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Experimental Perspectives on Intergenerational Altruism: A Study on Public Good Dilemmas

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Abstract

Humans evolved over millennia into agents that invest heavily, both directly and indirectly, in their children. Part of the investment into children is represented by contributions to long-run public goods, including the educational system, the health-care system, major infrastructures and environmental protection. Moreover, the production of some of these public goods has wide-ranging externalities to local or global communities (think of vaccination programs, for example).

This Doctoral Thesis is a collection of three essays on the topic of long-run, across-the-border public goods, from the vantage point of Experimental and Behavioral Economics. The first Chapter reviews the literature up to date, re-organizing previous works on Public Good games for the benefit of explaining why intergenerational and international public goods are different from standard ones. The second and third Chapters provide empirical evidence on matters such as heterogeneity linked to seniority and dynastic membership in the provision of public goods.

Keywords: Public Goods, Experimental Economics, Generations, Local and Global Public Goods, Heterogeneity, OLG, dynamic membership, spillovers.

JEL Classification: C92, D80, F59,H40, H41, J10.

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Introduction

Over the past 30 years, experimental economics has extensively proven that the classical economic assumption that describes agents as solely driven by the maximization of monetary incentives is a scientific artifact. When other motivations enter the picture of economic decision-making, outcomes tend to deviate from those predicted by standard economic models.

Behavioral and experimental economics contributed to the modification of the traditional rationalistic paradigms in economics, particularly those related to unbounded rationality, complete self-control and pure self-interest. Amongst many fundamental findings (such as Simon's Bounded Rationality, Kahneman and Tversky Prospect Theory, again Kahneman Dual-System Theory, Samuelson and Zeckhauser status quo bias, Frederick, Loewenstein and O'Donoghue time discounting etcetera) those linked to the social dimension of the economic behavior are attracting more and more research projects.

True is that individuals are shaped and embedded in social environments, and therefore social forces affect their decision-making. Topics such as fairness and reciprocity, trust and dishonesty, commitment and social norms have been largely investigated and researchers in the field have produced a vast amount of literature showing the extent of the influence of social preferences.

However Behavioral and Experimental Economics have only recently started to look into issues related to intergenerational dynamics. More specifically pushing the edge of the envelope by considering aspects already studied by biology and anthropology could prove to help explaining why, for example, individuals care so much about environmental issues or charitable giving. Humans evolved over millennia into agents that invest heavily, both directly and indirectly, in their children. Part of this investment is represented by contributions to long-run public goods, including the educational system, the health-care system, major infrastructures and environmental protection. Moreover, the production of some of these public goods has wide-ranging externalities to local or global communities (think of vaccination programs, for example).

These are the type of public goods that are dealt with in this Doctoral Thesis from the point of view and using the tools of Behavioral and Experimental Economics.

The first chapter, titled *Genes, Generations and Nations in Public Goods Experiments – A Critical Evaluation of the Experimental Literature*, aims at portraying a picture of the state of the art of the Experimental literature on intergenerational and international public goods (PG). By characterizing the structure of standard PG games and extending the classic taxonomy of PG, the chapter lays the first stone for the identification of new challenges surrounding future Experimental research. In addition, the literature available to date is scanned and organized to serve the purpose of highlighting specific promising future developments and identifying valid methods and tools that can be re-applied to the aforementioned advances.

Chapter 2, *Helping Out the Young and Inexperienced: an Experimental Approach to Generational Heterogeneity and Redistribution in Public Good Games*, proposes a model that explains how equilibrium in a PG game is reached when heterogeneity linked to seniority and strategic interaction is finitely repeated. Within this model the case of financial aid schemes for economic development is explained using a redistribution rule that benefits the younger players, as a compensation for their inexperience. Experimental evidence shows that subjects who belong to low or middling marginal per capita return types are negatively affected by heterogeneity, whereas groups benefit from the presence of experienced subjects. In other words, when a public good is generated and benefits more the young and inexperienced individuals, social comparison mechanism play a role in shaping the levels of contribution to the PG. Some critical pointers for policy makers are also presented at the end of the chapter.

Chapter 3, *Grandparents Matter: Perspectives on Intergenerational Altruism - An Experiment on Family Dynamic Spillovers in Public Goods Games*, presents the results of an experiment that aspires to mimic PG intergenerational dynamics, not only from an economic point of view but also from a biological one. The experiment considers the case where a PG is produced by one generation of individuals and the following cohort partially reaps the benefits of it. Within this model the case of intergenerational public goods production is explained using a spillover rule, where a percentage of the public good produced in time t by experimental parents will integrate the endowment of their Artefactual children in $t+1$. A cascade mechanism allows also for the rebirth of three generations of players, mimicking the biological and anthropological mechanisms of gene transmission and intergenerational altruism. Results shows that subjects who are reminded of their lineage membership tend to contribute more compared to those who are not included in a dynastic model. More importantly, evidence displays that the real dynastic background of individuals is a prominent influence in the levels of investment in public goods.

Lastly, section *Concluding Remarks,* besides briefly summarizing the results of the experiments and the limitations of the study, emphasizes some of the potential lines of future research on international and intergenerational PG.

Chapter 1 - Genes, Generations and Nations in Public Good Experiments – A Critical Evaluation of the Experimental Literature

1.1 – Introduction

The creation and redistribution of resources across ages and geographical areas has been a central issue throughout human history. However in recent years the complexity of the matter has been escalating.

For the industrial world this is due to change in the shape of population age distribution, the alteration of dependent economic life cycles and the adjustment of the institutional context and the State functions (Lee et al., 2008). Firstly, the sheer trends in ageing, fertility changes (such as baby booms, bust and declines) and mortality affect the average national old age dependency ratio (65+/20-64). In addition the major population ageing has yet to come, with future claims of the elderly over founded and unfounded old age support systems. The age-structural transition witnessed in the last century and continuing well into the 21st century has had strong repercussions on the economic climate and future economic activity, particularly on the demand and production of public goods and the flow of such goods across different ages of the human life cycle (Tuljapurkar et al., 2007). Adding to this already complex scenario, the classic challenges surrounding the production and distribution of PG (such as free-riding and the tragedy of the commons) still exist in the intergenerational and international set-ups.

The production of public goods (PG) regards a wide range of fields such as peace and security, health, environmental and cultural heritage, knowledge and information, equity and justice, and market efficiency. These PG cross not only generational boarders but also National borders. The example of the eradication of smallpox is enlightening[1]. In 1960s smallpox was endemic in more than 30 Countries, and represented one of the world's most devastating diseases, with over 130.000 reported cases a year (that could have represented only 5% of the total number of cases), a 30-35% mortality rate and long term consequences for those who survived (blindness, scarring, deformities). An estimated 300 million people died in the 20th century due to smallpox. In 1966 the World Health Assembly voted for a special budget to be allocated for the eradication of the disease. While for Western Coutries vaccination was sufficient, for Developing Countries a program of surveillance and containment assisted vaccination. Thanks to the World Health Organization's (WHO) systematic efforts the last wild case of human variola major was registered in 1975 and the last wild case of human variola minor was registered in 1977 in Somalia. In 1980 the WHO declared smallpox eradicated[2]. The campaign for the elimination of smallpox is a good example of an intergenerational and international PG, and its challenges, for several reasons: firstly, it paved the way for today's concept of global health; secondly, it shows that concerted and adapted efforts across borders benefit the whole international community; thirdly, since we do not vaccinate anymore for smallpox and there hasn't been any wild case since 1978, future generations are also free from the disease; lastly, it showed that the last countries to harbor a disease are the "weak-link" in eradication programme.

Even tough most of these changes and increase in complexity have been in the making for decades only recently the accumulating effects have reached the attention threshold for both researchers and policy-makers. Since public policy is often used to

[1] Eradicating a pest or a disease is a public good since it has nonrival and nonexcludable benefits. In most cases (i.e. smallpox, malaria, poliomyelitis, etcetera) these transcend both national and generational borders. Smallpox is an intense infection due to a virus from the orthopoxvirus family, i.e. the variola virus.

[2] All information regarding the timeline of smallpox eradication is available at http://www.who.int/csr/disease/smallpox/en/.

persuade individuals to contribute to public goods when their private incentive is to free-ride or abuse the common resources, it is vital to explore how individuals behave when time and space dimensions are added to the circumstances surrounding PG production and distribution. To achieve this goal, and advise policy makers on how to improve institutions, behavioral economist employ laboratory experiments. Unfortunately the experimental literature has not fully adjusted to the complexity of the issue and a critical literature review could help researchers in their quest for gaining insight into how intergenerational and international PG should be produced and redistributed.

More specifically the purpose of this chapter is to discuss the following questions: what are the peculiarities of intergenerational and international PG games? In what do they differ from standard PG games?

In order to bring more evidence to bear on this question the chapter examines 2 strands of the literature on PG games that have developed simultaneously: the first one looks into the extent of the introduction of families and intergenerational interactions into PG experiments, while the seconds looks into local and global public good games. In the process of examining the existing literature we highlight several open questions.

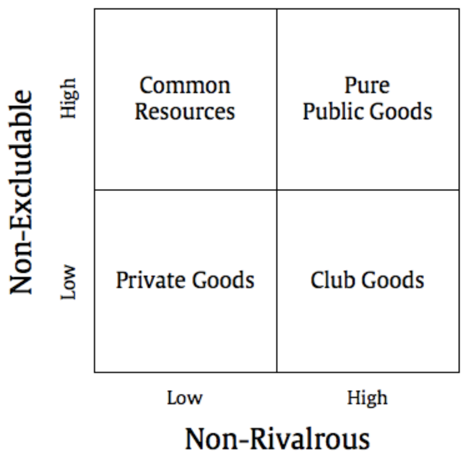
The chapter is structured as follows: section 1.2 looks into the definition and taxonomy of PG games; section 1.3 contains the critical survey of the experimental literature, looking into specific aspects of intergenerational and international PG games; concluding remarks follow in section 1.4.

1.2 – Definitions and Taxonomy

1.2.1 – Classic Taxonomy and Old Challenges

Following Samuelson's definition (1954), public goods are goods with two properties: they are non-rival and non-excludable. In other words, once they are produced an additional consumer can consume them at no additional cost, and consumers cannot be excluded from consumption once public goods are produced. The degree and extent of such properties determines the type of public good. In the classic literature public goods are divided in pure and impure. The former are those that are completely non-excludable and non-rival. The latter are characterized by the fact that individuals' benefit depends on number of users because of congestion. Impure public goods could be of two kinds: club goods, when consumption is non-rivalrous up to a certain number of users, but subject to congestion thereafter and exclusion is possible; or common pool resources (CPR), when consumption is non-rivalrous up to a certain number of users, but subject to congestion thereafter and exclusion is impossible.

Figure 1.1 – Classic Taxonomy of Public Goods



Some examples of public goods include pollution abatement, national defense, mass-transit systems, school systems, and etcetera. Examples of club goods are private parks or satellite television, while common property examples fish-stocks, or irrigation systems.

Public goods have been systematically studied by various disciplines in the social sciences and ever since the very early economic theoretical models (Samuelson, 1954, and McMillan, 1979) contribution problems have been identified and posed serious challenges for the sustainability of the necessary cooperation behind the production of public goods. In particular free riding and the “tragedy of the commons” have attracted the attention of researchers. Free riding is a well-known phenomenon that takes place when an individual is able to obtain the benefits of a good without contributing to the relative costs of production. In the case of a public good, since the provider cannot exclude from the consumption of the good, the problem is even more relevant. Buchanan (1968) described the free riding problem in his seminal work:

> It may prove almost impossible [...] to secure agreement among a large number of persons, and to enforce such agreements as are made. The reason for this lies in the "free rider" position in which each individual finds himself. While he may recognize that similar independent behavior on the part of everyone produces undesirable results, it is not to his own interest to enter voluntarily into an agreement since, for him, optimal results can be attained by allowing others to supply the public good to the maximum extent while he enjoys a "free ride"; that is, secures the benefits without contributing to the costs. Even if an individual should enter into such a cost-sharing agreement, he will have a strong incentive to break his own contract, to chisel on the agreed terms.

Similarly, for common resources, it is in the interests of all producers to hold down output with the intention of preserving the common resource, while the interest of the single producer is to increase output when others restrain production.

1.2.2 – New Challenges: Intergenerational and International Public Goods

Intergenerational public goods provide benefits across generations and such benefits are non-rival and non-excludable both within and among generations (Sandler, 1999). Examples are eradicating a disease, limiting ozone shield depletion, building major infrastructures, and preserving local biodiversity.

On the other hand, when public goods have wide-ranging benefit spillovers to the global community they are called global or transnational public goods. While transnational public goods involve more than one country, global public goods involve the entire world. However global public goods are further complicated because their production could be done either at the national, transnational or global level, independently from the location of the beneficiaries. In other words they are non-rival and non-excludable both within and among their geographical extension.

Summing up, intergenerational and international public goods are goods with benefits that extend beyond the borders of a single Country and/or benefit the next generations, and are therefore non-rival and non excludable within and among these two dimensions. Therefore the social dilemmas surrounding standard PG games are extended both geographically and temporarily. This means, for example, that intergenerational public goods depend not only on the ability of the current cohort to cooperate but also on the extent of their care for the future generations.

1.3 – Critical Survey of the Experimental Literature

1.3.1 – Stylized Facts on Standard PG Experiments

Many theories predict what it should expected from public goods experiments, and although it has long been accepted that the traditional microeconomic and game theoretic prediction of complete self-interest (and full free-riding) cannot explain the data of a vast experimental literature, there is not an unambiguous and comprehensive theory that can predict results with certainty. This is mostly due to the complexity of public goods: experimental research has to simplify in order to transpose the reality of production and consumption of public goods into the laboratory, and by doing so only some effects can be isolated, ignoring potential cross-effects. Nevertheless the literature reports on how private contributions to public goods vary with treatment parameters such as repetition, heterogeneity in endowments and returns, punishment, communication etcetera.

The foundation of experimental research on the private provision of public goods is the Voluntary Contributions Mechanism (VCM). The typical setup has subjects allocated into groups of size N (generally between 3 and 5), and each individual is endowed with a definite amount of experimental currency unit (ECU) denoted with z_i. The private good contributed (t) by the i^{th} individual is used to produce the public good following a production function $Y = f(\Sigma t_i)$ where t_i is the amount of private good contributed by each individual in order to produce Y. The production function $f(\Sigma t_i)$ represents the benefits from cooperation before being equally divided among all N group members. The outcome of a public good experiment consists of two items: a level of public good Y and a reallocation for each agent $x_1, ..., x_N$. Player's i's individual payoff, π_i, equals: $\pi_i = z_i - t_i + (a+b\delta_i)\ \Sigma t_i$, where $(a+b\delta_i)$ is the decomposition of the marginal per capita return (MPCR) with δ_i being an individual productivity factor. If $1/N < (a+b\delta_i) < 1$ the game is a social dilemma.

Given the structure of the payoff function the equilibrium predictions are identical for one-shot and repeated games: the unique dominant strategy equilibrium is for all players to fully free-ride, contributing zero to the group account. In other words, following conventional microeconomics and game theory, the public good will not be produced and consumed, since all individuals will hold their full endowment in their private accounts. On the other hand the social optimum is reached when all individuals contribute their endowment to the group account: the public good will be produced and consumed by all individuals who will not retain any endowment into their private account.

Neither of these two predictions are however observed when subjects play public good games: on average, in one shot public good games contributions are around 40-60% of the endowment, while on repeated public goods they decrease over time towards a free-riding solution (0-30%) but without reaching the one-shot dominant strategy of full free-riding (Marwell and Ames, 1979; Ledyard, 1995). In other words subjects tend to split their endowment between the private and the public account. There is a considerable subject heterogeneity since systematic differences are registered between individuals that consistently contribute and some never do, while others switch from not contributing to contributing (Palfrey and Prisbrey 1997, Brandts and Schram, 2001).

Contribution levels are further influenced by various factors: group size, different MPCR, number of repetitions, heterogeneity of endowment, communication and punishments, just to name the most relevant.

Groups that are held constant through periods show concentrated contributions as the experiment progresses (Brandts and Schram, 2001). Another element of relevance in public good games is the heterogeneity in endowment and MPCR. For what concerns the effect of endowment asymmetry the results are mixed: some studies have shown an increase in cooperation (Chan et al. 1996, 1999; Buckley and Croson, 2006), while others found a reduction (Anderson et al. 2008, Cherry et al. 2005). On the other hand if heterogeneity is linked to public or private accounts the results are consistent. Palfrey and Prisbrey (1997), for example, by assigning subjects different rates of return for their private accounts found that when the opportunity cost of public contribution is increased through greater returns to the private good, cooperation rates are lower. Fisher et al. (1995) examine heterogeneity by changing the marginal per capita return (MPCR) within groups. In this case subjects with high-MPCR contribute more to PG compared to low-MPCR ones. Further complicating the influence of MPCR on PG contributions is the awareness of such heterogeneity. When subjects are aware of the heterogeneity, contributions increase in general. But, high-MPCR types give more than low-MPCR types when contributions can be associated to the type of the donor but give less otherwise. When contributions cannot be linked to the types of subjects but individuals are aware of the heterogeneity, low-MPCR types give more than high types. Recent extension of the experimental research on public goods has studied other regarding preferences and reciprocity (see Fehr and Gätcher 2000 for an overview): individuals tend to reciprocate others' behavior but when punishment is available free riders are heavily punished by cooperating individuals, even if the punishment has a cost and does not provide material benefits to those who punish.

Given this brief general background on standard PG games it is clear that emotions, limits to rationality, social and cultural influences that are thought to influence voluntary giving towards a common project in the real world are having an effect also in experiments. Moreover these observations can be extend beyond the classic take into intergenerational and international public goods. Although a standard VCM experiment does not capture the whole dynamics of intergenerational and international public goods, past literature has already moved some steps towards a greater understanding of such mechanisms.

In the following sections previous studies on generations and global and local public goods will be presented in order to gather the exponentially growing literature and provide a framework from where further research can stem[3].

1.3.2 – Generations in Public Good Experiments

The overlapping generations model (OLG) was first introduced by Samuelson (1958), then reprised by Diamond (1965), and has since become a standard tool in economics to explain phenomena such as welfare systems, tax policies and the provision of public goods. Simplifying, the greatest innovation introduced with the OLG model is the turnover in the population: since new individuals are continually born, and old individuals are continually dying, a range of new economic interactions is established. Of particular relevance is the fact that the decisions of the older generations affect younger ones, therefore the central question regards the conditions under which the overall efficient and cooperative equilibrium can be reached and sustained. On the other hand it is important to note that individuals that aim at reaching an OLG cooperative equilibrium expose themselves to the possibility that their successors defect.

Experimental investigations of the OLG model can use various design mechanisms, depending of course on the focus of the research. However, in order to

[3] For an extensive literature review of the early studies and major stylized facts see Ledyard (1995), Zelmer (2003) and Laury and Holt (2008).

realistically portray the social dilemma of long-lived public goods, the essential unit of the design of experimental OLG models is the **carryover mechanism**. Most of the current research on repeated PG games is still lacking a valid mechanism that links decision-making processes across periods. More specifically, since contributions to a group account may be left available from one period to the following and therefore impact the effective endowment of subjects, the basic constitutional unit of any OLG PG game should be some form of carryover, either strictly downwards (from parent to offspring) or bidirectional (from parent to children and vice versa).

Cadigan et al. (2011) are the first to study the influence of carryover on contributions to a common project in a two-stage VCM game. The authors envisage two different types of carryover: one affecting the endowment and one impacting the MPCR. While the ratio behind the first scenario is clear (PG sometimes are available in the long run) the idea behind the second treatment is more sophisticated: organizing and producing public goods could impact the costs of future similar projects, specifically in terms of experience and learning-by doing, and consequently influence the MPCR (the efficiency of provision). In the endowment treatment the returns from stage 1 became the stage 2 endowment, while in the MPCR treatment the MPCR in stage 2 increases on the basis of the level of stage 1 contributions to the group account. The impact of endowment carryover has mixed results. However carryover in MPCR increases contributions in both stages 1 and 2. The latter finding supports the behaviorally based hypothesis that carryover is ought to increase contributions. Even tough Cadigan et al. (2011) presented a valid carryover design they did not include generations of players, since subjects remained constant throughout stages.

Offerman et al. (2001) tested in the laboratory the Pension Game studies by Hammond (1975), where the decision of a subject influences not only her payoff but also the payoff of her predecessor. The game is played by an infinite series of players

(P_1, P_2, P_3, …) where the first player does not make any choice. Each succeeding player makes a choice between the set {A,B} with the following payoff scheme:

Table 1.1 – Pension Game

	Choice of Player P_{t+1}	
Choice of Player P_t	A	B
A	50	15
B	70	30

If P_2 chooses A, P_1 receives 50, or if P_2 chooses B, P_1 receives 30. Each ensuing player P_t's payoff is determined by his own choice and by the choice of the next player P_{t+1}, his descendant. The conclusion of the game is determined by a 90-10 lottery. In the baseline treatment only 13.8% choices were cooperative, while with the introduction of a recommendation of grim trigger strategy by experimenters, 29,3% of individuals made cooperative choices. The relevance of Offerman et al. (2001) experiment is related to the mechanism embedded into overlapping generations: often there is no chance to revise your strategy when you leave a legacy to future generations. Also the experiment showed the importance of learning before the start of the game, in the form of direct communication between successive generations[4].

Schotter and Sopher (2001a,b and 2003) pioneered an inter-generational communication model, pointing out that when confronted with social dilemmas (specifically ultimatum and trust games) individuals tend to access to the wisdom of the past. The same approach has been extended to public goods games by Chauduri et al (2005): in their experiment subjects in one generation could leave advice for the next generation. When such advice is common knowledge rather than private (only for the immediate successor) or public (available to everybody but nor read aloud by

[4] Offerman et Al. (2001) make use of a Dictator Game (DG) to explore intergenerational altruism. Before them VanVan Der Heijden et al. (1998) used a similar approach. Later on also Güth et Al. (2002) researched intergenerational trasfers by means of a DG. Both studies have found that direct or indirect reciprocity does not seem to be a determinant that explains integenerational transfers.

the experimenter) it generates a process of social learning with higher contributions and less free riding. Since advice is generally exhortative, meaning that it suggests higher contributions and a cooperative strategy, the behavior is supported by general optimistic beliefs about others' contributions.

The most recent development in OLG PG experiments is imputable to Duffy and Lafky (2014). The mechanism design proposed in the paper consists of periodically replacing old members of a group with new members over time. Their findings show that, although first-period contributions to the public account are not influenced by the OLG matching protocol, average contributions experience considerably lower decay levels over time compared to standard VCM environment with fixed group membership. Consequently it could be that the traditional pattern of contribution and decay generally seen in PG games does not truthfully mirror the behavior of groups with changing membership, as it is observed in real life examples of PG production. In the same line of research in chapter 2 we propose a model that explains how equilibrium is reached in a context where heterogeneity is linked to seniority and strategic interaction is finitely repeated. The chapter studies cooperation and free-riding behavior through a three-person linear public good game in which agents are asymmetric in productivity (heterogeneous MPCR), experience (seniority) and history.

Williams (2013) on his working paper looked into yet another side of intergenerational PG. In his study he created a laboratory experiment to test if different methods of financing the public good can dynamically impact the welfare of subjects. The results showed two different results: the ability to borrow leads higher natural endowments for the next generation (through higher contributions and corresponding spillovers) but the next generation has a lower net endowment (endowment plus savings minus debt repayment) than the previous generation. This difference happens because the debt reimbursement is higher than the gains from the previous generation's investment in the public good.

Another way of looking into intergenerational PG related dilemmas is by introducing the concept of intergenerational common pools resources (CPR), which are exploited by one generation after another. Fischer et al. (2004) run an experiment where the stock accessible to each generation changes following the extent of exploitation by prior cohorts and on resource's growth rate (slow or fast). The goal of their experiment is to test the hypothesis that the overexploitation of CPR may be inferior than anticipated by previous experimental findings. The intuition behind this hypothesis lies in the fact that most of these experiments make use of models in which the consideration and fretfulness for future generations, and future generations themselves, are omitted. However intergenerational dynamics could provide significant incentives to restrain the exploitation of resources. Results of Fischer et al. (2004) experiment show that subjects' behavior exhibits a form of altruistic restraint in the exploitation of the stock (intergenerational altruism), but not in an adequate amount to achieve the social optimum. The existence of an intergenerational connection induces subjects (in both slow and fast growth rate treatments) to anticipate fewer cases and lower levels of resource exploitation from each other compared to what individuals anticipate in a single generation control. However, on average, expectations are too optimistic and there is a clear discrepancy between expectations and appropriation behavior. Such inconsistency could imply that the sustainable use of CPR should not achievable on a purely voluntary basis, even if the principle of sustainable development is agreed upon.

1.3.3 – Families and Genetic Transmission

The most elementary unit of generational carry-over is *de facto* the family. Humans evolved over millennia into agents that invest heavily, both directly and indirectly, in their children, which are surprisingly dependent until a late age, if compared to other mammals. Furthermore adults support this heavy investment in children remaining net producers until old age, when they withdraw from labor and begin to consume more than they produce.

Part of this investment consists of contributions towards family public goods (housework, care for sick family members, a trimmed garden) and part towards more general public goods (specifically long-run PG: education or health systems, major infrastructures and environmental protection). Families therefore voluntarily contribute to many public goods whose benefits spill over to members of other households. Private income transfers represent the remaining part of investment into children. The sum of these investments, plus personal parental consumption, are motivated by both care about children and other motivations such as self-interest.

This dichotomous motivation has been pointed out since Adam Smith (1853), who in a famous passage argued that although people are selfish in their market transactions, altruism is very important within a family:

> Every man […] is first and principally recommended to his own care. […] After himself, the members of his own family, those who usually live in the same house with him, his parents, his children, his brothers and sisters, are naturally the objects of his warmest affections. They are naturally and usually the persons upon whose happiness or misery his conduct must have the greatest influence. […] It approaches neared, in short, to what he feels for himself.

Becker (1974) took from Smith's intuition to model his famous **"Rotten Kid Theorem"** which claims the following: if a family has a household head which is caring towards other family members and he is also sufficiently rich, then it is in the self-interest of other household members (i.e. the children) to make those strategic decisions that maximize the total family income, even at a cost to their own private income. In other words a selfish child has an incentive to invest in the optimal amount of the family public good, even when free-riding would maximize her own utility.

To understand the interdependence of the relationship parent-child in terms of income and consumption we can use a simple example with one parent (P) and one child (K) (Peters et al., 2004). Consumption levels of P and K, denoted by C_P and C_K, are respectively:

$$C_P = Y_P - t \qquad \text{and} \qquad C_K = Y_K + t$$

where t is the generational transfer motivated by altruistic preferences, Y_P is the exogenous income of the parent and Y_K is the exogenous income of the child. The preferences of the parent depend positively on the utility of the child, which in return depends positively on the transfer t. Also if Y_P is sufficiently larger that Y_K, the parent will allocate her own income between her own consumption and the redistribution to the child, influencing therefore the total consumption of her child. In addition t, and consequently C_P are increasing in ($Y_P + Y_K$). The intuition is that the child would not make a decision that will reduce Y_P more than it increases Y_K, since the reduction of Y_P will reflect into a reduction of t greater than the increase in Y_K. A child should therefore aim at maximizing the total family income.

Peters et Al. (2004) tested exactly this theorem using experimental methods. By means of a standard Voluntary Contribution Mechanism (VCM) they compared groups with strangers and groups with members of real-life families, both with the same composition of two parents and two children. The results were consistent with altruism since parents and children contributed more to the public good when in the real family setting, compared to groups composed of strangers. Further, parents contributed more compared to children and kept contributing even when they were in groups with children from other families. However the most striking result was that children's behavior fell short of maximizing the total family income, in contrast with the predictions of the Rotten Kid Theorem.

A possible explanation of these results can draw from the debate in evolutionary biology that parallels the economists' Rotten Kid Theorem. Evolutionary biology brings two main concepts into the study of the economics of the family:

1. Reproductive success is the measure of payoffs in games between family members; and
2. The rules of Mendelian inheritance (with offspring tending to be like their parents) determine the passing of genes that program the strategy that an individual uses in games with its relatives. Individuals do not consciously choose strategies, but those are embedded into the genes that are transferred through natural selection.

In what Bergstrom (1989) calls the "parent-offspring conflict" parents may disagree with children on how the resources of the family should be redistributed between its members, with children tending to desire that parents transfer more resources than the parent would, but with parents still being significantly altruistic. The biological model of kin selection by Hamilton (1964) could explain the final allocation of such resources. **"Hamilton's rule"** focuses on the gene rather than the individual: altruistic behavior among kin is governed by the implicit assumption and unconscious calculation of expected benefits and costs in terms of reproductive success. He predicted that a costly act that benefits a family member would be undertaken "if and only if the fitness cost incurred by the actor is outweighed by the discounted fitness benefit bestowed on the relative, where the discount factor is Wright's coefficient of relatedness" (Alger & Weibull, 2011). In other words parents are altruistic towards their children in order to increase the probability of survival of his own genes, while children are not fully aligned to the Rotten Kid Theorem (not showing symmetrical altruism to parents) because the flow of genes, and therefore resources, is essentially downwards. A child will tend to be essentially selfish until he himself becomes a parent.

Another related stream of research focuses on the transmission of prosocial behavior values from parents to offspring, which indeed influence the propensity to free ride or cooperate in public goods games. Although this literature has not reached strong conclusions on whether parenting truly is the determinant of prosocial behavior, Harris (1995) argues that the true influence on behavior stems from childhood and adolescence peer groups. Cipriani et Al. (2007) tested this theory in the laboratory with an experiment in which a group of African American and Hispanic families played a standard public good game.

The main results found by Cipriani et Al (2007) are striking: there is no significant correlation between the degree of cooperation of a child and that of her parents. However the difference between the children and parents' average contribution is not statistically significant, consistently with previous findings by Harbaugh and Krause's (2000)[5]. Still the contributions of children have a greater degree of variability compared to parents, presenting a higher proportion of "extreme contributions". Furthermore girls contribute more than boys, younger children

[5] Using a public good game played by children aged between 6 and 12 years old, Harbough and Krause's (2000) examined the development of altruistic and free-riding behavior. They find that the level of prosocial behavior in children and adults is similar, although repetition has different effects on the two age groups. While adults tend to decrease their contributions in time, young children tend to increase their contributions in later rounds.

contribute more than older ones and children from large families (more than 3 children) contribute less than small households.

1.3.4 – Local and Global Public Goods Experiments

Introducing the topic of this chapter international PG were described. These goods can be excluded using space or distance as determinants. In this sense some types of goods are globally public, and others are only nationally or even locally public. Practically, the property rights to consumption of public goods are linked to their geographical extension: local public goods might be accessible only to the residents of a limited region while global public goods are available to the whole population of the world. Furthermore it is important to underline that local public goods have a tendency to grant higher marginal benefits only to the group's members due to physical limitations, while global public goods give benefits more efficiently and broadly, but also more anonymously (Nitta, 2014). Moreover individuals, and institutions, could be able to choose among different levels of contribution between global, national or local public goods.

The favorite choice of researchers, in order to capture in the laboratory this dichotomous social dilemma, is a linear VCM experiment, where subjects can **contribute** to both a **local and a global public good**. There are numerous experimental results available that consider multiple public goods under a VCM: the main feature of these experimental designs is that individuals are at the same time put into a local and a global environment and have to decide how to distribute their own endowment between the private good, the local public good and the global public good. Generally the global environment is designed in such a way that it contains the entire local groups. A common setting also includes higher marginal benefit for the local public good compared to the global public good, which represents the socially optimal choice.

The available literature since Hirshleifer's (1983) shows a bias toward contributing to local needs. In his paper Hirshleifer discussed three different social composition functions that could represent different ways in which PG are produced: summation, weakest-link and best-shot. In the case of summation, which is the standard case, the PG available to the community (X) is simply made up by the sum of the individuals' contribution ($X = {}_{i} x_i$, where $i = 1 \ldots n$ are the members of the community). In the second mechanism (weakest-link) the socially available quantity X corresponds to the minimum of the individual x_i ($X = \min_i x_i$), while for the last mechanism (best-shot) the socially available quantity X corresponds to the maximum of individual x_i ($X = \max_i x_i$). By introducing two alternatives PG social composition functions the author was able to explain why, for example, during times of catastrophe social behavior displays strong cases of cooperation and self-sacrifice. Relief and rescue operations are, during those times of hardship, fundamental public goods. Without those the community could not survive or strive in future, and cooperation is essential: even those who are normally selfish need to be cooperative if they wish for the community to simply outlast the threat. However these extreme cases of self-sacrifice disappear when the risk of community collapse is back again to, or close to, pre-disaster levels. Also intervention and support to a community is much faster and effective when there is close spatial proximity to it.

Blackwell et al. (2003) were the first to experimentally investigate how different levels of spatial excludability effect the production of PG. Their model included to different public goods: a local (excludable one) PG and a global (non-excludable) PG. The following variables were defined:

x_i: contribution of person *i* to the personal account,

g_i: contribution of person *i* to the local account,

G_i: contribution of person *i* to the global account,

α_g: individual return to the local public good, $0 \leq \alpha_g \leq 1$,

α_G: individual return to the global public good, $0 \leq \alpha_G \leq 1$, and $\alpha_G \leq \alpha_g$,

n: number of individuals in the local group,

N: number of total individuals, n < N.

Under budget constraint the subject that seeks to maximize the individual payoff had to consider the following:

W_i: initial allocation of tokens, where W_i: $x_i + g_i + G_i$,

T_i: payoff to individual *i*,

T: $\boldsymbol{xi \ + \alpha gj = ngi \ + \alpha Gk = NGk}$

The Nash equilibrium predicted for their game a dominant strategy of zero contribution towards both PG. The experiment tested three main hypotheses[6] with four different treatments combining different MPCR and APCR (average per capita return, or the return to the whole society) for local and global public goods. The results showed that when the APCR for the local PG is smaller than that for the global PG individuals allot the majority of their PG contribution to the global PG. In addition contributions to the local PG are increasing in the previous contributions of the others in the local group and are negatively correlated to contributions to the global PG. More generally, contributions to the global PG decay over time but those to the local PG do not. Since contributions to the global PG decline over time it is plausible to state that the global PG effects dominates overall contributions.

[6] The three hypotheses tested in Blackwell and McKee (2003) were the following: individuals will contribute to PG, inidividuals will prefer contributing to the local Pg rather than the global PG, and lastly, individuals can be nudged to contribute to the global PG by increasing the social return to the global PG.

Fellner and Lunser (2008) extended previous investigations on the connection between MPCR to the contributions to local and global PG by holding constant the MPCR of the local PG and varying the MPCR of the global PG. The experimental results show that when the local and the global group have identical MPCR, individuals prefer to contribute towards the local PG, where, nevertheless, the familiar decline of contributions over rounds ensues. In contrast, Fellner and Lunser (2008) show that even if the global public good is more efficient and subjects' first attempt is to cooperate in the global public good this tendency quickly solves and cooperation in the local public good increases.

However, neither of the two studies addressed **income heterogeneity**. Nitta (2014) investigates how endowment heterogeneity between areas affects subjects' provision decisions in the presence of both local and global PG. The paper finds that for the local public good, the high-income individuals contribute a higher percentage of their endowment to the local public good compared to low-income individuals. On the other hand for the global PG, high-income individuals contribute a greater percentage of their endowment to the global PG in the early stages, but their contributions decline faster compared to those of the low-income individuals.

An interesting take into the provision of local and global public goods is the inclusion of a **threshold** setting: in a standard threshold PG game, if sufficient contributions are made to reach the indicated threshold level of contributions, the public good is produced, otherwise the funders lose their contributions and the good is not produced. The underlying intuition is that additional options make coordination more complex: Corazzini et al. (2013) is the first experimental paper to make this point in a setting with multiple public goods. The experiment includes four distinct treatments: the first is a benchmark with a single threshold public good, while the remaining three treatments, each with four public goods to which subjects may contribute, study different combinations of efficiency between public goods. They show that when the number of potential recipients increases, total donations decrease. However nobody has yet shown the behavioral response to a threshold local and public goods game.

Another important point that has not been considered yet regards **spillover effects**. An increased openness of Countries means a greater mobility of the public good, but also of the public bad, generating greater global systemic risks. Furthermore even if the benefit, or the detriment, is global, only some groups produce a global public good (or bad) because the others don't have access to the opportunity to contribute or control it. Cross-border effects (which in experimental settings are represented by cross-group effects) produced by a group are often a mere externality, and as such they should be internalized ("internalizing externalities" principle). Also individuals not always fully understand and consider the benefits and costs during their decision-making process. This is also a central reason why public goods tend to be undersupplied, while public bads are likely to be oversupplied.

A **public bad** take on a global and local experimental setting could reveal interesting dynamics since individuals tend to make more cooperative choices in the public good game compared to the public bad game (Offerman, 1976). In Offerman's (1997) public bad game individuals are asked to choose if and how much to withdraw from a common pool, that is if too many withdrawals are made no public good will be provided. One of the predictions made by Offerman (1997), in line with Pruitt (1967; 1970; 1981) is that in the public good game individuals consider the interdependence between themselves and other participants as higher, compared to the public bad game. They also value mutual cooperation more in the public good game. Such prediction holds for both individualists and cooperators (Offerman, 1997: 122).

Another useful experimental design in order to investigate global and local public bad dynamics is similar to Andreoni (1995) "cold-prickle" **negative framing**. In his paper he points out that the, as mentioned earlier in this chapter, of investing in the private good is that one did not invest in the public good. As a consequence saying that contributing to the public good will benefit all members of the group is mathematically equivalent than saying that investing in the private good will make the other members of the group worse off. Practically, in the negative framing individuals have to allocate their endowment between two projects, A and B, while investing in project A gives a direct private return it also has a negative external effect: each token invested in project A has a negative return to all group members. This framing is obtained by substituting into the payoff function the budget constraint in place of the sum of the tokens given to the public good account. The results show that people are significantly more willing to contribute to the public good when the problem is posed as positive externality rather than as a negative externality, even if the incentives are the same. This shows that cooperation in public good games cannot be explained solely by pure altruism since the opportunities of free riding are the same independently of the frame (Andreoni, 1995).

Finally another aspect of relevance for the production of local and global public goods is **leadership**. Moxnes and Van Der Heijden (2003) modeled the effect on the followers' willingness to contribute toward the social optimum in a public bad setting, showing that there is a small but significant effect of a leader setting the good example. In the control treatment, with no leader, all participants made their investment decisions simultaneously, with the same type of behavior found in previous studies. On the other hand, in the leader treatment individuals were asked to decide simultaneously only after a leader made his choice, observable by all members of the group. On average, contributions to the public bad are lower in the presence of a leader, and the level of the leader investment is important: followers' contribution fluctuates from round to round following the variations in leader's contributions.

Leadership is relevant especially for global environmental and health problems that can be described as commons or public bad problems (climate change, ozone depletion, vaccination and finding a cure for a disease are all prominent examples). In such cases the individual (or local) marginal benefits of producing an extra unit of a public bad are thought to exceed the extra costs caused by relatively small own contributions to the total public bad. Conversely, global marginal costs possibly will be considerably higher than marginal benefits. This social dilemma makes global public bad problems hard to solve: solutions require coordination between individuals and groups, as well as supervision and enforcement. Leadership could possibly solve the issue, with international lead agencies being appointed and becoming every day more relevant in order to enhance the provision of global public goods or the control of global public bads.

1.4 – Conclusion: Where to from here?

The evidence presented in this chapter suggests that both generations and spatial membership play an important role in defining cooperative and selfish behavior in public good games. However current experimental literature has moved only small steps towards finding a conclusive theory regarding the direction and intensity of these effects. Clearly including generations and spatial membership in experimental settings is not a straightforward exercise since both require complex designs that are influenced by many variables.

A potential option to push the envelope is to look into socio-biological theories of human cooperation based on kin selection and genetic transmission (Hamilton, 1964). In particular drawing from models of biological succession could help in designing an efficient mechanism to mimic generational carryover and the important dichotomy of altruistic parents and selfish children.

For what concerns local and public goods the experimental literature is definitely well along but has yet to clarify what happens if thresholds are included in the production of the two PG (will subjects contribute more to the local PG or the global PG? What happens is the thresholds are different for local and global PG?). Also, there is little research done in terms of local and global public bads.

Finally it is advisable that the theoretical insights gained in future developments of the international and transnational PG experimental literature are tested in field settings. This approach would further confirm the importance of considering “time and space” in institutional design aimed at the production of PG.

Chapter 2 – Helping Out the Young and Inexperienced: an Experimental Approach to Generational Heterogeneity and Redistribution in Public Good Games.

2.1 – Introduction

The production of public goods often involves more than one generation of individuals, leaving the classic literature on voluntary provisions partially unfit to explain phenomena such as those related to welfare systems, climate policies, grants and aids for young entrepreneurs and major infrastructure projects.

It appears therefore necessary to introduce adequate and plausible demographical and societal hypothesis into public good (PG) experiments in order to improve the understanding of voluntary contributions to long-lived public goods. In these experiments, **groups** – which may represent different levels of societal aggregation, such as organizations, institutions, lobbies or even unions – could be thought as entities with indefinite or infinite life, while **individuals** have finite and non-coterminous life spans (Dickson, 2001). In addition, it is reasonable to introduce the entry and exit of individuals at different stages of the game: birth, election, recruitment, enrollment as well as death, retirement, dismissal, and voluntary discharge are all events that determine the beginning and the end of individual provisions to public goods within groups. Furthermore, the level of seniority **typifies** individuals, in terms of experience, rights earned in time and cumulated benefits. Also, the benefit extracted from a public good is sometimes pre-determined by the legislator who sets the limits and modalities of utilization in relation to specific individual features. Summarizing, in order to fully understand the dynamics behind the production of intergenerational PG it is necessary to take into account groups with indefinite lives, individuals with definite lives and their type.

The model presented in this chapter focuses on the equilibrium that arises from repeated strategic generational interaction within groups, when individual heterogeneity is linked to seniority. More specifically the case of grant aids for fixed investments, as part of a broader industrial policy program, is fitted into the model in the form of a redistribution rule that benefits the younger players as a compensation for their inexperience. This is the case of policies that are aimed at supporting start-ups or young companies in highly competitive environments or during recession (see section 2.1.1).

This chapter makes two types of contributions: a methodological one and a policy one. The first one provides a relevant framework for the evaluation of the effects of seniority and imposed redistribution rules in voluntary provisions. It also raises the possibility of investigating generational interactions between heterogeneous players. The policy contribution highlights the importance of understanding the degree and type of heterogeneity between subjects before implementing a policy in order to generate the greatest extent of consensus possible. Consensus building is in fact a major challenge for policy makers since it can determine the success or failure of polices. Another reason for past policy failures could also be linked to underestimated effects of generational heterogeneity amongst stakeholders. This study makes a step forward in understanding the possible implications of demographical differences amongst the participants to a public good game.

2.1.1 – Grants and Aids for Young Entrepreneurs and Start-Ups

Listing some examples of complex PG phenomena we mentioned grants and aids for young entrepreneurs. Economic Prosperity is frequently cited as one of the greatest PG, and public policy has often turned to entrepreneurship to “maintain, restore or generate economic prosperity” (Acs et al., 2009). In addition an increase in economic wealth is often associated with an increase in spending in health, education, social protection etcetera.

This chapter was originally conceived as research program in collaboration with the “Provincia Autonoma di Trento” (PAT – the autonomous province of Trento), more specifically the “Dipartimento Industria e Atigianato” (Department of Trade and Industry). PAT supports the development of local enterprises through the granting of incentives for investments in fixed assets, innovation and research, and through a series of systematic interventions governed by provincial law 6/1999 favoring young entrepreneurs, start-ups or companies facing serious challenges that undermine their solidity. In particular, this project intended to focus on those policies supporting fixed capital investments, understood as investments in properties, plants, machineries, equipment, patents, acquisitions of know-how as well as costs related to environmental protection measures. In 2013/2014 the Department was considering an overhaul of the structure of such incentives; in particular it was evaluating the possibility of introducing more strict selection criteria and the “integrated package” (pacchetto integrato). The latter consists of a set of 3 tools (capital contributions, interest rate subsidies and financial guarantee) with the aim of transforming simple grants into conditional aids. Given the sensitivity of this transformation the Department formally shown its interest in the research of tools that facilitate the consensus over this transition. In this light the Department was involved in the design of the experiment. However during the development of the experiment it was clear that the results were generally applicable to a wide range of PG issues, from redistribution of PG benefits to interaction dynamics between experienced and non-experienced players.

2.1.2 – Public Good Games, Heterogeneity and Social Preferences

This chapter lies at the intersection of the literatures on repeated public good games, the effects of heterogeneity on cooperation, overlapping generations (OLG) and evolution, adaptation and learning in voluntary contribution experiments.

Public good games have been widely used in experimental economics in order to study the mechanisms behind free riding and cooperation. The literature on voluntary contribution mechanisms is extensive, especially in the context of homogenous groups (for a survey see Ledyard, 1995). Previous experimental research in this field has revealed that one-shot games contributions are relatively high (around 40% to 60% of the initial endowment) while finitely repeated public good games are characterized by decay in contributions over time (Isaac et al., 1985).

Recent progress that accounts for deviations from the expected free-riding zero contribution and decline over time has been made in two directions (Chaudhuri, 2011). One has investigated the existence of different types of players, whom vary in their social preferences and/or beliefs about their peers. In this line of research the main outcome has been the formal and structured definition of conditional cooperators. The second set of studies has examined distributional concerns and intention-based models.

Public good games with homogenous players have shown that individuals make positive, even if suboptimal, contributions to public good provision (Cherry et al. 2005; Gatchter and Herrmann 2009), but the effect of heterogeneity on cooperation has not been fully explained. First of all heterogeneity can refer to income, group or individual productivity differences. Secondly, different types of heterogeneity can produce effects that work in opposite directions.

Income heterogeneity has been introduced in public goods games by varying subjects' initial endowment: the results in literature are mixed. Some studies found that cooperation is increased (Anderson et al. 2004, Cherry et al. 2005) while others claim that endowment asymmetry reduces cooperation (Chan et al. 1996, 1999; Buckley and Croson, 2006).

Heterogeneity can also be introduced by varying subjective impact on either public or private accounts. Assigning to individuals different rates of return for their private accounts showed that the greater the return to the private good, the lower the cooperation rates (Palfrey and Prisbrey, 1997).

Lastly, heterogeneity in productivity is introduced using the proxy of marginal per capita return (MPCR). MPCR is a key parameter in public good games and represents the benefit that each participant receives from each money unit contributed to the group account by any group member. Hence, high MPCR players show higher propensity to contribute to public good provision if compared to low MPCR players (Fisher et al., 1995). The explanation given is that high MPCR types contribute more, either because they can take greater advantage from the joint project or because their costs of contribution is lower.

Another explanation could take into account social preferences. Andreoni's (1995) research on public goods suggests that the motivations related to social preferences might depend on whether the provision of the public good is framed positively or negatively. This finding was elicited with the standard linear public good game under two experimental conditions: one with a positive framing, so that subjects would be motivated by warm-glow altruism and the other with a negative framing, so that subjects would be motivated by a desire to avoid a "cold prickle" of guilt. The result is that subjects in the positive frame treatment are much more cooperative than subjects in the negative frame treatment, since the tendency to free ride is higher in the negative framing. However experimental studies that investigate the framing valence of different MPCR are not yet available. The current literature introduces at maximum two different MCPR, one high and one low, while no study has considered at least three MCPR within groups. Different MPCR, as said before, represent different levels of within group productivity. Such differences could be linked to subject-specific characteristics, or be imposed as a redistribution rule by an external third party.

Regarding transfers over time in public games, these have been modeled as repeated two-stage games with carryover that can either benefit the same or another group (Cadigan et al, 2011 and Grolleau et al., 2013). In this paper imperfect-overlapping generations (OLG when the exit of players happens after they benefitted from their contribution to a public good) has been represented by different MPCR assigned to different generations of subjects. Repeated public good games with OLG have mainly looked into public imperfect monitoring over the intergenerational cooperative dimension with long-lived public goods, especially in the field of climate policy (Karp, 2013).

The model proposed in this chapter has been developed keeping in mind the peculiarities of grant aids for fixed investments. Since grants are considered the offset of taxes – i.e., they are based on redistribution, while taxes follow contribution rules – heterogeneity in MPCR has been used as a policy proxy. From this perspective, the relevant behavioral economics literature covers the issues of fairness and social preferences.

Social preferences are defined as the care of people not only for their own well-being, but also for the payoffs and/or actions of others. Such preferences include altruism, fairness, reciprocity, and inequity aversion. Amongst the numerous social preferences theories, those developed by Fehr and Schmidt (1999), Bolton and Ockenfels (2000), and Charness and Rabin (2002) have received the most attention, especially from scholars attempting to evaluate the predictions of these models using laboratory experiments. Laboratory tests comparing social preferences theories have generated mixed results especially on iniquity aversion, which is the dislike of people for inequitable outcomes – i.e., in order to achieve more equitable outcomes subjects are willing to give up some monetary payoff (Kritikos and Bolle, 2001; Riedl and Vyrastekova, 2003; Güth et al., 2003; Engelmann and Strobel, 2004; Bereby-Meyer and Niederle, 2005; Chmura et al., 2005).

In order to frame redistribution rules, it is crucial to consider some specific biases and heuristics related to iniquity aversion. The informative representation of the redistributive norm could exploit the compromise and contrast effects (Sunstein, 2000) and the framing effect (Tversky and Kahneman, 1981). This approach should also consider the repercussions of the status quo (Knetsch and Sinden, 1984) and anchoring and adjustment biases (Kahneman and Tversky, 1981, 2000). For example, when entrepreneurs see their grant aids diminishing from one year to the next, they tend to be less supportive towards the industrial policy program, even if the same program has endowed them with additional benefits, such as lower taxes.

However just introducing altruism cannot explain why subjects do not contribute their entire endowment when this is the socially optimum equilibrium. This leads to the introduction of dynamic models of evolution and adjustment. A particularly simple model in literature introduces the idea of replicator dynamic, where the probability of a specific contribution level is assumed to change depending on the earnings relative to the average of the population (Miller and Andreoni, 1991).

In other words contributions with an expected payoff above the population average should increase in frequency, while contributions below this average should decrease.

Additional empirical evidence demonstrated that contributions tend to be lower in late rounds of a session than in early rounds, and experienced participants contribute less than inexperienced ones (Holt and Laury, 2008). Learning is often pointed as the explanation for such behavior: individuals might either learn to use a dominant strategy or what to expect from others, which possibly will affect their attitude toward others' payoffs.

Given the above background, the experiment presented in this chapter tests in the laboratory two main hypotheses:

> ***HP$_1$:*** Complete information of heterogeneity in individual productivity (represented by different marginal per capita return within groups) increases voluntary contributions toward a public good.
>
> ***HP$_2$:*** The introduction of imperfect OLG, and therefore the creation of experienced players, improves the levels of cooperation in public good games.

These hypotheses will be tested and measured by means of three different public good games, as illustrated in the next section.

2.2 – Method and Model

We model grants with imperfect OLG as a variation of a public good game where there are two goods – one private and one public – and N individuals. Each individual $i = 1, .., N$ is endowed with an amount of the private good, z_i. The private good contributed (t) by the i^{th} individual is used to produce the public good following a production function $Y = f(\Sigma t_i)$ where t_i is the amount of private good contributed by each individual in order to produce Y. The production function $f(\Sigma t_i)$ represents the benefits from cooperation before being equally divided among all N group members. The outcome of a public good experiment consists of two items: a level of public good Y and a reallocation of the private good for each agent $x_1, \ldots, x_N$. Player's i's individual payoff, π_i, equals: $\pi_i = z_i - t_i + (a+b\delta_i)\,\Sigma t_i$, where $(a+b\delta_i)$ is the decomposition of the MPCR with δ_i being an individual productivity factor. If $1/N < (a+b\delta_i) < 1$ the game is a social dilemma since individually, each player is best off giving nothing to the public good, but collectively the players are best off donating their entire endowments.

2.2.1 – Experimental Design

The experiment consisted of four treatments: the Baseline Treatment (BT), the Horizontal Baseline Treatment (HBT), Treatment 1 (T1) and Treatment 2 (T2). Table 2.1 summarizes the main features of the four treatments.

Table 2.1 – Treatments Structure.

Treatment	Over # days	Heterogeneity (MPCR)	Entry/Exit of Subjects	Number of Sessions	Number of Subjects Involved
BT	1	3 MPCR (0.40 0.65 0.90)	No	4	66
HBT	3	1 MPCR (0.40)	Yes	1	30
T1	3	3 MPCR (0.40 0.65 0.90) *Constant*	Yes	2	55
T2	3	3 MPCR (0.40 0.65 0.90) *Decreasing*	Yes	2	55

The baseline treatment (*BT*) involved 66 individuals, which were randomly and equally assigned to three different categories of players (named *type A*, *type B* and *type C)*, each with a different δ_i. In particular $\delta_{Type\ A} < \delta_{Type\ B} < \delta_{Type\ C}$, with $\delta_{Type\ A} = 0$, $\delta_{Type\ B} = 0.5$, $\delta_{Type\ C} = 1.0$, and $\mathrm{MPCR}_{Type\ A} = 0.40$, $\mathrm{MPCR}_{Type\ B} = 0.65$, $\mathrm{MPCR}_{Type} = 0.90$. Individuals then formed constant groups of three members each, one from each category, and played 20 consecutive rounds of a standard public good game.

A second baseline treatment was run in order to check for the effect of new subjects entering the PG game. We called it "Horizontal Baseline Treatment" (HBT) and it ran over three consecutive days (*D0*, *D1* and *D2*), involving a total of 30 subjects playing each day 20 rounds of a public good game. In *D0* 18 subjects belonged to *type A* players, with $\delta_{Type\ A}$ = 0 and $MPCR_{Type\ A}$ = 0.40, formed constant groups of three members each and played 20 consecutive rounds of a standard public good game. At the end of *D0* 12 individuals were randomly drawn to participate to the experiment in *D1*[7]. In *D1* 6 new individuals were introduced with the same parameters of *type A* players, but they were labeled as *type B*. New constant groups of 3 subjects were formed by randomly choosing 2 *type A* and 1 *type B* individuals. At the end of *D1* 6 individuals were randomly drawn from the 12 *type A* players to participate to the experiment in *D2*, while all *type B* players moved on to *D2*. In *D2* 6 new individuals were introduced with the same parameters of *type A* and *type B* players, and they were labeled *type C*. New constant groups of 3 subjects were formed by randomly choosing 1 *type A,* 1 *type B* and 1 *type C* individuals.

The first treatment (*T1*) ran over three consecutive days (*D0*, *D1* and *D2*), involving a total of 55 subjects playing 20 rounds of a public good game. In *D0* 33 subjects belonged to *type A* players, with $\delta_{Type\ A}$ = 0 and $MPCR_{Type\ A}$ = 0.40, formed constant groups of three members each and played 20 consecutive rounds of a standard public good game. At the end of *D0* 22 individuals were randomly drawn to participate to the experiment in *D1*. In *D1* 11 new individuals were introduced with the parameters of *type B* players: $\delta_{Type\ B}$= 0.5 and $MPCR_{Type\ B}$= 0.65. New constant groups of 3 subjects were formed by randomly choosing 2 *type A* and 1 *type B* individuals. At the end of *D1* 11 individuals were randomly drawn from the 22 *type A* players to

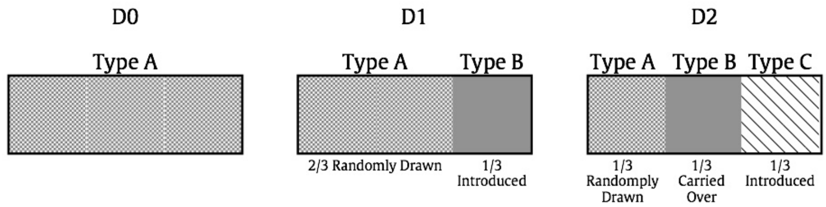
[7] At the end of each day, subjects that were not randomly drawn to continue participating in the experiment in the next day were paid and left. They were not eligible for any other treatment of the same experiment.

participate to the experiment in *D2*, while all *type B* players moved to *D2*. In *D2* 11 new individuals were introduced with the parameters of *type C* players: $\delta_{Type\ c}$ = 1.0 and MPCR$_{Type\ C}$ = 0.90. New constant groups of 3 subjects were formed by randomly choosing 1 *type A*, 1 *type B* and 1 *type C* individuals.

The second treatment (*T2*) ran as well on three consecutive days (*D0*, *D1* and *D2*), involving 55 subjects playing each day 20 rounds of a public good game. In *D0* all 18 subjects belonged to *type A'* players, with $\delta_{Type\ A'}$ = 1.0 and MPCR$_{Type\ A'}$ = 0.90, formed constant groups of three members each and played 20 consecutive rounds of a standard public good game. At the end of *D0* 12 individuals were randomly drawn to participate to the experiment in *D1*. In *D1* 6 new individuals were introduced with the parameters of *type B'* players: $\delta_{Type\ B'}$ = 1.0 and MPCR$_{Type\ B}$ = 0.90, while *type A'* players saw their parameters being reduced with $\delta_{Type\ A'}$ = 0.5 and MPCR$_{Type\ A'}$ = 0.65. New constant groups of 3 subjects were formed by randomly choosing 2 *type A'* and 1 *type B'* individuals. At the end of *D1* 6 individuals were randomly drawn from the 12 *type A'* players to participate to the experiment in *D2*, while all *type B'* players moved to *D2*. In *D2* 6 new individuals were introduced with the parameters of *type C'* players: $\delta_{Type\ C'}$ = 1.0 and MPCR$_{Type\ C'}$ = 0.90, while *type A'* players saw their parameters being reduced with $\delta_{Type\ A'}$= 0 and MPCR$_{Type\ A'}$= 0.40 and *type B'* with $\delta_{Type\ B'}$= 0.5 and MPCR$_{Type\ A'}$= 0.65. New constant groups of 3 subjects were formed by randomly choosing 1 *type A'*, 1 *type B'* and 1 *type C'* individuals.

Figure 2.1 summarizes the group composition over the 3 days of the experiment for treatments HBT, T1 and T2.

Figure 2.1 – Day and group composition for a standard session



The computerized experiment took place at the CEEL (Cognitive and Experimental Economics Laboratory) at the University of Trento in June, September, October and November 2013 and May 2014. As they entered the laboratory, subjects were randomly seated at computer stations separated by partitions. At the beginning of each session the instructions were read aloud and subjects were invited to answer four multiple-choice control questions to test their comprehension of the experimental task. The answers were checked and if wrong, corrected. Afterwards, participants were encouraged to pose clarifying questions in private. Once all doubts were clarified the experiment began.

In all treatments players interacted anonymously, but their types and relative parameters was common knowledge. Each individual received 30 experimental currency units (ECU) at the beginning of each round and simultaneously had to decide how much to put into their private account and how much to contribute towards the common pool. At the end of each round they were informed about the individual contribution, the total contribution to the common pool and their own payoff. At the end of the 20 rounds – except for players in HBT, *T1* and *T2* that were randomly chosen to continue the experiment the next day – individuals were paid, using a random lottery incentive mechanism, 0.20 euro for each ECU earned plus a daily show up fee of 3.00 euro. Subjects earned, including the show up fee, on average 14.49 euro (SD=6.27 euro) for *BT*, 16.12 euro (SD=9.42) for HBT, 17.41 euro (SD=7.17 euro) for *T1* and 28.20 euro (SD=14.70 euro) for *T2*. Individuals were enrolled by voluntary subscription among students of the University of Trento.

2.2.2 – Behavioral Predictions

Formally, standard game theory predicts that, if the game is played only once, the dominant-strategy Nash equilibrium is zero contribution. When the public good game is finitely repeated and backward induction arguments are applied, zero contributions are expected in all rounds. However, laboratory experiments show that subjects tend to contribute more than predicted. In addition contributions tend to increase in MPCR and in the number of players, even if changes in these parameters do not affect the Nash equilibrium. More specifically as the marginal valuation of the private good gets closer to the marginal valuation of the public good more and greater violations of the dominant strategy are observed. Full free riding is generally not observed, even after as many as 60 rounds. Nevertheless violations of the dominant strategy diminish both with repetition and with experience (Palfrey and Prisbrey, 1997).

Summarizing, specific behavioral predictions for the treatments are:

BT:		– $t_{\text{Type A}} < t_{\text{Type B}} < t_{\text{Type C}}$
T1 and T2:	*In D1*	– $t_{\text{Type A}} < t_{\text{Type B}}$
		– $t_{\text{Type A in D1}} < t_{\text{Type A in D0}}$
	In D2	– $t_{\text{Type A}} < t_{\text{Type B}} < t_{\text{Type C}}$
		– $t_{\text{Type A in D2}} < t_{\text{Type A in D1}} < t_{\text{Type A in D0}}$
		– $t_{\text{Type B in D2}} < t_{\text{Type B in D1}}$

where t is the private good contributed.

2.3 – Results

In this session the results are illustrated, which are based on 206 subjects who attended and played 9 experimental sessions, 5 of which over 3 days. Firstly, partial consistency with the results of previous experiments is shown. However the main results focus on the impact of generational heterogeneity, both in terms of individual productivity and contribution decisions, showing new decision dynamics in PG games. The core analysis includes both non-parametric statistics and regression methods.

2.3.1 – Comparison to Previous Experiments

Figure 2.2 shows the evolution of average group contributions over time in the four treatments. The results of the BT show analogous patterns to the stylized facts of repeated PG games: contributions start high and decay over the period of repetition. This hints that cooperation strategies have decreasing gains as the game nears its end. Still, neither BT nor HBT or T1 or T2 decline to complete free riding.

Figure 2.2 – BT, HBT-D2, T1-D2 and T2-D2 average group contribution.

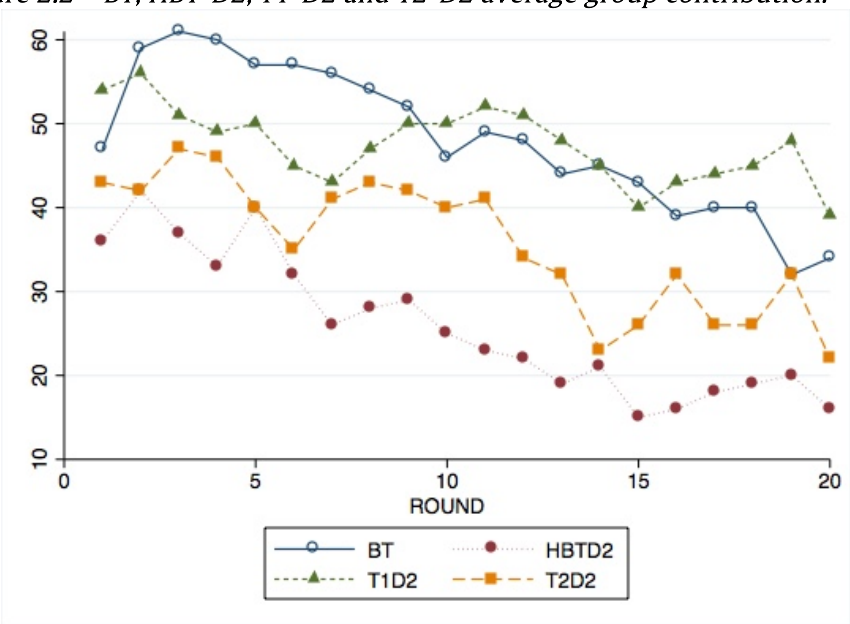


Table 2.2 depicts the average percent individually contributed to the public good, combining all 20 rounds and discerning between treatments BT, HBT, T1 and T2. For the treatments that developed over three days we considered only the last day (D2), so that comparison for the same group composition was possible.

Table 2.2 – Average percent individual contribution to the public good.

	α	HBT – D2	α	BT	T1 – D2	T2 – D2
Overall	-	28.6%	-	53.5%	52.9%	39.5%
Type A	0.40	24.3%	0.40	45.1%	42.5%	27.6%
Type B	0.40	32.9%	0.65	47.5%	50.7%	48.0%
Type C	0.40	28.6%	0.90	68.0%	65.4%	43.0%

In BT the average contribution across all rounds [53.5%] is significantly higher compared to other standard public good games such as Andreoni (1988, 1995) [33.2%] and Croson (1996) [35.7%]. However HBT-D2 shows closer average contributions to the standard classic literature [28.6%], fostering our hypothesis that it is heterogeneity in MPCR that has an impact in PG contributions, not only experience. Furthermore BT shows lower rates of non-cooperative end-game behavior compared to standard public good games. Last rounds average contributions range from 43.0% in the fifth-last round to 38% in the last one. These are higher compared to 11.6% in Andreoni and 10.6% in Croson. This is consistent with previous literature, which has already shown that if individuals are aware of heterogeneity, contributions will increase in general (Fellner et al., 2011).

Another result in line with previous studies (Fellner et al. 2011)is that when contributions can be linked to the type of the player individuals with greater MPCR (Type C) contribute more compared to individuals with lower MPCR (Type A and B).

This result holds for BT and T1, however in T2 average contributions are generally in line with standard public good games. In particular Type A players seem to have a significantly lower average contribution compared to both the literature and their counterparts in this experiment.

2.3.2 – Descriptive Statistics

Looking again at table 2.1 we can observe a striking difference between the four tratments. Consequently the Wilcoxon rank-sum test is calculated. The difference between the average group contributions in BT and T1 is significant (Wilcoxon signed rank Test, p=0.002325). Also the difference between average group contributions in BT and T2, as well in T1 and T2 are significant (Wilcoxon Test p-value <0.0001). However analyzing exclusively the average individual contribution in D2 shows that the difference between BT and T1 is not significant (Wilcoxon Test p-value 0.932), while between BT and T2 and T1 and T2 the differences are significant (Wilcoxon Test p-value 0,02159 and 0.03483 respectively).

RESULT 1 *- Individuals with a high MPCR will contribute a larger percentage of their per-period income to the public good, except in T2.*

Tables 2.3 and 2.4 show that in BT and T1 the introduction of a middling MPCR (Type B) yields results that are aligned to standard behavioral predictions. In particular it is expected that the average contribution follows the relation $t_{Type\ A} < t_{Type\ B} < t_{Type\ C}$.

Table 2.3 – BT average contribution to the public good and relative standard deviations, for type of player.

	α	μ	σ
Type A	0.40	13.53	3.67
Type B	0.65	14.24	3.00
Type C	0.90	20.39	2.51

Table 2.4 – T1 daily average contribution to the public good and relative standard deviations.

	D0			D1		D2	
	α	μ	σ	μ	σ	μ	σ
Type A	0.40	11.25	3.68	13.93	4.24	12.76	3.52
Type B	0.65	-	-	14.56	4.00	15.20	1.98
Type C	0.90	-	-	-	-	19.63	1.67

On the other hand in T2 it can observed that the introduction of a middling MPCR (Type B) yields puzzling results: in D2 the average contribution follows the relation $t_{Type\ A} < t_{Type\ C} < t_{Type\ B}$ (Table 2.5). In other words the middling type contributes the most to the public good. This effect is most probably due to the MPCR design in T2.

Table 2.5 – T2 daily average contribution to the public good and relative overall round average standard deviations

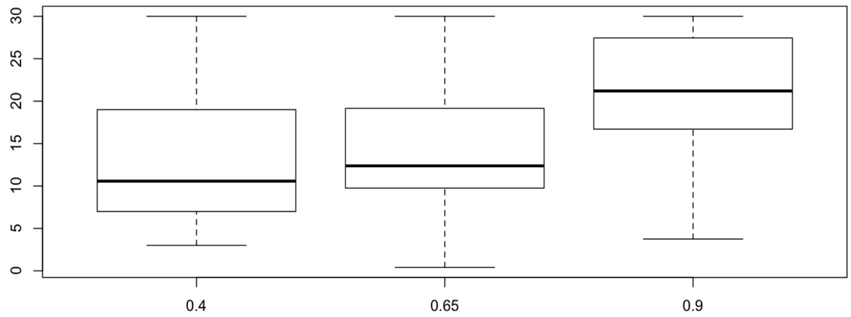
	D0			D1			D2		
	α	μ	σ	α	μ	σ	α	μ	σ
Type A	0.90	18.08	1.85	0.65	16.45	1.13	0.40	8.26	3.37
Type B	-	-	-	0.90	19.44	2.02	0.65	14.38	3.10
Type C	-	-	-	-	-	-	0.90	12.89	3.04

RESULT 2 *– Upward social comparison negatively affects contributions.*

Comparing between the self and the others is a fundamental psychological mechanism influencing individual's beliefs and behaviors. When individuals want to know how they should or shouldn't behave they naturally compare their characteristics, wealth and/or weaknesses to those of others. Social comparison is essentially of two kinds: downwards or upwards. Downward comparisons are done by people that seek lower standards to boost their self-view with a favorable comparison (Wills, 1981). Individuals with a threatened self-view will be particularly prone to downward comparison since it has the capability to protect or enhance one's self-view (Wills, 1981). On the other hand the need to self-improve is most likely satisfied by comparisons with upward standards, which could serve as models. However upward comparison is effective if, and only if the self is perceived as mutable. If the self in perceived as set and unchangeable individuals could react defensively, undermining or disputing the relevance of the standard (Mussweiler, Gabriel & Bodenhausen, 2000). Since subjects playing public good games want to maximize their payoff function, improving their outcome after each round, they naturally tend to apply upward comparisons. Unfortunately part of their self, specifically their assigned MPCR, is not adjustable. Therefore they might react defensively by reducing, rather than increasing, their voluntary provision.

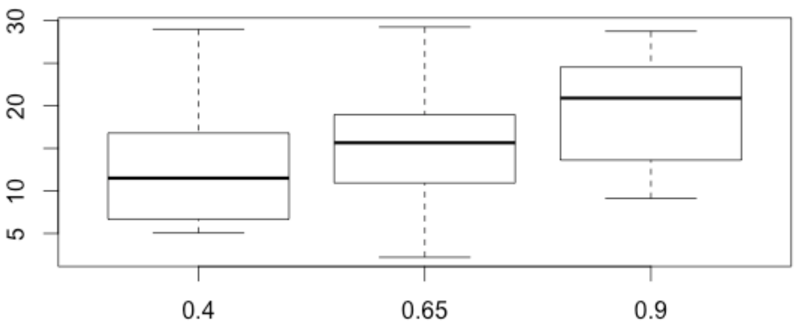
The intuition of the negative effect of upward social comparison is confirmed by the Wilcoxon signed rank test: differences across types of players in BT show that choices of Type A and Type B statistically differ from Type C at the 5% confidence level (p-values respectively of 0.005 and 0.009). No statistically significant differences are registered for the other remaining comparison (Type A from Type B, p-value 0.5109). Thus, relative disadvantage seems to affect contribution choices more than relative advantage (Figure 2.3).

Figure 2.3 – Box plot of average contribution for each type of player in BT.



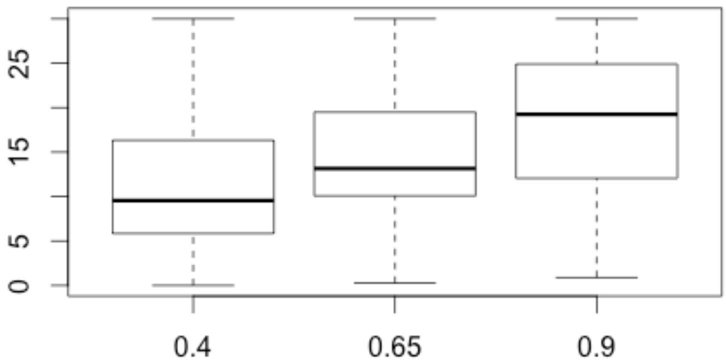
The same test has been repeated for the treatment T1 and T2. In T1 the result is only partially consistent with what has been found in BT (Figure 2.4): Wilcoxon signed rank test shows that only choices of Type A statistically differ from Type C at the 5% confidence level (p-values of 0.03998). No statistically significant differences are registered for the other remaining comparison (Type A from Type B, p-value 0.3316 and Type B from Type C, p-value 0.1713).

Figure 2.4 – Box plot of average contribution for each type of player in T1.



On the other hand in T2 results are consistent with what has been found in BT (Figure 2.5): differences across types of players in T2 show that choices of Type A and Type B statistically differ from Type C at the 5% confidence level (p-values respectively of 0.0002 and 0.0234). There are no statistically significant differences between Type A and Type B (p-value 0.0688).

Figure 2.5 – Box plot of average contribution for each type of player in T2.



RESULT 3 *– Heterogeneity increases the difficulty of settling on a strategy for Type A and Type B players.*

In standard public good games, with homogeneous players, individuals favor a contribution strategy of equal provisions and are willing to apply costly punishments to group members that depart from this strategy (Fehr and Gachter 2000, 2002; Fehr and Fischbacher 2004; Gachter et al. 2008; Gachter and Herrmann 2009). However when heterogeneity is introduced equal contributions yield unequal payoffs and a contribution norm is harder to achieve, especially for those who are penalized by heterogeneity itself. In particular the standard deviation follows the following relation $\delta_{Type\ A} > \delta_{Type\ B} > \delta_{Type\ C}$ in treatments BT and T1 (Tables 2.3 – 2.4). Interestingly in T2-D2 for all players there is a similar standard deviation: possibly both heterogeneity in MPCR and the variation of MPCR between days for the same type of players generates greater difficulty in settling on a strategy.

RESULT 4 *– When heterogeneity is linked to seniority, favoring least experience players, cooperation is negatively affected.*

Individuals penalized by heterogeneity also show different degrees of cooperation and free-riding if heterogeneity is assigned randomly as in BT or can be directly link to the history of playing as in T1. A first glimpse of this effect can be seen in Table 2.6 , where the percentage of times all ECU are contributed is 22.3% for the BT, while only 16.4% for T1-D2 and6.5% for T2-D2.

Table 2.6 – Average Contribution, Zero ECU, All ECU (aggregated over all rounds)

	Average percent contributed	Percent of times **zero** ECU contributed	Percent of times **all** ECU contributed
BT	53.5	15.6	22.3
T1 – D0	37.5	33.6	11.7
T1 – D1	47.4	26.2	19.1
T1 – D2	52.9	10.8	16.4
T2 – D0	60.3	6.21	28.48
T2 – D1	58.2	14.6	20.8
T2 – D2	39.5	26.1	6.5

If the same results are broken down by type of individual it is clear that Type A is the most affected by seniority, with a significantly lower percentage of all ECU contributed in T1 compared to BT (13.6% and 24.3% respectively).

Table 2.7 – Percentage zero ECU contributed, percentage all ECU contributed (specified for type of player).

	Type	α	Percent of times zero ECU contributed	Percent of times all ECU contributed
BT	A	0.40	14.8	24.3
	B	0.65	17.3	18.2
	C	0.90	7.5	40.2
T1 – D0	A	0.40	33.6	11.7
T1 – D1	A	0.40	30.5	20.2
	B	0.65	17.7	16.8
T1 – D2	A	0.40	20.9	13.6
	B	0.65	8.2	14.5
	C	0.90	3.2	20.9
T2 – D0	A	0.90	6.2	28.5
T2 – D1	A	0.65	14.8	18.4
	B	0.90	14.1	25.5
T2 – D2	A	0.40	36.8	2.7
	B	0.65	22.7	6.8
	C	0.90	18.6	10.0

Also it is interesting to compare T1-D2 and T2-D2: as shown in Table 2.8, T2 presents greater levels of "zero ECU contributed" as well as much lower levels for "all ECU contributed".

Table 2.8 – Percentage zero ECU contributed, percentage all ECU contributed (specified for type of player for T1-D2 and T2-D2).

Type	α	Percent of times zero ECU contributed		Percent of times all ECU contributed	
		T1	T2	T1	T2
A	0.40	20.9	36.8	13.6	2.7
B	0.65	8.2	22.7	14.5	6.8
C	0.90	3.2	18.6	20.9	10.0

RESULT 5 *– Becoming disadvantaged affects public good provision more than just being at a disadvantage*.

In T1, Type A individuals maintained their MPCR constant and equal to 0.4 in all 3 days of the experiment. In D1 and D2 subjects had to play with new entrants whose MPCR was higher than theirs. In T2 Type A individuals saw their MPCR being reduced from 0.9 in D0 to 0.65 in D1, and from 0.65 in D1 to 0.4 in D2. In other words subjects Type A in T2 had to play with new entrants whose MPCR was equal to theirs in the previous day (Table 2.9).

Table 2.9 – Evolution of MPCR for Type 1 individuals in T1 and T2
(comparison to their counterpart)

Treatment	Player Type	D0	D1	D2
1	A	0.40	0.40	0.40
	B	-	0.65	0.65
	C	-	-	0.90
2	A	0.90	0.65	0.40
	B	-	0.90	0.65
	C		-	0.90

Heterogeneity in MPCR has been always considered to have a strong effect on the voluntary contributions towards public goods, while experience, repetition and learning have generally mixed effects (Ledyard, 1995). In this experiment experience does not seem to have an effect on average contributions, for any type of player (Table 2.10, column p-value (μ_iBT, μ_iT1-D2)). On the other hand history generates effects worth of note (Table 2.10, column p-value (μ_iBT, μ_iT2-D2)). In particular for Type A players (Wilcoxon Test p-value 0.06674) and Type C (Wilcoxon Test p-value 0,0153).

With the term "history" we intend the way in which players were led to an experimental setting of three members per group with three different MPCR of 0.40, 0.65 and 0.9 each. In the BT a random process defined the setting. In T1 the process was initially random but subsequently it was only partially unsystematic: players who started in D0 were assigned a constant MPCR of 0.40, while players who started in D1 were assigned a constant MPCR of 0.65 and both participated to the experiment in subsequent days by random draw. In T2 the process was initially random but subsequently a clear reduction of the MPCR was made upon those subjects with experience: players who started in D0 were assigned a MPCR of 0.90, participated to the experiment in D1 and D2 by random draw and saw their MPCR being reduced to 0.65 and then 0.40 in favor of new players (Table 4).

Table 2.10 – Comparison of average contributions for types of players in BT, T1 and T2 (Wilcoxon Rank-Sum test)

Type	α	μBT	μT1-D2	μT2-D2	p-value (μ_iBT, μ_iT1-D2)	p-value (μ_iBT, μ_iT2-D2)	p-value (μ_iT1-D2, μ_iT2-D2)
A	0.40	13.53	12.76	8.26	0.9695	**0.06674**	0.133
B	0.65	14.24	15.20	14.39	0.5538	0.7745	0.89
C	0.90	20.40	19.63	12.90	0.6605	**0.0153**	**0.0336**

2.3.2 – Regression Analysis

Table 2.11 reports the results of a random effects GLS regression of the individual contributions. The dependent variable Contributions is regressed on the explanatory treatment variables, namely T1, T2, alpha 0.65 and alpha 0.90. The interactions between are also included in the model: T1 with alpha 0.65, T2 with alpha 0.65, T1 with alpha 0.90 and T2 with 0.90 (the interactions are denoted by the X term).

Table 2.11 – Random Effects GLS Regression (individual contributions)

Contribution	Coeff. (Std. Err)
T1	-0.768 (2.810)
T2	-5.264 (2.810)**
alpha 0.65	0.714 (2.294)
*alpha 0.90***	6.870 (2.294)**
T1 X alpha 0.65	1.736 (3.974)
T2 X alpha 0.65	5.409 (3.974)
T1 X alpha 0.90	0.002 (3.974)
T2 X alpha 0.90	-2.238 (3.974)
Obs	2640
Groups	132
Wald Chi-Square test (p-value)	0.0008

**p < 0.05, *p < 0.1

Table 2.13 reports the results of a cluster estimator of the individual contributions on the same explanatory variables listed before. This allowed for intragroup correlation, specifying that the data has repeated observations on individuals.

Table 2.12 – Linear Regression Cluster Id (individual contributions)

Contribution	Coeff. (Std. Err)
T1	-0.768 (2.793)
*T2***	-5.263 (2.546)
alpha 0.65	0.714 (2.426)
*alpha 0.90***	6.870 (2.312)
T1 X alpha 0.65	1.736 (3.839)
T2 X alpha 0.65	5.409 (3.861)
T1 X alpha 0.90	0.002 (3.757)
T2 X alpha 0.90	-2.238 (3.716)
Obs	2640
Log Likelihood (p-value)	0.0001

**p < 0.05, *p < 0.1

Both regressions confirm the previous insights about the importance of history (how we reached a specific MPCR set up): treatment2 has a negative impact on individual contributions. On the other hand, and consistent with the literature, the highest MPCR (alpha3) has a positive and significant impact on mean individual contributions.

In addition we also checked for gender (dummies 1 for female and 0 for male) but with no statistically significant effect (p-value 0.909).

2.4 – Discussion

This paper studies cooperation and free-riding behavior through a three-person linear public good game in which agents are asymmetric in productivity (heterogeneous MPCR), experience (seniority) and history. The data analysis uncovers the following conclusions.

First, when more than two MPCR are used as a proxy of complex heterogeneity within groups, strategic interactions are in line with previous robust results on “simple” heterogeneity (two MPCR - one “high” and one “low”). However the strength of this effect is not linear. This suggests that policy makers who intend to control voluntary provisions cannot disregard the degree and extent of heterogeneity. In particular when heterogeneity is imposed from top to bottom, upward social comparison is negatively affecting middling-types. These tend to focus more on their relative disadvantage compared to high-types, than focusing on their advantageous condition compared to low-types.

Secondly, heterogeneity generates distress in reaching a settlement between parties. Specifically, middling and low types of players struggle more to decide the strategy behind their contribution level.

On the other hand seniority overall reduces this effect: the presence of experienced players in a group is reflected in lower levels of variance in average contributions. This is in line with the conclusions of Tan (2008), who showed that the behavior of productive and experienced individuals generates greater side effects than their less productive counterparts. This mirrors reality where privileged are under higher pressure, since their choices profoundly impact society.

Chapter 3 - Grandparents Matter: Perspectives on Intergenerational Altruism - An Experiment on Family Dynamic Spillovers in Public Goods Games.

3.1 – Introduction

Public goods are both characterized and defined by a very simple, yet difficult to fully unravel and explain, social dilemma: individuals are conflicted between maximizing personal gain and cooperate for the collective interest. They are called to choose if and how much to invest between a private good and a common project that, although more fruitful, benefits both contributors and non-contributors. At the end of the choice spectrum two options are available: the Nash Equilibrium of free riding and the social optimum of full cooperation. In between rests a continuum of possibilities.

Also, as illustrated in Chapter 1, issues around public goods are further complicated when time and space are included into the picture. Focusing on the time dimension for the purpose of this chapter, it is clear that each generation inherits from the previous one many things, including public goods and their externalities (think, for example, of infrastructures, health care or education systems, etcetera). This also means that generations invest into public goods that will benefit future generations, which indicates the existence of a kind of intergenerational altruism and cooperation. The results of the experiment carried out by Fischer et al. (2004) suggest that intergenerational responsibility is actually recognized, leading individuals to consider the additional externalities of their actions and consequently moving closer to the social optimum.

Intergenerational altruism and cooperation, and per contra account intergenerational free-riding, could be also viewed from a biological point of view, since future generations are the offspring of current ones. Tension between individual and group success is universal at all levels of biological organization, from bacteria to institutions. However altruistic behavior is more common in species with complex social structures[8]. Making matters slightly more complex is the exact notion of altruism in evolutionary biology: an organism is said to behave altruistically when its behavior benefits other organisms, costing him. Reproductive fitness measures costs and benefits (estimated number of progeny). Thus by behaving altruistically, an organism decreases the number of progeny it is expected to generate for itself, but increases the estimated number of progeny for other organisms. The presence of altruism in nature is therefore puzzling from a strictly Darwinian point of view.

However natural selection does not simply occur at an individual level, but also at a group level: altruism might detrimental for the individual but it is beneficial for the group, and since groups composed just (or mainly) of selfish organisms go extinct, groups containing altruists will prosper. Hamilton (1964) proposed a refinement of this explanation of altruism in nature, using the concepts of "*kin selection*" predicting that organisms are more likely to behave altruistically towards their relatives than towards unconnected members of their own species. Likewise, Hamilton's Rule predicts that the closer the relationship the greater the extent of altruism. The rule specifically states that r, the coefficient of relatedness or the probability of sharing a gene, must be greater than the cost-to-benefit ratio of an altruistic act: $r > c/b$. For interest's sake the probability of sharing a gene with a brother is ¼, and with a cousin 1/8. After Hamilton's hypothesis was conceived empirical work has plentifully affirmed his predictions.

Together with altruism, cooperation is a key aspect of social evolution, since evolutionary processes are all based on it to some extend. Novak (2006) summarized

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[8] For example in many bird species newly parents receive the help of other birds in order to raise their offsprings. Also, in most of the social insect colonies (such as bees and wasps, ants and termites), sterile workers are devoted to looking after the queen, building and protecting the nest, gather food and looking after the eggs and the larvae.

the five rules for the evolution of cooperation as follows: direct reciprocity ($w > c/b$, where w is the probability of encountering the same individual again), indirect reciprocity ($q > c/b$ where q is the probability of knowing somebody's reputation), spatial selection ($b/c > k$ where k is the average number of neighbors), multi-level selection ($b/c > 1 + n/m$ where n is the maximum group size and m is the total number of groups) and kin selection.

The far-reaching research question of this chapter focuses on the possibility of contaminating experimental economics with biology in order to explain intergenerational public good provision. The topic implies the need to mimic into the laboratory many overlapping generations, joined by some common resource and characterized by some form of kin detection and selection, plus a proxy for genes transmission.

3.2 – Method and Model

Again, we use the Public Goods Game (PGG) to study the evolution and maintenance of cooperation in a setting where each of the groups can be thought of as a generation within a dynasty. Additionally a proxy for genes transmission is introduced: individuals can experience rebirth for a set, but unknown, number of rounds.

We model the dynastic PGG as a variation of a standard PGG where there are two goods – one private and one public – and N individuals. Each individual $i = 1, .., N$ is endowed with an amount of the private good, z_i. The private good contributed (t) by the i^{-th} individual is used to produce the public good following a production function Y

$=f(\Sigma t_i)$ where t_i is the amount of private good contributed by each individual in order to produce Y. The production function $f(\Sigma t_i)$ represents the benefits from cooperation before being equally divided among all N group members. The outcome of a public good experiment consists of two items: a level of public good Y and a reallocation of the private good for each agent $x_1, \ldots, x_N$. Player's i's individual payoff, π_i, equals: $\pi_i = z_i - t_i + (a+b\delta_i)\ \Sigma t_i$, where $(a+b\delta_i)$ is the decomposition of the MPCR with δ_i being an individual productivity factor. If $1/N < (a+b\delta_i) < 1$ the game is a social dilemma since individually, each player is best off giving nothing to the public good, but collectively the players are best off donating their entire endowments.

The spillover is modeled, simplified to only two ensuing players (i.e. Parent and Child), as follows:

Parent Public Good (PPG)

$i = 1, .., N$

z_{pi}: private good of parent

t_{pi}: private good contributed by the parent

$Y = f(\Sigma t_i)$: production function

Outcome of PPG:

p_i's individual payoff, π_i, equals:

$\pi_{pi} = z_{pi} - t_{pi} + \beta(\alpha\ \Sigma t_{pi})$

Where β is the share of subject PPG payoff kept by the parent and $(1-\beta)$ is the share transferred the child.

Therefore the new condition for the game in order to be an intergenerational social dilemma is $1/\beta N < \alpha < 1/\beta$, where $0<\beta<1$.

Child Public Good (CPG):

$i = 1, .., N$

z_{ci}:	private good of child

Z'_{ci}:	private good of child+transfer

t_{ci}:	private good contributed by the child

Outcome of CPG:

c_i's individual payoff, π_i, equals:

$\pi_{ci} = z'_{ci} - t_{ci} + \beta(\alpha\ \Sigma t_{ci})$

with $z'_{cj} = z_{cj} + (1-\beta)(\alpha\Sigma t_{pi})$ and where β is the share of subject PPG payoff kept by the child and (1-β) is the share transferred to the grandchild. Again the new condition for the game in order to be an intergenerational social dilemma is $1/\beta N < \alpha < 1/\beta$, and $0<\beta<1$.

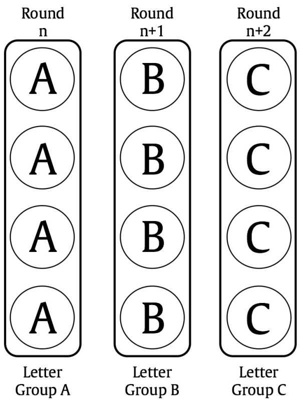
In our experiment we set β = 0.9 (therefore (1-β) = 0.1) and α =0.5 which satisfies the newly found condition for the intergenerational social dilemma $1/\beta N < \alpha < 1/\beta$. It is important to highlight that our new condition shifts the lower and upper bounds forward compared to the standard social dilemma condition of PGG.

3.2.1 – Experimental Design

The experiment consisted of two treatments: the baseline (BT) and the dynasties spillover (DT). We used a between subject design: each session was composed by 24 participants and consisted of 15 rounds. Participants were informed that several rounds composed the experimental session, but the exact number was not specified. However the set number of rounds was 15.

At the beginning of each session individuals were informed about their role during the experiment. In the BT they were presented with an envelope containing a card with a letter printed on it (either A, B or C). They were also presented with the following image, both in the instructions and in the first screen of the software programme, representing the structure of the game.

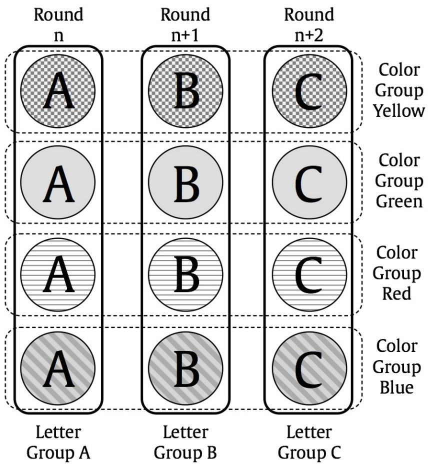
Figure 3.1 – BT Group Structure.



As shown, each individual belonged to a “Letter Group” and was called to make a decision in turns: first individuals belonging to the “Letter Group” A, then individuals belonging to the “Letter Group” B, then individuals belonging to the “Letter Group” C, then again individuals belonging to the “Letter Group” A, then individuals belonging to the “Letter Group” B, then individuals belonging to the “Letter Group” C, and so on until the experiment reached its ending.

In the DT they were presented with an envelope containing a colored card (either yellow, green, red or blue) with a letter printed on it (either A, B or C) plus a colored wristband (of the same color as the card) to be worn from the very beginning of the experiment. They were also presented with the following image, both in the instructions and in the first screen of the software programme, representing the structure of the game.

Figure 3.2 – DT Group Structure



As shown, each individual belonged both to a "Letter Group" and a "Color Group" and was called to make a decision in turns: first individuals belonging to the "Letter Group" A, then individuals belonging to the "Letter Group" B, then individuals belonging to the "Letter Group" C, then again individuals belonging to the "Letter Group" A, then individuals belonging to the "Letter Group" B, then individuals belonging to the "Letter Group" C, and so on until the experiment reached its ending.

In this treatment each "Letter Group" represented a generation, while each "Color Group" represented a dynasty. In order to induce and improve individual group identity and membership we introduced a preliminary task that each "Color Group" had to undertake. This consisted in submitting as many correct answers to a crossword as possible in 9 minutes time. The sum of the correct answers for each "Color Group" was multiplied by 5 ECU and paid at the end of the experiment, when also a feedback on the preliminary task was individually given. Both at the end of the preliminary task and at the end of the experiment, participants were asked to inform experimenters on how much they felt like they belonged to their "Color Group". We based our question on both Tropp and Wright (2001) and Sani et Al. (2007) and we developed a continuous Inclusion of the In-group in the Self (IIS) measure. To the contrary of what has been done previously (where the IIS was quantified by a single-item measure based on seven Venn-diagram figures) we proposed two circles – one representing the in-group and one representing the self – that could be overlapped to any degree that subjects deemed fit to represent their sense of psychological overlap with the group. Participants were asked to simply “drag and drop” with the mouse the self-circle within the boundaries of the software window.

In addition the structure of the “Color Group” – with different subjects taking turns playing for their color – allowed for the recreation a phenomena called “perceived collective continuity” or PCC (Sani et al., 2007). Individuals tend to see their in-groups (i.e. Nation, extended family, ethnic group etcetera) as having temporal continuity, as entities that are capable to move through time (Reicher & Hopkins, 2001). People therefore perceive themselves as part of the endless chain that goes beyond space and time.

Individuals in both treatments were also informed that the endowment at the beginning of each round would be different, either given by the experimenters (BT) or partially originated by the outcome of the PG game in the previous round (DT).

In particular individuals in the DT knew that the endowment was composed by the sum of 30 ECU plus a spillover of 10% of whatever the group in the previous round produced as the return from the public good, implying that only 90% was retained by the previous generation.

The endowments given by the experimenters in BT were generated by means of a backward design. The sessions of DT ran before those of BT, so we were able to mirror the endowments generated in DT for BT, as a set amount, so that we could compare the behavior in the two treatments controlling for a potential endowment effect.

In this way we recreated a simplified intergenerational setting where generations played a PG game at different stages, while each dynasty was affected by the actions of previous generations.

As usual in experiments on Public Goods, neutral terms have been used in both instructions and software, so there was no mention of any terminology linked to generations, dynasties or families.

Concluding the experiment was a structured questionnaire that, besides the standard socio-demographic questions, included a set of 15 questions aimed at investigating the generational and dynastic profile of participating subjects.

3.2.2 – Behavioral Predictions

As already discussed in section 2.2.2, standard game theory predicts that, using backward induction, the Nash Equilibrium for a repeated PG game should be free-riding. However countless experiments on PGG showed that such scenario is hardly ever achieved, even after 60 rounds. Furthermore previous literature shows that contributions to the PG tend to increase with higher marginal per capita returns (MPCR), chances of communication between subjects, homogeneity, and positive framing (see section 1.1).

In addition, looking at previous experiments related to the dynastic lineage hypothesis, we can expect some form of increase in PG investments when the game is framed as an intergenerational setting. Peters et al. (2004) showed that parents and children contributed more to the PG when in the real family setting (compared to a strangers setting, as in Andreoni, 1988 and Croson, 1996). Parents also contributed more compared to children and kept contributing more even in groups with children from other families.

This background allows the formulation of at least two testable predictions:

HP_1: Introducing a proxy for dynastic lineage increases the investment in the public good.

HP_2: The socio-demographic background of individuals, in particular their family composition and status, influences the levels of public good investment.

3.2.3 – Participants and Procedures

The Experiment ran in Trento (Italy) at the Cognitive and Experimental Economics Laboratory (CEEL) of the University of Trento. Participants were recruited through the CEEL online recruitment system. On the day of the experiment participants were accommodated in computer-equipped booths that did not allow for either verbal communication or visual contact. In order to avoid the use of external aids (such as calculators or mobile phones) during the experiment, participants were asked to leave their personal belongings on the side of the room. The participants were mainly students of University of Trento.

A total of 96 participants (58 males and 38 females; mean age of 22.23 – min of 20, max of 33 – with SD of 2.52) took part in the experiment, divided into 4 sessions of 24 participants. Each treatment had two experimental sessions.

On the day of the experiment instructions (for each corresponding treatment) were distributed and participants were allowed to read them individually. To establish and ensure common knowledge instructions were also read aloud. Furthermore, before the beginning of the session a questionnaire was submitted to check the understanding of the experimental structure.

The experiment lasted approximately 60 minutes for BT and 90 for the DT. For their participation and punctuality subjects received, in addition to the result achieved in the experiment, a show-up fee of 3 Euro. The cumulative payoff of the active rounds was converted in Euro (1 ECU = 0.03 Euro) and privately paid to each subject. On average, participants in BT earned 9.70 Euro (SD 1.55) and in DT 9.81 Euro (SD 1.27) without the payment of the preliminary task and 12.47 (SD 1.62) including it.

3.3 – Results

3.3.1 – Descriptive Statistics

Table 3.1 summarizes the average, standard deviation, minimum and maximum of the contributions to the public good and the group contribution in BT, DT and overall respectively.

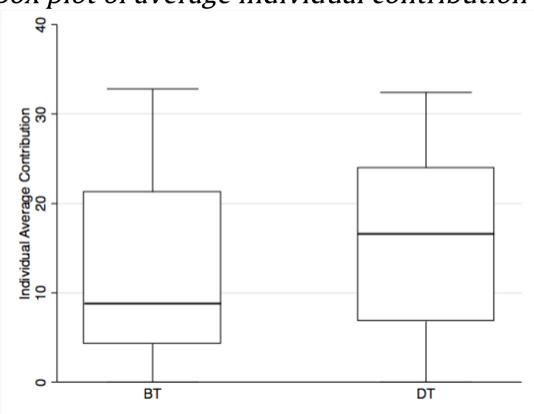
Table 3.1 – Average contribution to the public good.

Statistic	Individual Contribution			Group contribution		
	BT	DT	Overall	BT	DT	Overall
Mean	11.36	15.49	13.42	45.44	61.96	53.70
SD	12.80	11.89	12.51	39.49	31.06	36.44
Min	0	0	0	0	9	0
Max	35	35	35	128	110	128

RESULT 1 *– Giving in dynastic treatment is greater than in the baseline treatment.*

Looking at all the different aspects of subject and group contribution we can observe a clear difference between the two treatments. At a first glance, as depicted in both table 3.1 and figure 3.3, it is perceptible a difference between the two treatments, with higher average individual and group contribution for DT, and higher SD for BT.

Figure 3.3 – Box plot of average individual contribution in BT and DT.



In order to confirm such hypothesis we firstly ran two tests for normality. The Shapiro–Wilk test has p-value < 0.001 showing evidence that the data tested are not from a normally distributed population. This is confirmed by the skewness/kurtosis test of normality (p-value = 0.1381 and p-value = 0.0000 respectively).

As a consequence we choose a series of non-parametric tests between experimental treatments that are fit for the non-normal distribution at hand. We ran a two-sample Wilcoxon rank-sum test comparing the average individual contribution between the two treatments, confirming that there is a marginally significant difference between BT and DT (p-value = 0.0686). The existence of differences across the two experimental treatments is corroborated also by Kruskal-Wallis equality-of-populations rank test comparing average group contributions in BT and DT (p-value = 0.0147). From the output, we see that we can reject the hypothesis that the populations are the same at any level below 1.47%[9].

Figure 3.4 graphically depicts the trend of group average contributions for the rounds from 4 to 15, for BT and DT[10]. It is clear that the two treatments have different average group contributions (being those of DT higher than those of BT), but the trend of such data seems irregular. This is most probably due to the fact that groups were playing in turns and each had its very own trend of contributions, with possibly a restart effect playing its part into shaping group contributions. However, since our game is repeated, we should observe some degree of decay, even if subjects do not know the length of the game for sure.

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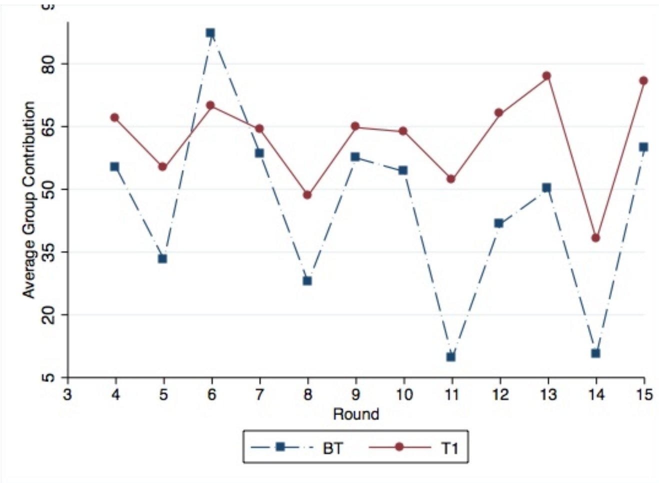
[9] For the purpose of calculating the Wilcoxon Rank Sum Test and the Kruskal-Wallis Test we calculated the average of contributions for each individual, agreegating therefore the observations into 48 for each treatment.

[10] From this point onwards and for all statistical information we do not consider rounds 1 to 3. These were dropped since they represented the first round for each “Letter Group” in both treatments and did not contain any “generation”effect.

Figure 3.4 – Average Group Contributions in BT and DT.



In order to isolate restart hypothesis we summarized the average investment in public good per group In table 3.2 the difference between the two treatments is highlighted. In addition we grouped the observations in turns rather than rounds, where a turn clusters together sets of three rounds. Each round therefore is representing from the first to the fifth choice of each "Letter Group".

Table 3.2 – Average investment in the public good per group, in turns.

	Turn 1	Turn 2	Turn 3	Turn 4	Turn 5	Overall
BT	63.58	58.50	47.92	35.25	40.08	49.07
DT	60.75	63.83	59.17	61.33	63.50	61.72
Difference	*2.83*	*-5.33*	*-11.25*	*-26.08*	*-23.42*	*-12.65*

RESULT 2 *– Being part of a dynasty matters. Not only the investment in the public good is higher, but also the levels of free riding are lower.*

Looking into table 3.3, it can be seen that in the first turn subjects in DT free ride more than subjects in BT. However the free riding percentage constantly increase for subjects in BT, reaching its maximum of 35.4% in the fifth turn, while it remains fairly constant for subjects in DT, except for a peak of 18.8% in turn 3. Not coincidentally, in the third turn of BT we can also see a drop in group contributions (Table 3.2).

Table 3.3 – Percent of subjects' free riding, in turns.

	Turn 1	Turn 2	Turn 3	Turn 4	Turn 5	Overall
BT	6.3%	16.7%	25.0%	33.3%	35.4%	23.3%
DT	10.4%	10.4%	18.8%	12.5%	10.4%	12.5%
Difference	*-4.2%*	*6.3%*	*6.3%*	*20.8%*	*25.0%*	*10.8%*

To confirm the hypothesis of lower free riding in the presence of dynasties we ran a two-sample Wilcoxon rank-sum test comparing the number of free riders between the two treatments (in all rounds), confirming that there is a significant difference between BT and DT (p-value = 0.0549). At this point it is interesting to attest to the levels of full cooperation and compare it between the two treatments. As can be seen from Table 3.4 the results are reversed, with greater levels of full cooperation in the baseline treatment. However the trend for the two treatments shows a different story: while in BT the levels of full cooperation steadily decline with a downward peak in the fourth turn, in DT full cooperation progressively increases in each turn reaching its peak in the fifth turn. Coincidentally both treatments end at a 20.8% level of full cooperation.

Table 3.4 – Percent of subjects fully cooperating, in turns.

	Turn 1	Turn 2	Turn 3	Turn 4	Turn 5	Overall
BT	27.1%	22.9%	20.8%	16.7%	20.8%	27.1%
DT	6.3%	8.3%	10.4%	18.8%	20.8%	12.9%
Difference	*20.8%*	*14.6%*	*10.4%*	*-2.1%*	*0.0%*	*8.8%*

Again, in order to verify that the difference between the two treatments is significant we ran the Kruskal-Wallis equality-of-populations rank test comparing the number of occurrences of full cooperation in BT and DT, which returned a p value of 0.0845, showing only marginal significance, if any.

Falling in the "dynasty effect" are the results of the continuous Inclusion of the In-group in the Self (IIS) measure described in section 3.2.1. We checked for IIS in DT at the beginning of the experimental session as well as at the end of it. Briefly, the measure of membership is given by the distance in pixels between the center of the circle representing the self and the one representing the “Color Group”. When the two circles perfectly overlap the measurement is equal to 0, any other degree of overlapping is greater than 0 but smaller or equal than 100, and no overlapping is greater than 100 up to a maximum of 736 pixels.

Firstly a cluster analysis was run in an attempt to determine the natural clusters of the observed levels of membership (Tables 3.5 and 3.6). The two clusters show different ranges for the groups, with smaller lower and upper bounds for the measurement before the experimental session began. One hypothesis is that during the course of the experiment subjects could not reach their desired outcome for the self and/or the group and therefore felt less attached to their “Color Group”. To check if there is any relation between the measurement of the membership at the end of the experiment and the “Color Group” we ran a simple Pearson product-moment correlation coefficient. The Pearson’s r for the correlation between the average inheritance for each subject and the post-experiment measure of membership is equal to -0.4216, showing that there is only a very weak negative correlation. On the other hand one can speculate that the preliminary “Color Group” task had an effect on the levels of membership perceived. Again we ran the Pearson product-moment correlation coefficient, this time between the number of correct answers to the crossword and the pre-experiment IIS measurement. The result of -0.1844 clearly shows that the performance in the preliminary task did not affect the perceived IIS measure. However, seeing that 75% of subjects had some sort of overlapping between the self and the group circles, it is plausible to believe that the proxies (colored cards, wrist bands, software reminders) to induce group identity and membership worked at least to some extent.

*Table 3.5 – Membership cluster analysis, **beginning** of experimental session.*

Min	Mean	Max	Frequency
0	4.56	21	18
25	42.08	66	12
77	99.18	123	11
159	182.6	241	5
369	480.5	592	2
0	*74*	*592*	*48*

*Table 3.6 – Membership cluster analysis, **end** of experimental session.*

Min	Mean	Max	Frequency
0	30.85	55	20
67	89.63	108	11
125	155.75	201	8
275	351.67	422	3
592	616.17	736	6
0	*158.35*	*736*	*48*

3.3.2 – Socio-Demographic Profiling of Subjects

At the end of the experiment we administered an extended socio-demographic questionnaire aimed at profiling subjects from a dynastic point of view. In addition to the standard questions (age, gender, year of birth, academic background), questions regarding the family composition were asked. In particular the following information was elicited: number of cohabiting family members, number of brothers/sisters, number of grandparents, distance and frequency of face-to-face interactions with mother, father and each grandparent. Table 3.9 depicts the dynastic profiling of participating subjects.

Table 3.7 – Dynastic profiling of subjects, by treatment.

#	Cohabitating family members (including subject)				Number of brothers/sisters				Number of (living) grandparents			
	BT		DT		BT		DT		BT		DT	
	#	%	#	%	#	%	#	%	#	%	#	%
0	-	-	-	-	6	12.5%	9	18.8%	6	12.5%	11	22.9%
1	1	2.1%	-	-	32	66.7%	26	54.2%	13	27.1%	11	22.9%
2	2	4.2%	2	4.2%	8	16.7%	7	14.6%	18	37.5%	12	25.0%
3	9	18.8%	10	20.8%	2	4.2%	4	8.3%	6	12.5%	11	22.9%
4	26	54.2%	23	47.9%	-	-	2	4.2%	5	10.4%	3	6.3%
5	8	16.7%	7	14.6%	-	-	-	-	-	-	-	-
6	2	4.2%	4	8.3%	-	-	-	-	-	-	-	-
7	-	-	2	4.2%	-	-	-	-	-	-	-	-

The most common profile of a participating subject is that of an individual living with other 3 family members, namely the mother, the father and a brother/sister, and has two living grandparents. Although the sample of our subjects is somewhat biased since we can expect students to be still dependent and cohabitating with their parents, the picture portrayed by our data fits the one given by ISTAT (Italian National Institute of Statistics) in his 2014 Yearly Report[11].

In Italy the numbers of couples with children are declining: currently there are about 8.6 million (about 320,000 less than in 2006-2007) and represent only 34.6 percent of all households (average for years 2012-2013). More specifically, following the decline in marriage and fertility (average of 1.29 children per female), married couples with children are declining more rapidly. In the same span of time families with children went from 37.3 to 32.6 percent. Nowadays only one in three families in Italy are of the more traditional form (parents plus child/children).

Grandparent's role also has drastically changed due to recent demographic shifts, such as the already mentioned fertility decline and longevity pattern. Demographic forecasts for Italy for the next 30 years show an escalation of the aging

[11] Since the experiment was carried out only in Trento (Italy) we compared our data with the Italian National Statistics. However it would be interesting to compare the results with other Countries where the socio-demographic framework is either very similar or somehow distinct.

process, especially in the South, where in the period between 2011 and 2041 the proportion between individuals aged 60 to 100 and young people under the age of 15 will more than double (going from 123 to 278). During the same period in the Nothern and Central Italy, the aging index[12] will increase by more than one and a half times, going from 159 to 242. This projection of an inverse pyramid society where more grandparents will have contact with fewer grandchildren has led researches to investigate this evolving relationship. Since such trends are common to most industrialized Countries the results of international papers on this subject can be extended to the Italian case[13].

Neugarten and Weinstein (1964) in their early anthropological investigation of 51 societies discovered that the roles of grandparents differed cross-culturally: if grandparents were not invest anymore in a role of authority and guidance their relationships with grandchildren were more kind and affectionate compared to those societies where economic power and status lied with the elderly. Much later studies (Silverstein, 2001) have highlighted that factors such as family life stage, gender, marital status, geographical place, ethnicity and education were amongst the most recurrent variables influencing grandparents-grandchildren relationships. For example young grandparents live closer to their grandchildren and offer practical support, such as baby-sitting, while older grandparents live further away and prefer supporting their grandchildren economically.

Current socio-demographical shifts such as lower fertility rates and higher full-time employment for women also affect the importance of grandparents in the upbringing of children, and later in life, as role models for the grandchildren they

[12] The ageing index is a composite demographic ratio, defined as the percentage between the old age population (over 65) and the young population (under 15).
[13] For the purpose of this experiment the most relevant findings are those that look into the influence of grandparents over adult grandchildren.

(helped) raising[14]. In particular this trend (of grandparents substituting parents in childcare duties) is the focus of not only contemporary studies, but also lobbying initiatives.

As a result of grandparents being the caretakers of their grandchildren a sense of obligation towards each other has developed (Lumby, 2010). As grandchildren grow older, the relationships are more likely to evolve from care to giving advice and support. In addition grandparents provide a link to the past and act as sources of family history, heritage and traditions. Grandparents, being the link between many strands of the same lineage, also have an active role in keeping wider sets of relatives connected.

For what concerns Italy, Putnam et al. (1993) in their overview of 25 years of social trends concluded that low social capital reserves produced impoverished communities. Social capital is the results of social cohesion that starts from the very basic unit of the family. If and when families are capable of teaching and transmitting the values trust and respect, then they produce citizens who are engaged in rich social networks within communities.

It seems only plausible that, given the renewed importance of grandparents and their traditional role in families, individuals that have greater and better relationships with their grandparents are also more prone to cooperate, as a good member of a tight community would.

[14] Kennedy (2009) explained that "*grandchildren tended to feel closer to their mother's parents than to their father's parents and that they perceived their grandparents as loving, helping and comforting and as role models who are important in their lives*".

3.3.3 – Regression Analysis

The dependent variable of the regression analysis performed is the level of individual investment (contribution) to the common project (public good). The following fixed explanatory factors were considered:

- *Inheritance*: 10% of the public good individual return that is transferred from the previous player in DT, or the extra endowment that each player received in BT;
- Previous group contribution (*groupcprev*): how much the group has contributed as a whole in the previous turn of activity;
- Dynasty previous contribution (*dynstycprev*): how much the group (in lineage) playing in the previous round has contributed;
- *Turn*;
- *Generation*.

Furthermore, to illustrate the importance of the dynastic background of subjects, we included several control variables: the number of living-in family members (*family*), the number of grandparents (*gp*), and the frequency of the face-to-face interaction with grandparents (*freqgp*). In addition we controlled for the gender (*male*) and faculty (*eco*). Also the interactions between the number of grandparents, the inheritance and the gender with DT were included. Lastly we introduced a random explanatory factor in order to control for the potential bias in estimation due to the repetition of the choices and unobservable characteristics of participants into the experiment.

Table 3.7 reports the results of a Random Effects Tobit Regression. This specification has been chosen to account for the limits imposed in the experiment for the contribution choices. Also, since the initial endowment was varying in time depending on the inheritance received from the previous generation (or set by experimenters in BT), it was necessary to standardize the levels of contribution. Therefore the dependent variable is still the level of individual investment (contribution) to the common project (public good), but it is expressed as a value between 0 and 1. The contribution in percentage is regressed on the explanatory treatment variables previously specified.

Table 3.8 – Random Effects Tobit Regression
(individual contributions – values between 0 and 1)

Perc_Contribution	Coeff. (Std. Err)
DT	-0.059 (0.224)
Inheritance	0.042 (0.030)
Group Previous Contribution	0.009 (0.001)***
Dynasty Previous Contribution	0.002 (0.001)*
Turn	-0.010 (0.177)
Generation (Group B)	-0.262 (0.098)**
Generation (Group C)	0.010 (0.092)
Family	0.046 (0.039)
Grandparents	-0.150 (0.096)
Frequency Grandparents	0.036 (0.032)
DT X grandparents	0.320 (0.130)**
DT X frequency gp	-0.046 (0.046)
DT X inheritance	-0.171 (0.049)***
DT X gender (male)	0.317 (0.151)**
Male	-0.120 (0.109)
Economics	-0.077 (0.084)
Obs	78 left-censored observations at perc_contr<=0 239 uncensored observations 67 right-censored observations at perc_contr>=1
Wald Chi-Square test (p-value)	< 0.0001

***p< 0.001 **p < 0.05, *p < 0.1

The results of the regression show a significant positive impact of the group previous contribution (what the subjects in their own “Letter Group” contributed in the previous active round). A smaller, and less significant effect is also registered for the dynasty previous contribution (what the subjects belonging to the same lineage or “Color Group” contributed in the previous round). Greater positive and significant impacts are also registered in the interaction of DT with the number of grandparents, and gender. Significant negative influence on contribution is found for individuals belonging in the “Letter Group” B and a marginal negative effect is found in the interaction between DT and the inheritance levels.

3.4 – Discussion

This study examined the influence of dynastic lineage over investments in public goods in an experimental setting. During the last two decades, laboratory experiments have become a recognized method for testing economic theories and paradigms. Experimental economics has the obvious advantage to generate empirical information in a controlled environment that is also replicable. However, amongst other limitations, a standard questionnaire for collecting socio-demographic and economic data to administer to participating subjects is not yet available. This type of standard instrument would not only improve the comparability of different datasets and analyze the selectivity of subject pools (Gächter, 2009) but also extend the understanding of the influence that socio-demographic characteristics of subjects have over economic decision-making processes.

As suggested by Gächter (2009), the integration of experiments into representative surveys would allow researchers to explore the impact of socio-demographics on experimentally observed behavior. Since it is already a standard practice amongst most researchers in the field of experimental economics to elicit socio-demographic information from subjects at the end of experimental sessions, it would be reasonable to coordinate such effort. Such surveys are relevant since they could provide explanatory variables for unclear decision-making processes. This consideration is particularly relevant for the purpose of explaining intergenerational public good investments: as shown in section 3.3.2 individuals with a greater number of (living) grandparents tend to contribute more to the common project. If an extended version of a standard socio-demographic questionnaire were not administered relevant information that explain such an important intergenerational dynamic would not be available.

The experiment presented in this chapter is a first step towards the identification of potential intergenerational factors affecting public goods provision, and much remains to be understood. First and foremost future research should investigate whether dynastic lineage in real families is as strong as the results of this experiment suggested. Also future work should look into the possibility of investing in either a dynastic family good or a public good, similar to what has been done for local and global PG experiments. Another line of research could look at the same issue by means of a sequential dictator game, extending the work of Bahr and Requate (2007).

Concluding Remarks

This dissertation is set up to explore, from an Experimental and Behavioral perspective, the concept of Intergenerational and International public goods. The production of such long-lived and/or across-the-boarder PG depends not only on the ability of the members of the current cohort to cooperate, but also on the extent to which they care about future or neighboring cohorts.

Overview, empirical findings and implications.

Intergenerational and International PG have received scant attention from experimentalists. However some work in this direction has been already done. Chapter 1 reviewed the literature available to date. While various researchers have already investigated some aspects of Intergenerational PG, there is no systematic approach to the topic yet. On the other hand International PG issues have been tackled organically using the already established tool of local vs. global PG game. This assessment of the literature highlighted some potential developments in the field. First and foremost it has been demonstrated the necessity of modeling in a simple, yet meaningful, manner the overlap of different generations, producing long-lived PG.

The remainder two Chapters aimed at producing relevant experimental evidence on two major research questions within the general topic of the dissertation: what happens when a PG is produced but it benefits the young and inexperienced more then the old and experienced? And what are the consequences and decision-making dynamics of leaving part of the PG produced to future generations?

Chapter 2, *Helping Out the Young and Inexperienced: an Experimental Approach to Generational Heterogeneity and Redistribution in Public Good Games*, analyzed the impact of heterogeneity in MPCR, linked to seniority, in the production of a PG. Although the experiment did not introduce any form of OLG structure or spillover mechanism, the design focused on the implications of the entry and exit of individuals in a cohort. This dynamic membership was linked to different returns from the investment in the common project. In one treatment the MPCR was held constant for each type of player, while in the other treatment the MPCR was decreasing in experience. The results showed that loosing status (i.e. having the MPCR reduced over the three days in which the experiment took part, in favor of the new entrants) was eroding the contributions towards the PG much more than being at a stable disadvantage. Furthermore heterogeneity created distress in finding a cooperative equilibrium.

The third and last chapter, titled *Grandparents Matter: Perspectives on Intergenerational Altruism - An Experiment on Family Dynamic Spillovers in Public Goods Games*, focused the attention on lineage membership in PG games. To this end the experimental design developed across the dynastic dimension: in one treatment there was no recollection of any sort of family membership, while on the other we took plenty of care in recalling such attachment (color coding, wristbands, software reminders). We found that, not only the dynastic treatment (DT) produced higher contributions to the PG, but that it also nudged individuals to recollect their own dynastic framework. Results demonstrated how the actual socio-demographic background of experimental subjects had an effect on their contributions: in DT the greater the number of living grandparents, the greater the contribution to the PG. This specific result had two major implications: the first and most direct was that individuals might care more for the future cohorts when the lineage membership is evident (in line with evolutionary and biological findings); the second, less direct, regards the necessity for Experimental Economics to review the importance of socio-demographic questionnaires as a standardized tool for the discipline (Gächter, 2009).

Limitations and Future Research

This study has offered an evaluative outlook on an important topic for policy makers, and was conducted through computerized experiments in the laboratory. As a direct consequence of this methodology, the study encountered a number of limitations (besides the classic argument of external validity), which need to be considered.

Firstly, this Doctoral Thesis looked only at some of the issues surrounding the production of international and intergenerational public goods, and has done it in a compartmental manner. It would be of interest to construct an experimental design that brings together all the relevant features of long-lived PG: dynamic membership (birth and death of subjects), family lineage, spillovers (carryover of the PG) and means of financing of the PG (borrowing from the future cohorts). In addition it would be interesting to investigate how individuals distribute their wealth when they are called to choose between investing in a PG that benefits the future generations and leaving an inheritance for their own descendants (public vs. private goods spillover). Also it would be of value to run some experimental sessions with both non-related subjects and real families.

For what concerns international PG, which did not find a proper experimental essay in this dissertation, an obvious way forward would be the introduction of thresholds in local and global PG experiments. Another line of research could merge intergenerational and international public goods. In other words it would be interesting to see the behavior of subjects when they are called upon choosing to invest on a long-run local or global PG.

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Appendix A: Original and Translated Instructions – Experiment in Chapter 2

Note: the label [Common] identifies instructions which are common to all treatments; the label [BT] identifies instructions which refer exclusively to the Base Line Treatment (standard PG with 3 MPCR); the label [T1] identifies instructions which refer exclusively to the constant MPCR between days for the same Type of player and [T2] identifies instructions which refer exclusively to the decreasing MPCR between days for the same Type of Player.
Further the labels [D0], [D1] and [D2] identify the day of the experiment.

General Instructions

ORIGINAL
Caro Partecipante,
Ti ringraziamo per aver deciso di partecipare a questo esperimento. Da questo momento in poi ti chiediamo di non comunicare con gli altri partecipanti. Se dovessi avere delle domande, ti preghiamo di alzare la mano e attendere che uno degli sperimentatori venga a rispondere privatamente alle tue domande.

The Experiment

[BT] L'esperimento di oggi è costituito da 20 round, ognuno dei quali è indipendente dagli altri. Questo significa che le decisioni prese in un round influiscono solo sui guadagni di quel round e non sui guadagni degli altri round. Davanti a te trovi un foglio con indicato un numero (1, 2, o 3). Questa lettera stabilisce il tuo tipo di giocatore. Nel primo round sarai associato casualmente ad altri 2 partecipanti e assieme formerete un gruppo di 3 persone, una del "TIPO 1", una del "TIPO 2" e una del "TIPO 3". La composizione del gruppo sarà la medesima per tutti e venti i round, cioè gli altri 2 partecipanti del tuo gruppo saranno sempre gli stessi. La loro identità non sarà mai portata a tua conoscenza. Allo stesso modo la tua identità non sarà mai rivelata a loro.

[T1][T2] L'esperimento si svolge in tre giornate consecutive.

[D0] Alla fine dell'esperimento di oggi (primo giorno) saranno estratti a sorte 12 individui (più due riserve) che parteciperanno all'esperimento che si terrà domani (secondo giorno). Tra questi 12, alla fine dell'esperimento di domani saranno estratti a sorte 6 individui (più due riserve) che parteciperanno all'esperimento che si terrà dopodomani (terzo giorno) .

[D1] Alla fine dell'esperimento di ieri (primo giorno) sono state estratte a sorte 12 persone (più due riserve) che indichiamo con il nome "TIPO 1" e che parteciperanno all'esperimento di oggi (secondo giorno). A queste si aggiungono 6 nuove persone che indichiamo con il nome "TIPO 2". Alla fine dell'esperimento di oggi saranno estratti a sorte 6 individui (più due riserve) tra i "TIPO 1" che parteciperanno all'esperimento che si terrà domani (terzo giorno) . Mentre tutte le persone di "TIPO 2" parteciperanno all'esperimento che si terrà domani (terzo giorno).

[D2] Alla fine dell'esperimento dell'altro ieri (primo giorno) sono state estratte a sorte 12 persone (più due riserve) che indichiamo con il nome "TIPO 1" e che hanno partecipato anche all'esperimento di ieri (secondo giorno). A queste si sono aggiunte 6 nuove persone che indichiamo con il nome "TIPO 2". Alla fine dell'esperimento di ieri sono stati estratti a sorte 6 individui (più due riserve) tra i "TIPO 1" che parteciperanno all'esperimento di oggi (terzo giorno) . Mentre tutte le persone di "TIPO 2" parteciperanno all'esperimento di oggi (terzo giorno). Alle persone del "TIPO 1" e del "TIPO 2" si aggiungono oggi 6 persone che indichiamo con il nome "TIPO 3".

[T1][T2] I tre esperimenti sono indipendenti. In altre parole i guadagni di domani non dipendono dai guadagni di oggi, e i guadagni di dopodomani non dipendono dai guadagni di oggi e domani.

[T1][T2] L'esperimento di oggi è costituito da 20 round, ognuno dei quali è indipendente dagli altri. Questo significa che le decisioni prese in un round influiscono solo sui guadagni di quel round e non sui guadagni degli altri round.

[D0] Nel primo round sarai associato casualmente ad altri 2 partecipanti e assieme formerete un gruppo di 3 persone. La composizione del gruppo sarà la medesima per tutti e venti i round, cioè gli altri 2 partecipanti del tuo gruppo saranno sempre gli stessi. La loro identità non sarà mai portata a tua conoscenza. Allo stesso modo la tua identità non sarà mai rivelata a loro.

[D1] Nel primo round sarai associato casualmente ad altri 2 partecipanti e assieme formerete un gruppo di 3 persone, 2 del "TIPO 1" ed una del "TIPO 2". La composizione del gruppo sarà la medesima per tutti e venti i round, cioè gli altri 2 partecipanti del tuo gruppo saranno sempre gli stessi. La loro identità non sarà mai portata a tua conoscenza. Allo stesso modo la tua identità non sarà mai rivelata a loro.

[BT][D2] Nel primo round sarai associato casualmente ad altri 2 partecipanti e assieme formerete un gruppo di 3 persone, una del "TIPO 1", una del "TIPO 2" e una del "TIPO 3". La composizione del gruppo sarà la medesima per tutti e venti i round, cioè gli altri 2 partecipanti del tuo gruppo saranno sempre gli stessi. La loro identità non sarà mai portata a tua conoscenza. Allo stesso modo la tua identità non sarà mai rivelata a loro.

[COMMON] All'inizio di ogni round ti saranno assegnate 30 unità di moneta sperimentale (UMS). Di queste 30 UMS dovrai decidere, individualmente ed autonomamente, se e quanto destinare ad un progetto comune. Anche gli altri soggetti nel tuo gruppo saranno chiamati a esprimere la stessa scelta. Assumiamo, per comodità, che tu sia denominato A e gli altri 2 componenti del tuo gruppo siano denominati rispettivamente B e C. Definiamo la tua contribuzione al progetto come C_A e le contribuzioni degli altri 2 componenti del tuo gruppo come C_B e C_C.

[D0] Gli utili totali derivanti dal progetto sono calcolati sommando alla tua contribuzione (C_A) le contribuzioni degli altri 2 componenti del tuo gruppo (C_B e C_c) e moltiplicandola per 2.7. Il risultato sarà poi diviso equamente tra tutti e 3 i componenti del gruppo. In altre parole il tuo utile derivante dal progetto è calcolato sommando alla tua contribuzione (C_A) le contribuzioni degli altri 2 componenti del tuo gruppo (C_B e C_c) e moltiplicandola per alfa pari a [T1] 0.4 (=1.2 diviso 3) [T2] 0.9 (=2.7 diviso 3).
Ciò che deciderai di non contribuire (cioè 30 UMS – C_A) verrà messo sul tuo conto personale.

[D1] Gli utili totali derivanti dal progetto sono calcolati sommando alla tua contribuzione (C_A) le contribuzioni degli altri 2 componenti del tuo gruppo (C_B e C_c) e moltiplicandola per 2.2. Il risultato sarà poi diviso tra tutti e 3 i componenti del gruppo a seconda del loro TIPO.
In altre parole il tuo utile derivante dal progetto è calcolato sommando alla tua contribuzione (C_A) le contribuzioni degli altri 2 componenti del tuo gruppo (C_B e C_c) e moltiplicandola per alfa.
Alfa assume i seguenti valori:

- [T1] 0.40 [T2] 0.65 per le persone del "TIPO 1"; e
- [T1] 0.65 [T2] 0.90 per le persone del "TIPO 2".

[BT][D2] Gli utili totali derivanti dal progetto sono calcolati sommando alla tua contribuzione (C_A) le contribuzioni degli altri 2 componenti del tuo gruppo (C_B e C_c) e moltiplicandola per 1.95. Il risultato sarà poi diviso tra tutti e 3 i componenti del gruppo a seconda del loro TIPO.
In altre parole il tuo utile derivante dal progetto è calcolato sommando alla tua contribuzione (C_A) le contribuzioni degli altri 2 componenti del tuo gruppo (C_B e C_c) e moltiplicandola per alfa.
Alfa assume i seguenti valori:

- 0.40 per le persone del “TIPO 1”;
- 0.65 per le persone del “TIPO 2”; e
- 0.90 per le persone del “TIPO 3”.

[COMMON]In ogni round i tuoi guadagni sono dati dalla somma delle due seguenti voci:
- gli UMS che hai messo sul tuo conto personale (30 UMS - C_A);
- gli utili derivanti dal progetto [alfa x (C_A+ C_B+ C_C)].

Alla fine di ogni round ti sarà comunicato il valore delle singole contribuzioni degli altri membri del tuo gruppo (C_B, C_C), il valore della contribuzione totale del gruppo (C_A+ C_B+ C_C) e il tuo guadagno finale.

I TUOI GUADAGNI

[COMMON]Sarai pagato 3,00 EURO per aver partecipato ed esserti presentato in orario.
Inoltre alla fine dell’esperimento uno dei 20 round sarà estratto a caso e ti verrà pagato il tuo guadagno di UMS in quel round. Ogni UMS sarà convertita in 0,20 EURO.
Per gli individui che saranno estratti a sorte per partecipare all’esperimento domani, il pagamento avverrà alla fine della sessione di domani. Qualora questi individui siano estratti a sorte anche domani per l’esperimento di dopodomani il pagamento avverrà alla fine della sessione di dopodomani. Gli individui che non sono estratti per continuare con l’esperimento saranno retribuiti alla fine della sessione di oggi.
Il pagamento avverrà in contanti se il guadagno è inferiore o uguale a 25,00 EURO oppure con bonifico bancario se il guadagno è superiore a 25,00 EURO.

TRANSLATED
Dear Participant,
Thank you for taking part in this experiment. From this moment on, we ask you not to communicate with other participants. Should you have any questions, please raise your hand and wait for one of the investigators to respond privately.

The Experiment

[BT] Today’s experiment consists of 20 rounds, each of which is independent of the others. This means that decisions made in one round only affect earnings of that round and not the earnings of the other rounds. In front of you there is a piece of paper with a number written on it (1, 2, or 3). This number sets your type of player.

[T1] [T2] The experiment is carried out in three consecutive days.

[D0] At the end of today’s experiment (first day) 12 individuals (plus 2 reserves) will be randomly drawn and thy will participate in the experiment being held tomorrow (second day). Among these 12, at the end of the tomorrow’s experiment another 6 individuals (plus two reserves) will be randomly drawn and will participate in the experiment being held tomorrow (third day).

[D1] At the end of yesterday’s experiment (first day) 12 individuals (plus two reserves) were randomly selected and denoted by the name "Type 1". These individuals are participating in the experiment today (second day). In addition there are 6 new people denoted by the name "TYPE 2". At the end of today’s experiment of today 6 individuals (plus two reserves) among the "type 1" will be randomly drawn and they will participate in the experiment being held tomorrow (third day). All individuals labeled as "type 2" will take part in the experiment being held tomorrow (third day).

[D2] At the end of the experiment held the day before yesterday (first day) 12 people (plus two reserves) denoted by the name "Type 1" were randomly selected and also participated in yesterday’s experiment (second day). To these individuals six new people denoted by the name

"TYPE 2" were added. At the end of yesterday's experiment 6 individuals (plus two reserves) among the "type 1" were randomly drawn and will participate in today's experiment (third day). While all individuals of "type 2" will take part in the experiment today (third day). Today to the individuals of the "type 1" and "type 2" are added 6 people denoted by the name "TYPE 3".

[T1] [T2] These are three independent experiments. In other words tomorrow's revenues do not depend on today's gains, and gains the next day do not depend on the earnings of today and tomorrow.

[T1] [T2] The experiment today consists of 20 rounds, each of which is independent of the others. This means that decisions made in one round only affect the earnings of that round and not on the earnings of the other rounds.

[D0] In the first round you will be associated randomly to other 2 participants and together you will form a group of three people. The composition of the group will be the same for all twenty rounds that means that the other two participants in your group will always be the same. Their identity will never be brought to your knowledge. Similarly your identity will never be revealed to them.

[D1] In the first round you will be associated randomly to other 2 participants and together you will form a group of three people, two of the "Type 1" and one of the "type 2". The composition of the group will be the same for all twenty rounds, meaning that the other two participants in your group will always stay the same. Their identity will never be brought to your knowledge. Similarly your identity will never be revealed to them.

[BT] [D2] In the first round will be associated randomly to 2 other participants and together you will form a group of three people, one of the "Type 1", one of the "Type 2" and the "Type 3". The composition of the group will be the same for all twenty rounds, meaning that the other two participants in your group will always be the same. Their identity will never be brought to your knowledge. Similarly your identity will never be revealed to them.

[COMMON] At the beginning of each round you will be awarded 30 units of experimental currency (UMS). Of these 30 UMS you must decide, individually and independently, whether and how much to allocate to a common project. The other subjects in your group will be called to express the same choice. We assume, for convenience, that you are called A and the other two members of your group are named respectively B and C. We define your contribution to the project as C_A and the contributions of the other two members of your group as C_B and C_C.

[D0] The total profits generated by the project are calculated by adding up to your contribution (C_A), the contributions of the other two members of your group (C_B and C_C) and multiplying by [T1] 1.2 [T2] 2.7. The result will then be equally divided between all three members of the group. In other words, your profit on the project is calculated by adding to your contribution (C_A), the contributions of the other two members of your group (C_B and C_C) and multiplying by alpha of [T1] 0.4 (= 1.2 divided by 3) [T2] 0.9 (= 2.7 divided by 3).
What you decide not to contribute (30 UMS - C_A) will be put on your account.

[D1] The total profits generated by the project are calculated by adding up to your contribution (C_A), the contributions of the other two members of your group (C_B and C_C) and multiplying by [T1] 1.45 [T2] 2.2. The result will then be divided between all 3 components of the group according to their TYPE.
In other words, your profit on the project is calculated by adding to your contribution (CA), the contributions of the other two members of your group (CB and C_C) and multiplying by alpha.
Alfa takes the following values:
• [T1] 0.40 [T2] 0.65 for the people of the "Type 1"; and
• [T1] 0.65 [T2] 0.90 for the people of the "Type 2".

[BT] [D2] The total profits generated by the project are calculated by adding up to your contribution (C_A), the contributions of the other two members of your group (C_B and C_C) and multiplying by 1.95. The result will then be divided between all 3 components of the group according to their TYPE.
In other words, your profit on the project is calculated by adding to your contribution (C_A), the contributions of the other two members of your group (C_B and C_C) and multiplying by alpha.
Alfa takes the following values:
• 0,40 for people of "Type 1";
• 0.65 for the people of the "Type 2"; and
• 0.90 for the people of the "Type 3".

[COMMON] In each round your earnings are the sum of the following two items:
- The UMS that you put on your personal account (30 UMS - C_A);
- Profits accruing from the project [alpha x (C_A + C_B + C_C)].
At the end of each round you will be informed of the value of individual contributions of the other members of your group (C_B, C_C), the value of the contribution of the group (C_A + C_B + C_C) and your final gain.

YOUR EARNINGS
[COMMON] You will be paid 3.00 EURO for participating and being on time.
Also, at the end of the experiment one of the 20 rounds will be drawn at random and you will be paid your UMS gain in that round. Each UMS will be converted into 0.20 EURO.
For individuals who will be randomly selected to participate in tomorrow's experiment, the payment will be at the end of tomorrow's session. If any of these individuals are also randomly selected for the experiment on the day after tomorrow the payment will take place at the end of that session. Individuals who are not drawn to continue with the experiment will be paid at the end of today's session.
Payment will be made in cash if the payoff is less than, or equal to 25.00 EURO or by bank

Appendix B: Original and Translated Instructions – Experiment in Chapter 3

Note: the label [Common] identifies instructions which are common to all treatments; the label [BT] identifies instructions which refer exclusively to the Base Line Treatment; the label [DT] identifies instructions which refer to the Dynasty Treatment.

General Instructions

ORIGINAL
[COMMON]Cari Partecipanti,
Vi ringraziamo per aver deciso di prendere parte a questo esperimento. Da questo momento in poi vi chiediamo di non comunicare con gli altri partecipanti. Se doveste avere delle domande, vi preghiamo di alzare la mano e attendere che uno degli sperimentatori venga a rispondervi privatamente.

L'ESPERIMENTO
Ruoli e Gruppi
[BT] Posto sul tavolo dinanzi ad ognuno di voi c'è una busta contenente un tagliando con una lettera stampata (A, B, C). Questo tagliando v'informa sul ruolo che dovrete ricoprire durante l'esperimento.
[Ad esempio se davanti a voi c'è un tagliando con la lettera B significa che siete un giocatore del tipo B.]

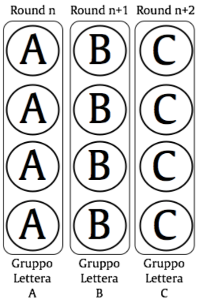
[DT] Posto sul tavolo dinanzi ad ognuno di voi c'è una busta contenente un tagliando colorato (giallo, verde, rosso o blu) con una lettera stampata (A, B, C). Questo tagliando v'informa sul vostro colore e sul ruolo che dovrete ricoprire durante l'esperimento.
[Ad esempio se davanti a voi c'è un tagliando rosso con la lettera B significa che appartenete al gruppo colore rosso e siete un giocatore del tipo B]. Inoltre nella stessa busta c'è anche un braccialetto con il colore che vi è stato assegnato: vi chiediamo d'indossarlo sin da questo momento.
L'esperimento di oggi è costituito da due parti.
La prima consiste in un compito preliminare (*vedi sezione 1.3 - Task del compito preliminare).*

[BT] L'esperimento è costituito da un certo numero di round, ognuno dei quali è indipendente dagli altri. Questo significa che le decisioni prese in un round influiscono solo sui guadagni di quel round che e non sui guadagni dei round successivi.
[DT] L'esperimento di oggi è costituito da due parti.
La prima consiste in un compito preliminare (*vedi sezione 1.3 - Task del compito preliminare).*
La seconda invece è costituita da un certo numero di round, ognuno dei quali è dipendente dagli altri. Questo significa che le decisioni prese in un round influiscono sia sui guadagni di quel round che sui guadagni di tutti i round successivi.

[COMMON] In ogni round parteciperanno tra loro solo gli individui di un certo tipo (A o B o C). Nel primo Round parteciperanno solo gli individui del tipo A (GRUPPO A), nel secondo solo gli individui del tipo B (GRUPPO B), nel terzo round solo gli individui del tipo C (GRUPPO C). Nel quarto round parteciperà nuovamente solo il GRUPPO A, nel quinto nuovamente solo il GRUPPO B, e nel sesto round nuovamente solo il GRUPPO C, e via dicendo fino alla fine dell'esperimento.

[DT] Anche la composizione del "GRUPPO COLORE" (un individuo del tipo A, uno del tipo B e uno del tipo C) sarà la medesima per tutti i round, cioè gli altri due membri del tuo "GRUPPO COLORE" rimarranno sempre gli stessi.
L'identità degli altri membri del tuo "GRUPPO COLORE" e del tuo "GRUPPO LETTERA" non sarà mai portata a tua conoscenza. Allo stesso modo la tua identità non sarà mai rivelata a loro.

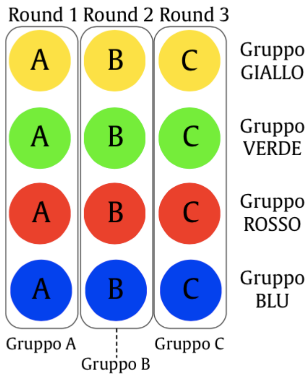
[BT] La composizione del "GRUPPO LETTERA" (giocatori del tipo A, B o C) sarà la medesima per tutti i round, cioè gli altri 3 membri del tuo "GRUPPO LETTERA" saranno sempre gli stessi. L'identità degli altri membri del tuo "GRUPPO LETTERA" non sarà mai portata a tua conoscenza. Allo stesso modo la tua identità non sarà mai rivelata a loro.



[BT] Figura 1 – Struttura dei Gruppi Lettera e Ruoli dei partecipanti.

La Figura 1 illustra la struttura dei "GRUPPI LETTERA" e dei Ruoli durante i round dell'esperimento. Vi chiediamo di osservarla attentamente per qualche secondo e d'identificare il vostro ruolo all'interno della struttura dei "GRUPPI LETTERA".

Ricapitolando: ogni giocatore appartiene a un GRUPPO LETTERA (GRUPPO A, GRUPPO B, GRUPPO C). L'esperimento è costituito da un certo numero di round e in ogni round giocano solamente gli individui di un certo GRUPPO LETTERA.



[DT] Figura 1 – Struttura dei Gruppi Colore, dei Gruppi Lettera e Ruoli dei partecipanti.

La Figura 1 illustra la struttura dei "GRUPPI COLORE", dei "GRUPPI LETTERA" e dei Ruoli durante i round dell'esperimento. Vi chiediamo di osservarla attentamente per qualche secondo e d'indentificare il vostro ruolo all'interno della struttura dei "GRUPPI COLORE" e "GRUPPI LETTERA"

Ricapitolando: ogni giocatore appartiene a un GRUPPO COLORE (GRUPPO GIALLO, GRUPPO VERDE, GRUPPO ROSSO o GRUPPO BLU) e a un GRUPPO LETTERA (GRUPPO A, GRUPPO B, GRUPPO C). L'esperimento è costituito da un certo numero di round e in ogni round giocano solamente gli individui di un certo GRUPPO LETTERA.

Task del compito preliminare

Prima di cominciare con il task dell'esperimento a ogni GRUPPO COLORE è chiesto di completare un cruciverba.

A turno, ogni membro di un GRUPPO COLORE ha a disposizione tre minuti per completare quante più definizioni del cruciverba possibili.

Al termine dei tre minuti disponibili per ogni individuo uno sperimentatore passerà a raccogliere il cruciverba per passarlo all'individuo successivo del proprio GRUPPO COLORE.

L'ordine con cui è passato il cruciverba è il seguente:

individuo A → individuo B → individuo C

Ciascun membro del GRUPPO COLORE sarà retribuito con 5 UMS per ogni definizione corretta data dal GRUPPO COLORE nel suo insieme (quindi indipendentemente da chi ha dato la definizione corretta all'interno del GRUPPO COLORE). Il risultato del task preliminare di ogni GRUPPO COLORE sarà comunicato al momento del pagamento finale (alla fine della sessione odierna).

Task dell'esperimento

[DT] Prima di cominciare il task dell'esperimento e subito dopo aver terminato tutti i round vi sarà richiesto di esprimere quanto vi sentite parte del vostro "GRUPPO COLORE".

[COMMON] All'inizio di ogni round saranno assegnate un certo numero (almeno 30) di unità di moneta sperimentale (UMS) a ogni membro del "GRUPPO LETTERA" attivo durante quel round. L'ammontare di UMS può variare di round in round, quindi vi chiediamo di prestare attenzione al numero di UMS assegnate di volta in volta.
Di queste UMS ogni membro del gruppo attivo dovrà decidere, individualmente e autonomamente, se e quanto destinare a un progetto comune. Anche gli altri soggetti nel GRUPPO LETTERA attivo saranno chiamati a esprimere la stessa scelta.
Assumiamo, per comodità, che tu sia un membro attivo denominato X e gli altri 3 componenti del tuo gruppo siano denominati rispettivamente Y, Z e W. Definiamo la tua contribuzione al progetto come C_Xe le contribuzioni degli altri 3 componenti del tuo gruppo come C_Y , C_Z e C_W.
Gli utili totali derivanti dal progetto sono calcolati sommando alla tua contribuzione (C_X) le contribuzioni degli altri 3 componenti del tuo gruppo (C_Y C_Z C_w) e moltiplicandola per 2. Il risultato sarà poi diviso equamente tra tutti e 4 i componenti del gruppo.
In altre parole l'<u>utile individuale lordo derivante dal progetto</u> è calcolato sommando alla tua contribuzione (C_X) le contribuzioni degli altri 3 componenti del tuo gruppo (C_Y C_Z C_w) e moltiplicandola per <u>alfa pari a 0.5</u> (=2 diviso 4).
Ciò che deciderai di non contribuire (cioè almeno 30 UMS – C_X) verrà messo sul tuo conto personale.

[DT] Dipendenza tra Round

Come già ricordato l'esperimento di oggi è costituito da un certo numero di round, ognuno dei quali è dipendente dagli altri. Questo significa che le decisioni prese in un round influiscono sia sui guadagni di quel round che sui guadagni di <u>tutti i round successivi</u>.
In ogni round in cui sei attivo i tuoi guadagni sono dati dalla somma delle due seguenti voci:

- gli UMS che hai messo sul tuo conto personale (almeno 30 UMS - C_x);
- gli utili derivanti dal progetto [alfa x (C_Y +C_Z+C_w+ C_x)].

Alla quale è sottratta la seguente voce:

- gli utili derivanti dal progetto [alfa x (C_Y +C_Z +C_w+ C_x)] moltiplicati per una percentuale pari al 10% , ovvero la quota trasmessa al membro del tuo GRUPPO COLORE nel round successivo.

[Ad esempio se siete un partecipante del tipo B e un membro del GRUPPO COLORE ROSSO lascerete il 10% del vostro guadagno derivante dal progetto comune al soggetto del tipo C della vostro stesso GRUPPO COLORE ROSSO.]
Questo significa che, escluso il primo round, a ogni round successivo l'effettivo ammontare di UMS disponibili per ciascun giocatore attivo è pari alle UMS assegnate dagli sperimentatori più la quota trasmessa dal membro del proprio "GRUPPO COLORE" che ha partecipato al round precedente.
Alla fine di ogni round in cui sei attivo ti sarà comunicato il valore delle singole contribuzioni degli altri membri del tuo "GRUPPO LETTERA" (C_Y C_Z C_w), il valore della contribuzione totale del "GRUPPO LETTERA" (C_Y +C_Z+C_w+ C_x), il valore trasmesso al membro del tuo "GRUPPO COLORE" che giocherà nel round successivo e il tuo guadagno netto finale.
Le informazioni comunicate ai membri inattivi di ogni "GRUPPO COLORE" saranno solo il valore della contribuzione del membro del proprio "GRUPPO COLORE" e il valore trasmesso al membro del proprio "GRUPPO COLORE" che giocherà nel round successivo.
Inoltre sarà fornito lo storico a scalare di questi risultati alla fine di ogni round.

[BT] In ogni round in cui sei attivo i tuoi guadagni sono dati dalla somma delle due seguenti voci:

- gli UMS che hai messo sul tuo conto personale (30 UMS - C_x);
- gli utili derivanti dal progetto [alfa x (C_Y +C_Z+C_w+ C_x)].

Alla fine di ogni round in cui sei attivo ti sarà comunicato il valore delle singole contribuzioni degli altri membri del tuo "GRUPPO LETTERA" (C_Y C_Z C_w), il valore della contribuzione totale del "GRUPPO LETTERA" (C_Y +C_Z+C_w+ C_x), e il tuo guadagno netto finale.

I TUOI GUADAGNI

[COMMON] Nota bene: tutti gli importi durante tutto l'esperimento s'intendono arrotondati per difetto se il primo decimale è minore o uguale a 5, o per eccesso altrimenti.
Sarai pagato 3,00 EURO per aver partecipato ed esserti presentato in orario.
Inoltre alla fine dell'esperimento sarà calcolato il tuo guadagno cumulativo al tuo ultimo round attivo.
[DT] Sarai inoltre pagato per il task preliminare con 5 UMS per ogni definizione corretta del cruciverba data dal tuo "GRUPPO COLORE".
[COMMON] Ogni UMS sarà convertita in 0,03 EURO.

TRANSLATED

[COMMON] Dear Participant,
Thank you for taking part in this experiment. From this moment on, we ask you not to communicate with other participants. Should you have any questions, please raise your hand and wait for one of the investigators to respond privately.

The Experiment
Roles and Groups
[BT] Placed on the table, right in front of each of you there is an envelope containing a coupon with a printed letter (A, B, C). This coupon informs you about the role that you will play during the experiment.
[For example, if in front of you there is a coupon with the letter B it means that you are a type B player].

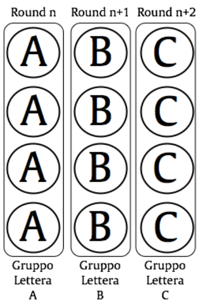
[DT] Placed on the table, right in front of each of you there is an envelope containing a colored coupon (yellow, green, red or blue) with a printed letter (A, B, C). This coupon informs you about your color and the role that you will play during the experiment.
[For example, if in front of you there is a red coupon with the letter B it means that you belong to the red group and a type B player]. In the same envelope you will also find a wristband of the same color that you have been assigned: we kindly ask you to wear it from now onwards.

[BT] The experiment consists of a given number of rounds, each of which is independent from the others. This means that decisions you make in one round only affect earnings of that very same round and not the earnings of later rounds.
[DT] Today's experiment consists of two parts.
The first is a preliminary task (see section 1.3 - Task of the preliminary task).
The second one consists of a given number of rounds, each of which is dependent on others. This means that decisions made in one round affect both the gains of that round and the earnings of later rounds.

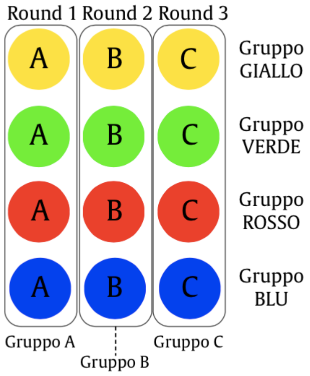
[COMMON] In each round individuals of a certain type (A or B or C) will be active and making decisions. In the first round only individuals of type A (GROUP A) will participate, in the second only individuals of type B (GROUP B), in the third round only individuals of the type C (GROUP C). In the fourth round again only GROUP A will participate, in the fifth again only to GROUP B, and in the sixth round again only GROUP C, and so on until the end of the experiment.

[DT] The composition of the "COLOR GROUP" (one individual of type A, one type B and one type C) will be the same for all rounds, meaning that the other two members of your "COLOUR GROUP" will always remain the same.
The identities of the other members of your "COLOUR GROUP" and your "LETTER GROUP" will never be brought to your knowledge. Similarly your identity will never be revealed to them.

[BT] The composition of the "LETTER GROUP" (players of type A, B or C) will be the same for all rounds, that is, the other three members of your "LETTER GROUP" will always be the same. The identities of the other members of your "LETTER GROUP" will never be brought to your knowledge. Similarly your identity will never be revealed to them.



[BT] Figure 1 - Structure of Letter Groups and Roles of the participants.
Figure 1 illustrates the structure of the "LETTER GROUP " and roles during the rounds of the experiment. We ask you to carefully observe it for a few seconds and identify your role within the structure of the "LETTER GROUP ".
In summary: each player belongs to a LETTER GROUP (GROUP A, GROUP B, GROUP C). The experiment consists of a given number of rounds and in every round only the individuals of a certain LETTER GROUP are playing.



[DT] Figure 1 - Structure of the Color Groups, Letter Groups and Roles of participants.
Figure 1 illustrates the structure of the "COLOR GROUP", the "LETTER GROUP" and roles during the rounds of the experiment. We kindly ask you to carefully observe it for a few seconds and indentify of your role within this structure.
In summary: each player belongs to a COLOR GROUP (YELLOW GROUP, GREEN GROUP, RED GROUP, or BLUE GROUP) and a LETTER GROUP (GROUP A, GROUP B, GROUP C). The experiment consists of a certain number of rounds and in every round only the individuals of a certain LETTER GROUP are going to play.
Preliminary task:
Before starting with the experiment each COLOR GROUP is asked to complete a crossword puzzle.
Taking turns, each member of a COLOR GROUP has three minutes to complete as many definitions of the crossword as possible.
At the end of the three minutes available for each individual an experimenter will collect the crossword and pass it next to the individual of the same COLOR GROUP.

The order in which the crossword is passed along is the following:
Individual A $\rightarrow$ Individual B $\rightarrow$ individual C
Each member of the COLOR GROUP will be paid with 5 UMS for each correct definition given by COLOR GROUP as a whole (so regardless of who gave the correct definition in the COLOR GROUP). The result of the preliminary task of each COLOR GROUP will be notified at the time of the final payment (at the end of today's session).

1.3 - Experiment
[DT] Before beginning the experiment and after finishing it you will be asked to express how much you feel part of your "COLOUR GROUP".

[COMMON] At the beginning of each round each member of the active "LETTER GROUP" will receive (at least 30) units of experimental currency (UMS). The amount of UMS may vary from round to round, so we ask you to pay attention to the number of UMS assigned from time to time.
Of these UMS every member of the active group will have to decide, individually and autonomously, whether and how much to allocate to a common project. The other active parties in the "LETTER GROUP" will be called to make the same choice.

[DT] 1.3 - Dependence between rounds
As already mentioned, the experiment consists of a set number of rounds, each of which is dependent on others. This means that decisions made in one round affect both the gains of that round and the earnings of later rounds.
In each round where you are active your earnings are the sum of the following two items:
- The UMS that you put on your personal account (30 UMS – C_x);
- Profits accruing from the project [alpha x ($C_x + C_y + C_z + C_W$)].
Which is reduced by the following entry:
- Profits accruing from the project [alpha x ($C_x + C_y + C_z + C_W$)] multiplied by a percentage equal to 10%, or the proportion sent to the member of your GROUP COLOR in the next round.
[For example, if you are a participant of type B and a member of the RED GROUP you will leave 10% of your gain from the common project to the type C individual of your own RED GROUP].
This means that, excluding the first round, in each subsequent round the actual amount of UMS available for each active player is equal to the UMS assigned by experimentes plus the portion transmitted by the member of its "COLOR GROUP" that was active in the previous round.
At the end of each round in which you are active you will get feedback on the value of the individual contributions of the other members of your "GROUP LETTER" (C_y C_z C_W), the value of the total contribution of the "GROUP LETTER" ($C_x + C_y + C_z + C_W$) The value sent to the member of your "COLOUR GROUP" that will play in the next round and your net gain final.
The feedback provided for inactive members of each "COLOR GROUP" will only consist of the value of the contribution of the member of its "COLOR GROUP" and the value sent to the member of his own "COLOR GROUP" that will play in the next round.
Previous rounds results will be also reported at the end of each round.

[BT] In each round you are active your earnings consist of the sum of the following two items:
- The UMS that you put on your personal account (30 UMS – C_x);
- Profits accruing from the project [alpha x ($C_x + C_y + C_z + C_W$)].
At the end of each round in which you are active you will get feedback on the value of the individual contributions of the other members of your "GROUP LETTER" (C_y C_z C_W), the value of the total contribution of the "GROUP LETTER" ($C_x + C_y + C_z + C_W$), and your net final gain.

YOUR EARNINGS
[COMMON] Please note that all amounts throughout the experimentare rounded down when the first decimal is less than or equal to 5, or otherwise they are rounded up.
You will be paid 3.00 EURO for participating and being on time.
At the end of the experiment we will calculate your cumulative gain to your last active round.

[DT] You will also be paid for the preliminary task with 5 UMS for each correct definition of crossword given by your "COLOUR GROUP".
[COMMON] Each UMS will be converted into 0.03 EURO.

Appendix C: Ex-Post Questionnaire – Experiment in Chapter 3

1 - In which faculty are you enrolled?
(Economics/ Humanities/ Engineering/ Law/ Physics and Mathematics/ Sociology or Psychology/ Other Natural Sciences/ Other Social Sciences/ not a student)

2 - In which year of studies are you enrolled?
(first year/ second/ third/ out-of-due date/ master student/ not a student)

3 - Which is your gender?
(female/ male)

4 - In which year were you born?

5 - How mamy members make up your family? (currently cohabiting)
(1 to 10)

6 - How may brothers or sisters do you have?
(1 to 4)

7 - How many living grandparendts do you have?
(1 to 4)

For each parent and grandparent please indicate the following:
8 – Distance in Km (living together / <1km / 1-16 km / >16 km / overseas / not applicable)
9 – Frequency of face-to-face interactions (daily / weekly / monthly / yearly / not applicable)