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Abstract

We use a controlled laboratory experiment with and without overlapping generations to study the emergence of public debt. Public debt is chosen by popular vote, pays for public goods, and is repaid with general taxes. With a single generation, public debt is accumulated prudently, never leading to over-indebtedness. With multiple generations, public debt is accumulated rapidly as soon as the burden of debt and the risk of over-indebtedness can be shifted to future generations. Debt ceiling mechanisms do not mitigate the debt problem. With overlapping generations, political debt cycles emerge, oscillating with the age of the majority of voters.

JEL-Code: C920, H410, H630.

Keywords: public debt and taxation, government spending, budget deficit, balanced budget, common pool resources.

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1 Introduction

Public debt, its accruement, its impact on the economic performance of states and the question how over-indebtedness can be successfully avoided are problems that seize top places in the agenda of economic research since decades. Consequently, the number of theories and approaches that try to deal with these problems is quite high. The pure normative theory tends to look at public debt in a relative relaxed way. Starting with Barro (1979) and Lucas and Stockey (1984), the indebtedness of states is modeled as an interplay between a benevolent rational planner, who tries to maximize the welfare of a representative individual with an infinite time horizon, and strictly rational citizens, who adapt their inheritance behavior in order to ensure that their children are able to pay the higher future tax that follows an increase of the public debt.

But this rather optimistic normative theory does not fit very well with the empirical observations. Neither the large number of national bankruptcies, nor the huge differences in the indebtedness of different nations can be explained by the normative model. Furthermore, during the last three decades we have observed a sharp increase in the public debt of a couple of important industrial countries, and this also cannot be explained by the normative model. Very recently, this development caused a dramatic situation in the southern states of the European Union, and in the USA the increasing debt triggered the illiquidity of the central government.

Given the high economic impact of public indebtedness, it is essential to understand what the driving forces for the observed phenomena are. This explains the large number of theoretical studies modeling the emergence of public debt based on a multitude of various hypotheses. All these models have in common that they no longer assume the perfect rationality of politicians and citizens. Starting with Nordhaus (1975), one of the most prominent assumptions is that voters are myopic insofar as they do not understand that an increase in the public debt today leads to higher taxes and/or higher inflation in the future. Rational politicians therefore have an incentive to debt finance benefits for their constituencies in return for their political backing. Beetsmar and Uhlig (1999) use exactly this argument to justify why governments have a tendency to increase public debt over time.[1]

[1] For this line of reasoning see also Alesina and Perotti (1995), Alesina et al. (1997), among others.

A related approach is modeled by Alesina and Tabellini (1990) and Perrson and Svensson (1989). In their models, political parties use public debt as a tool if they are in danger to lose the next election. Right wing parties, for example, may have the incentive to increase debt financed spending for military equipment to reduce the financial leeway of a subsequent left wing party to spend on redistributive measures.

A second, important approach concentrates on the intergenerational redistribution effects of public debt. Obviously, public debt and savings enable the current generation to shift financial burdens between generations. Cukierman and Metzler (1989) and Persson and Tabellini (2002) follow this road, pointing out the central role of the conflict between young and old citizens.[2] While the young prefer lower debt and lower pension payment, the old prefer the opposite. This implies that the degree of public indebtedness may depend on the age structure of a society. The temptation to shift burdens to future generations may be attenuated by intergenerational altruism in a broad sense or in the narrow sense of a bequest motive. Thus, in a democratic setting, in which voters decide on the extent of debt and deficit, this literature shows that individual preferences play a decisive role for the implemented public debt policy.

This is the point at which behavioral theories should enter the stage. It is an important question, whether people vote to increase public debt, because they intend to exploit the successive generations or simply because they are myopic. Although behavioral economist have assembled a very impressive number of stylized facts about individual behavior – in particular also about altruism and fairness – to our knowledge the number of behavioral results concerning the motives underlying public indebtedness is very limited. Baron and McCaffery (2004) conduct an online survey to find out why it is so difficult to reduce an existing public debt. They find that a great majority of the interviewed subjects have a clear preference for a balanced budget and are generally willing to cut public spending. However, when asked about the spending cuts in concrete areas (health care, schooling, etc.) most of the interviewees reject proposals to reduce government spending.

On a behavioral level, little is known about the driving forces of an increasing public debt. This makes it hard to answer the question how we can limit the public indebtedness. The aim

[2] Gordan and Varian (1988) and Shiller (1999) point out that public debt may have lead to an intergenerational Pareto improvement (i.e., welfare increase) if it is implemented to share intergenerational risk. The central idea in this literature is that a combination of public debt, social security payments, and taxes can replace the private risk sharing contracts that are not feasible in an intergenerational setting. The positive risk sharing effect may break down when each generation consists of individuals with heterogeneous preferences.

of this paper is to study these questions with a laboratory experiment to gain a better understanding of the *behavioral* foundations and the dynamics of debt emergence.

We find that the main driving force behind the public debt is the intergenerational transmission of the tax burden, even in small groups that entertain strong social ties across generations. Within a single generation, without future generations, we observe a prudent public debt policy that avoids excessive indebtedness by all means. *With* future generations, however, we observe that individuals are neither willing to keep the public debt on a low level, nor willing to reduce public debt voluntarily when the debt level is relatively high. As a consequence, intergenerational economies often run heavily into public debt, leaving the next generations at a high risk of over-indebtedness, public bankruptcy, and penalty taxation.

We implement an absolute debt ceiling mechanism to reduce excessive public borrowing in intergenerational setting, but find that the negative situation is not improved with the introduction of the debt ceiling mechanism. The debt ceiling fails to help, because it is simply removed by majority vote whenever it sets a binding constraint on new debt. Finally, with overlapping generations we find clear evidence for political cycles that are driven by the age structure of the electorate. Older individuals typically vote for higher levels of new debt than younger individuals. They also tend to vote for the elimination of debt ceilings more often than the younger do. We conjecture that as the demographic distribution in an economy shifts towards higher age, the problem of excessive debt is aggravated.

The remainder of the paper is organized as follows: In section 2, we provide a brief review of the related literature. In section 3, we present the design of the experiment, the treatments, and the experimental protocol. The results of our study are given in section 3. In our last section 4, we summarize our results.

2 Related Literature

Our experimental design is closest to experimental studies implementing dynamic common pool resource (CPR) games with multiple generations. Note that an economy's capacity of accumulating public debt is similar to a dynamic common pool resource (CPR) that is depleted over time (i.e., over generations) to generate welfare (i.e., public goods for all members of the economy). As public debt is accumulated over time, the economy's capacity of "harvesting" new loans decreases and the cost of new loans increases. Hence, the depletion of public debt capacity by one generation (i.e., accumulating public debt) poses a negative externality for the next generations, just as the depletion of a CPR does.

Chermak and Krause (2002) conduct an overlapping generations (OLG) common pool resource experiment with three players who "live" (i.e., can actively participate in extraction from the CPR) for three periods and are "born" at the rate of one person per period. In one treatment, the players are informed on their position within the intergenerational chain, while in the other treatment they are not informed. The study is mainly focused on the individual correlates (gender, age, race, political affiliation, religion, etc.) of extraction behavior. Many of the uncovered effects are influenced by the informational setting. Overall, subjects with exact information on their position in the intergenerational chain extract less and choose forward-looking "let it grow" strategies significantly more often than subjects with blurry information. The analogy to our experimental setup is that subjects in some of our treatments are precisely informed on the timing of their in-game lifetime, while they lack precise timing information in other treatments in which lifetime ends stochastically. Just as Chermak and Krause (2002), we observe less behavioral heterogeneity with perfect information. But in contrast to their results, the observed extraction levels (i.e., accumulated public debt) are statistically indistinguishable across our treatments. This difference seems to be due to the fact that the subjects in Chermak and Krause (2002) can extract and keep arbitrary amounts of the resource (heterogeneous private benefits), while extraction in our setting is homogeneous across subjects (homogeneous public good) and coordinated through a social choice process.

Fischer et al. (2003) examine the case of an intergenerational CPR game in which each generation consists of three players, making a single extraction decision each. Varying the growth rate of the CPR across treatments, Fischer et al. (2003) find that extraction rates are above the sustainable level with slow growing and below with fast growing resources. These results indicate that the resource in our study (the public debt capacity) will be depleted quickly, because it does not grow at all. Note, however, that the in-game lifetime of players in the experiment of Fischer et al. (2003) is only one period and is obviously non-stochastic and without generational overlaps. Furthermore, the extractions in Fischer et al. (2003) are heterogeneous and individually effective as in Chermak and Krause (2002) and as in contrast to our experiment.

Herr et al. (1997) study a dynamic CPR game with a single generation of players that repeatedly make extraction decisions. They find that most subjects make myopic choices instead of taking the resource dynamics into account. This exacerbates the commons problem and leads to a rapid depletion of the CPR. We also observe full depletion of the resource (the public debt capacity) in those settings in which a single generation repeatedly makes extraction choices. However, our subjects seem to plan the full depletion of the resource prudently in those settings, only increasing the debt level towards the end of their lifetime. As in the case of the two previously mentioned experimental studies, the extraction choices in Herr et al. are also individually effective and heterogeneous, perhaps allowing a more differentiated extraction path than in the politically coordinated game in our experiment.

Overall it seems that the experimental literature on multi-generational common pool resources may be informative for some aspects of public debt accumulation, but it is not perfectly suited to address our specific research questions. We identify two important differences between typical CPR settings and the public debt problem. First, the extraction decisions in typical CPR settings are not coordinated by a social choice process and are not homogeneous. Second, public debt capacity is a replenishable resource that – in contrast to most of the naturally occurring CPR – does not grow. Our study shows that the first property usually leads to a fast and coordinated depletion of the public debt capacity, because the majority rule makes it impossible for individuals with a low demand for public debt to offset those with a high demand. The second property of the public debt capacity makes it impossible for individuals to find a meaningful compromise between expanding debt-based consumption and keeping public debt at a sustainable level. The results of the CPR studies (especially Fisher et al. 2003) seem to indicate that sustained public debt levels would be easier to achieve in a world with sustained growth and a public debt capacity that grows steadily.

3 Experimental Design and Protocol

3.1 The Basic Experimental Design

In all our treatments, an economy exists for 30 periods. In every period, the economy consists of a group of three individuals. Individuals receive an endowment of 100 Cents at the beginning of each period. The group has to make two decisions in every period: (1) The group decides on the size of a public good *PG* and (2) the mixture of tax and debt with which the public good is financed. In both decisions, the group decides with a median voter mechanism. Individual proposals are not disclosed, but the resulting outcome of the voting, i.e., the median vote, is known by the group members.

The public good is a standard linear public good with an MPCR of 0.5, i.e., for every Cent invested in the public good, each individual receives 0.5 Cent from the public good. In the first decision, each individual chooses a multiple of 30 between 0 and 600 Cents (i.e., 0, 30, 60, …, 570, 600 Cents) for the public good size. The largest amount that covers at least 2 of 3 votes (i.e., the median vote) is implemented.

After the size of the public good is set, financing is decided by the group. Each group member chooses a tax between 0 and 100 Cents (denoted by t_i). The largest amount that covers at least 2 of 3 votes (i.e., the median vote) is implemented. The implemented tax t is automatically collected from every individual's account making tax evasion impossible. If the total tax revenue is smaller than the size of the public good (i.e., $3t < PG$), the difference is debt financed. Debt can accumulate over the periods, but it can also be repaid. If the total tax revenue is greater than the size of the public good (i.e., $3t > PG$), previous debt is first repaid and then savings are accumulated. If the total tax revenue is equal to the public good size (i.e., $3t = PG$), there is a balanced budget and no debt or savings are accumulated.

After each period, the accumulated debt D is checked. If accumulated debt is not above the safe threshold ($D \leq 300$), no over-indebtedness and no consequences occur. If accumulated debt is above the safe threshold ($D > 300$), a random draw decides whether the group is over-indebted and must face consequences. The probability of over-indebtedness increases with the size of the accumulated debt (see Table 1). If over-indebtedness is determined at the end of one period, a tax is imposed in the *following period(s)* until the accumulated debt is reduced to the safe threshold. The imposed tax $\overline{t}$ is paid by each group member and, again, no free-riding is possible. If the accumulated debt is greater than 600 Cents, the imposed tax equals 100 Cents (i.e., the maximum tax level). Otherwise, the imposed tax equals the third of the difference between the accumulated debt and the safe threshold.

$$\overline{t} = \begin{cases} \dfrac{D-300}{3} & \text{if} \quad D \leq 600 \\ 100 & \text{if} \quad D > 600 \end{cases} \tag{1}$$

As long as accumulated debt is not reduced to the safe threshold, no public good can be provided (i.e., $PG = 0$). Note that last period debt is not repaid by the group members.

The payoff π_i of each group member in each period is therefore determined as follows:

$$\pi_i = \begin{cases} 100 - t + 0.5 \cdot PG & \text{if} \quad \text{no tax is imposed} \\ 100 - \overline{t} & \text{if} \quad \text{tax is imposed} \end{cases} \tag{2}$$

If the experiment ends for a subject, the subject is paid the payoff sum from all periods in which the subject was *alive*, i.e., an active member of the economy. Thus, the level of public debt does not directly influence the payoff of a subject.

Table 1: Probability of over-indebtedness

accumulated debt	probability of over-indebtedness
≤ 300	0 %
301 to 400	10 %
401 to 500	20 %
501 to 600	30 %
601 to 700	40 %
701 to 800	50 %
801 to 900	60 %
901 to 1.000	70 %
1.001 to 1.100	80 %
1.101 to 1.200	90 %
> 1.200	100 %

3.2 Treatments

In total, we have five treatments which differ with respect to two dimensions: (1) the variation of the generational configuration and (2) the implementation of an absolute debt ceiling (see table 2 for a treatment overview). In our single generation treatment (*single-gen*), the economy consists of three group members who remain active in all 30 periods. As there is only a single generation, no intergenerational conflicts can arise. In our multi-generation treatments (*multi-gen*), 3 generations of three subjects participate 10 periods consecutively without overlap (independent generations). The accumulated debt (or savings) is the only intergenerational connection. In our overlapping generation treatments (*OLG*), each subject "lives" for a stochastic duration. When a subject *dies*, the experiment ends for the subject, who is paid the own "lifetime earnings" (i.e., the accumulated payoff from all active periods). Any subject that dies is replaced by another subject, who starts at the age of 1. The probability of dying increases from period to period. In the first four periods the probability is 0%. After the fifth period the probability to die is 10%, after the sixth period 20%, and so on until period 14 (100%). Thus, the "lifetime" of a subject in OLG (i.e., number of active periods) is at least

5 and at most 14 periods. As the whole economy starts in the first period, the first generation is not an overlapping generation.

Figure 1 shows an example of “birth events” (i.e., a new subject enters the economy) in each of the three generational configurations where each shaded cell indicates a “birth” in that economy. Note that the timing and frequency of births in the single generation and the multi-generation treatments is always exactly as depicted in the examples in figure 1. In contrast, the example presented for the OLG treatment is just one of the many possible realizations of the stochastic process, in which birth events in OLG immediately follow death events that occur at random between the 5th and 14th “in-game age” of each subject. Notice that each economy run through an own realization of this stochastic process in our OLG setting.

single generation

period	cabin 1	cabin 2	cabin 3
1	**1**	**2**	**3**
2	1	2	3
3	1	2	3
4	1	2	3
5	1	2	3
6	1	2	3
7	1	2	3
8	1	2	3
9	1	2	3
10	1	2	3
11	1	2	3
12	1	2	3
13	1	2	3
14	1	2	3
15	1	2	3
16	1	2	3
17	1	2	3
18	1	2	3
19	1	2	3
20	1	2	3
21	1	2	3
22	1	2	3
23	1	2	3
24	1	2	3
25	1	2	3
26	1	2	3
27	1	2	3
28	1	2	3
29	1	2	3
30	1	2	3

independent generations

period	cabin 1	cabin 2	cabin 3
1	**1**	**2**	**3**
2	1	2	3
3	1	2	3
4	1	2	3
5	1	2	3
6	1	2	3
7	1	2	3
8	1	2	3
9	1	2	3
10	1	2	3
11	**4**	**5**	**6**
12	4	5	6
13	4	5	6
14	4	5	6
15	4	5	6
16	4	5	6
17	4	5	6
18	4	5	6
19	4	5	6
20	4	5	6
21	**7**	**8**	**9**
22	7	8	9
23	7	8	9
24	7	8	9
25	7	8	9
26	7	8	9
27	7	8	9
28	7	8	9
29	7	8	9
30	7	8	9

overlapping generations

period	cabin 1	cabin 2	cabin 3
1	**1**	**2**	**3**
2	1	2	3
3	1	2	3
4	1	2	3
5	1	2	3
6	1	**4**	3
7	1	4	3
8	1	4	3
9	1	4	**5**
10	**6**	4	5
11	6	4	5
12	6	4	5
13	6	**7**	5
14	6	7	5
15	6	7	5
16	6	7	5
17	6	7	**8**
18	6	7	8
19	**9**	7	8
20	9	7	8
21	9	**10**	8
22	9	10	8
23	9	10	8
24	9	10	**11**
25	9	10	11
26	**12**	10	11
27	12	10	11
28	12	10	11
29	12	10	11
30	12	10	11

Figure 1: Example of birth events in the different generational configurations

Table 2: Treatment overview

treatment	generations	debt ceiling	# of independent observations (# of subjects)
single-gen	single	no	6 (18)
multi-gen baseline	multiple, independent	no	8 (72)
multi-gen DC		yes	4 (36)
OLG baseline	multiple, overlapping	no	6 (74)
OLG DC		yes	6 (75)

With respect to the second dimension, we either implemented an absolute debt ceiling mechanism or did not. In the baseline treatments, no debt ceiling is applied. In the debt ceiling treatments (DC), public debt is restricted to 300 Cents by default. Hence, proposals that imply a public debt level above the debt ceiling are not allowed and can technically not be submitted. At the beginning of each period, however, the debt ceiling can be removed by majority vote. If the absolute debt ceiling is removed, accumulated public debt can be increased to any level. The debt ceiling can be reinstalled in the following period.

3.3 Experimental Protocol

The experiment was conducted at the University of Magdeburg (MaXLab) and was programmed with z-Tree (Fischbacher, 2007) and subjects (mainly economic students) were recruited with ORSEE (Greiner, 2003). Before the experiment started, subjects were asked to complete a comprehension test to check that they had understood the rules of the game and the math regarding the payoffs. After all participants successfully finished the comprehension test, they participated in practice runs to familiarize them with the game situation. The first practice run consisted of 10 periods of the game with an initial public debt of zero. The second practice run consisted of 5 periods of the game with an initial public debt of -600. Neither the comprehension test nor the practice runs were relevant to subjects' payoffs.

In the multi-generation treatments, each generation of subjects was invited to the lab at the same time, with a generous time lag between generations. Subjects were randomly assigned to individual cubicals. After receiving instructions, completing the comprehension test, and participating in the practice runs, subjects proceeded with the actual experiment. The only difference between different generations was the size of the public debt at the outset of their in-game lifetime, i.e., the size of public debt that the preceding generations in their economy had accumulated at the time of their in-game birth.

To allow for a smooth transition between our in-game generations in the OLG treatment, we used two separate laboratories. The subjects for all generations were invited to one of the labs at the same time. Each subject was assigned to an individual cubical. After receiving instructions, completing the comprehension test, and participating in the practice runs, subjects were randomly assigned to generations. The first generation subjects were picked up individually and transferred to separate cubicals in the second lab. There they proceeded with the actual experiment. The subjects awaiting their in-game birth remained in the first lab, waiting silently in their cubicals until the lifetime of their in-game predecessor ended. As soon as the predecessor had left the second lab, the successor was transferred to the corresponding cubical in the second lab, where the "new born" player entered the proceeding OLG economy. The waiting subjects were allowed to read offline, but all forms of communication were prohibited, including e-mailing or texting on mobile phones.

4 Results

4.1 The Effect of the Generational Configuration

First, we examine the effect of the generational configuration on the accumulated public debt and on the level of public good provision. Table 3 shows the overall average values of public debt and public good provision in the baseline treatments. Figure 2 shows the development of the average values over time. In our single generation baseline treatment, we observe a moderate increase of public debt over time. Until period 29 the accumulated public debt on average does not exceed the safe threshold of 300. Average public debt rises above 300 only in the last period, in which no risk of over-indebtedness exists. We do not observe over-indebtedness in any of the economies in the single generation baseline treatment.

Table 3: Average observed parameters – Baseline treatments

treatment	average public good provision	average public debt	average number of periods with over-indebtedness	average number of periods with imposed tax
single-gen baseline	318	122	0	0
multi-gen baseline	277	385	2.63	4.25
OLG baseline	256	455	4.67	7.33

In contrast to the high degree of prudence that we observe in the economies of our single generation baseline treatment, all economies in our multi-generation baseline and OLG baseline treatment quickly accumulate substantial amounts of public debt. While the level of public debt level starts and swings on high levels in both multiple generations treatments, the pattern of debt accumulation and reduction varies over time. In the multi-generation baseline treatment, we observe a strong increase of debt just before and in the periods 10 and 20, i.e., in the last periods of each generation's lifetime. In the OLG baseline treatment debt is quickly accumulate from the beginning and is greater than in the multi-generation baseline treatment, except for the periods 9 to 11 and 19 to 21. Using the non-parametric Mann-Whitney U-test (MWU) for independent samples, we find significant differences between all three treatments ($p < 0.001$, two-tailed), with the most debt in the OLG baseline and the least in the single generation baseline treatment.

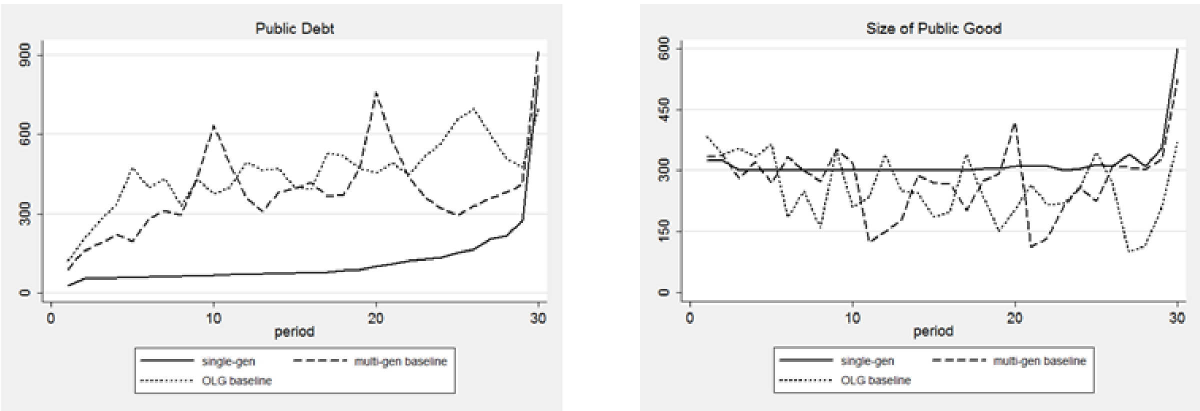

Figure 2: Public debt and public good provision – Baseline treatments

With respect to public good provision, we find that the size of the public good remains almost constant over time in the single generation baseline treatment, except for the final periods. In contrast, the extent of public good provision varies greatly in the multi-generation baseline and in the OLG baseline treatments. The MWU-test picks up a significant difference between the public good provision in the single generation baseline and the OLG baseline treatments (MWU, two-tailed, $p = 0.010$), but not in the other two comparisons.

Table 4 confirms the findings so far on a period by period level. There are clearly less deficit periods (about 28%) and more balanced budget periods (about 72%) in the single generation baseline treatment than in the other two treatments. Obviously, there is no need to accumulate savings in the single generation baseline treatment. In the other two treatments, however, we observe a small fraction of periods (about 11% in the multi-generation baseline and 7% in the OLG baseline), in which the subjects attempt to pay back some of their accumulated debt by saving some of the tax income voluntarily. But, the debt reduction effort exhibited in these treatments is neither frequent nor sizable enough to offset the accumulated debt. Hence, we observe periods of imposed austerity after over-indebtedness (about 14% in the multi-generation baseline and 24% in the OLG baseline treatments), in which the maximum necessary tax is levied and the full amount used for debt repayments.

Table 4: Frequency and average size of observed deficit – Baseline treatments

treatment	**deficit**		**balanced budget**		**voluntary surplus**		**imposed austerity**	
	rel. freq	mean	rel. freq	mean	rel. freq	mean	rel. freq	Mean
single-gen baseline	0.28	97.1	0.72	0	0.00	-	0.00	-
multi-gen baseline	0.49	142.9	0.26	0	0.11	66.9	0.14	233.2
OLG baseline	0.52	158.1	0.17	0	0.07	57.5	0.24	223.0

The Tobit regressions presented in table 5 provide further evidence for the treatment differences discussed above (robust standard errors clustered at the group level are shown in the parentheses under each coefficient).[3] We find a significantly positive (negative) effect of the treatment dummies for the multi-generation baseline and the OLG baseline treatments on public debt accumulation (public good provision). The difference between the two coefficients is significant only concerning public debt, i.e., in model 1 ($p = 0.044$). Additionally, we find a significantly positive effect of the period on the debt accumulation, indicating that there is a general trend for public debt to rise over time. We find no time trend of the public good provision.

[3] We use a Tobit regression, because the size of the public good is bounded between 0 and 600.

Table 5: Tobit public debt and public good regressions – Baseline treatments

	model 1	model 2
dependent variable	public debt	public good
dummy multi-gen baseline	360.76***	-48.44***
	(97.05)	(11.54)
dummy OLG baseline	430.66***	-79.02***
	(94.50)	(14.67)
period	12.32***	-0.15
	(1.98)	(0.80)
constant	-167.70	321.88***
	(108.89)	(12.59)
N	600	600
pseudo R squared	0.0496	0.0033

Robust standard errors are in parentheses. Test statistics: *** $p \leq 0.01$, ** $p \leq 0.05$, * $p \leq 0.1$

Shifting the focus of our analysis from the performance of the entire economy to the decisions of the individuals, we define the *revealed debt preference* (RDP) as a measure for an individual's preference for debt-driven public good provision. An individual's RDP is defined as the difference between the budget needed for the provision of the public good (i.e., public good size *PG* chosen by the group) and the total tax revenue that an individual proposes. Formally, our RDP measure can be described as follows:

$$RDP_i = PG - 3t_i \tag{3}$$

where t_i denotes the (per capita) tax individual *i* proposes. Remember that after the group votes and decides on the size of the public good, every individual proposes a tax that will be used to provide the public good. If the proposed tax generates less income than is necessary for the public good provision, our RDP measure will be positive, because the individual has revealed a preference for public debt. If, however, the proposed tax generates more income than is necessary for the public good provision, the RDP of the individual will be negative, indicating the individual's distaste for public debt. An RDP of zero obviously indicates a preference for spending no more on public goods than the taxes generated in the economy. Figure 3 displays the development of the median RDP in each of the three baseline treatments, including a maximum and a minimum band.

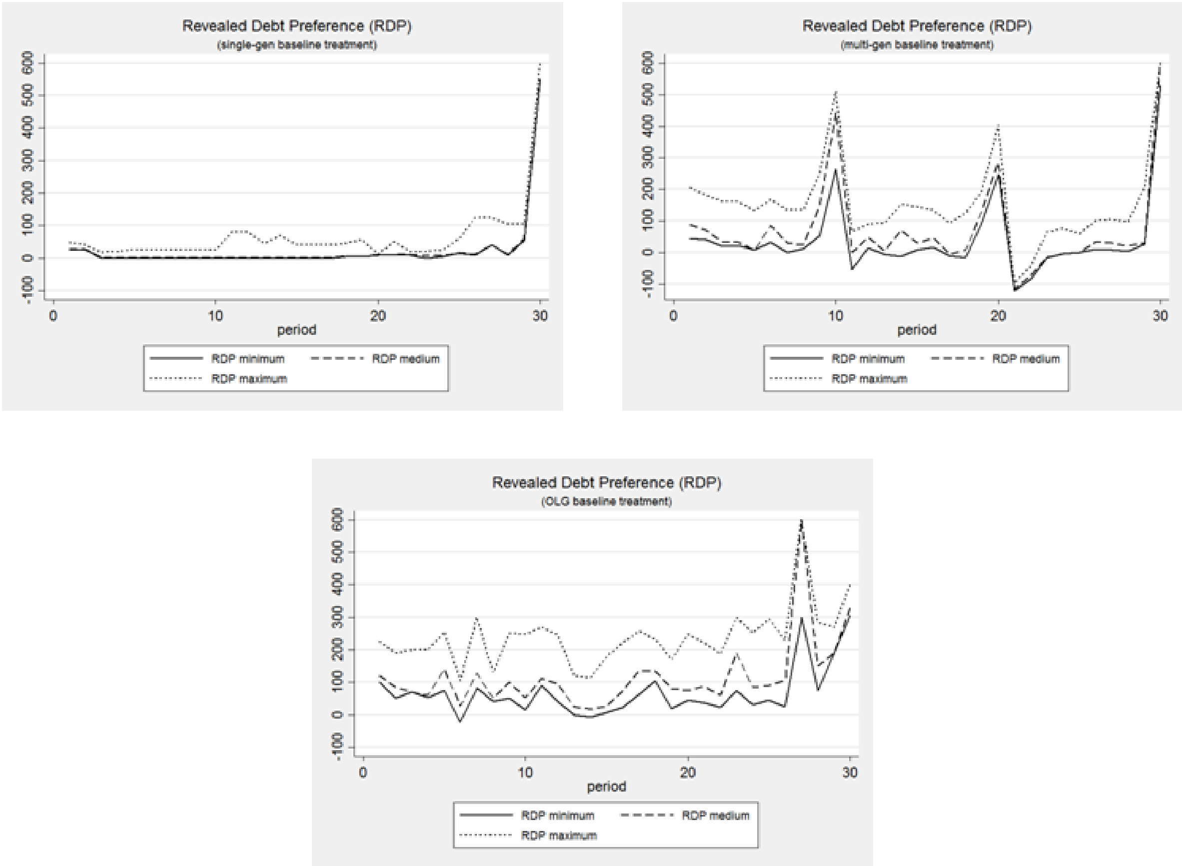

Figure 3: Revealed debt preference (RDP) – Baseline treatments

Figure 3 clearly demonstrates the differences between the treatments on the level of individual behavior. In the single generation baseline treatment, we find very homogeneous revealed debt preferences. The median and the minimum RDP are identical almost throughout the entire lifetime of the individuals and the economy. The maximum RDP runs only slightly above the median and the minimum, indicating that there is very little individual variance in the single generation treatment. In fact, there is almost no variation at all in the "end of lifetime" effect that has basically all subjects rationally voting for the maximum debt.

In the multi-generation baseline treatment, we also observe "end of lifetime" peaks in the median RDP, because subjects recognize that they need not fear their own over-indebtedness in the last period of their lives. Note, however, that there is much more variance in these "end of lifetime" peaks than we observe in the single generation treatment. Overall, the individuals in the multi-generation treatment reveal more heterogeneous preferences for debt than in the single generation treatment. Knowing that debt creation harms later generations obviously induces heterogeneity in the subject population's preference for public debt. Some subjects care more about the future generation's well-being than others.

We observe the same type of heterogeneity in the individual public dept preferences in the OLG treatment as in the multi-generation treatment. Again it seems clear that the individuals have diverse preferences for public debt, most probably due to the heterogeneity of their regard for future generations. Interestingly, the observed maximum RDP in all treatments seems to be further away from the median RDP than the observed minimum. It seems that on average there are two relatively cautious subjects and one with an extreme preference for public debt accumulation. Nevertheless, even the two relatively cautious individuals vote for debt levels that are not sustainable in the long-run.

We wrap up the analysis of the individual behavior with a set of regression models that relate each individual's revealed debt preference to the individual and environmental parameters. Table 6 displays the results of 6 Tobit regressions with robust standard errors in brackets clustered at the individual level. The first three models (models 3, 4, and 5) relate each individual's elicited RDP to that individual's in-game age, elicited risk aversion measure, gender, and to an indicator variable that has the value 1 if the individual's major field of study is in economics or management. Additionally, we include the environmental variable "lagged debt" and "last generation's debt" in the regression models. The former captures the reaction of the individual to the information on the economy's debt in the previous period. The latter captures the reaction of the individual to the information on the debt that the economy inherited from the previous generation (i.e., the debt level that the individual encountered in his very first lifetime period). The last three models (models 6, 7, and 8) additionally include a squared age parameter to allow for a non-linear response of the RDP on the in-game age. (Analogous regression analyses relating the individual's proposed size of the public good and proposed tax to the discussed parameters are contained in the appendix.)

Table 6: Tobit regressions – revealed debt preference (generational configurations)

	model 3	model 4	model 5	model 6	model 7	model 8
	single-gen baseline	multi-gen baseline	OLG baseline	single-gen baseline	multi-gen baseline	OLG baseline
in-game age	4.27***	30.89***	16.68***	-17.80***	-119.76***	14.61
	(0.43)	(3.21)	(4.62)	(1.54)	(12.44)	(16.24)
in-game age squared				0.71***	12.50***	0.19
				(0.06)	(1.18)	(1.52)
lagged debt	0.14*	0.06	-0.03	0.04	0.00	-0.03
	(0.08)	(0.07)	(0.06)	(0.06)	(0.07)	(0.06)
last generation's debt		-0.01	0.02		0.00	0.02
		(0.02)	(0.05)		(0.02)	(0.05)
risk aversion	0.94	3.16	-11.98	-1.99	2.06	-11.97
	(5.79)	(5.94)	(9.70)	(5.10)	(5.98)	(9.68)
male	-37.57	2.30	24.96	-47.62	0.98	24.87
	(41.08)	(17.62)	(27.75)	(38.25)	(17.60)	(27.88)
major in economics	-37.16***	3.74	21.12	-25.98***	5.94	21.16
	(11.64)	(17.97)	(26.24)	(7.80)	(18.36)	(26.22)
constant	-1.89	-123.90***	103.16	149.37***	270.63***	107.75
	(56.74)	(40.30)	(63.60)	(51.83)	(49.44)	(76.91)
N	522	550	344	522	550	344
pseudo R2	0.0162	0.0179	0.0056	0.0303	0.0352	0.0056

Robust standard errors are in parentheses. Test statistics: *** $p \leq 0.01$, ** $p \leq 0.05$, * $p \leq 0.1$

The results of the RDP regression models displayed in table 6 are straightforward. Obviously, the revealed debt preference increases with the in-game age in all treatments. In the single generation and the multi-generation treatments, age has a clearly non-linear effect on RDP. RDP starts out at a low level, increases rather slowly during most of the individual's lifetime, and explodes towards the end. In the OLG treatment, the non-linear effect of in-game age on RDP does not show up, because in-game life does not end abruptly at a predictable point in time. Instead, subjects in the OLG treatment gradually and linearly increase their RDP as their in-game age and, thus, their probability of in-game death increases. Apart from the effect of the in-game age on RDP and a surprisingly large negative effect of studying economics in the single generation treatment, we find no other significant effects.[4] The fact that we find no reaction of subjects' debt preferences to the level of inherited or accumulated debt indicates

[4] It is not surprising to find a negative effect of studying economics on the revealed debt preference, because public debt reduction is a central topic in many macro-economics courses. However, it is astonishing that the effect is only present in the single generation treatment, in which no future generations are affected by the accumulation of public debt. Hence, the prudence that the subjects with a major in economics exhibit seems to be more closely related to the fear of losing money in case of over-indebtedness than to the care for others.

that they are not backwards looking in their decisions on public debt as models of direct or indirect reciprocity would assume.

4.2 The Effect of Debt Ceilings

In this section, we examine the question whether introducing a debt ceiling can effectively limit public debt. From a purely game-theoretic perspective debt ceilings that can be modified at the outset of the period cannot be effective, because they are not binding. Table 7 displays the average observed parameters for the multi-generation and OLG treatments with and without debt ceiling. Figures 4 and 5 depict the development of these parameters over time. The numbers and figures clearly show that introducing a debt ceiling has almost no effect on the provision of public goods and the accumulation of public debt. Using the non-parametric Mann-Whitney U-Test, the only weakly significant difference that we find between the treatments with and without debt ceiling is a slightly higher size of public debt in the multi-generation treatment with a debt ceiling than without (weakly significant MWU-test, two-tailed, $p = 0.074$). Hence, we can conclude that debt ceilings do not affect behavior in any economically relevant way. If they make any difference at all, then it seems that they may be worsening the debt situation in the multi-generation setting.

Table 7: Average observed parameters – Debt ceiling treatments

treatment	average public good provision	average public debt	average number of periods with over-indebtedness	average number of periods with imposed tax
multi-gen baseline	277	385	2.63	4.25
multi-gen DC	277	417	4.00	6.25
OLG baseline	256	455	4.67	7.33
OLG DC	271	440	4.50	6.33

The reason that the debt ceilings are ineffective is that subjects simply lift them basically every time they threaten to constrain new debt. Figure 6 displays the development of the relative frequency of economies with a debt ceiling over time. The striking difference between the multi-generation DC and the OLG DC treatments is that the debt ceilings in the multi-generation DC are all reinstalled after period 11, i.e., after the second generation takes control of the economy. However, the graph in figure 6 also shows that the attempt to reinstall the debt ceiling is successful only at the beginning, but not sustained. By period 20, the number of multi-generation economies with a debt ceiling is back to zero and the third generation that takes control in period 21 makes no further attempt to reinstall the debt ceiling. We also see attempts to reinstall the debt ceiling in the OLG treatment. But due to the heterogeneous generational mix in the OLG economies, the peaks and troughs of the frequency of installed debt ceilings in the OLG DC treatment do not follow a clear pattern and are less pronounced than in the multi-generation DC treatment.

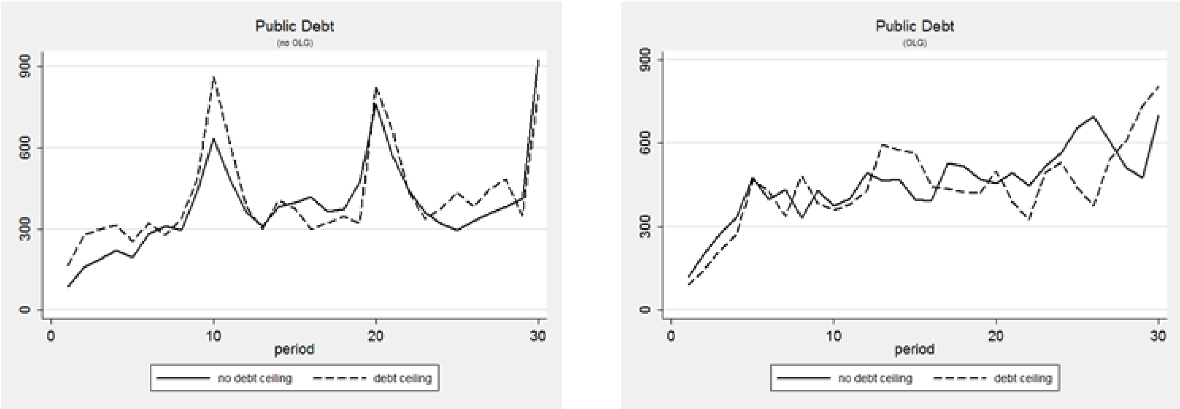

Figure 4: Public debt with and without debt ceiling (multi-gen and OLG)

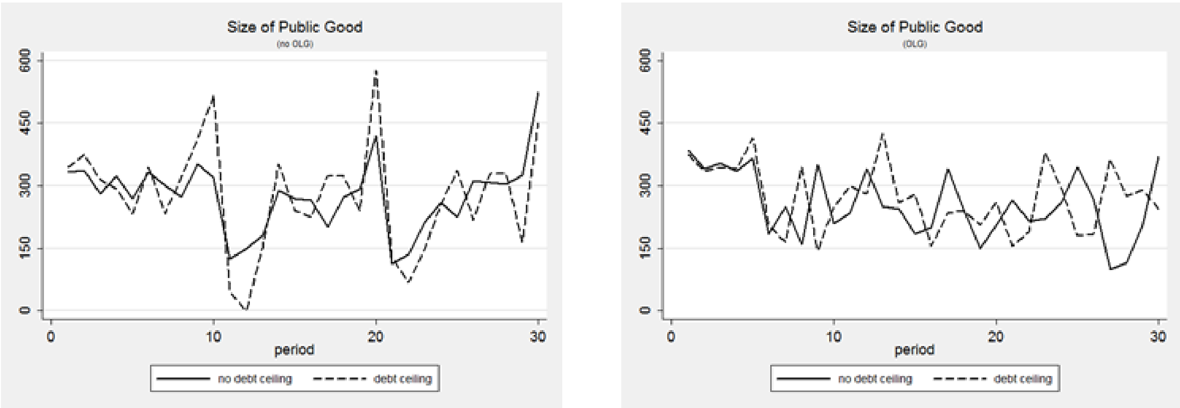

Figure 5: Public good provision with and without debt ceiling (multi-gen and OLG)

Table 8 compares the frequencies and average sizes of the observed deficits across the treatments with and without a debt ceiling. While none of the differences are statistically significant, it seems that debt ceilings do reduce the frequency of periods with a deficit and increase the frequency of balanced budgets slightly. But these lower deficit frequencies come at the price of greater average deficits and – in the multi-generation treatment – at the price of almost 50% more periods of imposed austerity, i.e., over-indebtedness.

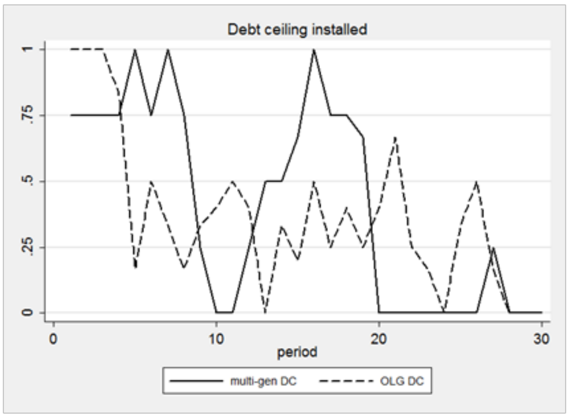

Figure 6: Frequency of debt ceiling installed

Table 8: Frequency and average size of observed deficit – Debt ceiling treatments

treatment	**deficit**		**balanced budget**		**voluntary surplus**		**imposed austerity**	
	rel. freq	mean	rel. freq	mean	rel. freq	mean	rel. freq	mean
multi-gen baseline	0.49	142.9	0.26	0	0.11	66.9	0.14	233.2
multi-gen DC	0.43	189.7	0.32	0	0.05	95.0	0.21	237.0
OLG baseline	0.52	158.1	0.17	0	0.07	57.5	0.24	223.0
OLG DC	0.49	174.8	0.24	0	0.06	132.0	0.21	247.5

As in the previous section, we run Tobit regressions for these treatments with the public debt level and public good size as dependent variables. We use the same model as before, but add the dummy variable "debt ceiling" that takes the value of 1 if the economy is in a debt ceiling treatment. Table 9 displays the results of our regression analysis. The regressions for the multi-generation treatments (model 9 and 10) are shown in second and third columns, while the regressions for the OLG treatments (model 11 and 12) are shown in the fourth and fifth columns of table 9. The debt ceiling dummy exhibits no significant effect on the public debt or the public good in any of the four models. As in the regression analysis of the previous section, the coefficient of the variable "period" is positive and significant in case of the public debt level in both settings, indicating rising public debt over time.

The development and dispersion of individual revealed debt preferences for the debt ceiling treatments are depicted in figures 7 and 8. The graphs underline the impression that debt ceilings have no effect whatsoever on behavior. Comparing the development of the revealed debt preferences in the multi-generation treatments with and without debt ceilings, we find the same prominent "end of lifetime" peaks. Comparing the revealed dept preference dispersions, we find that the median and the minimum RDP are very close to each other in both treatments, but the maximum RDP is well above in almost all periods except in the "end of lifetime" periods. The development and dispersion of the revealed debt preferences are also very similar comparing the plots of the OLG treatments with and without debt ceilings in figure 8. In fact, the Tobit regressions in table 10 that relate the RDP to a debt ceiling dummy and a number of individual and environmental parameters shows no significant effect of introducing a debt ceiling on the debt preferences of subjects. As in the case of the baseline treatments, we only find a clear and strong positive effect of in-game age on the preference for public debt in both treatments. The higher the in-game age, the stronger the preference of the individuals is for accumulating public debt.

Table 9: Tobit public debt and public good regressions – Debt ceiling treatments

	model 9	model 10	model 11	model 12
	multi-gen (no OLG)		OLG	
dependent variable	public debt	public good	public debt	public good
dummy debt ceiling	32.58	-4.56	-14.35	22.54
	(29.87)	(13.66)	(30.77)	(18.37)
period	9.33***	-0.06	11.98***	-4.15***
	(2.02)	(0.95)	(1.82)	(0.85)
constant	239.47***	270.08***	268.26***	292.88***
	(38.43)	(21.27)	(30.97)	(20.44)
N	360	360	360	360
pseudo R squared	0.0095	0.0000	0.0179	0.0024

Robust standard errors are in parentheses. Test statistics: *** $p \leq 0.01$, ** $p \leq 0.05$, * $p \leq 0.1$

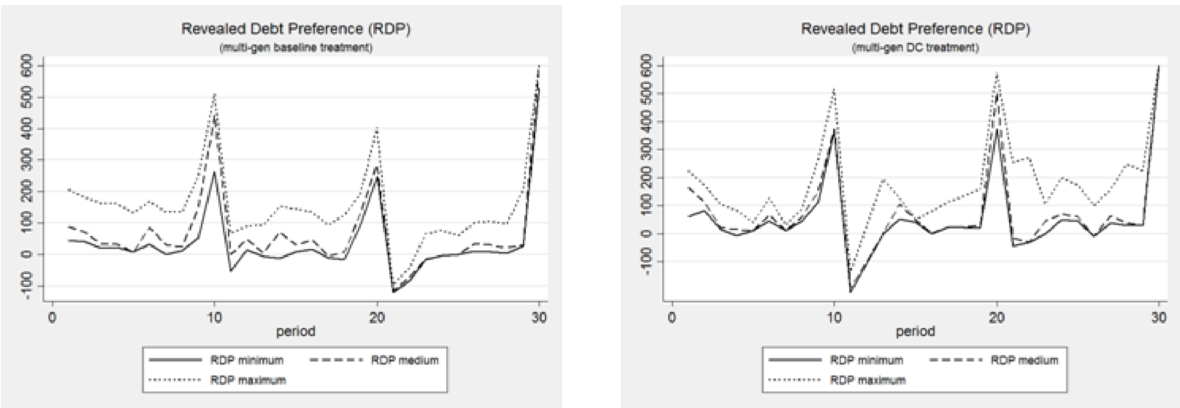

Figure 7: Revealed debt preference (RDP) with and without debt ceiling (no OLG)

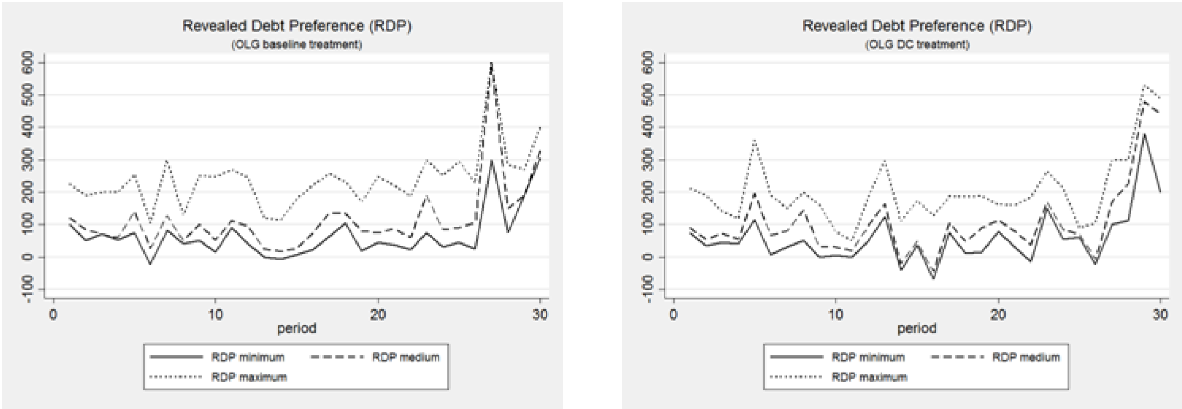

Figure 8: Revealed debt preference (RDP) with and without debt ceiling (OLG)

Table 10: Tobit regressions – revealed debt preference (debt ceiling)

	model 13 multi-gen DC	model 14 OLG DC	model 15 multi-gen DC	model 16 OLG DC
dummy debt ceiling	17.70	-4.38	21.88	-4.56
	(15.04)	(19.94)	(14.78)	(19.94)
in-game age	33.35***	17.07***	-142.04***	19.95*
	(2.47)	(3.69)	(10.25)	(11.54)
in-game age squared			14.38***	-0.27
			(0.93)	(1.13)
lagged debt	0.04	-0.07	-0.01	-0.07
	(0.07)	(0.05)	(0.06)	(0.05)
last generation's debt	-0.01	0.06	0.01	0.06
	(0.02)	(0.04)	(0.02)	(0.04)
risk aversion	5.62	-10.15	4.82	-10.17
	(4.62)	(6.27)	(4.60)	(6.27)
male	-4.49	37.07**	-4.48	37.11**
	(15.09)	(18.28)	(14.88)	(18.28)
major in economics	13.96	11.45	12.93	11.37
	(14.53)	(21.11)	(14.51)	(21.11)
constant	-146.62***	92.67*	310.58***	86.61
	(33.17)	(47.56)	(36.46)	(54.79)
N	811	704	811	704
pseudo R2	0.0193	0.0052	0.0409	0.0052

Robust standard errors are in parentheses. Test statistics: *** $p \leq 0.01$, ** $p \leq 0.05$, * $p \leq 0.1$

4.3 Political Cycles

In contrast to the strong "end of lifetime" peaks (around the periods 10 and 20) that we observe in the multi-generation treatments, we find political cycles driven by in-game age in the OLG treatments (see, for example, figure 4 and 5). These political cycles result from the variation in the age structure that the OLG economies undergo, due to the random in-game death and birth events. To analyze these political cycles we divide the members of each economy into two sub-groups. The "seniors" are those individuals who have reached an in-game age of 5 and, thus, face a positive end of lifetime probability (i.e., all individuals in the periods 5 to 14). The "juniors" are those individuals who have not yet reached the in-game age of 5 and, thus, are sure to survive at least to the next period (i.e., all individuals in the periods 1 to 4). Table 11 displays the average public good and tax proposals that the juniors and seniors made in the OLG treatment with and without a debt ceiling. In both treatments, the juniors propose significantly less public good provision and significantly higher taxes than the seniors (Mann-Whitney U-test, two-tailed, $p \leq 0.01$). Additionally, the number of juniors who vote to keep the current debt ceiling intact (shown in the bottom line of table 11), is significantly larger than the number of seniors (Fisher Exact Test, two-tailed, $p \leq 0.01$).

Table 11: Public good and tax proposals

	OLG baseline			**OLG debt ceiling**		
	juniors	**seniors**	**test**	**juniors**	**seniors**	**test**
Public Good	324	380	p = 0.001	322	380	p < 0.001
Tax	78	58	p < 0.001	80	68	p = 0.010
vote for DC	---	---	---	74%	55%	p = 0.010

Table 12 displays average new debt per period that results from an economy's social choice process. We show the averages separately for economies with a majority of juniors and for economies with a majority of seniors. Interestingly, the social choice process dilutes the differences between the juniors and the seniors that are substantial and significant, when we compare the individual proposals (see above). After the majority vote, we still see a much higher average public debt in the economies with a majority of seniors than in economies with a majority of juniors (122 to 89 and 141 to 72 in the OLG baseline and OLG DC treatments, correspondingly). However, the variance in the social choice of the public debt is so large that the Mann-Whitney U-test does not pick up a significant difference in the OLG baseline treatment and only a weak significance in the OLG DC treatment. Additionally, we find that the propensity to install a debt ceiling is significantly higher in economies with a majority of juniors, 50% compared to 22% when there is a majority of seniors.

Table 12: Voting outcome

	OLG baseline			OLG debt ceiling		
	more juniors	**more seniors**	**test**	**more juniors**	**more seniors**	**test**
new debt	89	122	p = 0.480	72	141	p = 0.061
DC installed	---	---	---	50%	22%	p = 0.001

5 Robustness Checks

5.1 Robustness Check 1: Unanimity

So far we have not been able to identify a reduction or deceleration effect of debt ceilings on public debt. In the following, we analyze how robust these results are with respect to the voting mechanism. To test the robustness of our results with a stricter social choice mechanism, we conducted an additional treatment in which removing and installing the debt ceiling requires unanimity in the popular vote instead of the simple majority. Hence, the debt ceiling in this treatment is only removed (or reinstalled) if all group members agree.

The main results are presented in tables 13 and 14, as well as in figures 9 and 10. Surprisingly, we do not observe any significant differences between the decision patterns in the unanimity treatments and our previous majority treatments (MWU, two-tailed, p-values above 0.1). As in the previous sections, we ran Tobit regressions with public debt and public good size as dependent variable (see table 15). We find no significant influence of this unanimity treatment variable in any of the regressions. Therefore, we conclude that even in an environment in which the debt ceiling can only be removed if all group members agree, we observe no deceleration of debt accumulation.

Table 13: Average observed parameters – Majority and unanimity treatments

treatment	independent observations (number of subjects)	average public good provision	average public debt	average number of periods with over-indebtedness	average number of periods with imposed tax
multi-gen DC (majority)	4 (36)	277	417	4.00	6.25
multi-gen DC (unanimity)	4 (36)	289	389	3.00	4.50
OLG DC (majority)	6 (75)	271	440	4.50	6.33
OLG DC (unanimity)	6 (72)	261	460	4.17	6.83

Table 14: Deficit behavior (unanimity)

treatment	**deficit**		**balanced budget**		**voluntary surplus**		**imposed austerity**	
	rel. freq	mean	rel. freq	mean	rel. freq	mean	rel. freq	mean
multi-gen DC (majority)	0.43	189.7	0.32	0	0.05	95.0	0.21	237.0
multi-gen DC (unanimity)	0.39	167.9	0.38	0	0.08	63.3	0.15	223.3
OLG DC (majority)	0.49	174.8	0.24	0	0.06	132.0	0.21	247.5
OLG DC (unanimity)	0.41	194.0	0.33	0	0.03	45	0.23	212.2

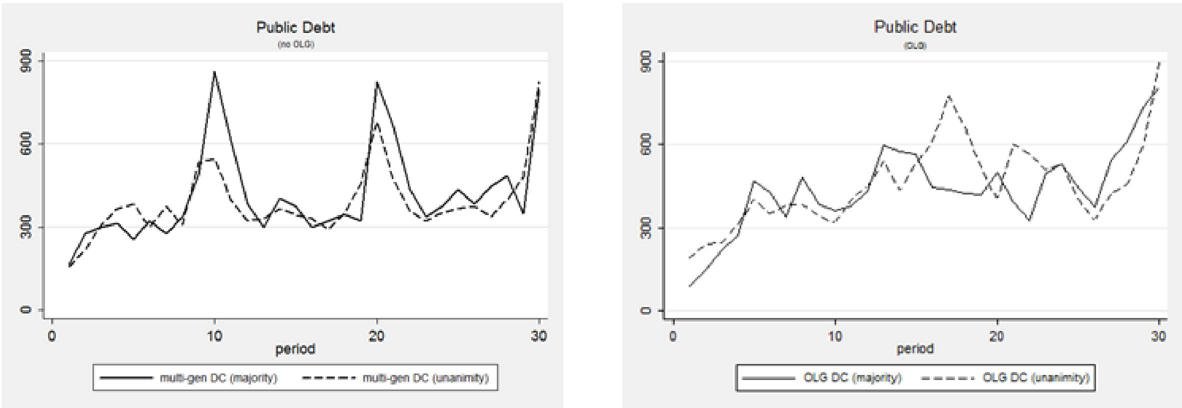

Figure 9: Public debt level with majority and unanimity voting on debt ceiling (no OLG and OLG)

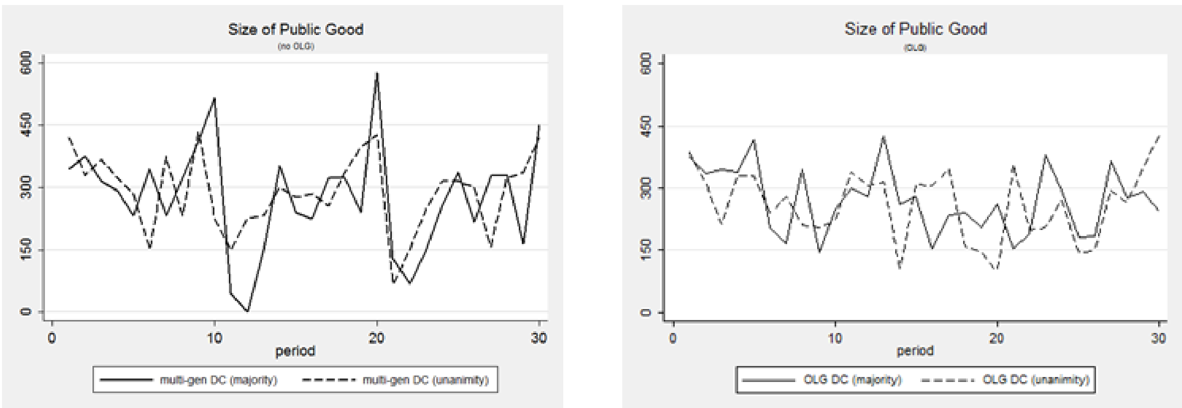

Figure 10: Size of Public Good with majority and unanimity voting on debt ceiling (no OLG and OLG)

Table 15: Tobit regressions – unanimity

	model 17	model 18	model 19	model 20
	multi-gen (no OLG)		OLG	
dependent variable	public debt level	size of public good	public debt level	size of public good
dummy unanimity	-27.88	16.47	5.20	9.41
	(22.03)	(10.95)	(38.92)	(22.85)
Period	6.91***	-1.26	11.58***	-3.30***
	(1.76)	(1.20)	(1.84)	(1.13)
Constant	309.54***	282.53***	274.46***	280.35***
	(38.91)	(20.97)	(31.32)	(22.78)
N	240	240	360	360
pseudo R squared	0.0074	0.0004	0.0150	0.0015

Robust standard errors are in parentheses. Test statistics: *** $p \leq 0.01$, ** $p \leq 0.05$, * $p \leq 0.1$

5.2 Robustness Check 2: OLG with Friends

One limitation of our design is that bequest motives only play a minor role in our treatments with anonymous strangers. To test whether bequest motives influence behavior when there are social ties across generations, we ran an additional treatment as a robustness check. For this purpose, we used the design of the OLG baseline treatment, but invited groups of friends as our subjects.[5] As the economy consists of three group members in each period, we recruited three groups of friends per session. Over time, we replaced each member of the economy whose lifetime ended by one of his or her friends.

The main results of this treatment compared to the results of the OLG baseline treatments are shown in tables 16 and 17, as well as in figure 8. Again, we do not observe any different decision patterns in the OLG treatment with friends compared to the treatment with strangers. None of the comparisons between the main variables are significant (MWU, two-tailed, p-values above 0.1).

As in the previous sections, we ran Tobit regressions with public debt and public good size as dependent variable (see table 18). To control for bequest motives, we use a dummy variable

[5] The only criterion to participate in the experiment as a group of friends is that all individuals must be friends since at least one year.

“friends”. In both regression analyses, we find no significant influence of this dummy variable. Therefore, we can conclude that even in an environment with friends, in which intergenerational ties may evoke bequest motives, debt accumulation strongly harming future generations is not reduced.

Table 16: Average observed parameters – Friends treatment

treatment	independent observations (number of subjects)	average public good provision	average public debt	average number of periods with over-indebtedness	average number of periods with imposed tax
OLG baseline	6 (74)	256	455	4.67	7.33
OLG baseline with friends	6 (73)	237	454	4.33	7.67

Table 17: Deficit behavior (friends)

treatment	deficit		balanced budget		voluntary surplus		imposed austerity	
	rel. freq	mean	rel. freq	mean	rel. freq	mean	rel. freq	mean
multi-gen DC (majority)	0.52	158.1	0.17	0	0.07	57.5	0.24	223.0
OLG DC (unanimity)	0.48	165.5	0.17	0	0.09	91.9	0.26	214.6

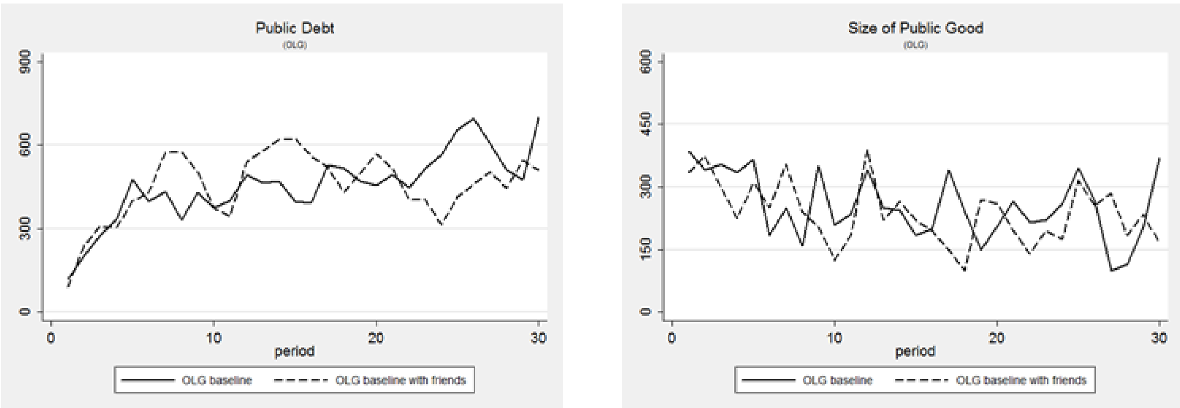

Figure 13: Public debt level and public good size with and without friends

Table 18: Tobit regressions – friends

	model 25	model 26
dependent variable	public debt level	size of public good
dummy friends	-0.67	-18.74
	(38.93)	(18.59)
Period	8.60***	-4.82***
	(2.21)	(0.75)
Constant	320.63***	302.60***
	(36.53)	(19.95)
N	360	360
pseudo R squared	0.0084	0.0031

Robust standard errors are in parentheses. Test statistics: *** $p \leq 0.01$, ** $p \leq 0.05$, * $p \leq 0.1$

6 Discussion

The aim of this paper is to gain a better understanding of the behavioral foundations and the dynamics of debt emergence. We find that on the behavioral level the main driving force behind the public debt is the intergenerational transmission of the tax burden. Without the possibility to shift the burden of public debt to future generations, individuals vote for a prudent public debt policy that avoids excessive indebtedness by all means. When burden of debt can be passed to future generations, however, we observe that individuals vote for the provision of excessive amounts of public goods that are debt financed. Over generations massive debt is accumulated leading to a high risk of financial meltdown followed by penalty taxations. Despite clear evidence of these financial threats for future generations, most individuals do not vote to reduce public expenditure. Even in small groups with strong social ties across generations we find no evidence of intergenerational concern, when it comes to the accumulation of public debt.

We additionally study the effect of absolute debt ceilings on the debt financing of public goods. We find debt ceilings that can be modified by popular vote are completely ineffective. The size and speed of debt accumulation is not affected by debt ceilings. Instead, we find that voters quickly learn to adapt debt ceilings to their unabated request for excessive amounts of debt financed public goods.

Furthermore, we can show that laboratory economies with overlapping generations create the smooth debt accumulation that is generally observed in real economies. In these overlapping generation economies total debt is higher than in multi-generational economies with homogeneous populations. Additionally, we observe political cycles in the economies with overlapping generations. A detailed analysis of the observed political cycles reveals that public debt problems are exacerbated with ageing population as older individuals tend to vote for higher levels of public debt and the elimination of debt ceilings more frequently than younger individuals. Thus, a demographic shift towards a higher aged population is likely to aggravate the financial situation of an economy and to make it more difficult to find a sustainable intergenerational balance in the public budget.

The most surprising result of our experiments is that we observe much less sense for intergenerational fairness or altruistic concerns for other generations than we expected. The behavioral literature offers a great number of findings which demonstrate that people harbor motivations like fairness, reciprocity or altruism. But in the intergenerational context we have in our experiment nearly none of these motivations seems to be of importance. On the opposite, subjects behave in a remarkable way as the economic model of rational behavior would predict. As long as it is in their own selfish interest, they do not hesitate to shift the heavy burden of public debt to the next generation. Of course our experiments do not cover a particular motive that may in reality attenuate the willingness to bedevil the next generation. The care for the own children and the concern that public debt might be a too heavy load to carry for them. This could be a concern parents may have. On the other hand it seems to be true that our results very well mirror what happened in the last two decades in many developed countries. Thus, it is an open question if the concern for children really is a decisive motive when it comes to the question of public debt.

Appendix

Table A1: Tobit regressions – public good size (generational configurations)

	model 3 single-gen baseline	model 4 multi-gen baseline	model 5 OLG baseline	model 6 single-gen baseline	model 7 multi-gen baseline	model 8 OLG baseline
in-game age	3.35***	19.38***	21.84***	-12.51***	-66.91***	14.11
	(0.76)	(3.13)	(6.24)	(2.00)	(12.02)	(19.40)
in-game age squared	0.02	-0.02	-0.07	-0.06	-0.05	-0.07
	(0.06)	(0.09)	(0.08)	(0.05)	(0.09)	(0.08)
lagged debt		-0.02	0.00		-0.01	0.00
		(0.03)	(0.07)		(0.03)	(0.07)
last generation's debt	-2.61	0.87	-16.28*	-4.71	0.27	-16.27*
	(4.55)	(8.27)	(8.54)	(4.08)	(8.16)	(8.50)
risk aversion	-6.02	39.93*	87.27***	-13.07	39.65*	87.01***
	(28.34)	(22.10)	(30.50)	(25.18)	(22.03)	(30.47)
male	-26.30**	-16.81	3.10	-18.27**	-15.67	3.33
	(12.01)	(20.17)	(30.60)	(9.04)	(20.32)	(30.49)
major in economics				0.51***	7.18***	0.71
				(0.06)	(1.07)	(1.94)
constant	297.83***	223.74***	323.62***	406.24***	448.21***	340.56***
	(28.93)	(51.42)	(69.67)	(26.77)	(53.07)	(77.19)
N	522	550	344	522	550	344
pseudo R2	0.0124	0.0110	0.0141	0.0250	0.0184	0.0141

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A2: Tobit regressions – tax (generational configurations)

	model 3 single-gen baseline	model 4 multi-gen baseline	model 5 OLG baseline	model 6 single-gen baseline	model 7 multi-gen baseline	model 8 OLG baseline
in-game age	-2.80	-11.01***	-10.55***	10.72**	49.93***	-0.00
	(2.30)	(2.37)	(2.42)	(4.73)	(10.23)	(7.58)
in-game age squared	-0.15	-0.11**	-0.05	-0.07	-0.09*	-0.05*
	(0.11)	(0.05)	(0.03)	(0.11)	(0.05)	(0.03)
lagged debt		0.00	0.01		-0.00	0.01
		(0.02)	(0.03)		(0.02)	(0.03)
last generation's debt	6.78	-6.06	11.01*	10.19	-5.43	11.06*
	(11.96)	(6.55)	(6.00)	(11.78)	(6.45)	(5.94)
risk aversion	82.56*	17.78	-0.80	85.02*	18.05	-0.41
	(46.23)	(18.38)	(12.11)	(46.30)	(18.10)	(12.06)
male	98.30**	-1.01	-1.71	84.36**	-1.74	-2.01
	(39.56)	(18.83)	(11.77)	(35.62)	(18.70)	(11.70)
major in economics				-0.42**	-4.97***	-0.96
				(0.20)	(0.95)	(0.71)
constant	130.46*	249.67***	93.82**	23.34	82.23*	70.04*
	(73.49)	(51.49)	(37.65)	(59.24)	(48.16)	(40.10)
N	522	550	344	522	550	344
pseudo R2	0.1030	0.0307	0.0259	0.1213	0.0491	0.0267

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A3: Tobit regressions – public good size (debt ceiling)

	model 13 multi-gen	model 14 OLG	model 15 multi-gen	model 16 OLG
dummy debt ceiling	10.31	1.04	13.05	1.17
	(20.77)	(21.64)	(20.84)	(21.51)
in-game age	21.19***	20.88***	-82.02***	18.58
	(2.42)	(4.23)	(9.68)	(14.55)
in-game age squared			8.50***	0.22
			(0.83)	(1.52)
lagged debt	-0.02	-0.08	-0.05	-0.08
	(0.08)	(0.05)	(0.08)	(0.05)
last generation's debt	-0.03	-0.01	-0.02	-0.01
	(0.02)	(0.05)	(0.02)	(0.05)
risk aversion	6.04	-14.21**	5.59	-14.20**
	(7.24)	(6.19)	(7.18)	(6.19)
male	32.91*	83.08***	33.19*	83.06***
	(17.94)	(19.69)	(17.80)	(19.67)
major in economics	9.38	-4.34	8.79	-4.27
	(19.55)	(25.20)	(19.62)	(25.15)
constant	185.33***	331.83***	452.70***	336.62***
	(46.49)	(50.21)	(47.93)	(54.89)
Observations	811	704	811	704
Pseudo R2	0.0124	0.0119	0.0228	0.0119

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A4: Tobit regressions – tax (debt ceiling)

	model 13 multi-gen	model 14 OLG	model 15 multi-gen	model 16 OLG
dummy debt ceiling	8.59	11.73	7.19	11.43
	(14.29)	(9.37)	(14.40)	(9.37)
in-game age	-11.57***	-7.93***	60.68***	-2.79
	(2.07)	(1.96)	(9.33)	(6.22)
in-game age squared			-5.82***	-0.48
			(0.85)	(0.63)
lagged debt	-0.14***	-0.03	-0.11**	-0.03
	(0.05)	(0.02)	(0.05)	(0.02)
last generation's debt	0.00	-0.01	-0.01	-0.01
	(0.02)	(0.02)	(0.02)	(0.02)
risk aversion	-9.24*	8.29**	-8.65*	8.29**
	(5.08)	(3.47)	(5.00)	(3.46)
male	21.59	3.41	21.34	3.51
	(15.12)	(8.79)	(14.83)	(8.79)
major in economics	-7.66	1.86	-6.97	1.69
	(14.47)	(10.25)	(14.40)	(10.23)
constant	281.63***	88.56***	83.49**	77.58***
	(44.36)	(25.59)	(35.81)	(27.16)
Observations	811	704	811	704
Pseudo R2	0.0339	0.0147	0.0572	0.0149

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A5: Tobit regressions – public good size (unanimity)

	model 21 multi-gen	model 22 OLG	model 23 multi-gen	model 24 OLG
dummy unanimity	-30.25	-15.78	-31.24	-14.97
	(26.48)	(21.60)	(25.83)	(20.83)
in-game age	21.23***	15.70**	-89.75***	22.45
	(2.66)	(6.21)	(10.21)	(18.20)
in-game age squared			9.07***	-0.59
			(0.88)	(1.93)
lagged debt	-0.03	-0.01	-0.03	-0.01
	(0.11)	(0.07)	(0.11)	(0.08)
last generation's debt	-0.02	0.00	-0.01	0.00
	(0.03)	(0.05)	(0.03)	(0.05)
risk aversion	1.27	-1.84	1.92	-1.94
	(8.00)	(8.51)	(7.92)	(8.53)
male	20.18	84.24***	19.92	84.16***
	(24.57)	(23.60)	(23.88)	(23.55)
major in economics	45.74	29.35	40.61	28.76
	(39.63)	(30.00)	(39.23)	(29.70)
constant	200.69**	252.74***	480.04***	238.04***
	(77.91)	(65.68)	(81.60)	(73.50)
Observations	546	715	546	715
Pseudo R2	0.0130	0.0078	0.0256	0.0079

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A6: Tobit regressions – tax (unanimity)

	model 21 multi-gen	model 22 OLG	model 23 multi-gen	model 24 OLG
dummy unanimity	11.94	2.04	11.27	1.74
	(21.71)	(10.17)	(21.55)	(10.09)
in-game age	-11.74***	-6.24**	78.56***	-8.65
	(3.38)	(2.43)	(15.42)	(7.20)
in-game age squared			-7.23***	0.21
			(1.33)	(0.69)
lagged debt	-0.27***	-0.05	-0.26***	-0.04
	(0.09)	(0.03)	(0.09)	(0.03)
last generation's debt	-0.01	-0.03	-0.03	-0.03
	(0.02)	(0.02)	(0.03)	(0.02)
risk aversion	-3.04	2.36	-2.89	2.39
	(6.04)	(4.09)	(6.01)	(4.12)
male	21.02	1.83	21.36	1.82
	(20.56)	(10.49)	(20.28)	(10.50)
major in economics	-30.77	-3.82	-26.60	-3.58
	(27.04)	(13.40)	(27.10)	(13.36)
constant	339.48***	141.24***	97.18*	146.58***
	(66.52)	(32.18)	(51.65)	(32.49)
Observations	546	715	546	715
Pseudo R2	0.0329	0.0103	0.0560	0.0103

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A7: Tobit regressions – public good size (friends)

	(1)	(3)
dummy friends	-25.99	-25.78
	(22.58)	(22.61)
in-game age	20.69***	3.16
	(4.15)	(13.34)
in-game age squared		1.63
		(1.33)
lagged debt	-0.13**	-0.12**
	(0.06)	(0.06)
last generation's debt	0.04	0.04
	(0.04)	(0.04)
risk aversion	-7.50	-7.55
	(7.77)	(7.73)
male	63.92***	64.13***
	(21.95)	(21.99)
major in economics	2.70	2.81
	(23.47)	(23.40)
constant	307.58***	345.17***
	(54.93)	(59.23)
Observations	690	690
Pseudo R2	0.0092	0.0094

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A8: Tobit regressions – tax (friends)

	(1)	(3)
dummy friends	-2.44	-2.52
	(9.67)	(9.60)
in-game age	-9.19***	2.39
	(1.83)	(5.79)
in-game age squared		-1.06*
		(0.57)
lagged debt	-0.04	-0.04*
	(0.02)	(0.02)
last generation's debt	-0.00	-0.00
	(0.02)	(0.02)
risk aversion	5.41	5.48
	(4.25)	(4.20)
male	11.86	11.67
	(9.56)	(9.54)
major in economics	-11.79	-11.80
	(10.27)	(10.17)
constant	111.92***	86.51***
	(27.46)	(29.18)
Observations	690	690
Pseudo R2	0.0173	0.0183

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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