their experimental design to consider investments being made in a real-time environment. This adjustment makes the experiment more akin to crowdfunding where investments are made sequentially. Two treatments are considered, a one public good treatment and a multiple public good treatment with four identical threshold public goods. The coordination problem involved in threshold public goods is heightened in the presence of multiple public goods as the group must also coordinate on which public good to invest in. By intuition and prior evidence on sequential investments, one would suspect that the real-time environment would help alleviate some of the inefficiency found when multiple public goods are present in Corrazini, Cotton and Valbonesi (2015). The design allows for leadership to emerge and hence aid in coordinating the group towards one of the plethora of equilibria. However, the real-time environment was found not to solve the inefficiency caused by multiple public goods. Individuals earned significantly lower in the presence of multiple public goods compared to one public good in the dynamic treatments. This inefficiency is caused by group members investing in more than one public good despite the restriction that only one can be fully funded. The success in reaching a threshold of one public good is also significantly lower at the start of the experiment when there are multiple public goods. These results are compared to the equivalent static treatments from Corazzini, Cotton and Valbonesi (2015). The dynamic treatments from the experimental design stated in Chapter 4 do not differ much in the level of reaching the threshold and overall efficiency. However, investment for multiple public goods are more stable in the real-time environment.

CHAPTER 2
FOLLOW THE FIRST FOLLOWER

2.1 Introduction and Literature Review

Many successful start-ups start with an 'ideas' man or woman, the initial investor, then a second investor who can finance that idea further to make it a success. It is the presence of the second investor that makes the idea available to the larger crowd of consumers. The crowd may be influenced into believing the idea is good due to the actions of the second investor, not only by his decision to invest but also by the level of his investment. This second investor could be viewed as a neutral expert. This influence of the second investor was termed the "first follower effect" in a TED video by a sociologist, Derek Sivers (2010)[8].

It has now become routine in the experimental economics and psychological literature on leadership to say that we need to know more about the role of followership. Leadership and followership are complementary and only by studying both together will gain the best understanding of how groups function. Little progress, however, seems to have been made in the study of followership. In this chapter, the focus will be, specifically, on the role of the first follower in the context of a linear public good game, which is the most common game used for studying leadership experimentally and so provides a natural one to consider. The simplicity of the game also allows precise theoretical predictions about behaviour.

Four different types of leadership structures will be compared theoretically and experimentally. Two of these structures have been studied before, namely, *leadership by example*, wherein one person acts before all others, and *sequential* choice, wherein people act one by one in sequence. One of the alternative structures considered will be called *first followership*. Here one person acts first (the leader) then a second (the first follower) and then all others (the followers). The second alternative structure considered will be called *shared*

[8] Note in this example, the public good or the 'idea of dancing' is proposed by the leader rather than a random imposition of this organisational hierarchy.

leadership. Here two people act first (the leaders) and then all others (the followers).[9]

It is argued that the first followership structure captures, in a stylised way, the notion of a first follower coined by Sivers (2010). This, therefore, is the structure of particular interest. A shared leadership structure is of interest in its own right. In particular, in both structures two people act before all others; the only difference is whether the two 'early movers' act at the same time (shared leadership) or in turn (first followership). Despite this relatively subtle change, it is examined whether the outcomes differ between first followership and shared leadership and to additionally compare outcomes in these new structures with the two standard structures already familiar in the literature.

To my knowledge, there have been only a few theoretical studies to study the impact of alternative organisational hierarchies to leadership by example in relation to public good provision. If asymmetric information is present, Zhou (2016) theorises that a fully sequential structure will be most efficient. Komai and Stegeman (2010) again with asymmetry of information present, emphasise the need for credibility in leaders' actions and that shared leadership could increase credibility. Zhou and Chen (2015) in a symmetric information context, consider a two-stage linear public good game of differing sized sub-groups who invest simultaneously in each stage. They hypothesise that two equally sized groups would have highest efficiency. In latter two studies mentioned the group of early movers choose their investments simultaneously.

The study of the first follower's impact can be related to topics in network economics and management. For instance, Feldman and Zoller (2012) observe that the presence of an intermediary individual, 'dealmaker' who has deep fiduciary ties within regional economics leads to a higher level of entrepreneurship than the number of start-ups within the region. Huy (2001) highlights the benefit of middle managements. Such benefits include increased entrepreneurial ideas, ensuring change initiative momentum is maintained and staying attuned to employees' moods and emotional needs. Note that in both

[9] Figuières, Masclet and Willinger (2012) mention the possibility of a public good game with two leaders.

examples, the intermediary is an expert within that field, however it remains of interest whether the inclusion of an intermediary with specific expertise can influence overall efficiency.

A closely related study by Figuières, Masclet and Willinger (2012) found that the later an individual invests within a sequence the less influence the leader's investment has. This result was coined vanishing leadership. They consider a fully sequential game and suggest that only players in an intermediary position can exhibit both reciprocity and leadership. In the first follower game considered in this chapter, the individual in the first follower position is the only person who can exhibit both leadership and reciprocation. The game is repeated several times with partner matching, therefore one might suspect individuals to be influenced by previous periods of investment. However, individuals in the current investment period are more influenced by the prior investments in the current period than late investments in the previous period.

Section 2.2 details the games and notation used throughout the rest of the chapter. In Section 2.3, a model of strategic leadership for the four leadership structures are worked through. Section 2.4 then states the hypotheses based on this model. There are two key determinants of predicted efficiency. (1) The structure itself can lead to different outcomes even if behaviour remains unchanged. Shared leadership, for instance, is particularly conducive to efficiency in this regard. Two leaders mean two chances for one of them to set a good example. Additionally, due to the higher number of individuals investing in stage one, there is a lower chance that imperfect reciprocation of prior investments to reduce efficiency. (2) Behaviour, however, will likely *not* remain constant across structures. The incentives of first (and second) movers differ across structures. In this regard, leadership by example is particularly conducive to efficiency. This is because the leader's pivotal role increases the incentive for them to set a good example.

Through a series of examples, it is demonstrated that the interplay between (1) and (2) means that no structure comes out as a clear winner. The relative efficiency of structures depends on parameters of the game, such as the number of players and return to the public good. The conditions under which first followership is best are discussed in detail, and it is argued to be a relatively versatile structure. As already hinted, the leader has most incentive to set a 'good example' in the leadership by example structure as their influence is not muddied by other individuals. The incentive for the leader to set a good example is also relatively high, though, in the first followership structure. So, this is a plus for first followership. The potential drawback with leadership by example is that there is only one person who moves before others. Therefore, there is only one shot at a good example. In all the other structures, including first followership, there are at least two people who can influence others. So, this is also a plus for first followership. However, notably the first follower has another role to show the socially acceptable reaction function to the leader's investment.

Section 2.5 reports on an experimental study to compare efficiency and behaviour across the four leadership structures. First followership results in the highest efficiency. Indeed, the experimental outcomes are remarkably consistent with the theoretical model in Section 2.3 with one exception, namely, efficiency in the leadership by example is lower than predicted. This latter finding is of note because the prior evidence on the success of leadership by example in raising public good investment is mixed. More specifically, some studies have found that investment with an exogenous leader are no higher than in simultaneous games (Potters, Sefton and Vesterlund 2007; Arbak and Villeval 2013). Leadership has proved more successful when leaders are endogenously selected (Haigner and Wakolbinger 2010; Rivas and Sutter 2011; Centorrino and Concina 2013), if leaders have additional information about the quality of the public good (Potters, Sefton and Vesterlund 2007), or leaders have the power to exclude (Güth et al. 2007).

The experimental results detailed in Chapter 2 can offer insight on why exogenous leadership by example increases efficiency less than might be expected. It is argued that the problem is a lack of strategic leadership. In this scenario, it was optimal for a (selfish) leader to invest in the public project in the leadership by example, first follower and sequential settings but not the shared leadership setting. In the leadership by example setting, however, there is little evidence of strategic leadership. One possible reason for this is the 'leaders curse'

(Gächter and Renner 2014) where leaders earn lower payoffs than followers. Generally, the leader earns a higher payoff if they invest a positive amount in the public good compared to free riding but also sees a gap between his payoff and that of others. In the leadership by example setting, there is a sense in which the leader stands alone in making this 'sacrifice'. In the first follower and shared leadership settings, by contrast, this sacrifice may seem shared.

2.2 Games and Notation

In the standard linear public good game, there are n players in a group, $N = \{1, \dots, n\}$. Each player is endowed with E units of a private good and decides how much of their endowment to invest into a public project. Let $x_i \in [0, E]$ denote the investment of player $i \in N$ and let $X = \sum_{i \in N} x_i$ denote total investment. Once all players in the group have invested, the total investment X is multiplied by factor $M > 0$ and split equally amongst all n players. Let $m = M/n$ denote the MPCR (Marginal Per Capita Return) on the public project. The payoff to player $i \in N$ is given by

$$u_i(x_1, \dots, x_n) = E - x_i + mX \quad (2.1)$$

The main objective is to compare games that differ in the timing of investment decisions. So, let $T = \{1,2, \dots, n\}$ be a set of investment stages. For any player $i \in N$ there exists a unique time $t_i \in T$ at which player i must decide how much to invest. Exogenous timing is considered so a player i has no choice over t_i. For any player $i \in N$ let $B(i) = \{j \in N: t_i < t_i\}$ be the set of players who must choose to invest before player i. Similarly let $Q(i) = \{j \in N \backslash \{i\}: t_j = t_i\}$ and $A(i) = \{j \in N: t_j > t_i\}$ be the set of players that choose, respectively, at the same time and after player i. Crucially, it is assumed that player i invests knowing the investment of every player in set $B(i)$ (but not knowing the investment of any player in set $Q(i)$ and $A(i)$).

The four games will now be introduced. In a leading by example setting (subsequently called **leader game**) player 1 invests first, $t_1 = 1$, and all other players subsequently invest simultaneously, $t_2 = \dots = t_n = 2$. This game has been widely studied in the literature (e.g. Potters, Sefton and Vesterlund (2005 and 2007); Güth et al. 2007; Levati, Sutter and van der Heijden 2007). In a **sequential game** player i invests in investment stage i, $t_i = i$ for all $i \in N$, and players invest according to an exogenously given sequence. This game has also been studied in the literature (e.g. Figuières, Masclet and Willinger 2012).

As discussed in the introduction an objective of this chapter is to consider a **first follower game.** In this game player 1 invests first, $t_1 = 1$, player 2 invests second, $t_2 = 2$, and then all others invest simultaneously, $t_3 = \cdots = t_n = 3$. Note that this game differs from a leader game solely in the fact that player 2 invests before players 3 to n. Even so, this means that sets $B(i)$, $Q(i)$ and $A(i)$ change for every player $i \neq 1$. As a comparator to the first follower game, shared leadership (henceforth **two leader game**) is considered. In this game players 1 and 2 simultaneously invest in the first investment stage, $t_1 = t_2 = 1$, and then all others invest simultaneously, $t_3 = \cdots = t_n = 2$. Note that sets $B(i)$, $Q(i)$ and $A(i)$ are identical in the first follower and two leader games for any player $i > 2$. The only difference, therefore, is the relative timing of player 1 and 2 investments.

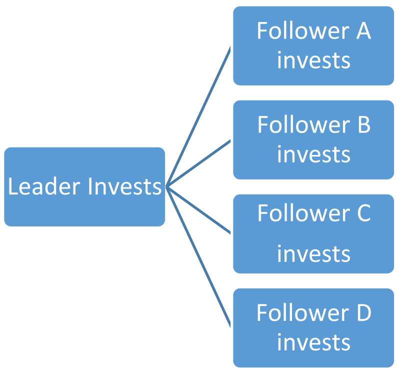

Figure 2.1a Leader Treatment Investment Sequence

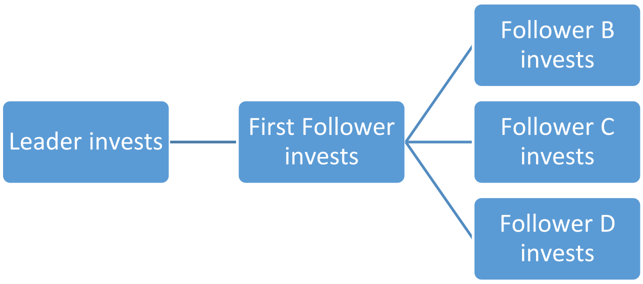

Figure 2.1b First Follower Treatment Investment Sequence

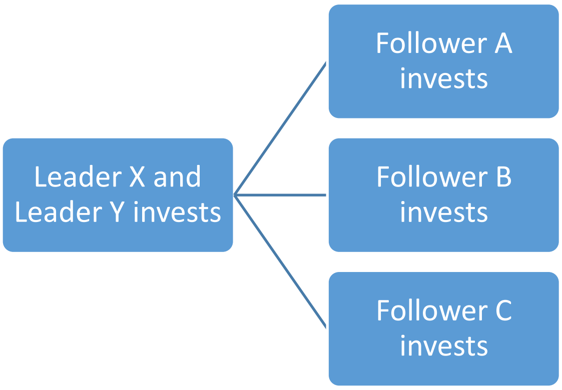

Figure 2.1c Two Leader Treatment Investment Sequence

Figure 2.1d Sequential Treatment Investment Sequence

Figures 2.1a-d show the four investment sequences diagrammatically. Following the economic literature, a positional definition of leader and follower will be used whereby a player is viewed as a leader or follower depending on whether they move first, second, or so forth. Underlying this approach, however, is an interest in process leadership (Dunham and Pierce 1989). It is of interest to uncover what makes someone a 'successful' leader, and how this depends on the organisational structure and behaviour of followers.

2.3 Strategic Leadership

Standard game theoretic arguments lead to the simple prediction, in all four games, every player $i \in N$ should invest zero. While these arguments are well rehearsed in the literature it will prove useful to briefly summarize them here. Consider, any player $i \in N$ that will move last, that is, a player for whom $|A(i)| = 0$. By construction, player i's investment cannot influence any other player. Thus, every unit he keeps in his private account will give payoff 1 and every unit invested in the group project will give payoff $m < 1$. Player i has a dominant strategy to invest zero.

Consider next, any player $i \in N$ that will move in the penultimate investment stage. Player i knows that his investment will be observed by players in set $A(i)$. Thus, player i's investment could potentially influence others. Recall, however, that players in set $A(i)$ have a dominant strategy to invest zero. This would suggest that player i's investment should not actually influence others and so he should also invest zero. The preceding discussion is already enough to argue that the unique Nash equilibrium in a leader and two leader game is that all players invest zero. It is simple enough to extend the argument for the first follower and sequential game.

A Nash equilibrium of zero investment stands in stark contrast to the experimental evidence (Guttman 1986). Numerous studies have shown that people are willing to invest in group projects. Particularly relevant is the strong evidence for conditional cooperation where an individual's investment is increasing with the average investment of others (e.g. Fischbacher, Gächter and Fehr 2001; Croson 2007; Chaudhuri 2011). What happens to the efficiency predictions if the evidence for conditional cooperation is inserted back into the earlier derivation of a Nash equilibrium? Firstly, a player who moves last may not invest zero. Second, and crucially for this purpose, a player who moves before last should consider the effect their investment will have on subsequent players. Conditional cooperation, therefore, gives rise to the potential for *strategic leadership*: a player may find it optimal to invest a positive amount if he believes that this will indirectly increase the investment of others (Potters, Sefton and Vesterlund 2007; Cartwright and Patel 2010; see also Kreps et al. 1982).[10]

To make some specific predictions about strategic leadership one shall work through a simple model. The model is stylised but captures the essential features of interest. It is assumed that there are two types of player – conditional cooperators and strategists. Conditional cooperators are 'automata' who invest an amount equal to the average investment of those before them. More specifically, for any $i \in N$ where $t_i > 1$ let

$$\bar{x}(i) = \frac{1}{|B(i)|} \sum_{j \in B(j)} x_j \qquad (2.2)$$

denote the average investment of those who move before player i. If player i is a conditional cooperator then he will invest $x_i = \bar{x}(i)$. The objective in this chapter is not to question the motives or origins of conditional cooperation. It is taken as given that conditional cooperators exist. It is also worth emphasising that the results to follow are not dependent on the specific form of conditional cooperation assumed. For example, the empirical evidence suggests that conditional cooperators often invest less than the average investment of others (e.g. Figuières, Masclet and Willinger 2012). It would be straightforward to extend these results to a more general setting where a conditional cooperator i invests $x_i = r\bar{x}(i)$ for some constant r (this scenario is extended in Section 2.3.4).[11]

A strategist is someone who acts to maximise his individual payoff. Crucially, the model allows that a strategist may consider the possibility of conditional cooperation. Specifically, if player i is a strategist then he has beliefs p_i where p_i is the probability he puts on a randomly selected player being a conditional cooperator (with $1 - p_i$ the probability they are a strategist).

[10] Note that this argument for strategic leadership is distinct from the argument that more informed leaders can influence followers (e.g. Potters, Sefton and Vesterlund 2005). In the former strategic leadership is driven by the potential for conditional cooperation while in the second it is driven by signalling. Potters, Sefton and Vesterlund (2007) considered a setting where both these possibilities could be directly compared and found that signalling was more important. Their setting, however, was one with relatively little incentive to invest even if reciprocity was expected.

[11] Heterogeneity in conditional cooperation could also be allowed.

Heterogeneity in beliefs is allowed for. If $p_i = 0$ then player i does not expect any conditional cooperation. In this case (as formally shown below) he will invest zero. If $p_i > 0$ then player i does expect some conditional cooperation. This opens the potential for strategic leadership. The objective in the following is to solve for the optimal strategy of a strategist.

2.3.1 First Mover

First the analysis of first movers. To illustrate the ideas behind strategic leadership, one shall work through the Leader game, which is easily the simplest of the four games to analyse. General results concerning the four games will be provided.

Suppose the first mover, player 1, is a strategist and invests L. Each of the $n - 1$ second movers will invest L if they are a conditional cooperator and 0 if a strategist. The expected total investment of others is, therefore, $(n-1)p_1L$. This means the expected payoff of player 1 if he invests L is given by

$$U(L) = E - L + mL\big(1 + (n-1)p_1{}^{12}\big) \quad (2.3)$$

There is clearly both a direct and indirect benefit of investing in the group project. The direct benefit of investing a unit in the group project is simply m. The indirect benefit is the likely increase in the investment of others as given by $m(n-1)p_1$. Investing a positive amount $L > 0$ is optimal if $m(1 + (n-1)p_1) > 1$. This gives a critical value for p_1 of

$$p^L = \frac{1-m}{(n-1)m} \quad (2.4)$$

If $p_1 > p^L$ then the first mover maximises expected payoff by investing E. If $p_1 < p^L$ he does best to invest 0.

To put some context to this condition, consider a setting where $n = 4$ and $m = 0.4$. Then $p^L = 1/2$. Experimental evidence suggests that the proportion of conditional cooperators is around 50-70% (e.g. Fischbacher, Gächter and Fehr

[12] This scenario assumes the probability that a follower copies the leader's investment is independent of the level of the leader's investment. Consider instead however if p1 was an increasing function of L then the first mover does best by inputting the maximum investment possible i.e. their endowment E.

2001; Cartwright and Lovett 2014). If, therefore, the first mover has beliefs consistent with this evidence, say $p_1 = 0.5$, it would be optimal for her to invest E. Only if the first mover has relatively pessimistic beliefs about the extent of conditional cooperation would it be optimal for her to invest zero. Clearly, p^L is a decreasing function of m and n. The intuition for these comparative statics is straightforward in that a higher marginal per capita return, MPCR, and larger number of second movers increase both the direct and indirect benefits of investing in the group project.

In all four games, there exists a critical value of p above which a first mover maximises expected payoff by investing E (and below which she maximises expected payoff by investing 0). Let p^{2L}, p^{FF} and p^S denote this critical value in the two leader, first follower and sequential games respectively. The first result (proved in Appendix A2.1) details these critical values. Note that for the sequential game it is only possible to derive an implicit solution (Cartwright and Patel 2010).

Proposition 1: In the leader, two leader, first follower and sequential games a strategic first mover, player i, will invest E if and only if $p_i > p^L, p^{2L}, p^{FF}, p^S$, respectively, (otherwise she invests 0) where

$$p^L = \frac{1-m}{(n-1)m}, \qquad p^{2L} = \frac{2(1-m)}{(n-2)m},$$

$$p^{FF} = \frac{\sqrt{n^2 - 8(n-2)\left(1 - \frac{1}{m}\right)} - n}{2(n-2)}, \qquad \prod_{j=1}^{n-1} \frac{j}{p^S + j} = m \quad (2.5)$$

To help with the interpretation of Proposition 1 an immediate corollary is provided. This corollary shows that a strategic first mover has 'more incentive' to invest in the leader game than in the first follower game, and more incentive in the first follower game than either the two leader or sequential game.

Corollary 1: It must hold that $p^L < p^{FF} < p^{2L}, p^S$. Depending on the values of n and m it may be that $p^{2L} > p^S$ or $p^{2L} < p^S$.

The intuition behind Corollary 1 is relatively straightforward. In a leader game, the first mover (i) can directly influence all n – 1 other players, and (ii) is the only player who can influence them. The first mover is, therefore, completely pivotal and this provides a strong incentive to invest and 'lead by example'. In the first follower game, the first mover can still directly influence the n – 1 other players, but she is not the only player who can do so. The investment of the second mover inevitably dilutes the influence of the first mover, especially considering imperfect reciprocation of the second mover. This reduces the incentive of the leader to invest; for instance if the 'leader sets of a good example' this may be offset by a 'bad first follower'. In essence, the first follower shows a social norm reaction function and their reaction maybe more influential than the action of the leader.

In the sequential game, the influence of the first mover becomes even more diluted than in the first follower game because there is a third mover, fourth mover and so on. In a two leader game, the influence of the first mover is diluted by there being two first movers. This scenario is similar to the first follower game. Note, though, that a first mover in the two leader game can have no influence on the other first mover while the first mover in a first follower game can affect the second mover. In other words, a first mover in the two leader game can only influence $n-2$ other players as compared to first movers being able to influence $n-1$ other players in the other three games.

2.3.2 Second Mover

It is not only the first mover that may have an incentive to invest strategically. Before exploring the implications of Corollary 1 in more detail, the incentive of the second mover in the first follower game is considered. Suppose the leader has invested L. If the second mover, player 2, invests K then the average investment observed by the other $n-2$ players will be $(L+K)/2$. So, if player 2 is a strategist his expected payoff can be written

$$U(K) = E - K + m\left(L + K + \frac{(n-2)p_2(L+K)}{2}\right) \quad (2.6)$$

Differentiating this with respect to K and setting equal to 0 gives a critical value of

$$p^{FF2} = \frac{2(1-m)}{(n-2)m} \quad (2.7)$$

If $p_2 > p^{FF2}$ then player 2 maximises his expected payoff by investing E, while if $p_2 < p^{FF2}$ he maximises his expected payoff by investing 0.

The incentives of the second mover in a sequential game were analysed by Cartwright and Patel (2010). One can immediately, therefore, proceed to the second proposition and corollary.

Proposition 2: In the first follower and sequential game a strategic second mover, player i, will invest E if and only if $p_i > p^{FF2}, p^{S2}$, respectively, where

$$p^{FF2} = \frac{2(1-m)}{(n-2)m}, \qquad \prod_{j=2}^{n-1} \frac{j}{p^{S2}+j} = m \quad (2.8)$$

Corollary 2: It must hold that $p^{FF2} = p^{2L} < p^{S2}$. Also $p^{S} < p^{S2}$.

The equivalence, $p^{FF2} = p^{2L}$ means that the incentives of a strategic second mover in a first follower game are identical to those of the first mover in a two leader game. This is more than a coincidence. In each case the strategist must take as given the investment of one player and potentially influence that of n – 2 others. The fact that the strategist knows the investment of this other player in the first follower game (but not in a two leader game) is irrelevant.

2.3.3 Total Investment

Having looked at the incentives of the first and second mover the effect on expected total investments is now considered. In doing so, some further preliminaries are required. One thing needed is to tie down the behaviour of a conditional cooperator in the event she is a first mover. It is assumed that she would invest her total endowment E. This assumption appears relatively innocuous given the available evidence (e.g. Fischbacher and Gächter 2010) and can easily be relaxed. The other thing to tie down are the beliefs of strategists. Let p denote the actual proportion of conditional cooperators in the population. It is then assumed that there exists a cumulative distribution function G that captures the distribution of strategist beliefs. Specifically, $G(y)$ is the probability that a (randomly chosen) strategist i has beliefs $p_i \le y$.

One can now make predictions on total investment to the public project. To illustrate, consider the leader game. With probability *p,* the first mover, player 1, is a conditional cooperator and invests E. With probability $1 - p$ the first mover is a strategist, in which case one needs to take account of p^L and apply Proposition 1. With probability $G(p^L)$ the strategist will invest 0 because she does not believe a high investment will pay back. With probability $1 - G(p^L)$ she will invest E. If the first mover invests E then each of the $n - 1$ second movers will invest E if they are a conditional cooperator and 0 if a strategist. If the first mover invests 0 then all second movers will invest 0. So, expected total investment is

$$X^L(n, p, G, m) = \Big(p + (1 - p)\big(1 - G(p^L)\big)\Big) E\big(1 + (n - 1)p\big) \quad (2.9)$$

Expected total investment can be similarly calculated for the other three games. Let X^{FF}, X^{2L} and X^S denote the respective values. With these values, the games are ranked in terms of the first best, the one that maximises total investment (and, therefore, efficiency), second best, etc. Some simple examples (provided in Appendix A2.2) are enough to show that there is no unambiguous first best. For different beliefs and values of n, p and m the relative rank of the four different games can change considerably. Indeed, any organisational structure can be most efficient.

To explore the reasons for different rankings conditional on the parameters, how efficiency in the first follower game compares to that in other games will be examined in more detail. In particular, a general statement detailing when expected investment is higher in the first follower game than two leader game is provided, as is a less general, but still useful, statement regarding the leader and sequential games. In the proof of the proposition, it is shown that general statements are relatively easy to derive for the leader and sequential games, but they are cumbersome and difficult to interpret. This method of proof is also easily extended to other comparisons, such as that between leader and shared leader, but details are omitted because of a vast number of possible combinations.

Proposition 3: (a) Expected total investment is weakly higher in the first follower game than the two leader game, $X^{FF} \geq X^{2L}$, if and only if

$$G(p^{FF})(1+p) \leq G(p^{2L}) \quad (2.10)$$

(b) If $G(p^{FF}) = 0$ then expected total investment is weakly higher in the first follower game than the leader game, $X^{FF} \geq X^{L}$, if and only if

$$G(p^{2L}) \leq \frac{2}{2+(n-2)p(1-p)} \quad (2.11)$$

(c) If $G(p^{S2}) = 1$ then expected total investment is weakly higher in the first follower game than in the sequential game.

To put some context to Proposition 3 consider the sufficient (not necessary) conditions under which the expected total investment in the first follower game is higher than in the other three games. Essentially $G(p^{FF})$ needs to be small, $G(p^{2L})$ to be large but not too large and $G(p^{S2})$ to be large. For instance, if $n = 4$ and $p = 0.6$ then a simple application of Proposition 3 shows that the first follower game maximises expected total investment if $G(p^{FF}) = 0, G(p^{2L} = 2/3) < 10/11$ and $G(p^{S2}) = 1$. The intuition behind this finding is relatively straightforward and gives general insight on the merits of different leadership structures. The parts (a)-(c) of Proposition 3 are considered in turn.

From (Corollary 1) there is more incentive for the leader to set a good example in the first follower than the two leader game. The gap between $G(p^{FF})$ and $G(p^{2L})$ is one way to capture this, and the larger the gap the more likely it is that a player would invest E if he was the leader in the first follower game but 0 in the two leader game. Note, however, that it is not enough simply that $G(p^{FF}) < G(p^{2L})$. This is because in the shared leader structure there are two leaders who could set a good example. The chance that *both* leaders invest 0 may be low. So, the advantage of the first follower structure is that it increases the likelihood a particular leader will invest E, while the advantage of shared leadership is that it decreases the likelihood the average investment of leaders is 0.

Also from (Corollary 1) there is more incentive for the leader to set a good example in the leader than in the first follower game. This increased incentive is the main advantage of the leader structure. Part (b) of Proposition 3 makes clear, however, that this is not the only relevant factor. If $G(p^{FF}) = 0$ then leaders in both the leader and first follower game will invest E and yet still either structure could be more efficient. This comes down to the incentives of the first follower. If the first follower invests 0, then overall investment would be lower relative to what it would have been in the leader game. But a strategist in the first follower position may have an incentive to invest E where they would have invested 0 as a follower in the leader game. The lower is $G(p^{2L})$ the more likely is this latter scenario. This logic naturally extends to a comparison between the first follower and sequential structures. If the sequential game is to be more efficient then it must be because it incentivises a strategic third, fourth mover and so on to invest E. This cannot happen if $G(p^{S2}) = 1$.

Proposition 3 and the preceding discussion has focused on showing that the first follower game *can* be best regarding maximising expected investment. Recall that any of the four games considered can be best depending on n, p and m. It is vital, therefore, to test whether the predictions of the model stand up to scrutiny. The experimental design is now described below.

2.3.4 Imperfect Reciprocation

As mentioned in Section 2.3.2, multiple studies have observed imperfect reciprocation of the previous investments. Specifically, in this context, imperfect reciprocators will invest rL where r is the rate of reciprocation and is less than 1 and L is the leader's investment.

Due to the linearity of the linear public good game all of the results stated in the sub-sections above remain the same for instance, the expected total investment of followers would become $r_1(n-1)p_1L$ in the Leader game. The early mover beliefs will account for the rate of reciprocation as well as presence of conditional cooperation and will be coined combined cooperation. For instance, $p_i r_i = 0.5$ means the person believes the combined cooperation is 50%.

2.4 Experiment Design

This experimental study has four treatments corresponding to the four different games introduced above. For all treatments, the parameters are set to $m = 0.4$, $E = 5$ and $n = 5$. A frequently studied set of parameters are $m = 0.4$ and $n = 4$ (e.g. Fischbacher, Gächter and Fehr 2001; Dannenberg 2015; Koukoumelis, Levati and Weisser 2012). The problem with $n = 4$, however, is that there is little incentive for strategic leadership in any game other than the leader game. As the following discussion, will illustrate, things become more interesting when $n = 5$.

Table 2.1 Incentive for leaders and first followers to invest their endowment

Treatment/game	First mover	Second mover
Leader	$p^L = 0.38$	n/a
First Follower	$p^{FF} = 0.47$	$p^{2L} = 1$
Two Leader	$p^{2L} = 1$	n/a
Sequential	$p^{SS} = 0.51$	$p^{S2} = 1$

Table 2.1 reports the critical values of p when $m = 0.4$ and $n = 5$. Notice that in the two leader game a strategist should invest 0 irrespective of her beliefs. By contrast, in the other three games a strategic leader may well have an incentive to invest E. Indeed, recall that realistic estimates of p are around 0.5-0.7; a strategist with beliefs in this range would be predicted to invest E. Finally, note that the incentives of a strategic leader and first follower are almost identical in the first follower and sequential games. These observations lead to some straightforward hypotheses. The first merely requires that $G(0.51) < 1$. The second that $G(0.25) < G(0.47)$.

Hypothesis 1: Leaders will invest more in the leader, first follower and sequential treatments than in the two leader treatment[13].

Hypothesis 2: Leaders will invest more in the leader treatment than the first follower and sequential treatments.

[13] This hypothesis is based on the incorporation of conditional cooperation stated in Section 2, however there is evidence from previous theoretical studies the leader may in fact free ride on the investments of subsequent investors.

The expected total investment is now considered. It is predicted that investment is less in the sequential game than first follower game. Inferred from Proposition 3b, predicted investment is likely to be lower in the first follower game than leader game. More specifically, even under the unrealistic assumption that $G(p^{FF}) = 0$, investment is predicted to be higher in the leader game if $p > 1/3$ and all the evidence suggests $p > 1/3$. With this, one obtains the next hypothesis.

Hypothesis 3: Total investment will be higher in the leader game than first follower game, and higher in the first follower game than the sequential game[14].

Tying down where the two leader game fits regarding predicted investment is less straightforward. It is projected, (see Proposition 3a) that predicted investment is higher in the first follower than two leader game if and only if $G(p^{FF}) \leq 1/(1+p)$. But, for plausible values of p this appears a relatively borderline condition. For instance, if $p = 0.5$ a third of strategists to believe $p \geq 0.5$ would be required. Without more evidence, it is difficult to judge whether this would hold or not.

Table 2.2 Predicted Expected Total Investment

	Leader	First Follower	Two Leader	Sequential
α = 0.5, β = 0.5, p=0.5	11.90	10.00	8.80	9.40
α = 5, β = 1, p=0.5	14.90	13.00	8.80	12.20
α = 1, β = 3, p=0.5	9.30	7.50	8.80	7.10
α = 2, β = 2, p=0.5	12.60	10.20	8.80	9.50
α = 2, β = 5, p=0.5	9.60	7.50	8.80	7.00
α = 0.5, β = 0.5, p=0.7	16.60	14.90	14.40	14.20
α = 5, β = 1, p=0.7	19.00	17.30	14.40	16.50
α = 1, β = 3, p=0.7	14.70	13.00	14.40	12.40
α = 2, β = 2, p=0.7	17.20	15.10	14.40	14.40
α = 2, β = 5, p=0.7	14.90	12.90	14.40	12.30

[14] Note that this is for the set of assumption specified previously.

Table 2.2 reports predicted total investment under a variety of scenarios. Beliefs, G, are assumed to have a beta distribution[15] with parameters α and β. (Note that the mean of the beta distribution is $\alpha/(\alpha+\beta)$ and the maximum possible total investment is 25.) In the two leader game a strategic leader would always invest 0 and so predicted investment is entirely driven by the proportion of conditional cooperators, p. In the other games predicted investment is sensitive to the distribution of beliefs. The more 'optimistic' are strategists then the higher the predicted investment. Table 2.2 makes clear the difficulty in hypothesising where the two leader game will come relative to the other three. In particular, the scenarios that a-priori seem most realistic are those with $\alpha = 2$ and the predicted total investment in the leader, first follower, and sequential games is very sensitive to the value of β in this case. If strategists are relatively optimistic, e.g. $\beta = 2$, then predicted total investment is relatively low in the two leader game. If strategists are relatively pessimistic, e.g. $\beta = 5$, then investment is relatively high in the two leader game. Even so, the numbers in Table 2.2 justify the final hypothesis.

Hypothesis 4: Total investment will be higher in the leader game than two leader game.

A total of 6 experimental sessions were conducted. At the beginning of each session, the participants received instructions for their treatment only. The participants were randomly placed into groups of five and interacted for 20 periods. In each period, the group played the same type of game but with the timing sequence randomly determined afresh. Given that the main focus was on the two new games there were more groups for these treatments - eight groups played the first follower game, nine the two leader game, five the leader game, and four the sequential game, giving a total of 130 subjects who participated consisting mainly of undergraduate and postgraduate students registered at the university. The study was run at the University of Kent using the z-Tree program

[15] The beta distribution is commonly used for studying population genetics. For the populace one expects a certain proportion to be conditional co-operators ranging from 0 (no conditional co-operators) to 1 (everyone is a conditional co-operator).

(Fischbacher 2007). A session lasted around 50 minutes, and participants earned an average payment of £6.86. The instructions for the First Follower treatment given to participants are available in Appendix A2.4.

2.5 Results

2.5.1 Total investment

First, the total investment behaviour to the public good between treatments is investigated. Total investment is highest in the First Follower treatment with 13.14 tokens invested by the group on average and lowest in the Sequential treatment with 8.14 tokens invested by the group; this is a difference of 38% across all periods. The other treatments, Two Leader and Leader, had values 11.13 and 8.65 tokens invested respectively. The difference in total investment between the First Follower and Two Leader treatments is not significant ($p = 0.18$, Mann-Whitney with the group as the unit of observation). Neither is the difference between the Leader and Sequential treatments ($p = 0.81$, Mann-Whitney).

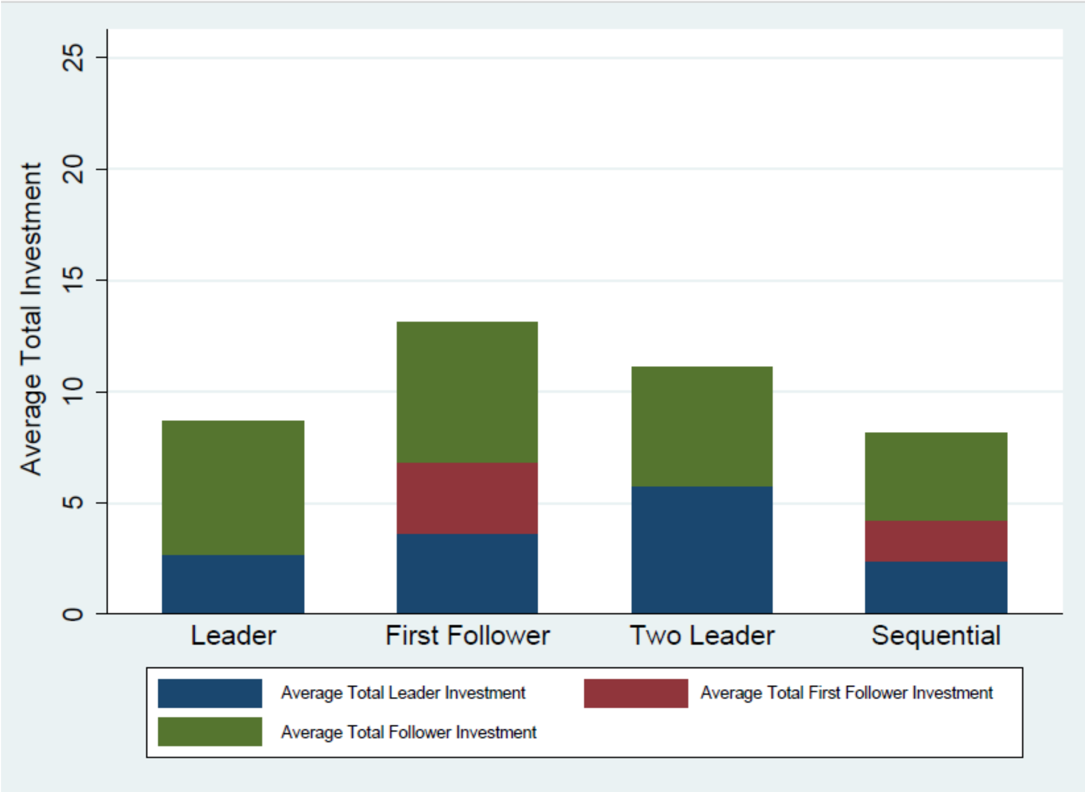

Figure 2.2 Average Total Investment split by role of Investor

Figure 2.2 shows average total investment to the public project across the various treatments, split by the role of the investor (either leader, first follower or follower[16]). Comparing Figure 2.2 to hypotheses 3 and 4 and Table 2.2 the stand-out feature is the relatively low investment in the Leader treatment. While investment in the First Follower, Two Leader and Sequential treatments are broadly consistent with the predictions in Table 2.2, that in the Leader treatment is not.

[16] Where a follower is defined as individuals who invest in investment stage 2 in the Leader and Two Leader games, and those who invest in investment stage 3 or later in the First Follower and Sequential games. The first follower is an individual who invests in investment stage 2 during either the First Follower or Sequential treatments.

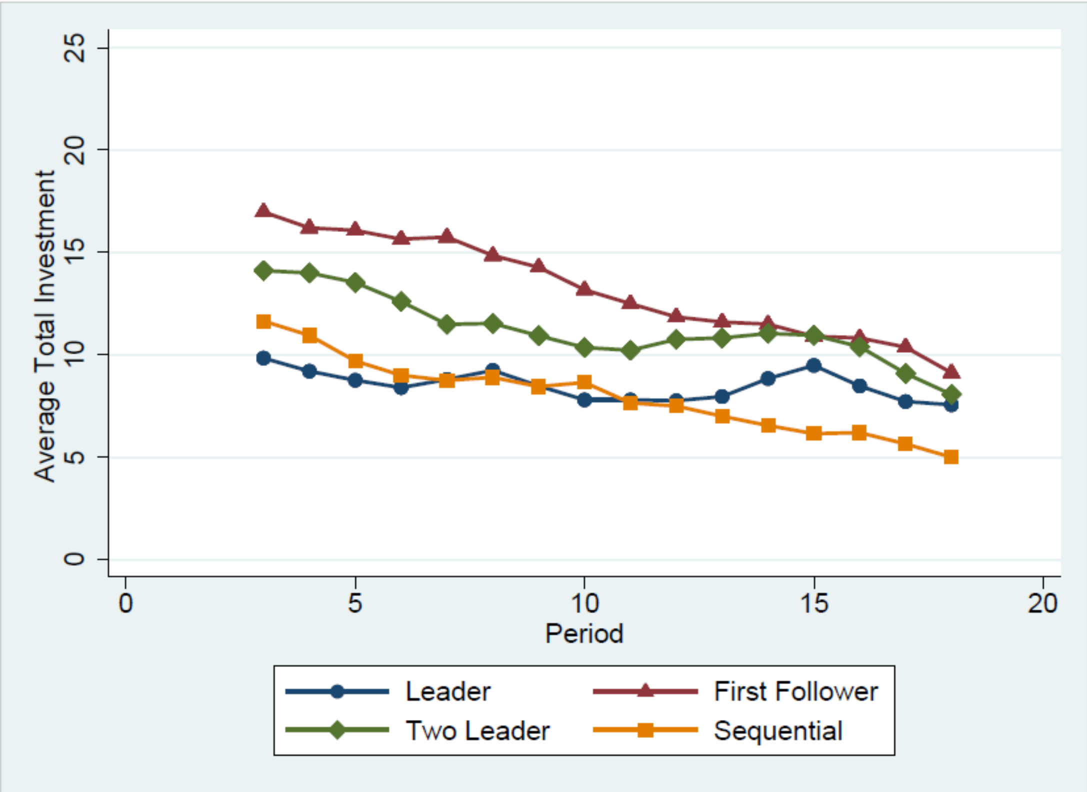

Figure 2.3 Total Investment (moving average across five periods)

Figure 2.3 shows the total investment by the group to the public project averaged over five periods. As the session progresses, the total investment declines which is consistent with the investment behaviour observed in previous linear public good experiments (Ledyard 1995). During the first half of the experiment, there is a distinct gap between the total investment of the First Follower and Two Leader treatments compared to the other two treatments. Recall from the introduction that a lack of investment in the Leader game is intriguing given the prior evidence that exogenous leadership does not lead to the increases in investment one might expect. If the results of the average group investment from the First Follower and Two Leader are combined and compared against the Leader and Sequential groups combined there is a 10% significance (p=0.08, Mann-Whitney). Therefore, this finding suggests that other types of leadership structure (namely First Follower and Two Leader) may work better. To explore this in more detail, leader and follower behaviour is examined in turn.

2.5.2 Leader behaviour

As expected from Hypothesis 1 the leader investment is higher in the First Follower than the Two Leader treatment (p = 0.04, Mann-Whitney).[17] Leader investment in the Leader treatment is not as great, however, as predicted. This clearly may invest to the lower than expected total investment. Like the observed levels of total investment, the First Follower treatment leads to the highest average leader investment with 3.66 tokens, then the Two Leader treatment with 2.89, then the Leader treatment with 2.71 and finally the Sequential treatment is the lowest with 2.40, considering all periods.

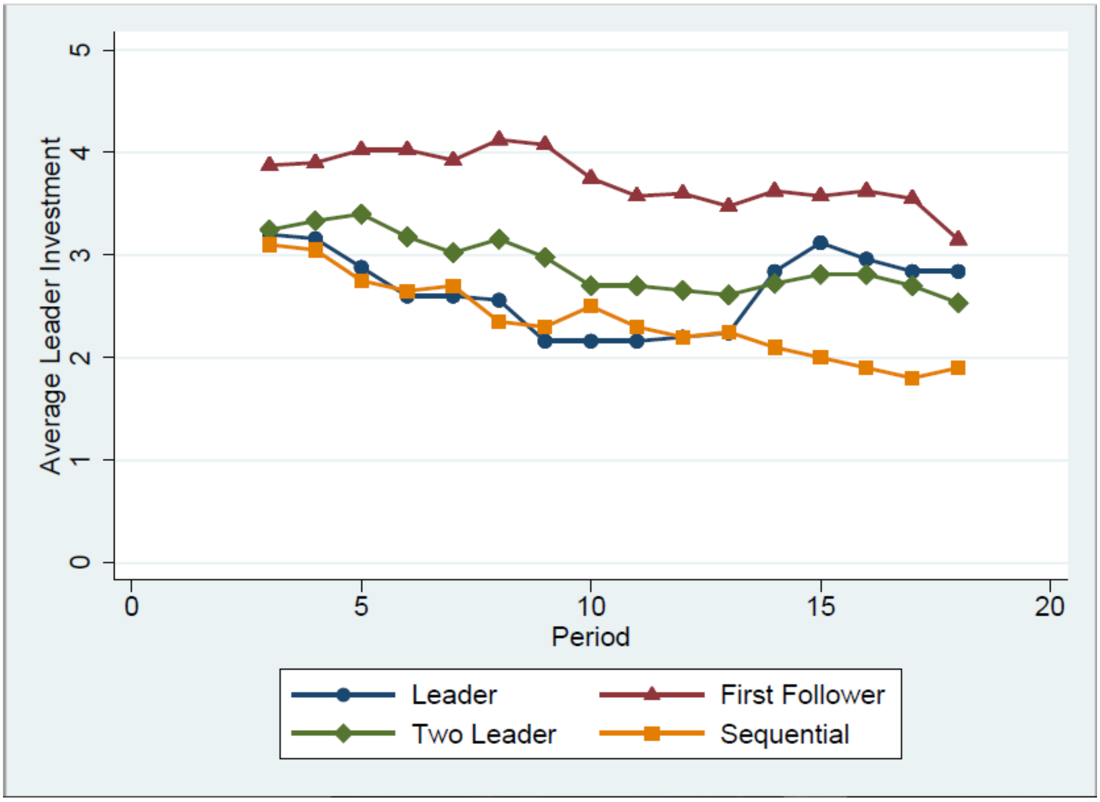

Figure 2.4 Average Leader Investment (moving average across five periods)

Figure 2.4 plots the moving average of leader investment (averaged across five periods). The average leader investment in the first follower treatment is consistently higher than the other treatments across the entire

[17] The average leader investment is also significantly more in the First Follower treatment compared to the Sequential treatment at the 10% level (Mann-Whitney, p=0.09) but not the Leader treatment (Mann-Whitney, p=0.24).

session. Notice that the average leader investment falls less over the course of the experiment than the overall total investment shown in Figure 2.3.

Table 2.3 Leader Investment Distributions

Investment	Leader	First Follower	Two Leader	Sequential
0	37.00 (37)	11.25 (18)	23.06 (83)	35.00 (28)
1	5.00 (5)	4.38 (7)	3.33 (12)	2.50 (2)
2	1.00 (1)	8.13 (13)	9.72 (35)	8.75 (7)
3	7.00 (7)	11.88 (19)	18.33 (66)	16.25 (13)
4	7.00 (7)	12.50 (20)	16.94 (61)	16.25 (13)
5	43.00 (43)	51.88 (83)	28.61 (103)	21.25 (17)

Note: Numbers in parentheses represent the number of occurrences and numbers outside are percentages.

Table 2.3 details the distribution of leader investment by treatment. Recall that the model predicts leader investments of either 0 or 5. This is largely confirmed with 0 and 5 being the most common choices in all four treatments. Even so, it is noticeable that the Leader treatment sees a more extreme distribution with 80% of choices being 0 or 5. This compares to only 63% in the First Follower treatment and 51% in the Two Leader treatment. The split between 0 and 5 token investments observed in the Leader treatment is what might be expected if there is no strategic leadership. In the First Follower treatment, there is evidence for strategic leadership with 76% of leader investments being 3 or above (which is significantly higher than any other treatment (compared to Leader treatment proportions test, p=0.01, Two Leader p=0.01 and Sequential p=0.00).

It was previously indicated that one benefit of the Two Leader is that it reduces the chance that both early movers will invest zero. Both leaders investing zero in the Two Leader treatment occurred 14 times. This is higher than the 10 times both the leader and first follower invested zero in the First Follower treatment, but lower than the 23 occurrences of both the leader and first follower investing zero in the Sequential treatment. The lower frequency of the two early movers investing 0 could be due to the stronger incentive for the leader to invest a positive amount in the First Follower game.

2.5.3 Follower behaviour

In looking at follower behaviour, one needs to be careful that like is compared with like given that treatments differ in the number of followers and the time at which they move. It is useful, however, to begin with a broad-brush measure of observed reciprocity. For each instance in which a participant does not move first, their investment x_i is considered as well as the average investment of those before them, $\bar{x}(i)$. A simple measure of reciprocity is $x_i/\bar{x}(i)$. Clearly this can only be applied where $\bar{x}(i) > 0$. The average reciprocity observed in the four treatments was 0.52, 0.61, 0.62 and 0.59 in the Leader, First Follower, Two Leader and Sequential treatments, respectively. These differences are not significantly different (p > 0.1, proportions test). Note that the observed reciprocity is in line with a p value of around 0.6. This point is expanded upon below.

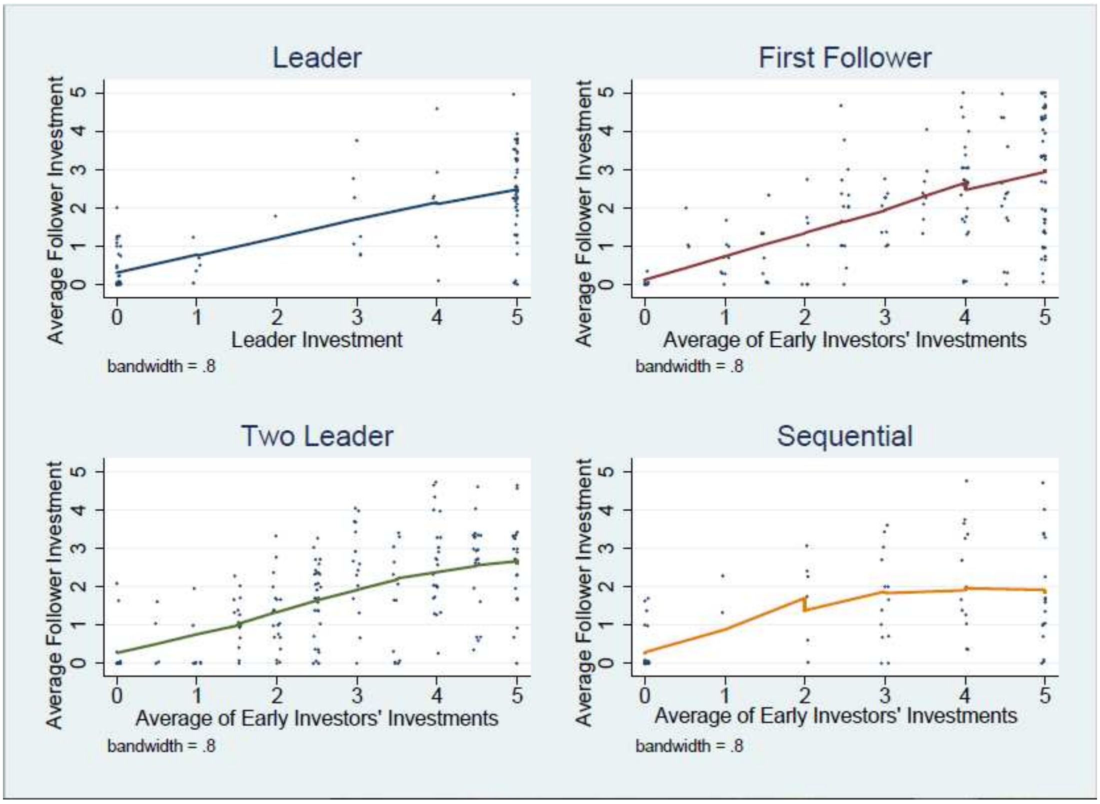

Figure 2.5 Average Conditional Follower Investment by treatment

Figure 2.5 depicts average investment as a function of previous investments. The broad measure of reciprocity discussed above suggests that follower behaviour was similar across treatments. To reinforce this finding, some specific comparisons are explored in detail. First, behaviour in investment stage 3 of the First Follower treatment is compared with that of investment stage 2 in the Two Leader treatment. Note that this is a like-for-like comparison because in both treatments two participants have invested and three are left to invest. For comparison, data from investment stage 2 from the Leader treatment and investment stages 3 to 5 in the Sequential treatment are also included in Figure 2.5.[18] There is a positive relationship between average follower investment and average investment made earlier in the sequence. This relationship is indicative of conditional cooperation and is found in all treatments. Note how the level of reciprocity is imperfect which is similar to previous observations (Figuières, Masclet and Willinger 2012; Fischbacher, Gächter and Fehr 2001).

Consider next the behaviour in the investment stage 2 of the First Follower and Sequential treatments; this is a like-for-like comparison because in both treatments there has been one previous investment and three will follow. Taking the average across all groups within a treatment, the first follower reciprocates 83% of the leader investment in the First Follower treatment and 78% in the Sequential treatment. As would be predicted, this difference is not significant (p=0.17, Mann-Whitney). A figure around 80% is, however, notably higher than the figure of 60% obtained for other followers, suggesting that first followers behave strategically to some extent. They also set the standard for positive reciprocation within the group.

[18] These are not a like-for-like comparisons because in the Leader game only one participant has invested and four are left to invest, while in the Sequential game there are three left to invest but they will invest in sequence.

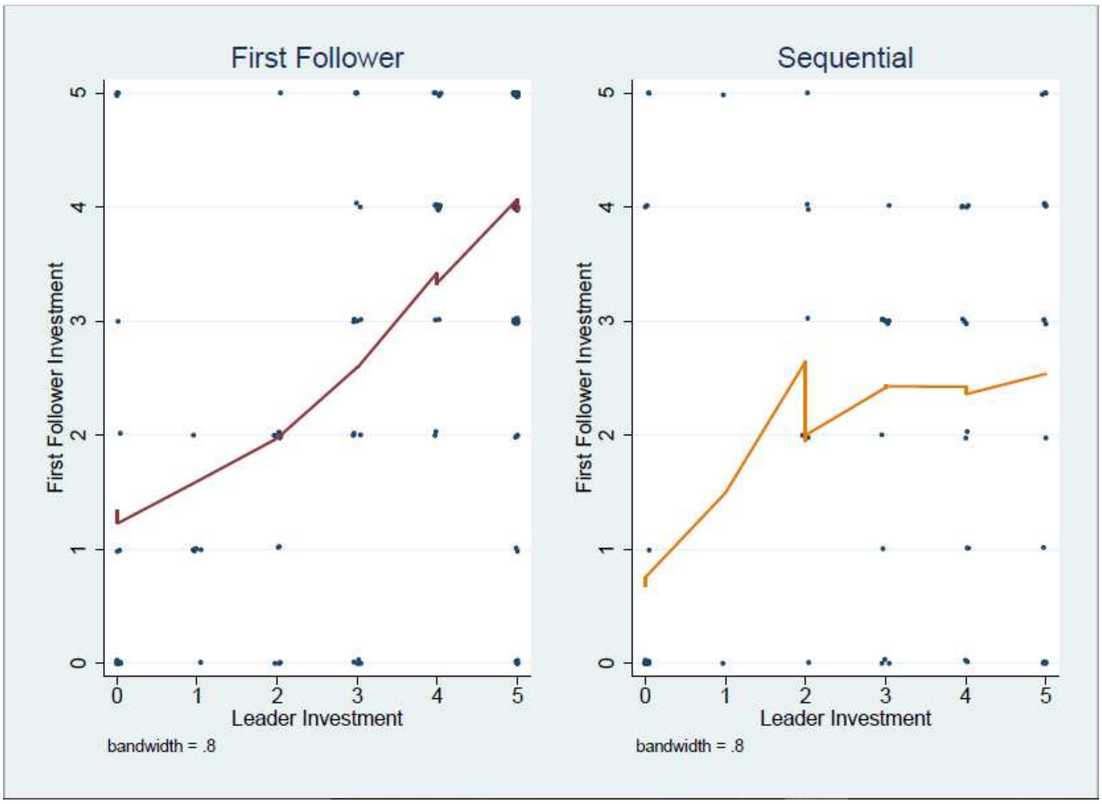

Figure 2.6 Average First Follower Investment conditional on Leader investment

Figure 2.6 illustrates the first follower investment conditional on the leader investment. In the First Follower treatment, a clear positive relationship is observed, and these first followers reciprocate more than later followers as seen in Figure 2.5. In the Sequential treatment, this relationship is less pronounced; their behaviour is similar to later followers as shown in Figure 2.5.

2.5.4 Leadership and fairness

Why was total investment lower in the Leader game than expected? Followers, as expected, reciprocated earlier investments. Moreover, follower behaviour was consistent across treatments. It is, therefore, to leaders that one must look for an explanation.

As already discussed the evidence suggests less (if any) strategic leadership in the Leader game than might have been expected. Therefore it is necessary to clarify that there was the potential for strategic leadership. Observed follower reciprocity would suggest a p value above 0.5. This is more than enough to imply that a leader would maximise their own material payoff by investing in the public project. For additional evidence the payoff of leaders who invested 0 is compared with those who invested 5. In the Leader treatment those investing 5 earned on average 7.6% *more* than those who invested 0. In the First Follower treatment, the gain was 4%. In the Two Leader treatment, as expected, those investing 5 earned on average less (11%) than those investing 0. The only anomaly was the Sequential treatment where one would expect those investing 5 to earn more but they earned less (6%).

There seem to be two basic possibilities why if strategic leadership made sense individuals did not exhibit it: (i) participants did not appreciate the possibility for strategic leadership, i.e. underestimated the extent of conditional cooperation, or (ii) were not willing to invest even if they did see the possibility for strategic leadership. There is undoubtedly evidence in the prior literature that would support point (i) (e.g. Potters, Sefton and Vesterlund 2007; Fischbacher and Gächter 2010; Cartwright and Lovett 2014). There is, however, evidence of strategic leadership (and strategic first followership) in the other treatments. This suggests that point (ii) must also play some role.

Table 2.4 Average period payoff by role of Investor

Treatment	All group members	Leaders	First Followers	Followers
Leader	33.65	5.75		6.98
First Follower	38.14	6.60	7.09	8.15
Two Leader	36.13	6.57		7.66
Sequential	33.14	5.86	6.43	6.95

One possibility is issues of fairness. Table 2.4 details average per period payoff for each role respectively across each treatment. For all treatments, the followers earn significantly more than leaders (all $p < 0.05$, Mann-Whitney). This result is consistent with the 'leader's curse' (Gächter and Renner 2014). This curse also extends to first followers with followers earning significantly more on average than the first followers in both the First Follower and Sequential treatments ($p < 0.01$). First followers in the First Follower treatment earn significantly more than the leaders (p = 0.02) but not for the Sequential treatment (p = 0.11).

The leader's curse may be a disincentive for a leader to set a good example. More specifically, a leader who invests 0 is guaranteed to earn at least as much as every other player. By investing their entire endowment a leader may increase his payoff but may also now find himself at a disadvantage relative to others. Standard theories of fairness, whether it be inequality aversion (Fehr and Schmidt 1999) or reciprocity, suggest this may not appeal. In the other three organisational structures, leaders do not face such a stark choice. In each structure, there is at least one other player who can share some of this responsibility and more fair from the perspective of the leader.

2.6 Discussion and Conclusion

This chapter aimed to uncover the impact of introducing a first follower on group behaviour within the context of a linear public good game. Four treatments were implemented: Leader, First Follower, Two Leader and Sequential, two of which (First Follower and Two Leader) to my knowledge have not been implemented previously. Following Cartwright and Patel (2010) it is hypothesised that a leader would have an incentive to invest their endowment in all treatments apart from in the Two Leader treatment, assuming followers invest half of the prior investment. The level of reciprocity followers exhibit in the experiment (0.52 to 0.62) is higher than assumed. From the observed levels of follower reciprocity, one should observe the leaders in the Leader, First Follower and Sequential treatments investing their endowment more often than during the Two Leader treatment. Hypothesis one is based of follower reciprocity of $p = 0.5$ which indicates leaders in the Leader and First Follower treatments would invest their endowment more frequently than the other treatments, this is more consistent with the experimental results than the actual observed levels of reciprocity.

Overall, the presence of a first follower appears to have had a larger impact on leader behaviour than subsequent follower behaviour. It seems that the exogenous existence of the first follower motivates leaders to set a better example for the rest of the group. The overall reciprocity of the first follower in the First Follower treatment is not significantly different to that observed in the Sequential treatment. However, those in the first follower role reciprocate proportionally more than those in a follower role: $p = 0.83$ for First Follower treatment and $p = 0.78$ for Sequential treatment. This result is consistent with the 'vanishing' leadership effect (Figuières, Masclet and Willinger 2012), where later investors are less influenced by the leader's investment.

Like previous findings, leaders set a good example at the expense of their own payoff. Leaders in all treatments earn significantly less than followers. Where applicable the first followers tend to earn somewhere in between that of leaders and followers. Consistent with the theoretical predictions in Section 2.3, leaders in the Leader and First Follower treatments are found to earn more on average when they invest their endowment compared to investing zero (as shown in Table A2.4 in the Appendix A2.3). The theory, however, does not explain why an investment of either zero or five tokens leads to the highest earnings on average when comparing all possible levels of investment. Evidently, there is more to explore in understanding how followers react to intermediate levels of investment as opposed to a dominant strategy (investing zero tokens) or socially efficient strategy (investing their endowment).

One of the main disparities in the results compared to the predictions is due to the surprisingly high levels of efficiency in the Two Leader treatment. When ranking treatments from the experimental data, the Two Leader treatment tended to have the second highest levels of total investment and efficiency. The followers may believe two previous investments are more credible than one prior investment, as suggested by Komai and Stegeman (2010) or at least two people are required to create a social norm. It would be interesting to uncover whether there is an ideal leader to follower ratio, for example, whether two leaders have the same influence in a ten-member group as one leader has to a group with five members. Perhaps more individuals would be required to move early to create a social norm. The question whether shared leadership would emerge organically is in part covered in Chapter 3.

To my knowledge, this is the first study to consider specifically the impact of first followership experimentally. It would be of interest to extend this research to other scenarios to uncover whether the presence of a first follower is also present. Due to the experimental design, subjects investing later in the sequence do not view the leader's investment at the same time as the first follower. It would be interesting to uncover whether automatic updating of previous investments makes a significant difference. This adjustment would allow the followers more time to consider the previous investments and update beliefs about what the first follower should have invested in response to the leader. Endogenous timing of investment choices is included in Chapters 3 and 4.

The model also assumes that the utility gain is purely from gaining the highest number of tokens. This seems simplistic in reality and individuals may gain utility from alternate sources such as preference for being a leader. Arbak and Villeval (2013) found that male nominees for leadership who failed to gain leadership readjusted their investments significantly downward. This observation suggests that 'leadership' is viewed as a positive role by participants. It would be worthwhile to see whether the same individuals within a group would nominate themselves as the first follower compared to leaders. Extending the experiments to consider endogenous selection would give insight into this issue. Chapter 3 expands on this topic.

CHAPTER 3
WE CAN BE LEADERS

3.1 Introduction and Literature Review

Chapter 2 investigated whether exogenously imposing different investment sequences (Leader, First Follower, Two Leader and Sequential) significantly impacted total public good investment. An investment sequence specifies the number of investment stages within each period and the number of group members investing during each stage. Group members are informed of all investments occurring in earlier stages but not those in the same stage or later stages. Chapter 2 introduced two new games to the experimental literature. The key new game was the First Follower game, which has three investment stages with one person investing in the first stage, the leader, another in the second stage, the first follower, and the rest of the group in the third stage, who are referred to as followers. The second new game was the Two Leader game which has two investment stages, with two individuals, the leaders, investing in the first stage, and the rest of the group in the second stage, the followers.

In Chapter 2, it was found that total investment is highest during the First Follower game. This finding led to the design of the experiment reported in this chapter. The experiment is designed so that individuals can choose *when* they want to invest. Therefore timing of investments is endogenous. To capture the distinction between the Two Leader, Leader and First Follower games, two treatments are implemented in this chapter, one with two investment stages (referred to as two-day) and one with three investment stages (referred to as three-day). In the two investment stage treatment, individuals can choose to lead or follow. In the three investment stage treatment, individuals can lead, be a first follower[19] or follower.

The first research question for this chapter is, do three investment stages lead to higher public good investment than two investment stages? Following the definition used in Chapter 2 and the prior experimental literature, a leader is defined as anyone who invests during investment stage one and hence has no

[19] In the three investment stage treatment, a first follower is defined as any group member investing during the second stage and is not necessarily unique.

knowledge of other investments before making his or her investment decision. The majority of previous studies, including Chapter 2, pre-define or restrict the number of individuals investing during each stage. In this experiment, the number of individuals investing in each stage is neither pre-determined or restricted hence the experiment can help inform the answer to the second research question: how many individuals choose to lead if the number of leaders is unrestricted? Extending this research question further, does the number of investment stages impact on the number of leaders and whether there are any key personal traits which determine an individual's willingness to lead.

The institutional design involved in implementing these treatments is more laissez-faire than treatments from Chapter 2. To implement either treatment from this chapter an institution need only to specify the number of investment stages, and individuals self-select which day to invest during. Whereas, applying any of the treatments considered in Chapter 2 would involve the institution specifying not only the number of stage but also the number of group members investing during each day, with an additional need to inform each group member which day to invest in. If there is not a significant decrease in total public good investment in these endogenous treatments, then one would imagine these designs are more favourable to impose.

Previous endogenous literature tested whether there is an impact on public good investment from increasing from one to two investment stages. However, the number of individuals investing during the first investment stage, leaders, is usually restricted to one. In both Arbak and Villeval (2013) and Centorrino and Concina (2013) multiple group members can nominate for leadership, yet restrict actual leadership at most one group member. When comparing endogenous leadership to exogenous leadership, the majority of studies have been in favour of the former (Potters, Sefton and Vesterlund 2007; Rivas and Sutter 2011; Centorrino and Concina 2013; Haigner and Wakolbinger 2010). Typically, in endogenous leadership experiments, if no one chooses to lead the game will revert to the simultaneous game (Arbak and Villeval 2013; Rivas and Sutter 2011; Centorrino and Concina 2013).

The closest previous experimental design to the design reported in this chapter is Vyrastekova and Garikipati (2008). In Vyrastekova and Garikipati (2008) all group members could split their investment across two investment stages. Therefore, leadership was unrestricted, since any group member could influence others to invest, by investing some amount during the first stage. This was compared to fully simultaneous treatment. They find that the dynamic game, with two investment stages increases investment but not overall efficiency. The key difference in this study is that participants can only invest on one day during the entire investment period therefore they must choose to lead or follow whereas in Vyrastekova and Garikipati (2008) participants can exhibit both leadership and followership within a period.

As highlighted in Chapter 1, crowdfunding[20] and online charitable donations are examples of public goods. Kickstarter, a well-known crowdfunding platform allows project creators to set the timeframe for funding between 1-60 days (Kickstarter, 2016b). Kickstarter specifically recommends a timeframe less than 30 days to create a sense of urgency for the project. On the other hand, the online charitable fundraising platform VirginMoneyGiving allows individual fundraisers to set up pages months in advance of the event; this is particularly notable for London Marathon fundraising. Using data from Kickstarter, Kuppuswamy and Bayus (2015) find that most investors invest only once during a fundraising period i.e., they are one-time backers. Their result indicates that this experimental design is more representative of real crowdfunding behaviour than the split investment design of Vyrastekova and Garikipati (2008). Kuppuswamy and Bayus (2015) also find investments are more likely in the first or last week of the fundraising period and projects which successfully reach their target level tend to have shorter fundraising periods.

A ubiquitous human trait is procrastination; as such one would suspect a large proportion of individuals will wait until the last investment stage to make their investment. Presence of procrastination has been previously examined in relation to charitable giving. Knowles, Servátka and Sullivan (2016) find a shorter

[20] Note that real world crowdfunding also has an element of asymmetric information regarding quality of the good. Discussion of this is mentioned in Chapter 4.

deadline for completing a survey leads to higher donations and most investment takes place on day two during the fundraising period. On the other hand, Damgaard and Gravert (2014) and Knowles and Servátka (2015) find no significant impact of deadline length on charitable behaviour. A result of interest is the now or never effect found in Damgaard and Gravert (2014) whereby individuals will invest early or not at all. A related finding is that free riders tend to take longer making their investment decisions (Nielsen, Tyran and Wengström 2014), which suggests free riders are less likely to be leaders or first followers.

In most endogenous leadership studies, the existence of leadership is explicitly highlighted in the experimental design. For example, there might be a pre-game leadership selection stage (Figuières, Masclet and Willinger 2012; Centorrino and Concina 2013). Contrastingly, in this experiment because any group member can 'lead', the leadership is not emphasised as part of the of the experimental instructions (the three-day treatment instructions are shown in Appendix A3.4). Consequently, leadership exhibited by participants in this experiment could be argued to be more alike to 'taking the initiative' (Bruttel and Fischbacher 2013). Bruttel and Fischbacher (2013) indicate in their game, that leadership emerges spontaneously as the option to take the initiative is not obvious. In both, taking the initiative works by individuals acting before other group members and anyone is able to take this initiative. This is similar to the options individuals have in this experiment. However, the game is rather different, Bruttel and Fischbacher (2013) investigate a 8-player game where group members pick a number between 2 and 100 and the person with the lowest number receives that number as a payoff and others receive nothing. Although not the stereotypical linear public good game, there is familiar conflict for the individual between choosing what is best for oneself as opposed to what is best for the group. Individuals selecting a high number are defined to be 'taking the initiative' as they are trying to coordinate the group to a higher level of group efficiency. This study is similar in the sense that anyone can 'take the initiative' by investing during the first investment stage in the hope of pushing the group towards the socially efficient outcome.

The rest of the chapter is structured as follows: Section 3.2 details the specifics of the two experimental treatments implemented, Section 3.3 lists the hypotheses expected from the treatments, Section 3.4 states the experimental design, Section 3.5 illustrates the key results from running the two treatments, and finally Section 3.6 discusses these results in more detail as well as giving concluding remarks.

3.2 Description of Treatments

Both treatments have the same underlying game as the treatments studied in Chapter 2, the linear public good game, and profit is determined by the same formula for all players. At the beginning of each period, each group member i is endowed with E tokens. Every group member must independently decide how many tokens to invest in the public good. Group member i's investment is denoted x_i, and once all n group members have made their investments the total investment, X, is multiplied by some factor M. The profit from the public good is split equally among all group members, regardless of their level of investment. Therefore, the marginal return for each token invested to the public good is $m = M/n$.

The payoff calculation for each group member is:

$$u_i(x_1, \dots, x_n) = E - x_i + mX \quad (3.1)$$

Each group member must also independently decide which investment stage to invest during. In any investment stage $t > 1$, group members are informed of who invested in prior stages $1\ to\ t-1$ and the prior investors' respective investments. All group members were randomly assigned an identifier e.g., group member 1, and these were randomly reassigned at the start of each new period, hence identities are anonymous. Investments made during the same investment stage are made simultaneously.

The **two-day treatment** has two investment stages, $t = 1,2$. At the beginning of the game, each group member is asked whether they would like to invest during $t = 1$. If an individual agrees, they make their investment during $t = 1$. If an individual does not invest in $t = 1$, they automatically make their investment during $t = 2$. Group members investing during $t = 2$ are informed of all investments that occurred in $t = 1$.

In Chapter 2, the Leader and Two Leader treatments both had two investment stages. The Leader game is equivalent to one person investing on day one and everyone else investing on day two in the two-day treatment. The Two Leader game is equivalent to two people investing on day one and the remaining three group members investing on day two in the two-day treatment. Consequently, within the two-day treatment individuals can either lead by investing during $t = 1$ or follow by investing during $t = 2$.

The **three-day treatment** has three investment stages, $t = 1, 2, 3$. At the beginning of the game, each group member is asked whether they would like to invest during $t = 1$. If an individual agrees, they make their investment decision during $t = 1$. Group members who did not invest during $t = 1$ are informed of all investments that occurred in $t = 1$. The remaining group members are then asked whether they would like to invest during $t = 2$. If an individual agrees, they make their investment decision during $t = 2$. If an individual has not invested in $t = 1$ or $t = 2$, they will automatically make their investment during $t = 3$. Group members investing during $t = 3$ are informed of all investments that occurred in $t = 1$ and $t = 2$ specifying when those investments occurred.

The First Follower game was the only treatment considered in the previous chapter which had three investment stages. This is equivalent to one person investing on day one, another person investing on day two and the rest of the group investing on day three during the three-day treatment. Therefore, in the three-day treatment individuals can choose to lead by investing during $t = 1$, be a first follower by investing during $t = 2$ or follow by investing during $t = 3$.

In both treatments, once all investments have occurred, all group members are informed of all investments along with the random identifiers and the day each investment was made. They are also notified of the total investment by their group and their payoff from the period. Additionally, if all investments are made in earlier stages, then the later stages will be skipped. For instance, during the three-day treatment if two people invest during $t = 1$, and three people invest during $t = 2$, then the third investment stage is skipped and the group goes to the feedback screen.

3.3 Hypotheses

A strategy is more complex in the n-player endogenous setting because an individual chooses when to invest as well as how much to invest. Standard arguments (see Chapter 2) would still suggest, however, that individuals should invest 0 to the public good, considering that the marginal per capita return (MPCR) for the public good m is less than 1.

Numerous experimental studies on sequential public good games have found that leaders invest more than followers (Arbak and Villeval 2013; Gächter and Renner 2014; Eckel, Fatas and Wilson 2010; Levati, Sutter and van der Heijden 2007) which applies to both exogenous and endogenous leadership. Due to their higher investment, leaders tend to have a lower payoff from the experiment. In this experiment, leaders have no extra powers such as punishment or exclusion (Eckel, Fatas and Wilson 2010; Levati, Sutter and van der Heijden 2007; Güth et al. 2007) which have previously been found to enhance public good provision. Consequently, in the games considered in this chapter, there is no direct benefit for individuals to invest first.

So why would an individual be willing to lead? One explanation stems from the reciprocal behaviour of followers. Positive reciprocation (also referred to as conditional co-operation) has been observed in numerous linear public good experiments (e.g. Fischbacher, Gächter and Fehr 2001; Cartwright and Lovett 2014) and charitable donation studies (Frey and Meier 2004; Shang and Croson 2009; Alpizar, Carlsson and Johansson-Stenman 2008). Specifically, in this experimental design, reciprocity is present if the investment of later investors is increasing in the average investment of the early movers. In a fully sequential game, Cartwright and Patel (2010) theorise that given sufficient reciprocity of subsequent investors an individual who is strategic[21] will have an incentive to invest a positive amount early in the sequence. The incentive to invest a positive amount to the public good increases the earlier an individual invests in the sequence, the greater rate of conditional cooperation and the greater the number of conditional cooperators left to invest. Although their theory cannot be directly applied to these games due to the uncertainty of the number of leaders, one can implement the essence of the theory, which is that those who invest during investment stage one will invest more than those that delay investment. To expand this individuals in this experiment are able to choose when they invest and investing on day one should maximise the influence of their investment. Hence more generous individuals individuals would self select into earlier investment stage to obtain the highest return for their generosity. This leads to the first hypothesis:

Hypothesis 1: Individuals self selecting themselves to invest during an earlier investment stage will invest proportionately more than individuals who choose to invest in later investment stages.

When the timing of investments is exogenous, as in Chapter 2, individuals clearly have no choice of whether to lead or follow. However, in Chapter 2 it was hypothesised and observed that a strategic leader and first follower may have an incentive to invest a positive amount in order to increase the investment of followers. When timing is endogenous, however, an individual can choose to lead or not lead, and it may be in an individual's interest to simply wait and see what others do (Bliss and Nalebuff 1984). So, does anyone choose to lead? Arbak and Villeval (2013) any group member to nominate themselves as a leader and often, more than one group member would nominate for leadership. However, only 25% of all participants were willing to serve as leader. Cappelen et al. (2015) in their no compensation treatment found that only 21% of individuals are willing to lead. Although there are multiple leadership nominations for some groups, this is not true for all groups, in Arbak and Villeval (2013) only 57% of groups had a

[21] A strategist is an individual whose behaviour is based on strategically maximising his own payoff (Cartwright and Patel 2010).

leader. After controlling for the group size there is equivalently just below one leader per group in Arbak and Villeval (2013) and Cappelen et al. (2015) which had 3-member and 4-member sized groups respectively. These results bring me to the next hypothesis:

Hypothesis 2: One group member will choose to invest on day one.

A primary finding from Chapter 2 was that the implementation of a first follower into the investment sequence led to an increase in the level of total investment. As stated in Chapter 2, first followers also have a strategic incentive to invest, similar to leaders. They might also use their investment decision to reinforce the leader's action, with the potential creation of a social norm (Sivers 2010). In the three-day treatment, group members investing on day two can both reciprocate the leaders' investments as well as influence later investors. Therefore, they are in essence equivalent to first followers in the First Follower game.

During the three-day treatment, those investing on the last day, the third day, will view investments occurring on day one twice. However, in the two-day treatment individuals investing on the final day, the second day, will only see the leaders' investments once. Regardless of the investments on the second day, the extra viewing of the leader investment may aid in reinforcing them as a social norm. Considering hypothesis 1, one would expect to observe the leaders attempting to induce a social norm towards the socially efficient point rather than the Nash equilibrium. One caveat is that one would only suspect this creation of social norm to be effective at raising investment if it is reinforced by the first followers. On the other hand because the leaders' investments are further in the past they maybe a less strong signal to those investing on the last day. Additionally, from Figuieres, Masclet and Willinger (2012) that one would expect imperfect reciprocity and vanishing leadership to be present. Therefore the higher the number of investment stages the more imperfect reciprocation to exist reducing the total investment.

Following the observation from Chapter 2 and the potential for increased strategic incentives for early movers to invest more in the three-day treatment leads me to the next hypothesis:

Hypothesis 3: The two-day treatment will have a higher level of total investment to the public good than the three-day treatment.

The definition of a leader used here, which follows previous experimental studies, is anyone who chooses invests during the first investment stage i.e. on day one. In these treatments, group members self-select whether to invest on day so they can arguably be defined as endogenous leaders. In Chapter 2, individuals are exogenously selected to invest during the first investment stage and hence classified as exogenous leaders. Therefore, a comparison of the investment behaviour of leaders in these treatments to leaders in the treatments from Chapter 2 is a comparison between endogenous and exogenous leadership. There is much debate in the literature to which type of leadership is more effective, and this analysis adds further evidence to that discussion. Hitherto, the majority of studies have found that endogenous leadership increases total investment more than exogenous leadership due to the increased incentives for endogenous leaders to invest (see also Chapter 1) (Rivas and Sutter 2011; Centorrino and Concina 2013; Haigner and Wakolbinger 2010; Dannenberg 2015). Therefore, the last hypothesis is as follows:

Hypothesis 4: Endogenous Leaders will invest more than exogenous leaders.

3.4 Experimental Design

The experiments were conducted at the University of Kent in March-April 2015 using the z-tree program (Fischbacher 2007). A total of 115 subjects participated, consisting mainly of undergraduate and postgraduate students from the University. Experimental sessions took around 50 minutes, and participants earned on average £6.73.

Table 3.1 Summary of Sessions

Session	Number of Participants	Number of Periods	Treatment
1	20	20	Two Day
2	20	15	Three Day
3	20	20	Two Day
4	20	20	Three Day
5	20	20	Three Day
6	15	20	Two Day

Table 3.1 summarises the sessions implemented. At the beginning of the session, participants received instructions for their treatment only. The participants were randomly allocated into groups of five at the start of period one and remained constant throughout the session. When comparing at the group level, there are 11 independent observations for the two-day treatment versus 12 independent observations for the three-day treatment. Unfortunately, during session 2, participants were slow at making decisions and thus all 20 periods could not be completed within the time limit. These individuals expected to play all 20 periods, so the results from this session are treated the same as the other sessions. After the experiment, a questionnaire (shown in Appendix A3.2) eliciting social value orientation (Van Lange 1999), risk preferences (Holt and Laury 2002), trust (Berg, Dickhaut and McCabe 1995) and patience (Bruttel and Fischbacher 2013; Dudley 2003) was conducted. The experimental parameters are set to the following; $E = 5, M = 2, n = 5$ and hence $m = 0.4$. These are the same parameters used in Chapter 2. Experimental instructions for the three-day treatment are given in Appendix A3.4.

3.5 Results

This section details the results from running the two treatments, two-day and three-day, experimentally and uncovering whether the hypotheses stated in Section 3.3 are consistent with the data.

3.5.1 Total Investment

First, consider total investment by the group to the public good. Recall, the Nash equilibrium for both treatments is all group members investing 0, and hence the total investment will be 0. The socially efficient level is where all group members invest their endowment and hence total investment will be 25 tokens. Total investment in the three-day treatment is significantly higher than that in the two-day treatment, using the group as the unit of analysis (Mann-Whitney, p=0.09).

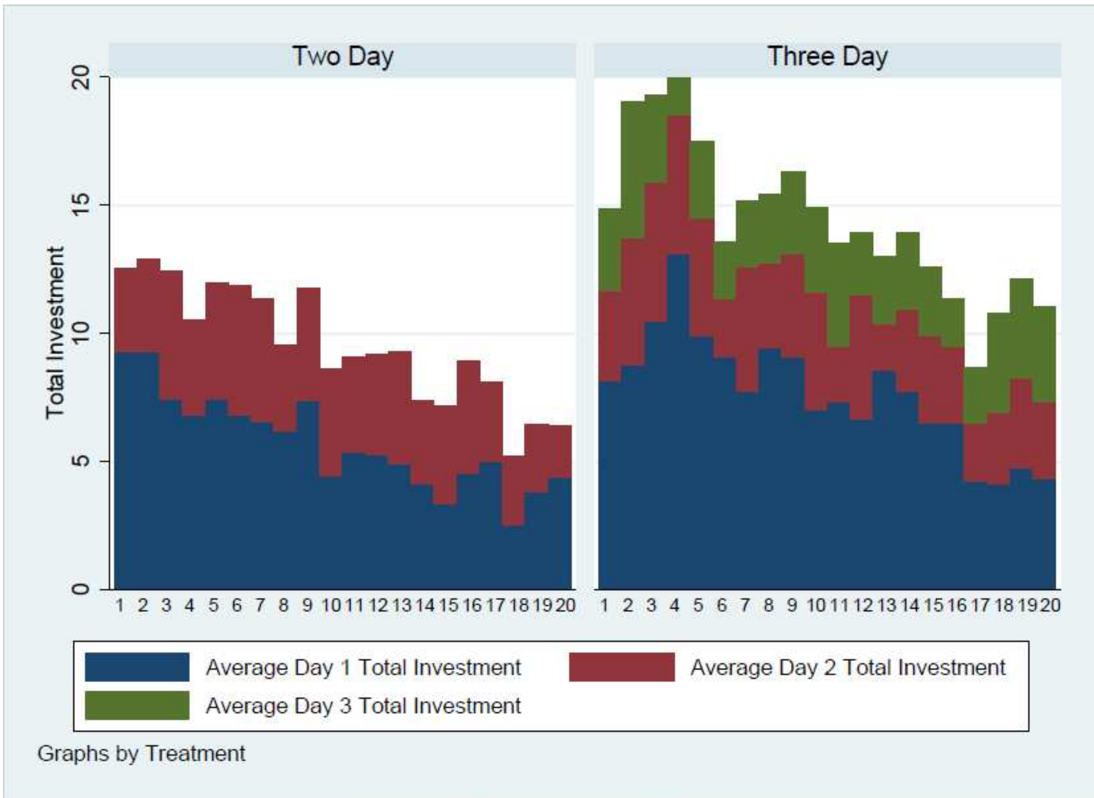

Figure 3.1 Average Total Investment by Day

Figure 3.1 plots the average total investment split by period and day and allows comparison between the two-day and three-day treatments. In both treatments, the total investment across all days falls over the course of the experiment; the drop is particularly prevalent for day 1.

Table 3.2 Average Total Investment by Day and Period

	Two-Day			Three-Day			
Period	Day 1	Day 2	All	Day 1	Day 2	Day 3	All
1	9.27	3.27	12.54	8.17	3.50	3.20	15.17
1-5	8.05	4.00	12.05	10.07	4.75	3.45	18.27
6-10	6.20	4.36	10.56	8.46	3.81	2.81	15.08
11-15	4.58	3.82	8.40	7.36	3.20	2.94	13.50
16-20	4.07	2.96	7.03	4.82	2.95	3.09	10.89
20	4.38	2.00	6.38	4.33	3.00	3.71	11.04

Table 3.2 shows the data from Figure 3.1 accumulated into groups of 5 periods as well as the first and last period. By the end of the experiment, the total investment made on day 1 is very similar for both treatments. The day 1 investment for both treatments drop significantly over the course of the experiment. On the other hand, the total investment levels on days 2 and 3 are relatively less variable. There is a larger difference between treatments when considering the accumulated investment from all days; notice that the last five periods of the three-day treatment has an average of 10.89 which is more than the average total investment of periods 6-10 in the two-day treatment.

Table 3.3 Random Effects Tobit regressions for Total Investment

		(1)	(2)	(3)
Total investment	Total investment last period	0.43	0.43	
		(8.59)**	(8.60)**	
	Number of Leaders	1.63	1.66	
		(8.31)**	(8.49)**	
	Treatment[22]	1.15		3.54
		(1.22)		(1.85)*
	Constant	0.66	2.31	5.34
		(0.43)	(1.60)**	(2.96)*
sigma_u	Constant	2.02	2.08	4.31
		(0.42)**	(0.47)**	(0.67)***
sigma_e	Constant	3.85	3.85	4.53
		(0.94)**	(0.16)**	(0.16)***
	Wald chi2 test	192.47***	178.78***	3.67*
Obs		417	417	440

Note: The upper limit is 25 tokens, and the lower limit was 0 tokens. There were 15 left censored observations and three right censored observations. Numbers in parentheses represent standard errors as Stata does not allow cluster robust standard errors with random effect Tobit models. *, ** and *** represents significance at the 10%, 5% and 1% significance levels respectively.

Table 3.3 shows the results from running a random effects Tobit regression with the total investment as the dependent variable. The two-day treatment is used as the base treatment. When the treatment and total investment last period are included as independent variables as shown in model 2, treatment is significant at the 5% level. However, if the number of leaders in that period is additionally included as shown in model 1, the treatment effect becomes insignificant. When treatment is included as the lone independent variable, model 3, it is significant at the 10% level. These results provide support against Hypothesis 3 albeit weak and show that extending the investment period by an extra day may increase overall investment.

[22] A regression with interaction variables, interacting the number of leaders and treatment was conducted but all interactions were found to be insignificant.

3.5.2 Leader Investment Behaviour

The data presented in Figure 3.1 and Table 3.3 is influenced by the number of individuals investing during each stage as well as how much each individual is investing. This section analyses differences in the average investment within treatments as well as between treatments.

Table 3.4 Average Individual Investment by Day of Investment and Treatment

Investment Day	Two Day	Three Day
1	2.78 (0.09)	3.10 (0.07)
2	1.20 (0.06)	2.85 (0.13)
3		1.32 (0.08)

Note: Numbers in parentheses are standard deviations.

Table 3.4 details the average individual investment by day and treatment. Congruent with previous results, leaders, those investing on day one, invest more than followers. Specifically, in these treatments leaders invest more than double the average invested on the last day in both treatments; this provides strong support for Hypothesis 1. The average day one investment is not significantly different between treatments (Mann-Whitney, $p=0.39$ with the group as the unit of observation). Neither is the average investment between the last possible day to invest, which is comparing day two in the two-day treatment with day three in the three-day treatment (Mann-Whitney, $p=0.46$ with the group as the unit of observation).

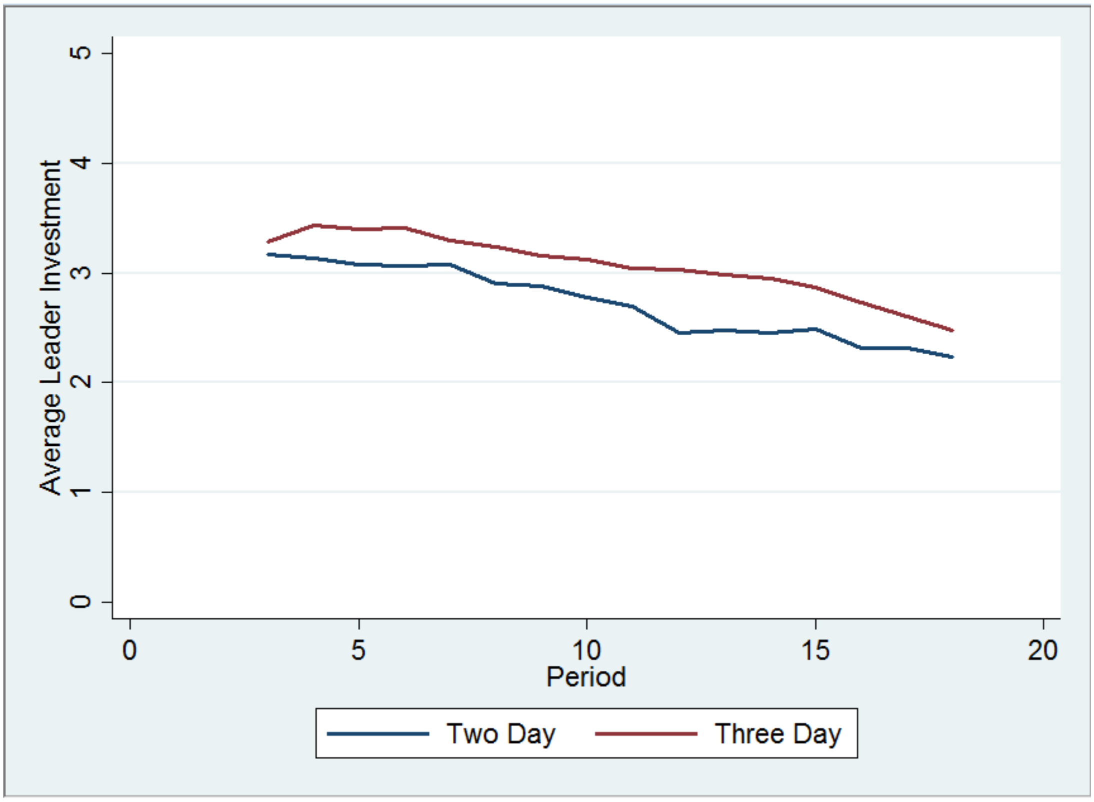

Figure 3.2 Average Leader Investment by Treatment (moving average across five periods)

Figure 3.2 plots a moving average leader investment over five periods. While leader investment is higher in the three-day treatment, it is not significantly so. The gap in leader investment between treatments does not change much over the course of the experiment. One interesting thing to note is how leader investment does not fall much over the 20 periods for either treatment; this is similar to the trend found in Chapter 2 (see Figure 2.3).

Table 3.5 Free Riding prevalence by Day of Investment and Treatment

Investment Day	Two Day	Three Day
1	19.08%	12.73%
2	51.60%	10.11%
3		43.82%

Table 3.5 shows the proportion of individuals who invest zero tokens split by day and treatment. Leaders free ride less frequently than those who choose to follow. Treating each group as a separate observation, the proportion of leaders

investing zero is not significantly different in the three-day treatment compared to the two-day treatment (Mann-Whitney, p=0.32).

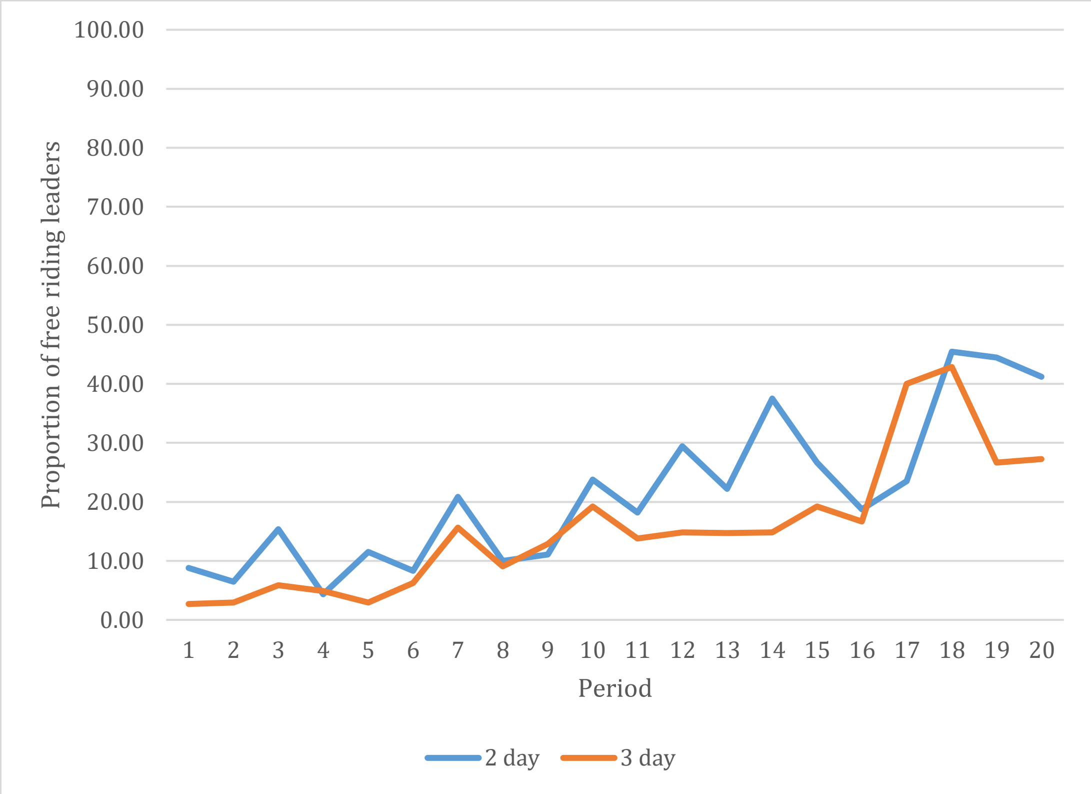

Figure 3.3 Proportion of Free Riding Leaders by Period

Extending this analysis, Figure 3.3 shows the proportion of leaders who invest zero during each period. Notably, as the experiment progresses, more leaders begin to free ride, which goes for both treatments.

3.5.3 Leadership Emergence

The key findings reported hitherto are that total investment is higher in the three-day treatment, and yet the average investment of leaders and followers is similar between treatments. This would suggest that differences in total investment are being driven by differences in the proportions of subjects who choose to lead and follow.

Table 3.6 Frequency of Investments by Day of Investment and Treatment

Frequency of Investments by Day	Two Day	Three Day
Day 1	37.64% (414)	50.00% (550)
Day 2	62.36% (686)	16.18% (178)
Day 3		33.82% (372)

Note: Numbers in parentheses denote the number of occurrences.

Table 3.6 summarises which day individuals chose to invest in, split by treatment and accumulates data from all 20 periods. In both treatments, a significant proportion of the group invests during the first day. It is equivalent to 2.5 leaders for the three-day and 1.84 leaders for the two-day treatment; this is higher than the one leader expected from hypothesis two. Crucially, in the three-day treatment a higher proportion of individuals investing during the first day is observed (Proportions test, $p<0.01$ treatment as a unit of observation). When coupled with the small proportion of individuals investing on day 2 during the three-day treatment, this also means there is a large drop in the proportion of individuals investing on day 3. Taking each group as a separate observation, there is a significant difference between treatments in the proportion of followers, those investing on the last day be (Mann-Whitney, $p<0.01$). These results are consistent with differences in total investment being driven by differences in the proportion who choose to lead and follow.

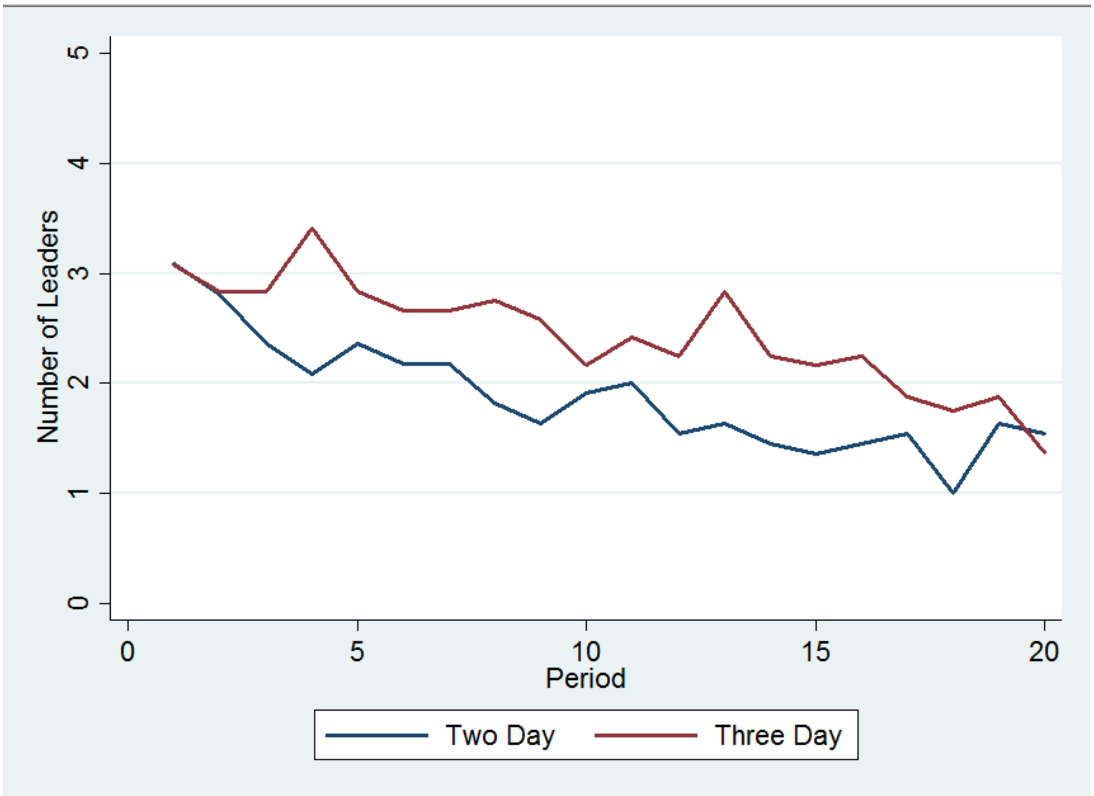

Figure 3.4 Average Number of Leaders by Treatment and Period

Further evidence is provided by Figure 3.4 which shows the number of leaders as the experiment progresses. The three-day treatment on average leads to a higher number of leaders compared to the two-day treatment other than in the first few and last few periods. Interestingly, the willingness to lead diminishes as the experimental session progresses, which is consistent with Arbak and Villeval (2013). Coupling this with the finding in Figure 3.3, not only are there fewer leaders as the experiment progresses but those who do still choose to lead, are free riding more.

Arbak and Villeval (2013) highlight the difference between individuals who nominate for leadership more than 35% of the time, frequent leaders, and those who nominate less than 35% of all periods, less frequent leaders. They find frequent leaders invest more than less frequent leaders and those who choose to follow. The distinction between the two is likely that frequent leaders are seeking social approval. In this experiment, all participants in the three-day treatment 'try' out leadership at least once and only 12.72% never lead in the two-day treatment. Using Arbak and Villeval (2013)'s classification for frequent leadership, 63.63% of participants in the two-day and 66.66% in the three-day treatment would be classified as frequent leaders. It seems, therefore, that the organisational structure of the treatments studied in this chapter encourages leadership.

By uncovering the number of leaders within each group, one can determine whether either the Leader or Two Leader games studied in Chapter 2 occurred organically in the two-day treatment. For the two-day treatment there are six possible investment sequences and in the three-day treatment, there are 21 possible sequences. These are detailed in Appendix A3.1.

Table 3.7 Frequency of Day 1 Nominations within the Group

Number of Leaders in group	Two Day	Three Day
0	10.45% (23)	2.73% (6)
1	29.09% (64)	20.91% (46)
2	31.36% (69)	29.55% (65)
3	20.91% (46)	23.64% (52)
4	7.27% (16)	16.82% (37)
5	0.91% (2)	6.36 % (14)

Note: Numbers in parentheses denote the number of occurrences

Table 3.7 provides a summary by showing the number of leaders observed within a group across all periods. Not surprisingly, it was rare that all group members lead or that none of them lead. Two leaders are most likely to occur in both treatments which is consistent with Bales (1953) who found that two informal leaders often emerge in leaderless groups. Treating each group independently, there is a significantly higher number of leaders in the three-day treatment (Mann-Whitney, $p=0.07$). The median number of investments made on day one is significantly different from 1 for both treatments (signrank, $p<0.01$). The distribution of the number of leaders cannot be said to be from distinctly different distributions (k-smirnov, $p=0.26$).

3.5.4 Follower reciprocity

Reciprocity is a principal reason stated in the both endogenous and exogenous leadership literature to explain why individuals have an incentive to invest more when they invest early. At the group level, this would imply that the higher the average invested on day one, the higher the investments will be of individuals delaying to days 2 or 3.

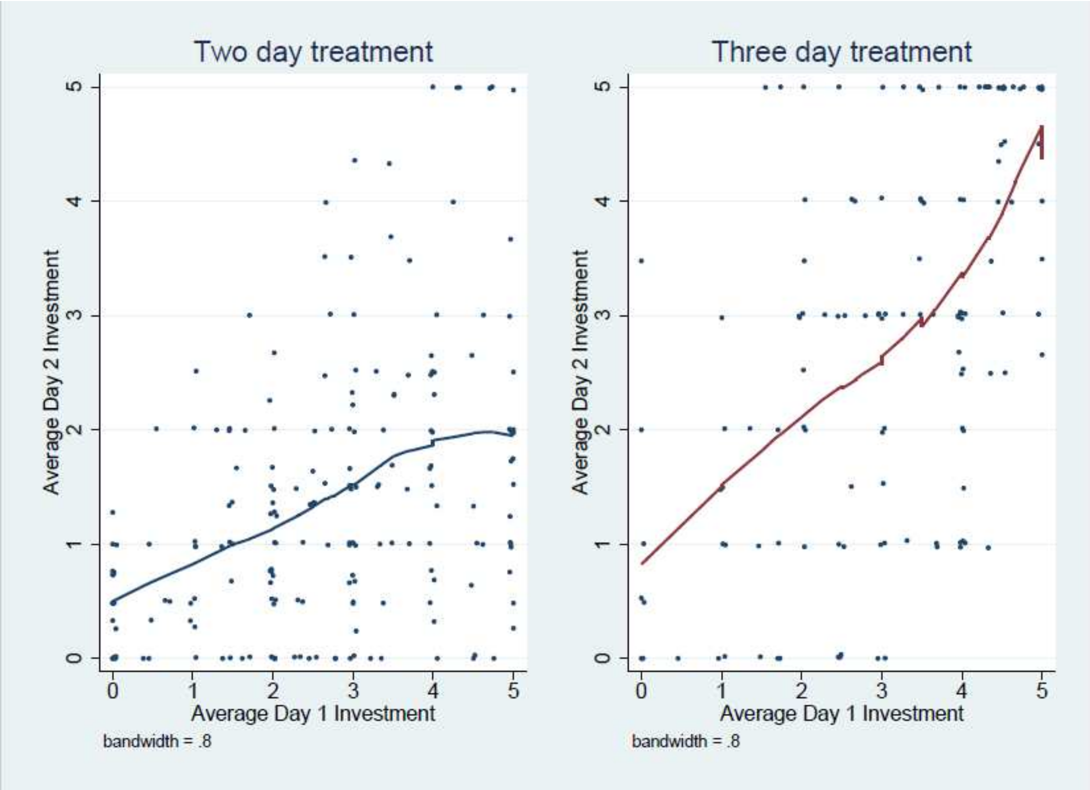

Figure 3.5 Follower Reciprocation on Day 2 by Treatment

Figure 3.5 shows the results from running a Lowess smoother for the average investment on day two conditional on the average invested on day one for both treatments separately. Clearly, those investing on day 2 in the three-day treatment are showing a higher average degree of reciprocity than those investing on day 2 in the two-day treatment Recall these first followers also self select into this role. This is a further reason why total investment is higher in the three-day treatment. The higher number of leaders plus the higher level of reciprocity in the three day treatment means that despite the vanishing leadership effect still being present the high proportion of individuals choosing to invest early overrides this effect to mean that the three day treatment leads to higher total level of investment.

Recall Figure 2.6 from Chapter 2, which compared first follower reciprocity between First Follower and Sequential games. The level of reciprocity exhibited by first followers in the three-day treatment resembles the level of first follower reciprocity observed in the First Follower game from Chapter 2, perhaps even steeper here. Whereas the reciprocity exhibited in the two-day treatment is most similar to the follower reciprocity found in the Sequential and Leader games from Chapter 2 as shown in Figure 2.5. Similar to the argument in chapter 2 the higher level of exhibited reciprocity could be due to the observability of the reciprocity whereas those investing during the last day do not have their reciprocity observed before the end of the period.

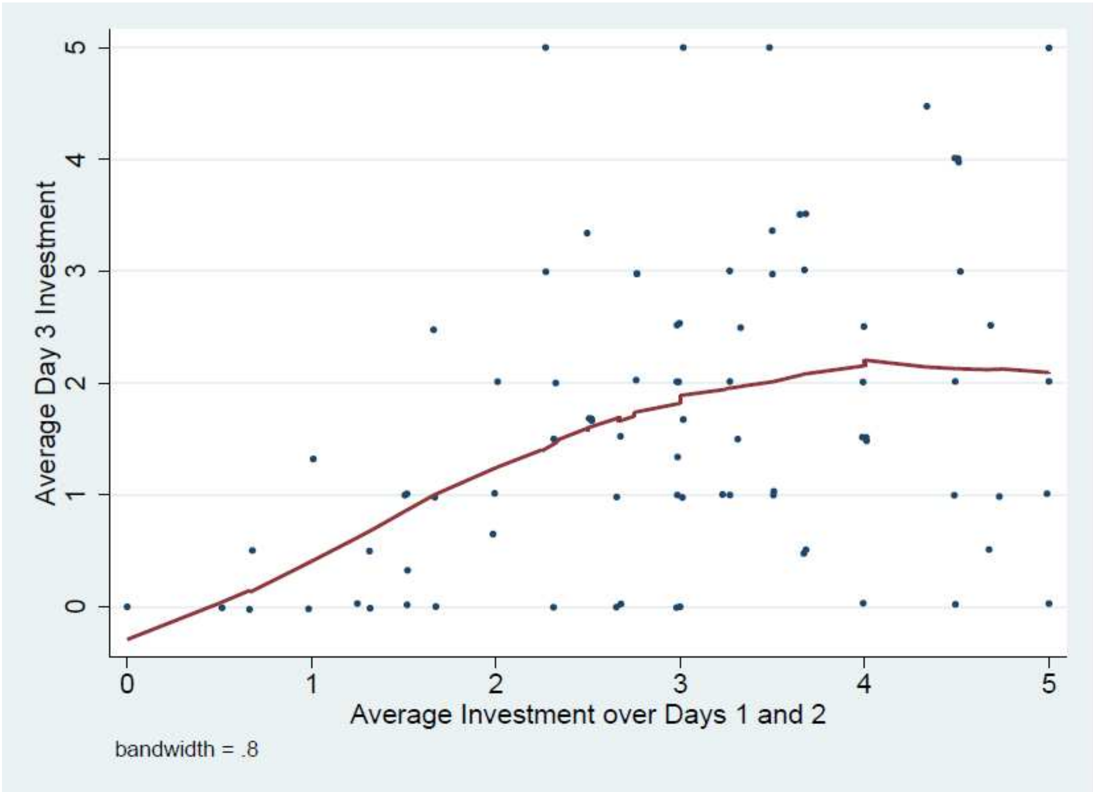

Figure 3.6 Follower Reciprocation on Day 3

Figure 3.6 demonstrates the result of running a Lowess smoother of the average investment made on day 3, conditional on the average invested over days 1 and 2. The level of reciprocity exhibited plateaus above a prior average investment of 3 tokens. Notably, the follower reciprocity exhibited in the three-day treatment is more similar to the follower reciprocity in the two-day treatment shown in Figure 3.5 than first follower reciprocity. The lower levels of reciprocity exhibited on later days is consistent with the diminishing reciprocity observed by Figuières, Masclet and Willinger (2012) and self selection of individuals to invest before the last possible day.

Markedly, not many individuals invest during day 2 in the three-day treatment, therefore, it is of interest to uncover whether emergence of a first follower impacts on public good provision. When at least one individual invests on day two in the three day treatment, i.e. at least one first follower, the average total investment is 13.40 tokens compared to 10.59 if no one does.

Table 3.8 Random Effects Tobit regressions for Total Investment (three-day treatment only)

		(1)	(2)
Total investment	Number of Leaders[23]	1.81	
		(0.30)***	
	First Follower dummy	3.49	3.29
		(0.66)***	(0.71)***
	Constant	5.54	10.32
		(1.49)***	(0.81)***
sigma_u	Constant	3.97	4.52
		(0.50)***	(0.55)***
sigma_e	Constant	4.17	4.46
		(0.24)***	(0.25)***
	Wald chi2 test	60.74***	21.37***
Obs		220	220

Note: The upper limit is 25 tokens and the lower limit 0 tokens. There were four left censored observations and two right censored observations. Numbers in parentheses represent standard errors as Stata does not allow cluster robust standard errors with random effect Tobit models. *, ** and *** represents significance at the 10%, 5% and 1% significance levels respectively.

Table 3.8 shows the results from running a random effects Tobit with total investment as the dependent variable and includes results from the three-day treatment only. Included as independent variables are the number of

[23] Stata had an error when trying to compute this regression when a lag for total investment was included and therefore is not included in Table 3.8.

investments made on day one i.e. the number of leaders and a first follower dummy which equals one if at least one person made an investment on day two. In model one, both independent variables are significant at the 1% level indicating that the greater the number of leaders and the existence of a first follower significantly increases total investment. Also tested is a model with the first follower dummy as a lone independent variable, model 2, which is significant at 1%. These results suggest that the presence of a first follower increases total investment in the three-day treatment.

3.5.5 Leader self-selection

So far it has been established that significantly more subjects opted to lead in the three-day treatment and that this was a primary factor in increasing total investment. This section delves deeper into the behaviour of leaders and their individual characteristics.

At the end of the experiment, the participants were asked a series of questions which are shown in Appendix A3.2. The questionnaire covered elicitation of social value orientation (Van Lange 1999), time preference (Gneezy and Potters 1997), and risk preference (Holt and Laury 2002). Also included was a hypothetical trust game (Berg, Dickhaut and McCabe 1995), index stories (Bruttel and Fischbacher 2013), patience questions (Dudley 2003) and finally questions regarding social characteristics. These were implemented to examine if any of these traits impact on willingness to lead and the level of investment as a leader. Also, it is good practice to uncover whether there are any differences in the participants' social characteristics between treatments.

Regarding social value orientation, individuals were classified into one of three categories: Competitive, Individualistic or Prosocial (Van Lange 1999). If their choices did not consistently reflect any of these categories, they are unclassified.

Table 3.9 Social Value Orientation by Treatment

Social Value Orientation	Two Day	Three Day	All
Competitive	3.64% (2)	2.50% (1)	3.16% (3)
Individualistic	50.91% (28)	25.00% (10)	40.00% (38)
Prosocial	43.64% (24)	55.00% (22)	48.42% (46)
Unclassified	1.82% (1)	17.50% (7)	8.42% (8)

Note: Numbers in parentheses are the number of occurrences.

Table 3.9 shows the proportion of group members' classified into each social value orientation category split by treatment. The key differences between treatments is the higher proportion of individualistic and lower proportion of unclassified in the two-day treatment. There is a significant difference in the proportions of social value orientation classification between treatments (Fisher's exact test, $p<0.01$).

Table 3.10 Times invested as Leader by Social Value Orientation and Treatment

Social Value Orientation	Two Day	Three Day
Competitive	3.50	14.00
Individualistic	5.25	11.90
Prosocial	9.87	9.77
Unclassified	11.00	11.57

Table 3.11 Average Leader and Follower Investment by Social Value Orientation and Treatment

	Two Day		Three Day	
Social Value Orientation	Leader	Follower	Leader	Follower
Competitive	2.43 (1.90)	1.28 (1.13)	0.57 (1.09)	2.33 (1.86)
Individualistic	2.44 (1.85)	1.04 (1.43)	2.62 (1.60)	1.09 (1.32)
Prosocial	3.06 (1.83)	1.51 (1.82)	3.34 (1.75)	1.36 (1.72)
Unclassified	2.36 (1.91)	1.95 (1.91)	3.54 (1.74)	1.92 (1.67)

Note: Numbers in parentheses are the standard deviations

Table 3.10 shows the average number of times individuals in each social value orientation category invested as a leader. Interestingly, in the three-day treatment individuals classified as competitive or individualistic are more likely to choose to be leaders than prosocial or unclassified. Recall, however, the number of individuals classified in these categories are small. Whereas in the two-day treatment, prosocial and unclassified individuals most frequently invest as a leader.

Table 3.11 shows the average investment split by the social value orientation of the individual and whether they invested as a leader or follower. Despite the higher willingness to lead by competitive and individualistic individuals in the three-day treatment, they invest less than pro-social and unclassified leaders. For both treatments, those classified as pro-social invest most as leaders. This result is consistent with behaviour observed in Gächter et al. (2012) and Préget et al. (2016). Concerning follower behaviour, unclassified comes top in the two-day treatment and competitive followers invest highest in the three-day treatment. However both of these respective categories only have one person classified as them and therefore likely to be biased.

Table 3.12 Tobit Regressions for Frequency as Leader

Frequency as Leader	(1)	(2)
Treatment	0.15	0.22
	(0.08)**	(0.08)***
Trust	-0.11	
	(0.10)	
Index Stories	-0.00	
	(0.01)	
Patience	0.16	0.18
	(0.06)***	(0.06)***
Social Value Orientation		
Individualistic	0.06	
	(0.14)	
Pro-Social	0.23	
	(0.16)	
Unclassified	0.25	
	(0.18)	
Age	0.00	
	(0.01)	
Economics	-0.09	
	(0.07)	
Gender	-0.07	
	(0.09)	
Constant	-0.36	-0.39
	(0.33)	(0.18)**
F test	4.24***	13.27***
Observations	95	95

Note: The upper limit is 1, and the lower limit is 0. There were seven left censored observations and five right censored observations. Numbers in parentheses represent standard errors clustered by the group. *, ** and *** represents significance at the 10%, 5% and 1% significance levels respectively.

Table 3.12[24] shows the results from running Tobit regressions with the proportion the individual invested as a leader as the dependent variable. This is calculated by dividing the number of times the individual invested on day 1 by the number of periods, hence ranges from 0 if the individual was never a leader to 1 if they were always a leader. The two-day treatment is used as the base treatment. Therefore the treatment dummy equals 1 if from the three-day treatment. In model 1, the treatment variable is significant at the 5% level; the only personal trait elicited in the questionnaire to be significant is patience, which is significant at 1%. Model 2 shows results from running a regression with

[24] A regression was conducted with interaction variables between treatment and social value orientation, all of those variables were insignificant and hence not included.

only two independent variables, treatment and patience, both significant at the 1% level. These regression results give further evidence that individuals invest more frequently as leaders in the three-day treatment and that the majority of individual characteristics considered do not significantly impact on willingness to invest as a leader.

3.5.6 Endogenous versus Exogenous Leadership

In this section, the behaviour of those who act as a leader by investing on day one in these two treatments is compared to exogenously imposed leader behaviour from Chapter 2. In Chapter 2, leadership is exogenously imposed on one group member in the Leader and First Follower games and two group members for the Two Leader game[25]. The First Follower game is comparable to the three-day treatment as both have three investment stages, and the Leader and Two Leader games are similar to the two-day treatment as all of these have two stages.

Table 3.13 Average Exogenous and Endogenous Leader Investment

Type	Treatment	Average Leader Investment
Endogenous	Two Day	2.78 (0.09)
Endogenous	Three Day	3.10 (0.08)
Exogenous	Leader	2.71 (0.23)
Exogenous	First Follower	3.66 (0.14)
Exogenous	Two Leader	2.89 (0.10)

Note: Numbers in parentheses are standard deviations.

Table 3.13 shows the average leader investment for the two endogenous treatments from this chapter (two-day and three-day) and three of the treatments from Chapter 2 (Leader, First Follower, and Two Leader). Grouping together all results from the endogenous treatments and comparing to exogenous treatments, an insignificant difference in average leader investment is found (Mann-Whitney, p=0.48). Comparing two-day to exogenous Two Leader there is an insignificant difference in the average leader investment (Mann-Whitney, p=0.62). It is also insignificant against the Leader treatment (Mann-Whitney, p=0.87). There is similarly an insignificant difference between three-day treatment and First Follower game (Mann-Whitney, p=0.11)[26]. The inclusion

[25] The results from the Sequential treatment in Chapter 2 are not included as there is no comparative treatment in this chapter.
[26] All of the comparisons in this paragraph use the group as the unit of observation.

of three investment stages is more effective in the endogenous setting than the exogenous.

One can limit comparisons to instances where the Leader, First Follower and Two Leader games occurred organically in the two-day and three-day treatments. Recall that the Leader game occurs endogenously if there is one leader in the two-day treatment, and if two leaders emerge it is equivalent to a Two Leader game. The First Follower game occurs organically in the three-day treatment if one group member invests on day one, another on day two and the rest of the group on day three. Insignificant differences are found between the leader investments in the exogenous and endogenous Leader games (Mann-Whitney, p=0.34) and between the Two Leader games (Mann-Whitney, p=0.55). However, there is a significant difference for the First Follower games at the 5% level (Mann-Whitney, p=0.02[27]).

Table 3.14 Random Effects Ordered Probit Regressions for Leader Investment (Endogenous versus Exogenous)

		(1)		(2)
Investment	Treatment		Type	
	Three Day	0.16 (0.31)	Exogenous	0.13 (0.22)
	Leader	-0.04 (0.51)		
	First Follower	0.67 (0.34)**		
	Two Leader	-0.00 (0.30)		
Sigma2_u		0.95		1.00
	Wald chi2 test	6.27		0.32
Obs		1584		1584

Note: The standard errors are stated in the parentheses and are clustered by the group. *, ** and *** represents significance at the 10%, 5% and 1% significance levels respectively.

Table 3.14 shows the results from running random effects ordered probit regression with the individual's investment as the dependent variable, but only

[27] This significant result could however be due to the small number of organic occurrences of the first follower game.

if he was a leader. In model one, the two-day treatment is the base treatment, and the only significant treatment is the First Follower treatment at the 5% level. Model two splits the observations by exogenous versus endogenous treatments; there is no significance difference. These results suggest that endogenous leaders do not invest significantly more than exogenous leaders. Although no significant difference is found between leaders, there may still be differences in total investment.

Table 3.15 Average Endogenous and Exogenous Total Investment

Type	Treatment	Average Total Investment
Endogenous	Two Day	8.99 (0.38)
Endogenous	Three Day	12.28 (0.43)
Exogenous	Leader	8.65 (0.74)
Exogenous	First Follower	13.14 (0.54)
Exogenous	Two Leader	11.13 (0.45)
Endogenous	Leader	6.72 (0.47)
Endogenous	First Follower	9.28 (0.61)
Endogenous	Two Leader	9.65 (1.18)

Note: Numbers in parentheses are standard deviations.

Table 3.15 summarises the average total investment for the endogenous and exogenous treatments. Combining the exogenous results and comparing to the endogenous treatments, there is no significant difference in total investment (Mann-Whitney, p=0.61). Similar to the average leader investment comparisons, there is an insignificant difference in total investment between the two-day treatment and exogenous Two Leader treatment (Mann-Whitney, p=0.14), and two-day to Leader (Mann-Whitney, p=0.95). There is also an insignificant difference in total investment between the three-day and First Follower treatment (Mann-Whitney, p=0.62).

Table 3.16 Random Effects Tobit regression for Total Investment (Endogenous versus Exogenous)

		(1)		(2)
Total Investment	Treatment		Type	
	Three Day	3.56 (1.74)**	Exogenous	0.36 (1.36)
	Leader	-0.93 (2.25)		
	First Follower	4.26 (1.94)**		
	Two Leader	2.13 (1.87)		
	Constant	8.84 (1.25)***	Constant	10.70 (0.95)***
Sigma2_u		3.98		4.39
Sigma2_e		5.49		5.49
Wald chi2 test		9.02***		0.07
Obs		880		880

Note: The upper limit is 25, and the lower limit is 0. There were 59 left censored observations and nine right censored observations. Stata does not allow cluster robust standard errors with random effects Tobit therefore numbers in parentheses are standard errors. *, ** and *** represents significance at the 10%, 5% and 1% significance levels respectively.

Table 3.16 shows the results from random effects Tobit regressions with total investment as the dependent variable. The two-day treatment is used as the base treatment. In model one, where the results are split by treatment, both three-day and First Follower lead to significantly higher levels of total investment at the 5% level. Model 2 compares endogenous treatments to exogenous treatments by using the combined results from Leader, Two Leader and First Follower as the base. Endogenous groups are found not to have significantly different levels of total investment than exogenous groups which opposes hypothesis four, where it was expected that the endogenous groups should invest significantly more.

3.6 Discussion and Conclusion

This chapter focused on a novel experimental design where individuals could choose which day, or investment stage, they wanted to invest in. There was no restriction on the number of individuals investing during each stage and consequently there is no limitation to the number of leaders. A key result from Chapter 2 was that the First Follower treatment had the highest level of total investment. Notably, this treatment had three investment stages which was unique to that treatment. Also, included in Chapter 2 were the Leader and Two Leader games which both had two investment stages. Therefore, a treatment with two investment stages, a two-day treatment, is compared to a treatment with three investment stages, a three-day treatment.

There is no direct incentive to invest early in either treatment. However there is a potential incentive to delay investment to elicit as much information as possible regarding the other group members' investments. Evidently, there was a concern that both treatments would revert to the simultaneous game if all group members delayed investment to the last day. However, a large proportion of investments took place on day one. The most common number of leaders was two for both treatment. A significant majority of groups were successful in implementing at least one leader, 89.55% in two-day and 97.27% in three-day. This greater prevalence of leadership suggests that the institutional design considered in this experiment induces more individuals to lead than previously tested designs. The willingness to lead does, however, diminish as the game is repeated, starting at around three leaders and falling to just over one.

Consistent with previous results, endogenous leaders invest significantly more than those who choose to follow. As aforementioned, there is a stronger incentive to invest a positive amount the earlier they choose to invest.. There is no significant difference in average leader investment between treatments, but there is a significant difference in total investment at the 10% significance level. The difference in total investment seems to be correlated with the higher proportion of leaders emerging during the three-day treatment.

Notably, the emergence of at least one person investing on day two in the three-day treatment leads to a significant increase in total investment. Group members investing in this intermediate stage view investments on day one as well as having the potential to influence subsequent investors. In other words they can exhibit leadership and reciprocity. The individuals investing during the intermediate stage are arguably equivalent to the first followers in the First Follower game in Chapter 2; however, the first followers in the three-day treatment need not be unique in their position. The level of reciprocity exhibited by those investing on day two is also a similar rate to the reciprocity exhibited by first followers in the First Follower treatment (see Figure 2.6). It is higher than the level of reciprocity exhibited by individuals on day three which is consistent with the vanishing leadership effect observed by Figuières, Masclet and Willinger (2012).

In the three-day treatment, most investments are invested on the first or last day. This is congruent to the real-world crowdfunding behaviour where individuals are more likely to invest during the first or last week of the fundraising period (Kuppuswamy and Bayus 2015). The experimental results indicate that extending the fundraising period by an extra day leads to higher investment which, however, opposes Kuppuswamy and Bayus (2015)'s finding that crowdfunding projects with shorter fundraising periods are more likely to reach their target. This inconsistency could be due to the difference between the length of time periods being considered, as the longer deadline (three-day treatment) would still be considered extremely short for a crowdfunding project.

Endogenous leaders are found not to invest significantly more than those who were forced to act as leaders in Chapter 2. This result suggests there is no significant difference between endogenous and exogenous leadership. The comparison of leaders between treatments considered in this chapter and Chapter 2 is, however, questionable as the number of followers is unknown to those investing during day one in these treatments but known in Chapter 2. In addition, individuals in Chapter 2 were referred to as leaders in the experimental instructions which did not happen in this experimental design. Therefore, it is not clear whether individuals choosing to invest early in this experiment thought themselves to be ‘leaders’. The problem of a not exact comparison between endogenous and exogenous leaders has been highlighted in previous studies (Rivas and Sutter 2011). One potential reason is that in the exogenous leaders the leaders by design are a random member of the populace, hence their behaviour could be viewed as the average level of behaviour of the group whereas in endogenous the leaders self-select and therefore more likely to be more generous than the average. Although there are insignificant differences between endogenous and exogenous treatments, the treatments with 3 investment stages, namely First Follower and three-day, have the two highest average leader investment of the five treatments considered.

This insignificance between endogenous and exogenous leaders follows through to the total investment, endogenous groups do not invest significantly more in total than exogenous groups. Exogenous investment sequences specify the number of investment stages and the number of group members who invest in each stage. Whereas in the treatments considered in this chapter, endogenous investment sequences, the institution need only to specify the number of days. The investors choose when they would like to invest and hence they have more choice. Therefore, from the institutional point of view these endogenous treatments are more favourable as they do not significantly reduce total investment but are more flexible. Notice also that the First Follower game (1 person investing on day one, 1 person investing on day two and 3 people investing on day 3) rarely occurred endogenously, despite this being the most effective treatment in Chapter 2 at raising investment. There is also arguably a distinction to be drawn between those willing to be invest as a leader and those willing to invest as a first follower. As indicated in previous studies, generous individuals are more willing to nominate for leadership but for willingness to be a first follower it is more likely to be the person who wishes to praise generosity the most.

In these experimental treatments, investment stages are referred to as ‘days’. Primarily, this naming is implemented to make the scenario easier for participants to comprehend, but indirectly shows the connection with crowdfunding. Online crowdfunding takes place in a fully real time environment, which is considered in Chapter 4, rather than staggered dynamic stages as conducted in this experimental design. Nevertheless, it would be interesting to uncover whether the underlying institutional design in this chapter, i.e., updating pages every day, would be more effective than a real time updating for crowdfunding projects.

In previous studies, beliefs of how much other group members will invest is correlated with an individual's own investment (Bruttel and Fischbacher 2013; Gächter et al. 2012). The addition of belief elicitation in this experimental work would help clarify whether individuals investing early considered themselves as leaders. The number of possible investment stages could be increased further. If the number of possible stages were extended to equal the group size this would allow for comparison with prior results from exogenous fully sequential games such as in Chapter 2 and Figuières, Masclet and Willinger (2012).

CHAPTER 4
CROWDFUNDING IN THE LAB

4.1 Introduction

In the 'standard' public good framework, studied in the literature, there is one public good and one private good; thus individuals must decide how much of their endowment of private good they want to invest towards the unique public good. In applied settings, however, there are often multiple, seemingly identical, public goods. An individual, therefore, must not only decide how much to invest but also *where* to invest. Consider, for example, someone choosing to invest to a crowdfunding[28] project. As of 23rd May 2016, there were 5,199 live projects appealing for funding on Kickstarter (Kickstarter, 2016a). With such a vast number of projects vying for funding, this creates a competitive environment for obtaining donations.

In a recent experimental study, Corazzini, Cotton and Valbonesi (2015) demonstrate that a multiplicity of competing threshold public goods can lead to lower efficiency. More specifically, in a laboratory experiment, they found that efficiency was lower in a treatment with four identical threshold public goods than a benchmark treatment with one threshold public good. This gap in efficiency was insignificant if one of the public goods in a four public good treatment was commonly known to be more efficient, by means of a higher bonus, than the other three. This level of information seems, however, unlikely and thus competing projects may be bad for overall public good provision. The difficulties that might arise with multiple, competing projects are also discussed by Belleflamme, Omrani and Peitz (2015).[29]

Corazzini, Cotton and Valbonesi (2015) considered a framework with simultaneous choice. In settings with multiple public goods, it is arguably more common to observe *sequential* choice. Crowdfunding, for instance, is an inherently dynamic process with continuous updates on the amount of

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[28] Crowdfunding is defined as the practice of funding a project or venture by raising money from a large number of people who each invest a relatively small amount, typically via the Internet (*OED* 2016).

[29] Parker (2014) demonstrates, in a theoretical model with private information, that a larger number of projects may actually increase efficiency.

investment made to a project to date (Wash 2013; Mollick 2014; Kuppuswamy and Bayus 2015). Intuitively, as discussed in detail in Section 4.2, one might expect that sequential choice can facilitate coordination on a particular threshold public good and, in so doing, remove the efficiency gap from competing threshold public goods. This chapter is based on an experiment designed to test that intuition. Closely following the approach of Corazzini, Cotton and Valbonesi (2015), a treatment with four identical threshold public goods is compared to a treatment with one threshold public good. In both treatments, investments are made in real time resulting in sequential and endogenous timing.

In the experiment, efficiency was found to be lower in the treatment with four public goods than that with one public good. Moreover, the drop in efficiency was similar to that observed by Corazzini, Cotton and Valbonesi (2015) in the simultaneous move setting. Sequential choice appeared, therefore, to make little difference. This result provides a strong endorsement of the findings of Corazzini, Cotton and Valbonesi (2015), particularly further evidence of their key finding of multiplicity.

To my knowledge, this is the first study to incorporate multiple public goods in a real-time environment. There have, however, been other studies to test the presence of multiple public goods. Theoretically, Andreoni (1998) found that accumulated funding for multiple public goods leads to higher total public good provision than gaining financing for each public good separately. On the other hand, Bilodeau and Slviniski (1997) theorises the opposite is true. The latter theory is consistent with the experimental finding by Bernasconi, Corazzini and Maréchal (2009) which found that forcing participants to invest to two identical smaller public goods leads to higher total investment than one larger public good.

The rest of this chapter is as follows: Section 4.2 details the treatments implemented in this study, Section 4.3 states the hypotheses that are expected from the real time environment with multiple threshold public goods, Section 4.4 highlights the key results from the experiments, Section 4.5 further discusses the key results and Section 4.6 concludes the chapter with implications and limitations of this experimental study.

4.2 Theoretical background

Consider a setting with one private good and a set of $k \geq 1$ public goods, $K = \{1, \dots, k\}$. There is a set of n players, $N = \{1, \dots, n\}$. Each player $i \in N$ is endowed with $E > 0$ units of private good and must decide how much to invest towards each public good. An investment profile $(c_{1,1}, \dots, c_{n,k})$ details the amount invested by each player to each public good, where $c_{i,j} \in [0, E]$ is the investment of player $i \in N$ towards public good j. Let $C_j = \sum_{i=1}^{n} c_{i,j}$ denote total investment towards public good j.

Payoffs are determined relative to a threshold $T > E$, bonus $B > 0$, and marginal per-capita return $m \in (0,1)$. Given an investment profile $(c_{1,1}, \dots, c_{n,k})$, let indicator variable:

$$\lambda_j = \begin{cases} 1 & if \;\; C_j \geq T \\ 0 & otherwise \end{cases} \qquad (4.1)$$

Public good j is provided if $\lambda_j = 1$. The payoff of any player $i \in N$ can then be written:

$$u_i(c_{1,1}, \dots, c_{n,k}) = E - \sum_{j \in K} c_{i,j} + \sum_{j \in K} \lambda_j (B + mC_j) \qquad (4.2)$$

In interpretation, if total investment towards public good equal or exceed the threshold then everyone in the group receives the bonus B and a return from public good j. If investment falls short of the threshold then there is no return from the public good. Note that this particular threshold public good game is characterised by no refund and a linear rebate rule (Spencer et al. 2009; Cartwright and Stepanova 2015). Also note that the m public goods are identical in the sense that the threshold, bonus and marginal per-capita return are the same. Corazzini, Cotton and Valbonesi (2015) primarily focus on a setting where $2T > nE$ meaning that players can finance at most one public good. The same approach is adopted here.

The timing of the investments is key in the experimental design here. The game considered here is a *real time*, *irrevocable commitment game* (Goren, Kurzban and Rapoport 2003). In this experimental game, there exists some time frame $[0, \bar{t}]$ within which players can say how much they want to invest to each public good. A player can make their choice at any time but can only choose once.[30] Let timing profile $(t_1, \dots, t_n)$ detail the time at which each player makes his choice. Crucially, information about investments is made public as and when it happens. A player who has not made his decision by time t can, therefore, condition his choice on any investments made before time t. This type of game closely approximates the framework observed on charity donation websites (e.g. JustGiving.com, VirginMoneyGiving) and crowdfunding websites (e.g. Kickstarter, Crowdfunder, Indiegogo). More technically, the public goods are not homogenous and m may be unknown.

4.2.1 The problems of coordinating

To appreciate the strategic issues that arise within a threshold public good game, it is useful to begin by looking at the more commonly studied *simultaneous move* game. In this version, all players independently decide how much of their endowment to invest towards the public good without knowing the investment of anyone else. The strategy set of any player $i \in N$ is, therefore, the set of possible investments, $[0, E]$.

The set of Nash equilibria in the simultaneous move game is easily discerned: Investment profile $(c_{1,1}, \dots, c_{n,k})$ is a Nash equilibrium if and only if either: (1) $C_j = 0$ for all $j \in K$, or (2) There exists public good $j^* \in K$ such that $C_{j^*} = T$, $c_{i,j^*} \leq B + mT$ for all $i \in N$ and $C_j = 0$ for all $j \neq j^*$. In scenario (1) there are no investments to any public good. This is an equilibrium because $T > E$ and so there is no incentive for any player to invest if others invest zero. In scenario (2) investments are just sufficient to reach the threshold for one of the public goods. Note that it is in each player's interest to invest enough to reach the threshold because the benefit, $B + mT$, exceeds their investment. There is,

[30] This distinguishes an irrevocable commitment game to one where real time revisions are permitted (e.g. Dorsey 1992). If more than one public good could be financed it may be appropriate to allow multiple investments but in a setting where only one good can be financed an assumption of irrevocable commitments seems relatively innocuous.

however, no incentive to invest more than this because $m < 1$. Moreover, the assumption that $2T > nE$ means it is impossible to provide more than one public good.

The existence of Nash equilibria with positive public good provision illustrates the way in which a provision point threshold alleviates the free-rider problem familiar in linear public good games (Isaac, Schmidtz and Walker 1989; Rondeau, Schulze and Poe 1999). Even only around 40-60% of groups in the lab successful fund threshold public goods (e.g. Croson and Marks 2000; Alberti and Cartwright 2015). The main difficulty players face is that of coordinating their actions. Essentially, *if* a player knew for sure that an investment of say, c^* was necessary and sufficient to reach the threshold T on a particular public good then it would be in his interest to invest c^*. But, in this simultaneous move game, it is very hard for any player to know what investment is critical to achieve the threshold[31].

To expand on this problem, consider the following example. Suppose that $T = 100$, $n = 4$ and $k = 4$. As a starting point, consider the Nash equilibrium where each player invests 25 to public good 1. This results in total investment of 100 and public good 1 being provided. Consider next the Nash equilibrium where two players invest 24 and two invest 26 towards public good 1. This also results in total investment of 100 and public good 1 being provided. Moreover, the players who are only investing 24 would prefer this Nash equilibrium to the previous one while those investing 26 would not. Generalising, we see that there is a continuum of equilibria where public good 1 is provided and a non-trivial coordination problem concerning the distribution of investments within the group (Alberti and Cartwright 2016). Next observe that there is nothing special about public good 1. For instance, it is a Nash equilibrium for each player to invest 25 towards public good 2, or 3 or 4. In the multiple public good setting there is also, therefore, a problem of coordinating on a particular public good to provide (Corazzini, Cotton and Valbonesi 2015).

[31] Chen, Au and Komorita (1996) highlight the importance of an individual knowing whether they are critical in reaching the threshold.

Faced with such a multiplicity of equilibria a player may find it 'safer' to simply invest zero and have a guaranteed payoff of at least E. Or, they may expect that others will take the safe option and invest zero. This assurance problem can lead to the Nash equilibrium where there are no investment to any public good (Isaac, Schmidtz and Walker 1989; Coats, Gronberg and Grosskopf 2009; Bchir and Willinger 2013). Overall, therefore, there are three distinct coordination problems: (a) whether to provide a public good at all, (b) which public good, if any, to provide, and (c) what the distribution of investments should be.[32]

4.2.2 Coordinating in real time

Now consider a setting with real-time investments. The strategy space in this game is more intricate than that of the simultaneous move game because a player can condition on time and the investments of others. It is, however, possible to show that the set of investment profiles consistent with Nash equilibrium is the same in the real-time game as the simultaneous move game.[33] A-priori, therefore, the coordination problems discussed above can also be present in the real time setting. One can argue, however, that real-time choices should help mitigate the difficulties of coordinating (e.g. Schelling 1960; Marx and Matthews 2000). In particular, if a player makes a publicly observable investment to, say, public good 1, then this sends a strong signal that the group should try to provide public good 1. The size of the investment can also act as a signal on how to distribute investment.

Considerable experimental evidence exists on the comparison between simultaneous and sequential choice in a setting with one threshold public good. This evidence strongly suggests that sequential choice can alleviate the assurance problem (see, in particular, Coats, Gronenberg and Grosskopf 2000; Bracha,

[32] This translates into different types of inefficiency: (a) total investments are considerable but just short of the threshold (due to an inability to coordinate), or (b) total investments are near zero (due to coordination on the inefficient Nash equilibrium).

[33] Easiest is to argue that any Nash equilibrium in the simultaneous move game can 'generate' an equilibrium in the real-time game. To illustrate, consider a Nash equilibrium of the simultaneous move game with investment profile c. In the real-time game, strategies can be constructed where each player invests according to c on the equilibrium path and invests 0 off the equilibrium path. More difficult, is to argue that an investment profile is consistent with Nash equilibrium in the real-time game only if it is a Nash equilibrium in the simultaneous move game. It is known however that any equilibrium path would have a last investor. It is also known that this last investor would only invest enough so that total investment equals the threshold.

Menietti and Vesterlund 2011). In other words, it helps players avoid the 'trap' of zero investment. Evidence that sequential choice helps players coordinate on the threshold is, however, less clear-cut (e.g. Duffy, Ochs and Vesterlund 2007). Indeed, considerable inefficiency remains despite sequential choice (e.g. Dorsey 1992; Coats, Gronberg and Grosskopf 2009). Referring to the three coordination problems previously discussed, one can somewhat crudely summarise, therefore, that sequential choice appears to alleviate problem (a) but not (c) as stated in Section 4.2.1.

Prior results, however, have nothing to say on whether sequential choice alleviates problem (b) of creating a focal point. In other words, whether it helps groups coordinate on a particular public good. This is the issue which is the focus of this chapter. Recall that Corazzini, Cotton and Valbonesi (2015) observed significantly lower efficiency in a simultaneous move game with four public goods compared to a simultaneous move game with one public good. The main hypothesis is as follows:

Hypothesis: In a real time, irrevocable commitment game efficiency does not depend on the number of public goods.

In other words, the existence of multiple public goods is not a problem if choices are made sequentially. To motivate this hypothesis, particularly given the prior evidence, note that choosing which public good to provide is a pure coordination problem (in the sense of Schelling 1960). In particular, all public goods are identical, and so players simply need to coordinate on one of them. Problems (a) and (c), by contrast, are subtler in that they involve, respectively, Pareto-ranked equilibria or conflict of interest, creating a tension that sequential choice cannot fully remove. In a pure coordination problem, no such tension exists and so sequential choice may be more effective.

4.3 Experiment design

Two treatments were compared – a treatment with one threshold public good and one with four identical threshold public goods. One begins with a description of the treatment with one public good.

At the start of the session, individuals are randomly allocated into groups of four which remain constant across all 12 periods. At the beginning of each period, each group member is allocated 55 tokens which they can choose to invest in a public project. If the total invested to the project is equal to or greater than the threshold of 132 tokens, then each group member receives one token for each token invested in the project, regardless of which group member made that investment, plus a bonus of 30 tokens each. If the total invested to the project is less than 132 tokens, then group members receive no payoff from the project. They also do not receive a refund for any investment to the public project if it does not reach the threshold. Any tokens not invested into the project are automatically invested in a private account. Any token invested into the private account gives a return to the individual of 2 tokens. Note that this framing corresponds to a game with $n = 4$, $k = 1$, $m = 0.5$, $E = 27.5$, $B = 15$ and $T = 66$.

At the beginning of each period, the group members are given an anonymous identifier (Group Member W, Group Member X, Group Member Y or Group Member Z). Individuals are informed of their own identifier, and it is randomly changed at the start of each period. On the investment screen, individuals can view the current total invested into the project, which begins at zero, as well as a list of the investors. If an individual invests a positive amount to the project, then their investment is added to the current total invested and their identifier added to the list of investors. The other group members' investment screens are updated with this information. Individuals investing zero tokens to the public project are not included in the list of investors. Group members are given a timer of 120 seconds to make their investment decisions. However, they were not forced to make their decisions within 120 seconds, only encouraged to do so.

Once all group members have made their investment decisions (including zero token investments), feedback is given on the results of the period. Group members receive feedback: on the amount they invested to their private account, their investment to the public project, the total invested by the group to the public project and their individual profit from both the private account and from the public project.

In the four public good treatment, there are four possible projects for the individual to invest in. These are called Diamond, Rectangle, Square and Trapezoid, following the approach of Corazzini, Cotton and Valbonesi (2015). Due to the wealth connotation with 'Diamond,' in this experiment the order was changed from Diamond, Rectangle, Square and Trapezoid to Trapezoid, Rectangle, Square and Diamond. Individuals can invest in any of the public goods, and any of the tokens not invested into any of the four projects are automatically invested in the private account. An individual earns a return of 2 tokens for every token invested into their private account. Since the threshold is 132 tokens and the total endowment of the group is 220 only one of the public goods can be successfully funded. All four projects have the same bonus of 30 tokens if the threshold is successfully met. If the threshold is not fulfilled, then invested tokens are not returned to the individual.

On the investment screen (an example is shown in the instructions in Appendix A4.1), individuals are informed of the current total invested into each of the public goods and the list of investors for each public good anonymised with their group member identifier. If a group member invests a positive number of tokens to any of the public goods, their investment is added to the respective current total, and their group member identifier is added to the list of investors. If an individual invests zero tokens to any of the public goods, they are not added to the list of investors for that public good.

Once all group members have made their investments (including 0 token investments) to the four public goods, each group member receives feedback from the period. Feedback includes their individual investment to each of the four public goods, total invested by the group to each of the public goods; profit earned from the private account and profit earned from each of the public goods.

Table 4.1 Experimental Sessions

Session	Treatment	Number of groups	Number of periods	Questionnaire data?
1	Multiple	2	12	Yes
2	One	4	12	Yes
3	Multiple	4	12	No
4	One	4	11	No
5	Multiple	4	12	Yes
6	One	4	12	Yes

The experimental sessions were conducted in March 2016 using z-tree (Fischbacher, 2007) at the University of Kent using student volunteers from the University. There was a total of 88 participants, equivalent to 10 groups for the multiple public good treatment and 12 groups for the one public good treatment. Participants received instructions for their treatment only. For one session of the one public good treatment, the program crashed during the last period, and therefore there are 11 periods of data available instead of 12, and participants were paid the minimum amount. For the other sessions, one of the 12 periods was randomly selected for final payment from the experiment at a conversion rate of £0.01 per experimental token earned. The average payment from the experiment was £6.61. Table 4.1 lists the experimental sessions.

Individuals in Session 4 were expecting to play all 12 periods so one can arguably include these results within the same analysis as the other sessions. Due to time constraints and the issues with computer crashes, full questionnaire data is only available for 56 of the 88 participants.

4.4 Experimental Results

Throughout this section, the treatments ran for this experimental study within the real-time environment will be referred to as *d1PG* for the treatment with one public good and *d4PG* for the treatment with four public goods. When comparing at the group level, there are 12 independent observations for *d1PG* versus 10 for *d4PG*. The static comparator treatments from Corazzini, Cotton and Valbonesi (2015) are 1G which had one threshold public good in a simultaneous choice environment and 4G_EE which had four threshold public goods in a simultaneous choice environment, each with the same level of potential bonus and hence equal efficiency.

4.4.1 Individual Payoff

First, the individual payoff from the treatments will be compared. For all treatments, the maximum individual payoff was 305 tokens, occurring when an individual free rides while all other group members invest their entire endowment. Further, in this situation the total payoff for the group would be 890 tokens, since the other three group members earn 195 tokens each. The socially optimum outcome is where all group members invest their entire endowment, leading to a payoff of 250 tokens for each group member and a total group payoff of 1000 tokens.

Table 4.2 Average Individual Payoff across Treatments

Period	1	1-4	5-8	9-12	12	All
D1PG	148.21	174.88	167.54	191.98	171.94	175.93
	(11.17)	(4.62)	(4.51)	(4.38)	(12.40)	(2.71)
D4PG	50.25	94.4	146.92	163.82	160.35	139.33
	(5.65)	(6.13)	(5.44)	(6.43)	(11.95)	(3.61)
1G	178.00	182.89	196.76	188.66	184.21	189.44
4G_EE	57.75	103.93	164.43	160.53	134.50	142.96
D1PG-D4PG	97.96***	80.48***	20.62	28.16	11.59	36.60**
1G-4G_EE	120.25**	78.96***	32.33	28.14	49.71**	46.48***

Note: Numbers in parentheses are standard errors. Rows 3, 4 and 6 are taken from Table 4 in Corazzini, Cotton and Valbonesi (2015). Rows 5 and 6 show the results from running Mann-Whitney tests between the dynamic and static treatments respectively. There are no comparisons between static and dynamic due to the inability to compare treatments at the group level.

Table 4.2 summarises the average period payoff for the individual during the beginning, middle and end segments of the experiment. The *d1PG* treatment leads to significantly higher individual payoff than the *d4PG* treatment across the entire experiment (Mann-Whitney, p=0.03 at the group level). The presence of multiple public goods leads to lower efficiency in both environments, 36.6 points in the dynamic environment and 46.48 in the static environment. Although the dynamic treatments tend to lead to lower levels of efficiency than their comparative static versions, the difference is minimal. Notice that on average, neither dynamic treatment is close to the payoff associated with the socially efficient outcome of 250 tokens.

Figure 4.1 Average Individual Payoff by Period

Figure 4.1 shows the individual payoff averaged for each treatment and period. The dashed red line represents a payoff of 110 which corresponds to all group members free riding. Figure 4.1 emphasises the differences in payoff are becoming insignificant during the middle and final segments of the experiment (as shown in Table 4.2), caused by the large spike in payoff after period 5 in the *d4PG* treatment. The dynamics of the average individual payoff follows a similar trend to the equivalent static treatments as shown in Figure 2 from Corazzini, Cotton and Valbonesi (2015). Considering each group as a separate observation, both treatments lead to an average individual payoff significantly different to 110 at the 1% significance level for *d1PG* (signrank, $p<0.01$) and at the 5% significance level for *d4PG* (signrank, $p=0.04$). 19.29% of individual payoffs are lower than 110 for the *d1PG* treatment and 37.29% for the *d4PG* treatment. Both of these percentages are higher than the respective static treatments from

Corazzini, Cotton and Valbonesi (2015), which is 10.41% for 1PG and 33.33% for 4G_EE.

Table 4.3 Random Effects Generalised Least Squares Regressions for Individual Payoff

	(1)	(2)	(3)	(4)
Individual Payoff Last Period			0.27	
			(0.07)***	
Treatment	-36.23	-36.99	-20.77	-8.05
	(13.82)***	(13.70)***	(10.90)**	(3.02)***
Trend		4.65		
		(1.44)***		
Met Threshold				143.06
				(3.51)***
Constant	211.78	187.71	152.18	76.74
	(19.64)***	(21.57)***	(18.84)***	(5.95)***
Wald X2	6.87	20.93	17.79	1788
Prob>X2	0.01	0.00	0.00	0.00
Obs.	1040	1040	952	1040

Note: The numbers in parentheses are standard errors, and these are clustered on the group. The trend variable is a linear time trend. ***,**, and * denote significance at the 1%, 5% and 10% level respectively.

Table 4.3 shows the results from running random effects generalised least squares regression with individual payoff as the dependent variable. The presence of four public goods decreases individual payoff significantly at the 1% level in models one and two. When a lag of individual payoff is included the significance of treatment drops to the 5% level. The lag of individual payoff and time trend in models two and three respectively are significant at the 1% level. This suggests that there is a dependence on previous success. Unsurprisingly, meeting the threshold has a highly significant impact on individual payoff as indicated in model four. The above experimental results show that individuals in *d1PG* have a significantly higher payoff than those in *d4PG.* Consequently, efficiency is higher when there is only one public good.

4.4.2. Reaching the Threshold

There is a clear difference in the individual payoff between treatments; by successfully reaching the threshold the group can gain access to profit that is otherwise unavailable. As shown in Table 4.3, variation in groups successfully reaching the threshold had a significant positive impact on individual payoff. This section will delve further into the dynamics of groups successfully reaching a threshold.

The threshold of 132 tokens was successfully met in 75% of possible cases for *d1PG* and 55% for *d4PG*. Treating each group as a separate observation, there is a significant difference in the proportion of groups reaching the threshold between treatments at the 5% significance level (Mann-Whitney, p=0.03).

Table 4.4 Proportion of Groups Reaching Threshold

Period	1	1-4	5-8	9-12	12	All
D1PG	0.58	0.75	0.69	0.82	0.75	0.75
D4PG	0.00	0.28	0.70	0.68	0.70	0.55
1G	0.75	0.77	0.85	0.79	0.75	0.81
4G_EE	0.00	0.27	0.60	0.56	0.42	0.48
D1PG-D4PG	0.58***	0.47***	-0.01	0.14	0.05	0.20**
1G-4G_EE	0.75***	0.50***	0.25*	0.23	0.33	0.33***

Note: ***, **, and * denote significance at the 1%, 5% and 10% levels respectively. Rows 5 and 6 are testing the differences between treatments using a Mann-Whitney test with the group as the unit of observation. Rows 3,4 and 6 are taken from Table 3 in Corazzini, Cotton and Valbonesi (2015). Due to lack of available data on group level behaviour, one cannot test significance between dynamic and static treatments.

Table 4.4 shows the proportion of successful groups reaching the threshold within the first, middle and final segments of the experimental session also split by treatment. Considering all periods, groups with multiple public goods are significantly less successful at reaching the threshold at the 5% level in the dynamic environment and 1% level in the static environment. There is, however, insignificance between treatments by the end of the experimental sessions. These results indicate that although multiple public goods lead to significantly lower efficiency initially this might not always be true, perhaps it takes longer for individuals to comprehend the funding structure.

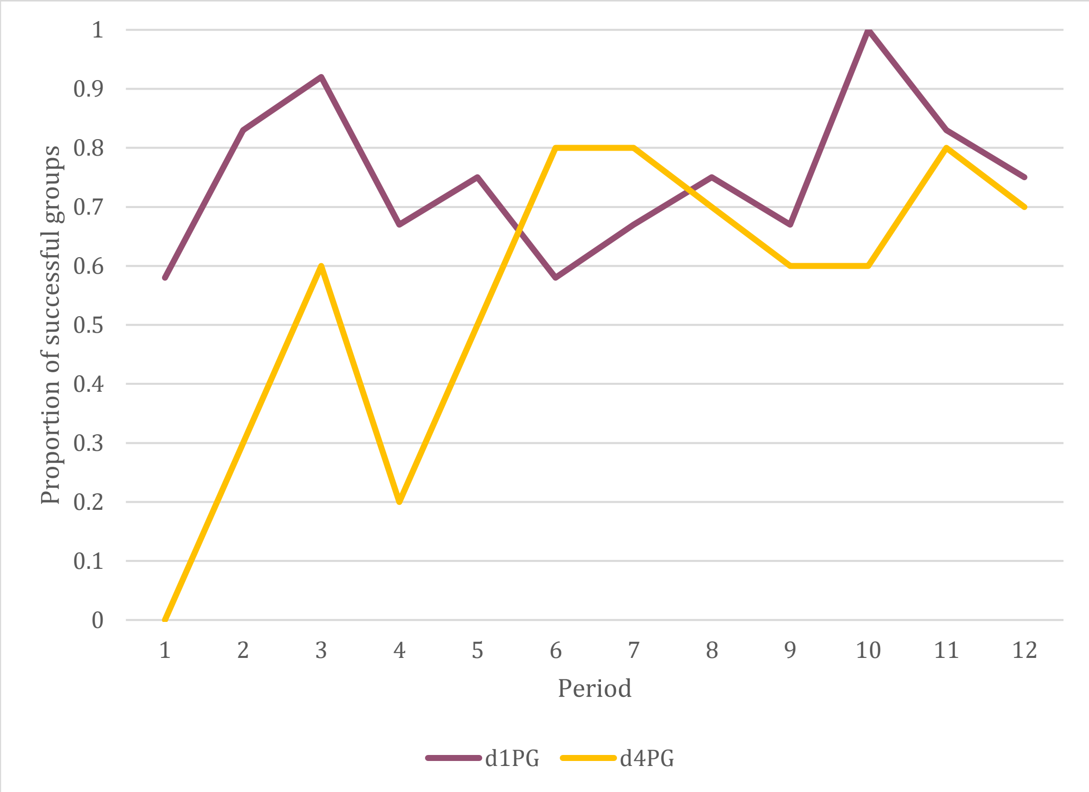

Figure 4.2 Proportion of Groups reaching the Threshold by Treatment

Figure 4.2 illustrates the proportion of groups meeting the threshold split by treatment for each period. For most periods, the proportion of successful groups is greater in the *d1PG* than *d4PG* treatment. However, as the experiment progresses, the proportion of successful groups converges. Notice, the similarity in trend in Figure 4.2 compared to group efficiency in Figure 4.1. The behaviour observed in *d4PG* follows a similar description to the static 4G_EE treatment in Corazzini, Cotton and Valbonesi (2015); they found a significant splitting of the trend of the successful groups from period five onwards from which the proportion of successful groups was strictly above 50%. The convergence of successful groups further highlights the problem of making claims from the average of the entire experimental sessions without considering dynamic effects.

Table 4.5 Random Effects Probit Regression for successfully reaching the Threshold

	(1)	(2)	(3)	(4)
Treatment	-0.65	-0.72	-0.46	-0.53
	(0.35)*	(0.38)*	(0.32)	(0.32)*
Met Threshold last period			0.44	0.39
			(0.22)**	(0.23)*
First Investment Time		-0.04		-0.03
		(0.01)***		(0.01)***
Constant	1.43	1.93	0.97	1.37
	(0.53)***	(0.60)***	(0.54)*	(0.56)**
Wald chi2	3.51*	11.66***	7.53**	17.87***
Obs	260	260	238	238
Cluster-robust standard errors?	Yes	Yes	No	No

Note: The numbers in parentheses are standard errors, and these are clustered on the group variant wherever possible. ***,**, and * represent significance at 1%, 5% and 10% respectively.[34]

Table 4.5 shows the results from running a random effects probit regression with meeting the threshold this period as the dependent variable. The dependent variable equals one if the total investment is 132 tokens or above for any of the public goods and 0 otherwise. Treatment is a binary variable which equals 1 if from the *d4PG* treatment and 0 if from *d1PG*. When included alone the treatment has a significant impact at the 10% level. However, the time (in seconds) of the first group member to invest is more significant, at the 1% level whenever included. Threshold met last period has a somewhat significant impact at the 5% level when included by itself, dropping to 10% significance when included with the first investment time variable. These regression results indicate that there is a significant difference in the success of reaching the threshold between *d1PG* and *d4PG*; however, the difference is not as significant as the variation in individual payoff, this suggests some other behaviour is also reducing efficiency when there are multiple public goods.

Group members can view the current total invested to all public goods separately. If the current total to a particular public good is 77 tokens or more the group member can reach the threshold using their endowment tokens alone. One would expect that if the threshold is within reach of one person's endowment, they will choose to invest as they would gain access to the bonus.

[34] Stata would not allow a lag independent variable as well as cluster robust standard errors.

For example, if the current total is 77 tokens and the individual is the last to invest, she would need to invest their entire endowment of 55 tokens to reach the threshold. If she chose to invest, she would earn 162 tokens compared to 110 if she chose to free ride by investing 0 tokens. One caveat would be if she were not the last person to invest, as she might wait to free ride on the third group member's investment. Additionally, they may be influenced by fairness similar to the argument for leaders in Chapter 2.

Table 4.6 Frequency of reaching Threshold being met if within reach

	One Public Good	Four Public Goods
Threshold met	90.28% (130)	83.05% (98)
Threshold not met	9.72% (14)	16.95% (20)

Note: Numbers in parentheses are the number of occurrences.

Table 4.6 details whether the threshold was always met when the threshold was within reach for one individual. Not successfully meeting the threshold occurred more often in the *d4PG* treatment than in the *d1PG* treatment when within reach. There is evidence of some calculation issues occurring; for both treatments, there is only one instance where the individual chose to free ride, in all other cases where the threshold is not met the individual still invested a positive amount. Not reaching the threshold may have been due to the expectation that another group member would invest. However, in both treatments, there are two instances when the threshold was not reached, and the individual was third to invest.

4.4.3 Individual Investment Behaviour

Now, moving on to an analysis of the number of tokens invested at the individual level. For *d4PG*, the average investment includes investment to any of the four public goods. Average investment for *d1PG* is 31.21 versus 31.39 for *d4PG*. Treating each group as an independent observation there is an insignificant difference between the average investment between the two treatments (Mann-Whitney, p=1.00).

Figure 4.3 Average Investment by Treatment

Figure 4.3 shows individual investment level averaged by period and treatment. The dashed red line represents an investment of 33 tokens. 33 tokens would be considered a 'fair' investment as it splits the burden of reaching the 132 tokens equally among group members. Both treatments follow a similar pattern of investment levels, which is relatively stable across the 12 periods rather than the typical trend of declining average investment usually observed in public good experiments (Ledyard 1995). Corazzini, Cotton and Valbonesi (2015) found a significant difference between 1G and 4G_EE and declining investments for both of those treatments. Markedly in Figure 4.3, the average investment in either treatment rarely surpasses the fair Nash equilibrium where group members invest 33 tokens each.

Table 4.7 Average Investment by Treatment[35]

Period	1	1-4	5-8	9-12	12	All
D1PG	30.52	31.10	31.46	31.06	32.47	31.21
	(1.82)	(0.88)	(1.01)	(1.01)	(2.16)	(0.56)
D4PG	29.88	31.75	31.74	30.68	32.48	31.39
	(2.82)	(1.39)	(1.44)	(1.26)	(2.48)	(0.79)
D1PG-D4PG	0.64	-0.65	-0.28	0.38	-0.01	-0.18

Note: Numbers in parentheses are standard errors. Row 3 shows results from Mann-Whitney comparisons taking each group as a separate observation with significance indicated at * for 10%, ** for 5% and *** for 1%.

Table 4.7 details the average investment across all public goods showing the start, middle and end segments of the experimental session. The difference in investments between treatments remains small across the session. None of the Mann-Whitney comparisons are significant. The average, however, does not give an indication of the distribution of investment levels, which is of importance in relation to problem (c) stated in Section 4.2.1.

Table 4.8 Frequent Investment Levels (above 50 observations)

Tokens Invested	All	d1PG	d4PG
33	11.06% (115)	11.25% (63)	10.83% (52)
30	10.19% (106)	13.39% (75)	6.46% (31)
40	9.71% (101)	9.46% (53)	10.00% (48)
55	8.94% (93)	5.00% (28)	13.54% (65)
35	8.56% (89)	12.32% (69)	4.17% (20)
0	6.73% (71)	5.89% (33)	7.92% (38)
50	5.19% (54)	4.82% (27)	5.63% (27)
20	4.90% (51)	4.29% (24)	5.63% (27)
25	4.90% (51)	5.18% (29)	4.58% (22)

Note: Numbers in parentheses represent the number of occurrences.

Table 4.8 shows the most frequently invested number of tokens. Notably, the fair Nash equilibrium of 33 tokens each is the most frequently observed investment level in both treatments. Comparing the differences in the common values between treatments, there are some interesting observations. Firstly, free riding prevalence is similar for both treatments and will be discussed in more detail later. Secondly, an investment of full endowment (55 tokens) occurs more

[35] Equivalent data for the static treatments from Corazzini, Cotton and Valbonesi (2015) are not included in Table 4.6 as they are not freely available.

frequently in *d4PG* at the 1% significance level than the *d1PG* treatment (proportions test, p<0.01 at the treatment level). Some other noticeable differences are the higher levels of frequency with which investment levels of 30 and 35 occur in the *d1PG* treatment compared to the *d4PG* treatment.

In *d1PG*, 5.89% of all potential investments are zero and this proportion is not significantly lower than the 7.92% in *d4PG* (Mann-Whitney, p=0.14 with the group as the unit of observation). This proportion of zero investment for *d4PG* is much lower than the 24% prevalence found in 4G_EE (see Table 4.9 below). However, the 6.3% percentage of zero investments in 1G is similar to the percentages found in these dynamic investment treatments. Additionally, there are no instances where all group members invest zero in the *d1PG* treatment and only one example in the *d4PG* treatment.

Table 4.9 Percentage of zero token investment by Treatment

Period	1	1-4	5-8	9-12	12	All
D1PG	0.04	0.03	0.07	0.07	0.06	0.06
D4PG	0.13	0.11	0.09	0.04	0.03	0.08
1G	0.04	0.05	0.05	0.08	0.13	0.06
4G_EE	0.23	0.19	0.27	0.27	0.27	0.24
D1PG-D4PG	-0.08	-0.08	-0.02	0.03	0.04	-0.02
1G-4G_EE	-0.19***	-0.14**	-0.21	-0.18	-0.15	-0.18

Note: Rows 3, 4 and 6 are taken from Corazzini, Cotton and Valbonesi (2015) appendix supplementary material. Rows 5 and 6 state results from running Mann-Whitney tests taking each group as an independent observation.

Table 4.9 shows the proportion of zero level investment occurring across the experiment. The real-time environment seems to reduce the percentage of individuals investing zero when there are multiple public goods. There is no such decrease when there is one public good. Between the static treatments, Corazzini, Cotton and Valbonesi (2015) found there to be a significant difference in the proportion of zero level investments for the first four periods of the experiment. For the dynamic treatments, there is no significant difference, and zero level investments become less prevalent in the *d4PG* treatment compared to the *d1PG* by the end of the experiment.

So far it has been established that the presence of multiple public goods leads to lower levels of efficiency; however, this is not due to differences in individual investment to all public goods or presence of zero level investment. Now another type of inefficiency will be considered, the existence of individuals who make investments to more than one public good.

Table 4.10 Proportion of Multiple Public Good Investments

Period	1	1-4	5-8	9-12	12	All
D4PG	0.48	0.34	0.23	0.14	0.18	0.23
4G_EE	0.48	0.29	0.08	0.04	0.04	0.14

Table 4.10 details the proportion of group members investing in more than one public project at the beginning, middle and end of the experiment. Learning seems to be present, as the level of zero level investment and investments to multiple public goods falls from the first to the final period. However, when compared to the static treatment, individuals in *d4PG* are not learning as quickly to invest in only one project.

A secondary focus of Corrazini, Cotton and Valbonesi (2015) was to understand whether one of the four public goods could be made more salient. Although this is not a focus of this study, it was found that one of four public goods was funded more often than the other 3. Of the 66 instances a threshold was met in *d4PG*, 56.06% of those were for the Trapezoid account. The other 3 (Diamond, Rectangle, and Square) were 10.61%, 16.67% and 16.67% respectively. Further, 5 of the 12 groups always funded one particular public good when there was successful funding. This somewhat indicates that groups coordinate on one public good even when there are multiple options.

4.4.4 Total Investment

Since the individuals are placed into groups which remain constant throughout the experiment, one would suspect there to be interdependence of individual choices within each group. Treating each group independently, there is an insignificant difference in the level of total investment between treatments (Mann-Whitney, p=1.00).

Table 4.11 Generalised Least Squares Regression results for Total Investment

	(1)	(2)	(3)
Treatment	1.24	4.38	2.18
	(9.95)	(9.06)	(8.67)
Met Threshold last period		14.17	10.55
		(5.44)***	(5.29)**
First Investment Time			-1.04
			(0.11)***
Constant	123.09	109.75	124.08
	(15.89)***	(14.42)***	(12.85)***
Wald chi2	0.02	8.60**	126.91***
Obs	260	238	238

Note: Numbers in parentheses are standard errors, and these are clustered on the group variant. ***, **, and * represent significance at the 1%, 5% and 10% respectively.

Table 4.11 shows the results from running regressions with total investment as the dependent variable. The base treatment for these regressions is the *d1PG* treatment. Treatment does not significantly impact total investment in any of the regressions, this consistent with the insignificance found through the Mann-Whitney comparisons. The threshold met last period variable, which equals one if the group successfully funded a public good last period and 0 otherwise, is significant at the 1% level if included alone and at the 5% level if included with the first investment time variable. First investment time is the time in seconds for the first investment decision to be made; note this need not be a positive level of investment. The negative and significant coefficient indicates that the later the first investment takes place, the less total investment there will be.

4.4.5 Timing of Investments

For these treatments, individuals were free to invest at any time within 120 seconds; the investment screen, however, did not time out. The average time (in seconds) taken for individuals to make an investment for the *d1PG* treatment is 26.55 and 32.65 for *d4PG*. Treating each group independently the average time taken for group members to make their investments is significantly different between treatments at the 5% significance level (Mann-Whitney, p=0.03).

Figure 4.4 Average Investment Time (in seconds) by Period

Figure 4.4 shows the time (in seconds) taken to make an investment decision averaged by period and treatment. In both treatments, group members are becoming faster at making their investment decisions as the experiment progresses, which is to be expected as the participants become accustomed to the experimental procedure.

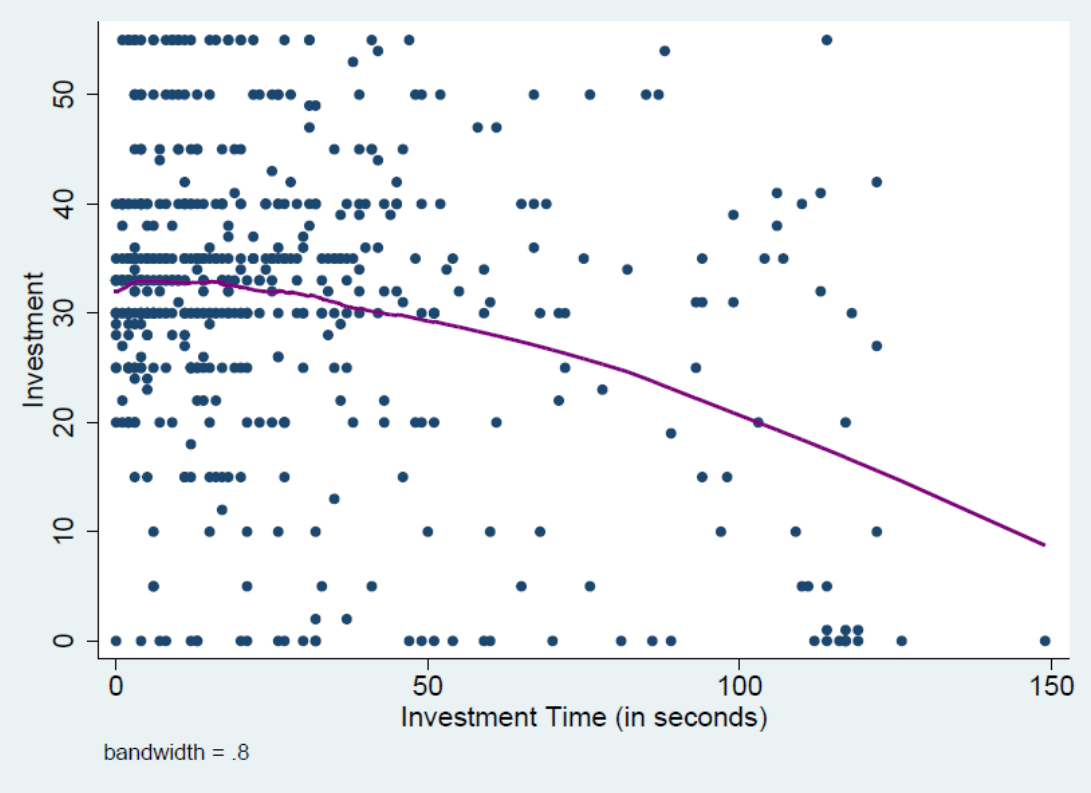

Figure 4.5 Relationship between Investment and Investment Time taken for d1PG treatment

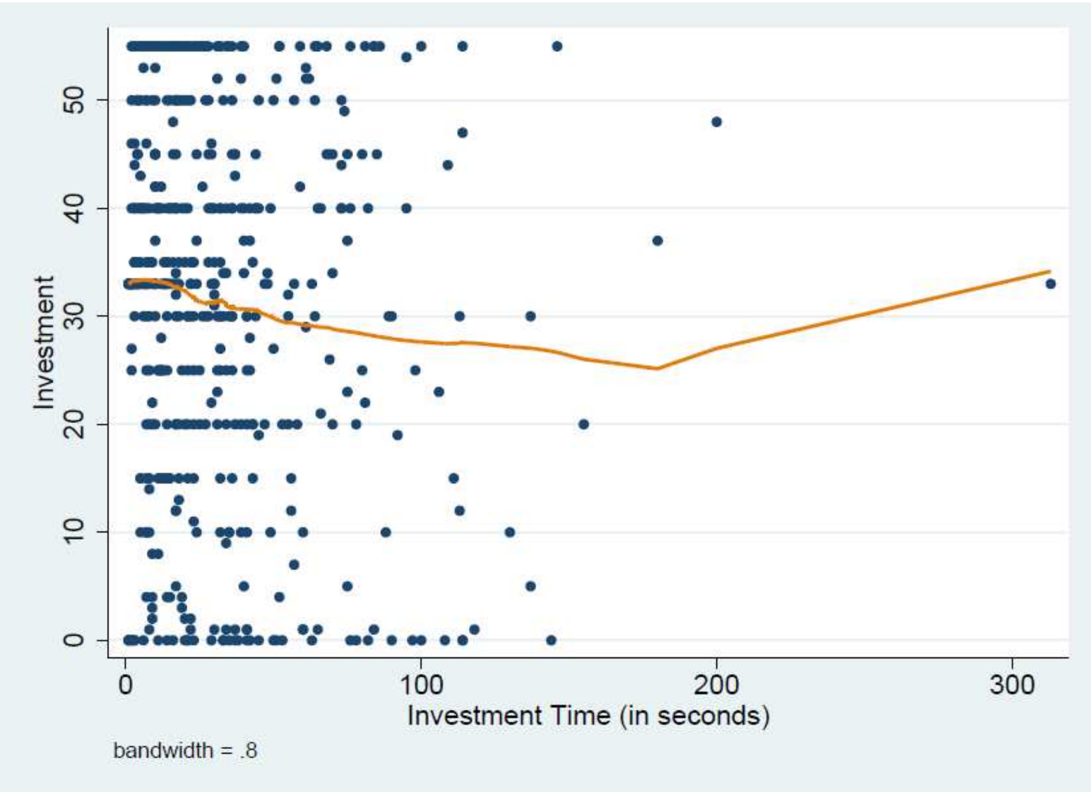

Figure 4.6 Relationship between Investment and Investment Time taken for d4PG treatment

Figures 4.5 and 4.6 show the relationship between time of investment and the level of investment for the *d1PG* and *d4PG* respectively. Note that times outside of the 120 seconds are late investors, and there are not many of these. The investment time does not seem to impact the level of investment in the *d4PG* treatment. Whereas investment level decreases as the time taken to make the decision increases for the *d1PG* treatment, this result is consistent with Nielsen, Tyran and Wengström (2014) who found free riders take longer to make their investment decisions in a linear public good game.

In this real-time environment, investments are made sequentially. Based on the observations from previous experiments on charitable giving, one would suspect that individuals within this experiment will be positively influenced by previous investments they observe.

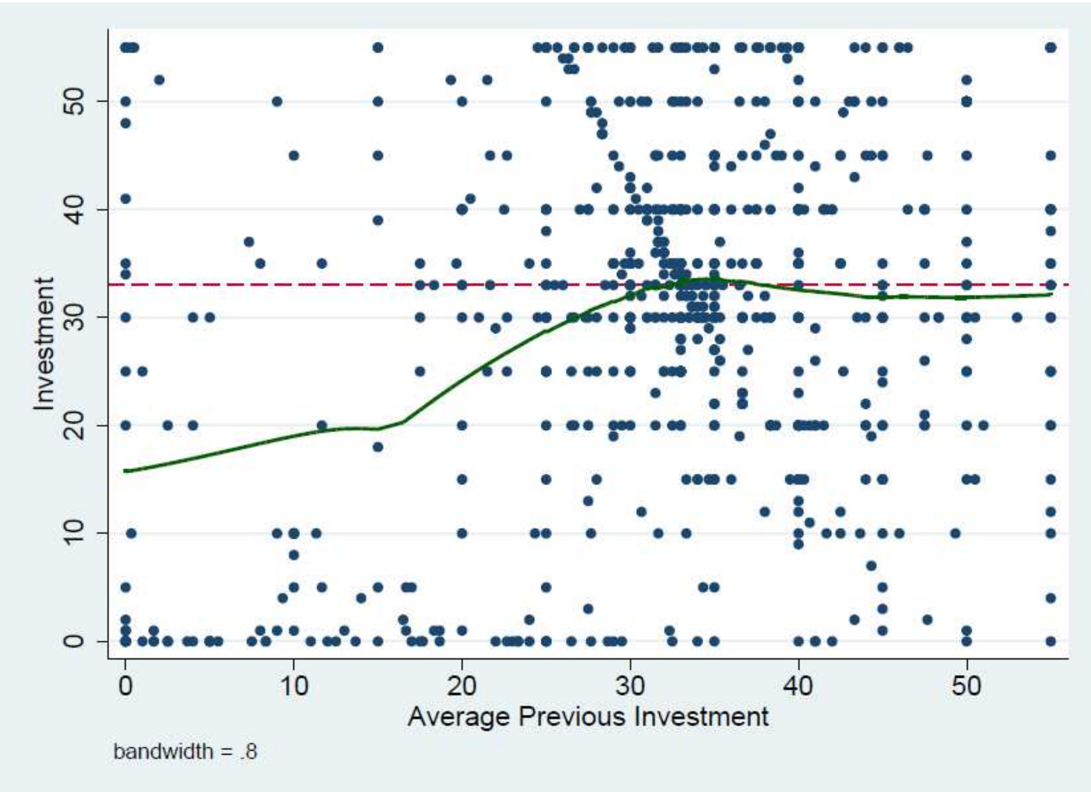

Figure 4.7 Follower Reciprocity for both treatments

Figure 4.7 illustrates a non-parametric relationship between the individual's investment to the public goods and the average of the previous investments. The dashed red line represents 33 tokens which is the fair investment if the threshold was exactly funded by all four group members split equally. There is evidence of positive reciprocity up until this point.

4.5 Discussion

4.5.1 Treatment effects

In the experiment, it was found that the presence of multiple public goods reduces efficiency significantly when compared to one public good. There is, however, not a significant difference during the second half of the experiment, suggesting that it takes longer for groups to coordinate in the presence of multiple public goods. Successfully funding a project, i.e. reaching a threshold, occurs significantly more often during the *d1PG* treatment compared to the *d4PG* treatment. Again, the significance is only apparent at the start of the experiment. The increases in efficiency of the *d4PG* treatment closely follow the increases in the proportion of groups reaching a threshold as shown in Figures 4.1 and 4.2.

There is an insignificant difference in investment levels between treatments across the entire experimental session. Therefore it is unlikely that the lower efficiency levels in *d4PG* are caused by differences in total investment (also evidence of this in Table 4.11). Likewise, there is an insignificant difference in the prevalence of free riding. However, investment levels in Figure 4.3 and Table 4.7 include investments to all public goods, and hence do not consider account for investments split over multiple projects. Since only one project can be fully funded, along with a no refund policy means that if an individual invests to more than one public good, it reduces efficiency. The frequency of individuals investing to multiple public goods falls during the course of the experiment, but there still is a significant proportion (17.5%) of individuals that invest in more than one public good in the final period.

4.5.2 Static to Dynamic

The outcomes from these dynamic treatments are compared to equivalent static treatments from Corrazini, Cotton and Valbonesi (2015). As stated by the hypothesis, one suspected that the real-time environment would solve the coordination problem involved with multiple public goods. However, the experimental results reject this hypothesis, the presence of multiple public goods still reduces efficiency as found in a simultaneous investment environment. This is an endorsement of the result in Corazzini, Cotton and Valbonesi (2015).

The individual payoff is lower in the dynamic treatments compared to the static environment although the difference is minimal. Yet, the average individual investment level is more stable for the dynamic treatments. There was no significant difference in investment levels between dynamic treatments, whereas Corazzini, Cotton and Valbonesi (2015) found investment lower in the presence of multiple public goods. The real-time environment fixes the problem of free riding in the presence of multiple public goods. There is a vast drop in free riding between *d4PG* treatment and 4G_EE treatment as shown in Table 4.9. However, the benefit in efficiency of lower free riding is offset by the increase of individuals investing to more than one public good in the *d4PG* treatment (Table 4.10). The reduction of free riding could be due to the decrease of risk involved in investment decisions; risk-averse individuals can 'wait and see' what other group members do before making their decision (Bliss and Nalebuff, 1984). This option is not available when investments are made simultaneously.

Corazzini, Cotton and Valbonesi (2015) ran further treatments (4 goods one less efficient, 4 goods one more efficient and 4 goods random signal) to test for the impact of saliency on solving the coordination problem involved in multiple public goods. They found that salience solved the coordination problem only if the good was more efficient as well as salient. Saliency is not of key interest for this chapter, however, the most left project on the investment screen in the *d4PG* treatment, namely the Trapezoid public good, had a much higher rate of success than any other project. This result suggests that the most left project is most salience despite being of equal efficiency, and one would suspect it is because individuals typically read from left to right. On Kickstarter, projects tend to be listed in multiple rows so it is also likely that projects on the top row will be funded compared to those in lower rows as well as the projects furthest left on the screen.

There also appears to be saliency in levels of investment; for both treatments a 'fair' investment level, 33 tokens, is the most frequently invested amount in both dynamic treatments. The other frequently invested amounts are in multiples of 5 which could be due to the endowment of 55 tokens making five more salient.

4.5.3 Endogenous Timing of Investments

The time of the first investment to the public project/s has a significant impact on both total investment and the success of reaching a threshold. The results from Table 4.11 indicate that the later the first investment decision by any member of the group, the lower the total investment. This result is similar to that found in Chapter 3 that people that choose to lead invest significantly more than those who choose to follow. Leaders that move earlier also may be investing more; from Figures 4.5 and 4.6 this would appear to be true for the *d1PG* treatment but not for *d4PG.*

Figure 4.7 also shows that individuals that wait to make their investment decision, positively reciprocate previous investments. This result is consistent with evidence from prior studies (e.g. Fischbacher, Gächter and Fehr 2001; Alpizar, Carlsson and Johansson-Stenman 2008; Shang and Croson 2009). However, positive reciprocity is only present up to an investment level of 33 tokens. It would appear from Figure 4.7 that even when the average previous investment is above 33 tokens, the current individual considers 33 tokens a sufficient level, potentially sufficiently 'fair'.

4.5.4 Anonymity

In all treatments, the investors remained anonymous; however in reality, there are often instances where investors will be known. Kim and Viswanathan (2016) found that the reputation of early investors influences whether a project will be funded. Additionally, Andreoni and Petrie (2004) found that the ability to identify donors via photographs increases investment. Therefore, it is possible that the level of investment is under-estimated in the laboratory setting. Regarding experimental set-up, the total investment for each public good is known (as shown in Appendix A4.1) rather than the distribution of investments. Often the distributions of donations are known as well as the total level is known; this is particularly relevant for online charitable fundraising sites on JustGiving. However, if individuals are paying close attention to the investment screen, they may be able to calculate how much each individual invested, based on updates to the investment screen.

4.6 Conclusion

The experimental design in this chapter follows closely the design of Corazzini, Cotton and Valbonesi (2015). A treatment with one threshold public good *d1PG,* is compared to a treatment with four identical threshold public goods, *d4PG*. In both treatments, investments are made in a real-time environment which makes the laboratory setting more akin to the sequential nature of fundraising on online charitable platforms (e.g. JustGiving and VirginMoneyGiving) and crowdfunding platforms (e.g. Kickstarter and Crowdfunder). Therefore, in this chapter, individuals choose *how much* to invest, *when* to invest and *where* to invest.

The key finding is that despite the expectation that the real-time environment would help solve the issue of coordination involved with multiple public goods, efficiency was found to be lower in the *d4PG* treatment than the *d1PG* treatment. Lower levels of efficiency in *d4PG* appear to be due to a significant proportion of individuals investing in more than one public good meaning that the success of reaching the threshold is significantly lower as well. As aforementioned there can be thousands of projects vying for funding at one time. Thus one would suspect that the increasing number of crowdfunding projects decreases overall efficiency. This experiment may underestimate the decreases in efficiency as the multiple public good treatment considers only four public goods.

There are some potential caveats to the statement above, as here the four public goods in the *d4PG* treatment are identical. This experiment, therefore, does not incorporate the heterogeneity of quality of real-world projects such as accounting for potential creator incompetence, fraud or project risk (Agrawal, Catalini and Goldfarb 2013). This, however, was not the aim of the study. This could be a topic to be explored in future research of a more qualitative nature. For instance, it would be of importance to understand how interchangeable projects are to potential investors. A limitation of the experimental design is the certainty of parameters, since in both treatments the potential number of investors and bonus is known. In reality, these are not certain. For instance, Mollick (2014) found that crowdfunding projects deliver on time only 10% of the time, and many deliver benefits late. Boudreau et al. (2015) note that many crowdfunding projects offer only intangible gifts for donations which are not accounted for in this study.

A no refund rule was implemented in this experiment; this policy is typically implemented for online charitable fundraising such as on JustGiving.com, where donations are taken even if the fundraiser does not reach their target. It is, however, different to the policy of crowdfunding websites such as Kickstarter whereby project creators must reach their target within a set period and only then can they claim the investments. It would be of interest to extend this experimental design to consider what impact a refund rule would have on the coordination problem; one would suspect it could make the situation worse as group members would have less incentive to coordinate. Again, this experiment may underestimate the detrimental impact of multiple public goods. In this experiment, individuals were given the current total and the number of donors, while in real world crowdfunding the previous donations tend to be stated in categories. Cartwright and Patel (2013) found that both high and low category thresholds, the donation level at which donors are recognised, can increase donations and that it can always do better than exact reporting.

Regarding the endogenous timing of investments, it was found that the earlier the first investment is made, the higher the total investment. This result again emphasises the importance of leadership and taking the initiative (Bruttel and Fischbacher 2013) for overall efficiency. Early investments, in reality, could indicate popularity for a project and higher faith that the project will reach its threshold. Early movers' investments are also important as it is found that individuals who wait to invest will positively reciprocate previous investments. Consistent with Shang and Croson (2009) there is a cap on the positive impact on the level of previous donations. They found the cap to be 95% of the prior distribution; here the cap is the 'fair' investment of 33 tokens. Considering later investments, for some popular crowdfunding projects, it is possible to invest a late pledge, for example, Dark Souls board game (Kickstarter, 2016c) where individuals can ‘fund’ the project after the project has reached the threshold.

CHAPTER 5
CONCLUSION

5.1 Summary of Results

This research examined the impact of first followership in solving cooperation and extended the topic of shared leadership to public good games. It also expanded the knowledge of both exogenous and endogenous leadership in public good provision.

Chapter 2 investigated the impact of four alternative investment sequences on efficiency in a linear public good game both theoretically and experimentally. Two new games were introduced to the literature: the First Follower game and the Two Leader game. The First Follower game has three investment stages, where in the first stage, a leader invests, in the second stage a first follower invests and the rest of the group invests in the third stage. As a comparator, a Two Leader game is considered which has two investment stages, where in the first stage, two leaders simultaneously invest then the rest of the group simultaneously invest in the second stage. The incentives of early movers (leaders and first followers) to invest a positive amount are examined theoretically assuming they believe a proportion of the followers are conditional cooperators. The treatments are ranked according to the level of expected investment and no one treatment is always highest.

Given the parameters (group size, MPCR and endowment) utilised in the experiment, leaders have the strongest incentive to invest during the Leader game. Consequently, the Leader game was hypothesised to have the highest total investment. However, the First Follower game was observed to have the highest level of total investment and leaders on average invested most in this treatment. The experimental data was however compatible with the hypothesis that the First Follower treatment would have higher public good provision than the Two Leader game and the Sequential game. The increase in total investment is, however, not significantly different to the other treatments. One reason for the observed insignificance is the higher than expected investment observed in the Two Leader game. Follower behaviour is assumed to be similar across treatments; as shown by Figure 2.5 the level of follower reciprocation does not significantly differ between treatments. The first follower in the First Follower treatment reciprocates a larger proportion than later followers which matches Figuières, Masclet and Willinger's (2012) finding of vanishing leadership in a sequential public good game.

Chapter 3 examined whether three investment stages (three-day treatment) leads to higher total investment than two investment stages (two-day treatment). Timing of investments was endogenous, and there was no restriction on the number of group members who can invest in each stage. In the two-day treatment, individuals could choose to lead, by investing on day one or follow by investing on day two. In the three-day treatment, individuals could lead by investing on day one, be a first follower by investing on day two or follow by investing on day three. The three-day treatment leads to a significantly higher total investment, stemming from the larger proportion willing to invest as leaders. Observed willingness to lead is higher than previous studies but decreases to previously observed levels exhibited as the experiment progresses. Seldom did group members choose to be first followers, but the emergence of at least one first follower led to significantly higher total investment. Similar to Chapter 2, first followers in this second experiment reciprocate more than later followers. Endogenous leaders, those investing on day one in the two-day and three-day treatments, are compared to exogenous leaders from Chapter 2, and the difference in investment is insignificant.

Chapter 4 ties together two existing concepts in the public good literature: the existence of multiple public goods and the real-time environment. Two treatments are considered, a one threshold public good treatment and a four threshold public good treatment. It was expected that the real-time environment would solve the coordination problem involved with multiple public goods detected by Corazzini, Cotton and Valbonesi (2015). Nevertheless, the presence of multiple public goods still led to significantly lower efficiency in a real-time environment. The inefficiency is caused by subjects investing in multiple public goods when only one can be fully funded. This dynamic environment is compared to the static environment treatments from Corazzini, Cotton and Valbonesi

(2015), where individuals choose simultaneously. Dynamic and static comparative treatments have similar levels of investment but investments are more stable during the course of the experiment in the dynamic treatments.

5.2 Implications of findings

The investment sequences with shared leadership or first followership led to the highest levels of public good provision indicating that a first follower or shared leadership institution may be preferable to those with one leader. This result is interesting given the focus on one leader in the existing literature and thought-provoking given the changes to the investment sequences are relatively minimal. The finding also may indicate that at least two people are required to create a social norm. It is, however, of importance to re-run this experiment with different parameters, as the theory indicates that the expected investment should change. The lower levels of efficiency in the Leader game could also be caused by lack of additional information that a leader would have in an asymmetric information environment.

The First Follower game rarely emerged organically in the second experiment. However, if there is at least one first follower in the three-day treatment leads to higher total investment, further stressing the benefit of first followers. The flexibility of the experimental designs implemented in Chapter 3 mean that not only could anyone nominate to lead, but everyone could lead. There is a higher proportion of individuals willing to lead than found in previous endogenous leadership studies, and arguably this implies that this type of institutional design promotes taking the initiative (Bruttel and Fischbacher, 2013). Restricting the number of possible leaders to one, as in previous studies, may have also reduced the number of individuals willing to nominate. Willingness to lead does however decrease as the experiment progresses. This reduction of leaders may be caused by individuals wishing to reduce their investment but not wanting this information to be known to subsequent investors as indicated by the lower average invested in later stages.

The effectiveness of endogenous leadership, Chapter 3, is found to be insignificantly different to exogenous leadership, Chapter 2. The majority of previous studies found endogenous leadership to be superior (Rivas and Sutter, 2011, Centorrino and Concina 2013 and Haigner and Wakolbinger, 2010). One reason for the insignificance observed could be that the leaders in the second experiment are not a direct comparator of the first experiment. For instance, the leaders in Chapter 2 are randomly selected from the group and hence more representative of average behaviour than self-selected leaders in Chapter 3. One fundamental difference between the experimental designs is that the number of followers is known to leaders in Chapter 2 but not in Chapter 3. Nevertheless, this finding of insignificance has interesting implication for institutional structure for public good provision. It suggests that a more laissez-faire approach will not significantly reduce total investment. To apply either of the treatments in Chapter 3 an institution would need only to specify the number of investment stages. Implementing any of the structures from the first experiment would require the number of investment stages, the number of individuals investing during each stage and a random selection process. Additionally, in all three experiments prior investments are perfectly observable. As found by Figuières, Masclet and Willinger (2012) a sequential order without observation does not increase investment compared to simultaneous, implying that an institutional design would require observability of prior investments to be effective.

The majority of investments took place on days one and three in the three-day treatment; this investment behaviour is comparable to that found in real world crowd-funding where funding often takes place on the first and last week (Kuppuswamy and Bayus, 2015). This finding is intriguing considering that crowd-funding is more akin to a threshold public good game implemented in Chapter 4 than a linear public good game as in Chapter 2 and Chapter 3. The inability of the real-time environment to solve the coordination problem involved in multiple public goods is particularly concerning for provision of crowd-funding projects. The multiple public good treatment considered only four public goods, where in reality, there can be thousands of crowd-funding projects competing for funding at any one time. One caveat is that the public goods considered in Chapter 4 were homogenous where creators of crowd funding projects may be able to differentiate themselves from competing projects.

5.3 Future Research

The first two experiments established the importance of first followership in impacting group behaviour, however all treatments were in the context of a linear public good game. Therefore, it is important to establish whether the presence of a first follower significantly changes group behaviour in other contexts. For example, does a first follower solve the coordination problem involved in multiple threshold public goods. Arguably, a less extreme expansion of this research could include belief elicitation of what individuals expect others to invest. This would clarify whether individuals believed they were leaders in the experiment in Chapter 3. It would also aid in clarifying the level of follower reciprocation expected by early movers.

The three core chapters rely on experimental data; it would be interesting to extend this research to the field, especially given the potential implications for organisational effectiveness and charitable fundraising. I would be particularly keen to test the imposition of the first follower structure to charitable collections or the treatments from the second experiment whereby investments could be announced after every day rather than updating in real time.

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CHAPTER 2 APPENDIX

A2.1. Proofs of main theorems

Proof of Theorem 1: The Leader game is examined in Chapter 2 and the sequential game by Cartwright and Patel (2010). Consider the Two Leader game. Suppose player 1 and player 2 are the first movers and player 1 is a strategist. Let L denote the investment of player 1 and K the investment of player 2. From the perspective of player 1, the expected investment of each second mover is $p_1(L+K)/2$. So the expected payoff of player 1 is

$$U(L) = E - L + m\left(L + K + \frac{(n-2)p_1(L+K)}{2}\right) \quad (A2.1)$$

Differentiating U(L) with respect to L and setting equal to zero gives the advertised critical value of p_1.

Consider next the First Follower game. Suppose that player 1 is the first mover and a strategist. Let L denote the investment of player 1. If the second mover is a conditional cooperator, she will invest L. If the second mover is a strategist she will (see Proposition 2 for a formal proof of this) invest an amount independent of L. Let K denote the amount player 1 expects a strategic second mover would invest. The expected payoff of player 1 can then be written

$$U(L) = E - L + m\left(L + p_1(1+(n-2)p_1)L + (1-p_1)\left(K + \frac{(n-2)p_1(L+K)}{2}\right)\right) \quad (A2.2)$$

Differentiating with respect to L gives

$$\frac{\partial U(L)}{\partial L} = -1 + m\left(1 + p_1(1+(n-2)p_1) + (1-p_1)\frac{(n-2)p_1}{2}\right) \quad (A2.3)$$

Setting this equal to 0 and simplifying gives

$$m = \frac{2}{(1+p^{FF})(2+(n-2)p^{FF})} \quad (A2.4)$$

Solving the quadratic formula gives the desired expression for p^{FF}.■

Proof of Theorem 3: There are various methods one could use to compare expected total investment in different organisational structures. In the following, an approach is used that seems particularly informative and transparent. For completeness, the exercise is worked through in full although there are clear redundancies that could be exploited to prove Theorem 3.

Consider the Two Leader and First Follower comparison. The type and beliefs are fixed for players 1 and 2 and the expected investments from the First Follower and Leader games are is compared. Concerning player 1, there are four possibilities which need to be considered: (i) Player 1 is a conditional cooperator (CC), (ii) player 1 is a strategist and has beliefs $p_1 < p^{FF}$, (iii) player 1 is a strategist and $p^{FF} \leq p_1 < p^{2L}$, and (iv) player 1 is a strategist and $p^{2L} \leq p_1$. With regard to player 2 there are three possibilities which need to considered: (i) player 2 is a conditional cooperator (CC), (ii) player 2 is a strategist and has beliefs $p_2 < p^{2L}$, (iii) player 2 is a strategist and $p^{2L} \leq p_2$. In Table A2.1 the resulting 12 combinations are worked through and details the expected investment in the first follower and two leader games.

In most instances, there is no difference in expected investment. What one needs to do is pick up the four cases where there is a difference and evaluate the probability of each case. For instance, the probability that player 1 is a strategist with beliefs $p_1 < p^{FF}$ and player 2 is a conditional cooperator is given by $(1-p)G(p^{FF})p$. One therefore, gets that $X^{FF} \geq X^{2L}$ if and only if

$$(1-p)(G(p^{2L}) - G(p^{FF}) \geq (1-p)G(p^{FF})p \quad (A2.5)$$

This reduces to the expression given in Proposition 3(a).

Table A2.1 Differences in Expected Total Investment between the First Follower and Two Leader games conditional on the Type and Beliefs of Players 1 and 2.

Player 1	Player 2	X^{FF}	X^{2L}	$X^{FF} - X^{2L}$
CC	CC	$E(2+(n-2)p)$	$E(2+(n-2)p)$	0
CC	$p_2 < p^{2L}$	$E\left(1+\frac{(n-2)p}{2}\right)$	$E\left(1+\frac{(n-2)p}{2}\right)$	0
CC	$p^{2L} \le p_2$	$E(2+(n-2)p$	$E(2+(n-2)p)$	0
$p_1 < p^{FF}$	CC	0	$E\left(1+\frac{(n-2)p}{2}\right)$	$-E\left(1+\frac{(n-2)p}{2}\right)$
$p_1 < p^{FF}$	$p_2 < p^{2L}$	0	0	0
$p_1 < p^{FF}$	$p^{2L} \le p_2$	$E\left(1+\frac{(n-2)p}{2}\right)$	$E\left(1+\frac{(n-2)p}{2}\right)$	0
$p^{FF} \le p_1 < p^{2L}$	CC	$E(2+(n-2)p)$	$E\left(1+\frac{(n-2)p}{2}\right)$	$E\left(1+\frac{(n-2)p}{2}\right)$
$p^{FF} \le p_1 < p^{2L}$	$p_2 < p^{2L}$	$E\left(1+\frac{(n-2)p}{2}\right)$	0	$E\left(1+\frac{(n-2)p}{2}\right)$
$p^{FF} \le p_1 < p^{2L}$	$p^{2L} \le p_2$	$E(2+(n-2)p)$	$E\left(1+\frac{(n-2)p}{2}\right)$	$E\left(1+\frac{(n-2)p}{2}\right)$
$p^{2L} \le p_1$	CC	$E(2+(n-2)p)$	$E(2+(n-2)p)$	0
$p^{2L} \le p_1$	$p_2 < p^{2L}$	$E\left(1+\frac{(n-2)p}{2}\right)$	$E\left(1+\frac{(n-2)p}{2}\right)$	0
$p^{2L} \le p_1$	$p^{2L} \le p_2$	$E(2+(n-2)p)$	$E(2+(n-2)p)$	0

Consider next the Leader and First Follower comparison. The above exercise can be repeated with a slight tweak to the possibilities needed to consider with regard to player 1. In Table A2.2 the relevant 12 combinations are worked through. As you can see, this comparison is more complicated than the Two Leader comparison. If one proceeds directly to write down an if and only if condition an expression is found that is tough to interpret. The assumption that $G(p^{FF}) = 0$ allows one to derive a simple expression. In particular, $X^{FF} \ge X^{L}$ if and only if

$$p(1-p)\big(1-G(p^{2L})\big)+(1-p)^2\big(1-G(p^{2L})\big)$$
$$\geq \frac{(n-2)p}{2}(1-p)^2G(p^{2L}) \quad (A2.6)$$

This reduces to the expression given in Proposition 3(b). One can briefly comment on what happens if the $G(p^{FF})=0$ assumption is relaxed then this leads to several cases where the leader game maximises investment and only one where the first follower game does. Moreover, the one case where the first follower game fares well requires the somewhat unlikely combination of $p_1 < p^L$ and $p_2 > p^{2L}$.

Table A2.2 Differences in Expected Total Investment between the First Follower and Leader games conditional on the Type and Beliefs of Players 1 and 2.

Player 1	Player 2	X^{FF}	X^L	$X^{FF}-X^L$
CC	CC	$E(2+(n-2)p)$	$E(2+(n-2)p)$	0
CC	$p_2 < p^{2L}$	$E(1+(n-2)p)$	$E(1+(n-2)p)$	0
CC	$p^{2L} \leq p_2$	$E(2+(n-2)p$	$E(1+(n-2)p)$	E
$p_1 < p^L$	CC	0	0	0
$p_1 < p^L$	$p_2 < p^{2L}$	0	0	0
$p_1 < p^L$	$p^{2L} \leq p_2$	$E\left(1+\frac{(n-2)p}{2}\right)$	0	$E\left(1+\frac{(n-2)p}{2}\right)$
$p^L \leq p_1 < p^{FF}$	CC	0	$E(2+(n-2)p)$	$-E(2+(n-2)p)$
$p^L \leq p_1 < p^{FF}$	$p_2 < p^{2L}$	0	$E(1+(n-2)p)$	$-E(1+(n-2)p)$
$p^L \leq p_1 < p^{FF}$	$p^{2L} \leq p_2$	$E\left(1+\frac{(n-2)p}{2}\right)$	$E(1+(n-2)p)$	$-E\frac{(n-2)p}{2}$
$p^{FF} \leq p_1$	CC	$E(2+(n-2)p)$	$E(2+(n-2)p)$	0
$p^{FF} \leq p_1$	$p_2 < p^{2L}$	$E\left(1+\frac{(n-2)p}{2}\right)$	$E(1+(n-2)p)$	$-E\frac{(n-2)p}{2}$
$p^{FF} \leq p_1$	$p^{2L} \leq p_2$	$E(2+(n-2)p)$	$E(1+(n-2)p)$	E

Finally, one can examine the first Follower and sequential comparison. Recall that $p^{FF} < p^S$. This implies that the expected investment of the first mover is weakly higher in the first follower than sequential game. If $G(p^{S2})=1$ then the second mover in a sequential game will invest 0. So, the expected investment of the second mover is weakly higher in the first follower than sequential game. It follows immediately that expected total investment is weakly higher in the first follower than sequential game. ■

A2.2 Examples of Total Investment

In this appendix, the relative ranking of the different organisational structures regarding predicted efficiency varies on the parameters n, m, p and G is illustrated.

Example 1: Consider the case $n = 4$ and $m = 0.4$. Note that $p^L = 0.5$ and $p^{FF} = 0.58$. Suppose that every strategist has belief $\hat{p}$ (and so $G(\hat{p}) = 1$ while $G(y) = 0$ for any $y < \hat{p}$). Suppose that where $p^L < \hat{p} < p^{FF}$. In interpretation, only in the leader game does a strategic first mover have an incentive to invest. Finally, suppose that $p = 0.5$. Knowing that $X^L = 5E/2$. What of the other games? In the two leader game there is a p^2 chance, that both first movers are conditional cooperators who invest E, and there is a $2p(1-p)$ chance that one invests E. Thus,

$$X^{2L} = p^2E(2 + (n-2)p) + 2p(1-p)E\left(1 + \frac{1}{2}(n-2)p\right) = \frac{3}{2}E \quad (A2.7)$$

The lack of strategic leadership results in $X^{2L} < X^L$. In the first follower game there is a p^2 chance that both first and second movers are conditional cooperators who invest E, and there is a $p(1-p)$ chance that the first mover is a conditional cooperator who invests E and the second mover a strategist who invests 0. Thus,

$$X^{FF} = p^2E(2 + (n-2)p) + p(1-p)E\left(1 + \frac{1}{2}(n-2)p\right) = \frac{9}{8}E \quad (A2.8)$$

Clearly $X^{FF} < X^{2L}$. The intuition for this result is that in the two leader game there are two independent chances for a conditional cooperator to 'set a good example' while in the first follower game everything depends on the first mover setting a good example. The details of the sequential game will be skipped but it is possible to show that $X^S < X^{FF} < X^{2L} < X^L$. The leader game is, therefore, first best.

Example 2: Keep everything the same as in Example 1, suppose that $p^{FF} < \hat{p} < p^{S}$. (Note that $p^{S} = 1$ and $p^{2L} = 1$) In interpretation, only in the leader and first follower games does a strategic first mover have an incentive to invest. The only thing that one needs to reconsider is X^{FF}. In this case it is known that the first mover will invest E. There is a p chance that the second mover will too. Thus,

$$X^{FF} = pE(2 + (n-2)p) + (1-p)E\left(1 + \frac{1}{2}(n-2)p\right) = \frac{9}{4}E \quad (A2.9)$$

So, $X^{S} < X^{2L} < X^{FF} < X^{L}$ meaning that the first follower game jumps up to second best.

Example 3: Suppose that $n = 4$ and $p = 0.5$ as before but now $m = 0.8$. Note that $p^{2L} = 0.25$ and $p^{S2} = 0.28$. In Chapter 2 the characterisation of incentives only up to the second mover in the sequential game was considered. One now needs to look at the incentives of the third mover. If the third mover invests E (rather than 0) then there is probability p that the fourth mover will invest an extra $E/3$. So it is in the interests of a strategic player 3 to invest E if $m(1 + p_3/3) > 1$. This rearranges to $p_3 > 0.75$.

Now suppose that every strategist has belief $\hat{p}$ where $p^{2L} < \hat{p} < 0.75$. In this case, the two first movers in the two leader game and the first and second mover in the first follower game will invest E. Thus,

$$X^{2L} = X^{FF} = E(2 + (n-2)p) = 3E \quad (A2.10)$$

So, $X^{L} < X^{FF} = X^{2L}$. For completeness consider the sequential game. If $p^{S2} < \hat{p}$ then the first two movers in the sequential game will invest E. The third mover will invest E with probability p. The fourth mover will invest E with probability p^2 and $2E/3$ with probability $(1-p)p$. Thus,

$$X^{S} = E\left(2 + p + p^2 + \frac{2}{3}(1-p)p\right) = \frac{35}{12}E \quad (A2.11)$$

Overall, therefore, $X^{L} < X^{S} < X^{FF} = X^{2L}$. The two leader and first follower game become first best while the leader game becomes worst. The intuition behind this result is that two players, not just one, have a strategic incentive to invest E.

Example 4: Keep everything the same as in the previous example except that $0.75 < \hat{p}$. (One could argue that this is an implausible belief given that $p = 0.5$ but the example would follow through with plausible beliefs for a higher value of m.) Now the first three movers in the sequential game will invest E. Thus,

$$X^S = E(3 + p) = \frac{7}{2}E \quad (A2.12)$$

So, $X^L < X^{FF} = X^{2L} < X^S$. The sequential game comes out first best because there is a strategic incentive for three players (rather than just two in the two leader and first follower games or one in the leader game) to invest E.

A2.3. Additional supplementary tables

Table A2.3 Treatment Investment stages

Leader	First Follower	Two Leader	Sequential
Leader [1]	Leader [1]	Leader X [1]	Leader [1]
Follower A [2]	Follower A [2]	Leader Y [2]	Follower A [2]
Follower B [2]	Follower B [3]	Follower A [3]	Follower B [3]
Follower C [2]	Follower C [3]	Follower B [3]	Follower C [4]
Follower D [2]	Follower D [3]	Follower C [3]	Follower D [5]

Note: Numbers in parentheses represent the investment stage the subject makes their investment decision.

Table A2.4 Leader Payoff by level of Investment

Leader Investment	Leader treatment	First Follower treatment	Two Leader treatment	Sequential treatment
0	5.51 (0.83)	6.53 (2.26)	6.98 (1.63)	5.56 (1.14)
1	5.28 (0.77)	5.60 (0.65)	6.23 (1.37)	7.60 (2.26)
2	6.60 (n/a)	5.71 (1.29)	7.15 (1.95)	6.94 (1.81)
3	6.06 (1.85)	6.57 (2.02)	6.61 (1.90)	6.09 (1.62)
4	5.86 (2.35)	6.82 (1.36)	6.29 (2.04)	6.26 (1.89)
5	5.93 (1.95)	6.79 (2.06)	6.21 (1.79)	5.20 (1.90)

Note: Numbers in parentheses are standard deviations.

Table A2.5 Average First Follower Payoff by level of Investment

Investment	First Follower treatment	Sequential Treatment
0	6.91 (1.92)	6.20 (1.84)
1	6.15 (1.28)	7.28 (2.83)
2	6.56 (1.46)	7.73 (2.12)
3	7.40 (1.98)	7.17 (1.37)
4	7.43 (1.23)	6.11 (1.50)
5	7.25 (1.97)	4.97 (2.10)

Note: Numbers in parentheses are standard deviations.

A2.4. Experimental Instructions for First Follower Treatment

Instructions to Part 1

In this experiment, you will make decisions, and earn an amount of money that depends on what you and others choose. Throughout the experiment, you can earn points. These points will be converted into money that is given to you at the end of the experiment. Each point will be converted into £0.02. Only you will know how much you earned. Please read the instructions carefully.

The decision situation

At the start of the experiment, you will be randomly allocated to a group of 5 people. You will remain with the same group of people throughout the experiment. Part 1 will consist of 20 consecutive rounds of play.

At the beginning of each round you are allocated 5 tokens. You must decide what to do with these 5 tokens. You can invest the tokens, any amount between 0 and 5, into a group project or put the tokens into a private account. Each token you do not invest into the group project will be automatically transferred to your private account.

Every other member of the group is also allocated 5 tokens. Like you, they must decide, individually, whether to invest their tokens into the group project or put the tokens into a private account.

Your income from the group project

For every token, you invest into the group project you, and everyone else in the group, earns 0.4 points. You will also earn 0.4 points for every token that any other group member invests into the project. Thus, for each group member the income from the project will be determined as follows:

Income from the project = 0.4 x sum of tokens invested into the project

For example, if the sum of tokens invested into the project is 10 then your income from the project is 4 points.

Your income from the private account

For each token transferred into your private account, you will earn exactly one point. For example, if you put 3 tokens into the private account, you will earn 3 points from your private account.

Your total income

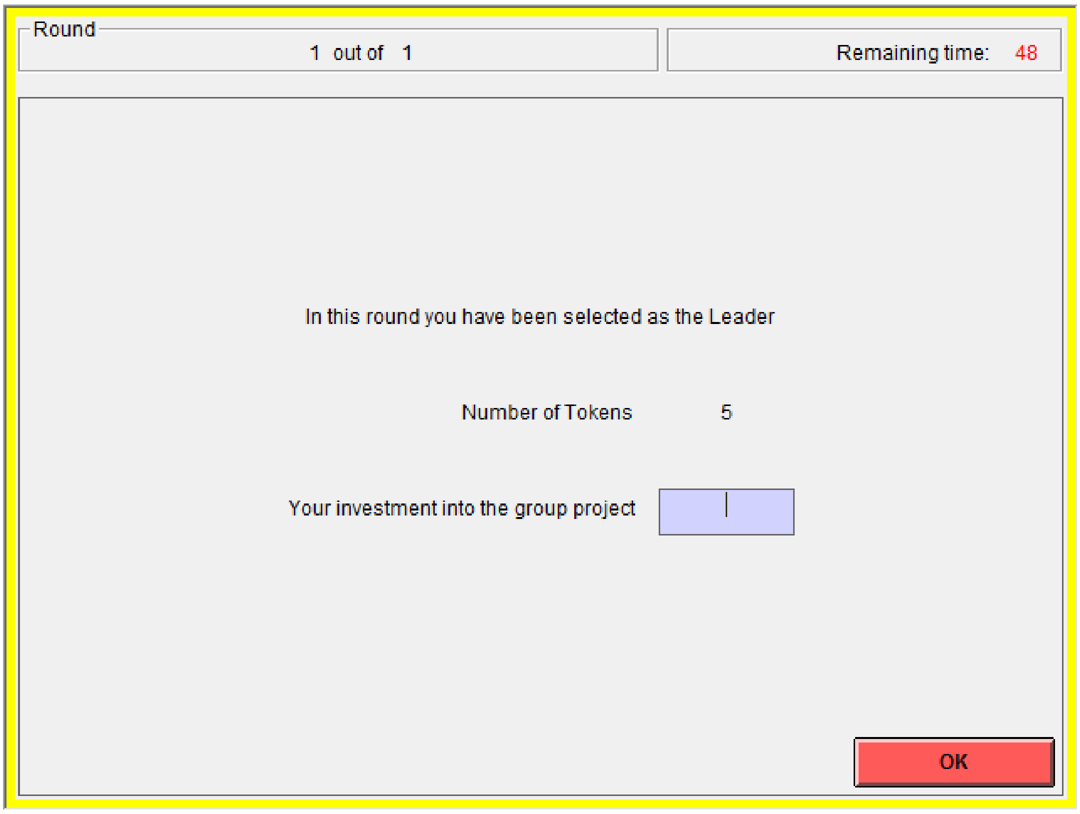
Your total income from each round results from the summation of your income from the private account and your income from the group project.

Income from the private account (5 – investment into the project) + Income from the group project (0.4 x sum of tokens invested into the project) = Total Income

Timing of investments

In each round, one member of the group will be randomly selected to act as Leader. The Leader will decide how many tokens to invest into the project before the rest of the group.

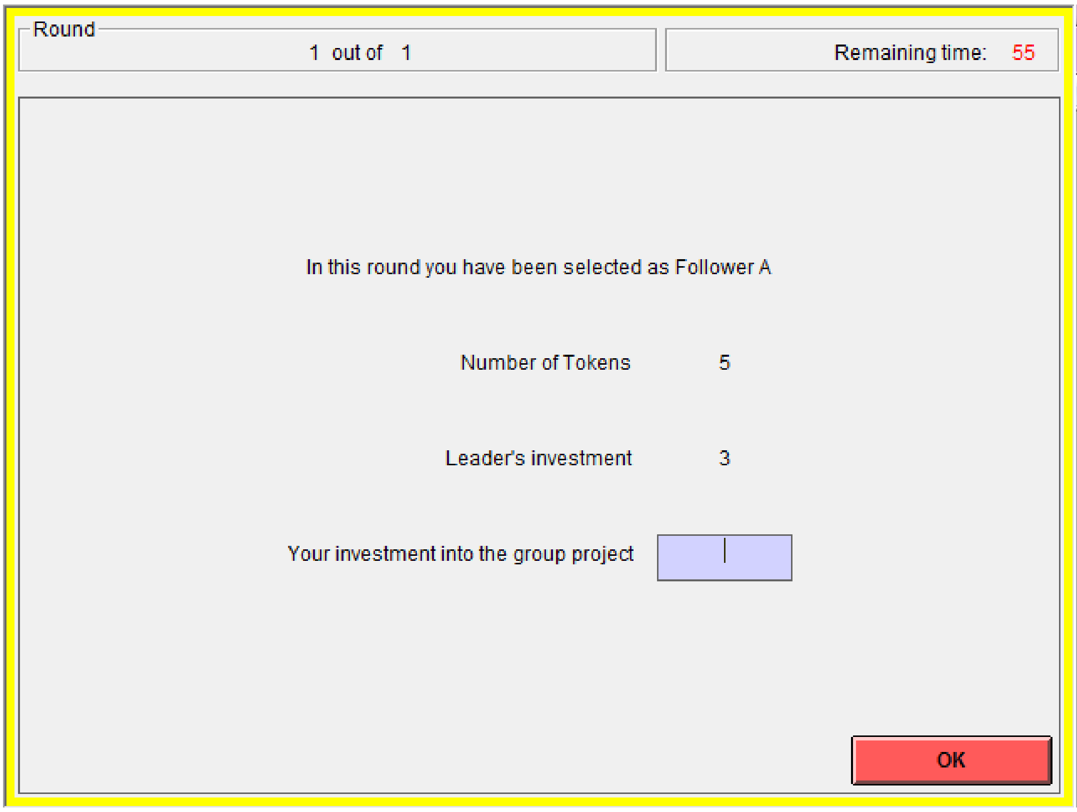
The Leaders’ screen will appear as below. Note that this is just an example.



The Leader should enter their decision in the box (decimal amounts are not permitted) and click the ‘OK’ button.

Another member of the group, labelled Follower A, will then be randomly selected to make their decision next. Follower A will be able to see how much was invested by the Leader before making their decision how many tokens to invest in the group project.

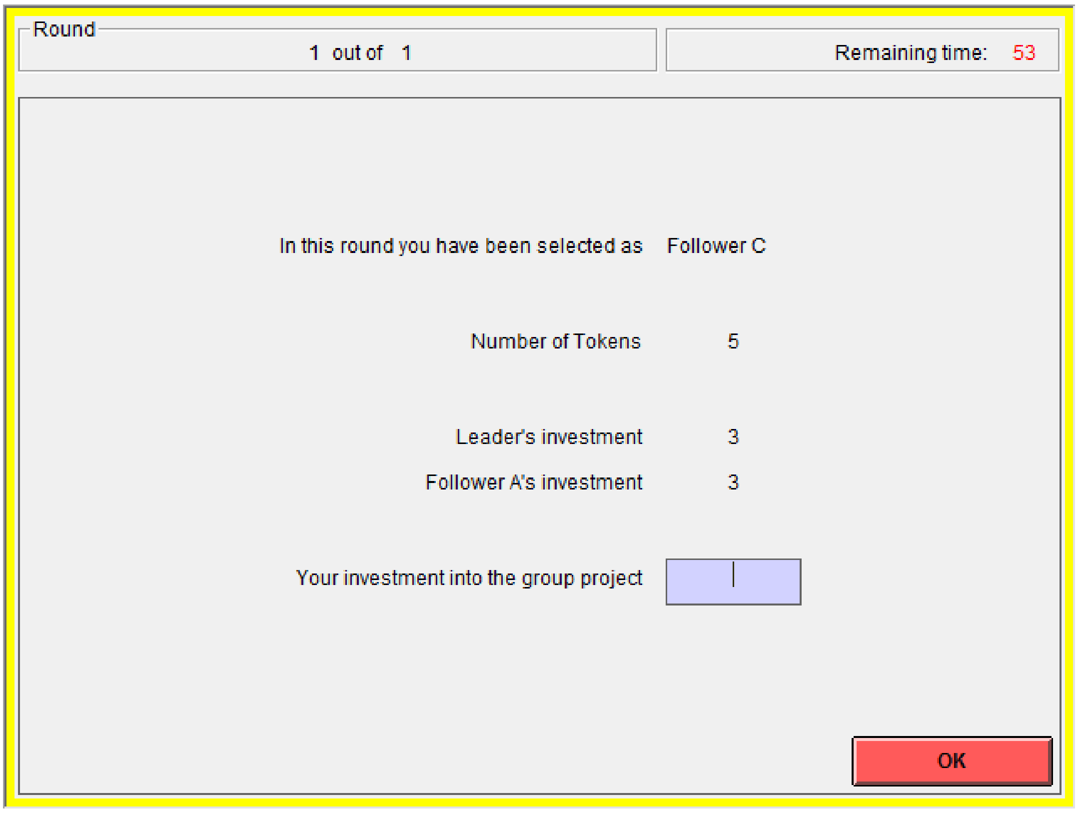
Follower A's screen will appear as below.



Follower A should enter their decision in the box and click the 'OK' button.

Once Follower A has made their decision all group members will get to see how much both the Leader and Follower A invested. Remaining members of the group, labelled Follower B, Follower C and Follower D must then decide how many tokens to invest into the project. Followers B, C and D will make their decisions at the same time and so will not know the investment of each other when making their decision.

Their screen will appear as below.



Follower B, C and D should enter their decision in the box and click the 'OK' button.

After all investments into the group project have been made the sum of investments, and a list of the investments of each group member will be displayed.

Once you have finished reading the instructions, please press the ‘OK’ button and wait for the experiment to begin.

CHAPTER 3 APPENDIX

A3.1. Possible Investment Sequences

For the two-day treatment, there are 6 possible investment sequences for a group of 5 individuals. Numbers in parentheses represent the number of occurrences.

1. All invest on day one (23)
2. All invest on day two (64)
3. 1 invests on day one and 4 invest on day two (69)
4. 2 invest on day one and 3 invest on day two (46)
5. 3 invest on day one and 2 invest on day two (16)
6. 4 invest on day one and 1 invests on day two (2)

For the three-day treatment, there are 21 possible investment sequences for a group of 5 individuals

1. All invest on day one (14)
2. All invest on day two (0)
3. All invest on day three (1)
4. 0 invest on day one, 4 on day two and 1 on day three (0)
5. 0 invest on day one, 3 on day two and 2 on day three (0)
6. 0 invest on day one, 2 on day two and 3 on day three (2)
7. 0 invest on day one, 1 on day two and 4 on day three (3)
8. 1 invests on day one, 4 on day two and 0 on day three (0)
9. 1 invests on day one, 3 on day two and 1 on day three (4)
10. 1 invests on day one, 2 on day two and 2 on day three (7)
11. 1 invests on day one, 1 on day two and 3 on day three (17)
12. 1 invests on day one, 0 on day two and 4 on day three (18)
13. 2 invest on day one, 3 on day two and 0 on day three (1)
14. 2 invest on day one, 2 on day two and 1 on day three (12)
15. 2 invest on day one, 1 on day two and 2 on day three (26)
16. 2 invest on day one, 0 on day two and 3 on day three (26)
17. 3 invest on day one, 2 on day two and 0 on day three (15)
18. 3 invest on day one, 1 on day two and 1 on day three (17)
19. 3 invest on day one, 0 on day two and 2 on day three (20)
20. 4 invest on day one, 1 on day two and 0 on day three (28)
21. 4 invest on day one, 0 on day two and 1 on day three (9)

A3.2. Experiment Questionnaire

Part 1: Hypothetical Trust Game

Suppose you are in the following situation.

There are two rooms A and B. Each individual from room A is paired with an individual from room B. Each person in room A and each person in room B will be allocated £10 as a show-up fee for participating. Persons in room A will have the opportunity to send in an envelope, some, all or none of their show up fee to a person in room B. Each pound sent to room B will be tripled. The person in room B will then decide how much money to send back to the person in room A and how much money to keep.

If you were in room A how much would you send? ___

If you were in room B please indicate how much you would send back to room A.

If person A sent you £1? ___

If person A sent you £2? ___

If person A sent you £3? ___

If person A sent you £4? ___

If person A sent you £5? ___

If person A sent you £6? ___

If person A sent you £7? ___

If person A sent you £8? ___

If person A sent you £9? ___

If person A sent you £10? ___

Part 2: Social Value Orientation Questions

Suppose you have to choose between A, B and C. Your choice determines how many points you and somebody else receive. Assume that the other person is somebody that you do not know and that every point is valuable to you and the other person. What would you choose?

1. A: You get 480, the other gets 80,

B: You get 540, the other gets 280,

C: You get 480, the other gets 480,

2. A: You get 560, the other gets 300,

B: You get 500, the other gets 500,

C: You get 500, the other gets 100,

3. A: You get 520, the other gets 520,

B: You get 520, the other gets 120,

C: You get 580, the other gets 320,

4. A: You get 500, the other gets 100,

B: You get 560, the other gets 300,

C: You get 490, the other gets 490,

5. A: You get 560, the other gets 360,

B: You get 500, the other gets 500,

C: You get 490, the other gets 90,

6. A: You get 500, the other gets 500,

B: You get 500, the other gets 100,

C: You get 570, the other gets 300,

7.A: You get 510, the other gets 510,

B: You get 560, the other gets 300,

C: You get 510, the other gets 110,

8. A: You get 550, the other gets 300,

B: You get 500, the other gets 100,

C: You get 500, the other gets 500,

9. A: You get 480, the other gets 100,

B: You get 490, the other gets 490,

C: You get 540, the other gets 300,

Part 3: Risk Preferences

Suppose now that you have the chance to take part in a lottery where you may win something or may not. For each of the following two options say which you would choose.

1. A: £10 for sure

B: 50% chance of £300 and 50% chance of £0.

2. A: £30 for sure

B: 50% chance of £300 and 50% chance of £0.

3. A: £50 for sure

B: 50% chance of £300 and 50% chance of £0.

4. A: £70 for sure

B: 50% chance of £300 and 50% chance of £0.

5. A: £90 for sure

B: 50% chance of £300 and 50% chance of £0.

6. A: £110 for sure

B: 50% chance of £300 and 50% chance of £0.

7. A: £130 for sure

B: 50% chance of £300 and 50% chance of £0.

8. A: £150 for sure

B: 50% chance of £300 and 50% chance of £0.

9. A: £170 for sure

B: 50% chance of £300 and 50% chance of £0.

10. A: £190 for sure

B: 50% chance of £300 and 50% chance of £0.

11. A: £210 for sure

B: 50% chance of £300 and 50% chance of £0.

Part 4: Time Preference

Finally, suppose now that you have the option to get money today or in 12 months time. For each of the following two options say which you would choose

1. A: £100 today

B: £100 in 12 months time.

2. A: £100 today

B: £103 in 12 months time.

3. A: £100 today

B: £106 in 12 months time.

4. A: £100 today

B: £109 in 12 months time.

5. A: £100 today

B: £112 in 12 months time.

6. A: £100 today

B: £115 in 12 months time.

7. A: £100 today

B: £120 in 12 months time.

8. A: £100 today

B: £125 in 12 months time.

9. A: £100 today

B: £130 in 12 months time.

10. A: £100 today

B: £135 in 12 months time.

11. A: £100 today

B: £140 in 12 months time.

Part 5: Patience Questions (adapted from Bruttel and Fischbacher 2013)

Please indicate on the scale provided how strongly you agree with each of the statements.

Scale:

Strongly Disagree

Disagree

Neither Agree or Disagree

Agree

Strongly Agree

Statements

1. I frequently feel like hurrying others.

2. If I want something I get it.

3. I always have something to do in case I have to wait.

4. I am often in a hurry.

5. I often lose track of what people are saying if they go on for too long.

6. I consider myself as easy going.

7. I have trouble finding time to get my hair cut.

8. I wait too long to act.

9. I get things accomplished without undue stress.

10. I have enough time to do the things that are important to me.

11. I work fast.

Part 6: Index Stories (also adapted from Bruttel and Fischbacher 2013)

Different scenarios are going to be presented to you. For each scenario we offer you different action alternatives. Select for each scenario which action alternative you would pick most likely and which you would pick the least.

1. The bus you have to take to the university every day is overcrowded. Since your stop is near the beginning everyone has a spot on the bus. However, this is not true for later stops, some people had to wait for the next bus. What would you do?

A. I am going to write a letter to the bus company and ask them to reduce the problem by putting in another bus in this line.

B. As long as I get in I do not care.

C. Because these many people bother me in the morning, I decide from now on to take a bus earlier or after the busy times whenever possible.

D. If it goes on like this the bus driver will soon realize that a change is necessary – and after all it is his task to make sure to transfer all passengers.

Which would you most likely pick? A/B/C/D

Which would you least likely pick? A/B/C/D

2. A good friend of yours is celebrating his birthday in two days. Among your friends it is common to buy a present from all of you. It is in the middle of February and exams are right ahead. Since everybody is studying nobody volunteers to get the present. What would you do?

A. As everybody knows I am going to write one more exam than the others. The others will consider this for sure and are going to leave me out of the organization of the present.

B. I propose that I will think about a present and somebody else will organize it.

C. I will go to the city after my class and check if I can find something suitable.

D. Since I have to study and I am hesitating to go to the party anyway I will keep out of it.

Which would you most likely pick? A/B/C/D

Which would you least likely pick? A/B/C/D

3. Since the introduction of tuition fees the university library has more financial resources. But there are still not enough copies of a standard reference which is needed by the second term students for their exam. What would you do in this situation?

A. I will buy the book at Amazon.

B. I will organize a study group with fellow students. So we can study together with one book.

C. I will go to the information desk of the library and ask them to get another copy of the book.

D. I assume that the professor knows about the shortage of the books and that he will not ask too many details in the exam.

Which would you most likely pick? A/B/C/D

Which would you least likely pick? A/B/C/D

4. Recently you moved in with two friends. So far there are not any agreements about the cleaning of the shared rooms (kitchen, bathroom). What would you do?

A. I will get an organizer in which I will list who will have cleaning duty in which week. I will start.

B. I will clean the kitchen and bathroom when the rooms become too dirty for me.

C. Since I am at the university all day and going home at the weekends, I make little dirt and do not feel responsible for cleaning.

D. I plan to talk to my roommates on the next occasion.

Which would you most likely pick? A/B/C/D

Which would you least likely pick? A/B/C/D

5. The cleaning staff did not refill the soap in the washing room of your working place for some days. How would you react?

A. I will post a note for the cleaning staff at the door to the washing room, they should remember refilling.

B. I will bring my own soap and put it at the sink.

C. That does not bother me. I rarely wash my hands with soap.

D. The cleaning staff gets controlled regularly at a random basis, somebody who is responsible for it will realize it soon.

Which would you most likely pick? A/B/C/D

Which would you least likely pick? A/B/C/D

Additional questions

What subject do you study? ___

Age: ___

What is your gender? ___

A3.3. Analysing questionnaire data

The level of patience is determined on a scale between 0 to 5 based on choices to statements in the experiment questionnaire. With 0 being the most patient to 5 being the least patient. On average the level of patience does not differ significantly between treatments, with a score of 3.008 for the two-day treatment versus 3.087 for the three-day treatment. For the Index stories for each 'story' individuals were given a score of either 1 for a taking of the initiative, 0 for neutral and -1 if acting against taking the initiative. Their scores for all five stories were summed and the higher the score this indicates they are more likely to take the initiative. Those in the three-day treatment have an average rating of 2.7 on this scale compared to 2.44 for those in the two-day treatment.

A3.4. Experimental Instructions for three-day treatment

Instructions

In this experiment you will make decisions, and earn an amount of money that depends on what you and others choose. Throughout the experiment you can earn points. These points will be converted into money that is given to you at the end of the experiment. Each point will be converted into £0.02. Only you will know how much you earned. Please read the instructions carefully.

The decision situation

At the start of the experiment you will be randomly allocated to a group of 5 people. You will remain with the same group of people throughout the experiment. The experiment will consist of 20 consecutive rounds of play.

At the beginning of each round you are allocated 5 tokens. You must decide what to do with these 5 tokens. You can invest the tokens, any amount between 0 and 5, into a group project or put the tokens into a private account. Each token you do not invest into the group project will be automatically transferred to your private account.

Every other member of the group is also allocated 5 tokens. Like you, they must decide, individually, whether to invest their tokens into the group project or put the tokens into a private account.

Your income from the group project

For every token you invest into the group project you, and everyone else in the group, earns 0.4 points. You will also earn 0.4 points for every token that any other group member invests into the project. Thus, for each group member the income from the project will be determined as follows:

Income from the project = 0.4 x sum of tokens invested into the project

For example if the sum of tokens invested into the project is 10 then your income from the project is 4 points.

Your income from the private account

For each token transferred into your private account you will earn exactly one point. For example, if you put 3 tokens into the private account, you will earn 3 points from your private account.

Your total income

Your total income from each round results from the summation of your income from the private account and your income from the group project.

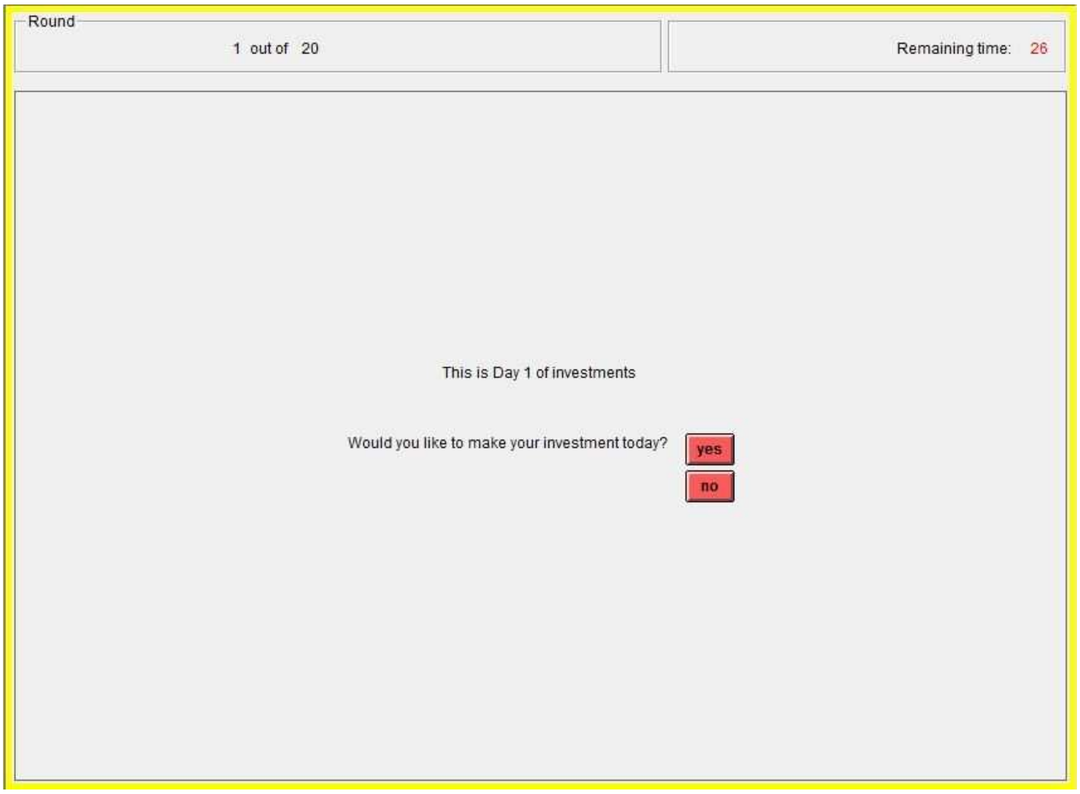
Income from the private account (5 – investment into the project) + Income from the group project (0.4 x sum of tokens invested into the project) = Total Income

Timing of investments

There are three days of investments. You can only invest during one of the three days.

You will first be asked whether you would like to invest on day one.

The decision to invest on day one will appear as below.



If you click ‘yes’, you agree to make your investment on day one and will be lead to the following screen to input your investment.

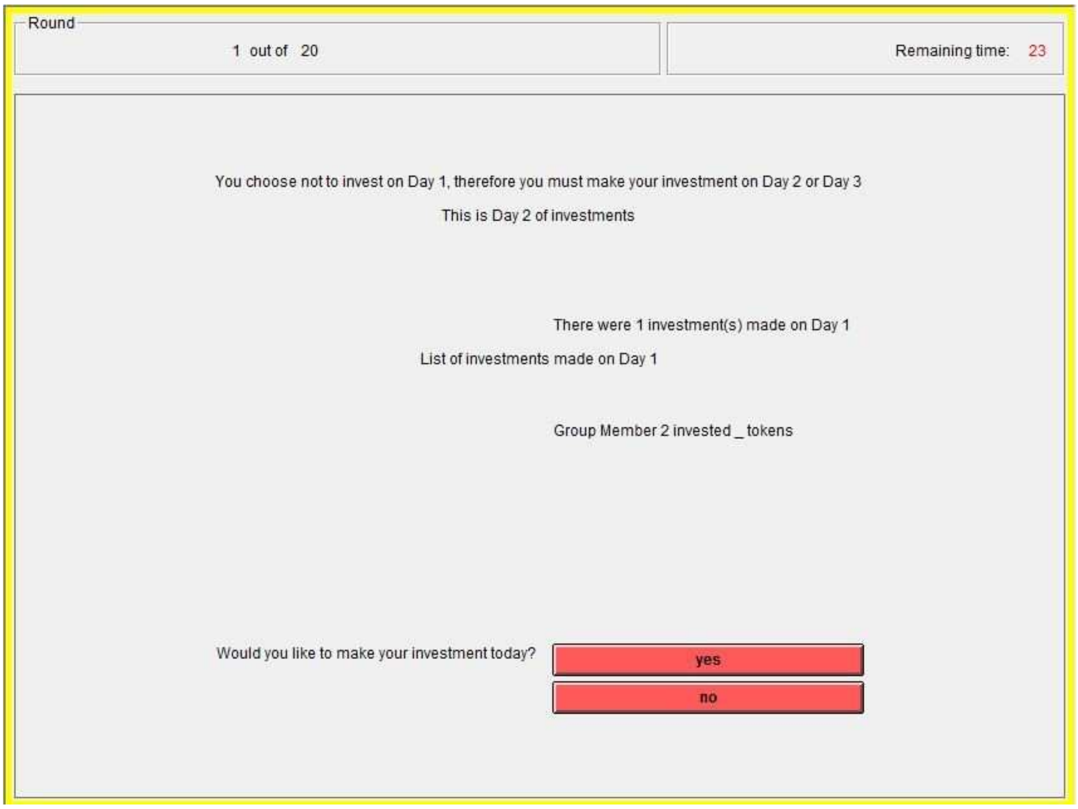
Once you have decided how many tokens to invest you should enter the decision in the box (decimal amounts are not permitted) and click the 'OK' button.

If you click ‘no’ to investing on day one, you must make your investment on day two or day three.

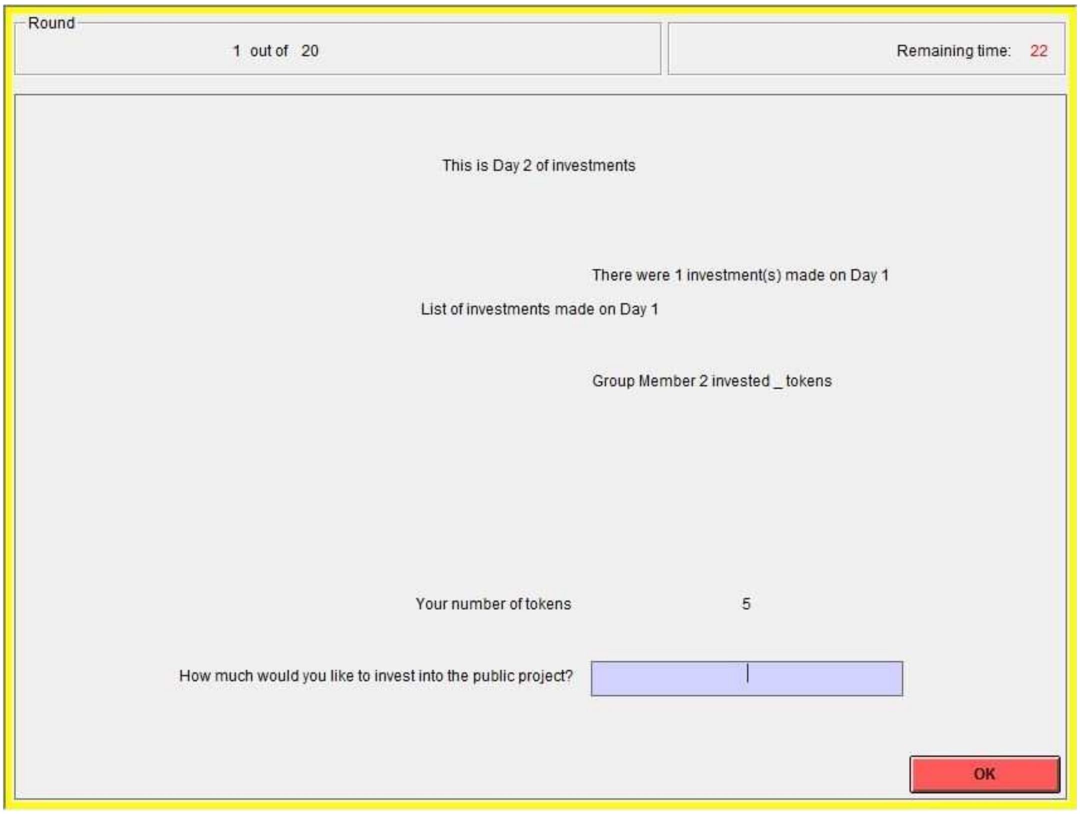
If you did not invest on day one, you will be shown all of the investments made on day one alongside a group member identifier i.e. Group Member 1. This identifier is randomly determined at the start of each round.

On the same screen you will be asked whether you would like to invest on day two.

The decision to invest on day two will appear as below.

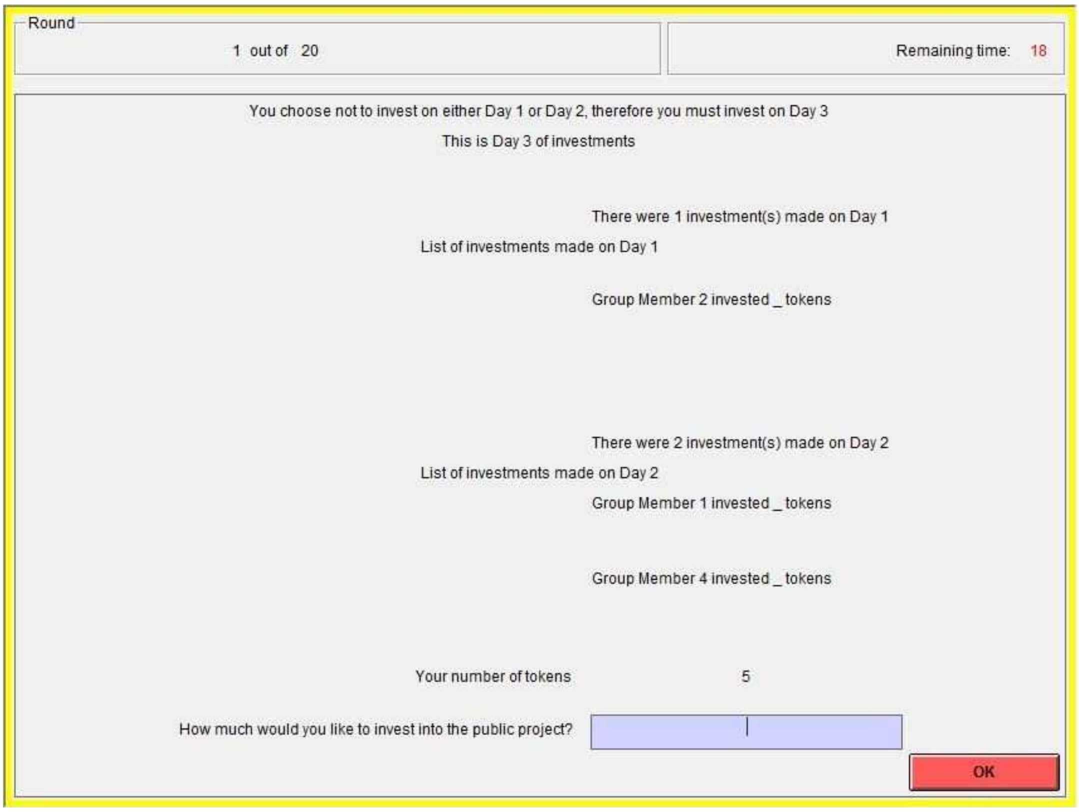


If you click 'yes', you agree to make your investment on day two and will be lead to the following screen to input your investment.



Once you have decided how many tokens to invest you should enter the decision in the box (decimal amounts are not permitted) and click the 'OK' button.

If you click ‘no’ to investing on day two then you must make your investment on day three. You will be shown all of the investments made on days one and two alongside a group member identifier. The investment screen will appear as below if you invest on day three.



Once you have decided how many tokens to invest you should enter the decision in the box (decimal amounts are not permitted) and click the ‘OK’ button.

After all investments into the group project have been made the sum of investments, a list of the investments of each group member and the day each group member made their investment will be displayed.

Note if all group members invest on day one, days two and three will be skipped or if all group members invest on days one and two, day three will be skipped.

Once you have finished reading the instructions please press the ‘OK’ button and wait for the experiment to begin

CHAPTER 4 APPENDIX

A4.1. Experimental Instructions for Multiple Public Good Treatment

Instructions

Welcome. Thanks for participating in this experiment. If you follow the instructions carefully you can earn an amount of money that will be paid to you in cash at the end of the experiment. During the experiment you are not allowed to talk or communicate in any way with the other participants. If you have a question raise your hand and one of the assistants will come to you. Throughout the experiment please refrain from using your mobile phone and please do not charge your phone using the pcs.

In this experiment you will interact for 12 rounds. At the beginning of the experiment you will be randomly and anonymously assigned to a group of four people. Therefore, the other three people in your group, will know neither your identity nor your earnings. The composition of your group will remain unchanged throughout the experiment. Once you have completed all 12 rounds, one of the rounds will be randomly selected for your final payment from the experiment, with a conversion rate of £0.01 per token earned.

Earnings calculation

At the beginning of each round, you and everyone else in your group is endowed with 55 tokens. Thus, the group will have a total of 220 tokens. In each round, you have to decide how to invest your tokens between a private account and four collective accounts (Square, Trapezoid, Rectangle and Diamond).

Income from the private account

Any tokens from your endowment you do not invest to any of the four collective accounts (Square, Trapezoid, Rectangle or Diamond) will automatically be invested into your private account. For each token allocated into your private account, you will receive 2 points. Other group members do not receive points from your private account.

Income from the collective accounts

You receive points from any of the four collective accounts (Square, Trapezoid, Rectangle or Diamond) if and only if the number of tokens allocated to it by your group is greater than or equal to a pre-specified number that is called "threshold". The threshold is the same across the four collective accounts and is represented by 132 tokens.

Therefore, if the total number of tokens invested to a collective account by your group is less than the threshold of 132 tokens, then you do not receive any points from that collective account. For example, if you invest 20 tokens to the Square account and 0 to all other collective accounts and all of your group members invest the same then your profit is (55-20)*2 = 70 tokens from your private account + 0 tokens from all four collective accounts for a total of 70 tokens.

If the total number of tokens invested to a collective account (Square, Trapezoid, Rectangle or Diamond) by your group is equal to or greater than the threshold of 132 tokens, then:

1. For each token invested to the collective account by you or any other group member you receive one point.
2. Additionally, you receive an additional number of 30 points as a "bonus". The size of the bonus is the same for all four collective accounts.

For example, if you invest 40 tokens to the Trapezoid account and 0 tokens to all other collective accounts and all of your group members invest the same. Then your profit is (55-40) * 2 = 30 tokens from your private account + 160 from the Trapezoid account + 30 tokens as a bonus from the Trapezoid account + 0 from all other collective accounts for a total of 220 points.

Timing of investments

When making your investments you will view the current total invested to each of the four collective accounts in real time as well as the group members' names (anonymised) who have invested a positive number of token to a specific collective account. The investment screen prior to any investment will appear as below.

Periode

1 von 2

Verbleibende Zeit [sec]: 103

This round you are Group Member Z

Number of tokens 55

Collective Account "TRAPEZOID"	Collective Account "RECTANGLE"	Collective Account "SQUARE"	Collective Account "DIAMOND"
Threshold 132	Threshold 132	Threshold 132	Threshold 132
BONUS in points 30	BONUS in points 30	BONUS in points 30	BONUS in points 30
Current Total Invested into the Collective Account	Current Total Invested into the Collective Account	Current Total Invested into the Collective Account	Current Total Invested into the Collective Account
0	0	0	0
Your investment to the collective account (from 0 to 55):	Your investment to the collective account (from 0 to 55):	Your investment to the collective account (from 0 to 55):	Your investment to the collective account (from 0 to 55):
Current list of Investors	Current list of Investors	Current list of Investors	Current list of Investors

OK

The number of tokens you invest across the four collective accounts must be equal to or less than your endowment. Remember any tokens you do not invest into any of the four collective accounts are automatically invested into your private account.

Below is an example of the investment screen when other group members have already invested but you have yet to invest. Note that a group member's name (anonymised) only appears under the current list of investors if they have invested a positive number of tokens to a specific collective account. In this specific example, Group Member X has invested a positive number of tokens to the Trapezoid account and 0 to the other collective accounts whereas Group Member Z has invested a positive number of tokens to both the Trapezoid account and Square account and 0 to the other collective accounts.

Once you have made your investment decision please click the 'OK' button.

Periode

1 von 12

Verbleibende Zeit [sec]: 0

Bitte entscheiden Sie sich jetzt!

This round you are Group Member W

Number of tokens 55

Collective Account "TRAPEZOID"

Threshold 132

BONUS in points 30

Current Total Invested into the Collective Account

57

Your investment to the collective account (from 0 to 55):

Current list of Investors

Group Member Z

Group Member X

Collective Account "RECTANGLE"

Threshold 132

BONUS in points 30

Current Total Invested into the Collective Account

0

Your investment to the collective account (from 0 to 55):

Current list of Investors

Collective Account "SQUARE"

Threshold 132

BONUS in points 30

Current Total Invested into the Collective Account

30

Your investment to the collective account (from 0 to 55):

Current list of Investors

Group Member Z

Collective Account "DIAMOND"

Threshold 132

BONUS in points 30

Current Total Invested into the Collective Account

0

Your investment to the collective account (from 0 to 55):

Current list of Investors

OK

At the end of each round, you will be informed of how many tokens you invested to your private account, how many tokens you invested to each of the four collective accounts, how many tokens have been invested by your group to each of the four collective accounts (this includes your investment), how many points you have obtained from your private account, how many points you have obtained from each of the four collective accounts, whether you obtained the bonus for each of the four collective accounts and how many points you have obtained overall for that round.

An example of the payoff display screen is shown below.

Note please click the ‘OK’ button to proceed to the next round.

Periode

1 von 2

Verbleibende Zeit [sec]: 39

This round you are Group Member X

Results from this round

PRIVATE ACCOUNT	Collective account "TRAPEZOID"	Collective account "RECTANGLE"	Collective account "SQUARE"	Collective account "DIAMOND"
	Threshold 132	Threshold 132	Threshold 132	Threshold 132
Your investment 25	Your investment to the Trapezoid account 30	Your investment to the Rectangle account 0	Your investment to the Square account 0	Your investment to the Diamond account 0
Your payoff from the private account: 50	Group investment to Square account 75	Group investment to Rectangle account 0	Group investment to Square account 13	Group investment to Diamond account 0
	You did not obtain the bonus of 30 points	You did not obtain the bonus of 30 points	You did not obtain the bonus of 30 points	You did not obtain the bonus of 30 points
	Points 0	Points 0	Points 0	Points 0

Overall, in this round you have obtained the following number of points: 50

OK

Once you have finished reading the instructions please press the ‘OK’ button and wait for the experiment to begin.