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Who Has Benefited from Nursing Home Expansion in Japan?: The Effects of Government Supply-Side Intervention in the Elderly Care Market *

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Abstract

This study analyzes the relation between the labor force participation of caregivers and the provision of informal in-home elderly care. In Japan, the national government both regulates the market entry of nursing home suppliers and intervenes in the supply side of the eldercare market. Using exogenous variations in this supply side intervention, our analysis finds that the Japanese policy of expanding nursing homes has increased the labor force participation of female workers with low opportunity costs in the labor market while simultaneously reducing their provision of informal care. As the per capita expense of nursing home care is higher than the wage income of most non-regular female workers who tend to provide the bulk of informal in-home care, one may reasonably conclude that the capacity of public nursing homes in Japan has expanded excessively, putting unnecessary pressure both on the Japanese budget and the personal provision of eldercare services.

JEL Classification Numbers: H51, I18, J14, J18, J22

Keywords: long-term care insurance system, labor supply, medical expenditure, regulation

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1 Introduction

Many developed countries have been facing the problems of a decreasing birthrate and aging population, and as the population ages, the cost of social security and social welfare increases, placing pressure on the country's budget. One of the main concerns of countries with aging populations is the increasing cost of eldercare, and this has prompted countries such as Germany and Korea to reform their nursing care systems. In Germany, a mandatory and universal system of long-term care insurance (LTCI) was implemented in 1995 (Schulz (2010)), and a national mandatory elderly LTCI was introduced in Korea in 2008 (Kwon (2009), Won (2013) and Chul et al. (2015)).

Within the research community, interest in both the demand and supply sides of the elderly care market has been growing in the United States and Europe since the 1980s. As for the demand side, one important topic is the effect of informal care on labor supply. However, as most of the literature has until recently focused not on macro features such as government policy or institutional change, but instead on household demographics such as family structure and parental health as instrumental variables, there has been little discussion until recently about the effect of government policy on the eldercare market. [1] However, this study analyzes the effect of informal care on the labor supply for eldercare by utilizing institutional variation caused by a policy change in the capacity of nursing homes aimed at reducing the burden on informal caregivers in Japan. In this way, we can identify how government policy influences female workers, thus providing insights into the effects of government intervention beyond what is available in the literature. [2]

As described by Tamiya et al. (2011), LTCI was implemented in Japan in 2000. Two important features of the Japanese care system relevant to our investigation are that there are three types of public nursing homes in Japan (Tokuyo, Roken and Designated Medical Long-Term Care Sanatoriums), and the supply of all three types is determined not by the market but by government regulation. Our analysis uses exogenous changes in public nursing

[1] Some recent studies have investigated the implications of nursing care policy (Fu et al. (2017), Løken et al. (2017), Geyer and Korfhage (2018)).

[2] This point will be discussed in more detail in section 2.

home capacity resulting from government intervention on the supply side of the elderly care market to estimate the demand side causal effect of informal care on the labor supply. To the best of our knowledge, this is the first study to use the exogenous variation of nursing home supply as an instrument to estimate the effect of informal care for the elderly on the labor supply. [3] In addition, this variation also provides insight into how government policies to reduce the burden of caregivers influences female workers.

According to our results, the expansion of public nursing care homes in Japan has reduced the provision of informal care by non-regular female workers and thus has helped increase their official labor participation. However, does this policy make sense from a public finance perspective? Following the literature investigating the public finance implications of nursing care policy, [4] we examine the expense incurred by the Japanese government in operating nursing homes relative to that of in-home service per capita. Since non-regular female workers in Japan earn at the lower end of the wage scale, the per capita cost of operating nursing care homes is higher than providing in-home service. Therefore, we expect that a shift in government policy away from expanding public nursing homes and towards promoting the use of in-home care service would lead to a substantial reduction in the cost of eldercare, while also potentially providing more personalized individual care.

The remainder of this paper is organized as follows: section 2 reviews the literature and section 3 describes the data. Following an explanation of the long-term care insurance (LTCI) system in Japan in section 4, the estimation methods are described in section 5. Sections 6 and 7 present and discuss the results, and section 8 concludes the paper and identifies areas for future research.

[3] Kondo (2016) also utilizes the exogenous variation of nursing home capacity but does not estimate the effect of informal care on labor supply, instead including capacity as an explanatory variable and directly estimating its effect on labor supply, which provides less comprehensive information about the effects of government policy. Meanwhile, other studies such as Shimizutani et al. (2008), Sugawara and Nakamura (2014), and Fukahori et al. (2015) analyze the effect of the introduction of LTCI in Japan on the labor supply, but also do not directly estimate the effect of informal care on the labor supply.

[4] Geyer et al. (2015) analyzes the indirect fiscal effect of a counterfactual reform whereby subsidies for informal care are replaced by increased subsidized formal care, and Kim and Lim (2015) discusses the possibility of reducing medical expenses by appropriately setting policy around home and facility care.

2 Literature Review

Since the 1980s, the elderly care market has been analyzed from both supply and demand sides. On the supply side, Nyman (1985, 1988), Gertler (1989, 1992), Cohen and Spector (1996), Grabowski (2001) analyzes the relationship between Medicaid reimbursement and the quality of nursing home care. There are also related studies (Nyman (1994), Norton (1992), Ettner (1993), Grabowski et al. (2008), and Ching et al. (2015)). On the demand side of the eldercare market, which is the focus of this study, one of the central topics has been the effect of informal care on the labor supply. This extensive literature has focused on the effect of informal care provision on labor supply (Wolf and Soldo (1994), Carmichael and Charles (1998), Leigh (2010), Michaud et al. (2010), Lilly et al. (2010)) and opportunity cost of informal cares (Carmichael and Charles (2003), Heitmueller and Inglis (2007)). Also see Hoerger et al. (1996), Carmichael et al. (2010). [5]

Since 2000, the focus of studies on the effect of informal care on labor supply has shifted to the issue of endogeneity in the provision of informal care and how best to control for it. Many studies have adopted an instrumental variable (IV) methodology, and Table 1 presents the instruments that have been used in the literature since 2000. As Van Houtven et al. (2013) notes, there are limitations to an IV approach when some of the instruments employed in literature are weak or have questionable exogeneity. Accordingly, some studies have adopted other techniques such as simultaneous equations or dynamic panel data methods. However, these studies are unable to identify any causal influence of exogenous variation on the provision of informal care.

As shown in Table 1, the IVs chosen for most studies to date have been demographic variables such as parental health and family structure [6] while, to our knowledge, institutional exogenous variation has not yet been utilized. In this study, we utilize the institutional exogenous variation resulting from a change in nursing care policy to identify the effect on

[5]For a thorough review of this literature, see Lilly et al. (2007) and Bauer and Sousa-Poza (2015). Additionally, while informal care has also been of great interest to the public health literature (see, for example, Tan (2000), Berecki-gisolf et al. (2008), Hassink and Berg (2011), and Trong and Brian (2014)), in this paper, we focus on the economics literature.

[6]See Crespo and Mira (2014) for a discussion of the validity of these instruments.

the provision of informal care. Additionally, when considering the behavior of an informal care provider in a household, this allows us not only to interpret the effect of government intervention on informal care, but also gain insight into how the government policy to expand nursing home care has influenced the female labor supply.

As mentioned above, the supply side of the eldercare market is regulated by the government in Japan, where an LTCI system has been in effect since 2000. There are two sources of exogenous variation that we use to estimate the effect of informal care on labor supply. First, the national government determines the number of approved public nursing homes, thus exogenously controlling the supply nationwide. However, there is also an exogenous variation of this supply of public nursing homes depending on municipality, so the availability of formal eldercare is heterogeneous among municipalities. While recent studies such as Fu et al. (2017), Løken et al. (2017), and Geyer and Korfhage (2018) have analyzed nursing care policy from a difference-in-difference methodology, within that framework, it is difficult to interpret how government policies work for caregivers in their framework. In contrast, our framework provides a direct method to understand the effect of government policies on caregivers. [7]

3 Data

The main dataset used for this study is the Japanese Study of Aging and Retirement (JSTAR), a panel survey of elderly people aged 50 or older conducted since 2007 initially by the Research Institute of Economy, Trade and Industry, Hitotsubashi University and, more recently, by the University of Tokyo. [8] JSTAR has survey counterparts in other countries

[7] Among the growing Japanese literature resulting from this 2000 policy change, many studies such as Shimizutani et al. (2008), Sugawara and Nakamura (2014), Fukahori et al. (2015) and Kondo (2016) do not estimate the direct effect of informal care on labor supply. Among those that do, such as Wakabayashi and Donato (2005), Ishii (2015), Yamada and Shimizutani (2015) and Moriwaki (2016), the exogenous supply side change in the informal care market employed in our study has not been utilized. Further, there appears to be an inconsistency in the magnitude of the effects reported in these studies. Nevertheless, a comparison of our results with those of these latter studies is provided in section A.1.

[8] See http://www.rieti.go.jp/en/projects/jstar/ for more information on JSTAR. For sampling design and other details, see Ichimura et al. (2009)

including the China Health and Retirement Longitudinal Study (CHARLS), the English Longitudinal Survey on Aging (ELSA), the Health and Retirement Study (HRS) in the US, the Korean Longitudinal Study of Aging (KLoSA), the Longitudinal Aging Study in India (LASI), and the Survey on Health, Aging, and Retirement in Europe (SHARE), and so harmonized data is generally available to coordinate with these other international datasets. [9] The JSTAR data used in this study is a panel dataset providing information about the residential area of the respondent at the municipality level and detailed information about parents' care needs and care utilization. Of the two access levels of JSTAR data, high and very high, this study uses the very high level of access which contains the full sample data including birth month and geographic information that allows us to identify the nursing home capacity for each municipality.

JSTAR provides a rich variety of variables that capture individual characteristics such as their economic and health status, family background, and social and work status and, in addition, for the elderly, JSTAR also includes respondent demographics, labor participation, informal care for parents, and the place of residence. Table 2 shows the summary statistics of the data. The survey years used in this study are 2007, 2009, 2011 and 2013, and while generally we used the Harmonized JSTAR data set, when variables were not available in the Harmonized JSTAR, we referred to the original JSTAR. [10] Additionally, for missing respondent data, we replaced the missing data with substituted values by following a method similar to the RAND HRS (Hurd et al. (2016)), as explained in section A.2.

Two other datasets used in this study were the Long-Term Care Insurance Business Status Report [11] and the Survey of Institutions and Establishments for Long-Term Care. [12] The

[9] All variables of each dataset aim to have the same items and follow the same naming conventions, and the Gateway to Global Aging Data (http://gateway.usc.edu) provides harmonized versions of data from the international aging and retirement studies (e.g., HRS, ELSA, SHARE, and JSTAR) to enable researchers to conduct cross-national comparative studies.

[10] The program code for generating the Harmonized JSTAR dataset from the original JSTAR dataset is provided by the Center for Global Aging Research, USC Davis School of Gerontology, and the Center for Economic and Social Research (CESR). Some variables in our study, such as measures of assets and income, were imputed by this code.

[11] For details on this report, see https://www.mhlw.go.jp/topics/kaigo/toukei/joukyou.html (in Japanese). The LTCI Business Status Report for 2014 was used in our study to coordinate with the JSTAR 2013 survey conducted between 2013 and 2014.

[12] See http://www.mhlw.go.jp/english/database/db-hss/siel-index.html for details on this survey.

2007, 2009, 2011, and 2014 reports from both studies were used to define the instrumental variables employed in this study, as explained more fully in section 4.1.

4 The Long-term Care Insurance (LTCI) System in Japan

4.1 Institutional Background of Nursing Care Homes in Japan

4.1.1 Demand Side: Need for Informal Care

Since the implementation of the LTCI system in 2000, all residents of Japan aged 40 and older must join the LTCI system and are eligible to receive public care services depending on their age and nursing care level. While those aged 65 and older can receive public care services with a co-payment ratio of 10 percent when they are deemed to require long-term care, those aged 40 to 64 can receive public care services with a co-payment ratio of 10 percent only for specific diseases related to aging. In this section, we explain the process of how people enter a nursing home in Japan.

The first step involves an assessment by the local government to determine whether an elderly person requires long-term care. If so, for those aged 65 or older, public care services are provided based on the required nursing care level as exemplified in Figure 2. [13]

- Step 1: Applying for care.

  A family member who finds that an elderly individual in the household has a physical problem can ask the local government to decide the nursing care level.

- Step 2: Determining level of care.

  Depending on the health condition of the elderly person and household characteristics such as the number of adults who could provide informal care, the local government

[13] We sincerely thank Hisataka Anezaki and Tetsuya Iwamoto for explaining this point. All remaining errors are our own.

determines the appropriate nursing care level. This decision provides a set of available public care service options from which an applicant can choose. For example, an applicant can use a particular nursing home if they require nursing care level 3. [14] Table 3 (Table 1 from Moriwaki (2016)) describes the various nursing care levels. [15]

More specifically, there are two steps in this stage of the nursing care level decision. The first step is automatically carried out by computer, which calculates the Standardized Time for Long-Term Care, or the expected amount of time required in nursing care. Figure 1 shows the relationship between Standardized Time for Long-Term Care and nursing care level. Note that there is no discontinuous jump after nursing care level 1. The second step relies on academic experts to assess the legitimacy of the first evaluation based on a special report from a doctor. In this report, information about the household of an applicant might be included and so the judgment about the nursing care level may be influenced by factors other than the health status of the applicant. After the nursing care level has been decided at this stage, an applicant can apply for a re-examination based on the situation of the applicant's household.

- Step 3: Meeting care manager

  At this stage, an applicant who decides to use home care will discuss their situation with a care manager who will plan the specific care service that an applicant will use.

4.1.2 Supply Side: Entry Regulations for Informal Care and Characteristics of Nursing Homes

As shown in Figure 2, in Step 2, an applicant can stay in a public nursing home when their nursing care level is above a certain level. Table 4 shows the number of facilities and the average level of nursing care provided by each of the three types of public nursing homes provided in Japan: Facility Covered by Public Aid Providing Long-Term Care to the Elderly

[14] This restriction became effective in 2015. Before then, the restriction required higher than nursing care level 1.

[15] For more information on how nursing care levels are determined, see http://www.mhlw.go.jp/topics/kaigo/nintei/gaiyo2.html) from the Japanese Ministry of Health, Labour and Welfare (in Japanese).

(Tokuyo), Long-Term Care Health Facility (Roken), and Designated Medical Long-Term Care Sanatorium. [16] Most elderly in Japan are provided nursing care in either Tokuyo or Roken facilities. Of the three types of public nursing homes, Tokuyo is the most popular because the price of nursing care is relatively low and the allowed length of stay is unlimited. Table 4 shows that the utilization rate is almost 100 percent. Roken, which are also popular, provide rehabilitation services for the elderly and so the maximum length of stay is limited to from three months to one year. The third type, the Designated Medical Long-Term Care Sanatoriums, have been phased out and are no longer commonly used to provide nursing care for the elderly. [17]

The supply of informal eldercare in Japan is restricted by two types of entry regulations. The first one determines who can provide informal care service, while the second one regulates the total capacity of public nursing homes. As for the first regulation, the Japanese government has determined that nursing homes such as Tokuyo and Roken cannot be operated by a public corporation but must be operated by a local government agency or a social welfare corporation. [18] Regarding the second regulation, the governor of a local jurisdiction is able to restrict the entry of new Tokuyo and Roken firms into the market when the total capacity exceeds the assigned number. [19]

The importance of these regulations for this study is that the supply of nursing home care is exogenously controlled by the government and independent of the demand for eldercare, which is consistently close to 100 percent. Table 4 shows that the utilization rate of Tokuyo in 2015 was 97.4 percent, and Figures 3 which show the admission capacity and utilization rate of Tokuyo and Roken, respectively, indicate that both types of nursing care show similar patterns of near 100 percent utilization. [20] While the ratio of people who provide informal

[16]For more details, see the following Ministry of Health, Labour and Welfare website: http://www.mhlw.go.jp/english/database/db-hss/siel-index.html.

[17]In April 2012, the government stated that it would not establish any new designated medical long-term care sanatoriums, and this type of facility was then abolished in March 2017. For details, see https://www.jftc.go.jp/houdou/pressrelease/h28/sep/160905_1.html (p.17, in Japanese).

[18]One Roken is operated by a medical corporation.

[19]See https://www.jftc.go.jp/houdou/pressrelease/h28/sep/160905_1.html (pp.22-25, in Japanese) for details.

[20]Utilization rate is calculated by dividing the admission capacity by the response rate each year.

care is influenced by the exogenous change of the admission capacity, the utilization rate remains at close to 100 percent and so we use this supply-side exogenous variation in capacity to control for any endogeneity in the provision of informal care.

In addition to the exogenous variation described above, there is also exogenous variation in the admission capacity of different regions over different time periods and, importantly, a household cannot use a nursing home outside the region of residence. Figure 4 shows for each JSTAR region the ratio of the Tokuyo admission capacity to the number of people needing care. [21] As this variation is exogenous for a caregiver in a household, we use this variation to control the endogeneity of informal care. Table 5 shows the similar variable for Roken, and we also observe the dynamic variation of this variable in some regions between 2007 and 2013.

Before 2015, an application for admission to Tokuyo required a need for nursing care above level 1, but after 2015, this was elevated to nursing care level 3. [22] From interviews we conducted with health professionals , although it is not officially stipulated, elderly requiring higher levels of care were preferentially assigned to public nursing homes when capacity was limited. From Table 4, we find that the average level of nursing care in Tokuyo facilities in 2015 was above 3. In addition, when elderly people trying to enter Tokuyo care were not admitted, some decided to enter Roken instead. In this way, there is some indication that one type of nursing home is a substitute for the other.

Figure 6 shows the utilization rate of formal care provided by both public and private suppliers by care level. We can see that the utilization rate increases as the nursing care level increases. From Figure 7, there is a clear indication that utilization of formal care strongly influences the provision of informal care in a household and, further, in a household with parents certified as needing nursing care (i.e. above level 1), there is a high probability that

[21]The calculation is (Tokuyo Capacity)/(Number of People Certified as Needing Long-term Care). This variable, which is explained in more detail in section 5, is constructed from years 2007, 2009, 2011 and 2014 of the Long-Term Care Insurance Business Status Report and Survey of Institutions and Establishments for Long-term Care. As we have access to population information only for 2005 and 2010, we have used the information nearest to the surveyed year of capacity.

[22]For details, see the Japan Fair Trade Commission website https://www.jftc.go.jp/houdou/pressrelease/h28/sep/160905_1.html (p.14, in Japanese).

neither male or female household members provide informal care.

In this paper, we also use the capacity of another nursing service provider called "Tsusyo", which provide care on an hourly basis, with the patients returning home after they receive the service. This type of facility also faces the same type of entry regulations on total capacity as do all public nursing homes.

4.2 The Availability and Cost of Nursing Care

In this section, we discuss the availability of nursing homes and the cost of using informal care services related to the long-term care insurance system in Japan Specifically, we discuss the availability of nursing homes to female elderly who also have parents needing nursing care, the total cost, the difference in cost between in-home care and nursing home care, and the relationship between the monthly cost per capita of nursing homes and the female wage.

Table 5 shows the proportion of households with at least one member living with them who needs nursing care, and we see that while the ratio has declined over time, it has remained at somewhat less than 10 percent since 2010. Note that this ratio includes only households in which a member needs care but is living at home. It therefore does not include household members who are already in nursing care. Therefore, Table 5 shows that the ratio of people who cannot obtain access to a nursing home even though they would like to is relatively low at less than 10 percent and continuing to decline. One might argue that the supply of nursing homes already comes close to satisfying demand. Further, as we consider here only those households with heads of household aged 50 to 59, and since most heads of households in Japan are male, this also indicates that for most female elderly who have parents needing nursing care, these needs are largely satisfied.

As for the total cost of providing nursing care, the vertical axis in Figure 8 indicates the total annual cost including LTCI insurance benefits, public expenditure and copayments. [23] The insurance benefit is contributed from long term care insurance system based on public expenditure and the insurance fee received from insured people and, in principle, the

[23] In this paper, we use the average 2018 exchange rate of 1 US dollar = 110.41 yen (https://www.boj.or.jp/statistics/market/forex/fxdaily/ex2018.pdf).

copayment ratio is 10 percent. According to Figure 8, the cost of providing nursing care service has increased since 2004, and by 2016 had become more than 7.5 trillion yen (about 68 billion dollars), or about 1.5 percent of real GDP, which was about 500 trillion yen (about 4.5 trillion dollars). [24] However, as local governments provide a subsidy for constructing nursing homes which is not included in these figures, the actual cost of providing nursing home care is higher than the amount indicated in Figure 8.

Next, we compare the costs of in-home care and nursing home care. Panels (a) and (b) of Figure 9 shows the cost per capita of providing care at least of Level 3 and Level 1, respectively. Although the cost of nursing home care is relatively stable regardless of level of care, in-home service does become more expensive as the level of care rises. However, at all levels of care, the cost of in-home service is substantially lower than either Tokuyo or Roken nursing home care. For example, for people needing at least level 3 care, the annual cost per capita of in-home service was only about 59 percent of the cost of Tokuyo care in 2016. [25]

Finally, we compare the cost of Tokuyo care and the average female wage. This relationship is important, because in this paper we analyze the effect of informal care on labor supply, using the availability of nursing homes as an instrumental variable, which is expected to improve female labor participation. Table 6 shows the employment status of female workers aged 50-59 in 2017, and we can see that the proportion of regular workers is about 35 percent and non-regular workers about 60 percent. Now, turning to Figure 10, which shows the wage distribution of regular, non-regular and self- employed female workers in 2017 and recalling that the annual cost of Tokuyo care was 3,240,000 yen or about 29,300 USD, we can see that more than 80 percent of non-regular female workers (panels (b) and (d)) and more than 35 percent of regular workers (panels (a) and (c)) did not earn the cost of Tokuyo care. Thus we can say that the cost of Tokuyo care is not low relative to the wage distribution of female workers. Considering instead the female wage relative to the annual cost of in-home

[24] GDP estimate provided by the Japan Cabinet Office:
https://www.esri.cao.go.jp/jp/sna/data/data_list/kakuhou/files/h28/h28_kaku_top.html (in Japanese).

[25] The annual cost of in-home service in 2016 was about 1.92 million yen (160,000 yen/month x 12) or around 17,400 dollars per year while the annual cost of Tokuyo service was about 3.24 million yen (270,000 yen/month x 12) or about 29,300 dollars.

care per capita of 1,920,000 yen or 17,400 USD in 2016, fewer than 28 percent of non-regular workers but more than 85 percent of regular workers earn more. [26]

On final consideration is the availability of in-home service. In Japan, in-home service is relatively easily available when a household cannot utilize a nursing home because of insufficient capacity in the area in which they live. Figure 11 shows the utilization in 2013 of long-term care covered by nursing care insurance when a person who has been deemed to require nursing care lives at home. This form of home care includes such services as home visits by nurses and meal delivery service. From Figure 11, we can see that most offspring and their spouses utilize these services when parents require long-term care and that the utilization rate remains at slightly more than 80 percent irrespective of work or family situation.

5 Estimation Method

In this section, we describe how we estimate the effect of informal care for the elderly on the labor supply and derive the estimation equations. [27] First, to construct the estimation equations, we must consider several direct and indirect factors potentially influencing the relationship between informal care and the labor supply. As shown in Figure 13, these include the relationships between: (1) labor supply and informal care, which is the relationship of primary interest in this paper; (2) informal care and formal care (including both nursing home and in-home care); (3) formal care and informal care for the spouse; (4) informal care and informal care for the spouse; and (5) between the instruments in this paper and informal care. In designing the estimation equations, we pay attention to both the direct relationships (1-4 above) and the indirect relationship (5), which implies that the instruments in this paper influence the provision of informal care through utilization of formal care.

The capacity of public nursing homes directly influences only the utilization of formal

[26] For non-regular workers, the percent for both females aged 50-54 and 55-59 is 28 percent, summing from 1500-1990 to 5000- on panels (b) and (d) of Figure 10. For regular workers, the percent for females aged 50-54 is 86 percent and for those 55-59 is 85 percent, summing from 2000-2490 to 15000- on panels (a) and (c).

[27] All models are estimated using the STATA module xtivreg2. See Schaffer (2010) for further details.

care which, in turn, influences the provision of informal care. Additionally, although parental health is commonly used as an instrument in the literature, Crespo and Mira (2014) questions its validity, for it is possible that parental health may directly influence the labor supply. We have indicated this by the direction of the arrow between these two variables in Figure 13. Accordingly, we do not utilize parental health as an instrument in this paper, though we do include it as an explanatory variable in the second stage, as explained below.

As discussed in section 4.1, we utilize the variation in public nursing home capacity caused by supply side government intervention in the eldercare market to estimate the effect of informal eldercare on the labor supply, where i is an individual living in region $j = j(i)$ $(1 \leq j \leq N_R)$ in time t:

$$y_{it} = \beta_0 + \beta_1 IC_{it} + \beta_2 NursingCareLevel_{it} + X'_{it}\delta_1 + \theta_i + \eta_{jt} + \epsilon_{1it} \quad (1)$$

$$IC_{it} = \alpha_0 + \alpha'_1 Capacity_{it} + \alpha_2 P(certified_{t-1}) \times 1\{NursingCareLevel_{it} \geq 3\}$$
$$+\alpha_3 1\{NursingCareLevel_{it} \geq 3\} + \alpha_4 NursingCareLevel_{it} + X'_{it}\delta_2 + \xi_i + p_{jt} + \epsilon_{2it} \quad (2)$$

We include $P(certified_{t-1}) \times 1\{NursingCareLevel_{it} \geq 3\}$ to control for the availability of services other than public nursing homes for a respondent in each region, which implies Z_{1it}. The other variables are defined as follows:

- y_{it}: Dummy variable indicating labor participation, or working hours per week;
- $NursingCareLevel_{it}$: A variable indicating the maximum level of nursing care of parents (this applies only to parents in contact with the respondent) [28]
- $Capacity_{it}$: A vector indicating nursing home capacities.
  We use the cross terms of both *Capacity Index of Tokuyo (Roken, Tsusyo)* and $1\{NursingCareLevel_{it} \geq 3\}$.

[28] We impute the nursing care level in the following way. Once $NursingCareLevel_{it}$ is more than three, we impute $1\{NursingCareLevel_{it} \geq 3\} = 1$ after the first period in which $1\{NursingCareLevel_{it} \geq 3\} = 1$ is satisfied.

$$\textit{Capacity Index of Tokuyo (Roken, Tsusyo)}_{it} = \frac{\textit{Capacity of Tokuyo (Roken, Tsusyo)}_{it}}{\textit{\# of people receiving certification of care}_{jt}}$$

[29], where

  - *Capacity of Tokuyo (Roken, Tsusyo)*$_{it}$: The Capacity of Tokuyo (Roken, Tsusyo) in the respondent's residential region in period t,

  - *# of people receiving certification of care*$_{jt}$: Population receiving certification of need for long-term care need in the residential region of the respondent in period t.

- $P(certified_{t-1}) \times 1\{NursingCareLevel_{it} \geq 3\}$: $P(certified_{t-1})$ = (Population receiving certification of need for long-term care in each region at $t-1$)/(The number of people aged 65 and over in each region at $t-1$). This is the cross term of both $P(certified_{t-1})$ and $1\{NursingCareLevel_{it} \geq 3\}$.

- IC_{it}: Dummy variable, which is equal to 1 if the respondent provides informal care.

- X_{it}: Other control variables, such as family characteristics, household assets and income.

- θ_i, ξ_i: Fixed effects.

- η_{jt}, p_{jt}: Year-residence region effects.

We use the cross terms of both nursing home capacity and the dummy variables indicating nursing care level ($Capacity_{it}$), considering the possibility that elderly with a higher nursing care level might be preferentially assigned to a nursing home and that there might

[29] We divide *Capacity of Tokuyo*$_{it}$ by the response rate after 2008 because the response rate is about 0.9 although it is almost 100 percent at 2007. In Takikawa city, *Capacity of Tokuyo*$_{it}$ has a missing value in 2011. We impute *Capacity of Tokuyo*$_{it}$ = 200 at Takikawa city in 2011 because *Capacity of Tokuyo*$_{it}$ = 200 except in 2011. In Tosu city, we use the value of population in the Tosu district-wide area municipal zone (which is greater than the number of people receiving certification of care in Tosu city proper) as *\# of the people receiving the certification of care*$_{jt}$. We do the same process for *Capacity of Roken (Tsusyo)*$_{it}$.

be substitutability between nursing home type (i.e. Tokuyo, Roken and Tsuyo). We also include $P(certified_{t-1}) \times 1\{NursingCareLevel_{it} \geq 3\}$ as a proxy for the availability of care (such as in-home service) other than in a public nursing home.

We assume the following when estimating the effect of informal care for the elderly on labor supply: Let $Z_{1it} = NursingCareLevel_{it}$ and $Z_{2it} = (Capacity'_{it}\ P(certified_{t-1}) \times 1\{NursingCareLevel_{it} \geq 3\}\ 1\{NursingCareLevel_{it} \geq 3\})'$. We also define $Time_{it} = (1\{t = 1\}...1\{t = T\})'$ and $Region_{it} = (1\{j(i) = 1\}...1\{j(i) = N_R\})'$. Additionally, let $l_{it} = (Z_{1it}, Z_{2it}, X'_{it}, Time'_{it}, Region'_{it})'$.

$$\textbf{Assumption A}: E[\epsilon_{1it}|L_i] = 0\ (t = 1, 2, ..., T)$$
$$L'_i = (l_{i1}, l_{i2}, ..., l_{iT})$$

For example, ϵ_{1it} includes unexpected shocks that would decrease the labor supply, such as a sudden injury to the respondent. When the assumption is valid, it is easy to show the identifiability of parameters by using the assumption. T is the total number of periods. We define the following notations: $\overline{A}_i \equiv \frac{1}{T}\sum_t A_{it}$ (A is a representative letter).

$$(y_{it} - \overline{y}_i) = \beta_1(IC_{it} - \overline{IC}_i) + \beta_2(Z_{1it} - \overline{Z}_{1i}) + (X'_{it} - \overline{X'}_i)\delta_1 + \eta_{jt} - \overline{\eta_j} + (\epsilon_{1it} - \overline{\epsilon}_{1i}) \quad (3)$$

Then, we rewrite equations (1) and (2) in the following way:

$$(y_{it} - \overline{y}_i) = \beta_1(IC_{it} - \overline{IC}_i) + \beta_2(Z_{1it} - \overline{Z}_{1i}) + (X'_{it} - \overline{X'}_i)\delta_1 + \eta_{jt} - \overline{\eta_j} + (\epsilon_{1it} - \overline{\epsilon}_{1i}) \quad (4)$$
$$(IC_{it} - \overline{IC}_i) = \alpha'(Z_{2it} - \overline{Z}_{2i}) + \alpha_4(Z_{1it} - \overline{Z}_{1i}) + (X'_{it} - \overline{X'}_i)\delta_2 + p_{jt} - \overline{p_j} + (\epsilon_{2it} - \overline{\epsilon}_{2i}) \quad (5)$$

$\alpha = (\alpha'_1\ \alpha_2\ \alpha_3)'$. Let $\tilde{L}_{it} = [(Z_{1it} - \overline{Z}_{1i}), (Z_{2it} - \overline{Z}_{2i}), (X_{it} - \overline{X}_i)', (Time_{it} \otimes Region_{it} - \overline{Time_i \otimes Region_i})']'$. Then, $\tilde{L}_{it}$ is a function of L_i, and we can write $\tilde{L}_{it} = A(L_i)$. As a result, $E[\tilde{L}_{it}(\epsilon_{1it} - \overline{\epsilon}_{1i})] = E[A(L_i)(\epsilon_{1it} - \overline{\epsilon}_{1i})] = 0$ by Assumption A. We can identify the parameter $\eta_{jt} - \overline{\eta_j}$ in equation (4) by using the variables such as $Time_{it} \otimes Region_{it} - \overline{Time_i \otimes Region_i}$. Here, the validity of **Assumption A** is checked by an over-identifying

restriction test. $Capacity_{it}$ controls the institutional factor to cause the respondent to provide informal care. When the respondent lives in an area where the capacity of Tokuyo (Roken, Tsusyo) is small, the probability of providing informal care becomes high because it is difficult to obtain admission to Tokuyo (Roken, Tsusyo) nursing homes. We return to this point when discussing the results in section 6.2.

Finally, we use models (4) and (5) to verify that there is no correlation between $(\epsilon_{1it} - \bar{\epsilon}_{1i})$ and $(IC_{it} - \overline{IC}_i)$. It is possible that $(IC_{it} - \overline{IC}_i)$ is exogenous, and some studies such as Ishii (2015) have reported that the provision of informal care is exogenous. We check the endogeneity of $(IC_{it} - \overline{IC}_i)$ by using the Durbin-Wu-Hausman (DWH) test,[30] including only samples having a parent who is alive and has contact with the respondent. [31] As the household structure is different between a couple and a respondent without a spouse, it would be preferable for our study for them to be analyzed separately. However, because the sample size of respondents without a spouse is small, we restrict the sample only to couples; more specifically, married females at first interview. In section 6.2, we show only the estimated results of female respondents aged from 50 to 61.

6 Results

6.1 The Effect of Nursing Home Capacity on Provision of Informal Care (The First Stage Result)

In this section, we check the validity of using the capacity of nursing homes such as Tokuyo, Roken and Tusyo as instruments when estimating the effect of informal care on the labor supply. As indicated in Figure 13, the capacity of nursing homes (i.e. availability)

[30] For a brief explanation of the DWH test, see Cameron and Trivedi (2010).

[31] There are two relevant questions in the JSTAR: QA:"During the past year, how often have you communicated with your father (mother)? Include communication by telephone, letter, e-mail, text message, etc." QB:"During the past year, how often has your spouse communicated with his/her father (mother)? Include communication by telephone, letter, e-mail, text message, etc." Respondents select one of the following possibilities: 1. We live together, 2. Daily, 3. Several times a week, 4. About once a week, 5. About once every two weeks, 6. About once a month, 7. Less than once a month, 8. Not in contact, 9. Don't know, and 10. Refused to answer. We define "having contact with the respondent" when the sample answers are from 1 to 7 in QA or QB.

indirectly influences informal care through its **direct influence** on utilization of formal care. These estimated effects are reported in Tables 7 and 8, respectively.

Beginning with the indirect effect of nursing home capacity on the provision of informal care, columns (2) and (3) of Table 7 show the effect of variables indicating nursing homes capacity (e.g., $1\{\text{NCL} \geq \text{C3}\} \times \text{Capa(Tokuyo)}$) and the level of certified nursing care of the parent (Linear of NCL). We can see that the effect of the level of certified nursing care of the parent ("Linear term of NCL") on informal care provision is positive, suggesting that informal care provision increases as health status becomes worse. In column (2), when nursing home capacity variables are not included, the coefficient "$1\{\text{NCL} \geq \text{C3}\}$" is negative. However, when we include the coefficients indicating nursing homes capacity (e.g., $1\{\text{NCL} \geq \text{C3}\} \times \text{Capa(Tokuyo)}$), the coefficient of "$1\{\text{NCL} \geq \text{C3}\}$" becomes positive and insignificant while the variables indicating nursing home capacity (e.g., $1\{\text{NCL} \geq \text{C3}\} \times \text{Capa(Tokuyo)}$) becomes negative. This means that the effect of coefficient "$1\{\text{NCL} \geq \text{C3}\}$" in column (2) includes the effect of nursing home capacity, which has a negative effect on informal care provision. Column (3), meanwhile, suggests that the variable "Linear term of NCL" controls the effect of parental health on informal care provision while the coefficient "$1\{\text{NCL} \geq \text{C3}\}$" indicates effect other than parental health.

Columns (4) and (5) of Table 7 show the estimation results when the sample is divided into two groups of women aged 54 at first interview: (1) non-regular or self-employed workers and those not working, and (2) regular workers. As discussed with Table 10, the wage level of non-regular workers and self-employed workers is low, and so Group 1 female workers have a low opportunity cost in the labor market. We can observe the difference in the effect of "$1\{\text{NCL} \geq \text{C3}\}$" and nursing home capacity among these two groups. First, the signs of the coefficients for "$1\{\text{NCL} \geq \text{C3}\}$" are different and the significance of the coefficients for nursing home capacity are different between Groups 1 and 2. For Group 1, all nursing home capacity variables except for "Roken" are significant, while none are significant for Group 2, although this is likely due to the small number of observations. Second, what "$1\{\text{NCL} \geq \text{C3}\}$" controls is heterogeneous between Groups 1 and 2, although it is not clear specifically what it controls. Nonetheless, the effect of "$1\{\text{NCL} \geq \text{C3}\}$" is positive and significant in column (4) but is

negative and not significant in column (5), which indicates that whether or not nursing care need is level 3 or more has a different effect between Groups 1 and 2. Third, as shown in column (4), the magnitude of the effect of Tokuyo is more than double that of Roken (-4.968 vs. -2.348). This could be due to the longer permitted length of stay at Tokuyo.

Next, we turn to the direct effect of nursing home capacity on the utilization of formal care, as shown in Table 8. The coefficient of the "Linear term of NCL" is positive, suggesting that use of formal care increases as health status becomes worse. When we compare the columns (2) and (3) in Table 8, we can understand the effect of "$1\{\text{NCL} \geq \text{C3}\}$". In column (2), in which the effect of nursing home capacity is not controlled, the coefficient of "$1\{\text{NCL} \geq \text{C3}\}$" is positive and significant. In the column (3), on the other hand, when we control the effect of nursing homes capacity, there is no significance. In columns (4) and (5), the coefficients of "$1\{\text{NCL} \geq \text{C3}\}$" are not significant, which suggests that there is no effect of "$1\{\text{NCL} \geq \text{C3}\}$" itself on use of formal care. Also, as the signs of the $1\{\text{NCL} \geq \text{C3}\}$ coefficients are negative while those of "Linear term of NCL" are positive, this indicates that the two have different effects on formal care utilization. Lastly, while the coefficients of nursing home capacity variables in columns (3) through (5) are all positive, only that of Roken in column (3) is weakly significant.

Finally, we discuss the effect of nursing home capacity on the time spent providing informal care (Table 9). Focusing on columns (1) through (4), which indicate the hours spent providing informal care by Group 1 females with low opportunity costs in the labor market, the variable "Linear term of NCL", which seems to control parental health, is positive and significant. We also see that for the various types of nursing homes, the magnitude of the effect of Roken is much larger than that of Tokuyo at higher levels of informal care provision, which indicates that the availability of Roken had a much more important role than that of Tokuyo on the time spent providing informal care.

6.2 The Effect of Providing Informal Care on the Labor Supply (The Second Stage Result)

In this section, we report the main results of the effect of informal care on the labor supply. Table 10 shows the effect of providing informal care on the labor supply of non-regular, self-employed or non-working women aged 54 at 1st interview (Group 1). "Working for pay" indicates whether women were working for pay or not, and "= 1 if working $\geq$ XXh/w " indicates whether they were working for more than XX hours per week. We include the variable "Linear term of NCL" to control for parental health in the second stage. [32] Table 10 shows the estimated results for both FE and FE-IV specifications, as well as the over identification test p-value, DWH test p-value and F statistics to test for weak instruments.

In column (1) of Table 10, the effect of informal care provision on working for pay is significantly negative (FE: -0.101), and the coefficient value of FE-IV in column (2) is nor substantially different (FE-IV: -0.112). On the other hand, we do not find any significant effect of the provision of informal care on working hours (columns (3)-(8)). We also do not find any significant effect of the "Linear term of NCL" indicating parental health status on paid work or hours.

Figure 14 shows the female labor participation rate depending on whether or not the respondent also provides informal care. Figure 14 was created from married female samples aged 50-61 at first interview who have contact with their parents and have a household member living with them certified as needing at least level 1 care. According to Figure 14, there is little variation in labor participation whether or not informal care is provided but when it is not, the labor participation rate is about 60 percent. In column (1) of Table 10, the effect of informal care provision on working for pay is -0.101. Therefore, the decrease in the labor participation rate is $-0.101/0.6 \simeq -0.168$.

Next, looking at the relationship between provision of informal care and work more deeply, Table 11 shows the results for the same categories of work (columns (1)-(8)) as in Table 10,

[32] Many studies in the literature do not include variables controlling for parental health in the second stage, but instead include parental health only as instruments. However, Crespo and Mira (2014) point out that using parental health as instruments is problematic.

but for different intensities in the provision of informal care. Here, "= 1 if LTC $\geq$ XXh/w " indicates whether workers spend more than XX hours per week providing informal care. Although the effect of "= 1 if spending for LTC $\geq$ 5h/w " on "Working for pay" is weakly significant (column (1) FE: -0.093), the other effects are not significant. Nonetheless, the absolute value of the coefficients in columns (3), (5) and (7) (FE: -0.067, -0.092, -0.100) are larger than that of column (1).

Now moving to regular workers (Group 2), Table 12 shows the effect of providing informal care on the labor supply for regular workers aged 54 at 1st interview (columns (3) and (4)), but we also show the results for Group 1 for ease of reference. Recall from Table 7 that there is no significant effect of nursing home capacity on the provision of informal care by regular workers. Also, we must consider that the "Linear term of NCL" may not be completely exogenous for the labour supply of this group, so we only have an imperfect instrument for this group. This point is elaborated more fully below when we discuss the estimated results. However, the results do enable us to understand how the "Linear term of NCL" changes Group 2 workers' behaviors. For this analysis, only "1{NCL $\geq$ C3}" are used as instruments, and the test statistics for the overidentification test cannot be computed.

Table 12 shows the relationship between the provision of informal care and the labor supply **at time t**. The columns at the top are dummy variables (1=yes, 0=no) intuitively indicating whether the woman is working, is a regular worker, is a non-regular or self-employed worker, or is unemployed. For each work status, both FE and FE-IV estimations are performed. We can see that the "Linear term of NCL" does not change directly if a woman is working but does show a significant change if the woman is a regular worker (FE: -0.027 and FE-IV: -0.033 in columns (3) and (4)). In other words, the "Linear term of NCL" changes a woman's job status from a regular worker to another job status but it does not change whether she works or not. In addition, from row 1, we see that the provision of informal care does not **simultaneously** change the labor supply.

Next, we investigate the effect of providing informal care in period t on the labor force participation in the subsequent two periods, t + 1 and t + 2 (see Table 13). Because the sample size is small, this result is only for reference, but it does provide some insight into

the different effects on women who are non-regular or self-employed workers or unemployed (Group 1) and regular workers (Group 2). For this estimation, we use samples from the 1st through 4th waves in five cities (Adachi, Kanazawa, Shirakawa, Sendai, Takikawa) because we want to analyze the effect of the provision of informal care on the labor supply in the next two periods for the same workers, and only in these cities was the survey conducted for all four waves. From Table 13, we can see that providing informal care at time t does not influence labor supply at time t or the next two periods for women in Group 1 (Non-regular/self-employed/not working). However, while it also does not influence labor supply at time t for Group 2 women who are regular workers, it does influence labor supply in the next two periods at a high level of significance, with t+1 positive and t+2 negative. The results of Table 12 and 13 together can provide an interpretation: at period t, when a woman's parents incur a health problem, she first changes her job status while continuing to work (Table 12, but after period t, may need to quit her job in order to begin providing informal care at period $t+1$ (Table 13).

7 Discussion

7.1 Estimation Results

In this section, we briefly discuss two main questions related to our main results:

- **The small effect of providing informal care on the labor force participation**

  As discussed in section 4.2, public in-home care is available in Japan when a person who requires nursing care continues to live in the home. This is most important in explaining our results, as we do not separate the samples into two groups who do and do not utilize in-home care. As discussed in section 6.2, as the amount of time spent providing informal care increases, the effect on the labor supply is stronger.

- **The effect of government intervention on the supply side of the eldercare market**

For analyzing the effect of government intervention on the supply side of the elder-care market on the provision of informal care in Japan, we check the coefficient of "Capa(Tokuyo) $\times 1\{NCL \geq C3\}$", which captures the effect of increasing the capacity of Tokuyo per capita on providing informal care. In Table 7, this coefficient is significant only for Group 1 (non-regular workers, self-employed workers and not working people at age 54 or 1st interview), which suggests that the change in Tokuyo capacity during the analysis period reduced the burden on Group 1 women providing informal care. This result also suggests that other nursing homes such as Tsusyo may also decrease this burden.

7.2 Impact and cost-effectiveness of government nursing home policy on female labor participation

As we observe, the effect of the increase in nursing home capacity improves female labor force participation, but this is chiefly among Group 1 women who are non-regular or self-employed workers or those not working at age 54 or 1st interview whose average wage, and opportunity cost, is low. Meanwhile, the cost of providing nursing care as discussed in section 4.2 continues to increase rapidly and puts pressure on the Japanese budget. As the per capita cost of operating nursing homes is larger than that of providing in-home service, and the proportion of female non-regular workers earning a wage greater than the per capita cost of operating nursing homes is small, it is possible that the Japanese policy of expanding nursing home capacity has already arrived at the point where the effectiveness of the policy is low and unnecessarily is putting pressure on the budget. Finally, while our focus has been on older working women, a related implication of our discussion is that if the Japanese government were to decide to reduce the number of nursing homes in order to cut costs, it is possible that the number of young female regular workers might decrease if they predict that they will be obligated to provide informal care at some point in the future and consequently stop developing their human capital early in life. While examination of this effect, and whether its impact may be greater or less than other potential cost-cutting measures such

as a reduction in child-care availability, is beyond the scope of this study, it is clear that the Japanese government will face difficult choices in deciding how best to reduce budgetary constraints in the future.

8 Conclusion

This study analyzes the effect of informal care for the elderly on female labor force participation, utilizing the exogenous variation in government management of the supply of formal public nursing care to estimate this effect. We find that According to our results, the following points are clarified.

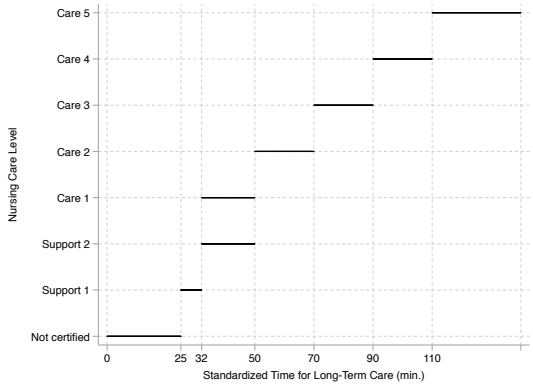
- The effect of the provision of informal eldercare on female labor force participation in Japan is small relative to the literature.
- The provision of informal care is primarily the domain of female household members in Japan, and the expansion of nursing home capacity during the period of analysis has been most effective in decreasing the burden associated with providing informal care for female non-regular workers with low opportunity cost.
- As the cost of operating nursing homes is larger than that of providing in-home service and the proportion of female non-regular workers earning a wage greater than the cost of operating nursing homes is small, it is possible that the Japanese policy of expanding nursing home capacity has already reached its point of maximum effectiveness.

In future work, the heterogeneity of utilizing home care services should be considered. As we have not separated those who do and do not use home care services in our analysis, our estimation of the effect of providing informal care on female labor force participation is small. However, for those not utilizing home care service, it is possible that the effect is very strong. Other limitations of the paper include the possibility that the variation in nursing home capacity used in this paper, which is limited to only the analyzed cities of the dataset, is insufficient. More variation in nursing home capacity would improve the

analysis. Additionally, public finance becomes important when considering public policy on nursing care, and so the public finance implications of this topic, as well as of government medical policy, should be investigated more comprehensively in the future. Finally, as many developed countries age and face the same problem, evidence from other developed countries is important in considering the effects of nursing care polices.

A Figures and Tables

Figure 1: Standardized Time for Long-Term Care and Nursing Care Level



Source: This Figure refers to Figure 3 of Takahashi (2019).

Figure 2: Nursing Care Determination Process

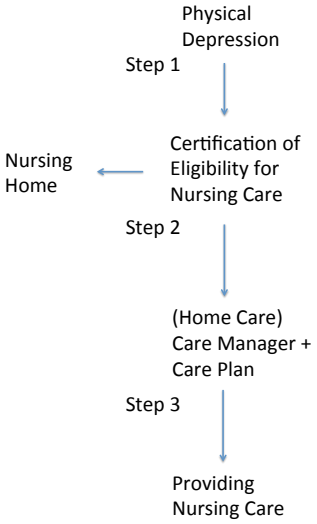
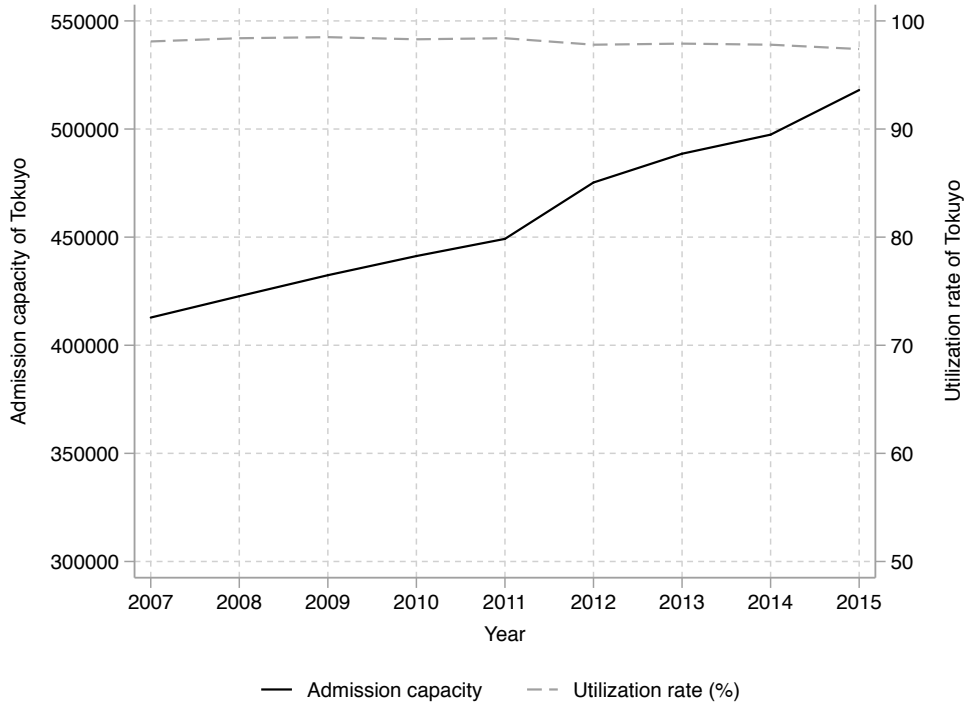
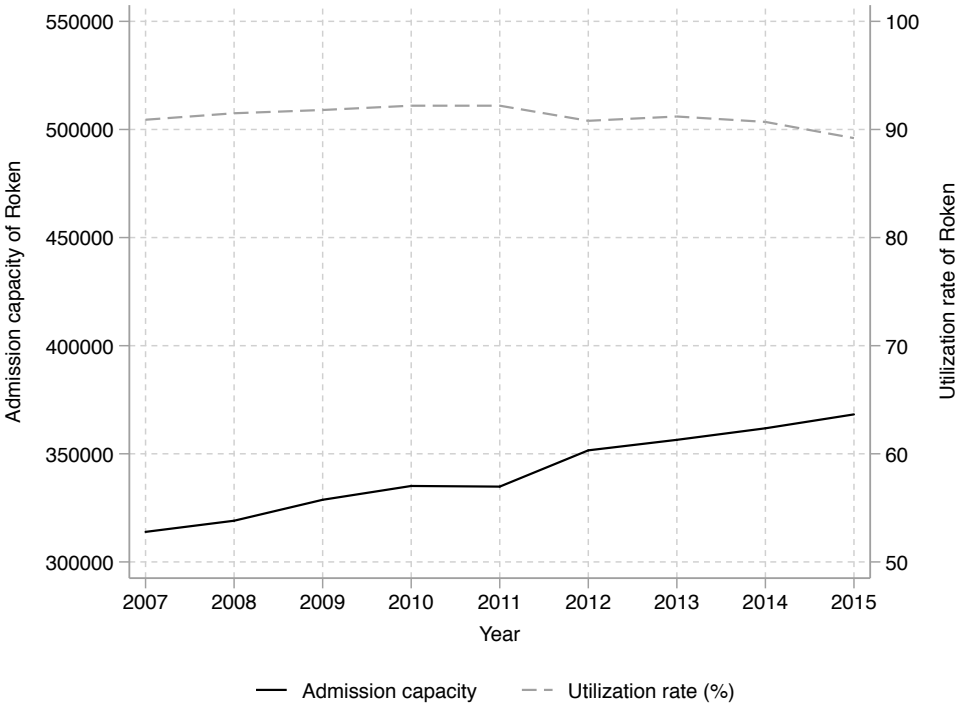


Figure 3: Admission Capacity and Utilization Rate of Public Nursing Home in Japan



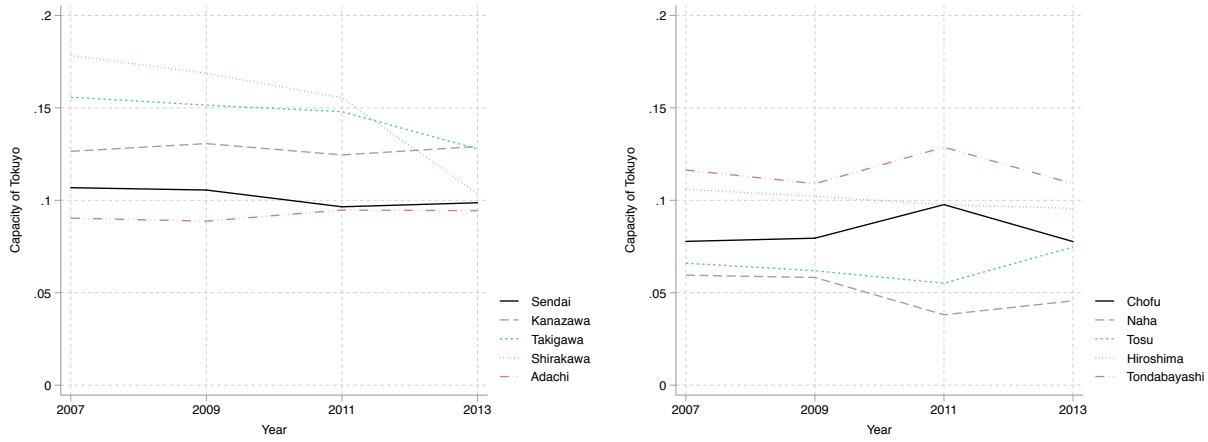
(a) Tokuyo



(b) Roken

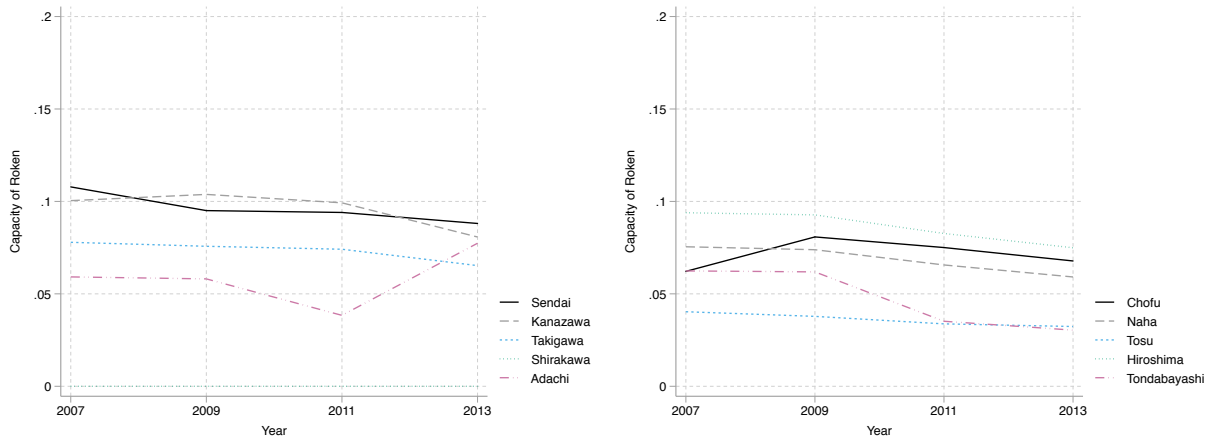
Source: Survey of Institutions and Establishments for Long-term Care, October 2007-2013

Figure 4: Admission Capacity of Tokuyo Per Capita Aged 65 or More By Region (Vertical Axis: 100 × (Tokuyo Capacity)/(Population with Long-term Care Certification) in each Region)



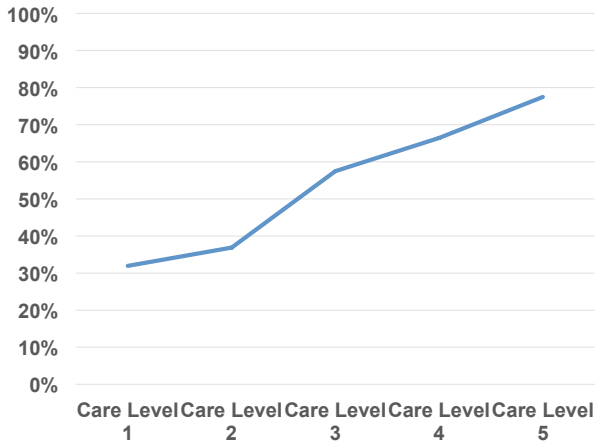
Source: Survey of Institutions and Establishments for Long-term Care, October 2007, 2009, 2011, 2014; and the Long-Term Care Insurance Business Status Report, 2005 and 2010.

Figure 5: Admission Capacity of Roken Per Capita Aged 65 or More by Region (Vertical Axis: 100 × (Roken Capacity)/(Population with Long-term Care certification) in each Region))

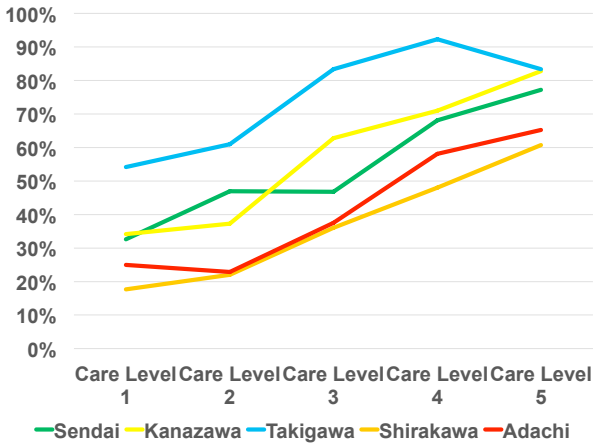


Source: Survey of Institutions and Establishments for Long-term Care, October 2007, 2009, 2011, 2014; and the Long-Term Care Insurance Business Status Report, 2005 and 2010.

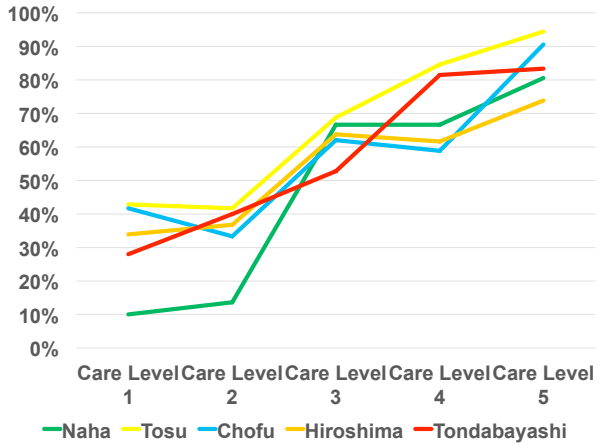
Figure 6: Utilization Rate of Formal Care by Care Level (Total and By City of Residence) (Horizontal Axis: Nursing Care Level of Respondent's Parents)



(a) Total



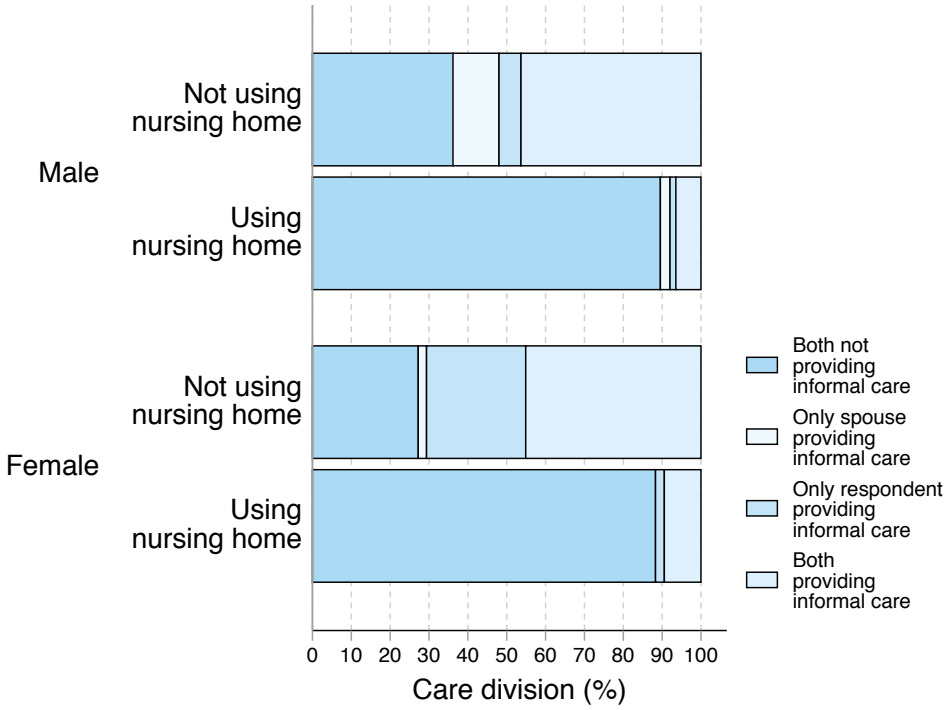
(b) Sendai, Kanazawa, Takikawa, Shirakawa and Adachi



(c) Naha, Tosu, Chofu, Hiroshima and Tondabayashi

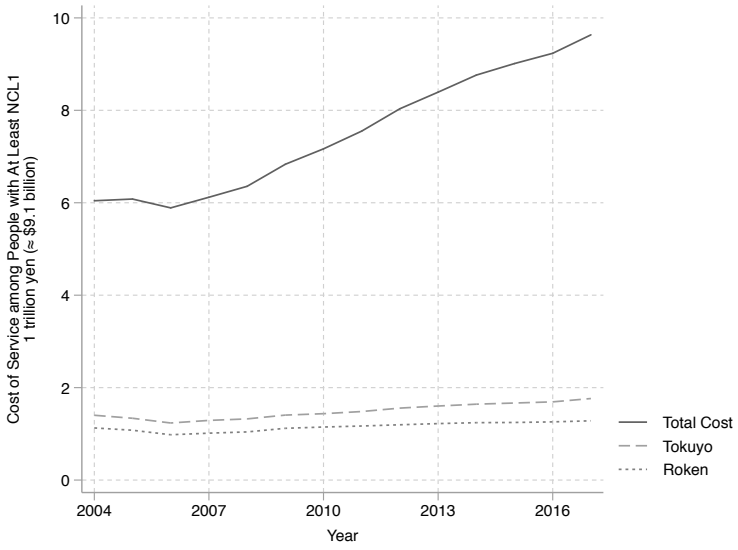
Source: JSTAR, 2007-2013.

Figure 7: Use of Formal Care and Provision of Informal Care by Couples with LTC-Certified Parents



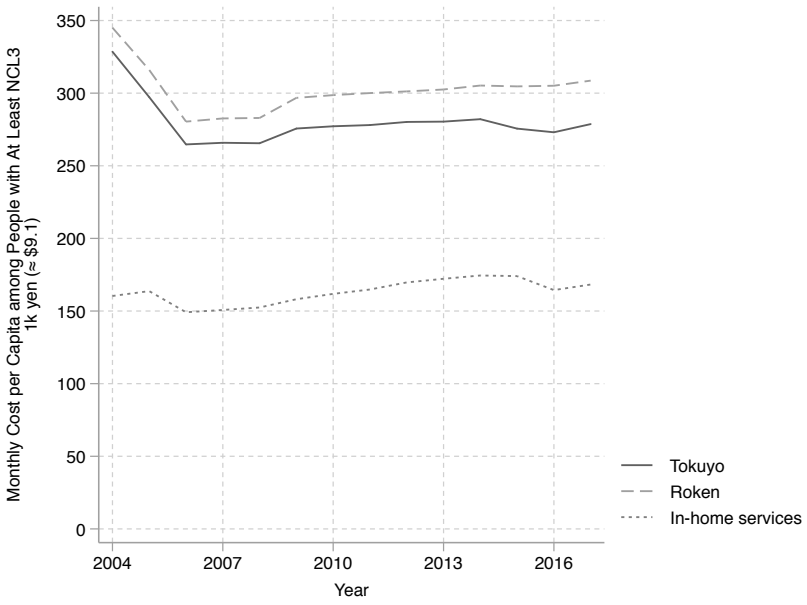
Source: JSTAR, 2007-2013.

Figure 8: Cost of Providing Nursing Care Service

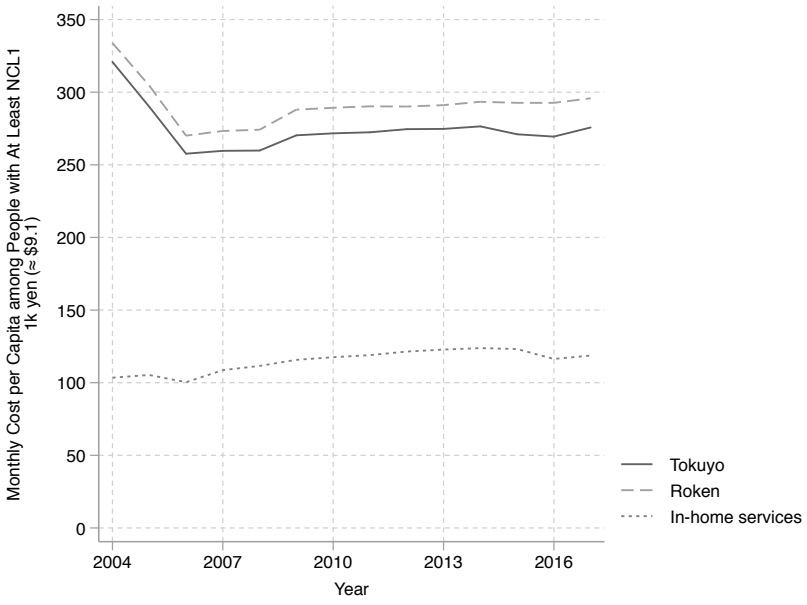


Source: Statistics of Long-term Care Benefit Expenditures, 2004-2016.

Figure 9: Cost of Using Nursing Care Service Per Capita



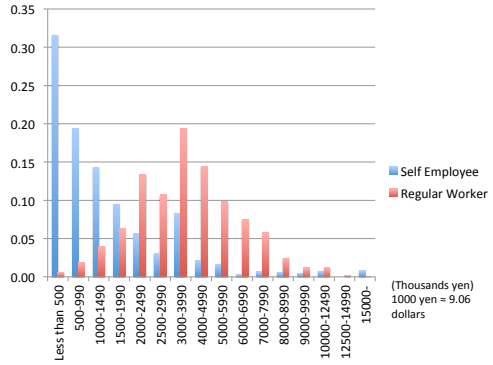
(a) Cost Per Capita of Nursing Care Level 3 and Higher



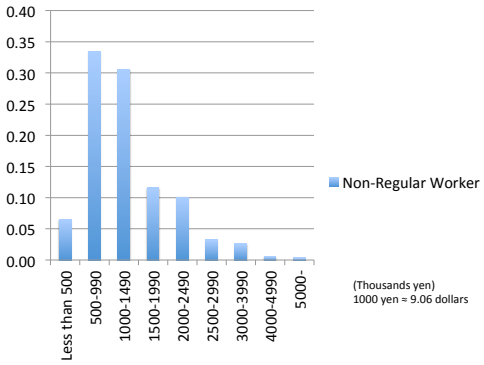
(b) Cost Per Capita of Nursing Care Level 1 and Higher

Source: Statistics of Long-term Care Benefit Expenditures, 2004-2016.

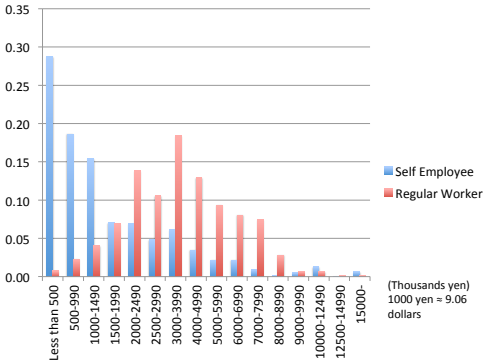
Figure 10: Wage Distribution of Female Workers in 2017



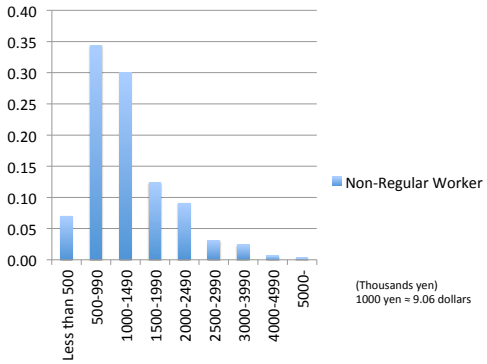
(a) Age 50-54 (self-employed or regular worker)



(b) Age 50-54 (non-regular worker)



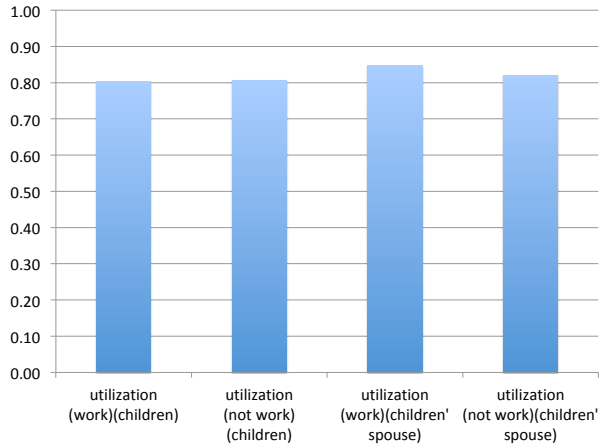
(c) Age 55-59 (self-employed or regular worker)



(d) Age 55-59 (non regular worker)

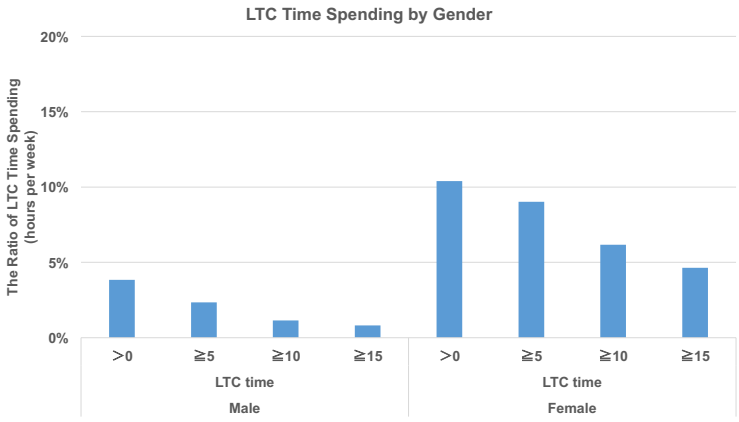
Source: Employment Status Survey, 2017.

Figure 11: Long Term Home Care Service Utilization Covered by Nursing Care Insurance When a Person Who Requires Nursing Care Lives in the Household



Source: Comprehensive Survey of Living Conditions, 2013.

Figure 12: Time Spent Providing Informal Care, by Gender



Source: JSTAR, 2007-2013.

Figure 13: Relationship between Labor Force Participation and Provision of Informal Care

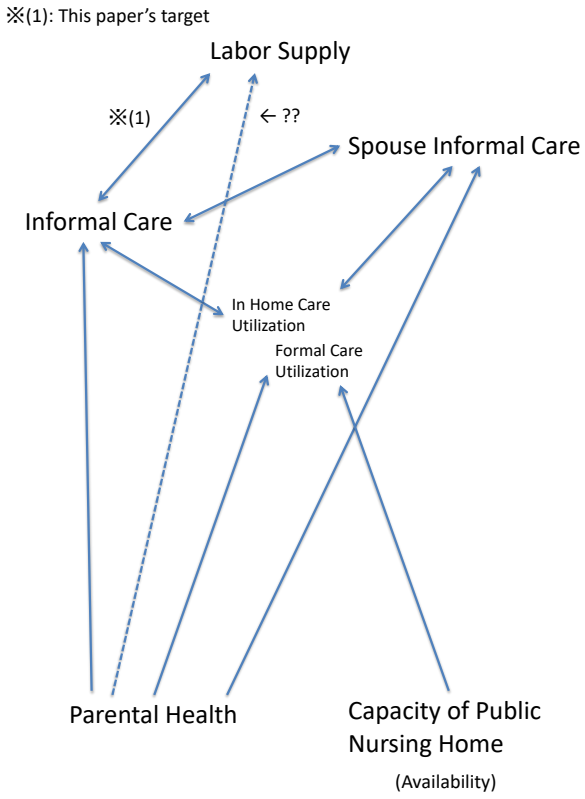


Figure 14: Labor Force Participation Rate and Provision of Informal Care

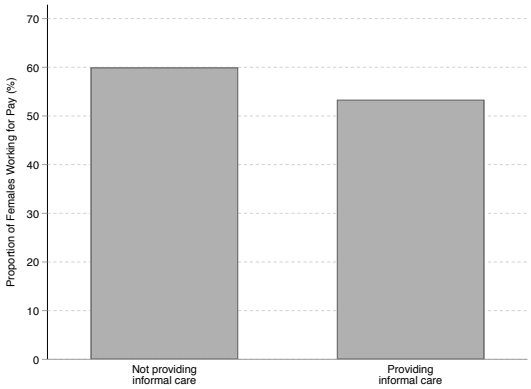


Table 1: Instruments Employed in the Literature

	Instruments	Memo
Main		
Heitmueller (2007)	• The number of sick and disabled people in the household • The age of the three closest friends of the respondent • The age of the parents and the geographic proximity of parents and friends	
Bolin et al (2008)	• Mother has bad health • Father has bad health • Age of mother • Age of father • Mother lives far away • Father lives far away • Mother is deceased • Father is deceased • Number of siblings	
Ciani (2012)	• The presence of disabled individuals living in the household • The presence of at least one co-resident individual reporting poor health	
Van Houtven, Coe and Skira (2013)	• Mother is ill • Mother in-law is ill • Mom died • Dad died • Mother in-law died • Father in-law died • Mother is recently widowed • Mother in-law is recently widowed	
Meng (2013)	• The four categories of ADL and IADL in which the impaired individual needs help are used as instruments • The variable which indicates whether disabled individuals are present in the household	
Others		
Van Houtven and Norton (2004)	• Proportion of daughters • Distance to the nearest child	• 2nd stage dependent variable: utilization of formal care
Bonsang (2009)	• Number of siblings	• 2nd stage dependent variable: utilization of formal care

Table 2: Summary Statistics

	(1) **5 cities**		(2) **2 cities**		(3) **3 cities**	
	mean	sd	mean	sd	mean	sd
Demographics						
Age	62.87	7.05	62.99	7.32	62.64	6.86
Age $\geq$ PA	0.58	0.49	0.55	0.50	0.52	0.50
Educ. $\geq$ Univ.	0.12	0.33	0.16	0.36	0.24	0.42
Female	0.50	0.50	0.53	0.50	0.55	0.50
Mariage	0.81	0.39	0.75	0.43	0.78	0.41
N um.of children	2.05	0.97	2.16	1.39	1.70	1.07
Economic variables						
HH income (US$)	41641	32794	44800	38118	61081	53419
Own house	0.77	0.42	0.63	0.48	0.69	0.46
Saving(imputed,US$)	63934	87361	54559	90933	91997	111633
Working status						
Not working for pay	0.43	0.49	0.51	0.50	0.43	0.49
Working hours $\geq$ 5	0.55	0.50	0.46	0.50	0.52	0.50
Working hours $\geq$ 10	0.52	0.50	0.44	0.50	0.49	0.50
Working hours $\geq$ 20	0.48	0.50	0.41	0.49	0.43	0.50
Full time worker (at 1st intw or age 54)	0.49	0.50	0.46	0.50	0.49	0.50
Nursing care and parents' information						
Provide informal care	0.13	0.33	0.11	0.31	0.15	0.35
Formal care utilization (for most severe parent)	0.10	0.30	0.14	0.34	0.14	0.34
NCL (for most severe parent) $\geq$ S1	0.23	0.42	0.24	0.43	0.30	0.46
NCL (for most severe parent) $\geq$ C3	0.13	0.34	0.13	0.34	0.15	0.36
Parents age(for most severe parent)	87.99	5.89	88.55	6.39	88.13	5.52
Year of 1st interview	2007		2009		2011	
Num. of waves	4 waves		3 waves		2 waves	

Table 3: Care Levels (Table 1 in Moriwaki (2016))

Care Level	Description
Special Elders	Currently independent, needs preventive healthcare
Support Level 1	Having difficulty standing up, getting up, and/or standing on one foot
Support Level 2 Care Level 1	In addition, having difficulty walking, washing body, keeping track of personal finances, and/or clipping nails
Care Level 2	In addition, having difficulty dressing, moving, and/or in decision-making
Care Level 3	In addition, having difficulty washing face, grooming, tooth-brushing, urination/defecation, and/or use of public transportation
Care Level 4	In addition, having difficulty eating, and/or communication
Care Level 5	In addition, having difficulty swallowing, memorizing and/or understanding

Table 4: Three Types of Public Nursing Home in Japan

	Facility Covered by Public Aid Providing Long-Term Care to the Elderly (Tokuyo)	Long-Term Care Health Facility (Roken)	Designated Medical Long-Term Care Sanatoriums
Number of Facilities	7065	3857	1318
Admission Capacity	484353	339142	58419
Utilization Rate	97.4	89.2	91.1
Average Nursing Care Level	3.87	3.26	4.38

Source: Survey of Institutions and Establishments for Long-term Care, October 2015.

Table 5: Proportion of Households with a Household Member Living at Home Needing Nursing Care (Including a Disabled Person; Head of Household Aged 50-59)

Year	Households with a Member Needing Nursing Care Living at Home	Total Households (Head Aged 50-59)	Ratio
2010	823	8849	0.093
2013	729	8251	0.088
2016	693	8181	0.085

[1] Source: Comprehensive Survey of Living Conditions.

Table 6: Female Labor Status Distribution, 2017

Age 50-54	Number	Ratio
Self Employee	120,100	0.041
Regular Worker	1,139,600	0.385
Non-Regular Worker	1,697,400	0.574
Age 55-59	**Number**	**Ratio**
Self Employee	129,400	0.052
Regular Worker	886,200	0.357
Non-Regular Worker	1,469,600	0.591

[1] Source: Employment Status Survey, 2017.

Table 7: Effects of Instruments on Provision of Informal Care

				Working status at age 54 or 1st interview	
	(1)	(2)	(3)	(4) Non-regular /self-employed /not working	(5) Regular worker
1{NCL ≥ C3}	0.005	-0.640***	0.568	1.091**	-3.091
	(0.055)	(0.072)	(0.519)	(0.555)	(2.109)
1{NCL ≥ C3}					
× Capa(Tokuyo)			-2.901*	-4.968***	1.603
			(1.614)	(1.771)	(5.263)
× Capa(Roken)			-1.682	-2.384	-5.114
			(1.430)	(1.961)	(5.553)
× Capa(Tsusyo)			-2.045**	-2.285**	-0.209
			(0.845)	(0.924)	(4.695)
× P($Certified\_t-1$)			-1.971**	-3.125***	14.438
			(0.957)	(1.065)	(13.513)
Linear term of NCL		0.147***	0.145***	0.138***	0.180***
		(0.014)	(0.014)	(0.017)	(0.028)
Number of observations	1083	1083	1083	760	205
Control variables	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes

[1] * $p < .1$, ** $p < .05$, *** $p < .01$

[2] Standard errors in parentheses are clustered robust at city and the maximum nursing care level of parents in all survey years.

[3] In the estimation model, we also include age, age squared, a dummy variable taking value one if the respondent is over the pension eligibility age, number of children, household income, house ownership, amount of savings, and city-year fixed effects.

Table 8: Effects of Instruments on Utilization of Formal Care

				Working status at age 54 or 1st interview	
	(1)	(2)	(3)	(4) Non-regular /self-employed /not working	(5) Regular worker
1{NCL ≥ C3}	0.455***	0.142**	-0.774	-0.742	-1.454
	(0.049)	(0.058)	(0.491)	(0.590)	(1.642)
1{NCL ≥ C3}					
× Capa(Tokuyo)			1.945	2.236	1.096
			(1.562)	(1.897)	(5.981)
× Capa(Roken)			2.164*	2.174	5.591
			(1.191)	(1.946)	(6.165)
× Capa(Tsusyo)			1.297	1.261	4.300
			(0.844)	(0.860)	(3.839)
× P($Certified\_t-1$)			1.580	1.371	2.263
			(1.687)	(1.749)	(8.996)
Linear term of NCL		0.071***	0.073***	0.070***	0.066**
		(0.013)	(0.014)	(0.017)	(0.029)
Number of observations	1083	1083	1083	760	205
Control variables	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes

[1] * $p < .1$, ** $p < .05$, *** $p < .01$

[2] Standard errors in parentheses are clustered robust at city and the maximum nursing care level of parents in all survey years.

[3] In the estimation model, we also include age, age squared, a dummy variable taking value one if the respondent is over the pension eligibility age, number of children, household income, house ownership, amount of savings, and city-year fixed effects.

Table 9: Effects of Instruments on Time Spent Providing LTC by Working Status at age 54 or 1st Interview

	Non-regular/self-employed /not working				Regular worker			
	(1) $\geq$ 5h	(2) $\geq$ 10h	(3) $\geq$ 15h	(4) $\geq$ 20h	(5) $\geq$ 5h	(6) $\geq$ 10h	(7) $\geq$ 15h	(8) $\geq$ 20h
1{NCL $\geq$ C3}	0.549	0.323	0.251	0.332	-3.479**	-3.388**	-0.742	-0.302
	(0.466)	(0.379)	(0.380)	(0.359)	(1.324)	(1.437)	(1.070)	(0.944)
1{NCL $\geq$ C3}								
$\times$ Capa(Tokuyo)	-2.424	-0.189	0.043	-0.054	2.229	-1.058	2.007	0.970
	(1.727)	(1.467)	(1.466)	(1.458)	(4.087)	(3.898)	(3.826)	(3.480)
$\times$ Capa(Roken)	-2.184	-2.636**	-2.472**	-2.151**	-10.983**	0.374	-1.155	-0.446
	(1.850)	(1.106)	(1.156)	(1.053)	(4.447)	(3.595)	(2.403)	(2.037)
$\times$ Capa(Tsusyo)	-1.876**	-1.138**	-1.174**	-1.237**	-6.253*	-5.643*	2.917	3.003
	(0.835)	(0.554)	(0.522)	(0.514)	(3.440)	(3.043)	(2.451)	(2.410)
$\times$ P($Certified\_t-1$)	-1.307	-0.701	-0.470	-0.559	25.658***	21.919**	-1.078	-2.734
	(0.925)	(0.883)	(0.889)	(0.886)	(8.640)	(8.832)	(3.086)	(2.919)
Linear term of NCL	0.102***	0.052***	0.051***	0.038***	0.129***	0.080**	0.051	0.033
	(0.016)	(0.012)	(0.012)	(0.012)	(0.040)	(0.038)	(0.031)	(0.025)
Number of observations	716	716	716	716	198	198	198	198
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[1] * $p < .1$, ** $p < .05$, *** $p < .01$

[2] Standard errors in parentheses are clustered robust at city and the maximum nursing care level of parents in whole survey years.

[3] In the estimation model, we also include age, age squared, a dummy variable taking value one if the respondent is over the pension eligibility age, number of children, household income, house ownership, amount of savings, and city-year fixed effects.

Table 10: Effects of Provision of Informal Care on Labor Force Participation (Non-regular; Self-employed; and Not Working) at Age 54 or 1st Interview

	Working for pay		Working ≥ 5h/w		Working ≥ 10h/w		Working ≥ 20h/w	
	(1) FE	(2) FE-IV	(3) FE	(4) FE-IV	(5) FE	(6) FE-IV	(7) FE	(8) FE-IV
Providing informal care	-0.101**	-0.112	-0.037	-0.030	-0.028	-0.043	-0.048	-0.143
	(0.045)	(0.101)	(0.049)	(0.087)	(0.047)	(0.109)	(0.040)	(0.106)
Linear term of NCL	0.003	0.003	-0.002	-0.003	0.004	0.004	0.003	0.008
	(0.008)	(0.009)	(0.008)	(0.008)	(0.009)	(0.010)	(0.008)	(0.010)
Number of observations	760	760	712	712	712	712	712	712
OverID		0.40		0.55		0.58		0.90
pvalue"		0.90		0.91		0.88		0.38
DWH pvalue		12.67		15.18		15.18		15.18
F statistic for weak identification	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[1] * $p < .1$, ** $p < .05$, *** $p < .01$

[2] Standard errors in parentheses are clustered robust at city and the maximum nursing care level of parents in whole survey years.

[3] In the estimation model, we also include age, age squared, a dummy variable taking value one if the respondent is over the pension eligibility age, number of children, household income, house ownership, amount of savings, and city-year fixed effects.

Table 11: Effects of Time Spent Providing LTC on Work Status (Working for Pay, Non-regular; Self-employed; and Not Working), at Age 54 or 1st Interview

	(1) FE	(2) FE-IV	(3) FE	(4) FE-IV	(5) FE	(6) FE-IV	(7) FE	(8) FE-IV
LTC $\geq$ 5h/w	-0.093*	-0.138						
	(0.054)	(0.151)						
LTC $\geq$ 10h/w			-0.067	-0.340				
			(0.058)	(0.314)				
LTC $\geq$ 15h/w					-0.092	-0.316		
					(0.068)	(0.316)		
LTC $\geq$ 20h/w							-0.100	-0.378
							(0.077)	(0.391)
Linear term of NCL	-0.002	-0.001	-0.004	0.000	-0.004	-0.000	-0.004	-0.000
	(0.007)	(0.009)	(0.007)	(0.010)	(0.007)	(0.010)	(0.007)	(0.010)
Number of observations	716	716	716	716	716	716	716	716
OverID		0.16		0.25		0.21		0.25
pvalue"		0.75		0.35		0.44		0.46
DWH pvalue		6.66		4.01		3.76		3.09
F statistic for weak identification	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[1] * $p < .1$, ** $p < .05$, *** $p < .01$

[2] Standard errors in parentheses are clustered robust at city and the maximum nursing care level of parents in whole survey years.

[3] In the estimation model, we also include age, age squared, a dummy variable taking value one if the respondent is over the pension eligibility age, number of children, household income, house ownership, amount of savings, and city-year fixed effects.

Table 12: Effect of Informal Care Provision on Working Status, Regular Worker Aged 54 or 1st Interview, Using Only NCL3 Dummy As Instrument

	Working		Regular worker		Non-regular /self-employed		Unemployed	
	(1) FE	(2) FE-IV	(3) FE	(4) FE-IV	(5) FE	(6) FE-IV	(7) FE	(8) FE-IV
Providing informal care	-0.075	0.128	-0.027	0.032	-0.077	0.009	0.091	0.182
	(0.058)	(0.125)	(0.112)	(0.183)	(0.108)	(0.230)	(0.090)	(0.154)
Linear term of NCL	-0.005	-0.026	-0.027***	-0.033*	0.005	-0.003	-0.008	-0.017
	(0.010)	(0.018)	(0.010)	(0.018)	(0.012)	(0.025)	(0.009)	(0.011)
Number of observations	205	205	204	204	204	204	204	204
OverID		.		.		.		.
pvalue"		0.09		0.67		0.61		0.42
DWH pvalue		26.29		26.56		26.56		26.56
F statistic for weak identification	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[1] * $p < .1$, ** $p < .05$, *** $p < .01$

[2] Standard errors in parentheses are clustered robust at city and the maximum nursing care level of parents in all survey years.

[3] In the estimation model, we also include age, age squared, the dummy variable taking value one if the respondent is over the pension eligibility age, number of children, household income, house ownership, amount of savings, and city-year fixed effects.

Table 13: Effect of Informal Care Provision on Lagged Working Status (FE)

	Non-regular/self-employed /not working			Regular worker		
	(1) Working at t	(2) Working at $t+1$	(3) Working at $t+2$	(4) Working at t	(5) Working at $t+1$	(6) Working at $t+2$
Providing informal care	-0.118	-0.062	-0.102	-0.137	0.458***	-0.286***
	(0.100)	(0.085)	(0.070)	(0.106)	(0.132)	(0.082)
Linear term of NCL	0.003	-0.003	0.022**	-0.001	-0.050**	0.023
	(0.018)	(0.014)	(0.010)	(0.020)	(0.022)	(0.015)
Number of observations	242	242	242	68	68	68
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes

[1] * $p < .1$, ** $p < .05$, *** $p < .01$

[2] Standard errors in parentheses are clustered robust at city and the maximum nursing care level of parents in all survey years.

[3] In the estimation model, we also include age, age squared, the dummy variable taking value one if the respondent is over the pension eligibility age, number of children, household income, house ownership, amount of savings, and city-year fixed effects.

A Appendix

A.1 Comparison with the Japanese Literature

Here, we comparing the results of this study with those of the Japanese literature summarized in Table 14. [33] In Japan, the studies directly analyzing the effect of informal care on labor force participation are Yamada and Shimizutani (2015), Ishii (2015), and Moriwaki (2016). Other studies estimate the effect of LTCI or nursing home capacity but do not directly estimate the effect of the provision of informal care on labor force participation. First, while Yamada and Shimizutani (2015) and Moriwaki (2016) find that providing informal care has a negative effect on male labor force participation, our study using exogenous variation in the supply side of the eldercare market finds no effect. Additionally, our estimates of the effect of informal care on female labor force participation are small compared to Yamada and Shimizutani (2015) and Ishii (2015). This is because we use different instruments compared to theses studies.

[33] We omit Wakabayashi and Donato (2005) because it does not consider the endogeneity of informal care.

Table 14: Japanese Literature

	Analysis Method	Instruments	Results	Data
Shimizutani et al (2008)	DID	-	Not Direct Effect	• Survey on Long-term Care Users • Survey on Elderly Medical Care Insurance
Sugawara and Nakamura (2014)	Two part model	-	No Direct Effect	Comprehensive Survey of Living Conditions
Yamada and Shimizutani (2015)	IV method	Age, Health Status, and Gender of a Parent.	• Negative Effect on Labor Force Participation (-0.202, Male)(-0.581, Female) (The effect of being a main caregiver on labor participation)	Comprehensive Survey of Living Conditions
Fukahori et al (2015)	DID	-	No Direct Effect	Comprehensive Survey of Living Conditions
Ishii (2015)	IV method	Age of Eldest Parent	• Exogeneity of Daily Care • Negative Effect on Female Labor Participation (-0.134 (Coresident, OLS))	JSTAR (only female)
Moriwaki (2016)	FEIV method	Care Level	• Negative Effect on Male Labor Force Participation (-0.545)	JSTAR
Kondo (2016)	Probit model	-	No Direct Effect	• Labour Force Survey • Employment Status Survey

A.2 Asset Level Imputation

In this paper, we use the imputed value of saving for our analysis in order to prevent sample omissions due to missing values. In this section, we explain the procedures for imputing the savings variable. First, we show the structure of the JSTAR questionnaire with respect to the savings variable and explain reasons why some saving values are missing. Then, we explain the imputation procedures, which are a simplified version of the HRS method as described in Hurd et al. (2016).

Finally, we compare the imputed saving values with the original saving values and the imputed values from the harmonized JSTAR.

A.2.1 Questionnaire Structure of Savings Variable

The JSTAR has two types of interviews. One is the leave-behind (LB) questionnaire interview and the other is a computer-assisted personal interview (CAPI). Respondents are required to answer the LB questionnaire first, followed by the CAPI. Questions about savings are asked in both questionnaires. Figure 15 shows the structure of questions with respect to saving values, based on the structure of JSTAR 2007.

First, in the LB questionnaire, respondents are asked to answer questions on the ownership and amount of savings for both the respondent and his/her spouse. The procedure is as follows:

1. A respondent indicates the ownership of their savings. (Q32)

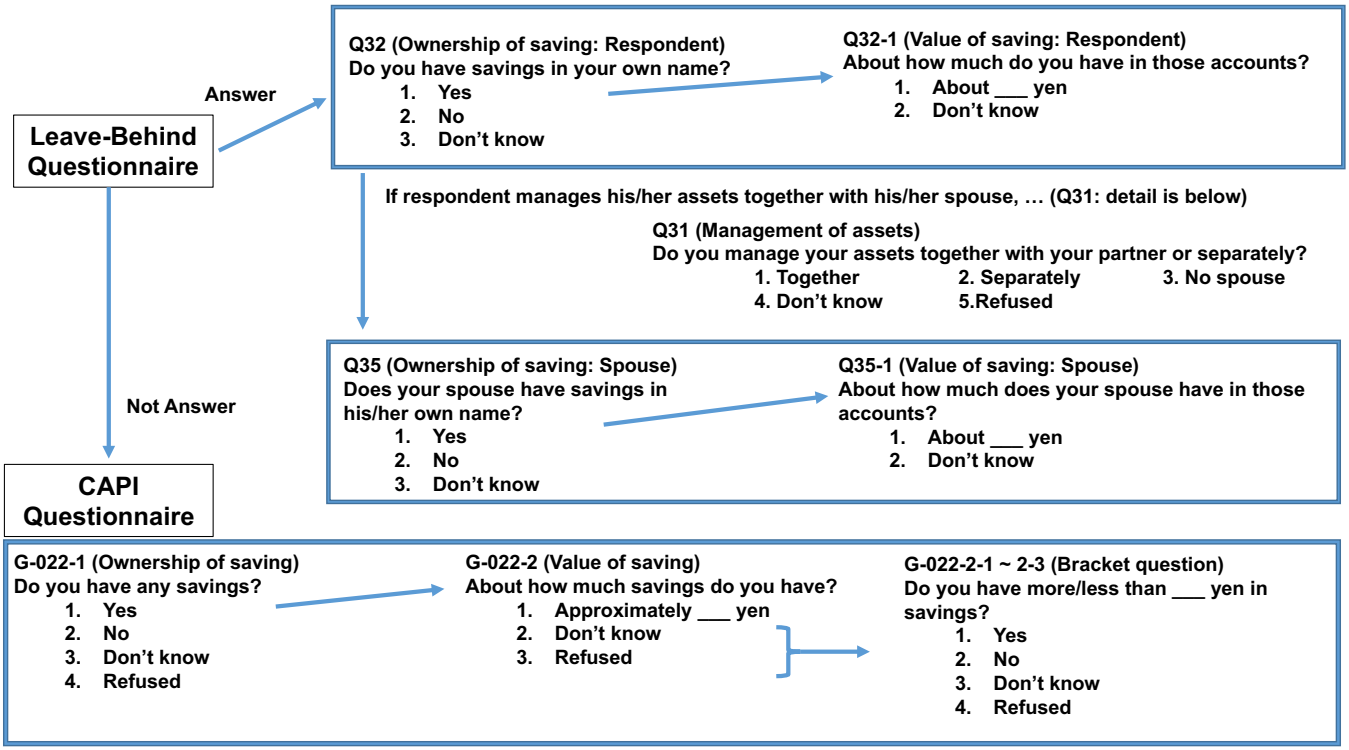
2. If answering "yes" in Q32, respondents indicate the value of their own savings. (Q32-1)

3. If a respondent manages his/her assets together with their spouse (Q31) [34], they move to questions about his/her spouse's savings information.

4. A respondent identifies the ownership of his/her spouse's savings. (Q35)

[34] Q31 asks "Do you manage your assets together with your spouse (or common-law spouse) or separately?" and the answer choices are "1. together"; "2. separately"; "3. no spouse"; "4. don't know"; and "5. refused."

Figure 15: JSTAR's questionnaire structure of saving variable



5. If answering "yes" in Q35, a respondent indicates the value of his/her spouse's savings. (Q35-1)

If not answering the savings information in the LB questionnaire, a respondent is asked to indicate household level savings in the CAPI. The procedure for the CAPI questions is as follows:

1. A respondent indicates the ownership of any savings. (G-022-1)

2. If answering "yes" in G-022-1, a respondent identifies the amount of savings. (G-022-2)

3. If the savings value is not answered in G-022-2, a respondent is asked to answer the savings value as a bracket question three times as described in Figure 15, G-022-2-1 ∼ G-022-2-3.

As a result of this procedure, we can obtain either the individual level (respondent and/or spouse) savings variables (ownership and value) or the household-level savings variables (ownership and value (or brackets)). Finally, using this information, we can construct the household-level savings values as follows:

Case 1: continuous values;

Case 2: bracket values;

Case 3: only ownership;

Case 4: no information about ownership.

However, in Cases 2, 3, and 4, savings values are missing and cannot be used for our analysis. Consequently, although the Harmonized JSTAR provides imputed values for savings for Cases 2 and 3, to be consistent, we impute the savings values for Cases 2-4. [35]

A.2.2 Imputation Procedures

We use the simplified version of the HRS method for imputing values for savings by using cross-sectional variation.[A.2] The outline of the imputation procedure is as follows:

Step 0: Constructing the HH level variables.

- Step 0-1: Construct the HH level variables using LB questionnaire information.
- Step 0-2: If there are missing values in the variables constructed above, merge those with the variables surveyed in CAPI.

Step 1: Ownership imputation.

- Step 1-1: Estimate the ownership imputation model using a binary logit model.
- Step 1-2: Calculate the predicted probabilities of ownership.
- Step 1-3: Draw random variables from the uniform distribution.

[35] See the codebook of the Harmonized JSTAR at `https://g2aging.org/startfile.php?f=codebooks/Harmonized%20JSTAR%20B.pdf` for more details.

Step 1-4: Assign ownership using the predicted probabilities and random variables.

Step 2: Bracket imputation.

Step 2-1: Estimate the bracket imputation model using an ordered logit model.

Step 2-2: Calculate the predicted probabilities in the j-th bracket.

Step 2-2: Draw random variables from the uniform distribution.

Step 2-2: Assign bracket j using the predicted probabilities and random variables.

Step 3: Value imputation

Step 3-a: Use nearest neighbor method for closed brackets

Step 3-a-1: Estimate the linear value imputation model.

Step 3-a-2: Calculate the predicted savings values.

Step 3-a-3: Define donor groups

Step 3-a-4: Assign the imputed values from the donor group.

Step 3-b: Use Tobit 25 method for upper open brackets

Step 3-b-1: Estimate the tobit value imputation model.

Step 3-b-2: Assign the imputed values from the estimated distribution.

In Step 0, we construct the household level variables such as the ownership, values, and bracket values of savings using both the LB questionnaire and CAPI information. First, we construct the household level savings ownership and values using individual level variables surveyed in the LB questionnaire. If the individual level variables have missing values, we merge those with the household level variables surveyed in CAPI. Then, we generate the household level bracket values using CAPI variables. [36] Finally, we obtain three household level variables (ownership, values, and bracket values) of saving and call these original household level variables.

[36] Here, for simplicity, we reconstruct the brackets as [0,500), [500,1500), [1500,∞), with unit: JPY 10k.

In Step 1, we impute the ownership of savings using the logit model. First, we regress the original ownership on covariates using logit and obtain the predicted probabilities of savings ownership, p_{it}.[37] Second, we draw a random variable, u_{it}, from the uniform distribution, $U(0,1]$, and assign ownership $(=1)$ if $u_{it} < p_{it}$ and non-ownership $(=0)$ otherwise.

In Step 2, we impute the bracket value of savings using an ordered logit model. We regress the bracket categories on the covariates using an ordered logit model and obtain the predicted probabilities of being in the j-th bracket, p_{ijt}. Then, we calculate the cumulative probabilities for each bracket, $P_{ijt} = \sum_{k=1}^{j} p_{ikt}$. Finally, we draw a random variable, v_{it}, from the uniform distribution, $U(0,1]$, and if $P_{i,j-1,t} < v_{it} \leq P_{ijt}$, we assign bracket j.

In Step 3, we impute the values of savings using two imputation methods depending on the bracket values. There are two types of brackets: closed brackets, which have a closed interval; and upper open brackets, which have an open upper interval. [38] For closed brackets, we use the nearest neighbor (NN) method. First, we regress the savings values applying an inverse hyperbolic sine transformation on the covariates using a linear regression model for all households and obtain the predicted values for savings. Second, for each bracket, we define a donor group from the households who report a value within the bracket of interest. Finally, from the donor group, the reported value that is closest to the predicted value is assigned to each household with missing continuous values and an original or imputed bracket.

On the other hand, for upper open brackets, we use the tobit 25 method. First, we regress the logged saving values on covariates using the tobit model with a threshold that is the 25th percentile of the savings value distribution. Second, from the estimated distribution, we assign the imputed values for households with upper open brackets conditional on the given bracket.

A.2.3 Imputation Results

Table 15 shows the summary statistics for the original and imputed savings values for each wave. The column "original" shows the original savings values, "ours" shows the values

[37] We use female dummy, age, age squared, education dummies, marital status dummies, number of children, and municipality dummy variables as covariates.

[38] Here, [0,500) and [500,1500) are the closed brackets and [1500,∞) is the upper open bracket.

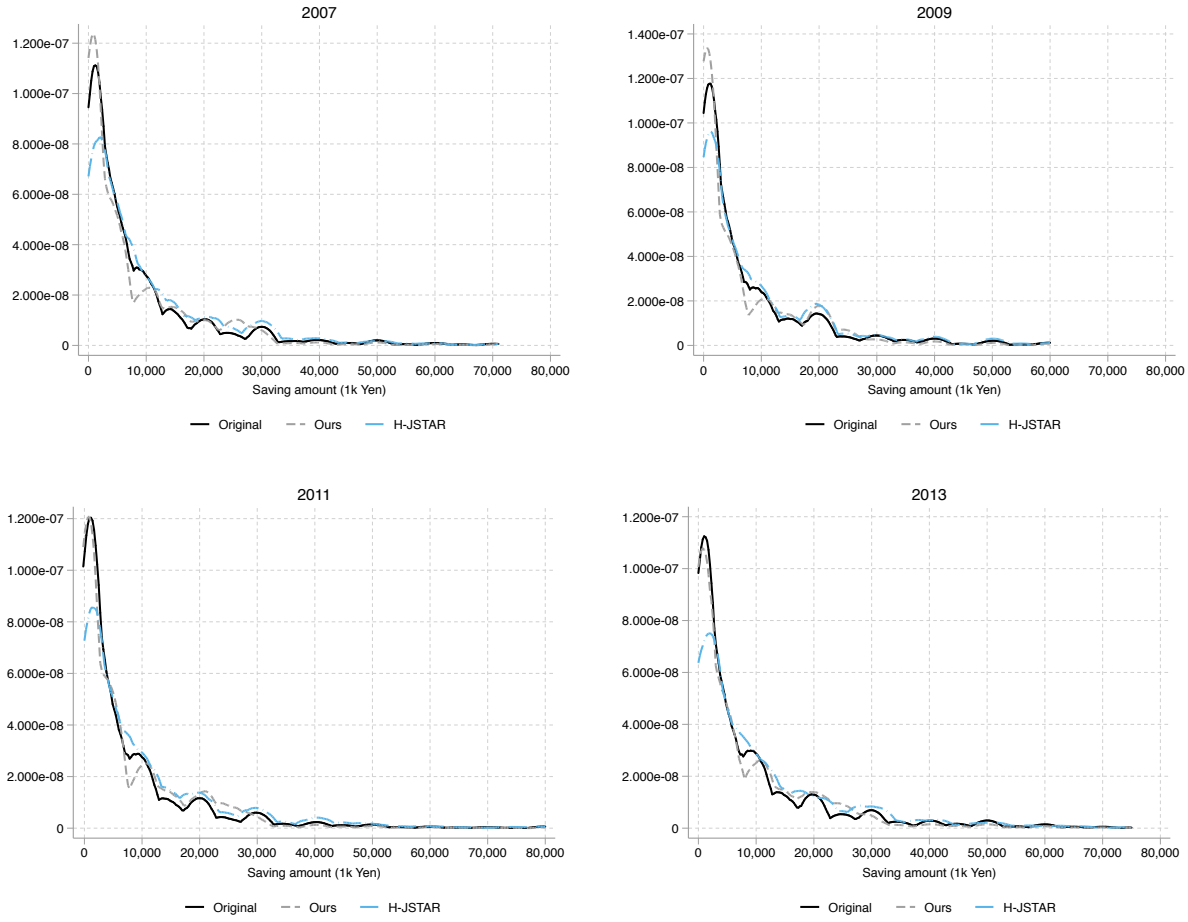
imputed by our method, and "H-JSTAR" shows the values imputed by the Harmonized JSTAR. The unit of saving values is ten thousand yen. In all waves, we recover the 1.5 times observations as original values. Figure 16 illustrates the distributions of the values. The blue solid lines indicate the distribution of the original values, and the red and green dashed lines show our and Harmonized JSTAR imputed values, respectively. Comparing the red and blue lines, the distributions of our imputed variables have roughly similar forms to the distributions of the original values.

Table 15: Summary statistics of original and imputed savings values

Statistics	**Original**	**Ours**	**H-JSTAR**	**Statistics**	**Original**	**Ours**	**H-JSTAR**
2007				**2011**			
observations	2479	4189	3170	Observations	2861	5319	4234
mean	8500.299	7604.792	10605.29	mean	12035.36	9759.859	14236.54
sd	14624.14	12382.25	15493.07	sd	191121.7	140290.6	160289.3
min	0	0	0	min	0	0	0
p10	0	0	0	p10	0	0	0
p25	1000	400	1500	p25	500	300	1000
p50	4000	3000	5000	p50	3000	3500	5000
p75	10000	10000	14000	p75	10000	10500	14000
p90	21000	21600	30000	p90	20000	21000	30000
p95	30000	27400	37000	p95	30000	26000	40000
p99	70000	50680	75000	p99	65000	50000	90000
max	300000	300000	300000	max	10000000	10000000	10000000
2009				**2013**			
observations	2574	4540	3369	Observations	2495	4370	3143
mean	8173.161	7039.629	9940.331	mean	9935.158	8621.014	11712.59
sd	15798.98	12629.73	16706.41	sd	22306.74	17644.23	17876.77
min	0	0	0	min	0	0	0
p10	0	0	0	p10	0	0	0
p25	440	100	1000	p25	1000	250	1000
p50	3000	2300	5000	p50	4000	4000	6000
p75	10000	10000	13000	p75	10100	11200	15000
p90	20000	20000	25000	p90	25000	22000	30000
p95	31500	25000	40000	p95	40000	28400	40000
p99	60000	50000	62000	p99	75000	60000	80000
max	400000	400000	400000	max	500000	500000	270000

[1] Unit: 1k yen

Figure 16: Distributions of original and imputed savings values



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