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Abstract

This study examines the effects of changes in economic conditions on cognitive function using individual panel data from the National Survey of the Japanese Elderly. This study captures the objective, subjective, absolute, and relative terms of economic conditions, and examines which aspects of economic conditions in particular affect cognitive function. The results reveal that deterioration in economic conditions damages cognitive function. Particularly, objective economic conditions affect the cognitive function of Japanese men. Furthermore, economic conditions in relative terms are more important than those in absolute terms. The results further suggest that these deteriorating effects could be attributed to less social engagement and low healthcare utilisation owing to a decline in economic conditions.

Keywords

ageing, cognitive function, economic conditions, the National Survey of the Japanese Elderly, relative income

JEL classification

C23, I14 ,J14

Introduction

Deterioration of cognitive function in old age is one of the main global health challenges. It is often accompanied by mild neurocognitive disorders and, in the worst cases, dementia. Globally, approximately 50 million people suffer from dementia (Prince *et al*., 2015), and the global cost of dementia is estimated to be about USD one trillion annually (Patterson, 2018). The burden of a deterioration in cognitive function affects patients, their families, and society.

A growing body of literature suggests that cognitive function is damaged by socioeconomic factors, including low educational attainment (e.g., Langa *et al.,* 2017; Stern, 2012), less social engagement (e.g., Christelis and Dobrescu, 2020; Fratiglioni, Paillard-Borg, and Winblad, 2004), lack of complexity in work and retirement (e.g., Bonsang, Adam, and Perelman, 2012; Kajitani, Sakata, and McKenzie, 2017), and poor economic conditions (e.g., Lynch, Kaplan, and Shema, 1997; Mani *et al.,* 2013).

In particular, existing studies suggest that poor economic conditions are associated with low cognitive function (e.g., Al Hazzouri *et al.,* 2017; Ayyagari and Frisvold, 2016; Lynch, Kaplan and Shema, 1997; Mani *et al.,* 2013; Marden *et al.,* 2017; Okamoto, 2019; Turrell *et al.,* 2002). For example, Al Hazzouri *et al.* (2017) show that individuals who were living in poverty throughout the survey period performed significantly worse than individuals who had not experienced poverty during the survey period in all three cognitive tests, namely verbal memory (z-score, −0.28; 95 % confidence interval = −0.43, −0.13), processing speed (z-score, −0.72; 95% confidence interval = −0.85, −0.58), and executive function (z-score, −0.32; 95% confidence interval = −0.47, −0.17).

Examining the relationship between economic conditions and cognitive function is challenging primarily because of the possibility of existing unobserved individual

time-invariant factors—such as innate non-cognitive ability—associated with both economic conditions and cognitive function. If the factors are not controlled, they could cause biased estimates—also called an endogeneity problem. However, only a limited number of studies deal with this problem. For example, Mani *et al*. (2013) and Okamoto (2019) reveal that poor economic conditions lead to cognitive decline by removing individual time-invariant factors. Ayyagari and Frisvold (2016) conduct instrumental variable estimations using an exogenous change in social security income in the United States and find that lower benefits lead to a decline in cognitive function. By contrast, Carvalho, Meier, and Wang (2016) randomly assign on online survey to United States households before or after payday. They find no differences in cognitive function between the two groups.

This study presents additional evidence on the effects of changes in economic conditions on cognitive function by addressing the endogeneity problem. To this end, individual time-invariant factors are removed using individual panel data that include randomly selected older Japanese individuals from the National Survey of the Japanese Elderly (NSJE). To address the endogeneity problem further, this study uses household economic conditions, rather than individual economic conditions, and controls for the observed individual characteristics that are considered important determinants in previous studies.

It could be argued that the endogeneity problem also arises through reverse causation as a decline in cognitive function may lead to a deterioration in economic conditions. This is not a significant problem in this study because cognitive function during the survey is measured on the survey day. Meanwhile, the respondents' responses about their annual household income and annual household consumption are based on

the previous years' calculations. Thus, a time lag exists between the cognitive function variable and the variables for economic conditions.

This study also highlights the following. First, although a growing number of studies suggests that economic conditions affect cognitive function, there is limited evidence on how the different aspects of economic conditions damage cognitive function. Most of the earlier studies use objective economic conditions, such as annual income, while a few studies use subjective economic conditions measured by perceived economic hardship (Al Hazzouri *et al.,* 2017; Carvalho, Meier and Wang, 2016) and relative terms of economic conditions measured by the income quintile group (Turrell *et al.,* 2002). This study captures the objective, subjective, absolute, and relative terms of economic conditions, and then examines which aspects of economic conditions in particular affect cognitive function. To the best of my knowledge, this is the first study to examine the effects of these four aspects of economic conditions on cognitive function in a single sample.

Second, this study uses data from Japan. One of the advantages of using Japanese data is that Japan has been ranked as the country with the largest proportion of adults over 65 for more than 15 years and has been facing the burden of a deterioration in cognitive function among older adults (Cabinet Office Japan, 2020). The results of this study also have important policy implications for other countries facing the challenges related to an ageing population.

Last, considering the possibility that the effects of changes in economic conditions may vary by gender, this study examines the effects of changes in economic conditions on cognitive function on both men and women to compare the results.

The results reveal that economic conditions matter. In particular, objective economic indicators measured by annual household income affect the cognitive function of Japanese men. The findings also imply that the relative economic indicator measured by the income quintile group is more important than the absolute economic indicator measured by the absolute value of income. These deteriorating effects remain even after controlling for unobserved individual time-invariant factors and observed socioeconomic and sociodemographic factors. The results suggest that these effects could be attributed to less social engagement and less frequent use of healthcare services due to a decline in economic conditions. Thus, financial support plays an important role in maintaining recipients' cognitive function.

Methodology

Data

This study uses a panel dataset from the NSJE that includes randomly selected Japanese citizens aged 60 years and older. The data include six waves of surveys conducted in 1987 (first wave), 1990 (second wave), 1993 (third wave), 1996 (fourth wave), 1999 (fifth wave), and 2002 (sixth wave). The surveys contain individual information about cognitive function, household economic conditions, sociodemographic status, socioeconomic status, health status, and health behaviour. The initial sample of Japanese adults aged 60 years and older was selected in 1987 using two-stage stratified random sampling and followed up in the succeeding waves. The dataset was supplemented by additional samples in the second, fourth, and fifth waves. Face-to-face interviews were conducted for each wave to collect the data. Table 1 presents the sample size and response rate for each wave. There is little difference in the sample distributions between the NSJE and relevant Japanese Census data (Kajitani, 2011; Kan, 2009). The

NSJE data are from the Social Science Japan Data Archive, Centre for Social Research and Data Archives, Institute of Social Science, the University of Tokyo. Informed consent was obtained for each survey point, and ethical approval was obtained from the Tokyo Metropolitan Institute of Gerontology Ethics Committee.

Model

To identify the effect of economic conditions on cognitive function by gender, I estimate the following linear probability model:

$$CI_{it} = \alpha_1 EC_{it} + \alpha_2 EC_{it} \cdot Female_i + X'_{it}\gamma + \mu_i + \lambda_t + e_{it} \quad (1)$$

where the outcome variable CI_{it} indicates whether or not an individual has cognitive impairment. The primary explanatory variable is EC_{it}, which denotes the respondent's household economic conditions. $Female_i$ is a dummy variable taking the value of 1 if an individual is a female respondent, and 0 otherwise. X'_{it} is a vector of additional control variables, including respondents' characteristics, such as age, city size, marital status, family size, home ownership, and employment status. Last, μ_i denotes a respondent's fixed effect, λ_t denotes the year fixed effect, and e_{it} denotes an error term. The analysis focuses on the effects of economic conditions on cognitive function: $\Delta CI_{it}/\Delta EC_{it} = \alpha_1 + \alpha_2 Female_i$. To account for autocorrelation and heteroskedasticity within individuals, standard errors are clustered by individual.

Cognitive impairment

Cognitive function is measured by employing a memory test. The test is based on a short portable mental status questionnaire (SPMSQ), which detects the presence of cognitive impairment and assesses the degree of impairment (Pfeiffer, 1975). In the test, investigators ask nine memory-related questions. (1) What is your address? (2) What is today's date (day, month, and year)? (3) What day of the week is it? (4) What is/was

your mother's maiden name? (5) Who is the current Japanese prime minister? (6) Who was the prime minister before him? (7) Can you count backwards from 20 in multiples of 3? (8) What is your date of birth? (9) How old are you? The answers are used to produce a dummy variable to indicate the existence of cognitive impairment. The dummy variable equals one when the respondent commits three or more errors when answering the questions, and zero otherwise. This measure is based on the SPMSQ criteria: zero to two errors signify normal cognitive function; three to four errors signify mild cognitive impairment; five to seven errors signify moderate cognitive impairment; and eight or more errors signify severe cognitive impairment (Pfeiffer, 1975). In this study, 'cognitive impairment' includes mild, moderate, and severe cognitive impairment.

Economic conditions

This study captures the objective, subjective, absolute, and relative terms of economic conditions. As mentioned in the introduction, this study uses household economic conditions to address the endogeneity problem.

This study uses annual household income and annual household consumption to represent objective economic conditions in absolute terms. Specifically, this study uses equivalent scales that divide household income and household consumption by the square root of family size. Household income is measured using multiple-choice questions with several income brackets. As these income brackets differ across the survey waves, I produce a continuous scale of household income by taking the median values of each income bracket. Household consumption is measured on a continuous scale in the survey. Note that because information on household consumption is collected only in the fifth and sixth waves, the sample size is smaller in the estimation.

I create a respondent income quintile, ranging from one to five, to represent objective economic conditions in relative terms. Quintile cut-off points are extracted from the Comprehensive Survey of Living Conditions (Ministry of Health, Labour and Welfare, 2020). The quintiles are defined for each survey wave and each age group. Information on quintile cut-off points is only available from 1996, so the sample size is smaller in the estimation.

This study uses four indicators to represent subjective economic conditions. The scale of economic burden is based on the question, 'Do you suffer from an economic burden incurred by your family and/or friends?' The responses are measured using five categories ranging from 0 ('not at all') to 4 ('very much'). The scale of economic satisfaction is based on the question, 'Are you satisfied with your household economic condition?' The responses are measured using five categories ranging from 0 ('not at all') to 4 ('very much'). The scale of adequacy is based on the question, 'How well do you feel your household is managing financially?' The responses are measured using five categories ranging from 0 ('find it very difficult to make ends meet') to 4 ('live comfortably'). The subjective economic condition in relative terms is based on the question, 'How do you rate your household economic condition against that of people of the same age group?' The responses are measured using three categories: 0 ('worse'), 1 ('about the same'), and 2 ('better'). On the economic burden scale, higher values denote worse economic conditions, whereas higher values denote better economic conditions on the other scales.

Other control variables

City size is grouped into five categories: (0) principal cities, including the 23 wards in the central Tokyo metropolis, and the cities of Osaka, Yokohama, Nagoya, Kyoto,

Kitakyushu, Sapporo, Kawasaki, Kobe, Hiroshima, and Fukuoka; (1) cities excluding (0) with a population of 200,000 or more; (2) cities with a population between 100,000 and 200,000; (3) cities with a population of less than 100,000; and (4) towns or villages. Marital status is an indicator variable that equals one if the respondent is married, and zero otherwise. Family size is measured by the number of family members. Home ownership is an indicator variable that equals one if the respondent owns a house. Employment status is an indicator variable that equals one if the respondent is employed.

Once the impact of changes in economic conditions is established, I examine possible pathways that may describe the relationship between changes in economic conditions and cognitive function. To identify the pathways, I run equation (1) with the outcome variables of possible pathways. The possible pathways include unhealthy lifestyle, social engagement, and healthcare utilisation.

Results

The summary statistics of all the variables used in the main estimation are presented in Table 2. The results show that 7 % of the respondents have cognitive impairment.

Table 3 shows the effects of objective economic conditions on cognitive function using a linear probability model. The coefficients of the indicator of economic conditions show the effects for men. The estimate of absolute income shown in column (1) is negative and significant at a 10% significance level. Column (2) shows that the estimate of consumption is insignificant but negative. The estimate of relative income shown in column (3) is negative and statistically significant at a 5% significance level. These results suggest that objective economic conditions affect cognitive function in Japanese men, in both absolute and relative terms.

According to the results obtained for men, the effect size of relative income is larger than that of absolute income. A drop in absolute income of JPY 1.51 million (the average reduction in income between two survey points) increases an individual's risk of developing cognitive impairment by 1.3 percentage points (effect size for the male sample with average characteristics). Meanwhile, a drop in relative income of one economic class (average degree of reduction between two survey points) increases an individual's risk of developing cognitive impairment by 1.7 percentage points (effect size for the male sample with average characteristics).

I next compare the results obtained for men with those obtained for women. The estimated effects (the standard errors in parentheses) of absolute income, consumption, and relative income for women are 0.002(0.004), 0.266(0.263), and 0.005(0.009), respectively. None of the effects are statistically significant at least at a 10% significance level. Thus, objective economic conditions do not affect cognitive function in Japanese women.

Thus, a deterioration in objective economic conditions damages cognitive function in Japanese men, and relative income plays a more important role than absolute income in developing cognitive impairment. These results are obtained after controlling for other sociodemographic and socioeconomic indicators (e.g., age, city size, marital status, family size, home ownership status, and employment status). I also control for unobserved individual time-invariant factors captured by fixed effects that utilise individual panel data.

These results for objective economic indicators differ from those on subjective economic indicators. Table 4 shows the effects of subjective economic indicators (e.g., economic burden, degree of satisfaction with household economic condition, financial

adequacy, and subjective economic conditions compared to others) on cognitive function. Columns (1)–(4) show that none of the estimates of subjective economic indicators are significant, at least at a 10 % significance level. The results suggest that subjective economic indicators do not lower cognitive function in Japanese men.

Next, I compare the results obtained for men with those for women. The estimated effects (standard errors in parentheses) of financial burden, satisfaction, adequacy, and subjective economic condition compared to others for women are 0.006(0.006), −0.009 (0.007), −0.006 (0.005), −0.010(0.008), respectively. None of the effects are statistically significant, at least at a 10% significance level. Thus, subjective economic conditions do not affect cognitive function in Japanese women.

I conclude that a deterioration in economic conditions is harmful to men's cognitive function. In particular, objective economic conditions do matter. Among objective economic conditions, economic conditions in relative terms are more important than those in absolute terms. The deteriorating effect remains even after controlling for unobserved time-invariant factors and observed socioeconomic and sociodemographic factors. There is a significant effect of change in economic conditions on cognitive function: the poorer the economic conditions, the worse the cognitive function. The following section focuses in-depth on the male sample.

Robustness checks

To check whether the estimated effects of income are sensitive to changes in other model specifications, I use a different functional form of absolute income, taking its logarithm. The result shows that the estimate of the logarithm of absolute income is significant at a 5% significance level and has a sign consistent with the main result.

I also assess the sensitivity of the definition of cognitive impairment. The main estimates use the questionnaire with nine memory-related questions to measure cognitive function. Two questions ask for the names of Japanese prime ministers. It is possible that the answers could reflect respondents' interest in politics rather than their cognitive ability. Respondents who are apathetic about politics could fail to answer these questions correctly, but this may not necessarily mean that they are cognitively impaired. Therefore, I re-estimate the absolute and relative income effects with cognitive function measured by seven questions, excluding the two questions about the prime minister. The results show that the estimates of both absolute and relative income are significant at a 5% significance level, and their signs are consistent with the main results.

Mechanisms

Why does a deterioration in economic conditions lead to cognitive impairment? Risk factors for cognitive impairment are well established in existing studies. Some of these risk factors, such as unhealthy lifestyles, unfavourable health conditions, and social isolation, can be affected by a deterioration in economic conditions. Therefore, they can be channels through which economic conditions affect cognitive function.

First, unhealthy lifestyles, such as physical inactivity, smoking, harmful use of alcohol, and unhealthy diet, are risk factors for cognitive impairment (e.g., GBD 2016 Dementia Collaborators, 2019; Livingston *et al*., 2017, 2020). A deterioration in economic conditions could lead people to adopt unhealthy lifestyles, which might cause a deterioration in their cognitive function. In this study, to examine whether this channel exists, I run equation (1) with the outcome variables of unhealthy lifestyles and present the estimates in Figure 1. None of the estimates of objective economic conditions are

significant, at least at a 10% significance level. The results of this study do not support unhealthy lifestyle as a channel for the effects of change in economic conditions on cognitive impairment. This finding may be because unhealthy lifestyles usually develop over time. Thus, they are controlled as individual time-invariant factors.

Second, lifestyle-related diseases, such as hypertension, obesity, and diabetes, are risk factors for cognitive impairment (e.g., GBD 2016 Dementia Collaborators, 2019; Livingston *et al*., 2017, 2020). Other studies (e.g., Marmot, Shipley and Rose, 1984) suggest that lifestyle-related diseases are associated with socioeconomic status. However, these diseases also usually develop over time. As this study controls for individual time-invariant factors, these chronic diseases might not be strong enough reasons to explain the current results.

Third, mental illness is another risk factor for cognitive impairment (Livingston *et al*., 2017, 2020). People may endure stress when their economic conditions worsen, which may damage their cognitive function. If this channel exists, then the effects of subjective economic conditions, such as economic burden and financial adequacy, should be observed in this study. However, as reported in Table 4, all the estimates of subjective economic conditions are statistically insignificant. The results of this study therefore do not support mental illness as a channel for the effects of change in economic conditions on cognitive impairment.

Fourth, social isolation is an established risk factor for cognitive impairment (Bassuk, Glass and Berkman, 1999; Christelis and Dobrescu, 2020; Fratiglioni, Paillard-Borg and Winblad, 2004; Rafnsson *et al*., 2020; Wang *et al*., 2002). Assuming that there are costs attached to interacting with others, such as a membership fee to join a senior citizen club, older adults may stop interacting with others when their economic

conditions worsen, and consequently become socially isolated. To examine whether this channel exists, I ran equation (1) with the outcome variables of the number of social engagements and present the estimates in panel A of Figure 2. The estimate of absolute income is positive and significant at a 5% significance level. The estimate of consumption is also positive and significant at a 5% significance level. The estimate of relative income is insignificant but positive. These results suggest that poor economic conditions could be related to less social engagement. Therefore, social engagement could be a channel through which economic conditions affect cognitive function. It could be argued that social isolation damages cognitive function in Japanese men, rather than economic conditions. However, the findings of my study do not support this argument. To verify this possibility, I ran equation (1), but added the number of social engagements as a control variable. Similar to Table 3, the estimated coefficient (robust standard errors in parentheses) of absolute income, consumption, and relative income are −0.008(0.004), −0.023(0.016), and −0.016(0.008), respectively. The effects of a change in economic conditions remain even after controlling for the number of social engagements, as well as the sociodemographic and socioeconomic indicators, and the individual time-invariant factors.

In addition to the above-mentioned risk factors for cognitive impairment, the broader literature on the social determinants of health suggests that healthcare utilisation mediates the associations between economic conditions and health outcomes (Saulsberry and Peek, 2019; Marmot, 2005; Wilensky and Satcher, 2009). This mechanism could be adapted for the purposes of this study. On the one hand, people could mitigate cognitive decline through healthcare utilisation even after cognitive function starts to decline. On the other hand, they might reduce or stop utilising

healthcare services when their economic conditions deteriorate, which might accelerate the progress of cognitive impairment. To examine whether this channel exists, I ran a regression with the outcome variable of healthcare utilisation and the explanatory variable of economic conditions. The estimate is presented in panel B of Figure 2. The estimate of absolute income is positive and significant at a 10% level. This positive estimator suggests that poor economic conditions could be related to less healthcare utilisation. Therefore, healthcare utilisation could be a channel through which economic conditions affect cognitive function.

Discussion and conclusions

This study investigates the effects of changes in economic conditions on cognitive function using panel dataset that include randomly selected older Japanese individuals from the NSJE. The results reveal that a deterioration in economic conditions damages cognitive function. In particular, objective economic conditions affect cognitive functioning in Japanese men. Furthermore, economic conditions in relative terms are more important than those in absolute terms. These deteriorating effects remain even after controlling for unobserved time-invariant factors and observed socioeconomic and sociodemographic factors. The additional analysis provides some evidence that these deteriorating effects should be attributed to less social engagement and lower healthcare utilisation owing to a decline in economic conditions.

These findings suggest that financial support for older adults who are facing a deterioration in their economic conditions could play an important role in maintaining recipients' cognitive functioning. The results also suggest that enhancing social engagement and healthcare utilisation in older adults could mitigate the negative impact of a deterioration in their economic conditions. It should be noted that Japan has

universal health coverage. Economic conditions do not always matter in Japan because people can utilise healthcare with low out-of-pocket medical costs. This study reveals that the effects of poor economic are evident even in Japan, suggesting there may be more significant effects in other countries without universal health coverage.

The findings of this study are mostly consistent with earlier studies showing that poor economic conditions are associated with lower cognitive function. The major strength of this study is that the results compensate for a gap in existing studies by addressing the endogeneity problem. This study addresses the endogeneity problem by controlling for individual time-invariant factors using individual panel data and reveals that the effects remain even after addressing the endogeneity problem. Moreover, to the best of my knowledge, this is the first study to capture the objective, subjective, absolute, and relative terms of economic conditions and examine which aspects of economic conditions particularly affect cognitive function.

This study has several limitations. First, although I control for individual time-invariant factors captured by fixed effects, I cannot control for time-variant factors, including physical health and motivation, to avoid bad control or due to data unavailability. It is possible that such omitted variables are associated with both economic conditions and cognitive function. Second, I find that changes in economic conditions have an insignificant association with the cognitive function of women. The null-finding for women is not surprising, as in Japan, men are more likely to be the sole breadwinners, and it is possible that men are more likely to be susceptible to changes in their household economic conditions compared to women. However, other important factors for women's cognitive function may exist. Therefore, future research is required to investigate the factors that affect women's cognitive function.

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Tables

Table 1. Sample size and the response rate

		Sample size	Number of valid responses	Response rate (%)
Wave 1 (1987)	New	3,288	2,200	67.2
Wave 2 (1990)	Continued	2,200	1,671	82.0
	Added	580	366	63.3
Wave 3 (1993)	Continued	2,441	1,864	83.7
Wave 4 (1996)	Continued	2,226	1,549	77.7
	Added	1,210	898	74.5
Wave 5 (1999)	Continued	2,969	2,077	76.9
	Added	2,000	1,405	71.0
Wave 6 (2002)	Continued	4,336	2,823	72.8

Notes: Samples where family members completed the survey on behalf of the respondent owing to the respondent's poor health were excluded from the number of valid responses. Respondents who had died were also excluded from the response rate.

Table 2. Summary of the statistics

Variables	All				Men				Women			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Dependent Variable												
Cognitive impairment	0.07	0.26	0	1	0.06	0.24	0	1	0.09	0.28	0	1
Independent Variables												
Objective economic conditions												
Annual equivalent income (million yen)	2.72	1.46	0.42	10	2.85	1.46	0.49	10	2.58	1.44	0.42	10
Annual equivalent consumption (million yen)	1.64	0.74	0	8.49	1.70	0.75	0.07	5.54	1.58	0.73	0	8.49
Relative income (income quintile groups)	3.86	1.31	1	5	4.01	1.29	1	5	3.70	1.31	1	5
Subjective economic conditions												
Burden	0.42	0.79	0	4	0.46	0.82	0	4	0.39	0.77	0	4
Satisfaction	2.81	0.79	0	4	2.79	0.81	0	4	2.82	0.78	0	4
Adequacy	2.72	1.01	0	4	2.73	1.01	0	4	2.71	1.00	0	4
Compared	1.14	0.60	0	2	1.16	0.60	0	2	1.13	0.60	0	2
Socio-demographic and socio-economic factors												
Age	70.87	6.77	60	98	70.76	6.72	60	98	70.99	6.81	60	96
City size	2.17	1.50	0	4	2.22	1.49	0	4	2.12	1.51	0	4
Married	0.71	0.45	0	1	0.90	0.31	0	1	0.52	0.50	0	1
Family size	2.84	1.74	1	12	3.13	1.79	1	12	2.53	1.63	1	11
Own house	0.82	0.38	0	1	0.86	0.34	0	1	0.78	0.41	0	1
Employed	0.33	0.47	0	1	0.43	0.50	0	1	0.22	0.42	0	1

Table 3. Effects of objective economic conditions on cognitive function (linear probability model)

	(1)	(2)	(3)
Absolute terms			
Equivalent income	-0.008**		
	(0.004)		
Equivalent income & Female	0.011*		
	(0.006)		
Consumption		-0.243	
		(0.179)	
Consumption & Female		0.509	
		(0.314)	
Relative terms			
Relative income			-0.017**
			(0.008)
Relative income & Female			0.022*
			(0.012)
Age	0.000	0.035***	0.004
	(0.007)	(0.010)	(0.013)
City size	-0.022	-0.018	0.024
	(0.017)	(0.021)	(0.029)
Married	-0.032	-0.009	-0.053
	(0.021)	(0.034)	(0.034)
Family size	-0.001	-0.016	0.004
	(0.005)	(0.011)	(0.008)
Own house	0.020	0.048	-0.003
	(0.023)	(0.049)	(0.050)
Employed	0.013	0.009	-0.015
	(0.009)	(0.023)	(0.016)
Survey year	0.021	-0.076**	0.001
	(0.021)	(0.031)	(0.040)
Observations	8,617	3,588	4,648
Number of id	3,747	2,528	2,749

Notes: The dependent variable is a binary indicator that equals one if there are positive screenings for cognitive impairment (three or more errors in memory-related questions). Robust standard errors are in parentheses. The sample size becomes smaller in column (2), because information on consumption was collected only in the fifth and sixth waves, and becomes smaller in column (3), because information on income quintile groups is available only from 1996. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 4. Effects of subjective economic conditions on cognitive function (linear probability model)

	(1)	(2)	(3)	(4)
Burden	0.006			
	(0.005)			
Burden & Female	-0.000			
	(0.008)			
Satisfaction		-0.006		
		(0.007)		
Satisfaction & Female		-0.003		
		(0.009)		
Adequacy			-0.003	
			(0.005)	
Adequacy & Female			-0.004	
			(0.007)	
Compared				0.000
				(0.009)
Compared & Female				-0.010
				(0.012)
Observations	13,274	13,294	12,641	12,417
Number of id	4,785	4,785	4,679	4,674

Notes: The dependent variable is a binary indicator that equals one if there are positive screens for cognitive impairment (three or more errors in memory-related questions). Robust standard errors are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Figures

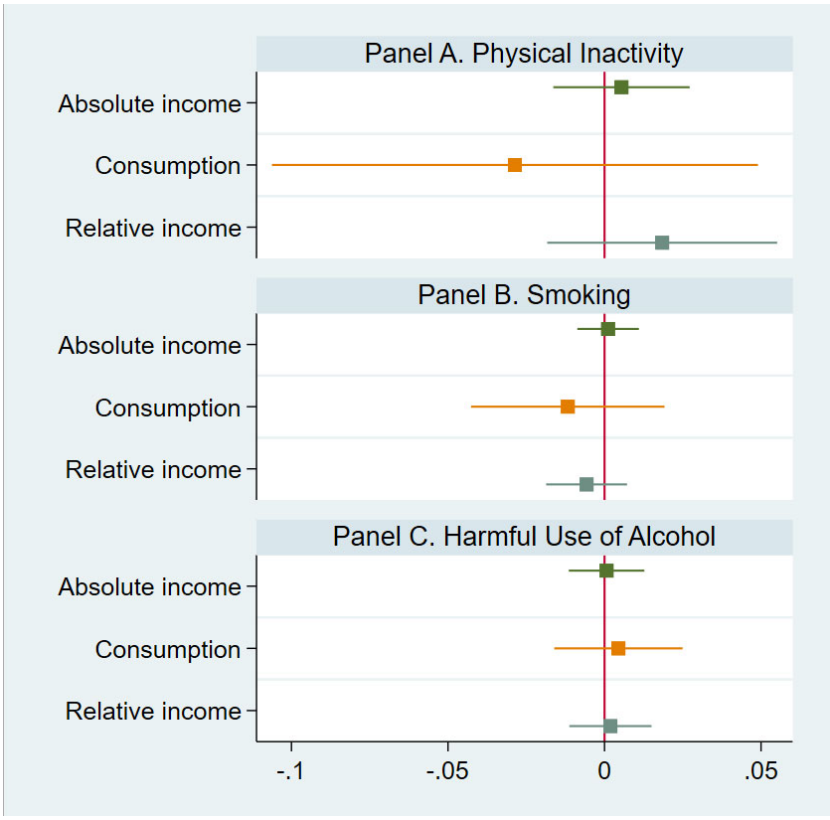

Figure 1. Effects of economic condition on unhealthy lifestyles

Notes: The figure shows the estimate for running equation (1) on the outcomes of physical inactivity (Panel A), smoking (Panel B), and harmful use of alcohol (Panel C). The sample is restricted to men. The green squares represent estimates for absolute income, the orange squares represent the estimates for consumption, and the grey squares represent the estimates for relative income. Horizontal lines indicate 95% confidence intervals. Note that the effects of an unhealthy diet could not be examined owing to data unavailability.

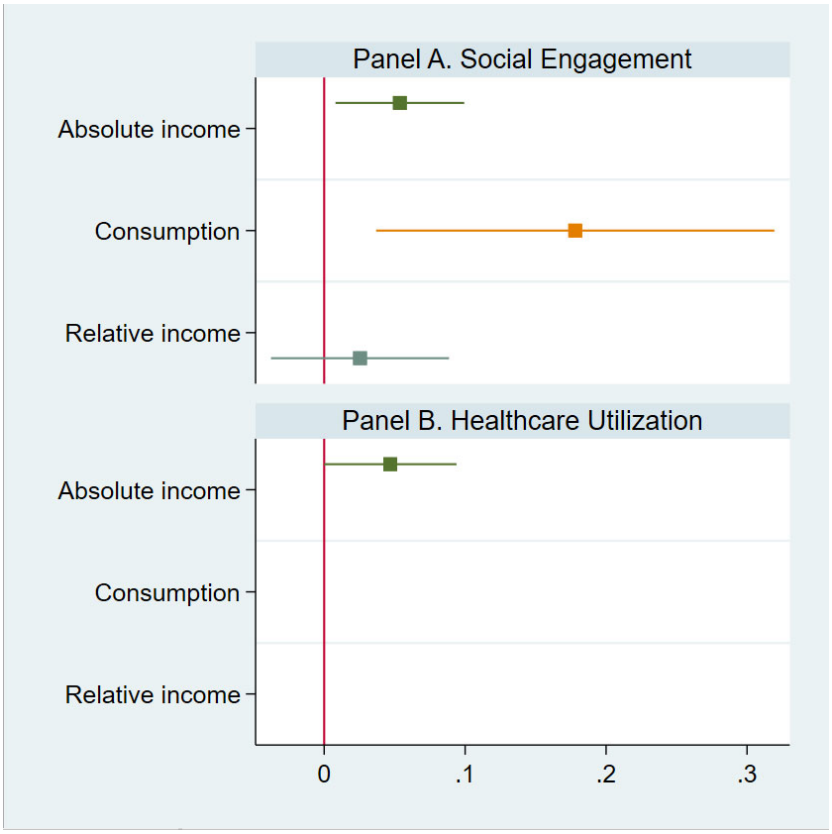

Figure 2. Effects of economic conditions on social engagement and healthcare utilisation

Notes: Panel A shows the estimates for running equation (1) on the outcomes of the number of communities, groups, and clubs to which respondents belonged. Panel B shows the OLS estimate for running a regression with the outcome of the natural logarithm of the number of medical check-ups respondents had in the survey year, with the same explanatory variable and covariates as equation (1). In panel B, we could not control for individual time-invariant factors because information on medical check-ups was only collected in the second wave; because of the latter, the effects of consumption (data available from the fifth wave) and relative income (data available from the fourth wave) could also not be examined. The sample was restricted to men. The green squares represent the estimates for absolute income, the orange squares represent the estimates for consumption, and the grey squares represent the estimates for relative income. Horizontal lines indicate 95% confidence intervals.