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Cash Demand and Demographic Changes in Japan

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Abstract

This paper examines the future evolution of cash demand in Japan, amid rapid demographic aging and the increasing adoption of cashless payments. Despite a decline in cash use for daily transactions, aggregate cash demand has remained stable, likely due to cash hoarding by older generations. Using survey data from 2021 that separates cash held for daily use and hoarding purposes by age group, we project cash demand through 2070. Our baseline scenario assumes constant cash-holding behavior by cohort, while an alternative scenario incorporates reductions reflecting the spread of cashless payments. Adjustments for the underrepresentation of high-cash-holding households are made using methodologies from the distributional national wealth literature, which employs Pareto distributions to align microdata with aggregate statistics. Results suggest that cash on hand (COH) will decline by 1.5%–2.4% annually, and cash at home (CAH) by about 1% annually. The rate of decrease in cash demand is faster than the population decrease of 0.7%, as we assume that future older individuals will hoard less cash than current older individuals, and future younger individuals will use less cash for day-to-day payment due to the spread of cashless payments. We find that a 1% rise in deposit rates would cause a 20% decrease in CAH demand, a much stronger effect than demographic aging. Finally, we discuss the implications for the Bank of Japan's balance sheet, as declining cash demand could increase the Bank's cost burden during monetary tightening.

Keywords: cash demand, population aging, demographic changes, cashless payment methods, cash hoarding
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1. Introduction

Japan has experienced two major structural changes over the last three decades: a dramatic demographic aging and a rapid spread of cashless payment methods. These two forces are expected to have contrasting effects on cash demand. On the one hand, the aging of the population could increase cash demand, as older people are less familiar with cashless payments and tend to hold more cash, including cash hoarding for precautionary motives. On the other hand, the younger generations, who are more accustomed to using credit cards and QR code payments, may reduce the demand for cash for day-to-day transactions and hoarding purposes. While the overall amount of cash in circulation relative to nominal GDP was stable at around 8 to 10 percent before 1995, it increased steadily afterward, reaching 22 percent in 2022 and slightly decreasing to 21 percent in 2023 and 2024. During the prolonged period of low interest rates since 1995, the share of the population aged 65 and over doubled from 15% in 1995 to 29% in 2020, and is projected to reach 36% by 2045. For example, an update of Fujiki and Nakashima (2020) based on aggregate data suggests that cash hoarding could explain about 46% of the cash in circulation in Japan as of 2024.

Several macroeconomic studies have discussed the potential effects of demographic changes on cash demand. Shirai and Sugandi (2019) argue that low interest rates and aging populations drive the growing global demand for cash. Using data from 204 countries and time series data from the United States, Wang and Zhu (2021) demonstrate that the proportion of the elderly population is negatively correlated with the velocity of money, suggesting that cash demand may increase as the population ages. Khiaonarong and Humphrey (2019, 2022) emphasize that cash demand tends to rise as

the share of older adults increases, as they generally prefer cash to digital alternatives. Z. Wang and Wolman (2018) find that cash usage for day-to-day transactions declined significantly in the U.S. over the early 2010s, mainly due to factors unrelated to demographics, suggesting that the pure time effect and technological progress are important drivers of the decline in cash usage. These studies suggest two contrasting effects within a country: a reduction in cash use for day-to-day payments, especially among young people, and an increase in cash hoarding among older individuals. Khiaonarong and Humphrey (2022) also find that interest rate changes have limited importance for cash use for day-to-day transactions. In Japan, the younger generation, accustomed to QR code payments, credit cards, and smartphone-based security investments, is unlikely to hoard significant amounts of cash even as they age, especially given the Japanese government's tax incentives for long-term investments in stocks and mutual funds, as well as concerns about cash robbery risks. These changing behaviors underscore the need to examine the interaction between cash hoarding and cash used for daily transactions, utilizing Japanese microdata.

Despite the rich macro-level studies, research that links microdata analysis with macroeconomic aggregates to forecast future cash demand under demographic transitions is limited. Using survey data from Fujiki (2023), which includes information on cash demand for day-to-day use and cash hoarding by age group as of 2021, this paper examines how the aging of the population and the diffusion of cashless payment technologies will impact future cash demand in Japan. Fujiki (2023) shows that older individuals have a higher demand for day-to-day cash and hoarded cash than younger individuals, which is consistent with the findings in macroeconomic studies. Nomura Research Institute (2024) also provided data for day-to-day cash and hoarded cash by

demographic groups. However, neither Fujiki (2023) nor Nomura Research Institute (2024) conducts cohort-based analysis or long-term forecasting, leaving an important gap in the literature.

This paper fills this gap by forecasting future cash demand by applying a cohort analysis approach, which tracks the same cohort as it ages. The key innovation is to predict future cash demand not only by assuming that current patterns remain unchanged, but also by accounting for the gradual decline in cash holdings among younger cohorts as they age, reflecting their increasing familiarity with cashless payments. Moreover, this study examines an important issue related to the macro-micro aggregation problem, highlighted in the Distributional National Wealth Project for European countries (Engel et al. 2022; Zwijnenburg et al. 2024), and in Vermeulen (2018) for the U.S. and Europe, and Japan by Nirei (2023) and Nishio (2008). These works show that microdata often underestimate macroeconomic aggregates because wealthy households are underrepresented. In the case of cash demand, survey non-response and the reluctance to report large cash holdings due to security concerns could cause similar biases. This paper addresses this issue by applying a Pareto distribution adjustment for the right tail of the cash holdings distribution.

Finally, this paper provides implications for Japanese monetary policy by discussing how the estimated declining demand for cash may affect the Bank of Japan's future profits. The Bank of Japan (2024) noted that unconventional monetary policy measures and balance sheet expansions could impact central bank finances during monetary tightening. The Bank's future profits depend on several factors, including the replacement of banknotes with interest-bearing reserves. The Policy Infrastructure

Division, Monetary Affairs Department, Bank of Japan (2025) simulates the Bank's future balance sheet, assuming that the demand for banknotes remains unchanged for a decade. By providing ballpark estimates of the effects of demographic changes and interest rate variations on cash demand, this paper contributes new insights into the sustainability of the Bank's future profitability.

2. Materials and Methods

2.1. Data Sources

This study primarily utilizes survey data collected by Fujiki (2023), which reports cash holdings separately for day-to-day transactions (cash on hand, COH) and hoarding purposes (cash at home, CAH) for different age groups as of 2021. Three thousand respondents reported their amount of COH by choosing from five ranges: less than 1,000 yen, 1,000 to 5,000 yen, 5,000 to 10,000 yen, 10,000 to 50,000 yen, and 50,000 yen or more. Similarly, CAH was reported by selecting among eight ranges: less than 10,000 yen, 10,000 yen to 50,000 yen, 50,000 yen to 100,000 yen,100,000 yen to 200,000 yen, 200,000 yen to 300,000 yen, 300,000 yen to 500,000 yen, 500,000 yen to 1,000,000 yen, 1,000,000 yen or more, and two options: "Do not know" and "Do not want to answer." Two thousand three hundred thirty-four respondents answered CAH (excluding respondents who chose options "Do not know" or "Do not want to answer"). [1]

[1] Fujiki (2023) used the following data from Intage monitors participating in the National Consumer Panel Survey (SCI). chosen from all the prefectures in Japan, both men and women, between the ages of 15 and 79, in proportion to the Japanese Census. Fujiki (2023) asked 4,578 participants in the SCI and Intage Special Payment Survey, conducted in July-August 2020, October 2020, and April 2021, to respond to questions about two types of cash holdings and their age. Overall, 3,029 monitors replied. We dropped twenty-one monitors who did not report the purchase records in both the 2019 and 2021 SCI, did not report the purchase records in the 2019 SCI, or participate in the 2021 SCI, and did not report the purchase records in the 2021 SCI or participate in the 2019 SCI. Only eight respondents under the age of 20 replied, and we excluded them, focusing on the 3,000 samples aged 20 to 79.

Importantly, responses above 50,000 yen for COH and above 1,000,000 yen for CAH are right-censored, requiring special handling in estimation. Table 1 reports the percentage of cash holdings chosen by age groups and the overall average for COH in Panel 1 and for CAH in Panel 2. Each panel shows that younger groups tend to hold a smaller amount of cash. We recognize two sources of potential bias related to survey non-response bias, highlighted by Dutz et al. (2021): (1) individuals who chose "Do not want to answer" in the survey could have substantial cash holdings, and (2) internet panel-based samples might underrepresent older or less technologically skilled individuals, leading to a downward bias in estimated cash demand. Unfortunately, we do not have good remedies for these points.

Additionally, we use the Population Projections for Japan (2023) to forecast the future population distribution by age group, which is necessary for projecting aggregate cash demand over time. We also utilize the Survey of Household Finances (SHF) 2021 for robustness checks, which provides published information on household cash holdings.

2.2. Estimation of Average Cash Holdings

Since the survey responses are reported in ranges, we compute weighted averages for COH and CAH using the midpoint of each range, except for the highest range (COH 50,000 yen or more and CAH 1,000,000 yen or more), where no upper limit exists. Regarding the left tail, assuming that everyone has a non-zero COH is reasonable. However, we identified respondents who do not have CAH because some chose "I do not have it now" for the question on the future use of CAH posted by Fujiki (2023). To estimate the mean cash holdings for the right-censored ranges, we apply different methodologies depending on the dataset:

(1) Following the methodology used in the Distributional National Wealth Project (Zwijnenburg et al., 2024; Engel et al., 2022; Vermeulen, 2018) and in Japanese studies (Nirei, 2023; Nishio, 2008), we adjust for the underrepresentation of high-cash-holding individuals. We fit a Pareto distribution to the top tail of the outstanding savings distribution in NHS 2019 to estimate the Pareto coefficient α. Using the estimated α, we infer the average holdings for the right-censored COH and CAH ranges. Appendix A discusses the details of the estimations. Specifically, we set the Pareto parameter $\alpha = 2.04$ and the average holdings for the right-censored ranges as follows: for COH of 50,000 yen or more, 98,100 yen; and CAH of 1,000,000 yen or more, 1,962,000 yen.

(2) Using the SHF 2021, we directly calculate the average cash holdings (combining cash on hand and cash at home) for those with one million yen or more cash balances from the published data, without assuming a specific distribution. This calculation is used solely for robustness checks related to CAH. Specifically, we set the average CAH holdings of 1,000,000 yen or more, 2,390,000 yen. Appendix B explains the details of the estimations.

(3) We assume that the average cash holdings of those who chose "less than 10,000 yen" is 5,000 yen if the respondents have non-zero CAH holdings and zero for those who chose "I do not have it now" for the question on the future use of CAH posted by Fujiki (2023). Specifically, the percentage of those who chose the option that "I do not have it now" for age groups is as follows: 20～29, 32.1%, 30～39, 20.2%, 40～49, 16.6%, 50～59, 12.5%, 60～69, 8.9%, 70～79, 8.9%.

2.3. Forecasting Methodology

We forecast future cash demand by multiplying the projected population of each age group by the estimated average cash holdings for that group. Our baseline assumption is that the average cash holdings for each age group remain constant over time, and our estimates based on 2021 survey data approximate the cash holdings in Japan as of 2020. Additionally, to account for behavioral changes associated with the spread of cashless payments, we incorporate an alternative assumption: the average COH demand declines by 1.35% per year for younger cohorts aged 20–29, based on observations from our dataset, as explained in Section 3.2.

For individuals aged 80 and above, whose data are not available in our micro dataset, we assume that their average cash holdings are the same as those of individuals aged 70 to 79. We also assume that the cash holdings of individuals under 20 are zero due to our data limitations. This assumption may overestimate cash holdings for the oldest age group, as suggested by life-cycle hypothesis-based studies on dissaving behavior (Horioka 2024); however, due to data limitations, this is a necessary simplification.

3. Results

3.1. Descriptive Statistics

The weighted average COH and CAH holdings by age group as of 2020 are shown in Table 2. Younger age groups (20–29) have the lowest average COH and CAH holdings, while older groups (70–79) show higher cash holdings, consistent with the findings of Fujiki (2023). This pattern underscores the importance of considering age when

forecasting future cash demand.[2] Population projections by age group from 2020 to 2070 are shown in Table 3. Japan's population is expected to decline significantly from 126,146,000 people in 2020 to 86,996,000 people in 2070, representing an annual decrease of 0.7%. This decline is particularly pronounced in the younger age cohorts, while the share of the elderly population is expected to increase.

3.2. Baseline Forecast: Constant Cash Demand per Cohort

Table 4 presents the projected total COH and CAH demand paths over time under different scenarios. Baseline forecasts suggest that total COH demand will decline from 1.98 trillion yen in 2020 to 0.95 trillion yen in 2070 (approximately 1.5% annual decline) or from 1.98 trillion yen in 2020 to 0.73 trillion yen in 2070 (approximately 2.4% yearly decline) when technological progress in cashless payments is assumed. Total CAH demand will decrease from 16.0 trillion yen to 9.5 trillion yen based on the NHS 2019 adjustment, or from 17.5 trillion yen to 10.5 trillion yen based on the SHF 2021 adjustment (about 1% annual decline). We will break down the results by age group as follows.

Regarding the projected path for COH demand by age groups, Table 5 summarizes the average COH holdings by age group assumed in the baseline simulation. Table 6 shows the projected total COH demand and its breakdown by age groups under the baseline assumption. Using the constant average cash holdings assumption, total COH

[2] For a robustness check, applying the same methodology for the average results reported in Nomura Research Institute (2024), the average COH holdings by age group as of 2024 are close to the average COH reported in Table 2. However, the average CAH holdings by age group over age 50 as of 2024 are 20% lower for the average CAH based on NHS and 30-40% lower for age groups less than 50 for the average CAH based on NHS. If we take the results from Nomura Research Institute (2024) at their face value, we might overestimate the CAH holdings, especially for younger age groups.

demand in Japan is projected to decrease from 1.98 trillion yen in 2020 to 0.95 trillion yen in 2070, implying an average annual decrease of approximately 1.5% over the next 50 years.

Table 7 reports the projected total COH demand, assuming technological progress in cashless payments, based on the following observations from Table 5, as explained below. Namely, Table 5 shows that individuals aged 20-29 have an average COH outstanding of 11.5 thousand yen, while those aged 60-69 have an average COH outstanding of 19.8 thousand yen. Since younger age groups prefer more cashless payment methods, we assume that average COH demand fell from 19.8 thousand yen to 11.5 thousand yen, reflecting the age gap of 40 years, which suggests about $100 \times \left(1 - \left(\frac{11.5}{19.8}\right)^{1/40}\right)$=1.35% decline of average COH demand per 1 more age. Using this result, let us assume that technological progress will reduce the average COH holdings by 1.35% per year for the age groups (20–29). Under this assumption, as Table 7 shows, total COH demand in Japan will decrease from 1.98 trillion yen in 2020 to 0.73 trillion yen in 2070, implying an average annual decline of 2.4%.

Regarding the projected path for CAH demand by age groups, Table 8 shows the average CAH holdings by age group under the NHS 2019 adjustment. Table 9 presents the projected total CAH demand and its breakdown by age group under the NHS adjustment. Table 10 shows the average CAH holdings by age group based on the SHF 2021 adjustment. Table 11 presents the projected total CAH demand and its breakdown by age group using the SHF 2021 adjustment. Total CAH demand will decline from 16.0 trillion yen in 2020 to 9.5 trillion yen in 2070 based on the NHS 2019 adjustment, or from 17.5 trillion yen to 10.5 trillion yen based on the SHF 2021 adjustment. Both scenarios

suggest a gradual but steady decline in total cash demand, driven mainly by demographic aging.

3.3. Robustness Checks: Sensitivity of total CAH demand to changes in α

In adjusting for the missing high-cash-holding households, our analysis used the estimated Pareto coefficient α from NHS 2019, which is 2.04. Table 12 shows the sensitivity of total CAH demand to changes in α. We chose α to be 1.04 because *CAH* demand in 2020 is approximately 1.04 trillion yen, which aligns with the household cash demand reported in the Flow of Funds statistics. Because our benchmark simulation uses a value of α equal to 2.04, we also use values of α equal to 1.29, 1.54, and 1.79, which increase the value of 1.04 by 0.25, 0.5, and 0.75, respectively. Using alternative values of α (1.04, 1.29, 1.54, and 1.79), we find that while the level of total CAH demand in 2020 varies significantly depending on α, the annual percentage decline in CAH demand remains about 1% in all cases. This suggests that our main result—steady decline in cash demand—is robust to reasonable variations in α.

3.4. Comparative Impacts on Cash Demand: Demographic Aging vs. Interest Rate Changes

Using estimates from Amromin and Chakravorti (2009) and Fujiki and Nakashima (2020), a 1% increase in the deposit interest rate would reduce total CAH demand by about 20%, and a 2% increase would reduce it by about 25%. This impact is much larger than the 1% annual decline caused by demographic aging. Figure 1 illustrates the comparative impacts of demographic aging and interest rate increases on total CAH demand. The figure shows that a 1% or 2% rise in deposit rates would cause a much larger reduction in cash demand

than the gradual effect of demographic transition. Thus, future interest rate changes could have a stronger and faster impact on cash demand than demographic shifts.

3.5. Implications for the Bank of Japan's Balance Sheet and Profitability

Under constant interest rate scenarios, our estimates indicate an annual decline of 2.4% in COH and a 1% decline in CAH. Suppose cash holders make bank deposits using the unnecessary COH and CAH, and the commercial bank requests that the Bank of Japan replace the unnecessary COH and CAH with bank reserves. In that case, it will result in an annual increase of approximately 1.2 trillion yen in excess reserves. If the Bank of Japan pays 1% interest on the increasing reserves, the cost would rise by 0.012 trillion yen per year, a modest 1% reduction in the Bank of Japan's annual profit of about 1 trillion yen.

In contrast, if deposit interest rates rise by 1% or 2%, the results in subsection 3.4 show that a reduction in CAH would lead to an increase in excess reserves of 23.44 trillion yen or 29.26 trillion yen, resulting in a rise in annual costs of 0.35 trillion yen or 0.73 trillion yen, respectively. These findings suggest that interest rate increases would have a much larger impact on the Bank of Japan's profitability than demographic aging alone.

4. Discussion

This paper provides several new insights into the future of cash demand in Japan and its macroeconomic implications. First, demographic aging is expected to lead to a gradual but steady decline in total cash demand. Baseline forecasts suggest that total COH demand will fall from 1.98 trillion yen in 2020 to 0.95 trillion yen in 2070 (about 1.5%

annual decline). Total CAH demand will decrease from 16.0 trillion yen to 9.5 trillion yen based on the NHS 2019 adjustment, or from 17.5 trillion yen to 10.5 trillion yen based on the SHF 2021 adjustment (about 1% annual decline). These results highlight the structural downward trend in cash demand driven by population dynamics; however, the rate of decrease in cash demand is faster than the rate of population decrease of 0.7%, as we assume that future older individuals will hoard less cash than current older individuals.

Second, behavioral changes resulting from technological progress, especially among younger generations accustomed to cashless payment methods, could accelerate the decline in cash demand for day-to-day use among future younger generations. Under a scenario where the average COH demand of each cohort falls by 1.35% annually, total COH demand would decline faster to 0.73 trillion yen by 2070.

Third, interest rate increases have a far greater impact on cash demand than demographic aging. A 1% rise in deposit interest rates would cause a 20% reduction in CAH demand almost immediately, compared to the slow 1% per year decrease caused by aging. Thus, monetary policy changes could sharply reduce cash demand in a short period.

Fourth, the implications for the Bank of Japan's profitability are significant. The gradual demographic-driven increase in excess reserves would have a small negative impact on profits. However, a sharp interest rate hike could considerably increase the cost of paying interest on reserves, threatening the Bank of Japan's profitability unless offset by higher-yielding assets.

Fifth, this paper emphasizes the significance of combining microdata and macro aggregates in analyzing cash demand. Applying the Pareto adjustment method, as used in

wealth distribution studies (Zwijnenburg et al., 2024; Engel et al., 2022; Vermeulen, 2018) and in Japanese studies (Nirei, 2023; Nishio, 2008), provides robustness against underestimation biases stemming from survey non-response and the underrepresentation of high-cash-holding households. Despite potential biases, our results on the trends in annual declines remain stable across a range of α values, underscoring the reliability of our forecasts.

5. Conclusion

This paper forecasts future cash demand in Japan, considering demographic aging and the diffusion of cashless payment technologies, by utilizing microdata that distinguishes between day-to-day cash use and hoarding of cash holdings. We find that demographic aging alone will lead to a gradual but steady decline in cash demand over the next 50 years. The rate of decrease in cash demand is faster than the rate of population decrease of 0.7%, as we assume that future older individuals will hoard less cash than current older individuals. Baseline forecasts suggest that total COH demand will fall by 1.5% annually, and total CAH demand will fall by about 1% annually. Further declines are expected if cashless payment technologies continue to spread among younger cohorts.

A comparative analysis reveals that changes in interest rates have a significantly more substantial impact on cash demand than demographic transitions. A 1% increase in deposit interest rates could reduce CAH demand by approximately 20%, a decline that would otherwise take about two decades due to demographic aging alone. These results imply important consequences for the Bank of Japan's balance sheet and profitability. Gradual increases in excess reserves resulting from demographic aging would have a modest impact on profits. In contrast, interest rate increases could lead to significant

increases in the payment of interest on excess reserves, posing a more immediate and severe challenge.

Finally, this paper contributes to the broader literature by applying a Pareto adjustment method for the right tail of the cash holdings distribution, ensuring robustness against survey non-response biases. Our findings suggest that while aggregate levels of cash demand are sensitive to assumptions about the distribution's tail, the trends in annual declines are stable and predictable. Future research should further explore cohort-based behavioral models, incorporating detailed information on future payment technology adoption rates and cross-country comparisons to enhance the generalizability of these findings. Future research should also examine the interest rate elasticity of cash demand using a recent data set.

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（Unit: %）

Age	<1k	1k-<5k	5k-<10k	10k-<50k	50k>
20-29	3.3	30.6	46.2	18.3	1.7
30-39	2.4	28.9	32.2	34.7	1.8
40-49	2.3	26.0	31.6	37.6	2.6
50-59	2.8	24.9	27.5	40.0	4.9
60-69	0.7	19.2	34.8	40.8	4.5
70-79	1.1	15.1	34.7	45.1	4.0
Total	2.0	23.8	33.8	37.1	3.3

Panel 1: Distribution of COH by age group

Age	10k<	10k-50k	50k-100k	100k-200k	200k-300k	300k-500k	500k-1000k	1000k>
20-29	38.3	28.5	13.3	8.9	3.1	4.2	0.7	3.1
30-39	18.4	44.0	17.1	9.2	4.2	2.8	1.2	3.1
40-49	17.3	40.8	20.8	8.5	4.3	3.8	1.5	3.0
50-59	17.5	35.2	24.5	9.5	4.2	2.0	4.2	3.0
60-69	12.1	38.6	22.8	12.3	3.9	4.4	1.7	4.3
70-79	8.2	40.2	23.3	13.2	5.8	3.0	2.3	4.0
Total	17.3	38.3	20.9	10.3	4.3	3.3	2.1	3.4

Panel 2: Distribution of CAH by age group

Table 1. Distribution of COH and CAH holdings by age group

Source: Author's calculations based on Fujiki (2023).

Notes: COH = Cash on Hand; CAH = Cash at Home. 1k = 1,000 JPY

（Unit: thousands of Japanese yen）

Age Group	Average COH	Average CAH (NHS)	Average CAH (SHF)
20–29	11.5	123	136
30–39	15.4	133	146
40–49	17.0	137	150
50–59	19.6	152	165
60–69	19.8	172	191
70–79	23.8	171	188

Table 2. Average COH and CAH holdings as of 2020 by age group

Source: Author's calculations based on Fujiki (2023), National Household Survey (2019), and Survey of Household Finances (2021).

Notes: COH = Cash on Hand; CAH = Cash at Home.

（Unit: thousands of people）

Age Group	2020	2030	2040	2050	2060	2070
20–29	12,704	11,976	10,741	8,830	8,493	7,565
30–39	14,212	12,964	12,358	11,101	9,141	8,792
40–49	18,345	14,154	12,937	12,340	11,090	9,136
50–59	16,678	18,025	13,936	12,761	12,186	10,961
60–69	15,679	15,956	17,300	13,427	12,338	11,808
70–79	16,253	13,998	14,472	15,774	12,341	11,424
80–89	9,146	11,949	10,480	11,275	12,406	9,896
90–99	2,311	3,333	4,879	4,374	5,223	5,810
100+	80	163	263	467	436	615

Table 3. Population projections for Japan

Source: Population Projections for Japan (2023). Available at: https://www.ipss.go.jp/pp-zenkoku/j/zenkoku2023/db_zenkoku2023/s_tables/1-9a.xlsx.

（Unit: 1 trillion Japanese yen）

Category	2020	2030	2040	2050	2060	2070
Total COH (Baseline)	1.98	1.77	1.54	1.31	1.12	0.95
Total COH (Technological Progress)	1.98	1.75	1.48	1.20	0.96	0.73
Total CAH (NHS adjustment)	16.0	14.9	13.5	12.0	10.8	9.5
Total CAH (SHF adjustment)	17.5	16.4	14.9	13.2	11.8	10.5

Table 4. Forecasted total COH and CAH demand in Japan

Source: Author's calculations.

（Unit: thousands of Japanese yen）

Age Group	2020	2030	2040	2050	2060	2070
20–29	11.5	11.5	11.5	11.5	11.5	11.5
30–39	15.4	11.5	11.5	11.5	11.5	11.5
40–49	17.0	15.4	11.5	11.5	11.5	11.5
50–59	19.6	17.0	15.4	11.5	11.5	11.5
60–69	19.8	19.6	17.0	15.4	11.5	11.5
70–79	23.8	19.8	19.6	17.0	15.4	11.5
80–89	23.8	23.8	19.8	19.6	17.0	15.4
90–99	23.8	23.8	23.8	19.8	19.6	17.0
100+	23.8	23.8	23.8	23.8	19.8	19.6

Table 5. Average COH holdings by age group

Source: Author's calculations.

（Unit: 1 trillion Japanese yen）

Age Group	2020	2030	2040	2050	2060	2070
20–29	0.15	0.14	0.12	0.10	0.10	0.09
30–39	0.22	0.15	0.14	0.13	0.11	0.10
40–49	0.31	0.22	0.15	0.14	0.13	0.11
50–59	0.33	0.31	0.21	0.15	0.14	0.13
60–69	0.31	0.31	0.29	0.21	0.14	0.14
70–79	0.39	0.28	0.28	0.27	0.19	0.13
80–89	0.22	0.28	0.21	0.22	0.21	0.15
90–99	0.06	0.08	0.12	0.09	0.10	0.10
100+	0.00	0.00	0.01	0.01	0.01	0.01
Total	1.98	1.77	1.54	1.31	1.12	0.95

Table 6. Future COH demand in Japan (baseline scenario)

Source: Author's calculations.

（Unit: 1 trillion Japanese yen）

Age Group	2020	2030	2040	2050	2060	2070
20–29	0.15	0.12	0.08	0.06	0.04	0.03
30–39	0.22	0.15	0.12	0.08	0.06	0.05
40–49	0.31	0.22	0.15	0.12	0.08	0.06
50–59	0.33	0.31	0.21	0.15	0.12	0.08
60–69	0.31	0.31	0.29	0.21	0.14	0.12
70–79	0.39	0.28	0.28	0.27	0.19	0.13
80–89	0.22	0.28	0.21	0.22	0.21	0.15
90–99	0.06	0.08	0.12	0.09	0.10	0.10
100+	0.00	0.00	0.01	0.01	0.01	0.01
Total	1.98	1.75	1.48	1.20	0.96	0.73

Table 7. Future COH demand in Japan assuming a 1.35% decline per age (technological progress scenario)

Source: Author's calculations.

（Unit: thousands of Japanese yen）

Age Group	2020	2030	2040	2050	2060	2070
20–29	123	123	123	123	123	123
30–39	133	123	123	123	123	123
40–49	137	133	123	123	123	123
50–59	152	137	133	123	123	123
60–69	172	152	137	133	123	123
70–79	171	172	152	137	133	123
80–89	171	171	172	152	137	133
90–99	171	171	171	172	152	137
100+	171	171	171	171	172	152

Table 8. Average CAH holdings by age group in Japan using the NHS 2019 adjustment

Source: Author's calculations.

（Unit: 1 trillion Japanese yen）

Age Group	2020	2030	2040	2050	2060	2070
20–29	1.6	1.5	1.3	1.1	1.0	0.9
30–39	1.9	1.6	1.5	1.4	1.1	1.1
40–49	2.5	1.9	1.6	1.5	1.4	1.1
50–59	2.5	2.5	1.9	1.6	1.5	1.3
60–69	2.7	2.4	2.4	1.8	1.5	1.5
70–79	2.8	2.4	2.2	2.2	1.6	1.4
80–89	1.6	2.0	1.8	1.7	1.7	1.3
90–99	0.4	0.6	0.8	0.8	0.8	0.8
100+	0.0	0.0	0.0	0.1	0.1	0.1
Total	16.0	14.9	13.5	12.0	10.8	9.5

Table 9. Future CAH demand by age group in Japan using the NHS 2019 adjustment

Source: Author's calculations.

（Unit: thousands of Japanese yen）

Age Group	2020	2030	2040	2050	2060	2070
20–29	136	136	136	136	136	136
30–39	146	136	136	136	136	136
40–49	150	146	136	136	136	136
50–59	165	150	146	136	136	136
60–69	191	165	150	146	136	136
70–79	188	191	165	150	146	136
80–89	188	188	191	165	150	146
90–99	188	188	188	191	165	150
100+	188	188	188	188	191	165

Table 10. Average CAH holdings by age group in Japan using the SHF 2021 adjustment

Source: Author's calculations.

（Unit: 1 trillion Japanese yen）

Age Group	2020	2030	2040	2050	2060	2070
20–29	1.7	1.6	1.5	1.2	1.2	1.0
30–39	2.1	1.8	1.7	1.5	1.2	1.2
40–49	2.8	2.1	1.8	1.7	1.5	1.2
50–59	2.7	2.7	2.0	1.7	1.7	1.5
60–69	3.0	2.6	2.6	2.0	1.7	1.6
70–79	3.1	2.7	2.4	2.4	1.8	1.6
80–89	1.7	2.2	2.0	1.9	1.9	1.4
90–99	0.4	0.6	0.9	0.8	0.9	0.9
100+	0.0	0.0	0.0	0.1	0.1	0.1
Total	17.5	16.4	14.9	13.2	11.8	10.5

Table 11. Future CAH demand by age group in Japan using the SHF 2021 adjustment

Source: Author's calculations.

（Unit: 1 trillion Japanese yen）

Value of α	2020	2070	Annual % Change
1.04	103.7	65.3	-0.9%
1.29	25.0	15.3	-1.0%
1.54	19.4	11.7	-1.0%
1.79	17.1	10.3	-1.0%
2.04	16.0	9.5	-1.0%

Table 12. Sensitivity of total CAH demand to changes in α

Source: Author's calculations.

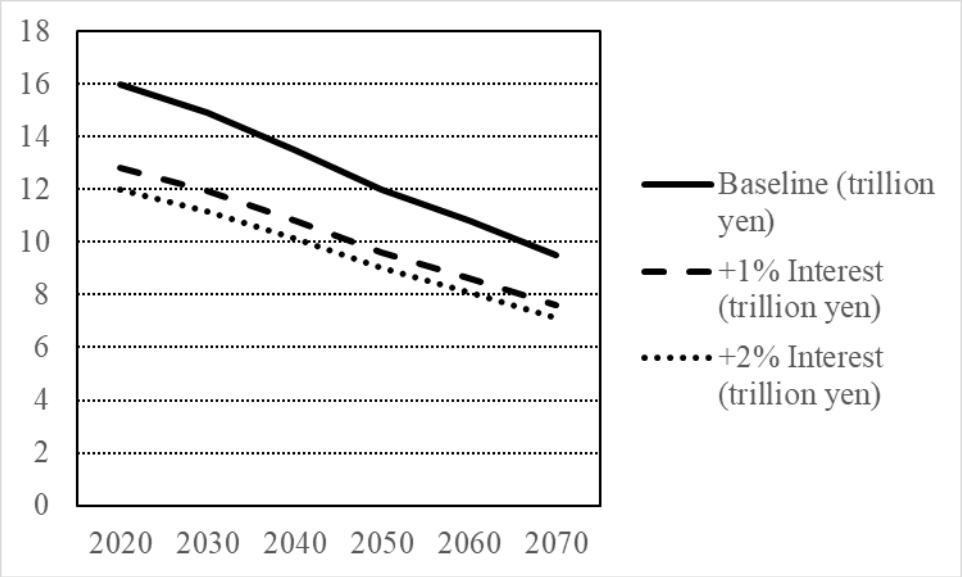

Figure 1. Impact of interest rate increases on total CAH demand

(Unit: trillion yen)

Appendix A. Estimation of Pareto Coefficient α

We estimate the average COH and CAH holdings for the right-hand side censored range (COH 50,000 yen or more and CAH 1,000,000 yen or more) to predict future cash demand. In doing so, we utilize the empirical regularity that the tails of income or wealth distributions often follow the Pareto distribution (Zwijnenburg et al., 2024; Engel et al., 2022; Vermeulen, 2018), as well as in Japanese studies (Nirei, 2023; Nishio, 2008).

The Pareto distribution has the following upper cumulative density function, shown in Equation (1):

$$\bar{F}(x) = \left(\frac{x}{L}\right)^{-\alpha}, x > L > 0, \quad (1)$$

In our analysis, *L* corresponds to the minimum level of cash demand, 50,000 yen in the case of COH 50,000 yen or more, and 1,000,000 yen in the case of CAH 1,000,000 yen or more. When $\alpha > 1$, the expected value of $\bar{F}(x) = \frac{\alpha L}{\alpha - 1}$ and the expected value $\bar{F}(x)$ conditional on the right-half open interval (x^*, ∞) does not depend on the value of *L* and is shown as Equation (2)

$$E(x|x > x^*) = \frac{\alpha}{\alpha - 1} x^*. \quad (2)$$

where L is a positive constant and α is the Pareto coefficient.

Assume that the right tail of the distributions of COH and CAH, whose values exceed x^*, follow a Pareto distribution. If we can estimate the parameter value of α, Equation (2) yields that the average COH holdings for those who chose COH 50,000 yen or more as $\frac{\alpha}{\alpha-1}50{,}000$, and the average CAH holdings for those who chose CAH 1,000,000 yen or more as $\frac{\alpha}{\alpha-1}1{,}000{,}000$. Using Equation (1), the upper cumulative

distribution function, which is conditional on $X > x^*$is written as Equation (3),

$$\bar{F}(x) = \left(\frac{x}{x*}\right)^{-\alpha},\ x > x^* > 0, \alpha > 0. \quad (3)$$

Taking the log of Equation (3) yields Equation (4):

$$\log(\bar{F}(x)) = constant - \alpha \times \log(x), \text{ when } x > x^*. \quad (4)$$

We will obtain an empirical inverse cumulative density function of $\log(\bar{F}(x))$ shown in Equation (3) and apply ordinary least squares methods to Equation (4) to get the parameter estimates of α.

We use the NHS 2019, which provides data on outstanding savings amounts (FA) for Japanese households. Since our cash survey data lacks enough information at the tail, we assume that the Pareto coefficient for FA is applicable to COH and CAH. Appendix Table A1 shows the log of FA's inverse cumulative density function based on the NHS 2019. By focusing on the top 12% of households, corresponding to FA ranges of 30–40, 40–50, 50–75, and 75–100 million yen, we apply OLS regression on log(Bound) and log(CCDF) and obtain the following relationship: ln(CCDF)=33.13-2.04×ln(Bound). Thus, we obtain the estimates of the Pareto parameter α = 2.04 based on the information on the upper 12% observations of *FA*.

Accordingly, the average holdings for the right-censored ranges are calculated as:

- For COH 50,000 yen or more: $\frac{2.04}{2.04-1}50{,}000$ =98,100 yen
- For CAH 1,000,000 yen or more: $\frac{2.04}{2.04-1}1{,}000{,}000$ =1,962,000 yen

This method aligns with established practices in wealth distribution studies and ensures robustness in forecasting future cash demand.

Appendix B. Estimation of average CAH of one million yen or more from SHF 2021

We used the distribution of average cash balances on hand reported in the SHF 2021 to estimate the average CAH holdings for those who chose CAH 1,000,000 yen or more for robustness checks. The SHF asks, "How much cash do you have on average in your household? (If it is zero, enter '0'). Cash refers to cash (notes and coins) in your household that is not deposited in a financial institution, and so forth." Notice that the SHF question does not distinguish between COH and CAH. Therefore, these statistics could include COH and thus overestimate the value of CAH.

The SHF 2021 surveyed 5,000 households with two or more people and 2,000 single-person households about their average cash balances. The SHF reported the average cash balances for all surveyed households and also reported the percentage of households with cash balances of less than 100k (hereafter k stands for thousand yen), between 100k or more and less than 200k, 200k or more but less than 300k, 300k or more but less than 400k, 400k or more but less than 500k, 500k or more but less than 700k, 700k or more but less than 1,000k, and 1,000k or more.

We estimate the average *CAH* holdings for those who chose CAH 1,000,000 yen or more by computing the average cash balance held by households with 1,000,000 yen or more. In doing so, we have assumed that the average cash balance held by households with less than 100k, between 100k or more and less than 200k, 200k or more but less than 300k, 300k or more but less than 400k, 400k or more but less than 500k, 500k yen or more but less than 700k, 700k or more but less than 1,000k equal to the median cash balances for each category: 50k, 150k, 250k, 350k, 450k, 600k, and 850k, respectively. The difference between the total cash balance held by all households and the sum of the total cash balance for those who have less than 1,000k must be equal to the total cash

balance held by households with 1,000k or more of cash balance. Thus, we can estimate the average value of *CAH* 1,000,000 yen or more as 2,350,000 yen for single-person households and 2,430,000 yen for households with two or more people. We took the average of the two and assumed the average *CAH* holdings for those who chose $\text{CAH } 1{,}000{,}000 \text{ yen or more} = 2{,}390{,}000$ yen. This estimate is 22% larger than the average *CAH* holdings for those who chose $\text{CAH } 1{,}000{,}000 \text{ yen or more} = 1{,}962{,}000$ yen based on the National Household Survey (2019).

(

FA (million JPY)	Observations (OBS)	Share	Bound (JPY)	ln(Bound)	ln(CCDF)
–0.25	7,570,917	0.150	-	-	-
0.25–0.5	1,392,879	0.028	250,000	12.429	-0.163
0.5–1	2,389,861	0.047	500,000	13.122	-0.196
1–1.5	2,468,069	0.049	1,000,000	13.816	-0.255
1.5–2	1,708,421	0.034	1,500,000	14.221	-0.320
2–3	3,231,139	0.064	2,000,000	14.509	-0.368
3–4.5	4,437,012	0.088	3,000,000	14.914	-0.465
4.5–6	3,329,682	0.066	4,500,000	15.320	-0.616
6–7.5	2,797,699	0.055	6,000,000	15.607	-0.747
7.5–9	1,900,535	0.038	7,500,000	15.830	-0.871
9–12	3,680,237	0.073	9,000,000	16.013	-0.966
12–15	2,434,901	0.048	12,000,000	16.300	-1.179
15–20	3,139,132	0.062	15,000,000	16.524	-1.349
20–30	3,968,259	0.079	20,000,000	16.811	-1.624
30–40	2,150,965	0.043	30,000,000	17.217	-2.134
40–50	1,294,003	0.026	40,000,000	17.504	-2.580
50–75	1,479,064	0.029	50,000,000	17.728	-2.994
75–100	526,477	0.010	75,000,000	18.133	-3.875
Over 100	520,003	0.010	100,000,000	18.421	-4.574

Appendix Table A1. Log of the inverse cumulative density function of FA from the National Household Survey (2019)

Source: National Household Survey (2019); author's calculations.

(FA = outstanding savings amount, Unit: million JPY）