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ABSTRACT

Voluntary Contributions to the Establishment and Operation of Public Goods: Theory and Experimental Evidence*

We study the dynamics of the private provision of a public good that requires both capacity buildup and ongoing operating costs. We show that setting a time limit for the collection of contributions dedicated to capacity buildup minimizes the utility loss at the Nash equilibrium. We test the theoretical model empirically by conducting contribution game experiments with religious Jewish students for the procurement of sustainable supplies for their campus synagogues and ongoing operations. The empirical findings support the model's prediction and demonstrate that the theory fairly describes the pattern of contributions when the group of contributors attributes high intrinsic value to the public good. More specifically, we find that total contributions increase over time, contributions to the capacity buildup increase with the time limit and with the number of contributors, and contributions to the capacity buildup decrease with ongoing operating costs. Additionally, we determine that gender and culture affect the pattern of contributions. We also find that individuals prefer to contribute to sustainable supplies, rather than to their ongoing operations. Our paper has practical implications for the financing of public goods through voluntary provisions.

JEL Classification: C73, C91, C92, H41

Keywords: differential games, experiment, public goods, voluntary provision

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1. Introduction

Many types of public goods require an initial investment to build up their capacities and periodic contributions to their ongoing operation. For example, an initial investment is required to build a hospital, a swimming pool, or a worship house, while their output depends also on period-by-period investment in their ongoing operation.[1] In many cases, communities find raising contributions to the capacity buildup of the public good (e.g., the actual building, or swimming pool) relatively facile in comparison to raising contributions to finance the ongoing operation of the public good. Consequently, a known problem concerning voluntarily supplied public goods is the difficulty in raising sufficient resources to finance their ongoing operations.

This paper establishes a theoretical model of voluntary contributions to capacity buildup and ongoing operations of public goods and conducts an original experimental test of the model. The model describes a two-stage game. In the first stage, whose length is limited to T,[2] individuals continuously contribute to the capacity buildup of a public good.[3] In the second stage, individuals benefit from the public good, provided they contribute to its ongoing operation. Within this setting, we show that in an open-loop Nash equilibrium (that is shown to be identical to the closed-loop Nash equilibrium), contributions to the capacity buildup of the public good are increasing over time, total contributions are increasing with the time limit T and the number of contributors are decreasing with the costs of the ongoing operation. We also suggest a policy implication of the model and show that, by setting a proper time limit to the collection of contributions to the capacity buildup of the public good, the social utility loss associated with free-ridership at the Nash equilibrium is minimized.

A unique feature of our paper is an empirical test of the model using original contribution game experiments. Most experiments are conducted in the form of a

[1] Ongoing operating costs usually include water and electricity bills, cleaning, periodic maintenance and the like. Without the ongoing operations, one cannot benefit from the public good.

[2] Unlike Admati and Perry (1991), Marx and Mathew (2000) and Kessing (2007), we are not considering a threshold public good—that is, there is no minimal capacity requirement to the public good.

[3] On the private provision of public goods in a differential game setting, see also Fershtman and Nitzan (1991).

linear public good game.[4] However, in real life, individuals contribute to public goods that they utilize and to which they attribute high intrinsic value.

We conducted four types of contribution game experiments at the campuses of the Jerusalem College of Technology (hereinafter: JCT), and all of the participants in these experiments were Orthodox and ultra-Orthodox[5] Jewish students. Unlike the common experiment protocols, in each of our experiments, subjects were handed an initial endowment of ECU (Experimental Currency Units) to be divided between themselves and a contribution to a *real* public good[6] they value and use on a daily basis – their campus synagogues.

The JCT is defined as a Jewish Orthodox religious institution, which combines secular academic studies with Jewish religious studies. Being a religious institution, the JCT also implements a strict separation of females and males on different campuses. Each of the campuses has a synagogue that is utilized by the students for their daily prayers,[7] religious studies[8] and other religious activities and ceremonies. Yet, it is important to note that there is no religious obligation to donate to synagogues.[9] The participants combine a religious way of life with high-level academic training and thus spend many hours in the academic institution.

Each participant was randomly assigned to only one of the four experiments. Experiment 1 is a five-round contribution game where contributions are dedicated to

[4] See Isaac et al. (1984, 1994), Andreoni (1988), and Fischbacher and Gächter (2010).

[5] Orthodox Judaism adheres to the interpretation and application of the laws in the Torah, as interpreted in the Talmud (the "Oral Law") and further developed and applied by later authorities. The differences between Orthodox and ultra-Orthodox Judaism relate primarily to religious attitude and evaluation of modernity and Zionism and are, therefore, irrelevant to this study.

[6] On private contributions to real public goods, see Zhang and Zhu (2011) and Carlsson, Johansson-Stenman and Nam (2014).

[7] The Jewish religion obligates males to three daily prayers (females have to pray at least once a day) and highly recommends public prayers within a synagogue with at least 10 participants.

[8] Some of the religious studies are in the form of courses. In most of them, students are not graded. Some are voluntary religious studies in which the students study in couples (*havruta*) according to the traditional Yeshiva method of learning.

[9] The Jewish charity is a religious obligation to help the poor and not an obligation to donate to religious institutions.

the procurement of sustainable supplies for the campus synagogue.[10] Experiment 2 is a single-round contribution game where contributions are dedicated to the procurement of sustainable supplies for the campus synagogue. Experiment 3 is a single-round contribution game where contributions are dedicated to the ongoing operation of the campus synagogue.[11] Experiment 4, similar to experiment 2, is a single-round contribution game where contributions are dedicated to the procurement of sustainable supplies for the campus synagogue with the difference that the participants were informed that 20% of contributions would be used to finance the ongoing operation of the synagogue.[12]

The strict separation of the campuses across genders enables examination of the effect of gender on the pattern of contributions.[13] In addition, we replicated experiments 1 and 4 with different group sizes to examine the effect of group size.

After concluding his participation in the experiment, each subject filled out a detailed anonymous socioeconomic questionnaire. The questionnaire enables a thorough examination of effect of other contributors on the pattern of contributions to public goods.

The results of the experiments support the model's main theoretical predictions and, therefore, its implications. We find evidence that the pattern of contributions of individuals contributing to a public good to which they attribute high intrinsic value is fairly predicted by the open-loop Nash equilibrium.[14] In particular, we find that total contributions to the procurement of sustainable supplies increase with the time limit for collecting contributions and with group size and decrease with ongoing operating costs. We also find that average per-round contributions increase over rounds. In

[10] Sustainable supplies include the procurement of praying books, religious books, religious artifacts and the like. These supplies increase the *capacity* of the synagogue—namely, the amount of people that can pray, study and attend religious ceremonies.

[11] Ongoing operations include food and beverages that are served during lessons and religious ceremonies, payment for invited lecturers, cleaning, maintenance, etc.

[12] The JCT finances the campus synagogues—that is, the contributions were made to enlarge the capacity of the synagogue and to increase its ongoing operating budget. It is important to note that students did not donate to the synagogues prior to our experiment.

[13] On gender differences in private contributions to public goods, see also Andersen, Bulte, Gneezy and List (2008).

[14] Arbel, Bar-El and Tobol (2014) applied the standard linear public good experiment protocol among religious students at the JCT and showed that the standard results are replicated.

addition, we find evidence that individuals prefer to contribute to sustainable supplies rather than to ongoing operations, despite the assurance of contributor anonymity—that is, in real life, where contributors to buildings, facilities and the like are publicly honored, the problems of financing the ongoing operations of public goods is probably aggravated.

Furthermore, we find evidence that females contribute more than males, that Ashkenazi Jews[15] contribute less than non-Ashkenazi Jews and that individuals who grew up in large families are more inclined to contribute. These findings indicate the effect of culture and gender on the pattern of contributions.

This paper proceeds as follows: Section 2 presents a survey of the literature. Section 3 describes the theoretical model and its policy implications. Section 4 presents the experimental design and results. Finally, section 5 presents the conclusions and summary.

2. Related Literature

The theoretical literature on the private provision of public goods started with the continuous type and showed in a static set-up that, if individuals comply with the standard assumptions regarding *homo economicus*—namely, rational selfishness—strategic behavior leads to free-ridership and, therefore, to under-provision.[16] Under-provision of pure continuous public goods occurs when the players move simultaneously and is aggravated when they move sequentially.[17] The ability to condition current contributions on total accumulated contributions also aggravates free-ridership in a dynamic setting (Fershtman and Nitzan 1991). Nevertheless, McMillan (1979) showed in a repeated game setting, where contributions and benefits are not accumulated over time, that the non-cooperative equilibrium can be efficient in an infinitely repeated game with trigger strategies if the future is sufficiently important to players. When the mechanism of punishing and rewarding players for

[15] Most of the Ashkenazi Jews' families are from Europe. The subjects who defined themselves as non-Ashkenazi are either Sephardi Jews, i.e., Jews whose families are from mainly Asia or northern Africa, or students who defined themselves as Ashkenazi and Sefaradi.

[16] See Olson (1965), Chamberlin (1974), McGuire (1974), Cornes and Sandler (1983), Bergstrom, Blume, and Varian (1986) and Bernheim (1986).

[17] See Varian (1994).

deviating from the mean contribution by an appropriate factor is implemented, efficient contribution becomes rational.[18]

The study of the voluntary provision of a "discrete" public good began with "binary" participation models, in which agents can contribute either a predetermined fixed sum or nothing (c.f. Palfrey and Rosenthal 1984). Gradstein and Nitzan (1990) extended the binary model and analyzed voluntary binary participation in a complete information setting, where the marginal product of participation is positive but decreases with the number of participants. They also show that, as in the continuous setting, Nash equilibria are inefficient, and the public good is underprovided in a pure strategies equilibrium, but can be overprovided in a mixed strategies equilibrium. Admati and Perry (1991) studied the pattern of contributions to a joint project where partners alternate in contributing to the project until the project is completed. They showed that socially desirable projects may not be completed, but when the costs of contributions are borne only when the project is completed, the outcome is efficient. Kessing (2007) showed in a dynamic setting that voluntary contributions to a discrete public good are strategic complements.

Marx and Mathew (2000) studied the dynamics of the private provision of public goods in the presence of imperfect information on the other players' contribution histories, complete information on aggregate contributions, and a time limit on the collection of contributions. They showed that if the contributing horizon is sufficiently long, players' preferences are similar, and they are sufficiently patient. If the period length is short, a perfect Bayesian equilibrium exists in which the project is completed and efficiency might be achieved.

Because the voluntary provision of continuous public goods results in social utility loss relative to the optimum, some authors have considered the implications of public policies. Warr (1983) showed that the private provision of a single public good is unaffected by income redistribution. However, this result is valid if and only if redistribution does not alter the contributing set.[19] Steinberg (1987) showed that the sign and the magnitude of the crowding out responses to a cut in federal expenditures on social services by private and social non-profit organizations are ambiguous. Itaya

[18] See Falkinger (1996) for theory and Falkinger, Fehr, Gächter and Winter-Ebmer (2000) for experimental evidence.

[19] For further discussion of this result, see, for example, Bergstrom, Blume, and Varian (1986) and Bernheim (1986).

and Schweinberger (2006) examined an economy consisting of two types of individuals, contributors and non-contributors, and provided necessary and sufficient conditions for an increase in total provision when the public good is financed by voluntary contributions and by distortionary income tax.

Many authors examined experimentally various factors affecting the total voluntary provision of continuous public goods and the degree of cooperation between individuals. Most experiments took place in a laboratory; others were natural or field experiments.[20] The degree of cooperation among contributors was found to be larger than predicted by the Nash equilibrium, although affected by several factors. Isaac, Walker and Williams (1994) showed that groups of 40 and 100 subjects provide public goods more efficiently than groups of 4 and 10 subjects. A similar result was obtained in a natural experiment of voluntary contributions to the Chinese Wikipedia. The authors showed that when Chinese speakers from Mainland China were prevented from contributing to the Chinese Wikipedia, contributions of other Chinese speakers fell by 42.8 percent (Zhang and Zhu 2011). However, Zelmer (2003) showed in a meta-analysis that group size is not statistically significant in determining the average contribution to a public good. History also affects the degree of cooperation: Shang and Croson (2009) found in a field experiment a complementarity between an individual's contribution and the contributions made by others. Bigoni and Suetens (2012) showed that information about the contributions made by others increases average contribution if the contributors' collective propensity to contribute is high. Carlsson, Johansson-Stenman and Nam (2014) combined a field experiment and a lab experiment to show that pro-social preferences are stable over time.

The effect of contributions' sequence on total contributions was studied by Gächter, Nosenzo, Renner and Sefton (2010), who showed in a laboratory experiment that sequential contributions lead to lower overall contributions relative to simultaneous contributions. Duffy, Ochs and Vesterlund (2007), showed that, in a dynamic setting, individuals contribute to charity more than in a static setting.

Although more cooperative than expected, the degree of cooperation among individuals declines and free-riding increases towards the end of the game (see Gonzalez, Guth and Levati 2005). Andreoni (1988) rules out the effect of strategic behavior or learning the nature of the contribution game on the end-game effect.

[20] See Chaudhui (2011) for an extensive survey.

Fischbacher and Gächter (2010) concluded that individuals are "imperfect conditional cooperators" and after a few rounds act to maximize income and, therefore, free-ride.

The characteristics of the participants also affect their contributions. Zelmer (2003) showed that children are more cooperative than adults, and Anderson and Mellor (2009) showed that religiosity does not affect free-ridership, although the decline in contributions over rounds is smaller. Crosson and Gneezi (2009) concluded in their survey that there is no significant difference in contributions to public goods across genders. Gächter and Herrmann (2011) conducted public goods experiments with and without punishment among 566 urban and rural subjects of young and mature age cohorts in Russia and found that sociological background matters for voluntary cooperation. In particular, they found higher levels of voluntary cooperation among rural residents than among urban residents. Andersen, Bulte, Gneezy and List (2008) also connected the size of contributions to public goods to societal structure and showed not only that matrilineal societies have fewer agents that avoid contributing but also that the level of public good provision tends to be higher.

The degree of cooperation among individuals is affected also by the type of activity. Stoop, Noussair and Soest (2012) conducted a field experiment that required recreational fishermen to reduce their fishing activity to increase group earnings. They showed that the fishermen did not cooperate and behaved according to theory. The lack of cooperation was explained by the type of the activity. Arbel, Bar-El and Tobol (2014) examined the context effect and showed that when the group of contributors attributes high intrinsic value to the public good, the end-game effect does not exist. Nevertheless, the end-game effect is valid when the group of contributors does not attribute high value to the public good. Moreover, they showed that the standard contribution pattern and size are replicated among religious students when applying the standard linear public good experiment protocol.

3. Model

Consider a group of $n \geq 2$ identical agents who jointly finance the establishment and operation of a public good by making voluntary contributions. The establishment of the public good is financed through continuous contributions accumulated over time of a finite length T that is taken as exogenous by the agents. The sum of total contributions determines the capacity of the public good. Starting from instant T,

individuals benefit from the public good. The benefit depends on infinitely repeated contributions to the ongoing operation of the public good.

In subsection 3.1, we derive the socially optimal contribution path to the ongoing operation of the public good and to its capacity buildup. In subsection 3.2, we derive the contribution path to the ongoing operation of the public good and to its capacity buildup in the open-loop Nash Equilibrium.

3.1. The Optimal Path

We first derive the socially optimal contributions to the ongoing operation of the public good and to its capacity buildup by maximizing the utility of the representative agent. We derive the socially optimal contribution path to the ongoing operation of the public good and to its capacity buildup by solving the maximization problem of a central planner in two stages: first, we derive the optimal contribution to the ongoing operation of the public good given a capacity level; then, we derive the socially optimal capacity level.

3.1.1. Socially optimal contributions to the ongoing operation:

The benevolent central planner maximizes the stream of instantaneous utilities of the representative agent discounted to $t=0$ defined over the total contributions to the ongoing operation of the public good at instant $t, G(t), (t \in (T, \infty))$, given the capacity of the public good accumulated until time T, $k(T)$:

$$V = \max_{G(t)} e^{-\rho T} \int_{t=T}^{\infty} e^{-\rho(t-T)} v(G(t)) dt \tag{1}$$

where ρ is the subjective discount rate.

We assume that the representative agent derives benefits from the use of the public good but bears the costs of its ongoing operation. The instantaneous benefit is positively related to the operating level of the public good and its capacity. Nevertheless, we assume that the amount contributed to ongoing operation is less effective as the capacity of the public good enlarges because larger facilities require

more periodic maintenance to prevent depreciation, more cleaning, electricity and the like.

For the sake of tractability and solvability, we assume the following instantaneous utility function:

$$v\left(G\left(t\right)\right)=ak\left(T\right)\frac{G\left(t\right)}{\sqrt{k\left(T\right)}}-\frac{c}{2}\left(\frac{G\left(t\right)}{n}\right)^{2},\quad \forall t\in\left(T,\infty\right) \tag{2}$$

where a and c are positive parameters. The term $\frac{G\left(t\right)}{\sqrt{k\left(T\right)}}$ represents our assumption that each \$1 of contribution to ongoing operations is less effective as the public good becomes larger. The term $ak\left(T\right)$ represents our assumption that individuals derive utility from larger public goods. The term $\frac{c}{2}\left(\frac{G\left(t\right)}{n}\right)^{2}$ is the representative agent's cost of contribution. Note that we assume that the utility derived from the public good at instant t is not carried to the next instant—that is, the public good needs to be operated to yield utility at instant *t*.

Differentiating equation (2) with respect to $G\left(t\right)$ yields the first order condition:

$$\frac{\partial v\left(G\left(t\right)\right)}{\partial G\left(t\right)}=a\sqrt{k\left(T\right)}-\frac{cG\left(t\right)}{n^{2}}=0\qquad \forall t\in\left(T,\infty\right). \tag{3}$$

Solving equation (3) yields the optimal total contributions to the ongoing operation of the public good at instant t:

$$G^{*}\left(t\right)=\frac{an^{2}\sqrt{k\left(T\right)}}{c}\qquad \forall t\in\left(T,\infty\right). \tag{4}$$

Note that the optimal contribution is time invariant.

Inserting equation (4) into equations (2) and (1) yields the following:

$$V = \frac{(an)^2}{2c\rho e^{\rho T}} k(T) \tag{5}$$

3.1.2. Optimal Contributions to the Capacity Buildup

We assume that the time limit on collecting contributions for the capacity buildup of the public good, T, is given exogenously. At instant t $(t \in [0,T])$, each individual contributes $x(t)$ to the capacity buildup of the public good. For analytical tractability, we assume that the cost of contributing is quadratic: $C(x(t)) = \frac{b}{2} x^2(t)$.[21] We also assume that total contributions, $k(t)$, are accumulated until time T according to the motion equation $\dot{k}(t) = nx(t)$. The benevolent central planner maximizes the utility of the representative individual subject to the motion equation, the initial condition, the inequality constraint and the transversality condition[22]:

$$\begin{aligned} u^* = \underset{x(t)}{Max} & \left\{ -\int_0^T \frac{b}{2} x^2(t) e^{-\rho t} dt + \frac{(an)^2}{2c\rho e^{\rho T}} k(T) \right\} \\ s.t. & \\ & \dot{k}(t) = nx(t) \\ & k(0) = 0 \\ & x(t) \geq 0 \\ & \lambda(T) = \frac{a^2 n^2}{2cre^{\rho T}} \end{aligned} \tag{6}$$

Solving (6) yields the following proposition:

Proposition 1:

a) The optimal contribution path is:

[21] Throughout our model, we assume quadratic utility functions following Starr and Ho (1969), Fershtman and Nitzan (1991), and Kessing (2007).

[22] On transversality conditions, see also Kamian and Schwartz p.160

$$x^*(t) = \frac{a^2 n^3}{2bc\rho} e^{\rho(t-T)} \qquad t \in [0,T]. \tag{7}$$

b) The optimal capacity level, $k^*(T)$, is:

$$k^*(T) = \frac{a^2 n^4 \left(1 - e^{-\rho T}\right)}{2bc\rho^2} \tag{8}$$

c) The utility of the representative individual at the optimum is:

$$u^* = \frac{a^4 n^6 \left(e^{\rho T} - 1\right)}{8bc^2 \rho^3 e^{2\rho T}} \tag{9}$$

Proof: See Appendix A.

The optimal contribution path to the capacity buildup and, therefore, the optimal capacity level increase with the number of individuals in the economy, n, and the value of the public good to the individuals, a. They decrease with the cost of contributing to the capacity buildup, b, with the cost of contributing to the ongoing operation, c, and with the subjective discount factor, ρ. In addition, the optimal contribution increases over time and the optimal capacity level increases with the time limit *T*.[23]

3.2. The Open-loop Nash Equilibrium

The Nash equilibrium is also calculated in two stages. We first derive the Nash equilibrium contributions to the ongoing operation of the public good given the capacity level. Then, we derive the Nash equilibrium contributions to the capacity buildup of the public good.

[23] We did not include any threshold capacity in the maximization problem. The inclusion of such a threshold would have yielded also a degenerate solution of zero contributions. We refer to this point also in footnote 27 in the next section (the experiment).

3.2.1. Voluntary Contributions to the Ongoing Operation:

Suppose that a capacity of $k(T)$ was accumulated until time *T*. At each instant, t $(t \in (\mathrm{T},\infty))$, individual *i* chooses his contribution to the ongoing operation of the public good, taking other individuals' contributions as given to maximize

$$\hat{V} = \max_{g_i(t)} e^{-\rho T} \int_{t=T}^{\infty} e^{-\rho(t-T)} v_i^t\left(g_i(t)\right) dt \tag{10}$$

where

$$\mathrm{v}_i^t\left(g_i(t)\right) = a\sqrt{k(T)}\left(g_i(t) + \sum_{j\neq i} g_j(t)\right) - \frac{c g_i^2(t)}{2} \qquad \forall t \in (T,\infty), \tag{11}$$

$\left(g_i(t) + \sum_{j\neq i} g_j(t)\right)$ is the total contributions to the ongoing operation at instant *t* and $\frac{c g_i^2(t)}{2}$ is individual *i*'s cost of contributing $g_i(t)$ at instant *t*.

Differentiating (11) with respect to $g_i(t)$ yields the first order condition as follows:

$$\frac{\partial v_i^t\left(g_i(t)\right)}{\partial g_i(t)} = a\sqrt{k(T)} - c g_i(t) = 0 \qquad \forall t \in [T,\infty). \tag{12}$$

As all individuals are assumed to be identical and the individual's problem is time invariant, we obtain from equation (12) that at the Nash equilibrium, an individual's contribution, $\hat{g}(t)$, and the total contributions to the public good $\hat{G}(t)$ are as follows:

$$\hat{g}(t) = \frac{a\sqrt{k(T)}}{c},\ \hat{G}(t) = \frac{an\sqrt{k(T)}}{c} \qquad \forall t \in (T,\infty). \tag{13}$$

Comparing (13) to (4) reveals that

$$G^*(t) = n\hat{G}(t) \qquad \forall t \in (T,\infty). \tag{14}$$

Equation (14) establishes that the Nash equilibrium is characterized by free-ridership. Thus, total contributions to ongoing operations at instant t is suboptimal.

The representative individual's stream of utilities discounted to $t=0$ as a function of the capacity level at the Nash equilibrium is

$$\hat{V}\left(\hat{k}(T)\right)=\frac{a^2(2n-1)}{2\rho c e^{\rho T}}\hat{k}(T). \tag{15}$$

3.2.2. Voluntary Contributions to the Capacity Buildup:

We model the interaction along time among agents voluntarily contributing to the capacity buildup of the public good as a non-cooperative differential game. At each instant t $\left(t\in[0,T]\right)$, individual i $\left(i=1,..,N\right)$ chooses his contribution to the capacity buildup of the public good, $\phi_i(t)$, taking other individuals' contributions as given. For the sake of tractability and simplicity, we assume that the agents can commit themselves at the outset of the game to particular contribution paths and that these commitments are enforceable. That is, we derive the open-loop equilibrium. Individual i 's maximization problem is as follows:

$$\begin{aligned}
&\hat{u}^i=\underset{\phi_i(t)}{Max}\left\{-\int_0^T e^{-\rho t}\frac{b\phi_i^2(t)}{2}dt+\frac{a^2(2n-1)}{2\rho c e^{\rho T}}k(T)\right\}\\
&s.t.\\
&\quad \dot{k}(t)=\phi_i(t)+\sum_{j\neq i}\phi_j(t)\\
&\quad k(0)=0\\
&\quad \phi_i(t)\geq 0\\
&\quad \phi_{j\neq i}\ (t)\ \textit{is given}\ \forall j
\end{aligned} \tag{16}$$

Solving (16) yields the following proposition:

Proposition 2:

a) The symmetric open-loop equilibrium contribution path is as follows:

$$\hat{\phi}(t) = \frac{a^2(2n-1)}{2\rho bc} e^{\rho(t-T)} \qquad t \in [0,T]. \tag{17}$$

b) The equilibrium capacity level is

$$\hat{k}(T) = \frac{a^2 n(2n-1)\left(1-e^{-\rho T}\right)}{2\rho^2 bc} \tag{18}$$

c) The utility of the representative individual at the Nash equilibrium is as follows:

$$\hat{u} = \frac{a^4(2n-1)^3\left(e^{\rho T}-1\right)}{8e^{2\rho T} bc^2 \rho^3} \tag{19}$$

Proof: See Appendix A.

The open-loop equilibrium contribution path to the capacity buildup and, consequently, the optimal capacity level increase with the number of individuals in the economy, n, and the value of the public good to the individuals, a. These values decrease with the cost of contributing to the capacity buildup, b, the cost of contributing to ongoing operations, c, and the subjective discount factor, ρ. In addition, the Nash equilibrium contributions increase over time, and the optimal capacity level increases with the time limit *T*.

By dividing equation (8) by equation (18), we determine that the utility of the representative individual at the optimum is greater than his utility at the Nash equilibrium, as follows:

$$\frac{u^*}{\hat{u}} = \frac{n^6}{(2n-1)^3} > 1 \;\; \forall \, n \geq 2 \tag{20}$$

Equation (20) shows that the ratio $u^* / \hat{u}$ is positively related to number of agents, *n*, and independent of other parameters. That is, the free-ridership problem is aggravated as the number of individuals in the economy increases.

An alternative equilibrium concept is the closed-loop equilibrium. The feedback equilibrium is usually considered to describe reality more accurately than the open-loop equilibrium, as it assumes that agents do not commit to contribution paths at the outset of the game but rather condition their contributions on time and the cumulative contribution to the capacity buildup of the public good. Yet, Fershtman and Nitzan (1991), Kessing (2007) and others showed that the characteristics of the open-loop equilibrium are similar to those of the closed-loop equilibrium, although the free-ridership problem is aggravated under feedback strategies. For the differential game described in this model, the following lemma holds:

Lemma 1: *The open-loop equilibrium is identical to the feedback equilibrium.*

Proof: The game described in our model can include all of the possible initial conditions (t_0, k_0). Moreover, the n-tuple time paths of the controls $(\phi_1(t),..,\phi_n(t))$ constitutes an open-loop Nash equilibrium for all possible initial conditions because by equation (17), the contribution of agent i at time t, $\hat{\phi}_i(t)$, is not conditioned on the cumulative contribution until time t and on the initial condition (due to the linearity of the salvage value in $k(T)$). Therefore, by proposition 2.1 in Fershtman (1987), it also constitutes feedback equilibrium. QED.

In the next section, we consider a public policy aimed at maximizing social utility at the Nash equilibrium.

3.3. Public Policy

Suppose that the policymaker seeks to maximize social utility at the Nash equilibrium. A conventional policy tool usually considered to achieve this goal is subsidization of the contributions to the public good. Nevertheless, the real-life financing of these subsidies usually involves an excessive burden. The dynamic

setting of the game enables us to introduce a novel policy tool, a limit on the time allowed for collecting contributions to the capacity buildup of the public good. This policy tool has the advantage of not producing an excessive burden.

Maximizing equation (19) over T and inserting the solution into equations (18) and (19) yields the following proposition:

Proposition 3:

a) The time limit that maximizes the social utility at the Nash equilibrium is

$$\hat{T} = \frac{\ln(2)}{\rho}. \tag{21}$$

b) The capacity level is

$$\hat{k}\left(\hat{T}\right) = \frac{a^2 n(2n-1)}{4bc\rho^2}. \tag{22}$$

c) The utility of the representative individual is thus

$$\hat{u}\left(\hat{T}\right) = \frac{a^4 (n-0.5)^3}{4\rho^3 bc^2}. \tag{23}$$

Equation (21) shows that the time limit $\hat{T}$ is negatively related to the subjective discount factor ρ. Equation (21) also shows that in the presence of a sufficiently large time limit individuals might over-contribute to the capacity buildup of the public good at the Nash equilibrium (namely, accumulate a capacity larger than $\hat{k}\left(\hat{T}\right)$) and under-contribute to its ongoing operation (relative to the optimum). This pattern will results in a loss of social utility.

4. Experiments

The tractable setting of the model enables us to draw hypotheses that can be tested by means of simple experimentation. We conduct four contribution game experiments with the objective of testing the hypotheses stemming from proposition 2, which describes the individual's behavior at the Nash equilibrium. In particular, the experiments were designed to test the following hypotheses:

a) Contributions to the capacity buildup of the public good increase over time.
b) Total contributions to the capacity buildup of the public good increase with the number of contributors.
c) Total contributions to the capacity buildup of the public good increase with the time limit for collecting contributions.
d) Total contributions to the capacity buildup of the public good decrease with ongoing operating costs.

In addition, we compare the contribution behavior directed at the capacity buildup of the public good with the contribution behavior directed at the ongoing operation of the public good. Furthermore, by using data collected by means of questionnaires, we examine the gender, culture and wealth effects on the pattern of contributions.

4.1. Experimental Design and Procedures

We test the model's hypotheses by conducting four experiments.[24] All experiments were conducted simultaneously on May 27, 2013 at the two JCT campuses in Jerusalem.[25] We sampled 222 first-year students, females and males, pursuing BAs in

[24] The instructions for the experiments appear in appendix B in consecutive order.

[25] Lev institute is the male students' campus, and Tal institute is the female students' campus. The two campuses are located several kilometers apart in Jerusalem.

accounting and management.[26] All the participants were either Orthodox or ultra-Orthodox Jews.[27]

The Jerusalem College of Technology (JCT) is defined as a religious Jewish college and thus maintains strict separation of the genders with geographically separate campuses for males and females. In addition to providing for high-level academic studies, the JCT obligates students to incorporate high-level religious studies into their curricula. Thus, the subjects spend many hours in the academic institution.

Unlike common practice in the relevant experimental literature, in each of our experiments, subjects were asked to contribute to *real* public goods that they use on a daily basis - their campus synagogues.[28] Being religious students in a religious institution, they pray and study religion in the synagogue on a daily basis[29] and are considered to be members of the synagogue's community.

Experiment 1:

Experiment 1 is a five-round contribution game where contributions are dedicated to the procurement of sustainable supplies for the campus synagogue, divided into three sessions. In every round, each subject was given 100 ECU (Experiment Currency Units worth approximately $2.84) to be privately divided between the contribution X ($0 \leq X \leq 100$) and himself (100-X). To ensure complete information, the subjects were informed about the total number of participants at the beginning of a session, and after each round the subjects were informed about the total contributions collected.[30]

We replicated the experiment by conducting three sessions. Session 1 involved 24 females, session 2 involved 24 males and session 3 involved 15 females. A total of 63 students participated in experiment 1.

[26] The academic year started on October 2012.

[27] See footnote 2. The subjects were asked to classify themselves as either secular, Orthodox or ultra-Orthodox.

[28] We conduct contribution game experiments to an institution that already exists to avoid cases of zero contributions that result from the threshold effect—that is, the lack of financial resources needed to finance the public good.

[29] The students in our sample spend 3-4 days at the JCT, and all utilize the synagogue daily for religious studies as part of their schedule, in addition to daily prayers.

[30] There was no communication between the participants.

Experiment 1 is designed to test hypotheses (a) and (b). Hypothesis (a) states that "Contributions to the capacity buildup of the public good increase over time." If hypothesis (a) holds, we anticipate a significant increase of the average contribution over rounds. Hypothesis (b) states that "Total contributions to the capacity buildup of the public good increase with the number of contributors." If hypothesis (b) holds, we anticipate that the average total contributions of the 24 females will exceed that of the 15 females. The partition between males and females enabled us to control for gender effects.

Experiment 2:

Experiment 2 is a single-round contribution game where contributions are dedicated to the procurement of sustainable supplies for the campus synagogue. The experiment was divided into two sessions and was conducted under terms of complete information. Each participant was handed 500 ECU at the beginning of the experiment to be privately divided between the contribution X ($0 \leq X \leq 500$) and herself/himself (500-*X*). We replicated this experiment by conducting two sessions. The first session involved 24 female students, and the second involved 24 male students—a total of 48 subjects, which enabled us to control for gender effects. Comparison with experiment 1 enabled us to control for round effects.

A comparison between experiments 1 and 2 enables us to test hypothesis (c), which states that "total contributions to the capacity buildup of the public good increase with the time limit for collecting contributions." If hypothesis (c) holds, we anticipate that the average total contribution in experiment 1 will exceed the average total contribution in experiment 2.

Experiment 3:

Experiment 3 is a single-round contribution game where the contributions are dedicated to the ongoing operation of the campus synagogue. Similar to the experiment 2, each subject received 500 ECU at the beginning of the experiment. The experiment was replicated by conducting two sessions. The first session included 24 female students, and the second included 24 male students. Overall, 48 students participated in experiment 3. That is, we controlled for gender effects, and in comparison to experiment 2, we controlled for the objective of the contribution effect.

Experiment 4:

Experiment 4 is also a single-round contribution game where the contributions were dedicated to the procurement of sustainable supplies for the campus synagogue. Similar to the experiment 2, each participant received 500 ECU to be privately divided between the contribution X $(0 \leq X \leq 500)$ and herself/himself (500-X). Deviating from experiment 2, however, the subjects were informed that only 80% of their contributions would be assigned to finance the procurement of sustainable supplies for the campus synagogue. The remaining 20%, the subjects were informed, would be assigned to finance the ongoing operation of the synagogue.

The experiment was divided into three sessions: the first involved 24 females, the second involved 24 males and the third involved 15 males. Overall, 63 students participated in experiment 4—i.e., we controlled for gender and group-size effects.

A comparison between experiments 2 and 4 enables us to test hypothesis (d), which states that "total contributions to the capacity buildup of the public good decrease with the ongoing operating costs". Compared to experiment 2, we thus anticipate a decrease in the average total contribution.

Recruitment of subjects to the experiment was held on a voluntary basis. Two days prior to the actual experiment, notices were posted on the various campuses. The notices stated only that participation is on a voluntary basis and that subjects will be paid for participation.

The experiments took place simultaneously at the campus computer labs using Google docs. The subjects were randomly assigned to only one of the experiments. After being seated at a computer terminal, each subject received an experiment identification number to ensure complete anonymity and written instructions for the specific experiment the student was attending (all of the subjects in a specific session participated in the same experiment). Understanding of the instructions was ensured by a control questionnaire subjects had to answer before the experiment started.[31] Completion of an experiment session took between 30 and 45 minutes (including completing the questionnaire).

[31] See appendix B.

At the end of each session, the experimenter handed each subject a short socioeconomic questionnaire.[32] Completing the questionnaire concluded the experiment. After concluding the experiment, each subject was handed a voucher to be exchanged for his actual payment, and the subject left the experiment area to prevent any contact with other subjects.[33] At the end of the experiment day, a representative of the student association at each of the campuses, who was at the experiment lab, divided the donations into contributions to the procurement of sustainable supplies and contributions to ongoing operations and transferred the contributions to the relevant campus synagogue.[34]

4.2. Results:

4.2.1. Experiment 1: The End-Game Effect

Table 1A displays summary statistics of the average contributions in experiment 1 stratified by rounds.

The summary statistics show that the average total contribution to the procurement of sustainable supplies for the campus synagogue equals 279.21 ECU (58% of the overall allocated sum of 500 ECU).[35] The average contribution significantly increases (at the 1% significance level) over rounds—that is, the end-game effect is reversed. In the first round, the average contribution to the public good equals 34.92 ECU (34.92 % out of the allocated sum per-round of 100 ECU). By comparing each two consecutive rounds (ΔECU), we see a significant increase at the 1% significance level. These results, which are displayed in figure 1, support hypothesis (a). Starting from the third round, the contribution is greater than 50% of the allocated sum of 100 ECU (54.27% in the third round, 63.70% in the fourth round and 81.79% in the fifth

[32] See appendix C.

[33] We ensured that the subjects had no previous acquaintance with the experimenters by recruiting the experimenters from outside the JCT.

[34] For example, a subject who contributed 50 ECU was left with 450 ECU at the end of the experiment that will be converted to 45 NIS.

[35] Arbel, Bar-El and Tobol (2014) showed that when applying the standard linear public good experiment protocol among the religious students of the JCT the average total contribution is significantly lower and equals to 189.18 ECU (38% of the overall allocated sum of 500 ECU).

round). The increase in the contributions is particularly high in the last round (18.01 ECU, which is significantly different from zero at the 1% significance level).

At the bottom of table 1A, we stratify the contributions by sessions of experiment 1. The average contribution in the first session of the 24 female subjects is 337.13 ECU. The equivalent average contribution drops to 219.42 ECU in the second session (of 24 male subjects) and in the third session (of 15 female subjects) decreases to 282.20 ECU. Interestingly, when gender is controlled and group size increases (from 15 female subjects in the third session to 24 female subjects in the first session), the average overall contribution significantly rises by 54.93 ECU (at the 5% significance level). This result supports hypothesis (b), which states that "total contributions to the capacity buildup of the public good increase with the number of contributors." A comparison between session 1 (24 females) and session 2 (24 males) shows a significant increase (at the 1% significance level) of 117.71 ECU in the average contribution. This result suggests that females contribute more than males. Moreover, stratification by sessions and separate analysis by rounds preserve the outcomes supporting hypotheses (a) and (b). In all three sessions, the contributions to the public good significantly increase with rounds, and the average contribution significantly increases with group size.

< Insert Table 1A here >

<Insert Figure 1 here>

Table 1B displays the summary statistics of the socioeconomic characteristics of the subjects of experiment 1. 62% of the participants (39 individuals) are females, and 38% (24 individuals) are males (FEMALES). Among the three sessions of experiment 1, the smallest session includes 15 female subjects (SMALL_SESSION). The subjects' ages range from18 to 37 with an average age of 21.57—that is, the subjects are young, which is consistent with a student population (AGE).

<Insert Table 1B here>

41% of the subjects (26 individuals) hold a job (EMPLOYEE). The monthly labor income of employees or self-employed individuals ranges from 2,500 to 8,200 NIS with an average of 4,811.54 NIS and a standard deviation of 1,388.71 (LI). The 95%

(99%) confidence interval of the average monthly labor income is 4,250 - 5,373 NIS (4,053 - 5,571 NIS); thus, we cannot reject the null hypothesis that the average wage equals the minimum wage of 4,300 NIS.[36]

Out of the 63 subjects, 83% (52 individuals) receive economic support from other sources (OTHER). The average non-labor monthly income of the subjects ranges from 500 to 3200 NIS and equals 1,475 NIS with standard deviation of 804.86 NIS (NLI).

The total monthly income from all sources (LI+NLI) varies from 800 to 8,200 NIS with an average of 3,203 NIS and a standard deviation of 257 NIS (INC). The 90% (95%) confidence interval of the average monthly income from all sources is 2,774 - 3,633 NIS (2,589 - 3,818 NIS). When we consider the total sample of 63 subjects, we reject the one-sided null hypothesis that the monthly income from all sources is greater than or equal to the monthly minimum wage of 4,300 NIS (the calculated *t*-value with 62 degrees of freedom of is 4.26).[37]

Other socioeconomic control variables include family size, homeownership status (renter or owner), origin, and degree of religiosity. The average number of core family members is 6.25 persons, indicating that the subjects come from large families (PEOPLE). Only 17% of the subjects (11 individuals) own an apartment (HOMEOWNER). 25 subjects (40%) defined themselves as Ashkenazi Jews (ASHKENAZI), and 16 subjects (25%) defined themselves as Orthodox Jews (that is, 75% of the subjects (47 individuals) define themselves as ultra-Orthodox Jews).

4.2.2. Summary Statistics of Experiments 2-4

Figure 2 and table 2A display the kernel densities and summary statistics of contributions in experiments 2, 3 and 4.

<<Insert figure 2 here>>

<<Insert Table 2A here>>

[36] Source: The Israeli Social Security website at: http://www.btl.gov.il/MEDINIYUT/GENERALDATA/Pages/default.aspx (Hebrew). The minimum wage level of 4,300 NIS is valid starting from October 1, 2012

[37] Ibid.

Tables 1A and 2A show that the highest overall average contribution in experiment 1 (the five-round contribution game where contributions are dedicated to the procurement of sustainable supplies to the campus synagogue) is the highest (279.21 ECU), and the lowest overall average contribution is in experiment 3 (the single-round contribution game where contributions are dedicated to the ongoing operation of the campus synagogue). A normality test supports the conclusion that the contributions in experiments 1, 2 and 3 are normally distributed (respective calculated Chi-squared values with 2 degrees of freedom of 5.35, 3.93 and 1.16 compared to the 10% critical value of 4.61 and 5% critical value of 5.99).

The average contribution in the experiment 2 (the single-round contribution game where contributions are dedicated to the procurement of sustainable supplies for the campus synagogue) is 199.02 *ECU*, or 39.84% of the available 500 ECU. By comparison, the average overall contribution in experiment 1 (the five-round first experiment contribution game where contributions are dedicated to the procurement of sustainable supplies for the campus synagogue) is 279.21 ECU. The 80.19 ECU difference between experiments 1 and 2 is statistically significant at the 1% level (calculated t-value with 76.78 degrees of freedom of 3.75). Moreover, a Kolmogorov-Smirnov (K-S) test clearly rejects the null hypothesis that the distributions of overall contributions to the public good in experiments 1 and 2 are not different at the 1% significance level (D, the maximum cumulative probability difference between the two distributions, equals 0.47).

A comparison between experiments 1 and 2 provides support to hypothesis (c). In both experiments, the objective of the contributions is to procure sustainable supplies for the campus synagogue, and the total maximum sum assigned for contributions is 500 ECU. The only difference between the experiments is the number of rounds.

Table 2A also reports the comparison between experiment 2 (the single round contribution game where contributions are dedicated to the procurement of sustainable supplies to the campus synagogue) and experiment 3 (the single round contribution game where contributions are dedicated to the ongoing operation of the campus synagogue). It provides statistical support to the conclusion presented in figure 2 according to which the lowest contribution is achieved in experiment 3. The prominent difference between experiments 2 and 3 lies in the objective of the

contribution. The average contribution in experiment 3 is significantly lower (at the 1% significance level) by 149.02 ECU compared to experiment 2.[38] Moreover, a Kolmogorov-Smirnov test clearly rejects the null hypothesis that the distributions of contributions to the public good in experiments 2 and 3 are not different at the 1% significance level (*D*, the maximum cumulative probability difference between the two distributions, equals 0.71). The difference in the average contributions between experiments 2 and 3 might indicate that people prefer to contribute to sustainable supplies rather to their ongoing operations. This result was observed in the absence of honors to the contributors to the sustainable public good, which suggests that in the presence of real-life honors, raising funds for the ongoing operations of public goods might be even more difficult.

At the bottom of table 2A, we compare the contributions in experiments 2 and 4. The prominent difference between these two experiments is the objective of the contributions. The contributions to the public good in experiment 4 are allocated between two objectives: 80% of the contributions were to be assigned to the procurement of sustainable supplies, and 20% of the contributions were to be assigned to ongoing operations. The table shows a significant decrease in the average contribution (at the 10% significance level) by 40.77 ECU and in the median contribution (at the 1% significance level) by 30 ECU (calculated Chi-Square Pearson Statistic with one degree of freedom of 3.99) between experiments 2 and 4. Even after controlling for group size, we cannot reject the null hypothesis that the average and median contributions are equal. Note that the actual decrease in the contribution to the procurement of sustainable supplies between experiments 2 and 4 is 71.86—that is, a decrease of 36%. These outcomes provide support for hypothesis (d).

Table 2B reports the summary statistics of the socioeconomic characteristics. 50% of the subjects in experiments 2 and 3 (24 individuals in each experiment) and 38% of the subjects in experiment 4 (24 individuals) are females (FEMALE).

The age groups among all of the subjects in these experiments vary between 18 and 37 years. The average age of the subjects in experiments 2, 3 and 4 is 25.13, 20.58 and 21.63 years, respectively. The sample is thus mostly comprised of relatively young students.

[38] The same result is obtained when we compare experiments 1 and 3 (a significant decrease, at the 1% significance level, of 229.21 ECU) and experiments 3 and 4 (a significant decrease, at the 1% significance level, of 108.95 ECU at the 1% significance level).

<<Insert Table 2B here>>

Out of the 48 subjects in experiment 2, 77.08% (37 individuals) hold a job (*EMPLOYEE*).[39] The equivalent figures for subjects in experiments 3 and 4 are 25% (12 students) and 27% (17 students), respectively. Of the 48 subjects in experiment 2, 58.33% (28 individuals) receive financial support from sources other than labor (*OTHER*). The equivalent figures for the subjects in experiments 3 and 4 are 85.42% (41 students) and 84.13% (53 students), respectively.

The respective average labor income (*LI*) of the subjects in experiments 2, 3 and 4 who hold jobs is 6,708 NIS, 5,433 NIS and 4,576 NIS (compared to a minimum wage of 4,300 NIS and a net average income of approximately 7900 NIS), respectively. The average non-labor income of the subjects in experiments 2, 3 and 4 is 1,321.43 NIS, 1,451.22 NIS and 1,213.21 NIS, respectively (*NLI*).

The total monthly income from all sources (LI+NLI) in all three experiments varies from 1,000 to 15,000 NIS. The average income is 5,942 NIS (experiment 2), 2,598 NIS (experiment 3), and 2,256 NIS (experiment 4).

Once again, we see that the subjects come from large families. The average number of core family members in experiments 2 – 4 is 5.0-6.0. Only a minority of the students own apartments (10% - 31%). 41.67% of the subjects in experiment 2 (20 individuals) define themselves as Ashkenazi Jews, while the equivalent figures for experiments 3 and 4 are 62.50% (30 individuals) and 46.03% (29 individuals), respectively. Finally, 28 of the subjects in experiment 2 (58%) define themselves as Orthodox Jews (that is, 42% of the subjects or 20 individuals defined themselves as ultra-Orthodox Jews). The equivalent numbers for the subjects in experiments 3 and 4 are 12 (25%) and 13 (21%), respectively—that is, the majority of subjects in experiments 3 and 4 are ultra-Orthodox.

4.2.3. The Effect of Control Variables and Difference-in- Difference Analysis:

[39] Note that all working individuals study in a special program with three full days of study. During these three days, all of the working students use the synagogue for prays and religious studies. Thus, the high participation rates in the workforce do not necessarily reduce the extent of use of the public good.

To complete the picture, it is important to demonstrate that the results of the summary statistics are still preserved across experiments after considering individuals with quality-adjusted socioeconomic characteristics. We thus run a difference-in-difference (*DD*) analysis. The first step of the *DD* analysis is to run an OLS regression on each experiment separately. The results are reported in table 3.

<<Insert Table 3 here>>

The regression analysis shows that the average contribution of females is significantly higher (at the 5% and 1% significance levels) by 23.75-95.13 ECU than that of males. Increasing the group size from 15 females in the third session to 24 females in the first session of experiment 1 significantly increases the average contribution by 54.19 ECU (at the 5% significance level). This result provides further support hypothesis (b).

The analysis of experiment 3 shows that contributions to the ongoing operations of the campus synagogue significantly increase by 3.40 ECU per year of age at the 5% significance level. Moreover, it shows that a shift from not-working to employee status significantly increases the average contribution by 37.97 ECU at the 5% significance level. A 100 NIS increase in overall monthly income in experiments 3 and 4 is expected to yield a significant decrease of 1-3 ECU in the average contribution (significant at the 5% significance level). An increase of one person per household is expected to significantly increase the average contribution by 12.82-19.10 ECU (at the 5% and 1% significance levels) in experiments 1, 2 and 4. Finally, analysis of experiments 1, 2 and 3 shows that Ashkenazi Jews contribute less than non-Ashkenazi Jews by 20.17-65.06 ECU (at the 10%- and 5% significance levels).

As noted earlier, to adjust the differences in average contributions to identical characteristics of subjects, we applied the DD analysis.[40] The second step of the procedure is to generate the projected values from these four regressions and compare them. The results of the differences in the average projected contributions after adjusting them to the socioeconomic characteristics of all the 222 subjects in the four experiments are reported in table 4.

[40] We would like to thank David Hoaglin for bringing the correct terminology to our attention.

<<Insert Table 4 here>>

As seen from table 4, all non-quality-adjusted results obtained in the previous sections are preserved and strengthened, even after adjusting them to identical characteristics of subjects.

The significant (at the 1% significance level) decrease of 56.98 ECU in the average projected contribution between experiments 1 and 2 might imply that the number of rounds positively affects the average contribution and, therefore, provides support for hypothesis (c).

The significant decrease (at the 1% significance level) of 52.05 ECU in the average projected contribution between experiments 2 and 4 indicates that the requirement to finance the ongoing operations of the public good might be the reason for the reduction in the average contribution to the procurement of sustainable supplies to the campus synagogue. This result, therefore, further supports hypothesis (d).

The average projected contribution in experiment 3 (62.00 ECU) is significantly smaller (at the 1% significance level) than in the fourth experiment (156.37 ECU). This finding may further indicate that individuals prefer to contribute to sustainable supplies rather than to ongoing operations.

Overall, we find the results of the experiments support all of our four hypotheses, and the results of the summary statistics are still preserved across experiments, even after considering individuals with quality-adjusted socioeconomic characteristics.

5. Summary and Conclusions

We study the contribution patterns of individuals to a public good that requires both initial investments to build up its capacity and investment to finance its ongoing operations by constructing a theoretic dynamic model and testing it experimentally.

The theoretical model predicts that voluntary contributions to the capacity buildup increase over time and that total contribution to the capacity buildup increase with the number of contributors, with the time limit to collect contributions to the capacity buildup and decrease with the ongoing operating costs.

We test the theoretical model by conducting four contribution game experiments among JCT's students who were asked to contribute to their campus synagogues for the procurement of sustainable supplies and ongoing operations. That is, the contributions were raised for a *real* public good that the subjects use on a daily basis and to which they attribute high intrinsic value.

The results of the experiments confirm the model's hypotheses and demonstrate that when a real and meaningful public good is involved the subjects' contribution pattern is fairly predicted by the Nash equilibrium. We also find evidence that gender and culture play an important role in shaping the pattern of contributions.

The experiment's findings also suggest that individuals are more inclined to contribute to sustainable assets than to ongoing operations, implying that, in the real world, in which many times contributors to sustainable supplies receive greater honors than contributors to ongoing operations, raising funds for ongoing operations is expected to be even more difficult, a problem well known to managers of privately financed public institutions, such as universities and hospitals.

Overall, the findings reinforce the policy implication that the contribution time for the capacity buildup of public goods should be limited. This policy is expected to reduce the prevalence of luxurious public facilities that are poorly maintained.

We think that it would be of interest to find more populations that share common preferences for other types of public goods, ones that are not related to religion, to further establish that the nature of the public good and its value to the group of contributors indeed affect contribution patterns.

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Table 1A: Summary Statistics of Experiment 1: Contributions by Rounds

Objective of Contributions : Five Rounds Experiment	**sustainable supplies to the campus synagogue**					
Variable: Description	**Overall**	**Round 1**	**Round 2**	**Round 3**	**Round 4**	**Round 5**
ECU: Experiment Currency Units (0-500 in all five rounds) (0-100 in each round)	279.21 (257.90, 300.52) [250.88, 307.54]	34.92 (29.52, 40.32) [27.74, 42.10]	44.52^{+++} (39.60, 49.45) [37.98, 51.07]	54.27^{+++} (49.53, 59.01) [47.96, 60.57]	63.70^{+++} (59.21, 68.19) [57.73, 69.67]	81.79^{+++} (77.59, 86.00) [76.20, 87.38]
ΔECU : First Difference between contributions of two consecutive rounds	–	–	9.60*** (7.27, 11.97) [6.50, 12.71]	9.75*** (7.86, 11.63) [7.24, 12.26]	9.43*** (7.55, 11.31) [6.93, 11.93]	18.01*** (15.13, 21.06) [14.16, 22.03]
Observations (Total)	63	63	63	63	63	63
Stratification by Sessions: Description	**Overall**	**Round 1**	**Round 2**	**Round 3**	**Round 4**	**Round 5**
ECU (Session 1 - females) : Experiment Currency Units (0-500 in all five rounds) (0-100 in each round)	337.13 (303.79, 370.46) [291.88, 382.37]	47.71 (36.63, 58.79) [32.67, 62.75]	56.79 (47.55, 66.03) [44.24, 69.34]	66.54 (58.62, 74.47) [55.79, 77.30]	74.92 (68.41, 81.42) [66.09, 83.74],	91.17 (87.36, 94.98) [85.99, 96.34]
ΔECU : First Difference between contributions of two consecutive rounds	–	–	9.08*** (4.33, 13.83) [2.64, 15.53]	9.75*** (5.19, 14.31) [3.56, 15.94]	8.38*** (5.37, 11.38) [4.30, 12.45]	16.25*** (10.28, 22.22) [8.15, 24.35]
Observations (Session 1)	24	24	24	24	24	24
ECU (Session 2 - males) : Experiment Currency Units (0-500 in all five rounds) (0-100 in each round)	219.42 (192.85, 245.99) [183.36, 255.47]	22.96 (17.70, 28.22) [15.82, 30.09]	32.29 (27.51, 37.08) [25.80, 38.79]	41.71 (35.76, 47.66) [33.64, 49.78]	50.88 (44.52, 57.23) [42.25, 59.50]	71.58 (63.68, 79.49) [60.85, 82.31]
ΔECU : First Difference between contributions of two consecutive rounds	–	–	9.33*** (5.96, 12.70) [4.76, 13.91]	9.42*** (7.29, 11.54) [6.53, 12.30]	9.17*** (5.48, 12.85) [4.17, 14.16]	20.71*** (16.10, 25.32) [14.45, 26.97]
Observations (Session 2)	24	24	24	24	24	24
ECU (Session 3 - females) : Experiment Currency Units (0-500 in all five rounds) (0-100 in each round)	282.20 (251.49, 312.91) [239.58, 324.82]	33.60 (27.42, 39.78) [25.02, 42.18]	44.47 (37.02, 51.91) [34.13, 54.80]	54.73 (48.25, 61.22) [45.73, 63.74]	66.27 (59.67, 72.87) [57.11, 75.43]	83.13 (75.44, 90.83) [72.46, 93.81]
ΔECU : First Difference between contributions of two consecutive rounds	–	–	10.87*** (6.38, 15.35) [4.64, 17.09]	10.26*** (8.14, 12.40) [7.31, 13.22]	11.54*** (8.38, 14.69) [7.16, 15.91]	16.86*** (12.28, 21.46) [10.50, 23.24]
Observations (Session 3)	15	15	15	15	15	15
ΔECU (Session 1–Session2) First Difference between contributions in Session 1 and Session 2	117.71*** (76.17, 159.24) [62.22, 173.20]	24.75*** (12.68, 36.82) [8.54, 40.96]	24.50*** (14.28, 34.72) [10.78, 38.22]	24.83*** (15.17, 34.50) [11.92, 37.75]	24.04*** (15.20, 32.89) [12.23, 35.85]	19.58*** (10.95, 28.22) [7.99, 31.18]
ΔECU (Session 1–Session3) First Difference between contributions in Session 1 and Session 3	54.93** (11.22, 98.63) [-3.66, 113.51]	14.11** (1.74, 26.48) [-2.50, 30.72]	12.33** (0.86, 23.79) [-3.04, 27.69]	11.81** (1.92, 21.70) [-1.45, 25.06]	8.65* (-0.28, 17.58) [-3.33, 20.62]	8.03* (-0.34, 16.41) [-3.36, 19.43]

Notes: 95% (99%) confidence intervals are given in round (square) brackets. $^{+++}$ significantly different from previous round at the 1% level. * significantly different from zero at the 10% level. ** significantly different from zero at the 5% level. *** significantly different from zero at the 1% level.

Table 1B: Summary Statistics of Experiment 1: Socioeconomic Control Variables

Variable	Description	Mean	Std.	Min	Max
FEMALE	1 - female, 0 - male	0.62	(0.49)	0	1
SMALL_SESSION	1 - Small session of 15 females. 0 – otherwise.	0.24	(0.43)	0	1
AGE	Age in Years.	21.57	(2.73)	18	37
EMPLOYEE	1 - Employee or Self Employed. 0 - Otherwise (not working).	0.41	(0.50)	0	1
LI (Labor Income)	Monthly Income from Labor for employees/self-employed.	4,811.54	(1,388.91)	2,500	8,200
OTHER	1 - Income from Sources other than labor. 0 - otherwise	0.83	(0.38)	0	1
NLI (Non Labor Income)	Monthly Income from Sources Other than Labor: parents' support, rent payments, and allowances	1,475.00	(804.86)	500	3,200
INC	Income from all sources. INC=LI+NLI	3,203.75	(257.26)	800	8,200
PEOPLE	Number of Core Family Members.	6.40	(1.96)	1	10
HOMEOWNER	1 – Homeowner. 0 – Renter.	0.17	(0.38)	0	1
ASHKENAZI	1 - Ashkenazi (Family Origin from Europe). 0 – non-Ashkenazi.	0.40	(0.49)	0	1
RELIGIOUS	1 - Orthodox Jew. 0 - Ultra-orthodox Jew.	0.25	(0.44)	0	1
Observations		63	63	63	63

Notes: Standard deviations are given in parentheses.

Table 2A: Summary Statistics of the Contributions in Experiments 2, 3 and 4.

Objective of Contributions : **Single Round Experiments**	**Procurement of sustainable supplies to the campus synagogue**	**Ongoing operation of the campus synagogue**	**80% assigned to the procurement of sustainable supplies to the campus synagogue, 20% assigned to the ongoing operation of the campus synagogue**
Variable : Description	**Experiment 2**	**Experiment 3**	**Experiment 4**
ECU: Experiment Currency Units (0-500) Average Contribution	199.02^{+++} (161.68, 236.37) [149.19, 248.85]	50.00^{+++} (40.74, 59.26) [37.64, 62.36]	158.95^{+++} (136.68, 181.23) [129.34, 188.56]
ΔECU_1 : Difference between average contributions of current and first experiments (unpaired samples and unequal variances)	–80.19*** (–122.81, –37.56) [–136.73, –23.64]	–229.21*** (–252.30, –206.11) [–259.82, –198.60]	–120.25*** (–150.78, –89.73) [–160.60, –79.91]
ΔECU_2 : First Difference between contributions of two subsequent experiments (unpaired samples and unequal variances)	–	–149.02*** (–187.39, –110.66) [–200.13, –97.91]	108.95*** (84.97, 132.94) [77.16, 140.75]
Observations	48	48	63
Experiments 2 - 4: Description	**Experiment 2**	**Experiment** 3	**Experiment** 4
ECU (all three Sessions of experiment 4): Experiment Currency Units (0-500) Average Contribution	199.02^{+++} (161.68, 236.37) [149.19, 248.85]	–	158.95^{+++} (136.68, 181.23) [129.34, 188.56]
ΔECU_3 : Difference between average contributions of experiments 2 and 4(unpaired samples and unequal variances)	–	–	–40.07* (–83.16, 3.02) [–97.21, 17.08]
ECU: Experiment Currency Units (0-500) Median Contribution	170.00 (146.86, 213.14) [125.77, 250]	–	140.00 (120.00, 170) [108.09, 170.00]
Calculated Chi-Square Pearson Statistic with one degree of freedom - equality of medians	–	–	3.99$^{©©©}$
Observations	48	48	63
ECU (The first and third Sessions of experiment 4): Experiment Currency Units (0-500) Average Contribution	199.02^{+++} (161.68, 236.37) [149.19, 248.85]	–	170.31 (143.30, 197.32) [134.27, 206.36]
ΔECU_5 : Difference between average contributions in experiments 2 and 4	–	–	–28.71 (–74.26, 16.84) [–89.06, 31.65]
ECU: Experiment Currency Units (0-500) Median Contribution	170.00 (146.86, 213.14) [125.77, 250]	–	150.00 (120.00, 171.57) [110.00, 180.00]
Calculated Chi-Square Pearson Statistic with one degree of freedom - equality of medians	–	–	1.54
Observations	48	48	48

Notes: 95% (99%) confidence intervals are given in round (square) brackets. $^{+++}$ significantly different from first experiment at the 1% level. $^{©©©}$ median contributions are significantly different across experiments at the 1% level. * significantly different from zero at the 10% level. ** significantly different from zero at the 5% level. *** significantly different from zero at the 1% level.

Table 2B: Summary Statistics of Experiments 2, 3 and 4: Socioeconomic Control Variables.

Objective of Contributions	**Single Round Experiments**	**Procurement of sustainable supplies to the campus synagogue**	**Ongoing operation of the campus synagogue**	**80% assigned to the procurement of sustainable supplies to the campus synagogue, 20% assigned to the ongoing operation of the campus synagogue**
Variable	**Description**	**Experiment 2**	**Experiment 3**	**Experiment 4**
FEMALE	1 - female, 0 - male	0.50 (0.51)	0.50 (0.51)	0.38 (0.49)
SMALL_SESSION	1 - small session of 15 male subjects 0 - otherwise	–	–	0.24 (0.43)
AGE	Age in Years (18-37 years)	25.13 (3.51)	20.58 (3.06)	21.63 (3.37)
EMPLOYEE	1 - Employee or Self Employed 0 - Otherwise (not working)	0.77 (0.42)	0.25 (0.44)	0.27 (0.45)
LI (Labor Income)	Monthly Income from Labor for employees/self-employed (1,400-15,000 NIS)	6,708.11 (2,756.95)	5,433.33 (1,975.46)	4,576.47 (1,275.01)
OTHER	1 - Income from Sources other than labor 0 - otherwise	0.58 (0.50)	0.85 (0.36)	0.84 (0.37)
NLI (Non Labor Income)	Monthly Income from Sources Other than Labor: parents' support, rent payments, and allowances (100-4,000 NIS)	1,321.43 (715.62)	1,451.22 (599.22)	1,213.21 (632.47)
INC	Income from all sources INC=LI+NLI (1,000-15,000)	5,941.67 (3,356.22)	2,597.92 (2,334.43)	2,255.56 (1,874.08)
PEOPLE	Number of Core Family Members (1-10)	5.40 (2.22)	5.08 (1.93)	5.78 (2.08)
HOMEOWNER	1 - Homeowner 0 - Renter	0.21 (0.41)	0.31 (0.47)	0.10 (0.30)
ASHKENAZI	1 - Ashkenazi (Family Origin from Europe) 0 – non-Ashkenazi	0.42 (0.50)	0.63 (0.49)	0.46 (0.50)
RELIGIOUS	1 - Orthodox Jew 0 - Ultra-orthodox Jew	0.58 (0.50)	0.25 (0.44)	0.21 (0.41)
Observations		48	48	63

Notes: Standard deviations are given in parentheses.

Table 3: Regression Analysis

	Experiment 1	Experiment 2	Experiment 3	Experiment 4
VARIABLES	ECU	ECU	ECU	ECU
Constant	87.44	188.73	-23.88	97.08
	(83.30)	(147.64)	(34.03)	(67.03)
FEMALES	95.13***	71.17**	23.75***	44.08**
	(19.16)	(31.91)	(6.99)	(20.64)
SMALL_SESSION	-54.19**	–	–	-24.98
	(20.67)	–	–	(20.63)
AGE	4.44	-4.43	3.40**	-0.92
	(3.21)	(5.72)	(1.62)	(2.76)
EMPLOYEE	42.59	-51.76	37.97**	83.74
	(30.71)	(63.85)	(17.30)	(50.67)
INC	-0.01	0.00	-0.01**	-0.03**
	(0.01)	(0.01)	(0.00)	(0.01)
PEOPLE	12.82***	17.27**	3.02	19.10***
	(4.65)	(7.71)	(1.86)	(4.62)
HOMEOWNER	4.07	37.23	-7.64	40.69
	(21.76)	(37.96)	(8.20)	(32.93)
ASHKENAZI	-38.30**	-65.06*	-20.17**	-30.34
	(16.84)	(33.92)	(8.70)	(20.36)
RELIGIOUS	-21.24	63.92	6.30	24.35
	(19.45)	(39.70)	(8.28)	(22.49)
Observations	63	48	48	63
R-squared	0.59	0.45	0.63	0.61
F-Statistic	8.41***	4.05***	8.21***	9.14***

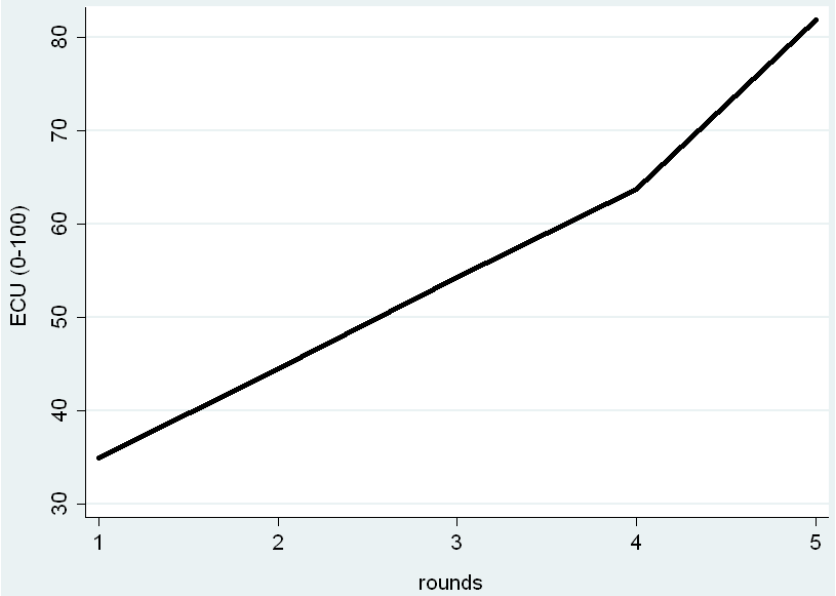
Notes: The dependent variable is the overall contribution to the public good in ECU. Standard errors are given in parentheses. * significant at the 10%-level. ** significant at the 5%-level. *** significant at the 1%-level.

Table 4: Difference in Difference (DD) Analysis

Experiment *i* vs Experiment *j*	**Average Projected Contribution in Experiment *i***	**Average Projected Contribution in Experiment *j***	**The difference between Exp *j*–Exp *i***
i=1 vs *j*=*2*	265.40 (256.63, 274.17) [253.84, 276.96]	208.42 (196.83, 220.01) [193.14, 223.70]	–56.98*** (–71.47, –42.49) [–76.06, –37.90]
i=1 vs *j*=3	265.40 (256.63, 274.17) [253.84, 276.96]	62.00 (58.75, 65.25) [57.72, 66.28]	–203.40*** (–212.74, –194.06) [–215.70, –191.10]
i=1 vs *j*=4	265.40 (256.63, 274.17) [253.84, 276.96]	156.37 (146.47, 166.27) [143.32, 169.42]	–109.03*** (–122.22, –95.84) [–126.39, –91.67]
i=2 vs *j*=3	208.42 (196.83, 220.01) [193.14, 223.70]	62.00 (58.75, 65.25) [57.72, 66.28]	–146.42*** (–158.45, –134.39) [–162.27, –130.57]
i=2 vs *j*=4	208.42 (196.83, 220.01) [193.14, 223.70]	156.37 (146.47, 166.27) [143.32, 169.42]	–52.05*** (–67.25, –36.85) [–72.06, –32.04]
i=3 vs *j*=4	62.00 (58.75, 65.25) [57.72, 66.28]	156.37 (146.47, 166.27) [143.32, 169.42]	94.37*** (83.96, 104.78) [80.65, 108.09]
Observations	222	222	222

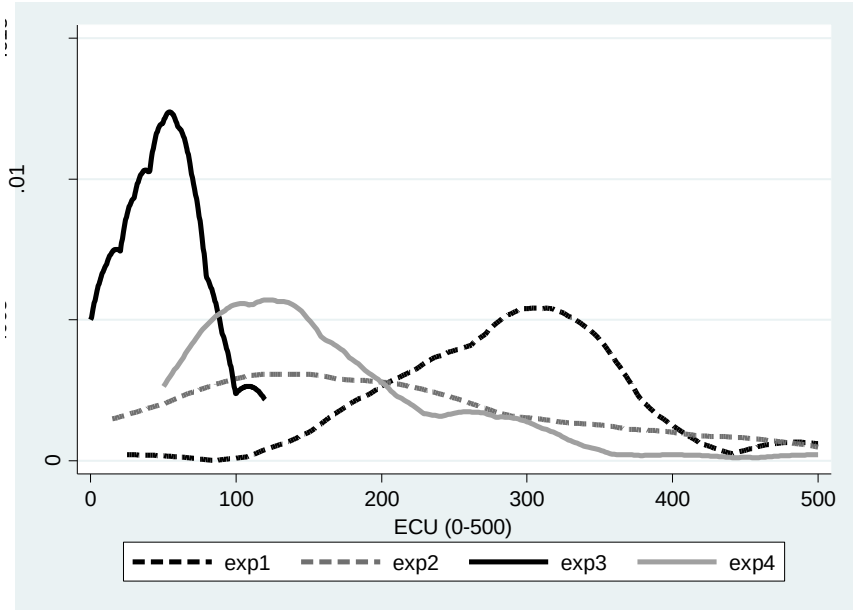
Notes: 95% (99%) confidence intervals are given in round (square) brackets.. * significant at the 10%-level. ** significant at the 5%-level. *** significant at the 1%-level.

Figure 1: Comparison between Contributions in Rounds 1-5 of Experiment 1



Notes: The figure compares the average contributions in rounds 1-5 of experiment 1.

Figure 2: Comparison between the Contributions in Experiments 2, 3 and 4.



Notes: The figure compares the kernel densities of overall contributions in the four experiments.

Appendix A: proofs of propositions 1 and 2:

Proof of proposition 1:

Setting the Hamiltonian:

$$H(\cdot) = -\frac{b}{2}x(t)^2 e^{-\rho t} + \frac{(an)^2}{2c\rho e^{\rho T}}k(T) + \lambda(t)nx(t), \tag{24}$$

The first order conditions are as follows:

$$H_x = -bx(t)e^{-\rho t} + \lambda(t)n = 0 \tag{25}$$

$$\lambda'(t) = -H_k = 0 \tag{26}$$

From (26), we determine that the optimal path $\lambda(t)$ is constant over time. From (25), we obtain that

$$\lambda(t) = \frac{x(t)}{n}be^{-\rho t} \tag{27}$$

From (26) and (27), we obtain the following:

$$\lambda'(t) = \left[\dot{x}(t) - \rho x(t)\right]e^{-\rho t} = 0 \tag{28}$$

By solving (28), we obtain the following:

$$x(t) = Ce^{\rho t} \tag{29}$$

As all individuals are identical, we obtain the following:

$$k(T) = nC\int_0^T e^{\rho t} = \frac{nC\left(e^{\rho T} - 1\right)}{\rho} \tag{30}$$

From (27) and (29) and by the transversality condition $\lambda(T) = \frac{a^2 n^2}{2c\rho e^{\rho T}}$, we obtain the following:

$$\frac{Cb}{n} = \frac{a^2 n^2}{2c\rho e^{\rho T}} \tag{31}$$

Therefore,

$$C = \frac{a^2 n^3}{2cb\rho e^{\rho T}} \tag{32}$$

From (29) and (32), we obtain the following:

$$x^*(t) = \frac{a^2 n^3}{2bc\rho} e^{\rho(t-T)} \tag{33}$$

From (30) and (32), we obtain the following:

$$k^*(T) = \frac{a^2 n^4 \left(1 - e^{-\rho T}\right)}{2bc\rho^2} \tag{34}$$

Proof of Proposition 2:

Setting the Hamiltonian:

$$H(\cdot) = -\frac{b}{2}\phi_i(t)^2 e^{-\rho t} + \frac{a^2(2n-1)}{2\rho c e^{\rho T}} k(T) + \lambda(t)\left(\phi_i + \sum_{j \neq i} \phi_j\right), \tag{35}$$

The first order conditions are as follows:

$$H_\phi = -b\phi_i(t) e^{-\rho t} + \lambda(t) = 0 \tag{36}$$

$$\lambda'(t) = -H_k = 0 \tag{37}$$

From (36), we determine that $\lambda(t)$ is constant over time. From (36), we obtain the following:

$$\lambda(t) = \phi_i(t) b e^{-\rho t} \tag{38}$$

From (37) and (38), we obtain the following:

$$\lambda'(t) = \left[\dot{\phi}_i(t) - \rho\phi_i(t)\right] e^{-\rho t} = 0 \tag{39}$$

By solving (39), we obtain the following:

$$\phi_i(t) = C e^{\rho t} \tag{40}$$

From (38) and (40) and by the transversality condition $\lambda(T) = \frac{a^2(2n-1)}{2\rho c e^{\rho T}}$ we obtain the following:

$$C = \frac{a^2(2n-1)}{2\rho b c e^{\rho T}} \tag{41}$$

From (40) and (41), we obtain the following:

$$\phi_i(t) = \frac{a^2(2n-1)}{2\rho b c} e^{\rho(t-T)} \tag{42}$$

As all individuals are identical, we obtain the following:

$$k(T) = nC\int_0^T e^{\rho t} = \frac{nC\left(e^{\rho T} - 1\right)}{\rho} \tag{43}$$

From (41) and (43), we obtain the following:

$$\hat{k}(T) = \frac{a^2 n(2n-1)\left(1 - e^{-\rho T}\right)}{2\rho^2 b c} \tag{44}$$

Appendix B: Instructions of the experiments:

Experiment 1:

Dear participant,
Thank you for agreeing to participate in our experiment.

There are other people in this room who are also participating in this experiment. You must not talk to them or communicate with them in any way during the experiment.
In this experiment, you will be asked to contribute privately to the procurement of sustainable supplies to the campus synagogue (e.g., praying books, religious books, religious artifacts, etc.). The experiment has five rounds. For each round, you will be given 100 tokens with a total worth of 10 NIS, i.e., each token is worth 0.1 NIS.

For each of the five experiment screens, you will be asked to decide, privately, the number of tokens you would like to contribute to the procurement of sustainable supplies to the campus synagogue (e.g., praying books, religious books, religious artifacts, etc.). At the end of each round, you will be notified of the total amount of contributions gathered up until and including that round.

The number of tokens that you did not contribute will be converted to NIS at the end of the experiment.

The experiment will take approximately 20 min, and at the end, you will be paid in private and in cash. The amount of money you will receive depends only on the extent of your contribution; however, the total value of contributions to the procurement of sustainable supplies to the campus synagogue depends on your contribution as well as on the other participants' contributions.

Here are two examples:
You will see the following screen:

How many of your 100 tokens (10 NIS) are you willing to contribute to the procurement of sustainable supplies to the campus synagogue (e.g., praying books, religious books, religious artifacts, etc.)? ☐

You will see this screen five times.

1) Suppose that you enter **10, 2, 50, 20 and 18** into each of the five answer boxes on each of the five screens. In that case, you will receive 40 NIS at the end of the experiment $\left(\frac{500 - (10 + 2 + \overset{100}{50} + 20 + 18)}{10} = 40 \right)$.

2) Suppose that you enter **12, 7, 45, 21 and 28** into each of the five answer boxes on each of the five screens. In that case, you will receive 38.7 NIS at the end of the experiment $\left(\frac{500 - \left(12 + 7 + \overset{113}{45} + 21 + 28 \right)}{10} = 38.7 \right)$.

Next, you will be asked to answer a short questionnaire.

The experiment's procedure and the nature of the questionnaire guaranty full anonymity. You are identified only by your experiment identification number that will be used to convert your private tokens (the tokens you chose not to contribute) to NIS at the end of the experiment.

At the end of the experiment, each participant will be identified by an experiment identification number and receive payment according to the contribution he or she has made, whereas the total value of contributions will be transferred to the campus Rabbi. After receiving the payment, we would ask that you then leave the experiment area.

To make sure everyone understands how earnings are calculated, we are going to ask you to complete a short quiz. Once everyone has completed the quiz correctly, we will continue with the experiment. If you finish the quiz early, please be patient.

The quiz (experiment 1):

1. How many tokens do you have for each round of the experiment?

    - 240
    - 100
    - 333
    - 150

2. How many times will you be asked to contribute to the procurement of sustainable supplies to the campus synagogue (e.g., praying books, religious books, religious artifacts, etc.)?
    - 1
    - 3
    - 7
    - 5

3. Which of the following is a legitimate answer to the question "How many of your 100 tokens (10 NIS) are you willing to contribute to the procurement of sustainable supplies to the campus synagogue (e.g., praying books, religious books, religious artifacts, etc.)??"

    - -20
    - 256
    - 135
    - 45

4. How much money will you receive at the end of the experiment if you have chosen to make contributions of 10, 34, 45, 3 and 20 tokens to the procurement of sustainable supplies to the campus synagogue (e.g., praying books, religious books, religious artifacts, etc.)?

    - 25.3 NIS.
    - 35.4 NIS.
    - 38.8 NIS.
    - 47.4 NIS.

Thank you for your participation.

Experiment 2:

Dear participant,
Thank you for agreeing to participate in our experiment.

There are other people in this room who are also participating in this experiment. You must not talk to them or communicate with them in any way during the experiment.

In this experiment, you will be asked to contribute privately to the procurement of sustainable supplies to the campus synagogue (e.g., praying books, religious books, religious artifacts, etc.). The experiment has one round. For this round, you will be given 500 tokens with a total worth of 50 NIS, i.e., each token is worth 0.1 NIS.

First, you will be asked to decide, privately, the number of tokens you would like to contribute. The number of tokens that you did not contribute will be converted to NIS at the end of the experiment.

The experiment will take approximately 15 min, and at the end, you will be paid in private and in cash. The amount of money you will receive depends only on the value of your individual contribution; however, the total value of contributions to the procurement of sustainable supplies to the campus synagogue depends on your contribution as well as on the other participants' contributions.

Here are two examples:
You will see the following screen:

How many of your 500 tokens (50 NIS) are you willing to contribute to the procurement of sustainable supplies to the campus synagogue (e.g., praying books, religious books, religious artifacts, etc.)? ☐

1) Suppose that you answer the question by entering "**100**" into the answer box. In that case, you will receive 40 NIS at the end of the experiment. $\left(\frac{500-100}{10}=40\right)$

2) Suppose that that you answer the question by entering "**205**" into the answer box. In that case, you will receive 29.5 NIS at the end of the experiment. $\left(\frac{500-205}{10}=29.5\right)$

Next, you will be asked to answer a short questionnaire.

The experiment's procedure and the nature of the questionnaire guaranty full anonymity. You are identified only by your experiment identification number that which will be used to convert your private tokens (the tokens you chose not to contribute) to NIS at the end of the experiment.

At the end of the experiment, each participant will be identified by an experiment identification number and receive payment according to the contribution he or she has made, while the total value of contributions will be transferred to the campus Rabbi. After receiving the payment, we would ask that you then leave the experiment area.

To make sure everyone understands how earnings are calculated, we are going to ask you to complete a short quiz. Once everyone has completed the quiz correctly, we will continue with the experiment. If you finish the quiz early, please be patient.

The quiz (experiment 2):

1. How many tokens do you have for the experiment?
    - 200
    - 135
    - 350
    - 500

2. How many times will you be asked to contribute to the procurement of sustainable supplies to the campus synagogue (e.g. praying books, religious books, religious artifacts, etc.)?

    - 2
    - 1
    - 3
    - 7

3. Which of the following is a legitimate answer to the question: "How many of your 500 tokens (50 NIS) are you willing to contribute to the procurement of sustainable supplies to the campus synagogue (e.g. praying books, religious books, religious artifacts, etc.)?
    - -20
    - 600
    - 135
    - 850

4. How much money will you receive at the end of the experiment if you have chosen to contribute 150 tokens to the procurement of sustainable supplies to the campus synagogue (e.g. praying books, religious books, religious artifacts, etc.)?

    - 25 NIS.
    - 35 NIS.
    - 40 NIS.
    - 27 NIS.

Thank you for your participation.

Experiment 3:

Dear participant,

Thank you for agreeing to participate in our experiment.

There are other people in this room who are also participating in this experiment. You must not talk to them or communicate with them in any way during the experiment.
In this experiment you will be asked to contribute privately to the ongoing operation of the campus synagogue (e.g. food and beverages to be served during lessons and religious ceremonies, payment for invited lectures and etc.). The experiment has one round. For this round you are given 500 tokens with a total worth of 50 NIS, i.e. each token is worth 0.1 NIS.

First you will be asked to decide, privately, the number of tokens you would like to contribute. The number of tokens which you did not contribute will be converted to NIS at the end of the experiment.

The experiment will take about 15 minutes, and at the end you will be paid in private and in cash. The amount of money you will receive depends only on the value of your individual contribution; however, the total value of contributions to the ongoing operation of the campus synagogue depends on your contribution as well as on the other participants' contributions.

Here are two examples:
You will see the following screen:

How many of your 500 tokens (50 NIS) are you willing to contribute to the ongoing operation of the campus synagogue (e.g. food and beverages to be served during lessons and religious ceremonies, payment for invited lectures and etc.)? ☐

1) Suppose that you answer the question by entering "**100**" into the answer box. In that case you will receive 40 NIS at the end of the experiment. $\left(\frac{500-100}{10}=40\right)$

2) Suppose that that you answer the question by entering "**205**" into the answer box. In that case you will receive 29.5 NIS at the end of the experiment. $\left(\frac{500-205}{10}=29.5\right)$

Next, you will be asked to answer a short questionnaire.

The experiment's procedure as well as the nature of the questionnaire guaranty full anonymity. You are identified only by your experiment identification number that which will be used to convert your private tokens (the tokens you chose not to contribute) to NIS at the end of the experiment.

At the end of the experiment each participant will be identified by an experiment identification number and receive payment according to the contribution he or she has made, while the total value of contributions will be transferred to the campus Rabbi. After receiving the payment we would ask that you then leave the experiment area.

To make sure everyone understands how earnings are calculated, we are going to ask you to complete a short quiz. Once everyone has completed the quiz correctly we will continue with the experiment. If you finish the quiz early please be patient.

The quiz (experiment 3):

1. How many tokens do you have for the experiment?
    - 200
    - 135
    - 350
    - 500

2. How many times will you be asked to contribute to the ongoing operation of the campus synagogue (e.g. food and beverages to be served during lessons and religious ceremonies, payment for invited lectures and etc.)?

    - 2
    - 1
    - 3
    - 7

3. Which of the following is a legitimate answer to the question: "How many of your 500 tokens (50 NIS) are you willing to contribute to the ongoing operation of the campus synagogue (e.g. food and beverages to be served during lessons and religious ceremonies, payment for invited lectures and etc.)?
    - -20
    - 600
    - 135
    - 850

4. How much money will you receive at the end of the experiment if you have chosen to contribute 150 tokens to the ongoing operation of the campus synagogue (e.g. food and beverages to be served during lessons and religious ceremonies, payment for invited lectures and etc.)?

    - 25 NIS.
    - 35 NIS.
    - 40 NIS.
    - 27 NIS.

Thank you for your participation.

Experiment 4:

Dear participant,

Thank you for agreeing to participate in our experiment.

There are other people in this room who are also participating in this experiment. You must not talk to them or communicate with them in any way during the experiment.
The experiment has one round. For this round you are given 500 tokens with a total worth of 50 NIS, i.e. each token is worth 0.1 NIS.

In this experiment you will be asked to contribute privately to the procurement of sustainable supplies to the campus synagogue (e.g. praying books, religious books, religious artifacts and etc.).

20% will be taken out of your contribution to finance the ongoing operation of the campus synagogue (e.g. food and beverages to be served during lessons and religious ceremonies, payment for invited lectures and etc.).

First you will be asked to decide, privately, the number of tokens you would like to contribute (remember that 20% will be taken out of your ECU to finance the ongoing operation of the campus synagogue). The amount of tokens which you did not contribute will be converted to NIS at the end of the experiment.

The experiment will take about 15 minutes, and at the end you will be paid in private and in cash. The amount of money you will receive depends only on the value of your individual contribution; however, the total value of contributions to the procurement of sustainable supplies to the campus synagogue depends on your contribution as well as on the other participants' contributions.

Here are two examples:
You will see the following screen:

How many of your 500 tokens (50 NIS) are you willing to contribute to the procurement of sustainable supplies to the campus synagogue, e.g. praying books, religious books, religious artifacts and etc.? ☐
(Remember that 20% will be taken out of your contribution to finance the ongoing operation of the campus synagogue, that is, food and beverages to be served during lessons and religious ceremonies, payment for invited lectures and etc.).

1) Suppose that you answer the question by entering "**100**" into the answer box. In that case you will receive 38 NIS at the end of the experiment. $\left(\frac{500-100}{10}=40\right)$

2) Suppose that that you answer the question by entering "**205**" into the answer box. In that case you will receive 29.5 NIS at the end of the experiment. $\left(\frac{500-205}{10}=29.5\right)$

Next, you will be asked to answer a short questionnaire.

The experiment's procedure as well as the nature of the questionnaire guaranty full anonymity. You are identified only by your experiment identification number that which will be used to convert your private tokens (the tokens you chose not to contribute) to NIS at the end of the experiment.

At the end of the experiment each participant will be identified by an experiment identification number and receive payment according to the contribution he or she has made, while the total value of contributions will be transferred to the campus Rabbi. After receiving the payment we would ask that you then leave the experiment area.

To make sure everyone understands how earnings are calculated, we are going to ask you to complete a short quiz. Once everyone has completed the quiz correctly we will continue with the experiment. If you finish the quiz early please be patient.

The quiz (experiment 4):

1. How many tokens do you have for the experiment?
    - 200
    - 135
    - 350
    - 500

2. How many times will you be asked to contribute to the procurement of sustainable supplies to the campus synagogue, e.g. praying books, religious books, religious artifacts and etc.?
   (Remember that 20% will be taken out of your contribution to finance the ongoing operation of the campus synagogue, that is, food and beverages to be served during lessons and religious ceremonies, payment for invited lectures and etc.).
    - 2
    - 1
    - 3
    - 7

3. Which of the following is a legitimate answer to the question: "How many of your 500 tokens (50 NIS) are you willing to contribute to the procurement of sustainable supplies to the campus synagogue, e.g. praying books, religious books, religious artifacts and etc.?
   (Remember that 20% will be taken out of your contribution to finance the ongoing operation of the campus synagogue, that is, food and beverages to be served during lessons and religious ceremonies, payment for invited lectures and etc.).
    - -20
    - 600
    - 135
    - 850

4. How much money will you receive at the end of the experiment if you have chosen to contribute 150 tokens to the procurement of sustainable supplies to the campus synagogue (e.g. praying books, religious books, religious artifacts and etc.)?

   (Remember that 20% will be taken out of your contribution to finance the ongoing operation of the campus synagogue, that is, food and beverages to be served during lessons and religious ceremonies, payment for invited lectures and etc.).

   - 35 NIS.
   - 25 NIS.
   - 40 NIS.
   - 24 NIS.

5. Suppose you have decided to contribute 200 ECU. How much money did you actually contribute to the procurement of sustainable to the campus synagogue?

   - 200
   - 100
   - 160
   - 120

Thank you for your participation.

Appendix C: The questionnaire:

1. What is your experiment identification number? _____
2. Gender: Male □ Female □
3. Age: _____
4. Country of birth: _____
5. Year of immigration to Israel (if relevant):_____.
6. Family status: Bachelor □ Married □ Divorced □ Widow(er) □
7. Number of children: _____.
8. Education: Yeshiva/Kolel □ Secondary □ Tertiary □ Academic, B.A or equivalent □ Academic, M.A. or equivalent and above □
9. Denomination: ultra-Orthodox □ Orthodox □ Traditional □ Secular □
10. Origin: Ashkenazi □ Sefaradi □ Ashkenazi and Sefaradi □
11. Region of residence: Center □ North □ South □ Jerusalem area □ Shfela □
12. Occupational status: Employee □ Freelance □ Unemployed □
13. What is your net monthly earned income:

    - 0
    - 1-5000
    - 5001-8000
    - 8001-12000
    - 12001-15000
    - 15001-17000
    - 17001 and above.

14. What is your monthly non-earned income (rents, allowance, etc.)

    - 0
    - 1-2000
    - 2001-4000
    - 4001-6000
    - 6001-8000
    - 8000-10000
    - 10001 and above.

15. Do you own an apartment? Yes □ No □
16. How many bedrooms are there in the place where you are living? _____.
17. What is the size of your core family including yourself (mother, father, sisters and brothers)? _____.

Thank you for your participation.