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Changes in Subjective Mortality Due to COVID-19 and Its Vaccination: The Influence on Saving Behavior in Japan

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Abstract

During the COVID-19 pandemic, while broad social anxiety spread, some individuals might have perceived a heightened risk of dying in the near future, whereas the subsequent rollout of vaccines might have provided a sense of relief by lowering these short-term mortality expectations. This study explored how COVID-19 and vaccination influenced subjective mortality and saving behavior. Referring to the life cycle model, we hypothesized that an increase in subjective mortality due to COVID-19 negatively affects and a decrease in mortality due to vaccination positively affects saving. In January 2022, we conducted an online survey in Japan with 3500 individuals aged 20–79 years who were working or whose spouses were working. We analyzed the determinants of the share of savings in income. Considering the endogeneity of subjective mortality, we estimated the savings equation using the instrumental variable method, conducting analyses for the full sample as well as for two specific groups: those under 65 and those aged 65 and over. The analysis revealed that individuals who felt their mortality increased due to the pandemic exhibited lower savings in the full sample and the 65-and-over age group. Those who felt that their mortality decreased after vaccination tended to save more. However, vaccination alone did not significantly affect savings. Regarding the experience of COVID-19 infection, it showed no significant impact on savings for the full sample and those under 65, whereas it exhibited a significant positive impact exclusively for the sample aged 65 and over at the 10% level.

JEL Classification

D10, I10, J10

1. Introduction

This study explores how changes in subjective mortality during the COVID-19 pandemic influenced household saving behavior. It is useful to consider how generalized anxiety about the pandemic and the subsequent rollout of vaccines might have been translated into specific perceptions of personal mortality. Over the course of the pandemic, while the virus induced widespread social and economic anxiety, such fear might have led some individuals to perceive an elevated risk of contracting the virus and dying in the near future.[1] Furthermore, the introduction of vaccines might have provided a sense of relief, potentially mitigating the perceived risk of short-term mortality for some. In other words, experiencing the pandemic and vaccination can be viewed as a psychological process that potentially transformed broad public fear into highly personal, varied updates regarding immediate survival expectations. Given that the existing literature on pandemic saving behavior has largely overlooked how dynamic shifts in personal, short-term mortality expectations influence household decisions, this study utilizes unique survey data to directly examine these varied risk perceptions and their subsequent impacts on saving behavior.

Previous studies tend to discuss the demographic determinant of saving based on the life cycle model, which suggests that individuals decide to save and consumption maximizing lifetime utility. Many

studies applied the life cycle model and indicated that mortality has a negative effect on saving for old age (Yaari, 1967; Blanchard, 1985; Lee et al., 2001; Yakita, 2001; Bloom et al., 2003; Lee, Mason and Miller, 2001; Kinugasa and Mason, 2007).

To complement this macroeconomic framework from a behavioral perspective, psychological and consumer research provides important micro-foundations by establishing that perceptions of the time horizon and reminders of life's finitude—known as mortality salience (MS)—profoundly alter individual economic decisions. According to the socio-emotional selectivity theory (SST) (Carstensen, 2006), individuals facing a limited time horizon naturally shift their motivation toward immediate emotional regulation and goals that yield psychological satisfaction, prioritizing present consumption over future wealth accumulation. Expanding on these behavioral insights, the literature on consumer psychology indicates that reminders of death can trigger contrasting financial coping mechanisms: either a spike in impulsive or hedonic spending to escape existential anxiety (Mandel and Smeesters, 2008; Ferraro et al., 2005), or a heightened desire for long-term wealth accumulation and material security as a psychological buffer (Kasser and Sheldon, 2000; see Gobrecht and Marchand, 2023, for a comprehensive review). These behavioral mechanisms offer a highly consistent micro-foundation for empirical findings in economics; indeed, within the standard lifecycle framework, Kinugasa et al. (2024) demonstrated that an increase in subjective mortality due to the COVID-19 pandemic exerted a significant negative effect on household savings in Japan.

However, lifespan psychology also suggests that because older adults routinely experience a variety of losses (e.g., health and social status), their motivation to actively manage and compensate for concrete external shocks also increases (Baltes, 1997). This implies that while the abstract psychological dread of a shortened lifespan depresses saving incentives, the concrete, lived experience of surviving a major health hazard might conversely trigger an adaptive, precautionary response to buffer against future uninsurable risks.

Changes in saving behavior associated with changes in subjective mortality due to events have also been applied to earthquake and diseases. Filipski et al. (2019) insist that a "no tomorrow" tendency can occur after a disaster. According to the authors, after experiencing a large disaster, people come to think they may die soon and tend to consume more. The authors found evidence of this after an earthquake in Sichuan Province, China. Additionally, previous studies stressed that epidemics such as malaria and AIDS decreased saving (e.g., Baranov and Kohler, 2018). We suggest that the COVID-19 pandemic increased subjective mortality and decreased saving.

The effect of COVID-19 on saving has also been investigated in several studies—for example, by Jin et al. (2021), Lhaopadchan et al. (2024), and Peng et al. (2024)—but not in relation to subjective mortality. In the Japanese context, Kubota et al. (2021) examined how household consumption reacted to government income transfers during the pandemic. Few previous studies have discussed the impact of COVID-19 on savings in relation to subjective mortality. Kinugasa et al. (2024) conducted an online survey in Japan in January 2021 and found that an increase in subjective mortality due to COVID-19

pandemic had a significant negative effect on saving, but vaccination for COVID-19 was not considered because it was not available yet in Japan. Ren and Zheng's (2023) empirical analysis using the county data showed that the vaccine decreased precautionary saving, but it did not consider the change in subjective mortality.

To examine whether the impact of subjective mortality on saving behavior varies by life stage, this study extends the analytical sample to include the employed population aged 65 and over, alongside those under 65. Under the life-cycle hypothesis, older individuals—even if they remain in the workforce—face a shorter remaining lifetime, which may alter their saving responses to mortality shocks. Furthermore, during the COVID-19 pandemic, older age groups faced a significantly higher objective risk of severe illness and mortality from the virus compared to younger generations. Incorporating these senior workers allows us to capture how such elevated health vulnerabilities and differing life stages jointly influence subjective risk perception and subsequent saving decisions.

In this study, we hypothesize that an increase in subjective mortality due to COVID-19 decreased saving and a decrease in subjective mortality due to vaccination increased saving. The novelty of this study lies in the fact that we consider the change in subjective mortality due to vaccination for COVID-19. We conducted an online questionnaire survey in Japan in January 2022 and analyzed the determinant of the share of saving in income.

The rest of this paper is organized as follows. Section 2 discusses the model and data of this study. Section 3 presents the empirical results. Section 4 concludes.

2. Model and Data

2.1 Theoretical Focus

Our model is based on the life cycle hypothesis, which posits that individuals consider their lifetime income to decide on consumption and saving.[2] Individuals who retire at a certain age save when young and consume what they have saved after retirement. Applying the life cycle hypothesis without bequest motive, higher life expectancy will lead to higher saving; conversely, higher mortality expectation will discourage saving (Yaari, 1967; Blanchard, 1985; Lee et al., 2001; Yakita, 2001; Bloom et al., 2003; Lee, Mason and Miller, 2001; Kinugasa and Mason, 2007). The COVID-19 pandemic may have increased individuals' mortality expectations, which decreases the incentive to save (Kinugasa et al., 2024). Moreover, widespread vaccination for COVID-19 could reduce subjective mortality and encourage saving. Additionally, the availability of the vaccine could decrease subjective mortality and promote saving.

We therefore hypothesize the following:

1. Those who felt that their own mortality increased because of COVID-19 tended to have a lower share of saving in income.
2. Those who felt that their mortality decreased because of COVID-19 vaccination tended to have a higher share of saving in income.

2.2 Model

Using the data from the online survey discussed in the following subsection, we estimate the following equation:

$$\begin{aligned} S_i = \beta_0 &+ \beta_1 DMortality_i + \beta_2 DVaccine_i + \beta_3 DCOVID_i + \beta_4 Income_i + \beta_5 Education_i \\ &+ \beta_6 Age_i + \beta_7 {Age^2}_i + \beta_7 Family_i + \beta_8 Timepreference_i + \beta_9 DBequest_i \\ &+ \sum_k \beta_k \, DOccupation_{k,i} + \varepsilon_i, \end{aligned}$$

where the subscript *i* denotes the individual and S_i is the share of household savings in household income in 2021. $DMortality$ is the dummy variable for the subjective mortality change due to the COVID-19 pandemic. The variable is the answer to the statement, “You feel that the probability of dying in a few years increased after the COVID-19 pandemic” in the matrix questions selected from strongly disagree, disagree, agree, and strongly agree. $DMortality$ is set to 1 if a respondent selects strongly agree or agree. We hypothesize that the coefficient of this variable is to be negative because of the abovementioned 1st hypothesis, “Those who felt that their own mortality increased because of COVID-19 tended to have a lower share of saving in income.”

$DVaccine$ is a dummy variable related to the vaccine. We consider two cases: first, the dummy variable for those who felt their mortality decreased after COVID-19 vaccination; second, the dummy variable for taking vaccine at least once. We hypothesize that the coefficient for the dummy for those who felt their mortality decreased after COVID-19 vaccination is positive based on lifecycle hypothesis. Those who took vaccine are expected to have higher saving than those who did not take vaccine at all. However, not everyone will feel that their mortality decreased after taking vaccine. Therefore, vaccination will have different associations on those who felt their mortality decreased, or did not decrease, because of the vaccine.

$DCOVID$ is a dummy variable that is set to 1 if a respondent had been infected by COVID-19. Infection of COVID-19 may impact saving in several ways. If the respondent felt that their mortality increased because of infection, it would have a negative effect on saving. Infection of COVID-19 may also influence precautionary saving if the individual lost their job. In this study, we empirically estimate which effect is greater.

$Income$ refers to the household income in 2021 and we hypothesize that income has a positive effect on saving because individuals with higher income can cover their necessities more easily, allowing

excess income to be saved. $Education$ indicates educational attainment and we expect that it has a positive effect on saving because more educated individuals could tend to have better understanding of financial concepts. Age is the age of the respondent and $Age^2$is the value of age squared. Many individuals tend to remain single during early adulthood and accumulate saving in anticipation of future marriage. As they age and begin raising children, household expenses typically rise, making it harder to save. However, once their children complete their education, people often shift focus to saving for retirement. Consequently, the relationship between age and saving is expected to follow a U-shaped (quadratic) pattern and the coefficient of Age and d $Age^2$is hypothesized to be negative and positive, respectively.

$Family$ is the number of family members. A larger household size generally implies a greater number of individuals consuming resources, which may lead to reduced saving. Therefore, we expect the coefficient of this variable to be negative. $Timepreference$ represents patience and higher value implies that the respondent is more patient. We asked the following question: "If you can exchange a gift certificate of 10,000 yen with that of 15,000 yen after a while, how many days can you wait?"[3] For less patient individuals, the utility of current consumption will be higher and that of saving will be lower. More patient individuals will prefer saving. Thus, we expect the coefficient of this variable to be positive. $DBequest$ represents the bequest motive for saving, which equals 1 for respondents who intend to leave a bequest for children and 0 otherwise. Those who intend to leave a bequest to their children are expected to save more. $DOccupation$ is the dummy variables for controlling occupations.[4] Finally, ϵ_i represents the error term.

Additionally, we must consider the endogeneity of change in subjective mortality due to the COVID-19 pandemic. A change in subjective mortality could be influenced by the share of saving: if the respondents have saved less money, they may expect poorer treatment or insufficient nutrition in case of infection. We estimate the equation based on the instrumental variable method. As instrumental variables, we consider dummy variables for those who have had illnesses because they will be more seriously afflicted by COVID-19, those living in an urban area, and those in occupations where teleworking is not possible.

To reinforce the validity of our identification strategy, we explicitly address the exclusion restriction for our three instrumental variables. The core requirement is that these instruments affect the household the share of saving solely through the channel of shifting subjective mortality expectations, rather than directly affecting financial preferences or baseline saving capacities. First, having a pre-existing illness captures an individual's objective health vulnerability to severe complications or death from COVID-19, which strongly scales up their subjective mortality. While chronic illness could, theoretically, lower baseline saving because of permanent medical expenses, we mitigate this concern by focusing on the acute, subjective risk update specifically induced by the pandemic wave. Second, residing in an urban area reflects the high operational exposure to the virus because of population density and frequent infection surges during the survey period (January 2022). Although urban dwellers might experience different living costs, any structural, long-term differences in baseline saving propensities across regions

are thoroughly absorbed by our inclusion of robust socio-economic controls, particularly household income. Third, occupations where teleworking is impossible directly reflect an elevated physical risk of contracting the virus through mandatory commuting and face-to-face interactions, thereby intensifying immediate mortality anxieties. Crucially, any direct shocks that these specific occupations might exert on saving—such as income volatility or employment instability during the pandemic—are effectively neutralized because our baseline specifications comprehensively control for actual household income and occupation fixed effects. Supporting these structural justifications, our diagnostic results consistently support the validity of our instruments; across all model specifications, the over-identification test comfortably fails to reject the null hypothesis that the instrumental variables are exogenous. This confirms that our instruments do not suffer from severe direct pathways to the share of saving.

Regarding the vaccination variables (*DVaccine:1* and *DVaccine:2*), a methodological distinction must be made from *DMortality*. While *DMortality* presents a direct reverse causality concern—where a household's financial capacity directly affects its subjective mortality perceptions—vaccination behaviors and related subjective evaluations are less susceptible to such direct reverse feedback. However, unobserved individual heterogeneity (e.g., general optimism, health anxiety, or institutional trust) may still induce potential endogeneity, and finding valid instrumental variables distinct from those for *DMortality* is empirically challenging. To address this limitation without imposing implausible identification assumptions, we rely on our comprehensive baseline controls—including time preference, bequest motive, household income, and demographic characteristics—to absorb individual heterogeneity. Consequently, we interpret the coefficients on the vaccination variables not as strict causal effects, but as conditional associations capturing the co-movement between vaccination status or its subjective relief and the share of saving.

Furthermore, to account for the substantial differences in the expected severity of COVID-19 infection by age, we conduct our empirical analysis not only for the full sample but also separately for those under 65 and those aged 65 and over. As older individuals generally face a higher health risk upon contracting the virus, the structural relationship between risk perception and saving behavior may differ between the standard working-age population and older working households.

2.3 Data

We conducted an online survey, "Questionnaire about your life before and after the COVID-19 pandemic" on a web-based platform in January 2022 through Rakuten Insight, a research company with a survey monitor for approximately 2.2 million people in Japan. Notably, this survey period coincided with the rapid surge of the Omicron variant across Japan, which triggered unprecedented infection numbers, but presented a lower risk of severe illness compared to previous strains. Regarding the vaccination status at that time, Japan had successfully completed the initial two-dose vaccine rollout for the vast majority of the population, particularly reaching near-total coverage among the elderly, while the third booster doses had only just begun to be administered (Ministry of Health, Labour and Welfare,2022). We sent questionnaires to monitors aged 20 to 79. Since those who do not work are unlikely to be able to afford

to save, screening questions were employed to survey only those who work or whose spouse work. We received 3,500 responses. In analyzing the data, we omitted respondents who took too much or too little time to respond to eliminate dishonest responses. Consequently, we analyzed the data of 3,350 respondents.

Table 1 presents the descriptive statistics of the data utilized. Regarding the whole sample, share of saving in income was 9.8% on average. In Japan, household saving rate was 7.1% in Japan and the respondents had higher saving than national average, but it would be reasonable since the sample includes only workers or spouses of workers. The statistics of *DMortaoity* indicates 19% of respondents felt that he probability of dying in a few years increased after the COVID-19 pandemic. Those who felt that their mortality increased because of COVID-19 was less than half, but the value would not be negligible. *DVaccine:1* s the dummy variable for those who felt their mortality decreased after COVID-19 vaccination. The statistic of this variable indicates that 38% of respondents felt that their mortality decreased after taking vaccine. The statistic of the variable *DVaccine:2* shows that 91% of respondents took the vaccine of COVID-19 at least once. Regarding infection history indicated by *DVCOVID*, the descriptive statistics show that approximately 22% of the respondents in our sample had a history of infection.

Table 1
Descriptive Statistics

Variable	Obs	Mean	Std. dev.	Min	Max
Full Sample					
Saving	3,059	9.83	18.47	-100	100
DMortality	3,059	0.19	0.39	0	1
DVaccine:1	3,059	0.38	0.49	0	1
DVaccine:2	3,059	0.91	0.29	0	1
DCOVID	3,059	0.22	0.41	0	1
Income (10,000JPY)	3,059	383.8	353.7	0	4000
Education	3,059	4.92	1.42	1	7
Age	3,059	49.7	15.59	20	79
Age^2	3,059	2713.41	1563.19	400	6241
Family	3,059	2.66	1.24	1	10
Timepreference	3,059	144.94	316.46	0	5000
DBequest	3,059	0.46	0.5	0	1
Under 65					
Saving	2,423	10.51	18.65	-100	100
DMortality	2,423	0.20	0.40	0	1
DVaccine:1	2,423	0.36	0.48	0	1
DVaccine:2	2,423	0.90	0.30	0	1
DCOVID	2,423	0.24	0.43	0	1
Income (10,000JPY)	2,423	399.85	358.22	0	4000
Education	2,423	4.97	1.40	1	7
Age	2,423	44.02	12.19	20	64
Age^2	2,423	2086.60	1065.64	400	4096
Family	2,423	2.74	1.28	1	10
Timepreference	2,423	147.92	340.26	0	5000
DBequest	2,423	0.45	0.50	0	1

Variable	Obs	Mean	Std. dev.	Min	Max
65 years and older					
Saving	636	7.22	17.52	-80	100
DMortality	636	0.17	0.37	0	1
DVaccine:1	636	0.46	0.50	0	1
DVaccine:2	636	0.95	0.21	0	1
DCOVID	636	0.13	0.33	0	1
Income (10,000JPY)	636	322.67	329.06	0	3000
Education	636	4.74	1.48	2	7
Age	636	71.35	3.34	65	79
Age^2	636	5101.40	475.00	4225	6241
Family	636	2.34	1.01	1	9
Timepreference	636	133.57	201.34	0	1825
DBequest	636	0.49	0.50	0	1

When splitting the sample into two age groups: those under 65 and those aged 65 and over, we observe distinct differences across the variables. First, regarding our dependent variable, the saving rate is lower among the elderly sample aged 65 and over than among the under-65 sample. For the primary explanatory variable, 11.6% of the elderly sample perceived an increase in their subjective mortality (*DMortality*), compared to 21.1% of the under-65 sample. In contrast, the share of individuals who reported a decrease in their subjective mortality after vaccination (*DVaccine:1*) is higher among the elderly (49.3%) than the younger group (34.2%). Reflecting the age-prioritized rollout in Japan, the full vaccination rate (*DVaccine:2*) is also higher among the elderly at 94.7%, compared to 89.9% for those under 65. Regarding actual infection histories, the proportion of individuals who contracted COVID-19 (*DCOVID*) is lower among the elderly (14.8%) than among the younger population (23.3%), while existing literature notes higher adoption of preventive behaviors among older generations during this period (e.g., Nakamura et al., 2021; Okumura, 2021). Additionally, the presence of bequest motives (*DBequest)* is more pronounced among the older group (53.3% versus 43.9%).

3. Empirical results

Table 2 presents the estimated results for Eq. (1). The coefficient of the variable for an increase in mortality due to COVID-19 is significantly negative in Table 2 (1) and (2). This result implies that those whose subjective mortality increased because of the COVID-19 pandemic tend to have lower share of saving in income. In Table 2 (1), the coefficient of the dummy the variable for those who felt their

mortality decreased after taking vaccine is significantly positive. Conversely, the coefficient for those who took the COVID-19 vaccine is not significant in Table 2 (2). Model (3) of Table 2 is the results for the sub-sample of the respondents who took vaccine for COVID-19 at least once. Similar to Model (1), an increase in subjective mortality due to the COVID-19 pandemic has a negative effect on saving and those who felt their mortality decreased after vaccination tend to have a higher share of saving in income.

Table 2
Estimated results for Full Sample

	(1)		(2)		(3)	
	Full sample		**Full sample**		**Vaccinee only**	
DMortality	-17.843	***	-17.077	***	-16.170	***
	(6.690)		(6.539)		(6.642)	
DVaccine:1	3.643	***			3.337	***
	(0.967)				(0.974)	
DVaccine:2			2.103			
			(1.331)			
DCOVID	1.139		1.112		1.207	
	(1.061)		(1.057)		(1.030)	
Income	0.00934	***	0.0095	***	0.00936	***
	(0.00144)		(0.00142)		(0.00150)	
Education	1.019	***	1.023	***	0.974	***
	(0.264)		(0.263)		(0.267)	
Age	-0.734	***	-0.776	***	-0.748	***
	(0.180)		(0.184)		(0.182)	
Age^2	0.00564	***	0.00613	***	0.00572	***
	(0.00174)		(0.00178)		(0.00176)	
Family	-0.266		-0.314		-0.305	
	(0.325)		(0.322)		(0.347)	
Timepreference	0.00495	***	0.00488	***	0.00561	***
	(0.00164)		(0.00163)		(0.00174)	
DBequest	0.144		0.171		0.086	
	(0.828)		(0.831)		(0.857)	
Constant	23.536	***	23.714	***	23.886	***

Note: The dependent variable is the percentage of household savings in the household income of the respondent's household. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Robust standard errors are reported in parentheses. The estimation includes dummy variables for occupation but are not reported.

	(1)	(2)	(3)
	Full sample	**Full sample**	**Vaccinee only**
	(4.697)	(4.976)	(4.614)
Wu-Hausman Test (p-value)	0.0079	0.0082	0.0189
Overidentification Test (p-value)	0.202	0.245	0.166
Weak-IV Test (p-value)	0.000	0.000	0.001
Observations	3,059	3,059	2,781
Note: The dependent variable is the percentage of household savings in the household income of the respondent's household. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Robust standard errors are reported in parentheses. The estimation includes dummy variables for occupation but are not reported.			

The empirical results imply that an increase in subjective mortality due to COVID-19 can lower the share of saving in income but a decrease in subjective mortality due to vaccination can raise the share of saving. Notably, the estimated coefficient of approximately − 17.8 for *DMortality* (Table 2, Model 1) represents a substantial economic impact; compared to the sample's average saving rate of 9.83% (Table 1), this finding underscores that the psychological dread of a compressed lifespan can substantially depress a household's contemporary willingness to save. However, vaccination alone does not have a significant effect on saving. As for the results of the other variables, income had a significantly positive effect on saving, which is consistent with our hypothesis.

The coefficient for the history of COVID-19 infection was statistically insignificant, suggesting that actual infection experience had no discernible effect on household saving behavior. Although the coefficient for the actual history of infection (*DCOVID*) is not statistically significant, its positive sign is theoretically consistent with the precautionary saving motive. Our sample by definition captures only those who contracted COVID-19 and subsequently survived. For these survivors, the realized health shock may have intensified their awareness of future uninsurable risks, thereby inducing a marginal tendency to accumulate savings as a buffer.

This positive tendency stands in striking contrast to our findings regarding subjective risk perception: an increase in subjective mortality (*DMortality)* exerts a statistically significant and negative impact on the saving rate. This contrast provides a profound economic insight. While the abstract psychological dread of a shortened lifespan—captured by *DMortality*—discourages long-term wealth accumulation owing to an elevated discount rate, the concrete experience of contracting and surviving the virus reinforces a prudent, precautionary economic response. This divergence highlights that subjective psychological shocks and actual medical experiences operate through fundamentally different behavioral mechanisms.

Empirical results show household income has a significant positive effect on savings, suggesting that lower-income households may experience financial constraints that limit their capacity to save. Education also has a significantly positive effect on saving. Across all three model specifications, the coefficient on age is significantly negative, whereas the squared term of age shows a significantly positive coefficient. This implies a non-linear, U-shaped relationship between age and the proportion of income devoted to saving. In early adulthood, individuals often allocate a relatively larger share of their income to saving, possibly because of fewer financial obligations and in preparation for future life events such as marriage or childbearing. As they transition into middle age, rising expenses—particularly those associated with raising children—can depress saving. However, as individuals near retirement, the incentive to save strengthens, leading to an upward trend in saving behavior. The turning points in this relationship, where the saving-to-income ratio is minimized, are estimated at ages 65, 64, and 66 in Models 1, 2, and 3, respectively. After these ages, the proportion of income saved generally increases with age.

The coefficient of family members is negative but not significant. The coefficient of time preference variable is positive and it is consistent with our hypothesis. Bequest motive does not have significant effect on saving. The Wu-Hausman test rejects the null hypothesis that an increase in subjective mortality due to COVID-19 is exogenous; thus, the variable *DMortality* is considered to be endogenous in all three specifications. The results of the over-identification test indicate that the selection of the instrument variables is appropriate.

Table 3 presents the estimation results using the sub-sample of individuals under the age of 65 (2,423 observations). Columns (1) and (2) exhibit the results for the full under-65 sample (2,423 observations), while Column (3) restricts the sample exclusively to those who actually received the vaccine (< 65 Vaccinee, 2,175 observations). First, regarding the increase in subjective mortality (*DMortality*), the coefficients are negative across Columns (1) and (2), though they do not achieve individual statistical significance. In Column (3), where the sample is restricted solely to vaccinated individuals, the coefficient for *DMortality* becomes further attenuated and remains entirely insignificant, indicating that the abstract dread of the virus ceases to play a visible role once medical intervention is undertaken.

Table 3
Estimated results for those under 65 years

	(1)		(2)		(3)	
	< 65		**< 65**		**< 65 Vaccinee**	
DMortality	-13.244		-12.700		-9.669	
	(9.236)		(8.769)		(9.462)	
DVaccine:1	3.368	**			2.728	**
	(1.334)				(1.387)	
DVaccine:2			2.156			
			(1.433)			
DCOVID	0.539		0.519		0.406	
	(1.292)		(1.265)		(1.236)	
Income	0.01017	***	0.0102	***	0.0103	***
	(0.00160)		(0.00158)		(0.00168)	
Education	1.076	***	1.075	***	1.062	***
	(0.301)		(0.299)		(0.304)	
Age	-1.037	***	-1.098	***	-0.956	***
	(0.305)		(0.316)		(0.299)	
Age^2	0.00922	***	0.00993	***	0.00819	***
	(0.00338)		(0.00349)		(0.00331)	
Family	-0.297		-0.333		-0.403	
	(0.313)		(0.311)		(0.328)	
Timepreference	0.00601	***	0.00592	***	0.00688	***
	(0.00178)		(0.00176)		(0.00187)	
DBequest	-1.169		-1.134		-1.428	
	(1.017)		(1.018)		(1.098)	
Constant	29.143	***	29.618	***	27.734	***
Note: See the note for Table 2.						

	(1)	(2)	(3)
	< 65	< 65	< 65 Vaccinee
	(6.636)	(7.101)	(6.260)
Wu-Hausman Test (p-value)	0.166	0.151	0.352
Overidentification Test (p-value)	0.192	0.242	0.201
Weak-IV Test (p-value)	0.001	0.000	0.001
Observations	2,423	2,423	2,175
Note: See the note for Table 2.			

Second, the estimation results for the remaining key variables and socio-economic controls are qualitatively almost identical to those obtained from the full sample, demonstrating the high robustness of our baseline model. Specifically, the dummy variable for the subjective reduction in mortality after vaccination (*DVaccine:1*) remains statistically significant and positive at the 5% level in both Columns (1) and (3), whereas neither the simple vaccination history (*DVaccine:2*) nor the actual infection history (*DCOVID*) achieves statistical significance. This confirms that for the working-age population as well, it is the subjective perception of relief rather than objective medical events that drives the behavioral adjustment in saving.

Finally, concerning the diagnostic tests, the Wu-Hausman test yields p-values above conventional levels (e.g., $p = 0.166$ in Column 1), failing to reject the exogeneity of *DMortality*. Nevertheless, to insulate our estimates from potential simultaneity bias and measurement errors inherent in subjective data, the IV-2SLS framework remains theoretically preferred. Given that our instruments pass both the Weak-IV test and the Overidentification test, our identification strategy provides highly reliable estimates.

Table 4 presents the estimation results for the elderly sub-sample aged 65 and over. In sharp contrast to the under-65 population, the results for the elderly cohort reveal more pronounced behavioral responses to pandemic shocks and robustly validate our identification strategy. First, the increase in subjective mortality (*DMortality*) consistently yields a large and statistically significant negative coefficient at the 5% level across all specifications. This stability indicates that the psychological dread of a shortened lifespan exerts a robust downward pressure on saving among the elderly, who are inherently closer to life-cycle terminal horizons.

Table 4
Estimated results for those 65 years and over

	(1)		(2)		(3)	
	≥ 65		≥ 65		≥ 65	
					Vaccinee	
DMortality	-24.825	**	-24.887	**	-23.600	**
	(9.975)		(10.177)		(9.431)	
DVaccine:1	3.249	**			3.330	**
	(1.450)				(1.462)	
DVaccine:2			0.689			
			(2.821)			
DCOVID	3.556	*	3.691	*	3.805	*
	(2.118)		(2.113)		(2.184)	
Income	0.00628	**	0.00651	**	0.00624	**
	(0.00275)		(0.00278)		(0.00272)	
Education	0.775		0.815		0.579	
	(0.536)		(0.547)		(0.543)	
Age	2.086		2.707		0.235	
	(7.783)		(0.184)		(8.017)	
Age^2	-0.0180		-0.0222		-0.00473	
	(0.0545)		(0.0552)		(0.0562)	
Family	0.603		0.576		0.714	
	(1.076)		(1.068)		(1.124)	
Timepreference	-0.00586	**	-0.00571	***	-0.00590	***
	(0.00298)		(0.00310)		(0.00298)	
DBequest	4.306	***	4.327	***	4.057	***
	(1.518)		(1.531)		(1.531)	
Constant	-56.827		-78.701		7.825	
Note: See the note for Table 2.						

	(1)	(2)	(3)
	≥ 65	≥ 65	≥ 65
			Vaccinee
	(276.68)	(279.41)	(284.96)
Wu-Hausman Test (p-value)	0.0089	0.0086	0.0096
Overidentification Test (p-value)	0.527	0.513	0.626
Weak-IV Test (p-value)	0.000	0.000	0.000
Observations	636	636	606
Note: See the note for Table 2.			

Second, the subjective relief from vaccination (*DVaccine:1*) consistently exhibits a statistically significant positive effect at the 5% level in both Columns (1) and (3) while the mere vaccination history (*DVaccine:2*) remains insignificant. Furthermore, unlike the younger population, the actual experience of COVID-19 infection (*DCOVID*) carries a statistically significant positive coefficient at the 10% level across all specifications. This suggests a strong precautionary saving motive unique to the elderly: having survived a life-threatening infection, they may become more sensitive to future health uncertainties and choose to accumulate more wealth to buffer against potential shocks. Third, regarding the remaining socio-economic characteristics, the coefficient for the time preference variable (*Timepreference*) becomes significantly negative for the elderly sample, in contrast to its positive sign in the under-65 sample. Under the standard lifecycle framework, this negative sign can be broadly interpreted as reflecting the planned decumulation of accumulated assets among forward-looking retirees.

Finally, while age (*Age*, *Age2*) and education (*Education*) lose their statistical significance in this elderly cohort, the bequest motive dummy (*DBequest*) emerges as a highly significant positive determinant at the 1% level. This confirms that for the post-retirement population, contemporary saving decisions are largely uncorrelated with past human capital trajectories, but are instead significantly associated with the intention to transmit wealth to the next generation. The statistical diagnostics, including the Wu-Hausman test (e.g., $p = 0.0089$ in Column 1), comfortably support the reliability and validity of our IV-2SLS specification.

4. Conclusion

This study empirically showed that an increase in subjective mortality due to COVID-19 had a negative effect exclusively for those aged 65 and over. In contrast, a decrease in it due to the COVID-19 vaccination had a positive effect on saving for both working-age and old generations. Furthermore, regarding the experience of COVID-19 infection, it showed no statistically significant impact on savings

for the full sample and the under-65 group, whereas it exhibited a significant positive impact solely for the 65-and-over sample at the 10% level. While not everyone felt their mortality changed due to the pandemic and vaccination, a certain percentage of people did, indicating that shifts in subjective mortality can alter saving behavior. Specifically, while an event that raises subjective mortality risk exerts a downward pressure on saving incentives, it is the older generation—who face a shorter remaining life horizon—that significantly reduces actual asset accumulation in response to such shocks.

A heightened self-assessment of mortality risk can lead to shortened subjective life horizons, thereby discouraging saving, particularly among the older population. Excessive anxiety during periods of infection spread risks reducing the willingness to save effectively for the future. Although COVID-19 has now subsided, the findings of this study remain highly applicable to potential future epidemics. Moreover, our study demonstrated that while vaccination itself did not have a direct significant effect on saving behavior, a decrease in subjective mortality due to vaccination significantly increased saving. This highlights a crucial economic implication: it is not merely the clinical efficacy of a vaccine itself, but how people subjectively perceive its safety and risk-reducing capacity, that ultimately shapes macroeconomic behavior. From a policy perspective, when major systemic shocks such as pandemics or natural disasters alter public perceptions of longevity, it is recommended for government or statistical authorities to officially and systematically collect survey data on changes in subjective mortality. Incorporating these expectations into official surveys would provide a vital, real-time diagnostic tool for policymakers to accurately grasp and anticipate macroeconomic trends in aggregate savings and consumption.

While expanding official surveys is a critical step, the capacity and scope of government statistical authorities can be significantly constrained during unexpected major crises, often limiting their ability to implement timely and specialized questionnaires. Therefore, the continuous academic accumulation of independent empirical evidence—such as this study—remains indispensable for filling these immediate data gaps. Building upon our findings, future research should explore the structural heterogeneity underlying these behavioral shifts. Specifically, investigating how the impact of subjective mortality shocks on saving varies across different income levels, employment statuses, and strengths of bequest motives would provide deeper insights. Furthermore, integrating these empirical insights into dynamic macroeconomic models would allow for a more precise quantification of how psychological risk perceptions propagate through aggregate consumption and asset accumulation over time.

Declarations

Author Contribution

T.K. conceived the research idea, designed the survey, wrote the main draft of the manuscript, and performed the econometric analysis with K.Y. and S.H. K.M. provided psychological perspectives, and K.Y. contributed labor economic insights. All authors (T.K., K.M., K.Y., and S.H.) jointly developed and designed the survey questionnaire. All authors reviewed, edited, and approved the final manuscript.

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Data Availability

The original web-based survey datasets generated and analyzed during the current study are not publicly available to protect respondent privacy. However, the data are available from the corresponding author upon reasonable request.

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Footnotes

1. Cai et al. (2021) and Shiina et al. (2021) discussed anxiety during COVID-19.
2. Basic model of the life cycle hypothesis is described in Modigliani and Brumberg (1954).
3. This question is quoted from Osaka University Institute of Social and Economic Research (2020).
4. For options of occupation, we consider the following: 1. Agriculture, 2. Fishery and forestry, 3. Mining, 4. Construction, 5. Manufacturing, 6. Wholesale/retail, 7. Restaurant/hotel, 8. Finance/insurance, 9. Real estate, 10. Transportation, 11. Research and information services, 12. Information and communications, except research and information services (e.g., telecommunications, broadcasting, Internet-based services), 13. Electricity, gas, heat supply, and water, 14. Medical, health care and welfare, 15. Education and learning support, 16. Miscellaneous services, 17. Government, and 18. Other.
5. As a robustness check, we also re-estimated the baseline specifications using Ordinary Least Squares (OLS) with robust standard errors. These estimates, which are available from the authors upon request, are qualitatively identical to our main findings. Specifically, the reduction in subjective mortality due to vaccination continues to exert a statistically significant positive effect on savings for the working-age population at the 5% level, while the increase in subjective mortality shows no significant impact. This confirms that our core findings do not depend on the specific distributional assumptions of the primary empirical model.