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WEALTH PREFERENCES AND WEALTH INEQUALITY: EXPERIMENTAL EVIDENCE

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Wealth preferences and wealth inequality: Experimental evidence^{*}

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Abstract

Some researchers claim that a preference for wealth accumulation is the main cause of the long-run stagnation of the Japanese economy. A theoretical implication of people having such a preference is the widening of wealth inequality. We experimentally test this theoretical prediction by inducing wealth preference in the laboratory. When all the participants are considered, our results provide limited support for the prediction that wealth inequality widened only in one of the four conditions we considered. However, if we focus on the participants who have followed conditionally optimal paths more closely than others, the widening wealth inequality is observed in all the conditions.

JEL Code: C91, E21, E71

Keywords: wealth preferences, experiment, consumption-saving decision, dynamic optimization

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1 Introduction

The Japanese economy has experienced stagnation over the last 30 years (often called lost 30 years). Various policies that aimed to stimulate the economy, including the quantitative easing policy led by the Bank of Japan, have been ineffective in stimulating aggregate demand (see, for example Ugai, 2007, for a survey of empirical studies on the effect of the quantitative easing policy).

Some researchers, such as Ono (1994, 2001), Ono and Ishida (2014), Ono (2015), and Michau (2018), attribute people having a preference for holding wealth as the main cause of this long-run stagnation.¹ They claim that while the marginal utility of consumption declines with the amount consumed (as usually assumed in economic analyses), the marginal utility of wealth-holding declines much slower and has a strictly positive lower bound. As a result, once the consumption reaches a certain level, the marginal utility of wealth accumulation becomes greater than the marginal utility of consumption. Accordingly, the additional income people receive will be allocated toward wealth accumulation instead of consumption. Akesaka et al. (2024) shows, using the data gathered through a survey of a Japanese representative sample, results consistent with this assumption.

¹There are other recent studies that incorporate preferences for wealth holding. Michaillat and Saez (2021) and Michaillat and Saez (2022) introduce a preference for relative wealth as a proxy for preference for status. Michaillat and Saez (2021) does so to solve the anomalies of the New Keynesian model under zero-lower bound. Namely, the prediction of the New Keynesian model under the zero-lower bound that "output and inflation are at implausibly low levels and the government spending and the forward guidance having implausibly large effects" are resolved when people have a strong enough preference for wealth. Michaillat and Saez (2022) introduce it to develop a simple model of the business cycle together with matching friction between consumers and producers. Michau et al. (2023b) shows the existence of rational bubbles in a frictionless economy with an infinitely-lived representative household when the representative household has a preference for holding wealth. Hashimoto et al. (2023) shows under-employment without high unemployment can be observed, as has been the case in Japan in recent years, under secular stagnation in a model with search and matching.

An implication of the existence of such a preference for wealth is the increase in wealth inequality (Ono (1994, Ch.10) and Michau et al. (2023a). To see this, consider two types of agents with low and high initial wealth holdings. Assume also that their preferences, both for consumption and for wealth, and their labor incomes are identical. Let's assume that the income flow, including the interest earnings from the wealth, is such that it allows the low initial wealth agent to consume exactly to the extent his marginal utility from consumption is the same as the marginal utility from wealth holding. Note that, in such a case, the income flow of the high initial wealth agent will be such that all the additional income she receives (due to higher interest earning) compared to her low initial wealth counterpart will be allocated toward wealth accumulation, which widens the wealth inequality.

In this paper, we aim to experimentally test this widening of wealth inequality hypothesis by explicitly inducing consumption and wealth preference as assumed by these models. Thus, our research questions are

- Does the wealth inequality widen, as predicted by the model, when participants are induced to have preferences for wealth in addition to preferences for consumption?
- Are the dynamics of wealth inequality affected by the magnitude of initial inequality as well as whether participants are informed of their ranking and the amount of the accumulated wealth?

Namely, in our experiments, participants decide how much to consume and save over 20 rounds.² They are given an initial amount of wealth and, in each period, receive

 $^{^{2}}$ The experimental literature on consumption-saving decisions has attempted to investigate whether individuals can solve a dynamic intertemporal optimization problem (e.g., Hey and

a constant labor income and interest earnings from the accumulated wealth. Participants are rewarded based on the amount they consume in each period (converted to payment according to a concave function, representing the decreasing marginal utility of consumption), as well as the accumulated amount of savings (converted to payment, although at a much lower rate than consumption, according to a linear function, representing the non-decreasing marginal utility of wealth accumulation).

There are two levels of initial wealth within each group of six participants. Namely, in each group, half of the participants start with a low initial level of wealth, and the remaining half start with a high initial level of wealth. The initial level is determined according to their performance in a real-effort task conducted before the consumption-saving experiment.³

We vary two factors in our 2×2 between-subjects design. One factor is the size of the gap between the low and the high initial wealth within a group. Another factor is whether the ranking and the amount of wealth accumulation within the group to which participants belong is displayed or not.

We conjectured the size of the difference in the initial wealth between the low and the high group to be an essential factor that influences the dynamics of wealth

Dardanoni, 1988; Carbone and Hey, 2004; Noussair and Matheny, 2000; Lei and Noussair, 2002; Ballinger et al., 2003; Carbone, 2006; Brown et al., 2009; Ballinger et al., 2011; Carbone and Duffy, 2014; Meissner, 2016; Crockett et al., 2019; Ahrens et al., 2022; Gechert and Siebert, 2022. For a general overview, see Duffy, 2015). While the experiments in which participants have to save part of their income initially for later consumption show a tendency to under-save (e.g., Carbone, 2006; Brown et al., 2009), the opposite is observed if participants have to borrow initially to consume optimally as their income becomes larger in the later periods (Meissner, 2016; Ahrens et al., 2022). Gechert and Siebert (2022) attributes preference for wealth as a reason for observed deviation (under consumption) in their experiment on consumption-saving decisions.

³We linked the initial wealth to the result of real-effort task because Clingingsmith and Sheremeta (2018) experimentally shows that conspicuous consumption, the purchase of chocolates during the experiment that does not contribute to participants' monetary reward, is high when it can be interpreted as the signal for their ability because income is determined based on the test score but not when income is determined randomly.

inequality, especially when participants are informed of the ranking and amount of their accumulated wealth. If the participants' status concern is stimulated by the display of the ranking as demonstrated experimentally in the context of consumptionsaving decision by Feltovich and Ejebu (2014),⁴ then those lower-ranked participants would be motivated to save more to claim the higher ranking, even if that means forgoing monetary reward from consumption. Thus, compared to the prediction of the model that assumes away such a status concern, the widening of wealth inequality will be smaller. However, if the difference in the initial wealth level is so large that it is not possible to climb up the ranking, the above-described motivation for saving by the lower-ranked participants will not operate. Thus, the wealth inequality would widen as predicted by the model.

The results of our experiments provide mixed support for the prediction of the model. Namely, the wealth inequality widened only when the initial gap was large and the participants were informed of the ranking of the accumulated wealth. In all the other three conditions, we did not observe statistically significant evidence of the widening of wealth inequality. Even in the case we observed the widening of the inequality, the magnitude was smaller than the prediction of the model. This is mainly because participants in our experiment with high initial wealth consumed more than what was predicted by the model.

As noted in footnote 2 above, overconsumption is a well-documented phenomenon in consumption-saving experiments when participants do not need to borrow to

⁴Feltovich and Ejebu (2014) shows the display of ranking in terms of accumulated utility from consumption, not wealth, induces participants to consume more than the case without display of such ranking. Carbone and Duffy (2014) also find that informing participants average previous period consumption of the participants in the same group stimulate consumption. While the context is similar, what they investigate is not the effect of wealth preference on consumption-saving behavior as we focus on this paper.

consume. To give the theory a better chance, as an additional (non-pre-registered) analysis, we divide participants according to whether they closely follow the conditionally optimal consumption path or not. The conditionally optimal consumption path is re-computed every round, conditional on the amount of savings participants have accumulated up to that round. We observe that for those who followed the conditionally optimal path of savings more closely (above the median) compared to others, the wealth inequality widens as predicted by the theory in all the treatments.

The rest of the paper is organized as follows. Section 2 describe the model that we are going to test in the experiment described in Section 3. The results are reported in Section 4, and Section 5 summarizes and offers concluding remarks.

2 A model

In the experiment, participants face a finite horizon and non-stochastic dynamic optimization problem. Decision makers are initially endowed with initial asset holdings, or wealth, k_0 . In each period, t = 1, 2, ..., T, the decision maker receives a constant basic income y and interest earnings from wealth accumulation rk_{t-1} , where r is the interest rate. At each period t, the decision maker allocates the budget $y + (1+r)k_{t-1}$ between consumption c_t and savings k_t , which is carried over to the next period. Note that in our model, there is no uncertainty in income. Thus, there is no pre-cautionalry motive for saving.

We assume that the decision maker enjoys utility $u(c_t)$ from consumption c_t in period t. Additionally, we assume the decision maker has a preference for wealth accumulation. Namely, the decision maker also obtains utility $\gamma(k_t)$ from savings k_t in period t, and utility $q(k_T)$ from the savings k_T left at the end of the final period T. We interpret $\gamma(k_t)$ as a manifestation of a pure preference for wealth holdings as in Michau et al. (2023b) and $q(k_T)$ to capture such motives as bequest motives. Under these assumptions, the optimal consumption level of the decision maker is determined independent of the initial asset k_0 , and it is determined by the marginal substitution rates of the utility functions u, γ , and q.

Formally, the utility maximization problem can be formulated as follows:

$$\begin{array}{ll} \underset{\{c_t\}_1^T, \{k_t\}_1^T}{\text{maximize}} & \sum_{t=1}^T \left(u(c_t) + \gamma(k_t) \right) + q(k_T) \\ \text{subject to} & c_1 + k_1 = y + (1+r)k_0 \\ & c_2 + k_2 = y + (1+r)k_1 \\ & \cdots \\ & c_T + k_T = y + (1+r)k_{T-1}. \end{array}$$

From the first-order conditions with respect to c_t and k_t for t < T, we obtain the equation

$$\frac{u'(c_{t+1})}{u'(c_t)} = (1+r)^{-1} \left(1 - \frac{\gamma'(k_t)}{u'(c_t)}\right) \qquad \text{for } t = 1, \dots, T-1.$$
(1)

Equation (1) is the Euler equation that intertemporal consumption satisfies over two periods. Note that, unlike the conventional Euler equation in a typical cakeeating problem, this includes the marginal rate of substitution between assets k_t and consumption c_t . Assuming that the change in consumption between two periods is sufficiently small (i.e., $c_{t+1} \sim c_t$), and using $u'(c_{t+1}) \sim u'(c_t) + u''(c_t)(c_{t+1} - c_t)$, the following approximation holds:

$$\Delta c_{t+1} \sim (1+r)^{-1} \left(r + \frac{\gamma'(k_t)}{u'(c_t)} \right) \frac{u'(c_t)}{-u''(c_t)} \quad \text{for } t = 1, \dots, T-1,$$
(2)

where $\Delta c_{t+1} = c_{t+1} - c_t$. Assuming that u' > 0, u'' < 0, and $\gamma' > 0$, it follows that $\Delta c_{t+1} > 0$, implying that consumption increases over periods.



Figure 1: Phase diagram

From the first-order condition of the utility maximization problem at t = T, we obtain the following relationship among the marginal rates of substitution between assets and consumption at the final period:

$$u'(c_T) = \gamma'(k_T) + q'(k_T).$$
(3)

Considering the no-borrowing constraints, $k_t \ge 0$, for any t, if consumption c_t derived from the difference equations (2) or (3) exceeds the budget constraint, then it will be restricted to the budget on hand, i.e., $c_t = y + (1+r)k_{t-1}$.

From the budget constraints, we have

$$\Delta k_t = rk_{t-1} + y - c_t,\tag{4}$$

where $\Delta k_t = k_t - k_{t-1}$.

Based on the two difference equations (2) and (4), as well as the terminal condition (3), we can draw a phase diagram, in the space of c and k depicted in Figure 1.



Figure 2: Optimal paths

Notes: (Left) The optimal path is illustrated on the phase diagram. The horizontal axis measures consumption c_t and the vertical axis measures savings k_t . All three paths progress from left to right during periods 1 to 20. The dashed line represents the condition where $\Delta k_t = 0$, and to the right of this line, the savings k_t decrease. (Right) The time evolution of the optimal savings k_t .

By the numerical calculations, the optimal paths for consumption and savings are illustrated in Figure 2. The parameters used for numerical calculations are listed as follows. These parameters were determined based on the experimental setup. Namely, T = 20, r = .05, y = 15, $k_0^L = 100$, $k_0^H \in \{150, 350\}$, $u(c_t) = ER \times [\alpha - \beta \exp(-c_t/\eta)] = 4 \times [20 - 20 \exp(-c_t/9)]$, $\gamma(k_t) = ER \times \psi k_t = 4 \times 0.01 k_t$, and $q(k_T) = ER \times \phi k_T = 4 \times 0.1 k_T$.

As can be noticed, we assume linear functions for $\gamma(k_t)$ and $q(k_T)$. This makes the analyses simple because, beyond a certain level of consumption, the marginal utility of consumption becomes lower than that of saving (wealth accumulation), which is the driving force of the increasing wealth inequality hypothesis in the presence of preference for wealth.

3 Experimental Design

The experiment consists of two parts. In the first part of the experiment, each participant engaged in a real-effort task designed to determine their initial wealth, high or low, in Part 2. In the second part of the experiment, participants made

decisions regarding consumption and saving over the course of 20 periods. We induce participants' preference for consumption as well as wealth accumulation, as described in Section 2, by rewarding participants based on their consumption and savings in each period, as well as the amount of savings left after the final consumption decision. Below, we describe each part in more detail. An English translation of the instructions is provided in Appendix B.

Part 1: Real-Effort Task Participants were asked to add two 2-digit numbers for a duration of three minutes as many times as they could. For each correct answer, participants earned one point. To ensure an understanding of the task, participants first undertook a one-minute practice session, during which their performance did not affect their subsequent rewards.

Participants in each experimental session were randomly divided into groups of either five or six individuals. After completing the effort task, participants were ranked based on the number of correct answers within their groups. The ties were broken randomly. Participants were told that attaining a higher rank in this task would increase their chance of earning higher rewards in the second part of the experiment. Indeed, their rank determined the initial savings (wealth) they would receive in Part 2.

Part 2: Consumption and Saving Decisions At the outset, participants were endowed with initial savings (wealth). Participants who ranked above the median in their group in Part 1 (H-type) received k_0^H points, whereas those below the median (L-type) received a fixed k_0^L points. In groups of six, there were three H-types and three L-types; in groups of five, there were two H-types and three L-types.

Each period, participants were provided with a fixed basic income of 15 points and earned interest on their savings at a rate of 5%. The budget for each period comprised the initial savings, the interest accrued, and the basic income. Participants decided how much to consume and how much to save, adhering to the budget constraint:

$$c_t + k_t = y + (1+r)k_{t-1}$$
 for $t = 1, 2, \dots, 20$

where c_t represents consumption, k_t represents savings, y is the basic income, and r = 0.05 is the interest rate.

The consumption is converted to the utility value and added to the participants' reward, and eventually to their monetary compensation, using the following concave function:

$$u(c_t) = 80 - 80 \exp\left(-\frac{c_t}{9}\right).$$

In order to induce the wealth preference, the savings not only contributed to future budgets but also were evaluated by $\gamma(k_t) = 0.04k_t$ and added to the participants' monetary compensation in each period in addition to those from consumption. Furthermore, the savings not consumed in the final period (k_{20}) were evaluated at $q(k_{20}) = 0.4k_{20}$ and counted toward the final monetary reward, alongside $\gamma(k_{20})$ for the period.

Thus, the total experimental reward for each participant was composed of a participation reward of 500 yen, combined with the aggregated utility from consumption $\sum_{t=1}^{20} u(c_t)$, the utility from saving in each period $\sum_{t=1}^{20} \gamma(k_t)$, and the utility from the final period savings $q(k_{20})$. As noted in Section 2, the per-period utility from saving $\gamma(k_t)$ represents a pure preference for wealth accumulation, and the final period utility from saving $q(k_{20})$ captures such motives as bequest motives.

Participants' decisions were facilitated by an interface that presented their savings, the interest received, the basic income, the current period's budget, and the accumulated experimental rewards. Furthermore, a simulation tool was available to help participants estimate the additional monetary compensation and future budgets based on their consumption or saving choices. See Figure 3 for a screenshot.

	Assets		90.00	
	Interest	for this period	4.50	
	Income for this period		15	
	Budget	for this period	109.50	
	Total ad earned	lditional rewards so far (yen)	80.74	
Consumption for th	is period	Min: 0 / Max: 109.50		
Assets to carry ove to the next period	r	Min: 0 / Max: 109.50		
Maximum consump	otion			

Figure 3: A screenshot of decision screen.

Although participants were prompted to submit their decisions within three minutes, they were allowed to submit beyond this time if necessary.

After reading the instructions for the experiment, participants took a comprehension quiz, and only after all participants answered all the questions correctly did the decision-making task begin.

Experimental Conditions A 2x2 between-subjects experimental design, as shown in Table 1 was employed. The first factor is the size of the initial wealth (saving) gap between L- and H-types. This factor varied by the initial endowment for H-types

Table 1: Treatments

		0	ize of initial gap in wee	
			50	250
Feedback	on		$(k_0^L = 100, k_0^H = 150)$	$(k_0^L = 100, k_0^H = 350)$
ranking	on	With feedback	Rank-Gap50	Rank-Gap250
amount	of			
wealth		Without feedback	No-Rank-Gap50	No-Rank-Gap250

Size of initial gap in wealth

while keeping that for L-type to be $k_0^L = 100$. k_0^H could be either 150 or 350 points. Thus, the initial gap in the savings between the two types was 50 in the former (Gap50) and 250 in the latter (Gap250).

The second factor is the presence or absence of feedback on the within-group rank of the amount saved after decision-making in each period.⁵ Below, we represent the treatments with feedback on rank with "Rank" and the treatments without feedback on rank with "No-Rank." This factor examined the effect of ranking feedback. For conditions with feedback, participants were shown their current amount of savings and their ranks at the end of each period. In cases of tie, ranks were determined randomly. This manipulation is implemented to investigate the status motives that have been studied based on consumption, for example, by showing the average consumption (Carbone and Duffy, 2014) or showing the ranking (Feltovich and Ejebu, 2014) but not based on savings, if any, on their saving behavior.

Procedures The experiment was computerized using the oTree (Chen et al., 2016). The experiment was conducted via Zoom as an online, real-time interactive

 $^{^5 \}mathrm{See}$ Figure B.3 in Appendix B for a screen shot.

experiment. The experimental tasks were web-based, and participants accessed them using their laptops or tablets. They were given the flexibility to choose any location, provided it had a stable internet connection and was a quiet environment free from disturbances. The experimenter communicated these conditions to the participants when recruiting.

At the beginning of each part, an audio recording of its instructions was broadcast via Zoom. While listening to the audio, participants read the instructions displayed on their screens. Throughout the experiment, participants could ask the experimenter questions personally using Zoom's chat function.

Participants were paid with Amazon Gift Cards (e-mail version). They received an e-mail with the gift card on the day of completing the experiment.

4 Results

In total, there were 187 participants in the experiment, of which 103 were male, 81 were female, and 3 did not specify. Participants were Osaka University students recruited from the ISER Lab pool managed by ORSEE (Greiner, 2015).

The number of participants per treatment is as follows: 46 for No-Rank-Gap50, 45 for No-Rank-Gap250, 48 for Rank-Gap50, and 48 for Rank-Gap250. Because participants were divided into groups of six, we recruited 24 participants for each experimental session. Although we recruited the same number of participants for each session, the actual number of participants varied due to no-shows. When the number of participants was less than 24, groups with five participants were created. Because a technical problem occurred midway through the experiment in one session, an additional session with one group of six participants was conducted.

The experiment lasted around 54 minutes (SD = 20), including instructions and comprehension quiz. The average earning based on all the tasks was 2112 JPY (SD = 250), which includes a fixed participation fee of 500 JPY.

4.1 Dynamics of the wealth inequality

Let us first investigate whether the data supports the model's main prediction, i.e., whether the difference in wealth (savings) between the two types (wealth inequality) widens as the period proceeds.

To do so, we divide the 20 periods of the experiment into five non-overlapping intervals, and the average wealth (cumulative savings) in each of these intervals are calculated for each type. The difference between these average wealth between the two types, relative to their initial differences, are the main dependent variables in the analyses.⁶

Figure 4 illustrates the dynamics of the mean wealth inequality between two types within each group for four treatments. The initial inequalities are normalized to zero. The predictions of the model in each condition, without psychological effects of feedback on ranking, are also shown in dotted lines. Table 2 complements Figure 4 by showing the results of linear regressions in which the dependent variable is the normalized wealth inequality between the two types, and the independent variables are the treatment dummies.

From Figure 4, we observe that the average wealth gap between the two types does not widen as much as what the model predicts. Yet, while we do observe a statistically significant widening of the gap in the Rank-Gap250 and No-Rank-Gap250 treatments (see Table 2) until the third interval, that is not the case for Rank-Gap50 and No-Rank-Gap50 treatments. Furthermore, even for the No-Rank-

⁶We obtain qualitatively the same results if we consider the difference in the median wealth of each type in a group.



Figure 4: Temporal Evolution of Wealth Inequality Between Two Types *Notes:* Initial inequality is normalized as zero. The error bars indicate the standard errors at the 5th, 10th, 15th, and 20th periods. The bold error bars correspond to the Rank condition, while the thin error bars correspond to the No-Rank condition.

	interval 1–5	interval 6–10	interval 11–15	interval 16–20
No-Rank-Gap250	35.420^{***}	93.118***	108.252^{***}	102.358^{*}
	(12.26)	(25.99)	(38.44)	(57.80)
Rank-Gap50	-1.607	17.015	29.646	38.853
	(12.26)	(25.99)	(38.44)	(57.80)
Rank-Gap250	43.889***	107.591^{***}	164.531^{***}	241.616***
	(12.26)	(25.99)	(38.44)	(57.80)
Constant	-4.567	-22.436	-34.399	-47.578
	(8.67)	(18.38)	(27.18)	(40.87)
Observations	32	32	32	32
Adjusted \mathbb{R}^2	0.384	0.423	0.389	0.357

Table 2: Regression Analysis on the Dynamics of Wealth Inequality

Notes: ***, **, and *: statistically significantly different from zero at 1%, 5%, and 10% levels, respectively. Standard errors are shown in parentheses.

Gap250 treatment, the final difference in the wealth gap between the two types is only marginally significantly different from zero, as can be seen by the regression coefficients reported in Table 2.

Thus, contrary to the prediction of the model, inducing preference for wealth

accumulation alone did not lead to the widening of wealth inequality. The widening of wealth inequality was observed only when the induced preference for wealth accumulation was combined with the stimulation of a status concern (via the display of the ranking) with high initial difference in the amount of wealth (thus, catch up by L-type was not possible).

4.2 Dynamics of savings in each group

To better understand the non-widening of wealth gap, we now investigate the outcome at group level. Figures A.1 and A.2 in Appendix A show the dynamics of the average saving of each type (red for H-type and black for L-type) for each group in No-Rank and Rank treatments, respectively. In each figure, the top panels show the outcomes of Gap50, and the bottom panels show the outcomes of Gap250.

In the No-Rank-Gap50 condition (shown in the top half of Figure A.1), contrary to the prediction of the model in which the H-type increases their saving over time, the average saving of the H-type at the final period is no higher than its initial level for 7 out of 8 groups. In some cases (groups 2, 3, and 7) where the average having of L-type is higher than the one for H-type in the final period. Similarly, in the No-Rank-Gap250, in 3 out of 8 groups, the average saving of H-type in the final period is lower than the initial level. A similar observation can be made for the Rank-Gap50 condition (shown in the top half of Figure A.2). Thus, although we have explicitly induced a preference for wealth accumulation, many of our participants in the role of H-type have over-consumed relative to the theoretical benchmark.

An exception is the Rank-Gap250 treatment shown in the bottom half of Figure A.2. In this treatment, the average saving of the H-type is higher than its initial level in most groups, although there is a large within-group heterogeneity as demonstrated by the large error bars.

	L-type			H-type		
	Mean	Std	Median	Mean	Std	Median
Rank-Gap50	152.533	(219.669)	74.208	185.932	(182.801)	109.144
Rank-Gap250	80.921	(87.535)	44.590	170.018	(219.978)	102.751
No-Rank-Gap50	100.811	(137.284)	61.593	1076.783	(2163.401)	296.783
No-Rank-Gap250	144.423	(190.846)	64.651	398.569	(810.019)	152.153

Table 3: Mean (std.) and median of mean squared deviation

4.3 Conditional optimality and dynamics of saving

As noted above, many of our participants have over-consumed relative to the theoretical benchmark. The prevalence of overconsumption is consistent with the existing experimental literature in which participants do not need to borrow to consume (e.g., Carbone, 2006; Brown et al., 2009; Carbone and Duffy, 2014). However, this leaves the question of whether the widening wealth inequality hypothesis would be supported if we focus our analyses on those participants who have made conditionally optimal choices.⁷ Conditionally optimal choices are optimal conditional on the amount of savings when making a decision. Focusing on the conditionally optimal choices instead of unconditionally optimal choices is not precedented. For example, Carbone and Duffy (2014) shows that deviation from the conditionally optimal choices is larger when participants receive social information, i.e., the average previous period consumption of all the participants in the group, than the case without such information.

In the following analyses, we first obtain the conditionally optimal paths, as in Carbone and Duffy (2014), by solving a dynamic optimization problem for the remaining T - t + 1 periods, with the initial assets being the allocable budget at

⁷The analyses reported in this section are not pre-registered.

period t for each participant. After computing the mean squared deviation (MSD) between the conditionally optimal savings and the actual savings for all participants, we divide participants into two groups, those with small MSD and those with large MSD, based on whether their MSD is smaller or larger than the median of the same type (H or L) in the same treatment. Table 3 shows the descriptive statistics of the MSD for each type and treatment.

Figure 5 illustrates the dynamics of the average wealth gaps between H- and L-types for (a) all the participants, (b) those with small MSD, and (c) those with large MSD in four treatments. Unlike Figure 4, which presented the average differences between two types within each six-person group, Figure 5 does so without accounting for the six-person group. Instead, it plots the difference between the average savings of two types.

The result of Panel (a) resembles the one shown in Figure 4, although the two figures are generated differently. Namely, wealth inequality widens until the final interval only for Rank-Gap250 treatment. In No-Rank-Gap250, it windens initially, but then converges to zero in the final interval. However, when we focus on those participants who followed the conditionally optimal saving path closely (shown in Panel (b)), we observe widening wealth inequality in all the treatments, except for the first 15 rounds in the No-Rank-Gap50 treatment. In particular, the observed dynamics of wealth inequality follow the theoretical prediction very closely for Rank-Gap250 and Rank-Gap50 treatments, although in the latter the variation in the outcome is large so that it will not be statistically significantly different from zero as will be shown in Table 4 below. The non-widening of wealth inequality we observed in Panel (a) is due mainly due to those participants who deviate from the conditionally optimal path, as demonstrated in Panel (c). For these participants, except for Rank-Gap250 treatments, the average wealth inequality is negative in the final round. This indicates among these large MSD participants, H-types has



Figure 5: Temporal evolution of wealth inequality

Notes: Not taking the group as an independent observation. Instead, the difference between the average savings of H- and L-types was taken for each treatment. Initial inequality is normalized as zero. The error bars represent the root sum square of the standard errors of the mean for the both types at the 5th, 10th, 15th, and 20th periods. The bold error bars correspond to the Rank condition, while the thin error bars correspond to the No-Rank condition.

consumed large part of their initial wealth compared to L-types.

Table 4 shows the results based on the regression analyses regarding the dynamics of wealth inequality corresponding to Figure 4. In particular, it reports the estimated marginal effects of the H-type dummy variable, thus capturing the difference in the average wealth between H and L type while the initial difference being normalized to zero, for each of the four treatments, derived from OLS regression analyses that used combinations of dummy variables representing H-type and four treatment dummies.

		(a) All		
	interval 1–5	interval 6–10	interval 11–15	interval 16–20
No-Rank-Gap50	-4.764	-21.212	-31.419	-43.441
1	(9.58)	(19.58)	(28.52)	(41.51)
No-Rank-Gap250	30.951***	70.241***	72.501**	53.384
-	(9.70)	(19.82)	(28.87)	(42.02)
Rank-Gap50	-6.174	-5.421	-4.752	-8.725
	(9.37)	(19.15)	(27.89)	(40.60)
Rank-Gap250	39.322***	85.155***	130.132***	194.038***
	(9.37)	(19.15)	(27.89)	(40.60)
	((b) Small MSD		
	interval 1–5	interval 6–10	interval 11–15	interval 16–20
No-Rank-Gap50	-4.519	-11.181	-1.195	29.621
	(8.29)	(19.93)	(31.75)	(46.40)
No-Rank-Gap250	26.481***	77.212***	135.796***	207.919***
	(8.29)	(19.93)	(31.75)	(46.40)
Rank-Gap50	4.297	19.385	36.183	48.376
	(8.09)	(19.45)	(30.99)	(45.28)
Rank-Gap250	44.868***	131.014^{***}	237.843***	386.200***
	(8.09)	(19.45)	(30.99)	(45.28)
	((c) Large MSD		
	interval 1–5	interval 6–10	interval 11–15	interval 16–20
No-Rank-Gap50	-4.784	-29.274	-56.382	-104.386^{**}
	(15.14)	(28.76)	(35.54)	(41.52)
No-Rank-Gap250	34.326**	62.548^{**}	13.478	-89.718^{**}
	(15.49)	(29.43)	(36.37)	(42.49)
Rank-Gap50	-15.035	-26.411	-39.390	-57.041
	(14.83)	(28.17)	(34.82)	(40.68)
Rank-Gap250	34.629^{**}	46.351	38.993	31.440
	(14.83)	(28.17)	(34.82)	(40.68)

Table 4: Estimated Marginal Effects of H-Type Dummy

Notes: These tables report the estimated marginal effects of the H-type dummy variable for each of the four treatment conditions, derived from OLS regression analyses that used all possible combinations of dummy variables representing H-type, Rank/No-Rank, and Gap50/Gap250 on average wealth after deducting initial amount. Reported coefficients correspond to the value measured on the vertical axis of Figure 5. ***, **, and *: statistically significantly different from zero at 1%, 5%, and 10% levels, respectively. Standard errors are shown in parentheses.

Panel (a) shows the results using all the observations, while Panels (b) and (c) show the results based on Small MSD and Large MSD participants, respectively.

The result of Panel (a) colloborates the observation we made for Panel (a) of Figure 4. For the Small MSD sample shown in Panel (b), we observe significantly higher wealth for H than L types that becomes larger as the periods progress in No-Rank-Gap250 and Rank-Gap250. For No-Rank-Gap50, initially L-types saved slightly more than H-types on average, which is reversed in the final interval. For Rank-Gap50, the average saving of H-types becomes increasingly higher than that of L-type. But these differences are not statistically significantly different from zero.

As noted already in Figure 4, for large MSD participants, in the final interval, the average saving relative to their initial amount of L-type is larger than that of H-type in No-Rank-Gap50, No-Rank-Gap250, and Rank-Gap50, and significantly so in the two No-Rank treatments. This suggest these H-types have consumed much large part of their initial savings than L-types, on average.

5 Conclusions

Suppose decision-makers have a preference for wealth accumulation. Suppose further that the marginal utility of wealth accumulation declines slower than that of consumption and has a strictly positive lower bound so that beyond a certain level of consumption, the marginal utility of wealth accumulation becomes larger than that of consumption.

An implication of the existence of such a preference for wealth accumulation is the increase in wealth inequality (Michau et al., 2023a). In this paper, we test this widening wealth inequality hypothesis in the laboratory by explicitly inducing the preference for wealth accumulation in addition to consumption in the otherwise standard intertemporal optimization (consumption-saving decision) experiment (see Duffy, 2015, for a survey of the literature).

When using all the data, we find limited support for the widening wealth inequality hypothesis. Only in one out of four treatments we have considered did we observe widening wealth inequality. This was mainly due to over-consumption among our participants. Participants failing to make optimal decisions is often observed in similar inter-temporal optimization experiments even without induced wealth preference. To investigate whether failure to support the hypothesis is due to participants failing to make optimal decisions, we split our sample into two: those who follow the conditionally optimal saving paths closely (above median) and those who do not (below median). Indeed, the wealth inequality widened among those who followed the conditionally optimal paths in all four treatments but not among those who did not.

While we assumed the existence of wealth preference and tested its implication by explicitly inducing it in the laboratory, testing the existence of such preference and its origins, if any, would be important for future research.

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A Group level outcomes

Figures A.1 and A.2 show the dynamics of the average saving of each type (red for H-type and black for L-type) for each group in No-Rank and Rank treatments, respectively. In each figure, the top panels show the outcomes of Gap50, and the bottom panels show the outcomes of Gap250.



Figure A.1: Dynamics of average saving of two types in No-Rank treatments. H-type in red. L-Type in black. Top Gap50. Bottom Gap250. Error bars represent the standard error of the mean.



Figure A.2: Dynamics of average saving of two types in Rank treatments. H-type in red. L-Type in black. Top Gap50. Bottom Gap250. Error bars represent the standard error of the mean.

B Instructions

Part 1

- In Part 1, you will work on calculations.
- A screen like the one below will be displayed.

Remaining time on this page 99:99	
12 + 34 =	
Press the Enter key to submit your answer	
You have already answered 999 questions.	

- After entering the answer to the addition problem displayed on the screen in the box, press the Enter key to submit your answer.
- Please enter half-width numbers in the box.
- You will earn 1 point for each correct answer.
- After practice for 1 minute, you will work on the actual task for 3 minutes.
- Please answer as many questions correctly as possible in 3 minutes.
- After Part 1, we will rank you based on your score.
- We will randomly assign today's participants to groups and rank them within those groups.

- The higher your rank within the group, the more likely you are to earn more rewards in Part 2.
- If there are multiple participants with the same score, we will randomly determine the ranking among those participants.

Part 2

- In Part 2, you will be asked to make decisions on how to allocate your budget between "consumption" and asset accumulation over 25 periods.
- Initially, you will receive initial assets based on your ranking in Part 1.
- The amount of the initial assets will be 150/350 points for participants who rank higher than the median, and 100 points for those who rank lower.
- Assets will accrue a 5% interest each period. However, interest less than 0.01 points will be rounded down.
- You will also receive an income of 15 points each period.
- For example, if the initial assets are 100 points, the budget for the first period is 120 points:

$$\underbrace{100}_{\text{Initial assets}} + \underbrace{0.05 \times 100}_{\text{Interest}} + \underbrace{15}_{\text{Income}} = \underbrace{120}_{\text{Budget for}}$$

• The decision you will make is the allocation between the amount to "consume" in that period and the amount of assets to leave for the next period from your budget. • The points you decide to consume will be converted into currency by the following function and added to your reward.



 $80 - 80 \times e^{-(\text{consumption points})/9}$ [yen]

• The conversion table summarizes the correspondence between specific consumption points and reward amounts.

The conversion table		
Consumption points	Reward amounts	
0.00	0.00	
0.20	1.75	
0.40	3.47	
0.60	5.15	
0.80	6.80	

- For example, if you allocate 30 points for consumption from your budget, an additional 77.14 yen will be added to your reward.
- The values listed in the conversion table are just examples. In actual decisionmaking, you can submit any value up to the second decimal place.

- All points not consumed within the budget will become assets for the next period.
- The following equation holds between assets carried over periods and consumption.



• For example, if the budget for the first period is 120 points and you only consume 30 points in the first period, the asset ammount carried over to the second period is 90 points:

$$120 - 30 = 90.$$

Budget Consumption Carried over assets

And the budget for the second period is 109.50 points:

$$\underbrace{90}_{\text{Assets}} + \underbrace{0.05 \times 90}_{\text{Interest}} + \underbrace{15}_{\text{Income}} = \underbrace{109.50}_{\text{Budget for}}$$

- You are not allowed to consume more than your budget for the period. Also, you are not allowed to make your consumption amount negative.
- In decisions from the first to the 19th period, if you carry over assets to the next period, the value obtained by multiplying the number of points carried over by **0.04** will be added to your experimental reward as currency.
- For example, if you allocate 30 points for consumption from a budget of 120 points, the assets carried over to the next period are 90 points, and 3.60 yen will be added to your reward. Combined with the 77.14 yen reward obtained

from consumption, the total reward for that period is 80.74 yen.

- The assets left unconsumed in the final 20th period will be refunded as currency by multiplying the number of points by **0.44**, and added to your experimental reward.
- Decisions are made on the following screen.

_	Period 2		
	Assets	90.00	
	Interest for this period	4.50 15 109.50	
	Income for this period		
_	Budget for this period		
	Total additional rewards earned so far (yen)	80.74	
Simulator (Automati	ically calculated when you enter a value Points	in the white box.) Additional re	ewards (yen)
Simulator (Automati	period	in the white box.) Additional re	ewards (yen)
Simulator (Automati Consumption for this Assets to carry over to the next period	ically calculated when you enter a value Points Min: 0 / Max: 109.50 Min: 0 / Max: 109.50 Min: 0 / Max: 109.50	in the white box.) Additional re	ewards (yen)
Simulator (Automati Consumption for this Assets to carry over to the next period Maximum consumption for next period	ically calculated when you enter a value Points Min: 0 / Max: 109.50 Min: 0 / Max: 109.50 Min: 0 / Max: 109.50 Dn	in the white box.) Additional re	ewards (yen)

• Before making a decision, you can use the simulator to calculate how much reward you can earn based on your consumption this period, and what the maximum amount you can consume in the next period (i.e., your budget for the next period) will be. Please enter a number in either the "Consumption for this period" or "Assets to carry over to the next period" field. The numbers in the other fields will be automatically calculated and displayed.

- The final decision is made by entering the number of points to consume in that period in the blue box at the bottom of the screen. Any number entered will be rounded down to the nearest hundredth of a point.
- Once you have entered the number of points to consume, press the "Confirm" button to submit.
- Please decide and submit the number of points to consume within 3 minutes. A warning will be displayed if 3 minutes have passed.

[For the **Rank** cond]

- After making a decision in each period, the ranking based on the amount of assets carried over to the next period will be displayed among the group assigned in Part 1.
- If there are multiple participants with the same amount of assets, the ranking among those participants will be determined randomly.
- The screen displaying the ranking will show the ranking and the amount of assets.
- Your information will be highlighted.

Your assets are 90.00 points.			
Your asset ranking was b .			
Rank	Asset Amount		
1	132.50		
2	112.50		
3	102.50		
4	90.00		
5	90.00		
6	70.00		

Figure B.3: Screen for providing feedback on rankings

Notes: This screenshot is not presented in the instructions.