A Survey on Policy Experiences in the Japanese Public Healthcare Systems: Effects of Patient Cost Sharing on Healthcare Utilization and Health*[*]

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Abstract

Since 1961, the Japanese public healthcare system based on the universal health insurance system has contributed to raising the level of health and life expectancy of the Japanese people through improving the equity in access to healthcare and the quantity and quality of healthcare services. On the other hand, the national medical care expenditure, a consideration for this contribution, has been increasing steadily. The level of patient cost sharing in the health insurance system contributes to the efficiency and sustainability of the system, but it also has an impact on the healthy and cultured life for the Japanese people as well as the state of public health policies. This paper summarizes the economic studies using Japanese data that examine the effects of patient cost sharing on healthcare utilization and health. In addition, I use individual panel data with rich individual attributes and conduct empirical exercises to confirm the robustness of the effect of the sharp reduction of the coinsurance rate from 30 percent to 10 percent at age 70 in Japan. Including my empirical results, the price elasticity with respect to healthcare is generally low and changes in patient cost sharing generally do not have a large impact on health.

Keywords: public healthcare system, patient cost sharing, healthcare utilization, health, price elasticity, Japanese Study of Aging and Retirement, regression discontinuity design
JEL Classification: H51, H75, I13, I18, I38

I. Introduction

Since 1961, the Japanese public healthcare system based on a universal health insurance system has contributed to raising the level of health and life expectancy of the Japanese people through improving equity in access to healthcare and the quantity and quality of medical services (Ikeda et al., 2011; Ikegami et al., 2011). On the other hand, the national medical

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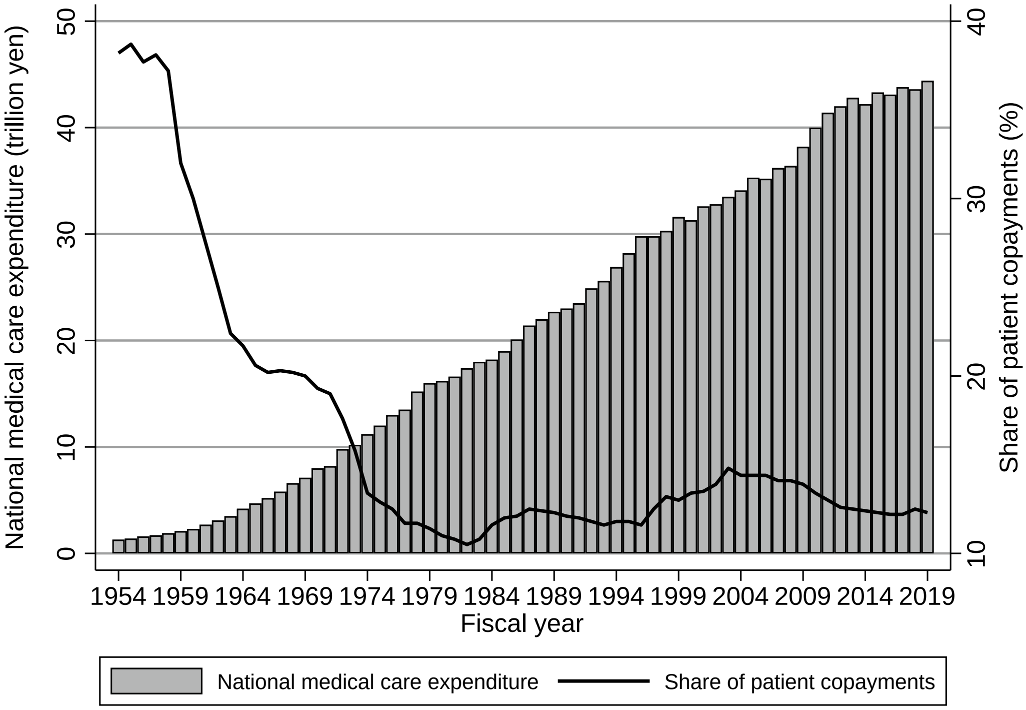
care expenditure, which is a consideration for this contribution, has steadily been increasing; 44.4 trillion yen in 2019 is equivalent to 16.3 times the amount in 1961 (Figure 1). While the increase in healthcare costs is commonly observed in developed countries, it is necessary to search for efficient management systems because there is no guarantee that financial resources can be reliably secured over the long term.

Figure 1. Trends in the national medical care expenditure and share of patient copayments



Notes: National medical care expenditure is adjusted 2020 price using consumer price index (*All items, less imputed rent*). Japan's fiscal year begins from April.
Source: The *National Medical Care Expenditure*, Ministry of Health, Labour, and Welfare.

The health insurance system, which is the core of medical coverage in Japan, has contributed to reducing the risk of injuries and diseases by not only equalizing the risk of income fluctuation in illness but also increasing demand for healthcare due to price reduction in healthcare services (price effect) as an investment good for health (Grossman, 1972). According to Figure 1, the share of patient copayments to the total national medical care expenditure has decreased by 67.8 percent over the past 65 years. This decrease may be the result of the maturation of the universal health insurance system and of its reforms to correct the imbalances among the systems. On the other hand, the average life expectancy during the same period has increased from 65.2 to 81.1 years for men and from 69.9 to 87.5 years for women (the Ministry of Health, Labour and Welfare (MHLW), 2022), suggesting that this price effect has contributed to improving our health levels. However, when insurers are unable to accurately observe individual behaviors and health status, a price decrease induces excessive healthcare utilization and costs due to two moral hazard effects. The one is ex-ante moral hazard, in which lower prices reduce individuals' voluntary health investment, which later leads to deteriorating health and consequently excessive healthcare costs. Another is ex-post moral hazard, in which individuals exaggerate the extent of their illness and overconsume low-cost available care (Zeckhauser, 1970; Cutler and Zeckhauser, 2000; Zweifel and Manning, 2000; McGuire, 2012)[1].

The merits and demerits associated with the development of the health insurance systems are important policy issues that can affect not only people's lives but also the nation's visions of public health (Baicker and Goldman, 2011). Although some public and health economic studies mainly in the United States have examined the qualitative and/or quantitative impacts of price changes in healthcare services on demand (e.g., Phelps and Newhouse, 1972), it has been difficult to precisely estimate the price effect because the demand for health insurance itself depends on individual health and healthcare utilization. Against this background, the RAND Corporation conducted a large social experiment, called the RAND Health Insurance Experiment (HIE), between 1974 and 1981 (Manning et al., 1987)[2]. In this experiment, more than 5,800 people in about 2,000 households in six U.S. cities were randomly assigned to one of 14 health insurance plans with a combination of coinsurance rates (0, 25, 50, or 95 percent) and deductibles (the smaller of 5, 10, or 15 percent of income or $1,000). This random assignment enables us to control in advance for the endogeneity of insurance demand and to estimate the causal effects of different patient cost sharing on healthcare utilization (price effect) and health (moral hazard[3])[4]. Manning et al. (1987) shows that the price elasticity for healthcare services is inelastic, approximately −0.2, and that four health conditions (hypertension, vision, dental, and serious conditions) are worse for those with a positive coinsurance rate. Another large social experiment on health insurance is the Oregon HIE. In 2008, some uninsured low-income adults in Oregon were selected by lottery to be given the opportunity to apply for Medicaid, which is the public health insurance for low-income people in the US. Finkelstein et al. (2012) considers this lottery selection as a large randomized controlled trial that can fill an important gap which has not been analyzed in the RAND HIE. This is because the coinsurance rate of the uninsured is 100 percent,

[1] In recent years, behavioral hazard is discussed as a new economic problem in health insurance. Behavioral hazard is defined that people often misperceive the benefits and costs of medical treatments and lead to overuse of low-value treatments and underuse of high-value ones (Baicker et al. 2015). Iizuka and Shigeoka (2022) is an example of the Japanese study and it finds that the local government subsidy program for children medical expenses increases the inappropriate use of antibiotics.

[2] There are the Japanese literature that well exposit the RAND HIE: Ii and Ohkusa (2002c), Yoo (2006), Noguchi (2016), Hanaoka (2020), and Goto and Ibuka (2020). In addition, Iizuka (2014), Komamura et al. (2015), and Tsugawa (2020) also introduce the Oregon HIE described below. Parts of this paragraph are based on them.

[3] Regarding the effect of decrease in the patient cost sharing on healthcare utilization, some Japanese health economics literature confuses the price effect with moral hazard. Although it is not known at the time whether the healthcare used is overtreatment or not, it should be interpreted as a price effect if increased treatment contributes to improved health. On the other hand, it should be interpreted as a moral hazard, a social loss, when overtreatment does not contribute to improved health.

[4] In the RAND HIE, households participating in the experiment were paid a lump-sum payment so that they would not be economically disadvantaged by participating in the study. High-income earners with annual incomes exceeding $25,000 (1973 prices) were also excluded from the study.

which was not assigned in the RAND HIE. Finkelstein et al. (2012) examines changes in healthcare utilization and health for uninsured people who were given insurance. The results show that in the year after random assignment, the treatment group selected by lottery was about 25 percentage points more likely to have insurance than the control group that was not selected. They also find that the treatment group have significantly higher healthcare utilization, lower out-of-pocket medical expenditures and medical debt, and better self-reported physical and mental health than the control group in the first year. Compared to the RAND HIE, their results indicate a slightly lower price elasticity and larger health effects.

In Japan, the patient cost sharing has been revised many times since the launch of the universal health insurance system in 1961 (Table 1). However, the results of the above social experiments cannot be regarded as the effect of the Japanese system reforms, because there are many differences in healthcare system, culture, and society between Japan and the US. In this paper, I summarize empirical health economics studies that focus on the effects of changes in patient cost sharing on healthcare utilization (price elasticity) and health. However, the two following should be noted. The first is that income is also an important variable in the demand analysis, but to my best knowledge, there are only a few Japanese health economic studies that take it into account. The estimated income effect on healthcare utilization and its income elasticity in Japan are generally small[5], which is consistent with the results for other developed countries (Chandra et al., 2011). However, most of the Japa-

Table 1. The history of patient cost sharing in the Japanese public health insurance system

Year/Month	National Health Insurance	Employee Health Insurance (employee)	Employee Health Insurance (dependents)		
1961/4	50%	fixed payments at only the first visit	50%		
1963/10	30% (only head of household)				
1968/1	30% (all)				
		Under 70		Over 70	
1973/1	30%[1]	fixed payments	30%[1]	Free	
1981/1			inpatient 20%, outpatient 30%		
1983/2				inpatient ¥300/day, outpatient ¥400/day	
1984/2		10%[1]			
1997/9	inpatient 30% outpatient 30%[2]	inpatient 20% outpatient 20%[2]	inpatient 20% outpatient 30%[2]	inpatient ¥1,000/day outpatient ¥500/day (four times a month)[2]	
2001/1				10% (monthly cap)[1], [3]	
2002/10	20% (only children aged under 3)	20% (only children aged under 3)	20% (only children aged under 3)	10%[4]	
2003/4	30%[3] (preschool children: 20%)	30%[3] (preschool children: 20%)	30%[3] (preschool children: 20%)		
2006/10				10%[5]	
				Aged 70-74	Over 75
2008/4	30% (preschool children: 20%)	30% (preschool children: 20%)	30% (preschool children: 20%)	20%[6]	10%
2022/10					20% (only elderly with a certain amount of income)

Notes: This table is composed by the authors based on Ikegami (2017). The public health insurance system in Japan is a universal health insurance system, but there are different types of insurance depending on occupation, employment status, and age. The EHI includes both the Health Insurance Society (HIS) and the Health Insurance Association (HIA). See footnotes 8, 10, and 12.

(1) Introduction of the high-cost medical expenses benefit (*kogaku ryoyo-hi seido*)
(2) Introduction of the patient cost-sharing for prescribed medicines
(3) Abolition of the patient cost-sharing for prescribed medicines
(4) 20% for those earning the same level as those of working age
(5) 30% for those earning the same level as those of working age
(6) 10% until FY2015 because of the fiscal measures

nese studies cited in this paper use the claims data, which are the bills from medical institutions to public health insurers. The claims data contain accurate individual monthly information on healthcare utilization but only a few of their attributes. Bhattacharya et al. (1996), an early Japanese study using microdata, mentions the importance of examining the relationship between income and healthcare utilization, but income is basically unavailable in the Japanese claims data. The second is the interpretation of the estimation results based on causal inference, such as the natural experiment approach. Specifically, those results are interpreted as a local average treatment effect (LATE), using a certain exogenous policy change, institutional reform, or environmental change among various changes. In the recent applied econometrics analysis, the LATE is not a whole effect of the exogenous change (average treatment effect, ATE). But I believe that it is important to steadily build up each LATE using a variety of situational changes to gain a better picture of the causal effect of the policy effects.

The reminder of the paper is organized as follows. Section II provides representative Japanese health economics studies that examine how differences in patient cost sharing in the public healthcare system have affected individual healthcare utilization and health. Section III reports the preliminary empirical results using individual panel data covering a wider range of people in order to discuss the robustness of the results in some previous studies introduced in Section II-2. Section IV concludes.

II. Patient cost sharing, healthcare utilization and health in the public healthcare system

In this section, I summarize representative Japanese empirical papers that have examined the effect of patient cost sharing on individual healthcare utilization and health. They can be categorized into the following four themes[6]: (1) research using differences in patient cost sharing among insurers, (2) research using the discontinuous decline in patient cost sharing due to the transition to the healthcare systems for the elderly, (3) research analyzing the effect of actual full insurance programs by the central government, and (4) research examining the effect of local governments subsidy programs for healthcare utilization for children.

II-1. The effect of differences in patient cost sharing among insurers

Table 2 summarizes the studies included in the first topic, and they can be divided into two groups. One focuses on the effects of the different coinsurance rates among insurers be-

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[5] For example, Tokita et al. (1997), Sawano (2000), Tokita et al. (2002), Yoshida and Takagi (2002), Kan (2009), Imahori et al. (2019), and Kato et al. (2022).

[6] There are a few other empirical analyses on the relationship between a patient's cost and healthcare utilization in Japan. Ogura (1990), Bessho and Ohkusa (2003), and Yuda (2007) focus on the effect of individual opportunity cost, and Sugawara (2021) uses a conjoint analysis to examine the effect of a fixed amount copayment for outpatient visits.

Table 2. Effects of differences in patient cost sharing among insurers on healthcare utilization

Articles	Data	Sample	Methods	Outcome variables	Main results
(i) Effects of differences in coinsurance rates among insurers					
Senoo (1985)	*Annual Report on the NHI Activity* (1980-1981)	Prefectural data	OLS	Consultation rate, days per claim	IP: $-0.72^* < \varepsilon_{ex} < -0.65$, OP: $-0.22 < \varepsilon_{ex} < -0.19$ Dentistry: $-0.18 < \varepsilon_{ex} < -0.12$
	Annual Statistical Report on the Social Security (1955-1979)	Time series data	OLS		IP: $-0.42^* < \varepsilon_{ex} < -0.11$ OP: $-0.25^* < \varepsilon_{ex} < -0.19$
Nishimura (1987)	*Annual Report on the NHI Activity* (1974-1983)	Prefectural data	OLS, AR	HCE per claim	IP: $-0.06 < \varepsilon_{in} < 0.06^*$ OP: $-0.13^* < \varepsilon_{in} < -0.08^*$
Ogura (1990)	*Comprehensive Survey of Living Conditions* and others (1986)	Age-groups data	OLS, IV	Consultation rates for OP visits and IP	IP (male) $-0.44^* < \varepsilon_{ex} < -0.17$ (female) $-0.78^* < \varepsilon_{ex} < -0.15$ OP (male) $-0.49^* < \varepsilon_{ex} < -0.25^*$ (female) $-0.16^* < \varepsilon_{ex} < 0.02$
Bhattacharya et al. (1996)	*Patient Survey* (1990)		Cox	Interval of OP visits	$-0.52^* < \varepsilon_{in} < -0.12^*$
Ii and Ohkusa (2002a)	*Comprehensive Survey of Living Conditions* (1986-1995, every 3 years)	Patients with minor ailments	MNP	OP doctor visits, OTC drug use, or others	$0.14^* < \varepsilon_{ex} < 0.15^*$
Ii and Ohkusa (2002b)	Original survey data (1997/11-1998/1)	Patients with a cold	MNP	OP doctor visits, OTC drug use, or others	$0.23^* < \varepsilon_{ex} < 0.36^*$
(ii) Effects of revision of the Health Insurance Act in September 1997					
Yoshida and Ito (2000)	HIS claims data (1996/9-1998/7)	Non-EHS insured (4 HISs)	Hurdle	Number of OP claims, days of OP doctor visit	$\beta_{ex} = 0.42^*$, $-0.32^* < \beta_{in} < -0.21^*$
Tokita et al. (2000)	NHI claims data (1997/4-1998/3)	Chiba prefecture	OLS, DD	Medical fees for treatments	$\beta = -8.20^*$ 70s: $\beta = 52.40^*$ 80s: $\beta = -42.91^*$
Tokita et al. (2002)	HIS claims data (1997/4-1998/3)	Non-EHS insured (1 HIS)	OLS	Medical fees for treatments	Employee: $\beta = 4.75$ Dependents: $\beta = -71.25^*$
Yoshida and Takagi (2002)	HIS claims data (1996/9-1998/8)	Non-EHS insured (6 HISs)	Hurdle	Choice of doctor visit, days of doctor visit	Before revision: $-0.26^* < \varepsilon < -0.18^*$ After revision: $-0.11^* < \varepsilon < -0.08^*$
Yoshida and Kawamura (2003)	HIS claims data (1996/4-1999/3)	Non-EHS insured (6 HISs)	Hurdle, DD	Number of dental claims, days of dentist visit	Short-term: $\beta_{ex} = -0.00$, $\beta_{in} = 0.26^*$ Long-term: $\beta_{ex} = -0.06^*$, $\beta_{in} = -0.2$
Izumida (2004)	HIS claims data (1996/6-1998/11)	Non-EHS insured (3 HISs)	OLS, DD	Choices of OP use, IP via OP, or direct IP	$-0.005 < \beta_{in} < 0.001$
Masuhara and Murase (2005)	HIS claims data (1998/7-12, 1999/7-12)	Non-EHS insured (3 HISs)	Hurdle, FM	Days of doctor visit	Hurdle (OP): $-0.85 < \beta_{ex} < -0.52$ FM (prescription drug & high density): $0.11 < \beta < 0.12$
Kan and Suzuki (2010)	HIS claims data (1996/4-1999/11)	Non-EHS insured (111 HISs)	RE, DD	Days of doctor visit, HCE per day	$\varepsilon_{in} = 0.06^*$

Notes: In *sample*, *Non-EHS insured* represents the people who are not the applicants of the elderly healthcare system. In *Methods*, *OLS* stands for ordinary least squares, *AR* an autoregressive model, *Cox* a cox proportional hazard model, *MNP* a multinomial probit model, *Hurdle* a hurdle model, *DD* a difference-in-differences model, *FM* a finite-mixture model, and *RE* a random effect model, respectively. In *Outcome variables*, *HCE* is an abbreviation for healthcare expenditure, *OP* for outpatient, and *IP* for inpatient or hospitalization, respectively. In *Main results*, β is estimated parameters or marginal effects, and ε is price elasticities rounded to two decimal places. Subscripts "*ex*" and "*in*" stand for extensive margin and intensive margin, respectively. * stands for statistical significance at the 1%, 5%, or 10% levels.

fore March 2003, and the other focuses on the effect of the healthcare reform in September 1997[7].

Early studies on the former group include Senoo (1985), Nishimura (1987), and Ogura (1990), who use time series and prefectural aggregated data of the Japanese National Health Insurance (NHI: *Kokumin Kenko Hoken*[8]), and find small price elasticities. The first study

[7] The history of healthcare systems and their reforms and related studies during this period in Japan are also summarized in Yashiro et al. (2006).

using micro data is Bhattacharya et al. (1996), who uses the *Patient Survey* conducted by the MHLW to estimate the effect of differences in coinsurance rates among insurers on the interval of outpatient visits. Their price elasticity estimated by Cox proportional hazard model ranges from −0.52 to −0.12, which is smaller than those using aggregate data above. In addition, Ii and Ohkusa (2002a, b) use a multinomial probit model to investigate the effect of differences in coinsurance rates on choices of doctor visits and over the counter (OTC) drug use. The price elasticities with respect to outpatient utilization in Ii and Ohkusa (2002a) using a sample of those with minor ailments range from 0.14 to 0.15, and Ii and Ohkusa (2002b) using original survey data finds the price elasticity for those with a cold range from 0.23 to 0.36. Although these estimated price elasticities with respect to healthcare utilization are generally low, these results have to be carefully interpreted and compared. As Appendix A provides a more detailed explanation, the demand for healthcare can be divided into two parts: utilization choice (extensive margin) and a patient's actual utilization (intensive margin), and coinsurance rates have a larger effect on extensive margin, where consumers' preferences dominate[9]. That is, Senoo (1985) and Ii and Ohkusa (2002a, b) whose dependent variable is consultation rate or utilization choice estimate the price elasticity for the extensive margin, while those of Nishimura (1987) and Bhattacharya et al. (1996) are for the intensive margin. This is because Nishimura (1987) uses healthcare expenditure per claim, approximately equivalent to the number of patients, as a dependent variable, and the *Patient Survey* used in Bhattacharya et al. (1996) only includes patients that visit a medical institution during a certain period.

The revision of the Health Insurance Act in September 1997 increased the coinsurance rate of the household head insured of the employee health insurance (EHI) from 10 percent to 20 percent for their inpatient and outpatient utilization (Table 1). The latter group of studies focuses on the unchanged coinsurance rate for EHI dependents, 20 percent for inpatient and 30 percent for outpatient, and estimates the effect of the coinsurance rate on healthcare utilization using claims data from the NHI and the HIS (Heath Insurance Society: *Kenko Hoken Kumiai*[10]). Tokita et al. (2002) uses the samples of the insured employee and dependents and find that the 1997 revision has a negative effect on the healthcare utilization of the insured person but has no significant effect on the dependents. Yoshida and Takagi (2002) uses the two samples separately before and after the 1997 revision and find that the price elasticity for the insured employees, for whom the coinsurance rate increased, decreases from −0.26 to −0.18 before to −0.11 to −0.08 after the revision. However, these elastici-

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8 The NHI is one of the public health insurances in Japan. The NHI covers the self-employed, non-regular workers, and the unemployed.

9 This approach is called as a two-part (TP) model or a hurdle model. See Appendix A for details. In addition, Deb and Trivedi (2002) explains the difference from the finite-mixture (FM) model discussed below. The TP and hurdle models are also often used in empirical studies of supplier-induced demand (e.g., McGuire, 2000) and cigarette consumption (Chaloupka and Warner, 2000).

10 The HIS covers employees in large companies and their dependents. The other employee health insurance is the Health Insurance Association (HIA) which covers employees in small- and middle-sized companies and their dependents. The HIS and the HIA are parts of the universal health insurance plans in Japan, and they are sometimes called the employee health insurance (EHI). See Table 1.

ties obtained by the subsamples may include the policy effect, time trends, and other common factors to each sample. To control this common trend, Yoshida and Ito (2000) and Yoshida and Kawamura (2003) regard the 1997 reform as a natural experiment and estimate the price elasticity using the difference-in-differences (DD) framework. Specifically, these studies regard the insured employees whose coinsurance rate is increased as a treatment group and the dependents whose coinsurance rate is unchanged as a control group. In addition, these papers use a hurdle model that divides the whole healthcare utilization into extensive and intensive margins (see Appendix A). Yoshida and Ito (2000) finds that the 1997 revision suppresses the demand for outpatient use by dependents rather than by the insured employees. This result is inconsistent with standard microeconomic theory, but Yoshida and Ito (2000) interprets this result as the total decrease in outpatient utilization by households. Yoshida and Kawamura (2003) examining the effect on dentistry utilization finds that the 1997 revision has no effect on extensive margin but significantly negative effect on intensive margin in the short-term. In the long-term, this revision significantly and negatively affects extensive margin and has no significant effect on intensive margin. In addition, Izumida (2004) examines not only the effect of the 1997 revision on outpatient and inpatient use, but also how inpatient use via outpatient use changes. The results by the DD estimation do not show the significant effect on these intensive margins.

Although the above studies on 1997 reform use large scale individual panel data, they are only pooled cross-sectional analysis, perhaps because of the complexity of the estimation models. This means that their estimates may be biased because the model does not control for individual unobservable heterogeneity. To address this problem, Kan and Suzuki (2010) uses a TP model with individual random effects and show that the price elasticity of the intensive margin is 0.06. However, this result should also be carefully interpreted because a RE model assumes that there is no correlation between individual effects and the error term. Because claims data contain little information on individuals or households, the RE assumption is restrictive for consistency.

Finally, Tokita et al. (2000) and Masuhara and Murase (2005) also examine the effect of the introduction of patient cost sharing for outpatient prescribed drugs in the 1997 health insurance reform. Tokita et al. (2000) using individual claims data taken from the Japanese NHI finds that the increase in patient cost sharing significantly reduces healthcare costs. Masuhara and Murase (2005) examines the effect of the abolishment above cost sharing in April 2003 on patient demand for outpatient visit and prescription drugs. Masuhara and Murase (2005) uses both a hurdle and a finite-mixture (FM) models[11] and find that the abolishment reduces outpatient utilization slightly and increases the demand for prescription drugs for high-frequency patients.

[11] A FM model divides the individual patients into two groups, high-frequency and low-frequency patients, to consider the differences in individual attributes and unobserved heterogeneity among these individuals.

II-2. The effect of the discontinuous decline in patient cost sharing on healthcare utilization and health among the Japanese elderly

Under the current public health insurance system in Japan, the coinsurance rate falls from 30 percent to 20 percent (until age 74) and then to 10 percent (after age 75) when a person turns age 70[12]. Table 3 summarizes the studies that attempt to estimate the price elasticity of demand for healthcare among the Japanese elderly by using this discontinuous change in patient cost sharing with age as a threshold. Sawano (2000) is a rare study that focuses on the change in patient copayment from a fixed coinsurance rate to fixed payments at age 70 in the elderly healthcare system. The price elasticity with respect to the extensive

Table 3. Effects of sharp decline in patient cost sharing on healthcare utilization and health for the Japanese elderly

Articles	Data	Sample	Methods	Outcome variables	Main results
Sawano (2000)	*Survey on the NHI benefits* (1986-1994) *Comprehensive Survey of Living Conditions* (1989-1995)	Prefectural panel data	FE, RE	Days per OP claim OP consultation rate	$-0.11^* < \beta_{in} < -0.09^*$ $-0.13^* < \beta_{ex} < -0.08^*$
Masuhara et al. (2002)	NHI and HIS claims data (1997) HIS claims data (1997)	The Insured of the NHI (4 prefecture) and 3 HISs	FE	Monthly OP HCE	Episode: $\varepsilon = 0.19^*$ Episode across disease: $\varepsilon = 0.23^*$
Masuhara (2004)	HIS claims data (1996/4-2001/3)	HIS insured (3 HISs)	Hurdle, FM	Days of doctor visit	Hurdle: $0.07 < \beta_{ex} < 0.18$, $0.11 < \beta_{in} < 0.20$ FM: [Low] $0.13 < \beta < 0.57$ [High] $0.32 < \beta < 0.41$
Suzuki (2005)	NHI claims data (1998/4-2003/3)	Toyama prefecture	TPM, RE	Days, HCE, and IP utilization	OP: $\varepsilon = 0.40^*$ IP: $\varepsilon = 0.10^*$
Kan (2009)	*National Survey of the Japanese Elderly* (1987-1993, every 3 years)		FE, RE	Number of doctor visit, subjective poor health	Number of doctor visit (male) $\beta_{ex} = 0.13$, (female) $\beta_{ex} = 0.13$ Subjective poor health (male) $\beta = 0.06^*$, (female) $\beta = -0.02$
Shigeoka（2014）	*Patient Survey* (1984-2008, every 3 years)		RDD	Days of OP visit, Length of hospital stay	OP: $\varepsilon_{in} = -0.18^*$ IP: $\varepsilon_{in} = -0.16^*$
Ibuka and Shoji (2015)	*Japanese Study of Aging and Retirement* (2007-2011, every 2 years)		FE, RE	Number of doctor visit, OP utilization	Number of doctor visit: $-0.13 < \beta_{ex} < 0.19$ OP utilization: $0.02 < \beta_{ex} < 0.09$
Fukushima et al.（2016）	Claims data, Japan Medical Data Center (2005/1-2013/12)		RDD	HCE	Total, OP, and IP: $\varepsilon = -0.16^*$
Ando and Takaku（2016）	*Japanese Study of Aging and Retirement* (2007-2011, every 2 years)		RDD	Denture utilization	$\varepsilon_{ex} = -0.41^*$
Yuda and Lee（2022）	*Japanese Study of Aging and Retirement* (2007-2011, every 2 years)		DDD	5 health indicators, utilization of OP, IP, dentistry, and in-home formal care	OP: $0.16^* < \beta_{ex} < 0.80^*$, IP: $0.04^* < \beta_{ex} < 0.08^*$ Dentistry: $0.01 < \beta_{ex} < 0.07^*$ In-home formal care: $-0.01^* < \beta_{ex} < 0.00^*$
Kato et al. (2022)	NHI claims data (2011/9-2014/3)	One municipality	RDD	HCE	$\varepsilon = -0.07^*$, (low income) $\varepsilon = 0.00$, (middle income) $\varepsilon = -0.08^*$, (high income) $\varepsilon = -0.11^*$
Komura and Bessho (2022)	*NDB database* (2012-2019, September - November)	Those aged 70 to 74 years born after April 1994.	RDD	HCE	Total: $\varepsilon = 0.04$, OP: $\varepsilon = 0.05$, IP: $\varepsilon = 0.04$

Notes: In *Methods*, *FE* stands for a fixed effect model, *RE* a random effect model, *Hurdle* a hurdle model, *FM* a finite-mixture model, *TPM* a two-part model, and RDD a regression discontinuity design, and *DDD* a triple differences model, respectively. In *Outcome variables*, *HCE* is an abbreviation for healthcare expenditure, *OP* for outpatient, and *IP* for inpatient or hospitalization, respectively. In *Main results*, β is estimated parameters or marginal effects, and ε is price elasticities rounded to two decimal places. Subscripts "*ex*" and "*in*" stand for extensive margin and intensive margin, respectively. * stands for statistical significance at the 1%, 5%, or 10% levels.

[12] In Japan, there is another health insurance plan for the elderly whose finance is contributed from the other public health insurance plans for the young, such as the HIS, HIA and NHI. This contribution makes their finance worse (See Yuda, 2016).

margin using prefectural panel data is small, ranging from −0.125 to −0.076. In an early empirical analysis using micro data, Masuhara et al. (2002) uses a fixed effects (FE) model to estimate the effect of the actual coinsurance rate, excluding additional benefits, on outpatient healthcare costs and finds that the price elasticity with respect to the extensive margin ranges from 0.185 to 0.228. Masuhara (2004) compares the results of a pooled cross-sectional hurdle and FM models to estimate the effect of a transition to the elderly healthcare system. But the coefficients of the transition dummy variable are not significant in either model, possibly because the models do not include individual age as an independent variable. Suzuki (2005) examines the impact of the shift to the elderly healthcare system on the number of outpatient days, healthcare costs, and inpatient utilization. The results based on a TP model with individual random effects indicate that the price elasticity with respect to outpatient utilization is 0.40 and to hospitalization probability is 0.10, respectively. However, these RE results should be carefully interpreted, as previously explained in Kan and Suzuki (2010). Ibuka and Shoji (2015) uses the *Japanese Study of Aging and Retirement* (JSTAR) to estimate the effect of the transition on intensive and extensive margins per month. The results of the various estimation models do not show any significant effects of the decline in the coinsurance rate, but those by specific diseases show that the monthly visit significantly increases after age 70 for individuals with liver diseases.

There are also several analyses that examine how discontinuous changes in coinsurance rates affect the health of the elderly. Kan (2009) examines the effect of the shift to the elderly healthcare system on the self-reported poor health. The results of the FE model do not show a significant impact of the decline in the coinsurance rate on the number of outpatient visits but slightly worsening self-reported health among male elderly. Shigeoka (2014) analyzes the impact on outpatient and inpatient utilization as well as mortality and health using the individual data from the *Patient Survey*. Using a regression discontinuity design (RDD) method, the results show that the price elasticities of outpatient and inpatient utilization are −0.18 and −0.16, respectively. Shigeoka (2014) also shows that a sharp reduction in the coinsurance rate has little impact on mortality and other health outcomes. However, note that these elasticities are with respect to the intensive margin, likely with Bhattacharya et al. (1996). Fukushima et al. (2016) estimates overall price elasticity by using the HIS claims data. The results using the RDD method show that the price elasticities for total, outpatient, and inpatient utilization are all around −0.16 and that the impact on health indicators are not significant. However, these results should be carefully interpreted because the elderly in the HIS do not necessarily have general attributes in terms of sample representativeness. Kato et al. (2022) examines the impact of discontinuous changes in coinsurance rate on healthcare utilization and subjective health using NHI claims data in a certain municipality merging administrative premium information at an individual level. Although the generality of the results should be carefully interpreted, the results of the RDD analysis show that there is no significant effect on inpatient utilization, the price elasticity for outpatient is significant at −0.07, and that there is no significant effect on subjective health. Kato et al. (2022) also analyzes by income group based on premium information and finds that low-income individuals have less elastic demand for outpatient care than other income groups. No difference in subjective health was found after the age of 70. Yuda and Lee (2022) examines the impact of the Great East Japan Earthquake on individual health using the JSTAR and finds that a sharp decline in coinsurance rate at age 70 increases healthcare utilization, and it reduces health deterioration in the afflicted area after the earthquake in their additional analysis using the triple differences (DDD) framework. Their results are more general because the JSTAR covers several municipalities across Japan and has the randomly selected respondents. In addition, Yuda and Lee (2022) also estimates the substitution effect of the elderly's change in relative price due to coinsurance rate reduction on formal long-term care utilization as well as on several health indicators. The results show that price elasticities for outpatient, inpatient, dental, and formal long-term care utilization are significant but inelastic and that there are no significant effects on health indicators. Ando and Takaku (2016) also uses the JSTAR to examine the impact of the discontinuous decline in coinsurance rates on denture use and masticatory function. The RDD results show that the elasticity with respect to denture use is significant but inelastic, at about −0.41, and that there is no significant health effect in chewing ability. Furthermore, Komura and Bessho (2022) estimates the long-term effects of the increase in the coinsurance rate from 10 percent to 20 percent for the elderly aged 70-74 born after April 1944 using the *National Database of Health Insurance Claims*. The RDD results indicate that the long-term effect of this revision reduces healthcare utilization, which is similar to or a little larger than the short-term ones observed in Shigeoka (2014) and Fukushima et al. (2016). In addition, they find no clear effects on health and health-related behaviors.

II-3. The effect of actual full insurance programs on healthcare utilization

The public assistance (PA) system in Japan provides comprehensive welfare benefits centering on income security to low-income households certified by a means test to maintain their minimum healthy and cultural standard of living. The medical assistance (MA) benefit, which is a part of the PA benefit, allows the recipients to receive the same medical treatments as those insured by the public health insurance without prior tax and insurance premium burden and copayments[13, 14]. MA expenditures have almost accounted for the largest share of PA expenditures since the PA system launched in 1950. This is because low-income

[13] Note that there is an access restriction that a PA recipient must visit a designated medical institution with a medical and dispensing ticket monthly issued by the welfare office when using medical care. However, because approximately 90% of medical institutions are designated, there are almost no restrictions on access in practice. In addition, because medical fees for a PA patient are based on the public health insurance system, risk selection by medical institutions is unlikely to occur. On the other hand, it has been pointed out that unnecessary or excessive treatments (induced-demand) are possibly provided because medical providers can certainly gain earnings (Yuda, 2018; 2022).

[14] The PA system in Japan also covers all costs associated with the use of formal long-term care services (long-term care benefit). Fu and Noguchi (2019) uses large scale claims data to find that long-term care costs and days of care are significantly higher for the PA recipients than for those insured by public long-term care insurance. However, they find that the moral hazard effect is very small because the estimated price elasticity is only approximately -0.1. Onishi (2023) summarizes the economic studies that examine the effect of the coinsurance rate in public long-term care insurance on long-term care utilization and health.

individuals generally have lower socioeconomic status, which is strongly correlated with lower health status and more use of medical treatments. Kumagai (2002) obtains evidence suggesting that the MA system has contributed to improving the health of the recipients at the macro level, and Hayashi (2011) uses municipal data and a quantile regression model and finds that the MA system has effectively responded to the changing medical needs of the low-income population in rural areas. In addition, Ohtsu (2013) and Nishioka et al. (2021) analyze the characteristics of healthcare utilization by the PA recipients. Ohtsu (2013) uses prefectural panel data to examine the determinants of per capita MA expenditures. The results of RE estimation reveal that the ratio of those with mental disorders significantly and positively increases the expenditure for both young and old generations. In addition, it is found that the physician density in general hospitals has a positive effect on MA expenditure per those aged 65 and older and that the increase in the number of *other households* has a negative effect on MA expenditure per those under 65. Nishioka et al. (2021) examines dentistry utilization by the recipients using individual data combining the PA database and MA claims data in two municipalities. The results show that younger, female and non-Japanese recipients and those with mental disorders use more dental treatments.

On the other hand, it is often reported that free use of healthcare causes excessive healthcare expenditures due to a moral hazard by the recipients. In this regard, Yuda (2018, 2022) use a nationally representative individual claims data for the PA and public health insurance patients. Yuda (2018) examines the effect of PA assignment on the healthcare expenditure of short-term hospitalization by a pooled instrumental variable (IV) estimation and finds that the estimated arc price elasticity is 0.2. Yuda (2022) estimates a price elasticity of 0.02 for outpatient utilization as a result using the fixed effects based on the pseudo-panel data analysis and propensity score matching (PSM) method.

Although these studies summarized in Table 4 use various unique large-scale micro data, there are several remaining tasks that have not yet been analyzed in detail, compared with the studies presented in section II-1 and II-2 (Tables 2 and 3). For example, the elasticities in Yuda (2018, 2022) are only those of the intensive margins of healthcare, and the generality of the results of Nishioka et al. (2021) based on data from only two municipalities is also debatable.

Finally, it is worth to describe another empirical study that examines the effect of an actual full insurance policy against a devastating natural disaster in Japan. In the three prefectures of Iwate, Miyagi, and Fukushima prefectures, heavily affected by the Great East Japan Earthquake and massive tidal waves on March 11, 2011, patient copayments on healthcare had been exempted, but Miyagi prefecture suspended this subsidy in FY2013. Matsuyama et al. (2018) uses municipal data in Miyagi prefecture and estimate the effect of this suspension on outpatient, inpatient, and dental care utilization. Their DD results show that the suspension reduces each healthcare utilization.

Table 4. Effects of the free healthcare programs on healthcare utilization

Articles	Data	Sample	Methods	Outcome variables	Main results
(i) Public assistance system					
Ohtsu (2013)	*Fact-finding Survey on Medical Assistance, National Survey on Public Assistance Recipients, Report on Social Welfare Administration and Services*, etc. (1999-2007)	Prefectural panel data	FE, RE	Medical assistance cost per capita	(see the text)
Yuda (2018)	*Fact-finding Survey on Medical Assistance, Survey of Medical Care Activities in Public Health Insurance* (2000-2010)		IV	Monthly HCE	ε_{in} = 0.20*
Nishioka et al. (2021)	Municipal public assistance database, medical assistance claims data (2016)	Two municipalities	Poisson	Dentistry utilization	(see the text)
Yuda (2022)	*Fact-finding Survey on Medical Assistance, Survey of Medical Care Activities in Public Health Insurance* (2003-2007)		FE, PSM	Monthly HCE, days of doctor visit	ε_{in} = 0.02*
(ii) Other					
Matsuyama et al.（2018）	*Annual Report on the NHI Activity* (2012-2013)	Municipals panel data in Miyagi prefecture	OLS	Utilization (OP, IP, and dentistry)	OP: β_{ex} = −0.61* IP: β_{ex} = −0.27 Dentistry: β_{ex} = −0.92*

Notes: In *Methods*, *FE* stands for a fixed effect model, *RE* a random effect model, *IV* an instrumental variable model, *Poisson* a Poisson regression model, *PSM* a propensity score matching model, and *OLS* ordinary least squares, respectively. In *Outcome variables*, *HCE* is an abbreviation for healthcare expenditure, *OP* for outpatient, and *IP* for inpatient or hospitalization, respectively. In *Main results*, β is estimated parameters or marginal effects, and ε is price elasticities rounded to two decimal places. Subscripts "*ex*" and "*in*" stand for extensive margin and intensive margin, respectively. * stands for statistical significance at the 1%, 5%, or 10% levels.

II-4. The effect of local government subsidy program for healthcare utilization and health for children[15]

In recent years, the out-of-pocket cost of children's healthcare expenses is subsidized by the local governments in order to reduce the financial burden on households with children. According to the annual survey regarding this subsidy program by the MHLW, all prefectural and municipal governments have provided some forms since FY2012 and there are variations in the eligible ages, benefit details, an income limit, and the level of cost sharing by each local government[16]. The expansion of this subsidy program enables the households to access high-quality pediatric healthcare at lower costs, which is expected to improve and maintain good health for children in the short term. In addition, because many studies find that good health in childhood has a positive effect on future health and socioeconomic variables (Currie, 2009; Smith, 2009; Currie and Almond, 2011; Nakamuro et al., 2013; Nozaki and Sano, 2016; Almond et al., 2018; Matsushima et al., 2018; Yuda, 2020), this subsidy program is expected to also have long-term positive impacts. On the other hand, in the short-term, it would lead to ex-post moral hazard due to lower patient cost sharing and an increased financial burden on local and central governments, which are ultimately responsible for financing healthcare costs.

Table 5 summarizes the empirical studies on this issue, and they can be classified into

15 Part of this subsection is based on Yuda et al. (2022).
16 In this regard, Adachi and Saito (2016) explores the factors of the qualifying age among municipalities from the perspective of the yardstick competition.

Table 5. Effects of the public subsidy programs for infant and children on healthcare utilization and health

Articles	Data	Sample	Methods	Outcome variables	Main results
(i) Prefecture					
Iwamoto (2010)	Annual Report on the NHI Activity (2002-2005)	Prefectural panel data	FE	HCE per capita under 3	Reimbursement: $\beta = -0.07$*
Bessho (2012)	*Comprehensive Survey of Living Conditions* (2007)	Non-inpatient aged 3 to 14 years	IV	Treatment, OP utilization, health indicators	Aged 3-6. Treatment: $\beta = 0.04$, OP: $\beta_{ex} = 0.04$ Aged 7−12. Treatment: $\beta = 0.03$*, OP: $\beta_{ex} = 0.09$*, Health: $\beta = -0.01$
Takaku (2017)	NHI claims data (2003/4-2006/3)	Infants aged 36 to 72 months in a municipality in Hokkaido prefecture	FE, DD	Healthcare utilization	OP utilization: $\varepsilon_{ex} = -0.23$*
(ii) Municipality					
Takaku (2016)	*Comprehensive Survey of Living Conditions* (1995-2010, every 3 years)	Children aged 1 to 12 years	OLS	Health indicators	Preschool children: $-0.05^* < \beta < -0.02^*$ Elementary school children: $-0.00 < \beta < 0.01$
Kato and Goto (2017)	Japanese Diagnosis Procedure Combination (DPC) database (2013-2014)	Children aged 6 to 18 years	FE	IP utilization	OP: $\beta_{ex} = 0.03$ IP: $\beta_{ex} = 0.03$
Miyakawa et al. (2017)	NHI claims data (2012/4-2014/3)	2nd to 4th grade children in a municipality	OLS, DD	Healthcare utilization	$-0.19^* < \varepsilon_{ex} < -0.13^*$
Abe et al. (2021)	Original Survey data (2016, 2017)	5th and 8th grades children in Tokyo, Nagano, and Hiroshima prefectures	Logistic	Healthcare suppression	5th grade. Fixed payment: $\beta = 0.41$*, 30%: $\beta = 0.88$, Reimbursement: $\beta = 1.41$ 8th grade. Fixed payment: $\beta = 1.47$, 30%: $\beta = 1.96$*, Reimbursement: $\beta = 2.04$*
Iizuka and Shigeoka (2021)	Claims data, Japan Medical Data Center (2005/4−2015/3)	Children aged 6 to 15 years	FE, DD	OP HCE	Price decrease: $\beta = 8.89$* Price increase: $\beta = -20.05$*
Yuda et al. (2022)	NHI claims data (2011/1-2014/3)	Children aged 9 to 15 years in 17 municipalities in Fukui prefecture	FE, DD	Healthcare utilization	HCE: $0.12^* < \varepsilon < 0.13^*$ Utilization: $0.07^* < \varepsilon_{ex} < 0.09$ Days: $0.13^* < \varepsilon < 0.15^*$
Iizuka and Shigeoka (2022)	Claims data, Japan Medical Data Center (2005/4-2015/3)	Children aged 6 to 15 years	FE, DD	OP utilization, OP HCE	Zero price effect. Utilization: $0.02 < \beta_{ex} < 0.33$, HCE: $2.02 < \beta < 7.84$
Kang et al. (2022)	*Patient Survey*, *Survey of Medical Care Activities in Public Health Insurance*, *Comprehensive Survey of Living Conditions*, Vital statistics (1990s)	Children aged 0-6 years	DD	OP utilization, IP utilization, Health indicators, mortality rate	OP. Utilization: $\beta_{ex} = 0.00$, HCE: $\beta_{in} = 0.52$* IP. Utilization: $\beta_{ex} = 0.00$, HCE: $\beta_{in} = -3.51$ Health. fever: $\beta = -0.02$*, cough: $\beta = -0.04$*, nasal discharge: $\beta = -0.02$*, mortality rate: $\beta = -0.07$.

Notes: In *Methods*, *FE* stands for a fixed effect model, *IV* an instrumental variable model, *DD* a difference-in-differences model, *OLS* ordinary least squares, and *Logistic* a logistic regression model, respectively. In *Outcome variables*, *HCE* is an abbreviation for healthcare expenditure, *OP* for outpatient, and *IP* for inpatient or hospitalization, respectively. In *Main results*, β is estimated parameters or marginal effects, and ε is price elasticities rounded to two decimal places. Subscripts "*ex*" and "*in*" stand for extensive margin and intensive margin, respectively. * stands for statistical significance at the 1%, 5%, or 10% levels.

those focusing on a prefectural program and municipal subsidy ones, respectively. In regard to the former, Iwamoto (2010) uses prefectural panel data to examine the effect of the prefectural subsidy program on per capita healthcare expenses for children under 3 years old. The results using FE and RE effects models show that the subsidy in kind raises healthcare expenses by 7.0 to 8.6 percent compared to reimbursement payments. Bessho (2012) uses nationally representative individual data to examine the effect of the prefectural subsidy program on children's healthcare utilization and health. The results suggest that the introduction of the subsidy program does not affect the outpatient utilization for preschool children but significantly raises that for elementary school children. It also suggests that the subsidy program does not necessarily contribute to improving children's health. However, these results should be carefully interpreted because these estimated policy effects may be a sum of effects of prefectural and municipal subsidy programs; prefectural subsidy programs firstly began to be introduced in the 1970s and municipalities followed to introduce the additional programs (Nishikawa, 2010, 2011). To address this identification problem, Takaku (2017) focuses on a policy change in the prefectural subsidy program in a municipality where the municipal program does not change. Specifically, the prefectural program changes the coinsurance rate for children of the NHI insured from 30 percent to 10 percent in general households and to 0 percent for those in low-income households. Takaku (2017) uses DD framework to examine the effect of this revision on healthcare utilization by children and find that the price elasticity with respect to outpatient utilization is −0.23.

In recent years, there have been empirical analyses focusing on the municipal subsidy programs. Takaku (2016) examines the effect on children's health using nationally representative individual data merged with original survey data on the eligible ages in each municipal program. The pooled cross-sectional results show that the subsidy program has a positive health effect for preschool children but not for elementary school children. However, because Takaku (2016) uses the repeated cross-sectional data with intervals between survey years, the results may include both the program effect and the macroeconomic effects in intervals as well as individual-specific unobservable heterogeneity. Miyakawa et al. (2017) uses claims data from a certain municipality to estimate how the exemption from the application of the subsidy program affects healthcare utilization. The DD estimation results show that the price elasticity ranges −0.19 to −0.13. Kato and Goto (2017) uses municipal aggregate data based on the medical claims from the Diagnostic Procedures Combination (DPC) program to estimate the effect of outpatient copayments reduction on inpatient utilization. The results of the FE estimation do not show an overall significant effect on inpatient care utilization but find that there is a substitution effect in low-income areas and a complementary effect in high-income areas, respectively. However, these results should be carefully interpreted because the DPC program is a medical fee schedule for patients with acute illnesses at relatively large hospitals, which implies that the price elasticity is originally expected to be very small. Abe et al. (2021) uses original survey data on households with children in the fifth grade and eighth grade in three prefectures to examine how the exclusion from the subsidy program leads to reduce healthcare utilization. The results of the logistic regression model show that children in a low-income household tend to refrain from healthcare utilization in both grades. They also find that eighth grade children living in municipalities whose coinsurance rate is set to 30 percent are about twice as likely to refrain from healthcare utilization, compared to those living in municipalities with zero coinsurance rate.

In addition, the empirical studies using panel data for a broader area include Yuda et al. (2022), Iizuka and Shigeoka (2021, 2022), and Kang et al. (2022). Yuda et al. (2022) uses the NHI claims data for all 17 municipalities in Fukui Prefecture to examine the effect of the subsidy programs on children's healthcare utilization, but their price elasticities are small. Iizuka and Shigeoka (2022) uses the HIS claims data to examine the effects of the subsidy programs on outpatient use and expenditure by children in 294 municipalities in 6 prefectures in the Tokyo metropolitan district. As a result of DD estimation with fixed effects, they find that zero price significantly increases healthcare utilization and its costs. Iizuka and Shigeoka (2021) uses the same data to compare the effect of eligibility (free of copayments) with that of exclusion from the subsidy program (existence of copayments). The results of DD estimation with fixed effects reveal that eligibility significantly increases healthcare use and the exclusion decreases healthcare use, as the theory suggests. In addition, the impact of the latter is much larger than that of the former, and that the demand response differs depending on the direction of the price change. Kang et al. (2022) uses the four nationally representative repeated cross-sectional datasets in the 1990s to examine the initial effects of the municipal subsidy program on children's healthcare utilization and health. The results using the 33 municipalities with large populations show that the subsidy programs increase inpatient utilization for infants aged 0 years, significantly improve subjective health, and contribute to a 0.79/1,000 reduction in the infant mortality rate.

III. Impact of sharp declines in coinsurance rates on healthcare utilization and health of the elderly

III-1. Background

The empirical studies examining the effect of a sharp decline in the coinsurance rate at age 70 reviewed in Section II-2 have some analytical problems. Specifically, the studies using claims data have difficulty in taking into account detailed individual and household attributes because the claims data do not contain the individual's health outcome, income, education, and family member's characteristics that would influence the demand for healthcare utilization and health. Other recent studies using the RDD method only use the samples with certain attributes, which means that their results may be difficult to interpret as a general effect. In this section, I discuss the robustness of these results by using individual panel data of the Japanese elderly with rich information on individual attributes. In particular, estimating income effects could provide useful policy implication for the revision of increase in the coinsurance rates from 10 percent to 20 percent for the elderly above a certain income level implemented in October 2022.

III-2. Data and empirical strategy

The data used in this analysis are the first to fourth waves of the JSTAR, which is a comprehensive panel survey of Japanese middle-aged and older adults, jointly conducted by the Research Institute of Economy, Trade and Industry, Hitotsubashi University, and the University of Tokyo[17]. In 2007, the JSTAR sampled five municipalities (with the sample size and prefecture in parentheses): Adachi-Ku (N = 868, Tokyo), Kanazawa City (N = 1,011, Ishika-

[17] See Ichimura, et al. (2009). In addition, part of this subsection is based on Yuda and Lee (2016) and Chen et al. (2022).

wa), Sendai City (N = 908, Miyagi), Shirakawa Town (N = 806, Gifu), and Takikawa City (N = 570, Hokkaido). In 2009, the JSTAR added two further cities, Naha City (N = 922, Okinawa) and Tosu City (N = 645, Saga), and in 2011, another three cities, Chofu City (N = 567, Tokyo), Tondabayashi City (N = 517, Osaka), and Hiroshima City (N = 1,100, Hiroshima), were added on the sampling areas of 10 municipalities in total. Although the JSTAR is not a nationwide random sampling survey, the survey areas are well geographically located across Japan. Respondents are individuals aged 50 to 75 years, randomly selected from the Basic Resident Registers in each municipality. The average (minimum and maximum range) response rate across all municipalities is 61.3 percent (45.9 percent to 87.8 percent) for the baseline survey and 87.7 percent (69.4 percent to 96.4 percent) for the follow-up surveys.

The empirical strategy in my analysis is the RDD method with age 70 years and 0 months as the threshold. The regression equation is:

$$Y_{ia} = f(a) + \beta \cdot Post70_{ia} + X'_{ia}\gamma + u_{ia} \qquad (1).$$

Y_{ia} is the monthly outpatient healthcare expenses of individual i at age in month a[18]. Note that because the healthcare cost information in the JSTAR is the self-reported average monthly out-of-pocket expense, Y is calculated by dividing it by the coinsurance rate of the public health insurance applied at time a and multiplying it by the average monthly outpatient visits in the past year. This measure may cause a measurement error in Y, which makes the estimated parameters less efficient, compared with those obtained by the administrative data such as claims data. $f(a)$ assumes the quadratic time trend of month age a, following Shigeoka (2014) and Fukushima et al. (2016). *Post70 is* a dummy variable that takes one for individuals aged 70 or older, and β is the average treatment effect (precisely, LATE) in the RDD. X contains not only basic individual characteristics such as age and sex (male is a reference) and local and yearly fixed effects but also those not considered in the previous studies, such as education (high school graduates or less), marital status, number of persons living together, respondent's income, and the amount of household financial assets.

In addition, I also estimate the following regression equation (2) to investigate the effects on several health outcomes H that are not focused on in most of the previous studies.

$$H_{ia} = f(a) + \beta \cdot Post70_{ia} + X'_{ia}\gamma + u_{ia} \qquad (2).$$

There are nine health indicators here: subjective poor health, activities of daily living, grip strength, poor mental health, lifestyle-related diseases, chronic diseases, nonstandard BMI (body mass index), artificial dentures, and mastication. Subjective poor health is a dummy variable that takes one for "poor" and "very poor" subjective health conditions. Activities of daily living is a dummy variable that takes one if the respondent has one or more difficulties in daily activities such as walking, getting up and down, going up and down, and carrying. Grip strength is the result of the grip strength test conducted in the personal interview. A dummy variable for poor mental health takes one if the respondent suffers from some depressive symptoms, which is based on the total Center for Epidemiologic Studies

[18] The JSTAR also includes questions on inpatient and long-term care use (Yuda and Lee, 2022) and dental use (Ando and Takaku, 2016), but I do not focus on the effects on this care utilization. This is because these questions ask about the sum of healthcare use and their total costs in the past year and the information on average monthly use is unavailable.

Depression Scale (CES-D) score exceeding 16 points out of 60 in total. Lifestyle-related diseases is a dummy variable that takes one if the respondent has one or more of the following diseases: hypertension, dyslipidemia, or diabetes based on the definition of the MHLW, and a chronic diseases dummy variable further includes heart diseases, stroke, chronic lung diseases, or joint disorders. Nonstandard BMI is a dummy variable that takes one for a respondent with a BMI of below 18 or above 25. Artificial dentures and mastication are proxy variables for oral function. Artificial dentures take one if the respondent reports to use dentures, and mastication takes one for individuals who has difficulty chewing, suggesting limited nutritional intake through eating. Except for grip strength, because the higher the value of health indicators stands for the poorer the health status, sharp decline in the coinsurance rate has a positive health effect when β is significantly and negatively estimated.

The sample consists of individuals aged 65 to 74 but does not include those who are subject to the high-cost medical expenses benefit (*kogaku ryoyo-hi seido*). This benefit subsidizes 99% of the monthly out-of-pocket expenses above the maximum amount. The maximum amount depends on age and income level and is 80,100 yen for those under age 70 and 12,000 yen for those over age 70. For those below a certain income level, all out-of-pocket expenses above the maximum amount are subsidized. This is because other thresholds make it difficult to estimate the price elasticity and because the patients with high medical expenses are presumed to be more seriously ill, and their price elasticity is expected to be small. The descriptive statistics of the main variables are summarized in Table 6. The average outpatient expenditure is 6,636 yen, the consultation rate is 27.0 percent (=1,598/5,924), and the average patient's outpatient expenditure is 24,600 yen per month. It can also be found that the consultation rate, outpatient expenditures, and health indicators other than nonstandard BMI worsen when the age exceeds 70 years.

Table 6. Descriptive statistics

Sample	All			Under 70			Over 70		
	N	mean	std. dvi	*N*	mean	std. dvi	*N*	mean	std. dvi
Monthly healthcare utilization (1,000 JPY)									
Outpatient expenditures	5,924	6.636	18.473	3,107	4.835	14.766	2,817	8.622	21.674
Outpatient expenditures (patients only)	1,598	24.600	28.696	798	18.826	24.208	800	30.359	31.542
Health outcomes									
Subjective poor health (= 1)	3,209	0.089	0.284	1,701	0.075	0.263	1,508	0.104	0.306
Activities of daily living (= 1)	3,338	0.170	0.376	1,771	0.130	0.337	1,567	0.214	0.411
Grip strength (kg)	3,089	29.808	7.477	1,633	30.483	7.699	1,456	29.050	7.146
Poor mental health (= 1)	2,797	0.137	0.344	1,514	0.127	0.333	1,283	0.150	0.357
Lifestyle-related diseases (= 1)	3,060	0.540	0.498	1,604	0.522	0.500	1,456	0.560	0.497
Chronic diseases (= 1)	3,060	0.613	0.487	1,604	0.592	0.492	1,456	0.637	0.481
Nonstandard BMI (= 1)	3,316	0.280	0.449	1,762	0.280	0.449	1,554	0.281	0.450
Artificial denture (= 1)	2,752	0.529	0.499	1,486	0.487	0.500	1,266	0.579	0.494
Mastication (= 1)	3,338	0.043	0.202	1,771	0.030	0.172	1,567	0.056	0.230
Individual attributes									
Female (= 1)	3,341	0.289	0.454	1,773	0.301	0.459	1,568	0.276	0.447
Higher education (= 1)	3,341	0.235	0.424	1,773	0.266	0.442	1,568	0.200	0.400
Marital status (= 1)	3,341	0.840	0.366	1,773	0.836	0.370	1,568	0.846	0.361
Number of cohabiters (persons)	3,341	1.548	0.890	1,773	1.556	0.893	1,568	1.539	0.887
Respondent's income [1]	3,341	5.151	1.310	1,773	5.188	1.279	1,568	5.109	1.344
Household financial assets [1]	3,341	4.210	3.278	1,773	4.188	3.272	1,568	4.236	3.286
Individuals (All/patients)	2,883/1,297			1,995/ 707			1,764/ 704		

Note: (1) the logarithm of ten thousand yen

III-3. Estimation Results

III-3-1. Effects on healthcare utilization

Table 7 presents the estimation results of equation (1)[19]. The left-hand side reports results for utilization choice (extensive margin) and the right-hand side for the patient's utilization (intensive margin). For each sample, column (1) shows the results that I regress only on *Post70*, I additionally control for regional and yearly fixed effects in column (2), and in column (3), the models control for observable individual attributes. Because the elderly are noticed in advance that the coinsurance rate declines at the age of 70, they may decrease their visits just before their birthday and overutilize immediately after. Although such be-

Table 7. RDD estimation results of the effects of sharp decline in patient cost sharing on outpatient utilization for the elderly

Utilization	Extensive margin				Intensive margin			
Model	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
(i) All	9.555***	9.722***	13.300***	6.540*	37.815***	40.121***	48.332***	19.476**
	(3.225)	(3.221)	(5.016)	(3.720)	(10.888)	(10.410)	(12.382)	(8.503)
ε	−0.247	−0.251	−0.306	−0.148	−0.251	−0.266	−0.313	−0.124
N	5,924	5,924	3,341	3,211	1,598	1,598	1,010	975
(ii) Males	10.201***	10.737***	15.560**	9.725**	42.300***	41.013***	53.263***	20.774*
	(3.914)	(3.822)	(6.336)	(4.200)	(12.878)	(12.458)	(14.072)	(10.942)
ε	−0.260	−0.273	−0.333	−0.206	−0.281	−0.272	−0.337	−0.129
N	4,041	4,041	2,374	2,289	1,107	1,107	746	717
(iii) Females	7.422*	5.539	5.808	−4.544	33.793*	41.653***	36.919	4.805
	(4.493)	(4.024)	(6.263)	(4.725)	(17.406)	(14.692)	(22.997)	(10.361)
ε	−0.198	−0.148	−0.161	0.122	−0.224	−0.277	−0.255	−0.033
N	1,883	1,883	967	922	491	491	264	258
(iv) Lower education	7.472**	7.290**	8.324*	2.727	30.350***	28.599***	22.960**	4.713
	(3.118)	(3.062)	(4.461)	(3.878)	(10.059)	(9.506)	(11.187)	(9.003)
ε	−0.197	−0.192	−0.204	−0.065	−0.207	−0.195	−0.156	−0.032
N	4,611	4,611	2,566	2,446	1,267	1,267	778	749
(v) Higher education	15.464	15.992	18.092	21.251**	74.181**	103.250***	152.460***	90.526***
	(11.048)	(10.544)	(15.079)	(9.134)	(36.035)	(28.107)	(16.395)	(21.488)
ε	−0.375	−0.388	−0.355	−0.414	−0.451	−0.628	−0.883	−0.515
N	1,289	1,289	785	765	326	326	232	226
(vi) HIS	12.496	15.406*	11.726	8.890	33.019**	24.385**	37.632	−44.534**
	(9.944)	(9.292)	(10.600)	(10.032)	(15.019)	(12.147)	(44.600)	(9.060)
ε	−0.383	−0.473	−0.324	−0.245	−0.237	−0.175	−0.272	0.321
N	381	381	226	215	99	99	67	63
(vii) HIA	19.949*	20.666*	33.020**	5.125	48.368***	45.315***	68.584***	43.922**
	(11.519)	(11.408)	(13.690)	(11.127)	(18.635)	(15.970)	(17.818)	(18.402)
ε	−0.386	−0.400	−0.640	−0.098	−0.337	−0.316	−0.504	−0.320
N	996	996	611	584	368	368	242	233
(viii) NHI	6.456*	5.564	7.012	5.231	33.295**	35.560***	44.270***	21.327**
	(3.694)	(3.658)	(5.172)	(3.958)	(15.289)	(13.309)	(16.060)	(10.379)
ε	−0.175	−0.151	−0.166	−0.121	−0.210	−0.224	−0.261	−0.124
N	4,014	4,014	2,262	2,181	979	979	615	596
Local and year fixed effects	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Individual attributes	No	No	Yes	Yes	No	No	Yes	Yes

Notes: Upper values are estimated coefficients β and robust standard errors clustered by individuals are in parentheses. ε is the price elasticity and N is the number of observations. ***, **, and * stand for statistical significance at the 1%, 5%, and 10% levels, respectively. All models include constant term.

[19] Graphical estimation results using the RDD are summarized in Appendix B. It should be noted that several points are difficult to interpret because they are preliminary results due to space and time constraints.

haviors are rational in economics, it is not appropriate to interpret this short-term fluctuation as a true policy effect. Following Fukushima et al. (2016), the results in column (4) therefore are the *donut hole* estimation that excludes the two months each before and after age 70 years 0 months in order to remove the effects of short-term fluctuations. Here, I mention the results of the price elasticity in columns (3) and (4) controlling for individual attributes.

I first focus on the results that are comparable to previous studies. As for the effect on extensive margin, the results for the HIS sample correspond to those of Fukushima et al. (2016). Although there are no significant effects except for column (2) probably due to the small sample size, the price elasticity, defined as $\varepsilon = \frac{\hat{\beta}}{\mathrm{E}[Y \mid age < 70]} \times \frac{0.1}{0.1 - 0.3}$, is -0.324, which is almost twice as that in Fukushima et al. (2016). The overall price elasticity is estimated as -0.306, which is almost as that of the HIS sample above. Other results that correspond to Shigeoka (2014) show that the price elasticity with respect to intensive margin is estimated as -0.313, which is as large as that of Shigeoka (2014). These results are higher than those of previous studies using more accurate information on healthcare utilization, but it is consistent that our elasticities of extensive and intensive margins are similar. In addition, the price elasticity of the *donut hole* estimation in column (4) ranges from -0.148 to -0.124, which is approximately half of the above price elasticities, and they are quite close to those of Shigeoka (2014) and Fukushima et al. (2016).

Table 7 also presents the treatment effects by attributes. The price elasticities of intensive and extensive margins for males are larger than those of females. In addition, the estimates for males are statistically significant but almost insignificant for females. By education level, price elasticities of intensive and extensive margins for those with higher education are larger than those for the elderly with lower education. Although all estimated parameters except for *donut hole* estimation for those with lower education are statistically significant, only a few parameters are significant in the extensive margin. By insurance type, the price elasticity of the extensive margin for the HIA is only significantly negative, but all elasticities are significant for the intensive margin. However, this elasticity for the HIA is larger than that for the NHI, and that for the HIS is positive for some reason.

In sum, although the estimated elasticities vary depending on the sample, it is found that the price elasticity for healthcare services is generally low even after controlling for various individual and household attributes.

III-3-2. Health effects

Tables 8 summarizes the effect of the sharp decline in coinsurance rate on the health of the elderly with controlling for various individual and household attributes. Panel A summarizes the results using the data over the entire period, and Panel B presents those of *donut hole* estimation.

In Panel A, a sharp decline in coinsurance rate significantly improves activities of daily living and mental health after age 70. More specifically, significant improvement in activities of daily living is observed for the insured of the HIA, women, and lower educated elderly. In addition, significant improvement in mental health is observed for the insured of the HIS and NHI and lower educated elderly. Moreover, other significant improvement is found in on lifestyle-related and chronic diseases among the insured of the HIS and NHI, on non-standard BMI and masticatory function among the HIS members, and dentures use for the lower educated elderly. On the other hand, the results of the *donut hole* estimation are not consistent with the above for a few reasons. Overall, the effect of a sharp decline in coinsurance rate significantly improves lifestyle-related and chronic diseases. Specifically, significant improvements of these diseases are found for the insured of the HIS and the HIA and lower educated elderly. Significant improvement in lifestyle-related diseases is also found for both genders and higher educated elderly. In addition, improved health effects on subjective poor health for the HIS insured, on activities of daily living and on nonstandard BMI for the HIA insured. In addition, health deterioration of activities of daily living, which is inconsistent with the above result. More specifically, health deterioration on activities of daily living is found for females, lower educated elderly, and the insured of the HIS and the NHI. In addition, there are several health deteriorations in subjective poor health for fe-

Table 8. Health effects of sharp decline in patient cost sharing for the elderly
(A) Full sample

Outcomes	Subjective poor health	Activities of daily living	Grip strength	Poor mental health	Lifestyle-related diseases	Chronic diseases	Nonstandard BMI	Artificial denture	Mastication
(i) All	0.014	−0.119*	0.712	−0.139*	−0.136	−0.118	0.027	−0.081	−0.040
	(0.057)	(0.072)	(0.942)	(0.077)	(0.103)	(0.100)	(0.090)	(0.127)	(0.040)
ε	−0.023	0.114	−0.003	0.137	0.033	0.025	−0.012	0.021	0.165
N	3,209	3,338	3,089	2,797	3,060	3,060	3,316	2,752	3,338
(ii) Males	−0.022	0.048	0.553	−0.105	−0.199	−0.090	0.089	0.000	−0.019
	(0.066)	(0.069)	(1.334)	(0.090)	(0.125)	(0.112)	(0.101)	(0.154)	(0.052)
ε	0.034	−0.052	−0.002	0.112	0.046	0.018	−0.038	0.000	0.070
N	2,271	2,373	2,187	2,009	2,177	2,177	2,357	1,964	2,373
(iii) Females	0.046	−0.400***	1.253	−0.192	−0.063	−0.176	−0.062	−0.134	−0.047
	(0.105)	(0.137)	(1.289)	(0.137)	(0.161)	(0.171)	(0.144)	(0.191)	(0.039)
ε	−0.095	0.303	−0.007	0.159	0.016	0.041	0.030	0.034	0.258
N	938	965	902	788	883	883	959	788	965
(iv) Lower education	−0.020	−0.144*	0.837	−0.162**	−0.139	−0.181	0.070	−0.253*	−0.038
	(0.069)	(0.080)	(1.083)	(0.077)	(0.124)	(0.121)	(0.104)	(0.144)	(0.046)
ε	0.033	0.130	−0.003	0.159	0.033	0.038	−0.031	0.062	0.145
N	2,460	2,555	2,365	2,124	2,326	2,326	2,536	2,125	2,555
(v) Higher education	0.011	0.070	0.008	0.041	−0.054	0.212	−0.091	0.176	0.009
	(0.062)	(0.123)	(1.845)	(0.124)	(0.249)	(0.245)	(0.220)	(0.202)	(0.051)
ε	−0.018	−0.081	0.000	−0.040	0.013	−0.045	0.041	−0.053	−0.046
N	749	783	724	673	734	734	780	627	783
(vi) HIS	0.059	−0.107	−7.778	−0.626**	−1.353***	−1.569***	−0.615**	0.410	−0.382*
	(0.125)	(0.122)	(5.220)	(0.267)	(0.344)	(0.316)	(0.281)	(0.292)	(0.223)
ε	−0.119	0.120	0.030	0.776	0.309	0.324	0.336	−0.130	1.462
N	214	226	216	185	208	208	226	192	226
(vii) HIA	0.040	−0.435***	0.979	−0.051	0.059	0.021	−0.075	−0.338	−0.072
	(0.146)	(0.136)	(3.035)	(0.075)	(0.216)	(0.214)	(0.169)	(0.245)	(0.107)
ε	−0.076	0.626	−0.004	0.052	−0.014	−0.005	0.032	0.091	0.286
N	585	611	547	536	570	570	607	479	611
(viii) NHI	−0.008	−0.087	0.850	−0.196*	−0.236*	−0.224*	0.092	−0.075	0.001
	(0.063)	(0.089)	(1.951)	(0.105)	(0.140)	(0.134)	(0.118)	(0.153)	(0.047)
ε	0.012	0.075	−0.004	0.188	0.057	0.047	−0.040	0.018	−0.002
N	2,180	2,261	2,113	1,877	2,070	2,070	2,246	1,866	2,261

(B) Donut hole estimation

Outcomes	Subjective poor health	Activities of daily living	Grip strength	Poor mental health	Lifestyle-related diseases	Chronic diseases	Nonstandard BMI	Artificial denture	Mastication
(i) All	0.044	0.125*	0.732	0.083	−0.327**	−0.237*	−0.063	−0.002	−0.018
	(0.061)	(0.073)	(1.075)	(0.085)	(0.127)	(0.122)	(0.085)	(0.121)	(0.045)
ε	−0.073	−0.120	−0.003	−0.082	0.078	0.050	0.028	0.001	0.079
N	3,209	3,338	3,089	2,797	3,060	3,060	3,316	2,752	3,338
(ii) Males	−0.067	0.068	1.190	0.042	−0.385**	−0.236	−0.103	0.098	0.048
	(0.071)	(0.081)	(1.483)	(0.099)	(0.157)	(0.145)	(0.103)	(0.134)	(0.053)
ε	0.104	−0.073	−0.004	−0.045	0.089	0.048	0.044	−0.025	−0.187
N	2,271	2,373	2,187	2,009	2,177	2,177	2,357	1,964	2,373
(iii) Females	0.315***	0.256*	−1.754	0.143	−0.337*	−0.266	0.071	−0.009	−0.113
	(0.086)	(0.142)	(1.204)	(0.143)	(0.185)	(0.191)	(0.145)	(0.207)	(0.090)
ε	−0.655	−0.198	0.010	−0.118	0.088	0.062	−0.035	0.002	0.609
N	938	965	902	788	883	883	959	788	965
(iv) Lower education	0.027	0.065	1.376	0.020	−0.275*	−0.231*	−0.105	−0.046	0.024
	(0.073)	(0.094)	(1.419)	(0.100)	(0.141)	(0.140)	(0.105)	(0.134)	(0.046)
ε	−0.046	−0.059	−0.006	−0.020	0.065	0.049	0.046	0.011	−0.100
N	2,460	2,555	2,365	2,124	2,326	2,326	2,536	2,125	2,555
(v) Higher education	−0.054	0.272*	0.422	0.367***	−0.330*	−0.129	0.030	−0.128	−0.141
	(0.093)	(0.160)	(2.142)	(0.129)	(0.193)	(0.234)	(0.167)	(0.233)	(0.126)
ε	0.085	−0.314	−0.002	−0.363	0.080	0.028	−0.014	0.039	0.678
N	749	783	724	673	734	734	780	627	783
(vi) HIS	−0.062**	0.387***	0.309	0.149	−0.597***	−1.287***	0.341*	0.386**	0.076***
	(0.029)	(0.142)	(2.705)	(0.169)	(0.184)	(0.181)	(0.198)	(0.170)	(0.024)
ε	0.123	−0.424	−0.001	−0.196	0.138	0.268	−0.187	−0.120	−0.353
N	214	226	216	185	208	208	226	192	226
(vii) HIA	0.099	−0.423**	2.297	0.093	−1.203***	−1.059***	−0.568***	0.091	0.010
	(0.112)	(0.205)	(3.105)	(0.236)	(0.181)	(0.172)	(0.215)	(0.248)	(0.036)
ε	−0.189	0.623	−0.009	−0.090	0.281	0.230	0.240	−0.025	−0.040
N	585	611	547	536	570	570	607	479	611
(viii) NHI	0.042	0.153*	0.394	0.097	−0.142	−0.022	0.009	−0.008	−0.004
	(0.065)	(0.085)	(1.955)	(0.098)	(0.149)	(0.142)	(0.110)	(0.143)	(0.053)
ε	−0.069	−0.133	−0.002	−0.094	0.034	0.005	−0.004	0.002	0.020
N	2,180	2,261	2,113	1,877	2,070	2,070	2,246	1,866	2,261

Notes: Upper values are estimated coefficients β and robust standard errors clustered by individuals are in parentheses. ε is the price elasticity and N is the number of observations. ***, **, and * stand for statistical significance at the 1%, 5%, and 10% levels, respectively. All models include individual attributes, local and yearly fixed effects, and constant term.

males, in poor mental health for higher educated elderly, and on nonstandard BMI, artificial dentures use, and mastication for the HIS insured. The one important finding is that these estimated elasticities are generally low, likely with the previous results on outpatient utilization.

IV. Conclusion

This paper summarizes the economic studies that examine the effect of changes in patient cost sharing on healthcare utilization and health using Japanese data. In addition, I use the JSTAR to conduct empirical exercises to confirm the robustness of the effect of the sharp reduction of coinsurance rate from 30 percent to 10 percent at age 70. Including my empirical results, the price elasticity of healthcare is generally low, and changes in patient cost sharing generally do not have a large impact on health.

The policy revision which raises the coinsurance rate to 20 percent for the elderly with income above a certain level from October 2022 was the subject of much discussion during the deliberation process of the bill in 2021. In addition, after the enactment of the bill, there are several discussions from the viewpoints of domestic trends (Endo, 2021), political background (Innami, 2021), and international comparison (Okubo, 2021), as well as discussions on the future vision of the sustainability of the elderly care system (Oguro, 2021[20]) and medical fee system (Nakamura, 2021), and the effects on households including regressivity (Hashimoto and Tokunaga, 2021). However, the 2022 revision does not apply to all of the elderly aged 75 and over but those with income above a certain level, who are estimated to be approximately 20 percent of the elderly aged 75 and over. Because there is a positive correlation between income level and health status, the eligible elderly are expected to be in better health. Based on this background and the empirical results of the economic research focused on in this paper, it can be inferred that the increase in the coinsurance rate is not expected to reduce healthcare utilization among the elderly, *ceteris paribus*. Even if it did, it would be a very small effect. This suggests that the health of the elderly is not expected to be significantly impaired by this revision. In the near future, some researchers will attempt to examine the impact of this 2022 revision, but given the current socioeconomic situations, it will be a very difficult challenge to accurately estimate the causal effect of this revision. Specifically, it is necessary to distinguish the policy effect with the other effects of huge social shocks that highly influence our daily lives: voluntary refraining from healthcare utilization due to the COVID-19 pandemic since 2020 (Kumagai, 2021; Ii and Watanabe, 2022; Suzuki and Yuda, 2022) and serious inflation due to the international situations (Teikoku Databank, 2022; Ministry of Internal Affairs and Communications, 2022). The estimates that should be examined in policy evaluation analysis are causal effects holding other conditions constant (*ceteris paribus*), and it is important to note and carefully interpret that these socioeconomic conditions may mislead us about the causal effect of policy enacted at the same time.

In recent years, research on the relationship between the social environment and population health and healthcare utilization has become an advanced and interdisciplinary field. It is important to accumulate scientifically reliable evidence one by one and to bring together cross-disciplinary knowledge in order to evaluate policies.

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Appendix A: The two-part (hurdle) model

Healthcare utilization can be divided into two parts with different characteristics. One is utilization choice, in which patient decision-making dominates (extensive margin), and the other is the patient's actual utilization, which primarily depends on physician discretions (intensive margin). When estimating the effect of policy and environmental changes on healthcare utilization, it is necessary to identify how each of these different types of utilization is affected. For example, the effect of changes in patient cost sharing, which is focused on in this paper, will have a large effect on extensive margin because consumer preferences primarily dominate. Also, medical fee revisions related to physicians' earnings will affect the intensive margin because of the amount of healthcare supplied by physicians with professionally medical knowledge. A two-part (TP) model, sometimes called a hurdle model, which explicitly divides these two parts is often used in the analysis of healthcare utilization.

When using aggregate data, healthcare expenditure per capita is decomposed into two parts by using the number of claims ($Claims_{it}$):

$$\frac{HCE_{it}}{POP_{it}} = \frac{Claim_{it}}{POP_{it}} \times \frac{HCE_{it}}{Claim_{it}} \quad \text{(A1)},$$

where, HCE_{it} is the aggregated healthcare expenditure and POP_{it} is the number of populations or of insured persons in a region i in year t. Because the claims are the bills from medical institutions to insurers for reimbursement for insured medical treatments provided to patients, the number of claims can be nearly regarded as the number of patients who visit a medical institution. Therefore, the first term, the ratio of the number of claims to the number of populations, represents the consultation rate (extensive margin), and second term, the healthcare costs per claim, can be interpreted as the healthcare expenditure per patient (intensive margin).

When using micro data, for example, in the case of claims data with its master data, it is common to use the sample including both patients and non-users to estimate utilization choice by a linear probability model or a binary choice model as the first part. Regarding the second part, the patient's actual utilization is estimated by a linear model or a count data model for the patients. More precisely, let y_{it} be the dependent variable, such as healthcare expenditure, the number of days of doctor visits, and length of hospital stay, for individual i in year t and x_{it} be the vector of individual attribute, the model can be written as:

$$g_{it}(y_{it} \mid \mathbf{x}_{it}) = \begin{cases} \{1 - \Pr(y_{it} > 0 \mid \mathbf{x}_{it})\} \times f_0(0 \mid y_{it} = 0, \mathbf{x}_{it}) & \text{if } y_{it} = 0 \\ \Pr(y_{it} > 0 \mid \mathbf{x}_{it})\} \times f_+(y_{it} \mid y_{it} > 0, \mathbf{x}_{it}) & \text{if } y_{it} > 0 \end{cases} \quad \text{(A2)},$$

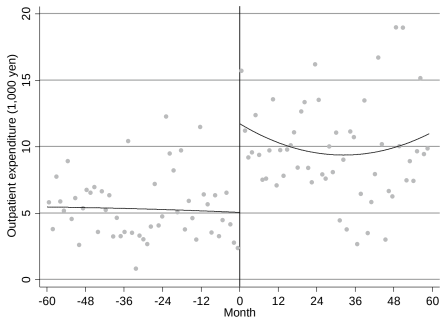
where, f_0 is the distribution of y_{it} when $y_{it} = 0$, and f_+ is the conditional distribution of y_{it} when $y_{it} > 0$. The former is the first part equation, and the latter is the second part equation, respectively.

Appendix B: Graphical estimation results for the effects of a sharp decline in co-insurance rate on healthcare utilization and health for the elderly

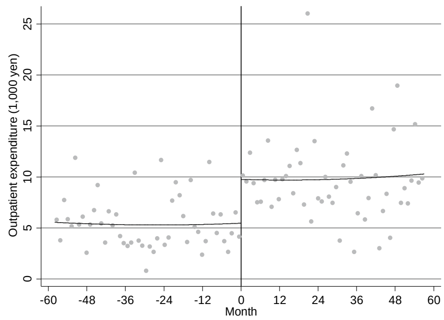
Figures B1 present the major estimation results of equations (1) and (2) by using the RDD method. The “0” on the horizontal axis indicates that the age is 70 years and 0 months. It should be noted that they are only preliminary results, as shown in footnote 19.

Figure B1. Graphical estimation results for the effects of sharp decline in patient cost sharing on outpatient utilization and health for the elderly

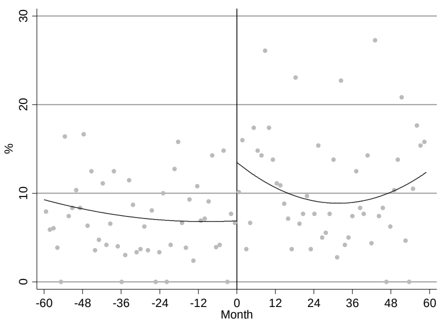
(1) Extensive margin



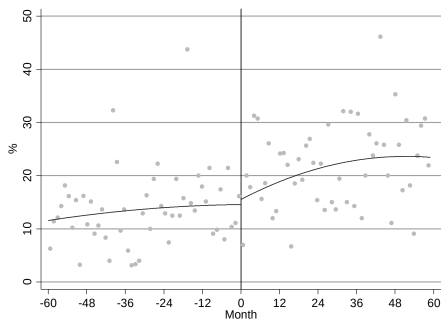
(2) Intensive margin



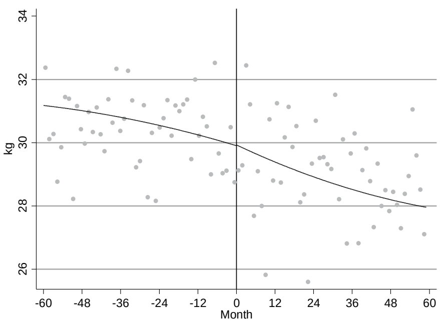
(3) Subjective poor health



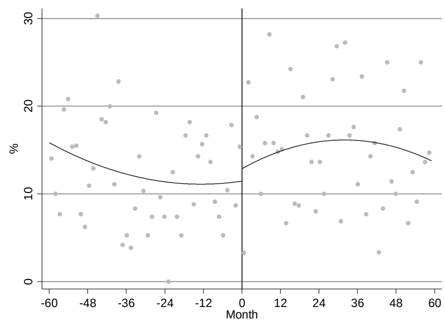
(4) Activities of daily living



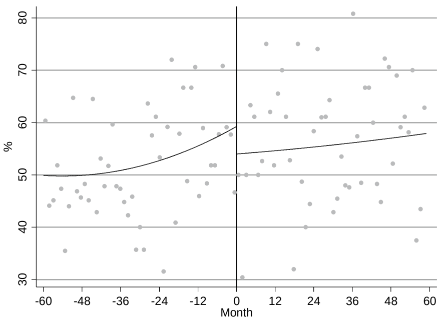
(5) Grip strength



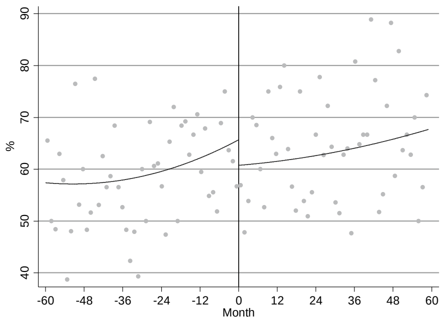
(6) Poor mental health



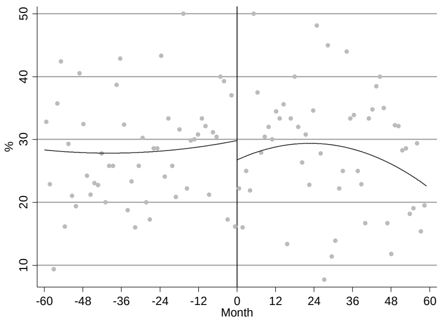
（7）Lifestyle-related diseases



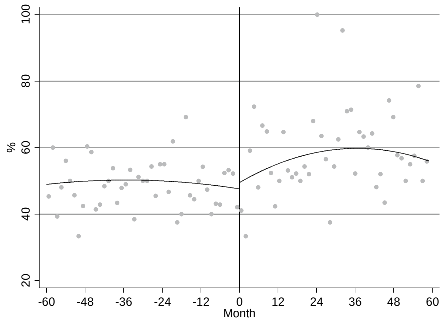
（8）Chronic diseases



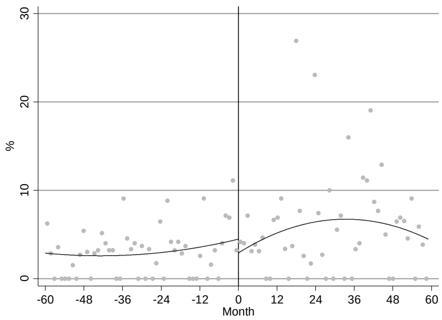
（9）Nonstandard BMI



（10）Artificial denture



（11）Mastication



Notes: The “0” on the horizontal axis indicates that the age is 70 years and 0 months.