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Abstract

We replicate Meissner (2016) where debt aversion was reported for the first time in an intertemporal consumption and saving problem. While Meissner (2016) uses a German sample, our subjects are US undergraduate students. All of the main findings from the original study replicate, with similar effect sizes. Additionally, we extend the original analysis by correlating a new individual index of debt aversion on individual characteristics such as gender, cognitive ability, and risk aversion. The findings suggest that gender and risk aversion are not correlated with debt aversion. However, cognitive ability is positively correlated with debt aversion. Overall, this paper confirms the importance of debt aversion in intertemporal consumption problems and validates the approach of Meissner (2016).

JEL Classification C91 · D84 · G11 · G41

Keywords Debt Aversion, Replication, Experiment

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1 Introduction

Debt is a powerful tool to allocate resources over time. Used appropriately, it increases welfare and fosters growth (Cecchetti et al., 2011). Yet, many people show an aversion to debt with far-reaching consequences for individual welfare and economic growth. For instance, debt averse entrepreneurs might pass on profitable investment opportunities (Paaso et al., 2021), debt averse households might waive profitable retrofit investments (Schleich et al., 2021), and debt averse high school students might forego a college or university degree (Callender and Jackson, 2005; Boatman et al., 2017; Callender and Mason, 2017).

In a recent laboratory experiment with German undergraduates, Meissner (2016) studies the role of debt in an intertemporal consumption and saving problem.[1] According to theory, subjects optimally allocate their expected lifetime income over time, saving when income is high and borrowing when income is low (e.g., Fisher, 1930; Friedman, 1957; Modigliani, 1986). By contrast, the experimental results of Meissner (2016) show that subjects generally fail to solve such intertemporal optimization problem. Furthermore, subjects display a striking reluctance to smooth consumption using debt which is not present in the context of consumption smoothing via savings. Meissner (2016) interprets this finding as a case of debt aversion.

This paper is an exact replication in the sense of Chen et al. (2021) of the experiment by Meissner (2016).[2] There are several reasons to replicate this study. First, debt aversion is a relevant problem that has not yet received a lot of attention in the dynamic optimization literature (see, e.g., Duffy (2016)). Replicating the existing work lends credibility to the limited existing results. Second, the task in the original experiment is complex, so reproducing the original results will help establish a reliable experimental design to study debt aversion. Thirdly, Meissner (2016) uses a sample of the student population in Germany, a country which - by international standards - is known for moderate levels of household debt (e.g., Christelis et al., 2021), an excessive reliance on cash payments (e.g., von Kalckreuth et al., 2014; Bagnall et al., 2016), and low tuition fees for higher

[1] For an extensive survey of laboratory experiments on dynamic stochastic optimization problems see Duffy (2016).

[2] While the author of the original experiment is an author of the present paper, he was not directly involved in running the new experimental sessions.

education (e.g., OECD, 2021), which imply low levels of student debt. Therefore, it is feasible that the observed debt aversion in Meissner (2016) is an artifact of a population with no previous experience acquiring debt (Duffy, 2016) or even of the German cultural abhorrence of debt. As Nietzsche notes, in German debt is spelled as "Schuld," which means both "debt" and "guilt," to argue that "debt" *with oneself* is the source of guilt/bad conscience (Nietzsche, 2021).

It is well-known that culture matters in experimental settings (Henrich et al., 2001; Chen et al., 2021), so, against this background, we use a population composed of undergraduate students at the University of Illinois at Urbana-Champaign (UIUC) to test the robustness of the results of Meissner (2016). The US is known for having a more tolerant view of debt (Calder, 2009) and for encouraging it through its institutions (Garon, 2011). Therefore, as is common in the United States, students at UCIC incur in student debt to pay for tuition fees and other expenses during their studies. The U.S. Department of Education reports an average annual cost of studying at UIUC of 15,880 USD and a median total debt after graduation between 15,000 USD and 26,000 USD depending on the field of study.[3] Therefore, it is safe to assume that the student body at UIUC is less restrictive about acquiring debt and have homegrown experience acquiring it compared to German students.

Furthermore, we extend the original analysis of Meissner (2016) by developing an index of debt aversion that allows us to compare debt aversion of students in the original sample of Meissner (2016) to the students from UIUC. Additionally, we collect information on subjects' gender, risk aversion, and cognitive ability. We are especially interested in subjects' cognitive ability, as it is a strong determinant in the financial behavior of subjects both in and outside the laboratory (see Gomes et al. (2021) and Bosch-Rosa and Corgnet (2022) for an overview of results in the field and the lab, respectively). Specifically, we measure cognitive ability using the Cognitive Reflection Test (CRT, hecenforth) of Frederick (2005). The advantage of the CRT is that it tests subjects' cognitive ability beyond their numerical skills, and has been shown to correlate with the ability to solve dynamic optimization problems Ballinger et al. (2011).

[3] These cost includes tuition, living costs, books and supplies, and fees minus the average grants and scholarships for federal financial aid recipients. See deatils at https://collegescorecard.ed.gov/school/?145637-University-of-Illinois-Urbana-Champaign

Our results show that the findings from Meissner (2016) replicate. Subjects fail to smooth consumption optimally and are disproportionately reluctant to smooth consumption via debt compared to savings. Moreover, both samples show similar effect sizes and there appears to be no difference in the degree of debt aversion between the two population samples. Regarding the determinants of debt aversion within the US sample, cognitive ability is negatively correlated with deviations from optimal consumption, but positively correlated with debt aversion. On the other hand, risk aversion and gender do not appear to be correlated with debt aversion.

The remainder of the paper is organized as follows. Section 2 presents the experimental design, Section 3 reports the results of the replicated experiment and how personal characteristics correlate with the new debt aversion index. Finally, Section 4 concludes.

2 Experimental Design

The design of the experiment is identical to Meissner (2016) and implements a simple life-cycle model of consumption. In each period of a life-cycle ($t = 1, \dots, 20$), subjects choose how much of their wealth (w_t) to consume (c_t) and how much to save (a_t). Savings can be positive or negative and negative savings are referred to as borrowings. We abstract from any interest payments on savings or debt and there is no discounting. Each period, subjects are provided with an exogenous income (y_t), which follows a trend stationary stochastic process. Consequently, wealth in period t is defined as $w_t = y_t + a_{t-1}$. In the initial period of a life-cycle, subjects start with zero savings ($a_0 = 0$) and in the final period of the life cycle all wealth has to be consumed as saving is not possible ($a_{20} = 0$). Taken together, the latter two restrictions imply that life-cycle consumption has to equal life-cycle income, i.e. $\sum_{t=1}^{20} c_t = \sum_{t=1}^{20} y_t$.

Consumption decisions are incentivized using a time-separable CARA utility function of the form $u(c_t) = 250\left(1 - e^{-\theta c_t}\right)$, where θ denotes the parameter of absolute risk aversion which we set equal to 0.02 as in Meissner (2016). The subject's objective is to choose a stream of consumption that maximizes her life-cycle utility. Therefore, in any period τ, the decision problem of subject is given by:

$$\max_{c_t} E_t \sum_{t=\tau}^{T} u(c_t), \tag{1}$$

$$c_t + a_t = w_t, \tag{2}$$

$$w_t = y_t + a_{t-1}, \tag{3}$$

$$a_0 = 0, a_T = 0. \tag{4}$$

Given CARA utility, Meissner and Rostam-Afschar (2017) show that for any income process $y_t = y_0 + st + \varepsilon_t$, where $P(\varepsilon_t = \sigma_\varepsilon) = P(\varepsilon_t = -\sigma_\varepsilon) = 0.5$, $\forall t$, period-t optimal consumption is given by

$$c_t^*(w_t) = \frac{1}{T-t+1}\left[w_t + \zeta_t - \Gamma_t(\theta\sigma_\varepsilon)\right], \tag{5}$$

$$\zeta_t = (T-t)\left(y_0 + s\left(\frac{T+t+1}{2}\right)\right), \tag{6}$$

$$\Gamma_t(\theta\sigma_\varepsilon) = \sum_{j=0}^{T-t}\sum_{i=1}^{j} \log\cosh\left(\frac{\theta\sigma_\varepsilon}{T-t+1-i}\right), \tag{7}$$

where ζ_t is the expected life-time income $\zeta_t = E_t\left[\sum_{j=1}^{T-t} y_{t+j}\right]$ and $\Gamma_t(\theta\sigma_\varepsilon)$ are precautionary savings. Equations (5)-(7) imply a smooth consumption path over the life-cycle for the given income process specified above.

The treatments in this experiment differ with respect to the income process. In the *borrowing treatment*, subjects face an income process $y_t^B = 10t + \varepsilon_t$, which is increasing over the life cycle. In order to smooth consumption, subjects have to borrow early on in their life-cycle and repay their debt from high income later in the life-cycle. In the *saving treatment*, subjects face a decreasing income process given by $y_t^S = 210 - 10t + \varepsilon_t$. Here subjects have to save early in the life-cycle and then live of their savings later on. In each period, the shock ε_t takes the value of $+10$ with 50% probability and the value of -10 with 50% probability. Given the same shock sequence, equations (5)-(7) imply the same optimal consumption path for both, the increasing and the decreasing income process. Figure 1 provides an example and shows the increasing (dashed line) and decreasing (dotted line) income process for a given shock sequence and the associated optimal consumption path (solid line).

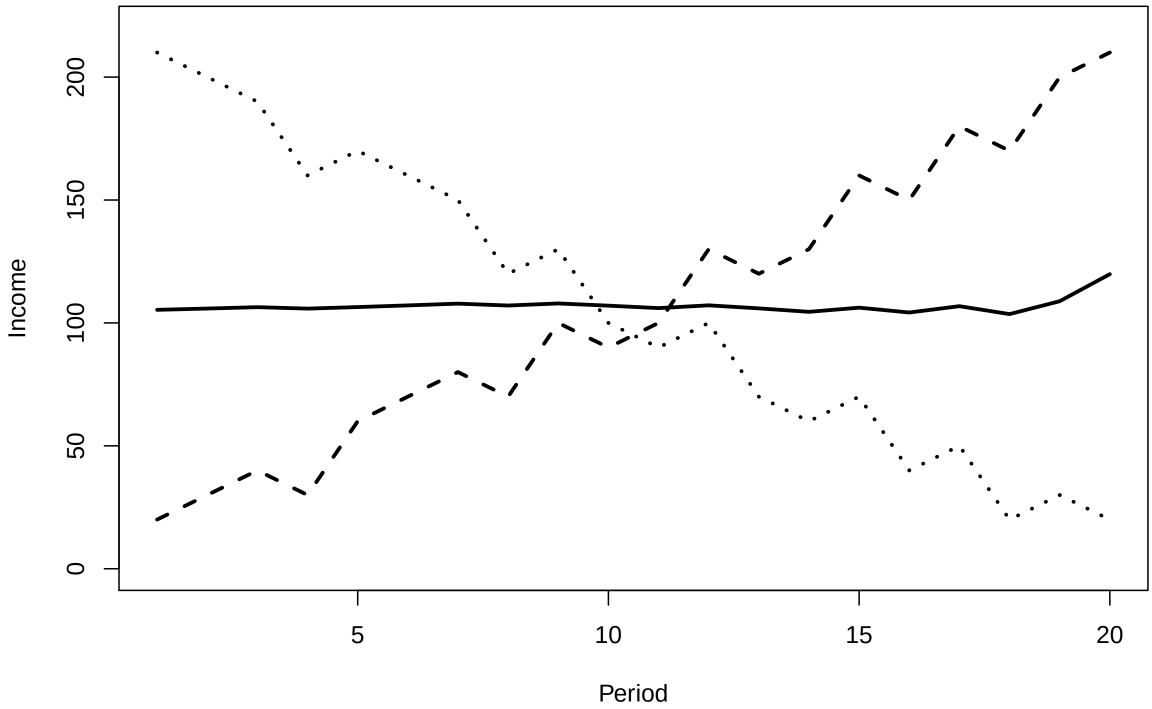

Figure 1: Example increasing and decreasing income streams and optimal consumption

To assess learning effects and to add a within-subject dimension, each subject plays three rounds of the borrowing treatment and three rounds of the savings treatment.

2.1 Experimental Procedures

In each session, subjects took part in six rounds, each of them 20 periods long. In the Borrowing First (BF) sessions, subjects participated in the *borrowing treatment* for three rounds followed by three rounds of *saving treatment*. In the Saving First (SF) sessions, the order of the treatments was inverted. While subjects knew that the session had six rounds, the specific instructions for each type of income process were read immediately before the start of each three-round sequence.

The experiment was conducted during the Fall of 2016 at the University of Illinois at Urbana-Champaign.The experimental software was written in z-Tree (Fischbacher, 2007). In total, 91 subjects participated in the experiment, 44 subjects in the Borrowing First sessions and 47 subjects in the Saving First sessions. The length of each session was around 60 minutes and approximately 40% of subjects were female. On average, subjects earned \$19.12. The minimum payoff was \$5.

3 Results

3.1 Consumption Choices

Figure 2 shows the mean and median consumption over all subjects of the Borrowing First sessions (upper two graphs) and the Savings First sessions (lower two graphs). The blue solid lines represent the results for the US sample, while the red dashed lines represent the results for the German sample from Meissner (2016). The black solid line marks the optimal consumption path according to equations (5)-(7).

For both samples the mean and median consumption increases steadily over the life-cycle when the income stream is increasing, whereas they decrease steadily over the life-cycle when the income stream is decreasing. Furthermore, in both cases, the mean and median consumption profiles are generally much steeper (i.e. less smooth) for increasing income streams relative to consumption profiles arising from decreasing income streams. Such similarities point towards a comparable behavior of subjects across both populations.

To further analyze individual behavior of subjects, we follow Meissner (2016) and define three different ways to measure the deviations from optimal consumption m_1, m_2, and m_3:

$$m_1 = \sum_{t=1}^{20} \left(c_t^*(w_t) - c_t\right) \tag{8}$$

$$m_2 = \sum_{t=1}^{20} \left|c_t^*(w_t) - c_t\right| \tag{9}$$

$$m_3 = \sum_{t=1}^{20} \left(u(c_t^*(w_t^*)) - u(c_t)\right), \tag{10}$$

where $c_t^*(w_t)$ is optimal consumption conditional on current wealth and $c_t^*(w_t^*)$ is the unconditional optimal consumption as a function of the optimal wealth. These measures summarize the accumulated deviations of a subject within each life-cycle, allowing us to study how subjects behave under each type of income stream. For example, for measure m_1, any value above zero means that subjects are under-consuming, while values below

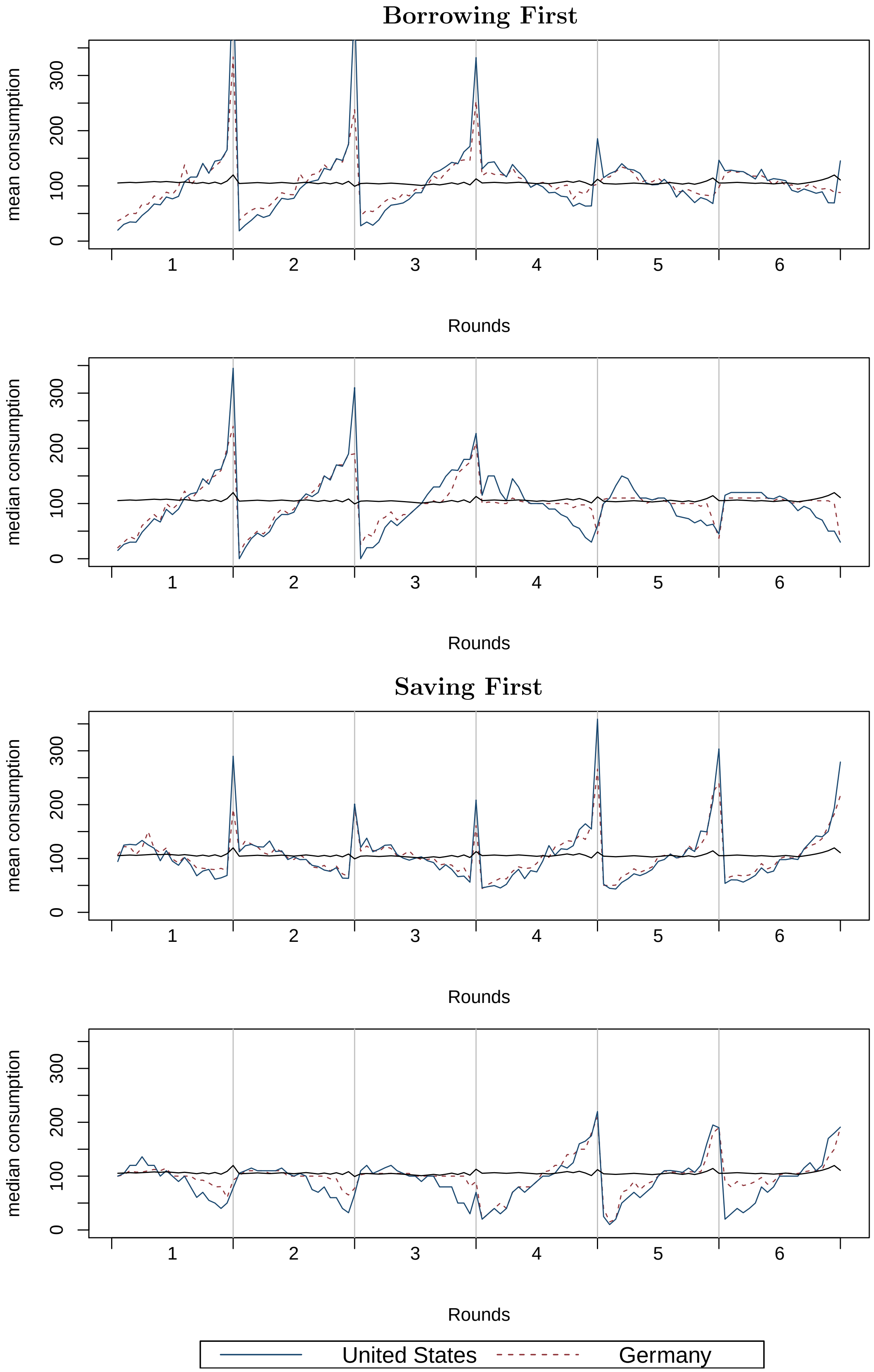

Figure 2: Median consumption

zero imply over-consumption. On the other hand, measure m_2 allows us to measure the absolute deviations from optimal consumption, and m_3 the loss of utility derived from such over-/under-consumption

In Figure 3 we plot the median of measures *m1*, *m2*, and *m3* across all subjects for each round and country. The behavioral patterns appear to be similar across countries, with both types of subjects over-consuming in savings rounds and under-consuming in borrowing rounds (see *m1*). It is also clear that US subjects perform worse than those from Germany, as measure *m2* appears higher for the US than for Germany (i.e., US subjects consume relatively less than Germans in borrowing rounds and consume relatively too much in saving rounds). Importantly, across all three measures the median deviation is significantly higher for both countries when subjects face an increasing income stream (i.e., when they should borrow) than when they face a decreasing income stream (i.e., when they should save).

In most cases, the differences in deviation for the different income streams are statistically different as shown in Table 1, where we report the exact values for the median of each measure and order as well as the p-values for each pair-wise Mann-Whitney U test. Importantly, the relative differences in deviations from optimal consumption in the saving and borrowing rounds are similar across samples. This can be seen in Table 3.1 where we report the effect sizes of the difference in deviations across treatments for each measure and country.[4] In all cases, the effect sizes are relatively close to each other except for rounds 1 to 3 for m_2, which are slightly larger for the US sample. This difference is most likely driven by the large deviations from optimal consumption in the first round of the savings treatment for the US sample (see the middle panel of Figure 3).

In fact, while in Meissner (2016) subjects seems to improve in their consumption decisions over time, the new sample seems to be consistently worse in the borrowing scenarios than in the saving ones. To study the learning of subjects, in Table 3 we replicate Table 2 of Meissner (2016) and present the *median differences* in measure m_2 between consecutive rounds ($\Delta_r^{r-1} m2$) and with the first round ($\Delta_r^{1} m2$). As in the original data, we see how the differences between consecutive rounds of the same type (saving or borrowing) are positive and significant in all cases except one. Also, as in Meissner (2016),

[4]To report effect sizes we calculate Cohen's D for each measure (m_1, m_2, m_3) across both samples. In our case, the standardized difference of the mean deviation from optimal consumption between the saving and borrowing treatments. For more details see Cohen (1988).

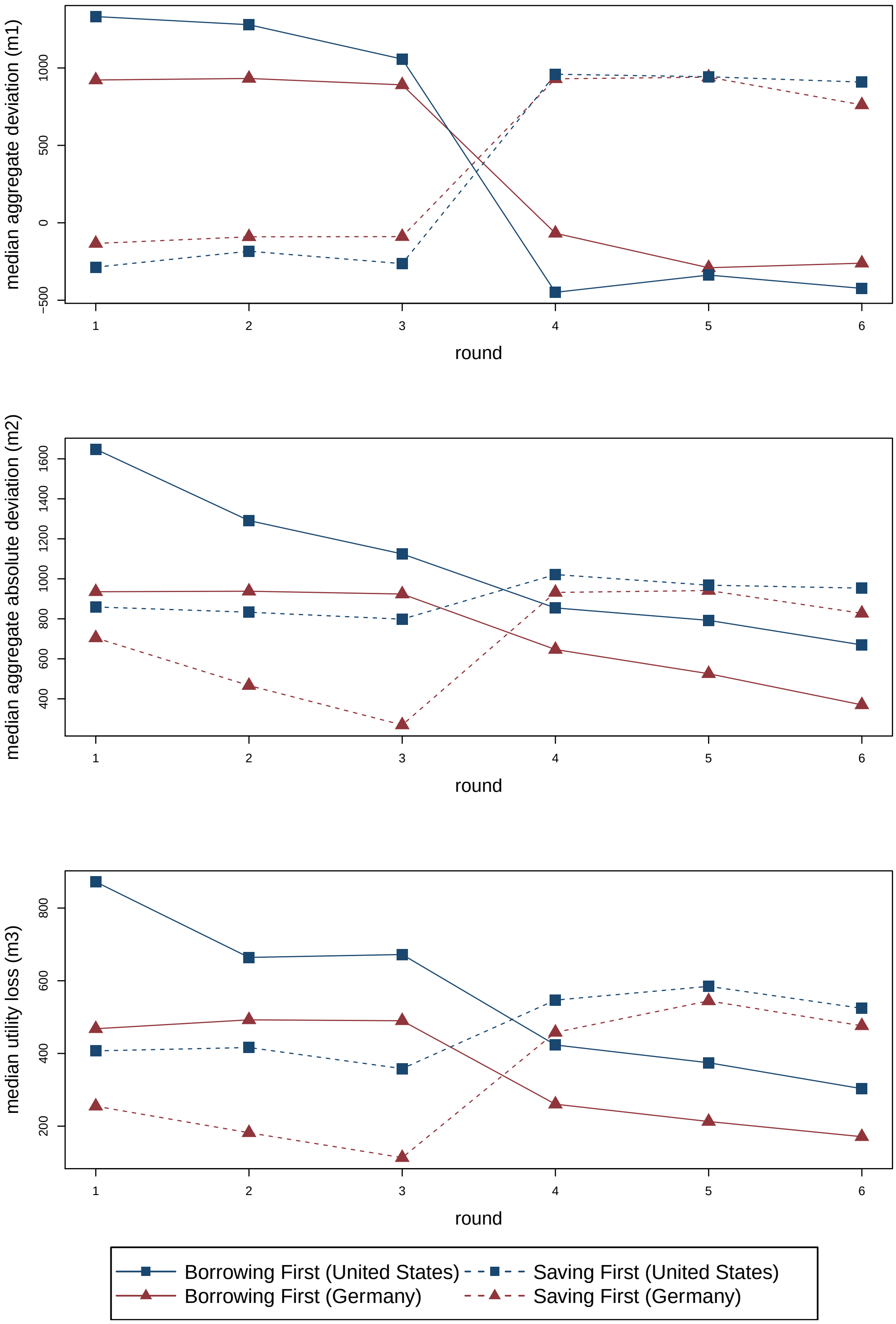

Figure 3: Median aggregate deviation

Measure	Session	Round					
		1	2	3	4	5	6
				United States			
Median m_1	BF	1331.968	1279.272	1057.301	−448.976	−337.514	−423.506
	SF	−286.689	−183.513	−263.750	959.476	943.169	908.636
$p-$value		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Median m_2	BF	1648.105	1291.288	1124.624	854.537	792.410	669.553
	SF	859.351	833.197	798.277	1021.381	968.282	953.587
$p-$value		< 0.001	< 0.001	< 0.001	0.005	0.014	0.060
Median m_3	BF	872.064	664.189	672.204	423.347	374.457	303.111
	SF	407.131	416.362	358.253	546.759	584.643	524.210
$p-$value		0.001	0.004	0.002	0.049	0.037	0.085
				Germany			
Median m_1	BF	922.395	932.217	890.805	−67.671	−290.294	−260.731
	SF	−133.438	−90.453	−89.256	929.985	940.529	761.430
$p-$value		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Median m_2	BF	935.503	938.093	923.923	646.581	525.672	369.829
	SF	704.668	466.493	269.223	932.037	941.523	827.583
$p-$value		0.017	0.009	0.005	0.185	0.096	0.222
Median m_3	BF	468.009	492.488	489.947	260.469	212.785	171.035
	SF	254.897	181.869	113.385	457.959	544.636	476.155
$p-$value		0.041	0.059	0.007	0.439	0.155	0.409

Table 1: Means and medians for each measure and for each round. For each country and round we present the median measure (*m1* to *m3*) across subjects for each round for each treatment order (BF or SF). The reported p-value is the result of a Mann Whitney test comparing the values for each round.

subjects perform significantly worse in the first round of the sessions compared to later rounds in BF sessions. However, subjects do not perform better in the borrowing rounds than in the first round in SF sessions. The replication of this result supports the idea that subjects perform worse in scenarios requiring borrowing compared to scenarios requiring saving and that there is an asymmetric learning process in which learning from borrowing rounds spills over to saving rounds, but not the other way around.

measure	country	Rounds 1-3	Rounds 4-6
m_1	US	1.310	1.156
	Germany	1.031	1.335
m_2	US	0.632	0.467
	Germany	0.339	0.320
m_3	US	0.125	0.117
	Germany	0.146	0.268

Table 2: Cohen's d in the US and Germany comparing the effect of borrowing vs. saving rounds.

3.1.1 Determinants of Deviations from Optimal Consumption

To better understand what determines deviations from optimal consumption, in Table 5 we regress the individual m_2 for each subject in each round on a series of controls.[5] In the first column, we use the full sample and include the variable *Germany* (which takes a value of one for observations from Meissner (2016)) and *Round*, which controls for the round. The results show that German subjects tend to perform better in their consumption choices. This difference in performance is mostly driven by differences in the borrowing rounds. This can be seen in Tables 6 and 7 of Appendix A, where we reproduce Table 5 using a partition of the data into saving and borrowing rounds.

Additionally, in columns (2) to (5) of 5 we analyze the effect that CRT, gender, and risk aversion have on determining deviation from optimal consumption. These measures were only collected for the US sample, so all analyses on individual characteristics is limited to US subjects. In column (2) we analyze the effects of CRT, to do so, we divide the sample into subjects who solved two or more questions ($CRThigh = 1$) and those who solved one or no question correctly ($CRThigh = 0$). The coefficient for the high CRT dummy is large, negative, and statistically significant, pointing at a strong correlation between cognitive ability and optimal consumption. In columns (3) and (4) we introduce a gender dummy ($Female$) and $RiskAversion$, which measures the amount of safe choices a participant has made in a multiple price list (MPL) risk elicitation task (see the Appendix for more details). The results show that both gender and risk aversion are positively correlated with deviations from optimal consumption. In column (5) we run the full model, including CRT, gender, and risk aversion. All the results are robust except for risk aversion which

[5] In all regressions of Table 5, the errors are clustered at the subject level.

Measure	Condition	Round					
		1	2	3	4	5	6
			United States				
Median $\Delta_r^{r-1}m2$	BF	NA	175.824	55.160	306.502	17.784	6.571
$p-$value			0.008	0.023	< 0.001	0.061	0.455
Median $\Delta_r^{1}m2$		NA	175.824	398.853	737.771	890.776	883.846
$p-$value			0.008	< 0.001	< 0.001	< 0.001	< 0.001
Median $\Delta_r^{r-1}m2$	SF	NA	183.457	30.174	-381.133	10.412	2.168
$p-$value			0.001	0.102	< 0.001	0.078	0.804
Median $\Delta_r^{1}m2$		NA	183.457	192.474	-124.496	-3.739	-23.383
$p-$value			0.001	< 0.001	0.286	0.741	0.757
			Germany				
Median $\Delta_r^{r-1}m2$	BF	NA	58.268	18.724	69.507	98.323	19.958
$p-$value			< 0.001	0.057	0.020	0.003	0.223
Median $\Delta_r^{1}m2$		NA	58.268	137.011	370.480	439.567	575.866
$p-$value			< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Median $\Delta_r^{r-1}m2$	SF	NA	66.591	80.909	-202.889	62.482	54.239
$p-$value			< 0.001	< 0.001	< 0.001	0.143	0.007
Median $\Delta_r^{1}m2$		NA	66.591	155.424	-40.365	37.363	69.948
$p-$value			< 0.001	< 0.001	0.413	0.752	0.381

Table 3: Learning

loses explanatory power once we control for CRT and gender.[6]

3.2 Debt aversion

Deviations from optimal consumption do not yet imply debt aversion. All else equal, larger debt aversion should lead to larger differences in deviations from optimal behavior between the saving and the borrowing treatment. Therefore, we construct an individual measure of debt aversion by taking the aggregated difference in absolute deviations from conditional optimal consumption (using m_2) in the saving and borrowing treatment, and normalizing by the aggregated deviations in both treatments. This individual index of

[6]In Tables 6 and 7 of Appendix A we split our sample into the saving and borrowing treatments, respectively. These tables replicate Table 3.1.1 and show that our results are robust; higher CRT results in better savings and borrowing decisions, while being female and risk aversion results in worse savings and borrowing decisions in both treatments.

	(1) Combined	(2) US	(3) US	(4) US	(5) US
Round	-64.13***	-76.44***	-71.62***	-71.07***	-71.07***
	(15.40)	(23.06)	(22.80)	(23.94)	(23.99)
Germany	-321.5***				
	(105.4)				
CRT high		-665.0***			-548.6***
		(174.2)			(180.0)
Female			528.5***		394.7**
			(154.6)		(169.7)
Risk Aversion				41.63**	15.42
				(18.09)	(19.04)
Constant	1363.2***	1888.5***	1180.9***	1129.8***	1534.6***
	(87.97)	(167.0)	(113.8)	(178.1)	(227.3)
N	1002	546	540	510	510
adj. R^2	0.049	0.125	0.096	0.043	0.171

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Determinants of deviations from optimal consumption. In each column, we regress measure 2 (m_2) on different covariates. The first column contains data from Germany and US. Columns (2) to (5) use only data from the US. All standard errors are clustered at the subject level.

debt aversion (DA) allows us to compare debt aversion across the two samples and is defined as:[7]

$$DA = \frac{\mathbb{1}_{BF}\left(\sum_{r=1}^{3} m_2^r - \sum_{r=4}^{6} m_2^r\right) + (1 - \mathbb{1}_{BF})\left(\sum_{r=4}^{6} m_2^r - \sum_{r=1}^{3} m_2^r\right)}{\sum_{r=1}^{6} m_2^r}, \tag{11}$$

where $\mathbb{1}_{BF}$ is an indicator function that takes the value of one for participants in the borrowing first order and zero otherwise. The larger DA, the larger is m_2 in rounds that require borrowing relative to those that require savings to consume optimally. The normalization ensures that the measure is confined to the interval $[-1, 1]$, a measure of $DA = 1$ indicates that a subject only deviates from optimal consumption in the borrowing treatment, and a measure of $DA = -1$ that she only deviates from optimal consumption in the saving treatment. A measure of $DA = 0$ indicates that deviations are the same in the borrowing and the saving treatment and thus that there is no debt aversion. Note that this index does not measure debt aversion itself, as is constructed based on deviations from

[7]For notational convenience, indices referring to subjects are omitted

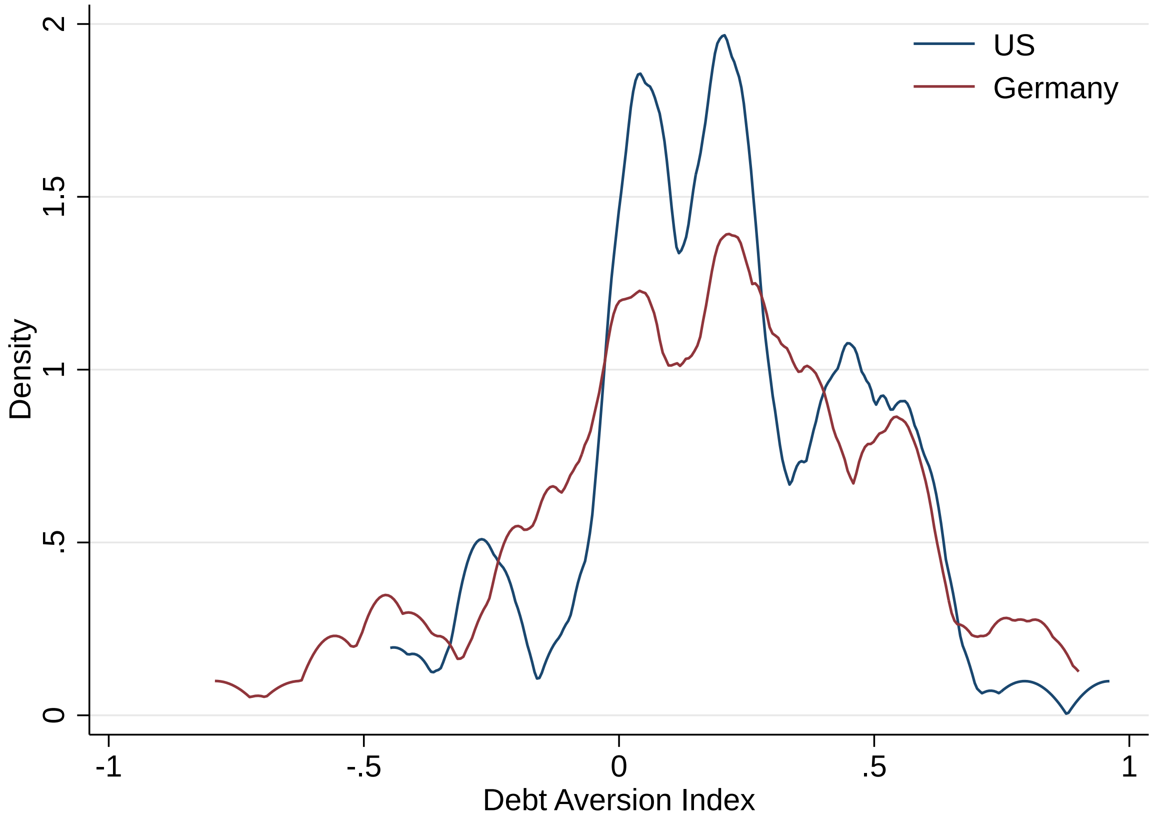

Figure 4: Debt Aversion in Germany and the US

optimal consumption. However, it may serve as a proxy that can be expected to correlate with debt aversion since a more debt averse person will borrow less in the borrowing treatments and therefore have a higher DA in these rounds.[8]

Figure 4 illustrates the distribution of the debt aversion index in Germany and the US. A Mann-Whitney U test fails to reject a difference in distributions between the German and the US data ($p = 0.5644$).

Table 5 contains regressions where the index of debt aversion (DA) is the dependent variable. In specification (1) we use the combined data of the US and Germany and control for country and order effects. *Saving First* is a treatment dummy that takes the value of one for subjects in the Saving First sessions, while *Germany* is a dummy that takes the value of one if the observation belongs to the original German sample. The results

[8]One might argue that a simpler proxy for debt aversion could be deviations from optimal consumption in the borrowing treatment. We prefer our index, because it controls for other confounding factors. For instance, a person may simply be bad at solving the intertemporal optimization problem, regardless of whether they have to borrow or save. This person would look like they are debt averse according to the deviations in the borrowing treatment only, but not using the debt aversion index.

	(1) Combined	(2) US	(3) US	(4) US	(5) US
Saving First	-0.215***	-0.255***	-0.242***	-0.241***	-0.250***
	(0.0444)	(0.0493)	(0.0504)	(0.0539)	(0.0535)
Germany	-0.0438				
	(0.0446)				
CRT high		0.115**			0.111*
		(0.0552)			(0.0591)
Female			-0.0431		-0.00998
			(0.0517)		(0.0574)
Risk Aversion				0.000365	0.00255
				(0.00712)	(0.00743)
Constant	0.318***	0.255***	0.346***	0.324***	0.240***
	(0.0378)	(0.0516)	(0.0423)	(0.0649)	(0.0797)
N	167	91	90	85	85
adj. R^2	0.118	0.233	0.194	0.185	0.203

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Debt aversion index 2

show that subjects who start with the saving treatment are less debt averse. However, this is likely an artifact caused by learning effects. As shown in Table 3 and Figure 3, learning from saving rounds spills over to borrowing rounds, but learning from borrowing rounds has a smaller impact on saving round consumption smoothing. This asymmetry in learning spillovers results in lower perceived DA for those subjects in SF sessions.

Importantly, in specification (1) we detect no differences across countries. While the coefficient for the nationality dummy is negative, which would indicate that German students are less debt averse than those form the US, the effect is small and not statistically significant. This result implies that there are no systematic difference between the levels of debt aversions between American and German students, and, therefore, that the original results of Meissner (2016) are robust to different credit cultures and (likely) experience acquiring debt.

In specifications (2) to (5) we use only observations from the US pool of subjects to study the effect of different covariates on DA. The results show that only CRT shows a weak correlation with debt aversion as subjects with a higher CRT score appear to be more debt averse, a result which is consistent by recent evidence of Assenza et al.

(2021). This result is surprising since subjects with a higher CRT score also have smaller deviations from optimal consumption overall (see Section 3.1.1).

4 Conclusion

Meissner (2016) runs a life-cycle consumption and saving experiment in which he shows that subjects perform relatively worse when they need to borrow to consume optimally, than when they need to save. This asymmetry is interpreted as a tendency to avoid getting in debt, that is: debt aversion. However, Meissner (2016) uses undergraduate students from a large public university in Germany as subjects. Therefore, it is feasible that the observed debt aversion in Meissner (2016) is a result of its population. Germany is known for its low debt levels and for a tradition of shunning debt. Moreover, undergraduate students of public universities in Germany are unlikely to have any experience acquiring debt, which might also contribute to Meissner (2016)'s results (Duffy, 2016).

The present paper test the robustness of the results in Meissner (2016) by running a replication using a subject pool of undergraduates from the United States. The United States is known for being more tolerant towards debt (Calder, 2009) and for encouraging it through its institutions Garon (2011). One of the most common types of debt in the US is student loans, which are common among university students (Avery and Turner, 2012). All of the main findings from the original study replicate, with similar effect sizes, confirming the significant role that debt aversion plays even within a population with previous experience acquiring debt.

Additionally, we extend Meissner (2016) by constructing an individual measure of debt aversion and correlating it to the individual characteristics of subjects. We do not detect any effects of gender or risk preferences on the levels of debt aversion. Interestingly, we find that CRT score is negatively correlated with deviations from optimal consumption, but weakly positively correlated with debt aversion. This is consistent with findings in Assenza et al. (2021). However, since the correlation is only weak, we would caution against overinterpreting the results.

To conclude, our paper contributes by replicating a pioneering work on debt aversion. We do so by using a population that *a priori* has different attitudes and experience towards debt, but nonetheless all of the main findings are replicated. Additionally, we extend the original paper by studying how the individual characteristics of subjects affect their debt aversion.

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A Additional Tables

A.1 Borrowing/Saving sample split

	(1) Combined	(2) US	(3) US	(4) US	(5) US
Round	-53.97*	-76.77**	-67.10*	-71.87*	-84.97**
	(29.83)	(35.75)	(38.50)	(41.85)	(37.68)
Germany	-209.7*				
	(109.1)				
CRT high		-706.8***			-620.8***
		(178.6)			(181.4)
Female			459.9***		319.2**
			(154.5)		(156.0)
Risk Aversion				29.31*	5.967
				(16.30)	(16.99)
Constant	1090.9***	1682.1***	959.8***	978.3***	1489.4***
	(132.9)	(209.5)	(174.4)	(211.0)	(253.6)
N	501	273	270	255	255
adj. R^2	0.031	0.188	0.099	0.030	0.218

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Measure 2 (m_2) - Saving treatment only

	(1) Combined	(2) US	(3) US	(4) US	(5) US
Round	-78.68**	-86.06*	-84.81*	-74.63	-64.17
	(32.58)	(45.83)	(44.57)	(50.12)	(48.28)
Germany	-434.6***				
	(118.9)				
CRT high		-620.2***			-482.4**
		(205.6)			(218.5)
Female			593.9***		469.4**
			(179.7)		(212.9)
Risk Aversion				53.73**	26.50
				(24.27)	(26.03)
Constant	1652.0***	2128.1***	1434.7***	1298.2***	1596.4***
	(125.9)	(213.1)	(170.1)	(264.1)	(290.5)
N	501	273	270	255	255
adj. R^2	0.073	0.103	0.108	0.059	0.166

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Measure 2 (m_2) - Borrowing treatment only

A.2 Alternative measures of deviation (m_1 and m_3)

	(1) Combined	(2) US	(3) US	(4) US	(5) US
Round	-76.09**	-92.40**	-84.72*	-82.91*	-82.91*
	(29.48)	(42.98)	(42.76)	(44.01)	(44.09)
Germany	-224.4**				
	(108.0)				
CRT high		-637.9***			-542.0**
		(211.0)			(218.9)
Female			430.3**		357.0*
			(190.4)		(210.0)
Risk Aversion				27.96	3.415
				(21.41)	(23.22)
Constant	854.6***	1374.4***	714.3***	712.0***	1116.0***
	(129.6)	(233.1)	(164.1)	(236.7)	(309.2)
N	1002	546	540	510	510
adj. R^2	0.022	0.069	0.041	0.017	0.082

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Measure 1 (m_1)

	(1) Combined	(2) US	(3) US	(4) US	(5) US
Round	-45.07***	-57.00***	-54.66***	-55.05***	-55.05***
	(11.76)	(16.58)	(16.59)	(17.47)	(17.51)
Germany	-190.0***				
	(72.76)				
CRT high		-407.0***			-343.4***
		(121.7)			(126.0)
Female			268.8**		179.1
			(103.2)		(113.2)
Risk Aversion				22.72*	9.112
				(12.59)	(14.36)
Constant	807.8***	1144.8***	736.8***	708.7***	970.2***
	(66.29)	(120.8)	(94.98)	(129.4)	(169.8)
N	1002	546	540	510	510
adj. R^2	0.035	0.096	0.056	0.032	0.108

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Measure 3 (m_3), winsorized at 1% level

A.3 Alternative measures of debt aversion (DA_1 and DA_3)

	(1) Combined	(2) US	(3) US	(4) US	(5) US
Saving First	-4.467	-11.51	-11.17	-7.794	-7.604
	(4.349)	(7.521)	(7.488)	(7.625)	(7.727)
Germany	0.234				
	(4.366)				
CRT high		-2.289			-2.060
		(8.420)			(8.533)
Female			11.89		4.895
			(7.673)		(8.290)
Risk Aversion				1.562	1.328
				(1.007)	(1.073)
Constant	3.908	9.207	2.812	-6.057	-5.081
	(3.704)	(7.869)	(6.285)	(9.180)	(11.51)
N	167	91	90	85	85
adj. R^2	-0.006	0.006	0.032	0.027	0.008

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Debt aversion index 1

	(1) Combined	(2) US	(3) US	(4) US	(5) US
Saving First	-0.255***	-0.315***	-0.292***	-0.297***	-0.314***
	(0.0688)	(0.0814)	(0.0844)	(0.0902)	(0.0892)
Germany	-0.0158				
	(0.0691)				
CRT high		0.219**			0.209**
		(0.0912)			(0.0986)
Female			-0.0522		0.0246
			(0.0864)		(0.0957)
Risk Aversion				-0.00892	-0.00659
				(0.0119)	(0.0124)
Constant	0.357***	0.229***	0.393***	0.426***	0.263*
	(0.0586)	(0.0852)	(0.0708)	(0.109)	(0.133)
N	167	91	90	85	85
adj. R^2	0.066	0.160	0.102	0.095	0.122

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Debt aversion index 3

Instructions (Part 1)

The experiment you are participating in today is part of a research project. It is meant to analyze economic decision making. The rules and instructions are the same for every participant. Your payoff depends on your decisions during the experiment. Please read the instructions carefully.

During the experiment you are not allowed to talk and exchange information with other participants. If you have a question, please raise your hand. An experimenter will come to you and answer your question. Please don't ask your questions out loud. If you break one of these rules we are obliged to exclude you from participation.

Overview

First you will have time to read the instructions. After that we will go through the instructions together and you will answer a quiz in order to make sure you understand the instructions. After that you may ask questions before the start of the experiment. After the experiment you will be asked to fill out a short questionnaire.

The experiment consists of 6 separate **rounds**, each of which consists of 20 **periods**. The duration of the experiment is around 1.5 hours. Instructions, quiz and questionnaire will take around 30 minutes. The remaining hour is dedicated to the actual experiment. In every period a countdown of 30 seconds will be displayed. You may take more or less time to reach your decision. The countdown is meant to provide some indication on how much time you can take in every period to finish the experiment in one hour. You may finish the experiment even if you play for more than one hour.

The following instructions apply to the first three rounds of the experiment. After three rounds, the experiment pauses and you will be asked to type in a password. You will be handed new instructions for the following three rounds, containing the password needed to continue with the experiment. After the last round, your experiment payoff will be displayed. Please raise your hand when you have finished the last period. You will be given a short survey. After filling in the survey, please raise your hand again. When everyone has filled in the survey, you will be given a short quiz. At the end of the session you will be individually called to the front desk to receive your experiment payoff.

You are playing an **"investment game"** and decide in every period how many **points** you want to purchase. The sum of all points purchased in one round is that **round's total result**. Your payoff depends on the results from two randomly drawn rounds.

Income, Savings and Wealth

In every period you obtain a certain **income**, denoted in the experimental currency "tokens." Your task is to choose in every period how many tokens you want to spend in order to purchase points. Thereby you (implicitly) also choose how many tokens you want to save or borrow. The difference between income and spending in one period is called **savings**. At any period in the experiment, your **wealth** is defined as the sum of savings from all previous periods. This implies that savings from one period added to the wealth in this period yields the wealth in the next period.

Note that the sign of your savings can be both positive and negative. If, in any given period, you decide to spend less tokens than your income, your savings have a positive sign. In this case your wealth in the next period is your wealth in this period **plus** the absolute amount of savings in this period.

If, in any given period, you decide to spend more tokens than your income, your savings have a negative sign. In this case your wealth in the next period is your wealth in this period **minus** the absolute amount of savings.

Example: assume your income in one period is 50 tokens and you spend 30 tokens to purchase points. Your savings IN THAT PERIOD are 20 tokens. If, instead, you spend 70 tokens your savings are -20 tokens. In the first case your wealth in the next period is the wealth in this period plus 20 tokens. In the latter case your wealth in the next period is this period's wealth minus 20 tokens.

Your wealth may as well take positive or negative values, depending on whether the sum of your savings from previous periods was positive or negative. Your wealth in the first period is 0 tokens.

In the last period of each round, your current wealth plus income will be spent automatically in order to purchase points. This implies that the sum of tokens spent in all periods of one round equals the sum of income obtained in all periods of this round.

In other words: you may spend more or less than your income in one period. However, over one round, the sum of income always equals the sum of tokens spent.

Determination of Income

Your **income** is **randomly** determined. Income y_t follows the random process:

$$y_t = 10 * t + \varepsilon_t$$

The index "t" denotes the period for which income is determined. Since the slope of the process is $+10$, it has a positive trend. Therefore, your expected income is increasing over time. ε_t is the random part of the process and can be either $+10$ or -10, both occurring with equal probability of 50%. For example, income in period 6 is $y_6 = 10 * 6 + \varepsilon_6$. Since ε_6 is either $+10$ or -10, your income in period 6 is either 70 or 50. Since one round consists of 20 periods, income in the last period will either be 210 or 190.

It is very important to understand that ε_t is truly randomly determined in each period. Which value ε_t takes in one period does **not** depend on the values it had in previous periods or how you behaved in previous periods.

Tokens and Points

Your task is to decide in every period how many tokens you want to spend in order to purchase points. Tokens are transformed to points as follows:

$$\text{Purchased points} = 250 * (1 - e^{-0.02*(\text{chosen amount of tokens})})$$

A graph of this function and a table with relevant function values are attached to the instructions.

Please note that the above function is defined on the positive as well as the negative domain. If you choose to spend a negative amount of tokens, you will receive a negative amount of points. In this case you "sell" points and gain tokens. Should your wealth plus income (in tokens) in the last period of a round be negative, you will automatically sell points in order to make sure that your token-account is balanced.

Payoff

Your payoff depends on the results from two randomly drawn rounds. One round is randomly drawn from the first three rounds and the other is randomly drawn from the second three rounds. Your payoff is calculated as follows:

$$Payoff\ in\ US\ dollar = \frac{(Result1 - 3000) + (Result2 - 3000)}{100},$$

where Result1 is the first randomly drawn result and Result2 is the second randomly drawn result.

Example: suppose the first randomly drawn result is 4300 points and the second randomly drawn result is 3800 points. Your payoff is:

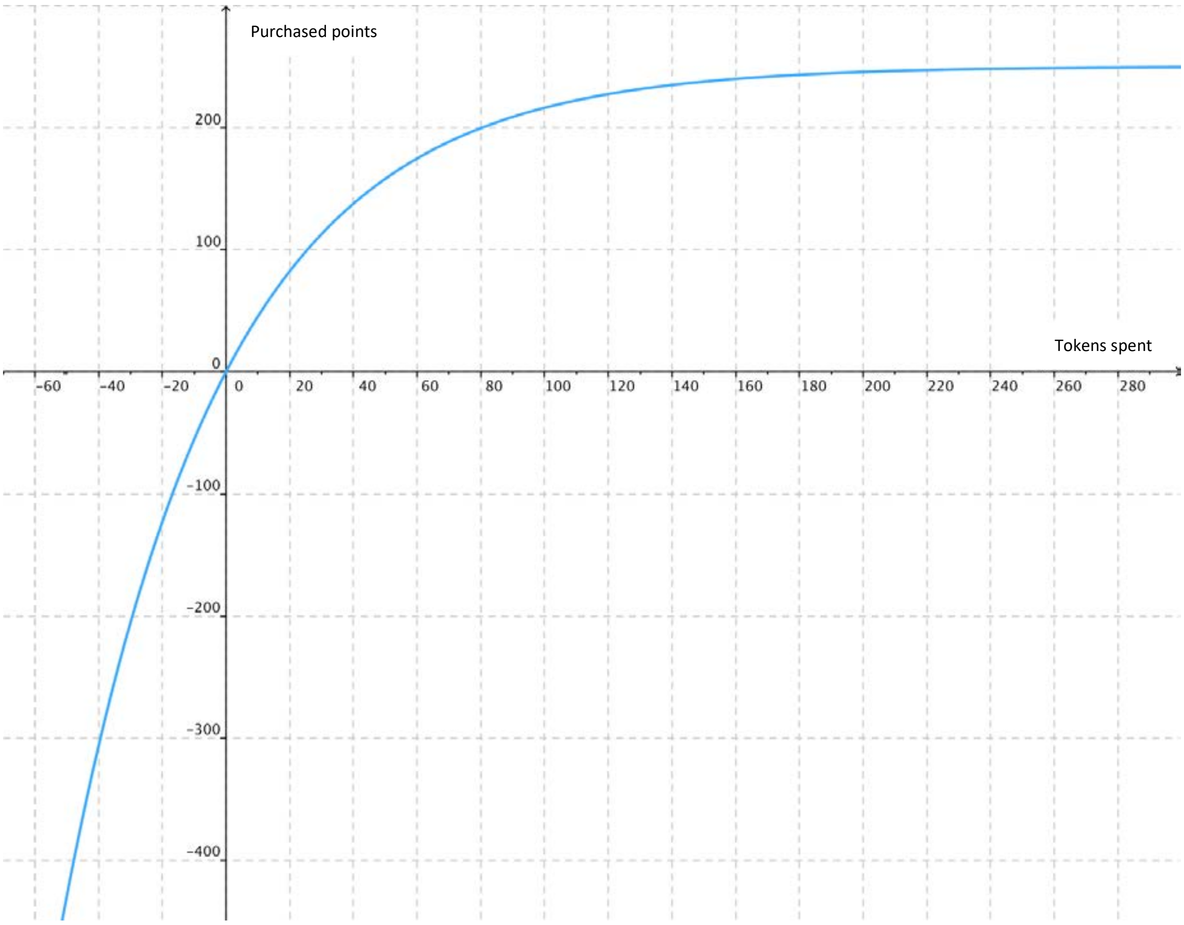
$$\frac{(4300 - 3000) + (3800 - 3000)}{100} = \frac{1300 + 800}{100} = \$21$$

Independent of your results you will be guaranteed \$5.50 for participation. If your payoff is below \$5.50 according to the formula above, you will not receive your calculated payoff but \$5.50 instead.

Quiz and Questions

You will now be asked to answer a short quiz regarding the contents of these instructions. In case you have questions after that, please raise your hand. An experimenter will come to you and answer your question.

Graph



Purchased points
200
100
0
-100
-200
-300
-400
Tokens spent
-60
-40
-20
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280

Table

Tokens spent	Purchased points
-250	-36853,29
-100	-1597,26
-50	-429,57
-40	-306,39
-30	-205,53
-20	-122,96
-10	-55,35
0	0
10	45,32
20	82,42
30	112,8
40	137,67
50	158,03
60	174,7
70	188,35
80	199,53
90	208,68
100	216,17
110	222,3
120	227,32
130	231,43
140	234,8
150	237,55
160	239,81
170	241,66
180	243,17
190	244,41
200	245,42
210	246,25
220	246,93
230	247,49
240	247,94
250	248,32
260	248,62
270	248,87
280	249,08
290	249,24
300	249,38
500	249,99
1000	250

Instructions (Part 2)

In the following three rounds only the random process that determines your income will change. Consequently, compared to the first part of the instructions, only the paragraph "Determination of Income" changes. The rest of the instructions is still valid.

Determination of Income

Your **income** is **randomly** determined. Income y_t follows the random process:

$$y_t = 210 - 10 * t + \varepsilon_t$$

The index "t" denotes the period for which income is determined. In contrast to your former income process this income process has a **negative** trend, since the slope of the process is -10. Therefore, your expected income is decreasing over time. The income process has a positive intercept (210). ε_t is the random part of the process and can be either $+10$ or -10, both occurring with equal probability of 50%. For example, income in period 6 is $y_t = 210 - 10 * 6 + \varepsilon_6$. Since ε_6 is either -10 or $+10$, your income in period 6 is either 140 or 160. Since one round consists of 20 periods, income in the last period will either be 0 or 20.

It is very important to understand that ε_t is truly randomly determined in each period. Which value ε_t takes in one period does **not** depend on the values it had in previous periods or how you behaved in previous periods.

The password to continue with the experiment is: 4213

Questionnaire

Please fill in your terminal number below so that we can link your decisions during the experiment to this questionnaire. Afterwards, please allow approximately 10 minutes to answer the following questions.

Your terminal number:

1. Please describe your strategy, how you have made your decisions during this experiment. Have you changed your strategy during the experiment? If yes, please explain why.

2. In the first part of the experiment (first three rounds), did you use a different strategy than in the second part of the experiment? If yes, please explain why. If no, please explain why.

Please go to the next page…

3. Assume you had the hypothetical choice between options A and B below. Option A yields a payoff as indicated in column 1 with 100% probability, while option B yields $30 with 50% probability and $0 with 50% probability. Option A takes different values, which are given in column 1. Please indicate for every row, which option you consider preferable and type your answer in the respective empty field in the third column.

Option A	**Option B**	**Your decision (A or B)**
$0	$30 with 50% probability $0 with 50% probability	
$1	"	
$2	"	
$3	"	
$4	"	
$5	"	
$6	"	
$7	"	
$8	"	
$9	"	
$10	"	
$11	"	
$12	"	
$13	"	
$14	"	
$15	"	
$16	"	
$17	"	
$18	"	
$19	"	

Please go to the next page…

4. Please fill in your field of study (if student):______________________________

5. Please fill in your gender: _____________________________

6. Please fill in your nationality: ____________________________

Please raise your hand once you have answered all questions.

Your terminal number:

Quiz

In this quiz, we ask you to answer three questions of differing difficulty. Please try to answer as many of them as possible. You have 5 minutes of time, and you will receive one US dollar for each question answered correctly.

1. A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?

   ____

2. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?

   ____

3. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?

   ____

4. Have you seen these questions before (yes/no)? ____________________

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