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Why Do the Japanese Enjoy Longevity? Do Health Care Expenditures Contribute it?

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Why Do the Japanese Enjoy Longevity? Do Health Care Expenditures Contribute it?☆

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Abstract

Considering health status as the output of health care, health care expenditures can extend life expectancy. We examine the impact of health care expenditures per capita on life expectancy using Japanese prefectural datasets over the past 30 years. We clarify that (1) decreasing medical resources indeed reduce health care expenditures and (2) inpatient health care expenditures have a significant positive impact on longevity. Decreasing health care expenditures could also decrease the health performance in Japan.

Key words: health care expenditure; life expectancy; longevity; medical resources

JEL classification number: H51, H75, I10, I12, I18, O39

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1. Introduction

Considering health outcomes as the output of health care investment, medical expenditures can extend life expectancy. Many papers discuss the relationship between health care expenditures and health outcomes. For example, Shaw et al. (2005) examine the determinants of life expectancy in 1997 for OECD countries and find that the pharmaceutical expenditures per capita have a positive effect on life expectancy. Using cross-countries datasets, Bokhari et al. (2007) also conclude that government health care expenditures have a positive impact on health outcomes. Caliskan (2008) reveals the positive impact of pharmaceutical expenditures on life expectancy, using cross-OECD-country panel datasets. These results obtained from cross-country comparison point out that increasing health care expenditures increase the health performance.

However, as for Japan, life expectancy remains high with relatively less health care expenditures. Japan enjoys the highest level of longevity in OECD countries. According to the 2008 OECD Health Data, life expectancy at birth for the entire Japanese population was 74.3 years in 1975 and 82.0 years in 2005. On the other hand, the medical expenditures in Japan are not significant among OECD countries. The total expenditure on health per capita in Japan, which was measured in purchasing power parity dollars in 2000, was $796 in 1975 and $2,212 in 2005, that in the United States was $1,555 in 1975 and $5,616 in 2005, and that in Sweden was $1.390 in 1975 and $2,841 in 2005.

Why is the life expectancy of the Japanese people higher, although its health care expenditures are not significant among OECD countries? It is possible that the Japanese people are originally healthier than people in other OECD countries. However, more importantly, there is an inherent heterogeneity associated with cross-country comparisons. Gerdtham and Jönsson (2000) point out that there is ample scope for imperfect reliability with respect to cross-country comparisons due to differential identification of health care services, systems, or policies. For example, medical fee is officially fixed under the public health insurance system in Japan, while the public health insurance system, except for Medicare and Medicaid, does not even exist in the United States. Japan has had a universal health insurance system since 1961, and everyone living in Japan, except for those receiving public livelihood aid, receive coverage under the public health insurance system.

Crémieux et al. (1999) consider that a cross-country comparison could suffer from a high degree of heterogeneity, and using regional-level panel datasets over the period of 1975–1994 in Canada, they reveal that the health care expenditure per capita has a positive impact on life expectancy. Using cross-region (cross-prefecture) datasets limits data heterogeneity.

Japan has 47 prefectures, and this regional partitioning has effectively provided a foundation for national solidarity. Many Japanese people feel affection for their native place and are proud of their regional identity, which can be expressed as their "prefectural characteristics." Cultures, traditions, and lifestyles differ among prefectures. In addition, health care expenditure per capita and life expectancy also vary among prefectures in Japan. However, there is a vaguely, but popularly held belief in Japan that cultures, traditions, and other scientifically unobserved regional factors, rather than health care expenditure, may have a potentially large impact on extending longevity.

Do the differences in health care expenditures between prefectures affect on the differences in life expectancy between them? Do higher health care expenditures prolong life expectancy in Japan? Suppose that a higher health care expenditure per capita in some provinces make the residents healthier; in that case, we would conclude that health care spending is a useful health care investment. Note that even if the residents of other provinces are not in good health, regardless of their high health care expenditures, we cannot simply conclude that their health care investments are less useful, because discrepancies would already exist with respect to the level of health between regions. Moreover, even if there were originally no discrepancies in the health status between regions, we could observe the effects of health care expenditures on health outcomes through the long-term relationship between the two factors. Long-term datasets are needed to examine the relationship between health care spending and health outcomes. Fukui and Iwamoto (2004) examine the relationship between medical spending and health outcomes using Japanese regional-revel datasets in 1990 and 2000, and they show that the increase in medical spending does not have a statistically significant effect on life expectancy. However, previous research considers the causal interrelationship between health care spending in Japan and Japanese health outcomes without using long-term regional-level panel datasets.

In this paper, we examine the impact of the health care expenditure per capita on life expectancy, which is regarded as a health outcome, using macro-level datasets collected from the 47 prefectures in Japan over the past 30 years. We distinguish health care expenditures for inpatients from that for outpatients by taking into account the difference between inpatients and outpatients with regard to the quality or cost of medical care received. The paper is organized as follows. In the following section (Section 2), we overview the features of life expectancy and consider health care expenditure by prefecture in Japan over the past 30 years. In Section 3, we describe the empirical model that we use to examine the impact of health care spending on longevity, and we report the estimation results in Section 4. In Section 5, we detail our conclusions.

2. Longevity and Health Care Expenditures in Japan: Data Description

Longevity does vary among prefectures in Japan. Figure 1 shows the Japanese life expectancy over the past three decades, which is reported by the Life Table (the Statistics Bureau). The average increase in longevity during the 15 years *after* 1990 remained small compared to that during the 15 years *before* 1990. However, the differences in the level of longevity between prefectures do not change significantly over the long-term. For example, Okinawa and Nagano have maintained higher life expectancy for several decades. The life expectancy at age zero in Okinawa was 72.15 years in 1975 and 78.64 years in 2005 for males, while it was 78.96 years in 1975 and 86.88 years in 2005 for females. On the other hand, Aomori has maintained the lowest life expectancy for several decades.

Figure 1 around here

Figure 2 around here

Meanwhile, health care expenditures also vary among prefectures. As shown in Figure 2, for several decades, the health care expenditure per person insured under National Health Insurance (hereafter NHI) in Okinawa has been the lowest in Japan, while Kochi, Hokkaido, Toyama, and

Ishikawa have maintained the highest medical expenditures per capita under NHI.[1] Some previous research has shed light on the differences between health care expenditures between regions or prefectures in Japan. Using Japanese prefectural-level datasets in 1993, Tokita et al. (2000) suggest that disparities in the number of hospital beds in each prefecture give rise to differences in medical expenditures per capita under NHI among prefectures. Moreover, they also point out that medical devices such as CT scanners or MRIs increase medical costs under NHI in Japan. In the U.S., the thesis that the primary reason for the increase in health care expenditures is the introduction and diffusion of new developments in medical technology is well supported (for example, Newhouse, 1992; Fuchs, 1996). Okunade and Murthy (2002) show that health R&D spending, which is a proxy for health care technological change, is one of the major drivers of health care expenditures in the U.S., using the 1960–1997 period time-series datasets.

Figure 3 around here

It is not surprising that health care expenditures differ from region to region. However, the differences in health care expenditures between regions may create differences in health conditions between regions. Figure 3 shows the correlations between health care expenditures under NHI and life expectancy in 1975 and in 2005 for both males and females. With respect to inpatients (Figure 3A), the data shows negative correlations between the two factors, except for females in 2005. On the other hand, regarding outpatients, there were no significant correlations between the two factors (Figure 3B). The data suggests that the impact of medical expenditures on life expectancy may differ between inpatients and outpatients.

Can these relationships be observed in the elderly populations, who have relatively higher health care expenditures than the younger populations? Examining the correlations between medical spending for those aged 70 and over and life expectancy at age 65, the positive correlations between inpatient health care spending and life expectancy become increasingly clear after 1995,

[1] NHI provides insured non-employees (for example, the self-employed and retirees) and their dependents with insurance benefits for their health care, but the insured patients must pay a portion of the health care expenditures themselves.

while the correlations between outpatient health care spending and life expectancy are ambiguous.

Provided that good health can decrease the health care expenditure per capita, we consider an increase in longevity as having a negative impact on health care spending per capita, after controlling for other characteristics. The negative impact of increasing longevity on health care expenditures is observed by Zweifel et al. (1999) and Werblow et al. (2007) using Swiss micro datasets, Shang and Goldman (2008) using American micro datasets, and Miller (2001) using American macro-level datasets. In Japan, Ohkusa (2002) and Suzuki and Suzuki (2003) point out comparable results using micro datasets. These results suggest that there is an endogeneity problem between longevity and health care spending. Furthermore, it seems that there exist unobserved prefectural characteristics, which affect the health care expenditures and health status. For example, the values in Okinawa and Nagano differ from those in other prefectures over the 30-year period. These findings indicate that we should take the endogeneity of health care expenditures and the prefectural heterogeneity into account when examining the impact of health care expenditures per capita on life expectancy.

Therefore, we use prefecture-level panel datasets and take the two-stage least squares estimation procedure to overcome the above-mentioned problems: the endogeneity and the heterogeneity. Figure 4 illustrates the logical framework we will use to analyze the causal interrelationship between health care expenditures and health outcomes. The symbols in brackets denote an expected impact. Health care expenditures per capita depend on the level of health care services available, e.g., the number of hospitals/clinics and the level of development of the medical technology available in the prefecture (path a), and health care expenditures will have a positive impact on health status (path b). Note that good health will also have a negative impact on health care expenditures (path c).

Figure 4 around here

3. The Impact of Health Care Expenditure on Longevity: Estimation Model

We will now consider a model in which individuals obtain satisfaction from not only consuming goods but also from their own health, and whereby their health status improves as a result of health care spending. Health care expenditures for individual i, HE_{it}, are specified as the following function:

$$HE_{it} = g(X_{it}, Z_{it}), \tag{1}$$

where both X_{it} and Z_{it} denote observable vectors of exogenous variables, X_{it} represents the level of income, and Z_{it} represents the amount of medical resources available. Considering the fact that health is produced by the optimum level of health care expenditures, HE^*_{it}, the health production function can be written as follows:

$$H_{it} = f(HE^*_{it}, X_{it}). \tag{2}$$

The above framework gives rise to the following empirical model:

$$HE_{it} = X_{it}\beta_1 + Z_{it}\gamma + p_i + u_{1it}, \tag{3}$$

$$H_{it} = \alpha HE^*_{it} + X_{it}\beta_2 + p_i + u_{2it}, \tag{4}$$

where i and t denote the prefecture and the year, respectively. Tables 1 and 2 summarize the details and descriptive statistics of the variables used in the empirical model, respectively. HE_{it} denotes the amount of health care expenditures per person insured under NHI and H_{it} denotes the number of years that an infant aged zero is likely to live, that is, longevity. p_i is an individual prefecture's unobservable specific factor, which consists of the effects of the cultures, traditions, or lifestyles of each prefecture, and u_{1it} and u_{2it} are unobserved error terms.

Next, we difference equations (3) and (4) over time to eliminate the unobservable factor, p_i. If we define $\Delta HE_{it} = HE_{it} - HE_{i,t-1}$; $\Delta H_{it} = H_{it} - H_{i,t-1}$; $\Delta X_{it} = X_{it} - X_{i,t-1}$; $\Delta Z_{it} = Z_{it} - Z_{i,t-1}$; and $\Delta u_{.it} = u_{.it} - u_{.i,t-1}$, we can respectively express equations (3) and (4) as follows:

$$\Delta HE_{it} = \Delta X_{it}\beta_1 + \Delta Z_{it}\gamma + \Delta u_{1it}, \tag{3'}$$

$$\Delta H_{it} = \alpha\Delta HE^{*}_{it} + \Delta X_{it}\beta_2 + \Delta u_{2it}, \tag{4'}$$

where ΔHE^{*}_{it} is the predicted value of HE_{it} that is gained from the estimation results in equation (3')[2]

Table 1 around here

Table 2 around here

We divide the amount of health care expenditure per person insured under NHI, HE_{it}, into health care expenditures for inpatients, HE^{In}_{it}, and that for outpatients, HE^{Out}_{it}, taking into consideration the difference between inpatients and outpatients concerning the quality or cost of medical care. Tokita et al. (2000) use Japanese prefectural cross-section datasets and report that the determinants of medical expenditures for inpatients are different from those for outpatients.

We include the variable "average income per household" controlling for household economic status and the variable "out-migrants" controlling for demographic composition in X_{it} both in equations (3') and (4'). Z_{it}, which represents the amount of medical resources, is included in the variables "the installation rate of computed tomography (CT) scanners" and "the number of hospital beds per 10,000 people," or "the number of hospitals or clinics per 10,000 people." Thirty years have passed since the first CT scanner was installed at a Japanese medical institution in 1975. According to the Survey of Medical Care Facilities, conducted by the Ministry of Health, Labor and Welfare, the degree of installation of CT scanners varies widely among prefectures, with many

[2] We conduct the J-test for over-identifying restrictions and report the results in Table 4.

hospitals and clinics having accelerated the installation of CT scanners since the 1990s in Japan.

Using "health care expenditures for inpatients" as a dependent variable, we include "number of hospital beds per 10,000 people" in Z_{it}. On the other hand, using "health care expenditures for outpatient" as a dependent variable, we include "number of hospitals or clinics per 10,000 people" in Z_{it}. Both variables would be institutional factors in the Japanese medical sector.

4. Estimation Results

4.1. Results for Persons Insured under NHI

Table 3 reports the estimation results of the health care expenditures function. The "year effects" in Table 3 represent the inclusion of an intercept and time dummies to capture the aggregate time effects. We separately conduct estimations for all persons insured under NHI and for only the elderly insured under NHI, because there are large differentials in health care spending between the elderly and the non-elderly. Insured persons aged 70 and over (or insured persons with disabilities aged 65 and over) are covered by the elderly health care system.[3] They can receive benefits for health care services at relatively lower copayments than the non-elderly.

Table 3 around here

Columns (1a) and (1b) show the results when the health care spending for all insured persons is used as the dependent covariate. First, let us examine the impact of income on health care expenditures on NHI. As shown in Column (1a), there is a positive impact of the average income per household on the inpatient health care spending at the 10% significance level. A 10% increase in the average income per household would be associated with an increase in inpatient health care spending per capita of approximately 1.5% ($0.016 \times \frac{21.25\times 10}{22.47}$), evaluated at the mean of covariates. Column (1b) shows the estimation results for outpatients. We can also observe the positive impact of the average income per household on the outpatient medical expenditures for the NHI insured at the 1% significance level. A 10% increase in the average income per household would be

[3]The eligible age for the elderly health insurance was raised from "70 and over" to "75 and over" in 2002.

associated with an increase in outpatient medical spending per capita of roughly 3.3% ($0.024 \times \frac{21.25\times 10}{15.44}$), evaluated at the mean of the variables.

Note that by focusing on only the elderly, we observe the negative impact of income on health care expenditure. Columns (2a) and (2b) report the estimation results for only the insured persons aged 70 and over on NHI. The signs of the coefficients in Columns (2a) and (2b) are negative, although the coefficient of income per household in Columns (2b) is not significant.

Increased medical resources are also associated with increased health care spending on NHI. A rise in the hospital bed stock per 10,000 people has a positive impact on the inpatient health care spending (Columns (1a) and (2a)), and there is also a positive impact of the number of hospitals/clinics per 10,000 people in Columns (1b) and (2b). An increase in the number of CT scanners, which is a proxy for medical technology, is also significantly associated with an increase in outpatient health care expenditures. These results could be interpreted as evidence that a reduction in the medical resources leads to a decrease in health care expenditures.

Table 4 around here

Following the first stage results, we examine the impact of health care expenditures on longevity. Columns (1a) and (1b) in Table 4A report the estimation results using the predicted values of inpatient health care spending for all NHI insured persons. We can observe the positive impact of inpatient medical spending on both male and female longevity at the 1% significance level after controlling for the effect of migration. Moreover, testing the null hypothesis–"the variable 'health care expenditures per insured person' is exogenous"–which is shown in the second line from the bottom in Columns (1a) and (1b), the sign of the predicted residual is negative and the null hypothesis is rejected. As mentioned in Section 2, there are two causal paths between health care spending and health outcomes; one is the impact of inpatient health care expenditures on health outcomes and the other is the impact of health status on inpatient health care expenditures. We could interpret the negative sign of the predicted residual as indication that good health has a negative impact on inpatient health care expenditures. Examining the impact of the elderly inpatient health care spending, we significantly observe the positive impact on male life expectancy at age 65 for the elderly at the 5% significance level (Column (2a) in Table 4B).

On the other hand, the impact of outpatient health care spending on longevity is ambiguous. Columns (1c)–(1d') in Table 4A report the estimation results when the predicted values of outpatient health care spending for all NHI insured persons are used.[4] The impact of outpatient health care spending is positive but insignificant with respect to longevity. Columns (2c)–(2d') in Table 4B suggest that outpatient health care expenditures for the elderly have a negative impact on life expectancy at age 65. The impact of health care spending on life expectancy differs for inpatients and outpatients.

4.2. Results for Persons Insured both under NHI and GMHI

As previously mentioned, we have focused on the health care expenditures for those insured under NHI. However, Japan has two large public health insurance systems besides NHI. One is the Government managed Employees' Health Insurance (GMHI) that provides salaried workers and their dependents in small/mid size firms with health insurance benefits, and the other is the Society managed Employees' Health Insurance (SMHI) that provides employees and their dependents in large size firms with health insurance benefits.

Figure 5 shows the relative share of the population covered by each of these insurance systems in Japan. Most of the population aged 70 and over is covered by NHI. Approximately 70% and 80% of the elderly were covered by NHI in 1990 and 2005, respectively (Figure 5B). On the other hand, only approximately 30% of the *total* insured persons (including dependents) were covered by NHI both in 1990 and 2005 (Figure 5A). Approximately 30% of them were covered by GMHI both in 1990 and 2005, and approximately 25% of them were covered by SMHI both in 1990 and 2005. These figures suggest that many people below the age of 70 are not covered by NHI.

Figure 5 around here

[4]Columns (1c') and (1d') show the OLS estimation results, because the null hypothesis, "the variable 'health care expenditures per capita' is exogenous," is not rejected, as shown in Columns (1c) and (1d) in Table 4A.

Moreover, the amount of health care spending per capita on NHI is quite different from spending on GMHI or SMHI. Table 5 shows the health care expenditure per capita by type of public health insurance. There is no difference between the health care expenditure for *the elderly* on NHI and that of the elderly on GMI, as shown in Table 5B. However, examining the health care expenditure for persons *under 70 years* (Table 5A), we observe a significant gap between health care spending on NHI and health care spending on GMHI, although there is not much difference between health care expenditure on GMHI and that on SMHI. These findings suggest that the estimation results that use only the health care expenditures on NHI would have a sample selection problem, because we do not take GMHI or SMHI into consideration.

Table 5 around here

Therefore, we estimate equations (3') and (4') by considering not only the health care spending per capita on NHI but also that on GMHI. Columns (3a) and (3b) in Table 3 report the estimation results of the health care expenditures function. "Regional trends" represents the inclusion of region dummies to capture region-specific trends, and the variable "Employee share" is included in the independent variable controlling for differences between NHI and GMHI in terms of size.[5]

The impact of the average income per household is positive but insignificant for both the inpatient and outpatient health care expenditures. Meanwhile, we observe that an increase in the

[5]We consider additional estimation models that allow for region-specific trends to evaluate the regions of Hokkaido, Tohoku, Kanto, Koshinetsu, Hokuriku, Tokai, Kinki, Chugoku, Shikoku, Kyushu, and Okinawa. Consider the following models, which allow each region to have its own time trend:

$$\begin{aligned} HE_{it} &= X_{it}\beta_1 + Z_{it}\gamma + p_i + \lambda_j t + u_{1it}, \\ H_{it} &= \alpha HE^*_{it} + X_{it}\beta_2 + p_i + \lambda_j t + u_{2it}. \end{aligned}$$

$\lambda_j t$ denotes the trends of region j. Differencing this equation gives the following:

$$\begin{aligned} HE_{it} - HE_{i,t-1} &= (X_{it} - X_{i,t-1})\beta_1 + (Z_{it} - Z_{i,t-1})\gamma + (p_i - p_i) + \lambda_j\{t-(t-1)\} + (u_{1it} - u_{1i,t-1}) \\ &= \Delta X_{it}\beta_1 + \Delta Z_{it}\gamma + \lambda_j + \Delta u_{1it}, \\ H_{it} - H_{i,t-1} &= \alpha(HE^*_{it} - HE^*_{i,t-1}) + (X_{it} - X_{i,t-1})\beta_2 + (p_i - p_i) + \lambda_j\{t-(t-1)\} + (u_{2it} - u_{2i,t-1}) \\ &= \alpha\Delta HE^*_{it} + \Delta X_{it}\beta_2 + \lambda_j + \Delta u_{2it}, \end{aligned}$$

that is, we include the region dummies in equations (3') and (4').

amount of medical resources is associated with a significant increase in health care spending. The increase in hospital beds per 10,000 people induces inpatient health care spending (Columns (3a)), and the increase in the number of hospitals/clinics per 10,000 people induces outpatient health care expenditures (Columns (3b)). The number of CT scanners also has a significant positive impact on outpatient health care expenditures. It seems that a reduction in medical resources does indeed lead to a decrease in health care expenditures.

As expected, a significant positive impact of inpatient health care expenditures on longevity can be observed when we use the average of the inpatient health care expenditure per capita on both NHI and GMHI as the variable. Columns (3a) and (3b) in Table 4C show the results when the predicted values of inpatient health care spending from Column (3a) in Table 3 are used. We observe the positive impact of inpatient medical spending on both male and female longevity at the 1% significance level. On the other hand, the impact of outpatient health care spending on longevity remains ambiguous. These results show that there is a difference in the impact on life expectancy between inpatient and outpatient spending.

4.3. Long-term Effects of Health Care Expenditure on Longevity

In the previous section, we examined the short-term effects of health care expenditures on health outcomes. However, there is also a long-term relationship between health care spending and health outcomes. We will now examine the long-term effects of health care spending on health outcomes. We will consider the following estimation model with the first-lagged variable:

$$H_{it} = \alpha HE_{i,t-1} + X_{it}\beta + p_i + u_{it}.$$

Differencing the above equation gives the following:

$$\begin{aligned} H_{it} - H_{i,t-1} &= \alpha(HE_{i,t-1} - HE_{i,t-2}) + (X_{it} - X_{i,t-1})\beta + (p_i - p_i) + (u_{it} - u_{i,t-1}) \\ &= \alpha \Delta HE_{i,t-1} + \Delta X_{it}\beta + \Delta u_{it}. \end{aligned} \tag{5}$$

We expect that a prior health care expenditure (one that occurred half a decade ago) will have a positive impact on the present health status. Table 6 reports the estimation results using the first-lagged health care spending. The coefficients of inpatient medical expenditures in Columns (1a) and (1b) are positive and significant at the 1% significance level, while the impact of outpatient health care spending on longevity is negative and significant at the 1–5% significance levels as shown in Columns (1c) and (1d). The impact of household income on longevity is ambiguous. There are, at least, long-term positive effects of inpatient health care expenditures on health outcome.

Table 6 around here

4.4. Determining Whether Longevity can be used as a Measure of Success

Life expectancy is defined as the average number of years that persons at a certain age can be expected to live, assuming that their age-specific mortality levels remain constant, or to put it simply, the length of time to death. Many previous studies have used life expectancy as a measure of health, because death can be interpreted as the worst possible health status. Life expectancy can also be derived from official statistics without difficulty. However, Zweifel and Breyer (1997) point out that life expectancy is an aggregate of all possible states of health with the exception of death.

Infant mortality has also been used as a health measure. The infant mortality rate is considered an indicator of access to sanitation or the performance of health care, because there is less heterogeneity in the personal characteristics among infants. Examining the effect of health care expenditures on infant mortality, we discover that there are significant negative impacts of inpatient health care expenditures on male infant mortality, as shown in Appendix Table 1. Note the importance of taking into account not only fatal but also non-fatal health outcomes.

Therefore, we calculate "healthy life expectancy," which is defined as the average number of years that a person can expect to live in full health by taking into account the number of years lived in less than full health due to disease or injury. Figure 6 shows the relationship between healthy life expectancy and life expectancy (regardless of health) in 2005 by prefecture. We can observe strong correlations between healthy life expectancy and life expectancy, while the prefectural average difference between healthy life expectancy at age 65 and life expectancy at age 65 is approximately 1.2 years for males and 2.5 years for females, respectively. There are no large distinctions between the two indexes, although it is important to capture the non-fatal health outcomes.[6]

Figure 6 around here

5. Concluding Remarks

In Japan, some people have the impression that increased spending on their medical care will not necessarily increase their life expectancy. Moreover, they are suspicious of physicians and worry about that they may prescribe treatment or medicine that is not necessary (this is referred to as“supplier induced demand”). Rather than health care, many Japanese people believe that certain regional characteristics, e.g., cultures, traditions, and other unobserved factors, are positively correlated with longevity. Does higher health care spending increase longevity? Focusing on the relationship between the differences in health care expenditures among prefectures and the differences in life expectancy among prefectures, we examined the causal relationship between health care expenditure per capita and life expectancy, considering prefectural heterogeneity.

Using prefectural macro datasets in Japan over the past 30 years, we clarified that decreasing the medical resources indeed reduced both the inpatient and outpatient health care expenditures. However, we further revealed that reducing inpatient health care expenditure lowered life expectancy significantly, although the impact of outpatient health care expenditure on life expectancy was ambiguous. These results suggest that decreasing health care expenditures could hinder the health performance of the Japanese people.

Almost everyone living in Japan has received coverage under the public health insurance system since 1961 and they have had relatively easy access to medical services. However, recently, the Japanese government has been curbing the overall medical expenditures (for example, reducing

[6]Lubits et al. (2003) point out that the life expectancy of the elderly with good health is higher than that with poor health using micro datasets based on the 1992–1998 Medicare Current Beneficiary Survey, which was conducted in the U.S.

the number of beds in health care facilities) in preparation for the rapid aging of the population. As a result it is possible that Japanese life expectancy, which was previously one of the highest in the world, could fall in the international rankings.

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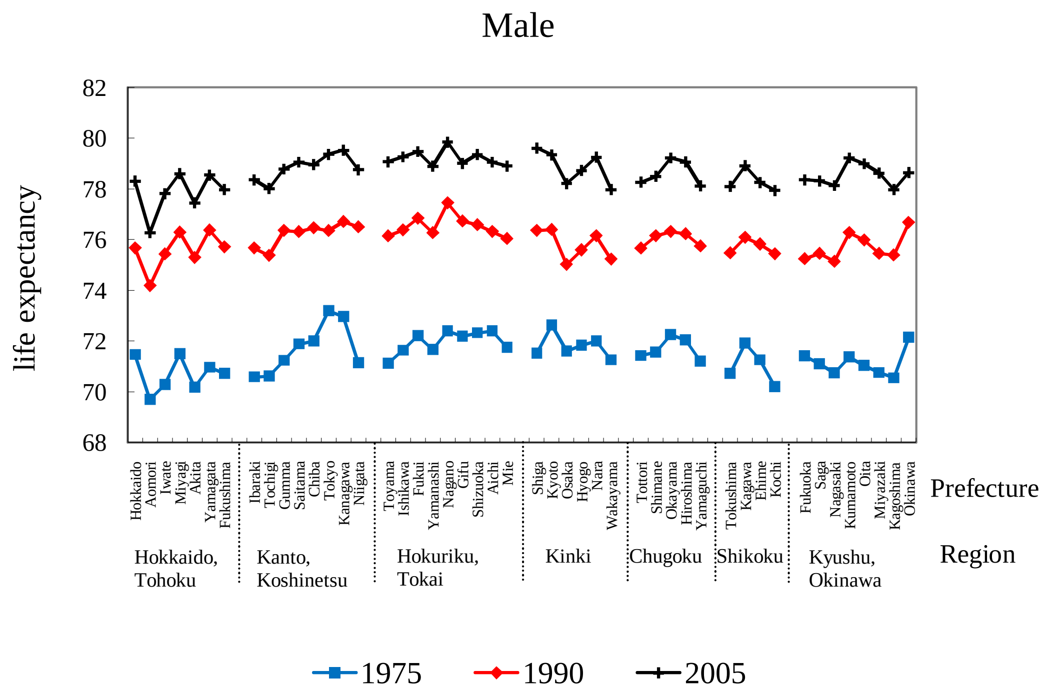
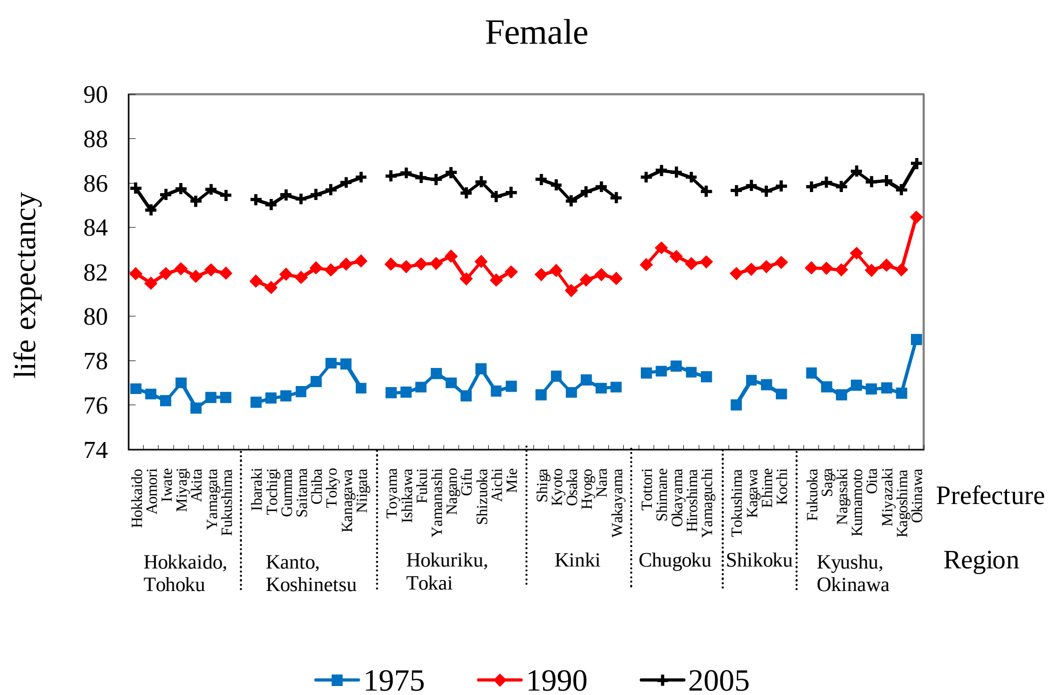
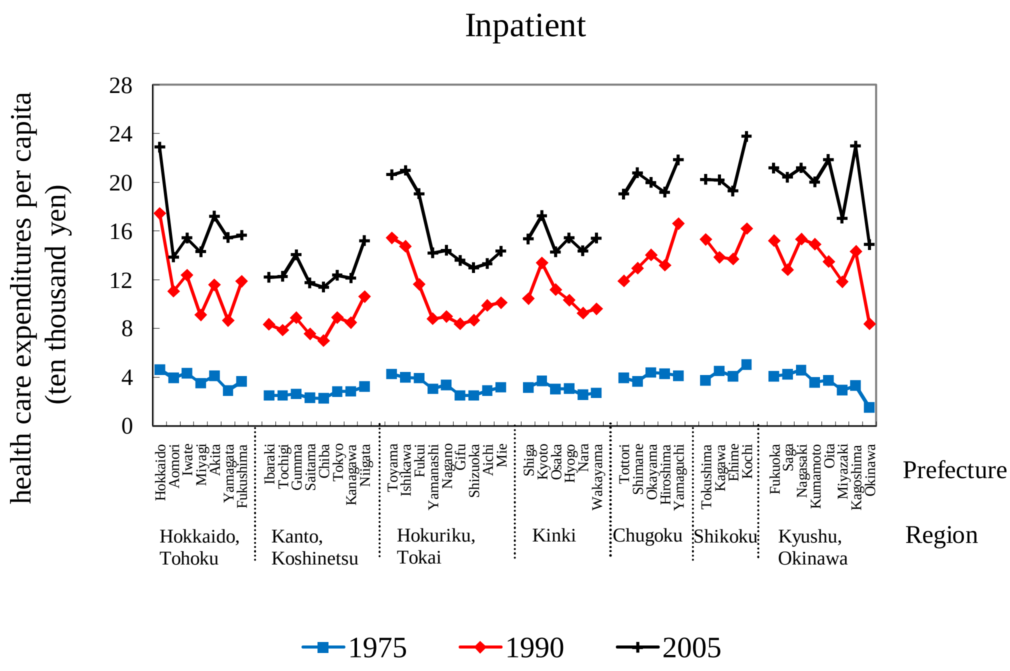
Figure 1: Trend of life expectancy in Japan

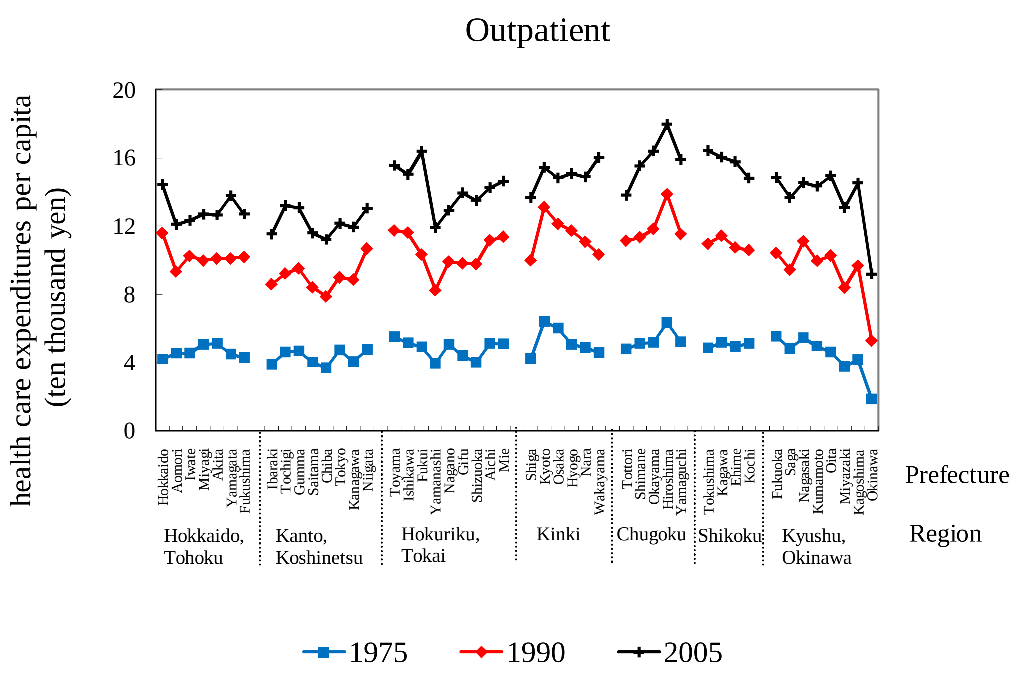




Source: The Life Tables

Figure 2: Trend of health care expenditures in Japan

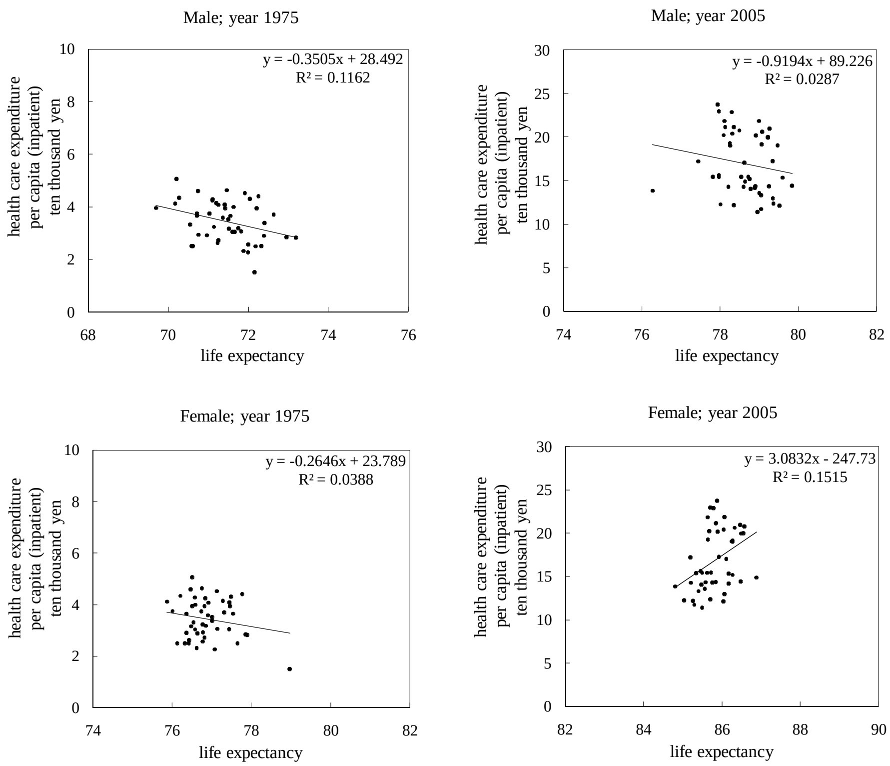




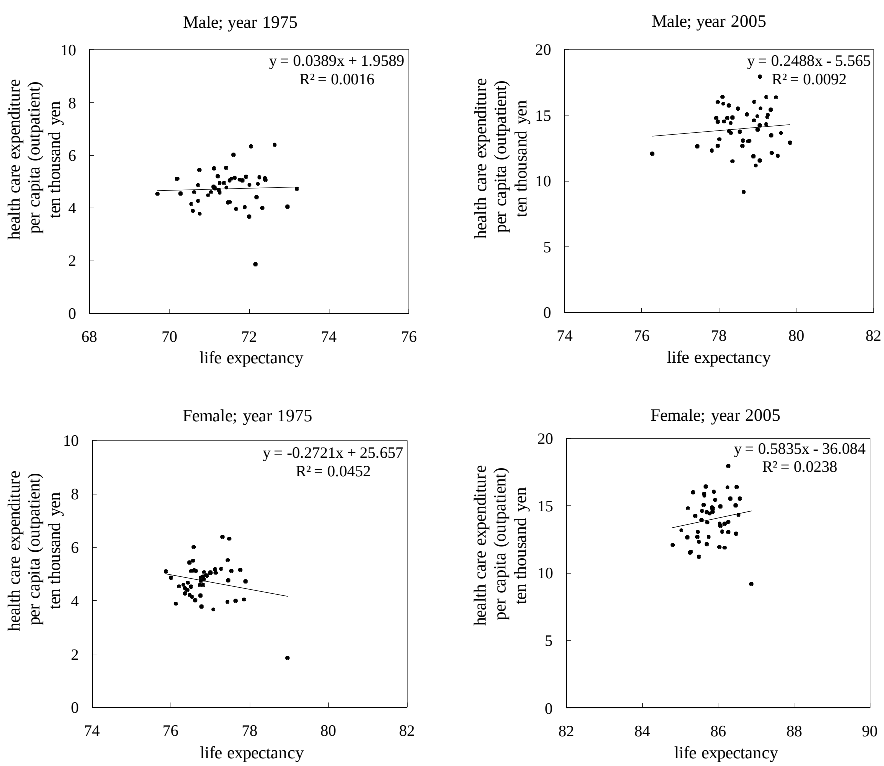
Source: The Annual Report on National Health Insurance (ARNHI)
Note: Health care expenditures are adjusted by Consumer Price Index.

Figure 3: Health care expenditure per capita and life expectancy by prefecture

A: Inpatient



B: Outpatient



Sources: The ARNHI

Figure 4: Framework of our analysis

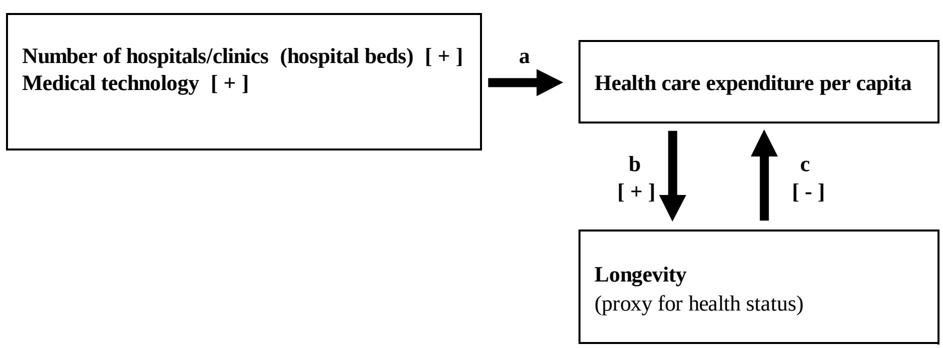
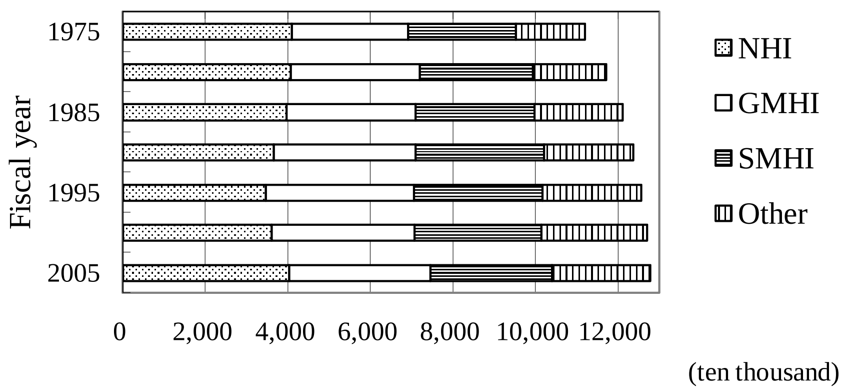
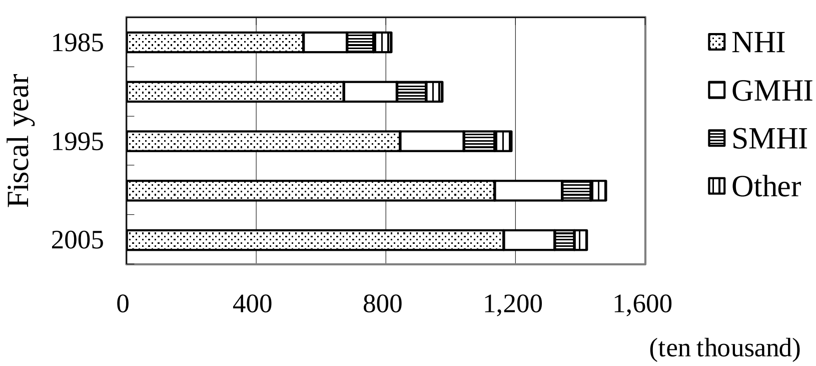


Figure 5: The share of the public health insurance system in Japan

A: The number of insured persons
(including dependents)



B: The number of elderly insured persons
aged 70 and over
(including elderly dependents)



Sources: The ARNHI, the Annual Report on Social Insurance Agency (ARSIA), and the Annual Report on Health Insurance Society (ARHIS)

Notes:

1) We define NHI, GMHI, and SMHI as National Health Insurance (*Kokumin Kenkō Hoken*), Government-Managed Health Insurance (*Seifu Kanshō Kenkō Hoken*), and Society-Managed Health Insurance (*Kumiai Kanshō Kenkō Hoken*), respectively.

2) The age of eligibility for the elderly health insurance (*Rōjin Hoken*) was raised from “70 and over” to “75 and over” in 2002.

Figure 6: Healthy life expectancy v.s. life expectancy

Sources: The Monthly Report of Nursing-care Benefits (*Kaigo Kyūfu-hi Jittai Chōsa Geppō*) and the Life Tables

Note: Healthy life expectancy is obtained by dividing the total number of years that the cohort of individuals will live in good health by the number of survivors. We calculate the healthy person ratio at age 65 as follows: 1−("the number of persons who are recognized as long-term care receivers at the end of October 2005"/"the population in 2005"). We regard a person whose care level (*yōkaigo-do*) is 3 and over as a long-term care receiver. This ratio is applied by weighting the number of years that the cohort of individuals will live during each age interval.

Table 1: Definition of the variables

Variables	Main Source	Definition
Male longevity[3)]	the Life Tables	The number of years that a male infant aged zero is expected to live.
Female longevity[3)]	the Life Tables	The number of years that a female infant aged zero is expected to live.
Male life expectancy at age 65[3)]	the Life Tables	The number of years that a male aged 65 is expected to live.
Female life expectancy at age 65[3)]	the Life Tables	The number of years that a female aged 65 is expected to live.
Inpatient H.E. per capita: total (*thousand yen*)	the Annual Report on National Health Insurance; ARNHI (*Kokumin Kenkō Hoken Jigyō Nenpō*)	The inpatient health care expenditure related to medical care per person insured under National Health Insurance. This variable is adjusted by the Consumer Price Index (CPI) in each prefecture.
Outpatient H.E. per capita: total (*thousand yen*)	the ARNHI	The outpatient health care expenditure related to medical care per person insured under NHI. This variable is adjusted by CPI in each prefecture.
Inpatient H.E. per capita: only the elderly (*thousand yen*)	the ARNHI	The inpatient elderly health care expenditure related to medical care per elderly person insured under NHI. This variable is adjusted by CPI in each prefecture.
Outpatient H.E. per capita: only the elderly (*thousand yen*)	the ARNHI	The outpatient elderly health care expenditure related to medical care per elderly person insured under NHI. This variable is adjusted by CPI in each prefecture.
Inpatient H.E. per capita: NHI & GMHI; Total (*thousand yen*)	the ARNHI and the Annual Report on Social Insurance Agency; ARSIA (*Shakai Hoken-chō Jigyō Nenpō*)	We calculate as follows: {(the amount of NHI inpatient health care expenditure+the amount of GMHI inpatient health care expenditure)/(the number of NHI insured persons+the number of GMHI insured persons)}. This variable is adjusted by CPI in each prefecture.
Outpatient H.E. per capita: NHI & GMHI; Total (*thousand yen*)	the ARNHI and the ARSIA	We calculate as follows: {(the amount of NHI outpatient health care expenditure+the amount of GMHI outpatient health care expenditure)/(the number of NHI insured persons+the number of GMHI insured persons)}. This variable is adjusted by CPI in each prefecture.
Income per household (*ten thousand yen*)	the National Survey of Family Income and Expenditure; NSFIE	The average income per household. The NSFIE is conducted every five years. This variable is adjusted by CPI in each prefecture. We use the data collected in 1974, 1979, 1984, 1989, 1994, 1999, and 2004, that is, one-year delayed.
Out-migration ratio (%)	the Internal Migration in Japan Derived from the Basic Resident Registers	Percentage of out-migrants over the population.
Employee rate (%)	the Population Census	The employees' percentage of the total population.
CT installation rate (%)	the Survey of Medical Care Facilities, the static survey; SMCF1	The percentage of hospitals or clinics where there is a computed tomography; CT over the total. The SMCF1 has been conducted every three years since 1975. We use the data collected in 1981, 1984, 1990, 1996, 1999, and 2005, and set the "CT installation rate at 1975" as zero. Note that, we treat the number of hospital with CT in 2002 as that in 2005 because the SMCF1 in 2005 does not report the number of hospitals with CTs.
Number of hospital beds per 10,000 people	the Survey of Medical Care Facilities, the dynamic survey; SMCF2	The number of beds in hospitals per 10,000 people.
Number of hospitals or clinics per 10,000 people	the Survey of Physicians, Dentists, and Pharmacists	The number of hospitals or clinics per 10,000 people.

Notes:
1) The number of the sample is 282.
2) The above variables are first-differenced: $X_t - X_{t-1}$.
3) We eliminate the effect of the 1995 Hanshin-Awaji earthquake from life expectancy in Hyogo prefecture.

Table 2: Descriptive statistics

	Mean	Std. Dev.	Min	Max
Male longevity	1.20	0.45	0.33	2.49
Female longevity	1.49	0.40	0.61	2.78
Male life expectancy at age 65	0.76	0.24	0.14	1.37
Female life expectancy at age 65	1.14	0.21	0.5	1.63
Inpatient H.E. per capita: NHI; Total (*thousand yen*)	22.47	8.83	−1.60	51.58
Outpatient H.E. per capita: NHI; Total (*thousand yen*)	15.44	11.90	−12.34	42.79
Inpatient H.E. per capita: NHI; Only the elderly (*thousand yen*)	41.01	45.12	−81.73	180.24
Outpatient H.E. per capita: NHI; Only the elderly (*thousand yen*)	16.54	23.41	−49.46	65.27
Inpatient H.E. per capita: NHI & GMHI; Total (*thousand yen*)	13.50	5.31	−0.68	27.63
Outpatient H.E. per capita: NHI & GMHI; Total (*thousand yen*)	9.06	7.91	−8.47	26.49
Income per household (*ten thousand yen*)	21.25	89.39	−201.53	170.01
Out-migration ratio (%)	−0.17	0.21	−1.18	1.02
Employee rate (%)	1.28	1.21	−2.54	3.91
C.T. induction rate (%)	1.97	1.62	−0.80	7.76
Number of hospital beds per 10,000 people	3.39	10.79	−19.72	35.54
Number of hospitals or clinics per 10,000 people	0.22	0.25	−0.46	0.97

Notes:

1) The number of the sample is 282.

2) The above variables are first-differenced: $X_t - X_{t-1}$.

Table 3: First stage estimation results: The health care function

	NHI; Total		NHI; Only the elderly		NHI & GMHI; Total	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
	HE^{In}	HE^{Out}	HE^{In}	HE^{Out}	HE^{In}	HE^{Out}
Income per household	0.016*	0.024***	−0.229***	−0.004	0.007	0.003
	[0.008]	[0.006]	[0.030]	[0.014]	[0.004]	[0.005]
Out-migration ratio	2.676	−1.962	−1.235	−6.1*	−0.47	−0.513*
	[1.935]	[1.251]	[8.663]	[3.433]	[0.292]	[0.297]
Employee rate					2.594***	−2.836**
					[0.962]	[1.126]
Additional instrumental variables						
C.T. induction rate	1.064**	0.9***	−0.197	1.841***	−0.289	0.584***
	[0.443]	[0.326]	[1.438]	[0.589]	[0.202]	[0.194]
Number of hospital beds per 10,000 people	0.532***		1.698***		0.292***	
	[0.065]		[0.227]		[0.032]	
Number of hospitals or clinics per 10,000 people		4.233***		9.801***		4.262***
		[1.371]		[3.352]		[0.945]
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Region trends	No	No	No	No	Yes	Yes
Observations	282					
adjust R^2	0.49	0.86	0.69	0.79	0.65	0.85
F-test H_0: all coeff. of variables except cons. = 0	35.87***	221.3***	112.6***	195.1***	36.6***	105.9***
Shea's Partial R^2	0.35	0.06	0.21	0.05	0.32	0.08
F-test H_0: all coeff. of the additional instruments = 0	57.54***	7.51***	35.94***	7.73***	49.61***	12.41***

Notes:

1) Standard errors in brackets are adjusted for heterogeneity.

2) *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 4: Second stage estimation results: The health production function

A: Instrumented variable: Health expenditures (NHI; Total)

	Inpatient		Outpatient			
	(1a) 2SLS	(1b) 2SLS	(1c) 2SLS	(1c') OLS	(1d) 2SLS	(1d') OLS
	Male longevity	Female longevity	Male longevity	Male longevity	Female longevity	Female longevity
Inpatient H.E. per capita	0.020***	0.015***				
	[0.004]	[0.004]				
Outpatient H.E. per capita			0.007	0.003	0.008	0.003
			[0.016]	[0.003]	[0.013]	[0.003]
Income per household	0.000	0.001***	−0.000	−0.000	0.001***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Out-migration ratio	−0.271***	−0.126	−0.151	−0.160	−0.035	−0.045
	[0.105]	[0.092]	[0.115]	[0.105]	[0.101]	[0.094]
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations			282			
F-test H_0: all coeff. of variables except cons. = 0	66.35***	94.42***	71.56***	72.73***	99.43***	100.02***
Adjusted R^2				0.61		0.67
Wu endogeneity t test	−6.11***	−4.41***	−0.31		0.66	
Over identification J test						
H_0: all instruments are uncorrelated with the error term.	0.21	1.57	13.8***		1.60	

Notes:

1) Standard errors in brackets are adjusted for heterogeneity.

2) *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

B: Instrumented variable: Health expenditures (NHI; Only the elderly) (Table 4 continued)

	Inpatient		Outpatient			
	(2a)	(2b)	(2c)	(2c')	(2d)	(2d')
	2SLS	2SLS	2SLS	OLS	2SLS	OLS
	Male longevity	Female longevity	Male longevity	Male longevity	Female longevity	Female longevity
Inpatient H.E. per capita	0.002**	0.001				
	[0.001]	[0.001]				
Outpatient H.E. per capita			−0.007	−0.001	−0.007	−0.003***
			[0.004]	[0.001]	[0.005]	[0.001]
Income per household	0.001*	0.001***	0.000	0.000	0.001***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Out-migration ratio	−0.060	−0.005	−0.093	−0.056	−0.045	−0.020
	[0.080]	[0.073]	[0.089]	[0.078]	[0.076]	[0.070]
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations			282			
F-test H_0: all coeff. of variables except cons. = 0	77.57***	30.16***	69.03***	79.39***	36.03***	39.31***
Adjusted R^2				0.61		0.35
Wu endogeneity *t* test	−2.77***	−3.58***	1.62		0.96	
Over identification *J* test						
H_0: all instruments are uncorrelated with the error term.	2.92*	0.37	12.00***		1.17	

Notes:

1) Standard errors in brackets are adjusted for heterogeneity.

2) *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

C: Instrumented variable: Health expenditures (NHI & GMHI; Total) (Table 4 continued)

	Inpatient		Outpatient			
	(3a)	(3b)	(3c)	(3c')	(3d)	(3d')
	2SLS	2SLS	2SLS	OLS	2SLS	OLS
	Male longevity	Female longevity	Male longevity	Male longevity	Female longevity	Female longevity
Inpatient H.E. per capita	0.043***	0.034***				
	[0.008]	[0.007]				
Outpatient H.E. per capita			−0.012	0.023***	0.004	0.010**
			[0.020]	[0.006]	[0.016]	[0.005]
Income per household	−0.001	0.001***	−0.001	−0.001*	0.001***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Out-migration ratio	−0.323***	−0.195**	−0.197	−0.094	−0.052	−0.034
	[0.106]	[0.093]	[0.133]	[0.115]	[0.114]	[0.100]
Employee share	0.069**	0.045*	0.048	0.063**	0.034	0.037
	[0.030]	[0.025]	[0.032]	[0.028]	[0.026]	[0.024]
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Region trends	Yes	Yes	Yes	Yes	Yes	Yes
Observations			282			
F-test H_0: all coeff. of variables except cons. = 0	24.97***	35.08***	24.79***	31.04***	39.16***	39.46***
Adjusted R^2				0.64		0.68
Wu endogeneity t test	−4.72***	−4.05**	2.68***		1.35	
Over identification J test						
H_0: all instruments are uncorrelated with the error term.	3.40*	0.17	8.26***		0.11	

Notes:

1) Standard errors in brackets are adjusted for heterogeneity.

2) *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 5: Health care expenditure per capita (thousand yen)

A: Insured persons and dependents under 70 years of age

fiscal year	1975	1980	1985	1990	1995	2000	2005
Inpatient							
NHI	14.04	29.59	44.68	62.97	74.50	81.16	86.16
GMHI	16.04	28.24	26.36	29.74	34.50	33.39	28.22
SMHI	10.92	18.84	18.17	20.62	25.00	25.43	22.03
Outpatient							
GMHI	21.35	36.44	46.12	68.56	86.06	85.78	93.96
SMHI	27.52	41.99	37.17	46.31	55.84	47.50	44.85
HIS	21.03	31.32	29.14	36.37	44.33	40.98	40.39

B: Insured persons and dependents 70 years of age and over

fiscal year	1975	1980	1985	1990	1995
Inpatient					
NHI	267.18	306.68	316.69	317.23	382.05
GMHI	291.72	315.63	329.18	318.20	368.98
Outpatient					
NHI	185.19	236.23	283.39	276.69	274.52
GMHI	190.08	223.96	276.01	260.70	245.16

Sources: The ARNHI, the ARSIA, and the ARHIS
Note: We report health expenditures in 2005 for “75 years of age and over” as per the change implemented by the government in 2002.

Table 6: Second stage estimation results using first-lagged health expenditures (NHI & GMHI; Total)

	Inpatient		Outpatient	
	(1a)	(1b)	(1c)	(1d)
	Male longevity	Female longevity	Male longevity	Female longevity
Inpatient H.E. per capita (first-lagged)	0.046***	0.027***		
	[0.008]	[0.006]		
Outpatient H.E. per capita (first-lagged)			−0.025***	−0.007**
			[0.004]	[0.003]
Income per household	−0.001	0.001***	0.002***	0.002***
	[0.000]	[0.000]	[0.001]	[0.000]
Out-migration ratio	0.027	0.006	−0.186	−0.067
	[0.105]	[0.079]	[0.114]	[0.086]
Employee share	0.019	−0.004	0.027	0.001
	[0.032]	[0.024]	[0.032]	[0.024]
Year effects	Yes	Yes	Yes	Yes
Region trends	Yes	Yes	Yes	Yes
Observations	235			
F-test H_0: all coeff. of variables except cons. = 0	14.67***	22.36***	15.62***	21.19***
Wu endogeneity t test	−3.43***	−2.76***	2.57**	2.50**
Over identification J test				
H_0: all instruments are uncorrelated with the error term.	1.97	0.51	0.37	0.03

Notes:

1) Standard errors in brackets are adjusted for heterogeneity.

2) *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

3) First stage estimation results are available upon request.

Appendix Table 1: Second stage estimation results: Infant mortality (NHI & GMHI; Total)

	Inpatient		Outpatient			
	(1a) 2SLS	(1b) 2SLS	(1c) 2SLS	(1c') OLS	(1d) 2SLS	(1d') OLS
	Male infant mortality	Female infant mortality	Male infant mortality	Male infant mortality	Female infant mortality	Female infant mortality
Inpatient H.E. per capita	−0.008**	−0.003				
	[0.003]	[0.003]				
Outpatient H.E. per capita			−0.005	−0.005**	−0.011	−0.006***
			[0.007]	[0.002]	[0.006]	[0.001]
Income per household	−0.001***	−0.000	−0.001***	−0.001***	−0.000	−0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Out-migration ratio	0.044	0.025	0.001	0.001	−0.018	−0.005
	[0.035]	[0.033]	[0.043]	[0.033]	[0.040]	[0.032]
Employee share	−0.008	−0.017	−0.006	−0.006	−0.021*	−0.018
	[0.010]	[0.012]	[0.011]	[0.010]	[0.013]	[0.011]
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations				282		
F-test H_0: all coeff. of variables except cons. = 0	23.28***	11.6***	24.28***	24.6***	12.41***	12.19***
Adjusted R^2				0.38		0.24
Wu endogeneity t test	2.18**	0.80	0.02		0.52	
Over identification J test						
H_0: all instruments are uncorrelated with the error term.	0.70	0.80	2.41		0.98	

Notes:

1) Standard errors in brackets are adjusted for heterogeneity.

2) *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

3) Male (female) infant mortality (%), which is reported by the Vital Statistics, denotes the male (female) infant deaths referring to those that occurred within a year after birth for the number of male (female) births. The mean value is −0.15 (−0.11) and the standard deviation is 0.17 (0.13).

4) First stage estimation results are available upon request.