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# Positive externalities of congestion, human capital, and socio-economic factors: A case study of chronic illness in Japan.

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## Abstract

This paper explores, using Japanese panel data for the years 1988-2002, how externalities from congestion and human capital influence deaths caused by chronic illnesses. Major findings through fixed effects 2SLS estimation were as follows: (1) the number of deaths were smaller in more densely-populated areas, and this tendency was more distinct for males; (2) higher human capital correlated with a decreased number of deaths, with the effect being greater in females than in males. These findings suggest that human capital and positive externalities stemming from congestion make a contribution to improving lifestyle, which is affected differently by socio-economic circumstance in males and females.

JEL classification: I19; R58

**Keywords**: population density, education, chronic illness

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## 1. Introduction

It is widely acknowledged that the maintenance of health has become one of the major issues of government policy. Especially in developed countries, a modern lifestyle is thought to harm an individual's health status, which is reflected in the prevalence of obesity (e.g. Chou et al, 2004; Loureiro and Nayga, 2005; Knai et al., 2007). Accordingly, a number of studies concerning obesity have been carried out in various areas such as the United States (e.g. Cutler et al., 2003; Boumtje et al., 2005), Europe (e.g. Vigenerova et al., 2007; Zellner et al., 2007), and Japan (Kobayashi and Kobayashi, 2006). According to the Ministry of Health, Labour and Welfare (2004), the prevalence of obesity in men in Japan is 1.5 times greater than it was 20 years ago. Obesity is considered as a key factor causing chronic illnesses, and leading to undesirable outcomes (Costa-Font and Gil, 2005).

Lifestyle depends on socio-economic circumstances. Previous reports have demonstrated that individual health status is better in larger cities in the United States than in small or medium ones (Ray and Ghoshi 2007).[1] This might be due, not only to more economic resources such as a higher level of income (Blumenthal and Kagen, 2002),[2] but also to easier access to health care facilities and medical services (Rabinowitz and Paynter, 2002). On the other hand, congestion in urban areas tends to cause land prices to soar, therefore resulting in an increase in housing expenditure. In addition, higher crime rates and pollution levels in urban areas create disamenities. Thus it is important to evaluate the amenities and disamenities of urban life in order to determine the optimal size of a city (Henderson, 1982; Herzog and Schlottmann, 1993).

The importance of the role played by spatial density rather than size in improving productivity in firms has been emphasized by Ciccone and Hall (1996).[3] This appears to hold true with respect to households, since the degree of congestion might be more closely related to the density of the population relative to physical space than it is to the overall population size. In densely populated areas such as

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[1] Family size (Koziel et al., 2004) and social capital (Kawachi et al, 1997; 1999; Islam et al., 2008) are also considered to have a significant effect on health.

[2] It was found that income improves health status (Pritchett and Summers 1997).

[3] Yamamura and Shin (2007) provide the evidence that spatial density has a critical role in economic growth in Japan.

Tokyo, congestion is expected to cause vehicles to be caught in traffic jams, therefore inducing individuals to take packed trains and walk through the business district in order to be in time for work when they commute at rush hour.[4] This undoubtedly represents a disamenity. Nevertheless, from the point of view of health, rail commuters have an increased amount of unintended exercise in daily life so that they are less likely to become obese, leading to prevention of chronic illnesses. This means that congestion has a positive externality in the improvement and maintenance of health. Little evidence is available, however, on this facet of congestion.

The distinction of sex might be related to health, which is influenced by socio-economic and cultural conditions (Zellner et al, 2004; Chranowska et al. 2007). In general, human capital is thought to play a significant role in improving health (Handa, 1998; Blumenthal and Kagen, 2002; Cooper et al., 2006).[5] Nevertheless, white-collar workers appear to attach higher priority to their jobs rather than to their families so that they frequently eat out, not only at lunch, but also at dinner.[6] Generally, menus at restaurants are high in calories, a fact which makes it difficult for white collar workers to reduce their calorie intake. As a consequence, highly educated males, who generally become white-collar workers, have difficulty in maintaining a good diet even if they understand the importance of calorie control. On the other hand, in Japan, although female education levels are higher than in the past, females are still less likely to take a full-time job. Even if females take a full-time job, they have a tendency to quit their job when they get married or give birth. Therefore, females are more likely to be freed from job constraints and put their learning about health into practical use when they prepare meals for themselves. As a consequence, females are more likely to have a healthy diet than males.

This paper mainly attempts to investigate how population density and human capital influence chronic diseases and compare their effects on males and females, using panel data for Japan, which is a relatively densely-populated and

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[4] One of reasons why the geographical location of manufacturing industries tends to disperse is congestion of cities (Mano and Otsuka, 2000).

[5] Greater education inequality is associated with greater health disparities (Ray, 2007).

[6] It should be noted that the assumption is primary based on the Japanese work culture and therefore is peculiar to Japan. Therefore, it is not necessarily the case that white-collar workers in most countries do this.

highly-educated country.

The organization of the remainder of this paper is as follows: Section 2 gives a brief overview of urban life and health conditions in modern Japan. In section 3, the method of data analysis and estimation are described. The results of the estimation and their interpretation are provided in section 4. The final section offers concluding remarks.

## 2. Overview of modern Japan

According to the World Bank (2006), the population of Japan in 2002 was 126 million, living in 364,500 square km, giving a population density of 346 people per square km. The population density of other developed countries, for instance, United States, Germany, and France, are 30, 107, and 235 respectively. That is to say, in comparison with other developed countries, Japan is the distinctly more densely-populated country. For closer investigation, let us look at the density distribution among prefectures in Japan.[7] From Figure 1, it can be seen that population density is remarkably skewed towards the left. Although most prefectures have a population density in the range below 500 per square km, there are some prefectures over 5,000 per square km. This implies that there is a distinct difference in population density between urban and other areas.

The well-developed rail and subway coverage in large urban areas such as Tokyo mean that people tend to use the public transportation system rather than driving a car. Plausible reasons for why the close-knit network of railway and metro was formed might be as follows. First, traffic jams frequently take place when driving a car, creating a higher risk of being late for work or other engagements. Second, high land prices cause parking costs to be high, so people are less likely to own a car. In short, congestion in urban areas raises the cost of using a car, increasing demand for substitute means of travel such as commuter trains and subways.

In the urban life of Japan, the most crowded time of day appears to be the commuting time in the morning. People take packed trains and walk through congested business districts. This commuting scenario is notorious and is

[7] Japan comprises 47 prefectures. There are smaller administrative divisions such as cities and villages. Various useful figures are available at the prefecture level, but not in smaller divisions. This is why prefecture level data is used in this research.

sometimes expressed as "commuting hell." As a consequence, commuters use a great deal of energy and become fatigued. From another point of view, this is an involuntary way for people to get regular exercise and maintain health on weekdays, although they suffer from psychological stress in the process. Thus one can presume that this unintended exercise stems from the positive externality of congestion and may benefit health. If this holds true, individuals living in urban areas would be healthier than people in other areas. In general, a lack of exercise and high calorie consumption is thought to lead to obesity, resulting in chronic diseases, therefore the number of deaths caused by chronic diseases in a prefecture can be regarded as a proxy for the regional health status (Ministry of Health, Labor and Welfare, 2004, Costa-Font and Gil, 2005). Looking at Figure 2 (a) showing percentage of deaths caused by chronic illnesses reveals that the percentage of deaths of urban residents is obviously smaller than that of other areas, although it increases gradually in both areas.[8] Furthermore, a negative relationship between population density and number of deaths from chronic illnesses appears in Figure 3(a). These are consistent with the presumption that the externality of congestion benefits health. Hence, we may postulate the following empirical hypothesis about the positive externality of congestion:[9]

*Hypothesis 1: There are a smaller number of chronic disease-related deaths in more densely populated areas.*

Ray and Ghosh (2007) shed light on the relationship between city size and health in the United States. Careful attention is required when considering the impact of city size and population density. In contrast to Tokyo, in American mega-cities such as Los Angeles, people ordinarily drive a car in daily life. The difference between Los Angeles and Tokyo may be partly due to the difference in population density. In more densely populated areas, land is relatively scarce, and therefore its price becomes higher than in less densely-populated areas. The scale of

[8] It should be noted that perhaps the urban population is younger and therefore would be less likely to have chronic diseases. Although calculations of percentage of deaths are required to be done using age-standardization, it cannot be done since number of deaths in each generation cannot be obtained. Hence, special attention is called for when Figure 2 is considered.

[9] We raise Hypothesis 1 from an empirical viewpoint. A foreseeable extension of this research would be to argue it theoretically.

the city does not necessarily lead to high land prices because land prices are determined not only by population size, but also by the land area. In the following sections, I attempt to distinguish the effect of population density from city size when the externality of congestion is explored.

As is illustrated in Figure 3(b), human capital, represented by the number of university graduates, is negatively associated with deaths from chronic illnesses, which supports the assertion of the existing literature that human capital makes a contribution to the improvement of health (Handa, 1998; Blumenthal and Kagen, 2002; Cooper et al., 2006). On the other hand, it has been reported that socio-economic conditions have a different influence on health status and body mass index (BMI) in males than in females (Zellner et al, 2004; Chranowska et al. 2007). It seems appropriate that there could be a difference in the effect of human capital on health between males and females, because the lifestyles of males and females often differ.

Japan ratified its "Convention on the Elimination of all Forms of Discrimination Against Women" in 1979 at the United Nations General Assembly.[10] The Equal Employment Opportunity Law for Men and Women was promulgated in 1985. Subsequently, its partial amendment was made in 1997 and it came into force in 1999.[11] In conjunction with this, female education levels became higher than in the past. Consequently, females were expected to rise in social standing, resulting in a greater influence on the social lives of the Japanese. Nevertheless, in actuality, the labor force non-participation rates for 2000 were 51.8% for females and 25.2% for males (Statistics Bureau of Ministry of Public Management, Home Affairs, Post and Telecommunications, 2004).[12] The gap between the sexes may presumably be due to many females being housewives, which counts as non-participation in the labor force. In Japan, full-time workers are expected to give devoted service to the company and thus spend long hours and much energy in doing their jobs. The company is considered as imposing strong constraints on a healthy lifestyle, even in educated workers who recognize the importance of maintaining their health. These

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10 See http://www.un.org/womenwatch/daw/cedaw/.

11 http://www.cc.matsuyama-u.ac.jp/~tamura/kintouhou.htm (in Japanese).

12 Labor force non-participation rate is defined as below (Statistics Bureau of Ministry of Public Management, Home Affairs, Post and Telecommunications, 2004):
(Students + homemakers + others)/persons 15-64 years old.

facts lead me to conjecture that females are able to make lifestyle decisions under looser constraints than males because females generally are less likely to be full-time workers. Females would be better able to allocate time and resources to health maintenance than males. Thus educated females can put their learning about health into practical use e.g. in preparing healthy food for themselves. As a consequence, females would be more likely to have a healthy diet than males. Figure 2(b) suggests that there are fewer chronic disease-related deaths in females than in males, which is in line with the conjecture above. These arguments can be summarized in the following hypothesis about how differences in human capital affect the health of males and females differently:

*Hypothesis 2: Human capital makes a greater contribution to the decrease in number of deaths from chronic diseases in females than in males.*

Undoubtedly, access to medical services is a key factor determining health status. The number of hospitals per capita can be regarded as a medical service. Contrary to this, cursory examination of Figure 3(c) reveals that the number of hospitals per capita is positively associated with deaths from chronic illnesses. This might be because hospitals tend to be located in areas where a lot of patients live. That is, there is an adverse causality between hospitals and deaths so that simple regression of Figure 3(c) cannot identify the effect of hospitals on deaths. To put it differently, endogeneity bias takes place when the proxy of medical service is incorporated. In the following section, I will attempt to control for the bias with the aim of precisely examining how a medical service benefits health.

## 3. Data and Methods

### *3.1. Data*

The data was aggregated at the prefecture level, comprising 46 prefectures, for the years 1988-2002 in Japan.[13] The structure of the data set used in this study was panel. Apart from *GINI* (Gini index of income) and *HC* (rate of people graduating from university), the sources of the data used in the regression estimations were

[13] Although Japan comprises 47 prefectures, BOOZE data was not available for the Okinawa prefecture, therefore, the data for only 46 prefectures was used for regression estimation.

Asahi Shimbunsha (2006) and Index Corporation (2006). *GINI* data was collected from the Statistics Bureau of the Ministry of Internal Affairs and Communications but was unavailable for some years. Therefore, Gini coefficient data was insufficient to construct as panel data, and additional data was generated by interpolation based on the assumption of constant changes in rates to make up for this deficiency.[11] The Ministry of Internal Affairs and Communications provided data related to the number of people who graduated from university: for 1980, 1990 and 2000. The data was generated by interpolation based on the assumption of constantly changing rates between 1980, 1990 and 2000. The annual data of 2001 and 2002 was collected from Ministry of Education, Culture, Sports, Science and Technology.

*3.2. Econometric Framework*

To test the hypotheses raised in the previous section, I will explore how health status is affected by congestion, as well as by human capital and socio-economic circumstances. Following the discussion hitherto developed, the estimated function takes the following form:

$$DEATH_{its} = \alpha_1 HOSPITAL_{it} + \alpha_2 DENS\ (POP)_{it} + \alpha_3 HC_{it} + \alpha_4 GINI_{it} + \alpha_5 INCOM_{it} + \alpha_6 SC_{it} + \alpha_7 BOOZE_{it} + \alpha_8 SERVICE_{it} + \alpha_9 AGE4059_{its} + \alpha_{10} AGE60_{its} + \alpha_{11} YEAR9702_t + \alpha_{12} YEAR9902_t + v_i + u_{its}$$

where $DEATH_{its}$ (Number of deaths caused by chronic illnesses) represents the dependent variable in prefecture *i*, year *t*, and sex *s*. $\alpha$ represents the regression parameters. Only the values of $DEATH_{its}$, $AGE4059_{its}$ and $AGE60_{its}$ are different between male and female. $v_i, u_{its}$ represent the unobservable specific effects of the individual effects of *i*'s prefecture (a fixed effects prefecture vector) and an error term, respectively. $v_i$ encompasses the time invariant feature, while $u$ is an error term. The descriptive statistics and definitions of independent variables are exhibited in Table 1.

Special attention must be paid to the omitted variable bias stemming from unobservable individual specific effects. With the aim of controlling for this bias, fixed effects estimations were employed. I used *HOSPITAL* (number of hospitals) as an independent variable to control for access to medical services, which has been known to generally improve health status. The anticipated sign of *HOSPITAL* is thus negative. Additionally, to address potential endogenous problems of the *HOSPITAL,* as pointed out above, fixed effects 2SLS estimations (Baltagi, 2005) were carried out, which allowed control of the endogeneity problem as well as unobservable individual fixed effects.

In an attempt to estimate the elasticity in comparing the magnitude of the dependent variables, the function took a linear form.[14] Accordingly, dependent and independent variables were evaluated at the sample means, and therefore the coefficient values reported can be interpreted as elasticity.[15]

*3.3. Density and Human Capital*

The variables on which the main stress falls are *DENS* (population density) and *HC*. They are incorporated for the purpose of examining the effect of the positive externality of congestion and human capital. If congestion induces unintended exercise and hence makes a contribution to amelioration of health problems, i.e. if Hypothesis 1 is supported, *DENS* would take a negative sign. Urban areas are not only densely populated, but also have large overall populations. It is thus critical to distinguish the effect of congestion and that of city size. To this end, the alternative specification was also examined where *POP* (population) was included instead of *DENS.*

If Hypothesis 2 holds true, *HC* would take the predicted negative sign. In

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14 Unfortunately, there is no theoretical model supporting the linear form. It is beyond the scope of this paper to theoretically justify the function form. This is an issue for future study.

15 See more details in Greene (1997, p.280).

In the linear model, $y = x'\beta + e$ the elasticity of y with respect to changes in x is

$$\gamma_k = \frac{\partial \ln y}{\partial \ln x_k} = \beta_k \left( \frac{x_k}{y} \right).$$

This value can be estimated at the sample means as

$$\lambda_k = \beta_k \left( \frac{\overline{x_k}}{\overline{y}} \right).$$

The standard error of the elasticity of y, $\gamma_k$ , can be calculated by the delta method (Greene 1997, pp. 278-280).

addition, its anticipated coefficient for females would to be larger than that for males.

*3.4. Control Variables*

Social capital is loosely defined as social trust or social networks, and is thought to have a significant role on human behavior (Putnam, 2000). In terms of health, various empirical studies have provided evidence that social capital is positively associated with health status (e.g. Kawachi et al., 1997, 1999; Islam, 2008). The social capital effect should thus be captured in order to evaluate its effect on health. Following previous Japanese studies (Yamamura, 2008a, 2008b, 2008c, 2008d), the number of community centers was incorporated as a proxy for social capital. The sign of *SC* was predicted to be negative.

Economic factors such as *INCOM* (per capital income) and income inequality were also considered to have a positive and a negative influence on health status, respectively (Pritchett and Summers 1997; Kawachi et al., 1997). Income inequality is expressed by *GINI* (Gini index of income) in this study. From the findings of previous studies, *INCOM* and *GINI* were expected to take negative and positive signs, respectively. It is generally known that alcohol consumption harms health, leading to the prediction of a positive sign for *BOOZE* (per capita consumption of alcohol). Accordingly, in comparison with other workers, service sector workers are less likely to do physical work, equating to a relative lack of exercise.[16] As a result, the rise in the proportion of workers in the service sector is associated with lifestyle-related chronic illnesses. Therefore, the coefficient of *SERVICE* (rate of employment in service sector) would be expected to take a positive sign. It is obvious that the older one becomes, the higher the likelihood that one will have a chronic illness (Riley, 1991; Costa-Font and Gil, 2005). This leads me to anticipate that *AGE4059* (proportion of population of age 40-59) and *AGE60_* (proportion of population older than 60) will take positive signs. Furthermore, the coefficient of *AGE60_* would be expected to be greater than that of *AGE4059.*

As mentioned earlier, the Equal Employment Opportunity Law for Men and

[16] It should be noted that the service sector includes not only office workers, but also shop and restaurant workers who would perhaps be active. Nevertheless, in comparison with other sectors comprising peasants, fishers, and construction laborers, workers in the service sector appear to be less active.

Women was revised in 1997 and took effect in 1999. *YEAR9702* was assigned as 1 during 1997-2002 and 0 in earlier years and *YEAR9902* was assigned as 1 during 1999-2002 and otherwise was 0. These captured the changes in socio-economic circumstances, especially in females.

### *3.5. Instrumental Variables: Controlling for Endogeneity of Hospitals*

The causality between health status and hospitals runs in both directions, thereby causing estimations to suffer from bias. In this study, fixed effects 2SLS estimation was employed in order to control for the bias (Baltagi 2005); therefore, instrumental variables need to be identified. It seems plausible to assume that the greater the area of the inhabited land, the greater is the number of hospitals that can exist in that given area. Therefore, the area of inhabited land can be considered to be an appropriate instrumental variable of the number of hospitals. [17] Accordingly, I used the area of inhabited land, its square, and its log-form values as instrumental variables.

## 4. Estimation Results and their Interpretation

Table 2 lists the results of the fixed effects estimations. In Table 3, the results of the fixed effects 2SLS model are presented. In each table, columns (1) and (4) exhibit the results of the total number of deaths caused by chronic illnesses. The results using the number of male deaths appear in columns (2) and (5) whereas those of females are in columns (3) and (6). As mentioned earlier, the values are elasticity, and those in parentheses are t-values calculated using the delta method.

### *4.1. Fixed Effects Estimation*

I will begin by discussing the results of Table 2. With respect to the access to medical services, contrary to prediction, coefficients of *HOSPITAL* took positive signs, with the exception of column (3) and (6). This result possibly suffers from endogeneity bias. Later, in order to examine the effect of *HOSPITAL* more closely, the results of the fixed effects 2SLS are discussed.

The coefficients of *DENS* demonstrated significant negative signs in columns (1),

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[17] Although inhabited land size seems to be correlated with *DENS*, it does not appear to be correlated with the error term.

which was in line with the anticipation. When the data was split into male and female deaths, *DENS* continued to show the expected negative sign in column (2), but a positive sign in column (3). This implies that congestion reduces male deaths from chronic illness while it does not have such an influence on female deaths. To put it in another way, there is a positive externality on health status for males but not for females. In my interpretation, males are more inclined to take a full-time job than females, thereby increasing the likelihood that they have unintended exercise while commuting. Columns (4)-(6) present the alternative specification results when *POP* replaced *DENS* as an independent variable. The positive signs of columns (4)-(6) indicated that population size did not reduce the number of deaths. To consider the above results together, even after controlling for the access to medical services by the inclusion of *HOSPITAL*, urban people could enjoy the positive externality coming from congestion but not from population size. In other words, the effect of population density is more important than that of population size in improving health status when access to the medical services is controlled for. As a whole, Hypothesis 1 was corroborated.

In terms of *HC,* as predicted, coefficient signs of columns (1) and (4) were negative and were statistically significant at the 5% level. Female results, which are shown in columns (3) and (6), exhibited the predicted negative signs, while being statistically significant at the 1% level. Furthermore, their magnitudes were approximately 0.20, which was about six times larger than in columns (1) and (4). In males, in contrast to females, *HC* took a positive sign. In short, *HC* has a positive influence on female health but not on male health.

Let me turn to economic factors such as *GINI* and *INCOM.* In all estimations, *GINI* had the anticipated positive signs, while being statistically significant at the 1% level. Nevertheless *INCOM* had positive signs in columns (1), (2), (4) and (5), which is contrary to expectation. On the other hand, inspection of the results of females in columns (3) and (6) revealed the expected negative signs. These results implied that males were less inclined to allocate income efficiently to maintain their health than females under work constraints. In Japan, females tend to cook for themselves and can easily reduce the calorie intake to maintain their health. Males ordinarily do not have enough time to make dinner at home and tend to dine out in restaurants where high calorie foods are generally provided. As for *BOOZE,* the magnitude of its coefficients for males was approximately 10 times greater than for females. This suggested that males have a higher propensity for drinking alcohol than females, presumably to combat job stress. The results of *INCOM* and *BOOZE* indicated that males are less likely to allocate income for health than females.

Consistent with prediction, *SC* and *SERVICE* took the negative and positive signs and were statistically significant at the 1% level in all estimations. In columns (1) and (4), both *AGE4059* and *AGE60_* displayed significant positive signs as predicted in the previous section. Values of *AGE4059* were, however, larger than for *AGE60_*. As is shown in the results of males, this tendency was more obvious, values of *AGE4059* were 0.10 and 0.07 and those of *AGE60_* were 0.004. It is surprising to observe that values of *AGE4059* were approximately 20 times larger than for *AGE60_*. Ordinary workers are thought to reach retirement age when they become 60 years old. Accordingly, retirement is expected to have a major impact on the health status of males. On the other hand, with respect to females, *AGE4059* exhibited negative signs whereas *AGE60_* showed significant positive signs with a value of 0.41. It is very interesting that values of *AGE60_* for females were about 10 times greater than for males. The findings above suggested that retirement leads to improvement of male health status, whereas it does not influence female health. The reason for the difference in the retirement age effect might be that females were less likely to have taken a full-time job.

### *4.2. Fixed Effects 2SLS estimation*

Before turning to discussion of the estimation results shown in Table 3, I will check the validity of the fixed effects 2SLS estimation. An over-identification test was used to test the hypothesis that the instrumental variables were uncorrelated to the error term. Since the P-values of the over-identification test were from 0.37 to 0.69, the results failed to reject the hypothesis which passed the over-identification test in all estimations.

After controlling for endogeneity bias, the signs of *HOSPITALS* became negative in all estimations, despite being statistically insignificant in columns (3) and (6) representing female estimations. Also, the absolute values for males were approximately double that of females. In Japan, workers have the opportunity to undergo medical examination by the company, meaning that males are more likely to have such an opportunity because males are more likely than females to be full-time workers. Assuming that the examination shows an abnormality, the easier the access to hospital, the more likely workers are to receive outpatient care. This might be a reason why access to hospitals had a greater effect on health status for males than for females.

The regression estimates concerning the rest of the variables were hardly affected by controlling for endogeneity bias. As is demonstrated in Figure 1, the distribution of the population density was uneven. This suggests that some outliers influenced the estimation results to a large extent. For the purpose of minimizing these effects, the same estimations of Table 2 and Table 3 were conducted without the most urbanized and densely populated prefectures.[18] The results are shown in Table A1 and A2 in the APPENDIX and were almost the same as those in Table 2 and Table 3, respectively. All in all, the results provided in Tables 3, A1, and A2 imply that the results obtained in Table 2 were robust

Up to this point, various estimated results have been presented. To sum up, it is suggested that the estimation results examined in this section are consistent with each of the Hypotheses 1 and 2 put forward in the preceding section.

## 5. Conclusion

Among lifestyle-related problems, efforts to reduce the rate of obesity and prevent chronic disease have attracted special attention as policy issues, especially in developed countries. It is widely known that exercise and moderate calorie intake benefit health. Lifestyle might vary with the degree of urbanization, which generates amenities and disamenities at the same time. Although previous studies pointed out that urban residents may enjoy easier access to health care facilities and medical services, resulting in better maintenance of health (Rabinowitz and Paynter, 2002), the positive externality generated by congestion has not been examined. Using panel data for the years 1988-2002 in Japan, this paper explored how the externalities from congestion, human capital and socio-economic factors had an influence on deaths caused by chronic illness.

First, it was found that, after controlling for medical services represented by the

[18] Tokyo, Kanagawa, Aichi, Osaka, and Hyogo prefectures are omitted in the estimations.

number of hospitals, the number of deaths was smaller in denser areas, and that this tendency was more distinct for males. On the other hand, population size hardly influenced deaths, regardless of the sex. This finding made it evident that there is a positive externality of congestion on lifestyle and health status. I interpret the sex differences of the externality effect to suggest that unintended exercise of workers during commuting time makes a contribution to health, mainly for males because most females do not have a full-time job and thus are less likely to enjoy the positive externality of congestion.

Second, human capital decreased the number of deaths, and the effect was greater in females than in males. In addition, the likelihood of death from chronic illness decreased strikingly after retirement age for males, whereas it substantially increased at the same age for females. From this, it is concluded that the lifestyle is substantially influenced by whether or not individuals have a full-time job. Individuals are thought to allocate their various resources between work and other activities. Under such constraints, educated individuals attempt to maintain their health status. Inevitably, the human capital effect on chronic disease is limited by the amount of resources which can be allocated to maintenance of health.

What came out most clearly from this investigation is the very substantial role played by human capital and the positive externality stemming from congestion in improving health status, which is affected by different socio-economic circumstances such as work status between males and females. Evidence concerning externality of congestion is in obvious contrast with the view that congestion in urban areas reduces the number of amenities. The positive externality of congestion should be taken into account when amenities and disamenities are evaluated.

Whether individuals take a full-time job or not depends in part on gender, and this influences the effects of various factors on health. Variables representing the differences in employment between males and females were not used. In addition, the research was based upon data aggregated at a prefectural level. The individual characteristics of individuals, such as marital status, amount of exercise and body mass index (BMI), were not considered. Hence, the ways and the extent to which unintended exercise was associated with BMI and chronic illness were not directly examined. Therefore, a future direction for the study will be to use individual data to include working conditions and to investigate the relationship between unintended exercise and chronic illness in order to corroborate the arguments raised in this paper.

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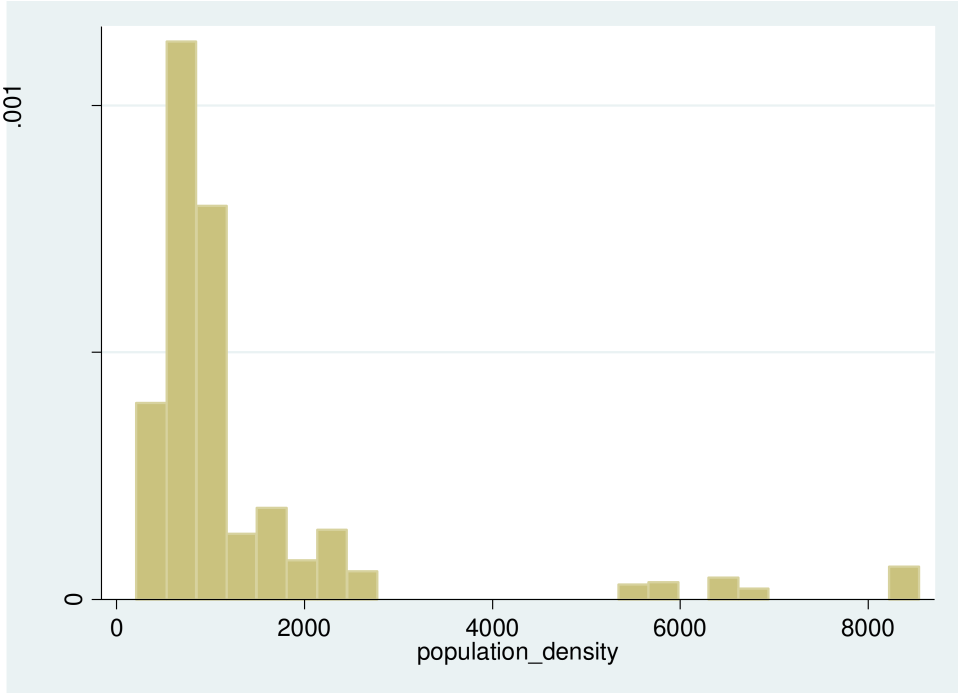
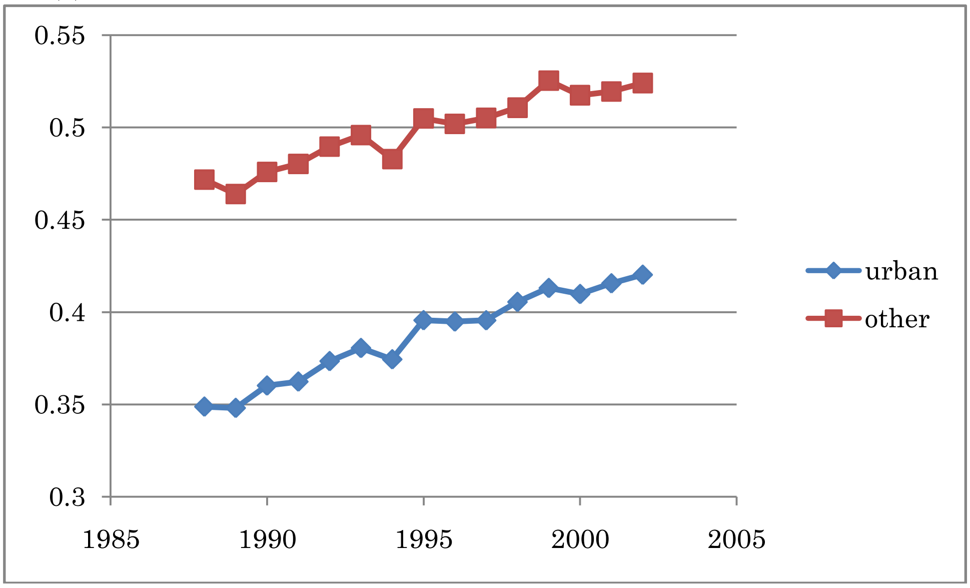



Figure 1. Histogram of population density.

Note: Population density was measured by people per square km of habitable land areas; x-axis and y-axis represent population density and its frequency, respectively.
Source: Index Corporation (2006)

(a) Urban and other areas




(b) Male vs Female

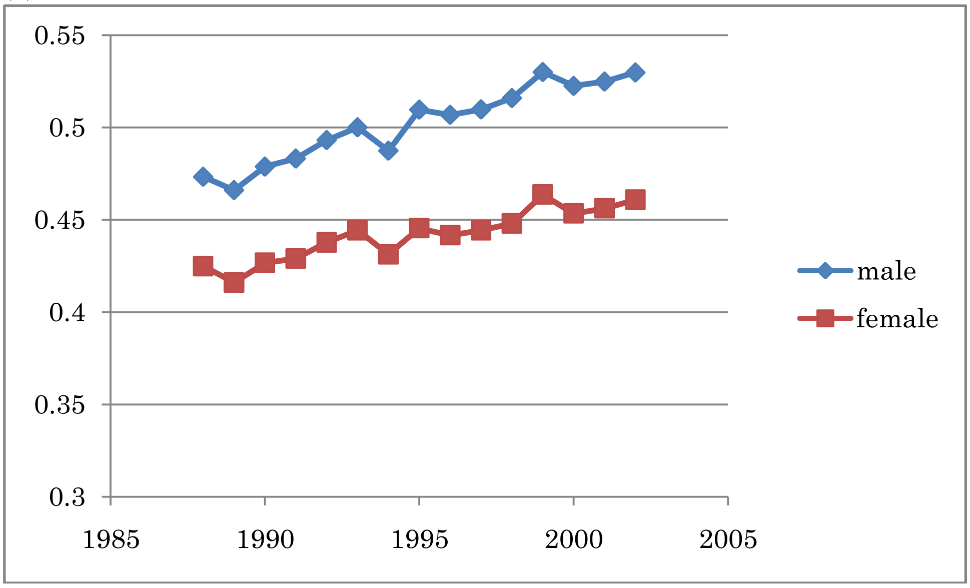
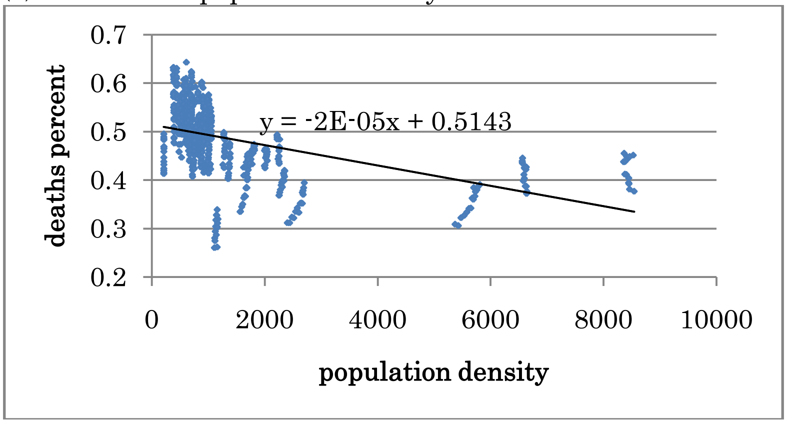


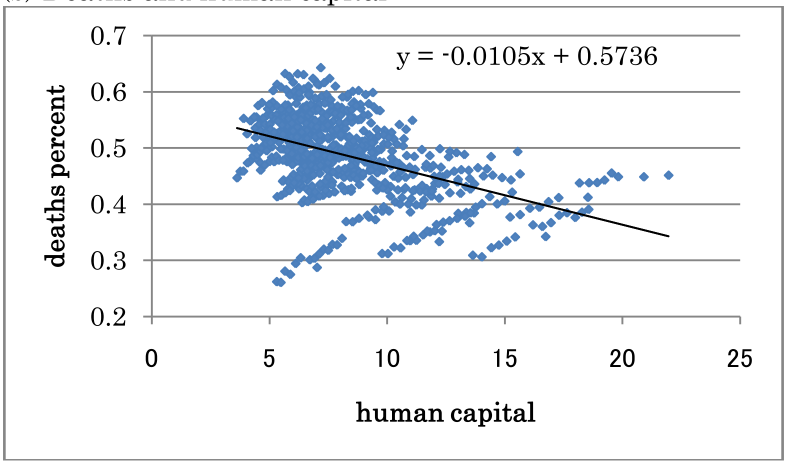

Figure 2. Deaths caused by chronic illnesses as a percentage of the population.

Note: In panel (a), values for males were calculated by using the number of male deaths and the male population and values for females were calculated similarly. In panel (b), urban areas comprised the top 5 most densely populated prefectures in 1988: Tokyo, Kanagawa, Saitama, Aichi, and Osaka.

(a) Deaths and population density




(b) Deaths and human capital




(c) Deaths and hospital per capita

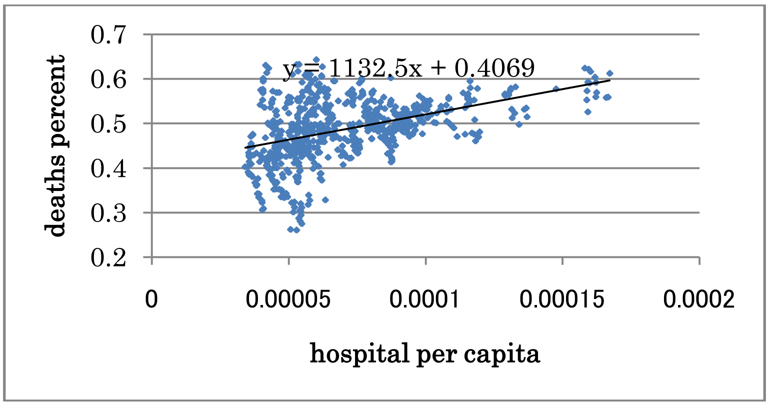



Figure 3. Simple regression equations of deaths against human capital and population density.

Note: Deaths caused by chronic illnesses as a percentage of the population is used for deaths percentage. The human capital index is the number of people who graduated from university as a percentage of the population.

Table 1

Descriptive statistics

| Variables | Definition | Mean | Std. Dev |
|---|---|---|---|
| *HOSPITAL* | Number of hospitals for internal diseases per population | $0.69*10^{-4}$ | $0.26*10^{-4}$ |
| *DENS* | Population density (Population/habitable land area ($km^2$)) | 1,346 | 1,565 |
| *POP* | Population (thousands) | 2,648 | 2,393 |
| *HC* | Number of people who graduated from university per population (%) | 8.3 | 0.3 |
| *GINI* | GINI index of income | 0.29 | 0.01 |
| *INCOM* | Per capita income (thousand yens) | 2,832 | 406 |
| *SC* | Number of community centers per capita | $2.20*10^{-4}$ | $1.70*10^{-4}$ |
| *BOOZE* | Per capita consumption of all types of alcoholic drinks (liters) | 72.2 | 9.7 |
| *SERVICE* | Rate of employment in service sector (%) | 29.9 | 0.27 |
| *AGE4059* | Proportion of population of people aged 40-59 (%) | 6.4 | 0.04 |
| *AGE60_* | Proportion of population of people older than 60 years (%) | 0.01 | 0.003 |
| *YEAR9702* | 1997-2002 years dummy variable (1 during 1997 and 2002, otherwise 0) | 0.40 | 0.49 |
| *YEAR9902* | 1999-2002 years dummy variable (1 during 1999 and 2002, otherwise 0) | 0.26 | 0.44 |

*Source:* Asahi Shimbunsha (2006), Index Corporation (2006), Statistics Bureau of the Ministry of Internal Affairs and Communications (various years).

Table 2
Determinants of death caused by chronic illnesses as a percentage of the population (Fixed Effects Model)

| | (1) All | (2) Male | (3) Female | (4) All | (5) Male | (6) Female |
|---|---|---|---|---|---|---|
| *HOSPITAL* | 0.001 | 0.001 | -0.04* | 0.003 | 0.003 | -0.03 |
| | (0.06) | (0.06) | (-1.72) | (0.15) | (0.13) | (-1.52) |
| *DENS* | -0.09* | -0.10* | 0.07 | | | |
| | (-1.90) | (-1.94) | (1.42) | | | |
| *POP* | | | | 0.04 | 0.03 | 0.12** |
| | | | | (0.95) | (0.58) | (2.63) |
| *HC* | -0.03* | 0.02 | -0.18** | -0.04* | 0.01 | -0.20** |
| | (-1.82) | (1.03) | (-7.69) | (-2.07) | (0.78) | (-8.05) |
| *GINI* | 0.11** | 0.11** | 0.10** | 0.11** | 0.11** | 0.10** |
| | (2.94) | (2.60) | (2.35) | (2.95) | (2.60) | (2.41) |
| *INCOM* | 0.05* | 0.06* | -0.07** | 0.05* | 0.05* | -0.06** |
| | (2.16) | (2.08) | (-2.50) | (2.09) | (1.97) | (-2.35) |
| *SC* | -0.03** | -0.04** | -0.02** | -0.03** | -0.04** | -0.02** |
| | (-3.27) | (-3.67) | (-1.69) | (-3.33) | (-3.71) | (-1.68) |
| *BOOZE* | 0.23** | 0.23** | 0.02 | 0.23** | 0.23** | 0.03 |
| | (7.99) | (6.94) | (0.62) | (7.97) | (6.94) | (0.90) |
| *SERVICE* | 0.37** | 0.42** | 0.15** | 0.35** | 0.40** | 0.15** |
| | (7.26) | (7.17) | (2.35) | (6.85) | (6.79) | (2.47) |
| *AGE4059* | 0.11** | 0.10** | -0.02 | 0.08** | 0.07** | -0.03 |
| | (5.38) | (4.22) | (-0.29) | (3.80) | (2.95) | (-0.43) |
| *AGE60_* | 0.05** | 0.004** | 0.41** | 0.05** | 0.004** | 0.41** |
| | (6.21) | (3.40) | (8.62) | (6.15) | (3.30) | (8.64) |
| *YEAR9702* | 0.005** | 0.009** | -0.004** | 0.005** | 0.009** | -0.004* |
| | (3.62) | (5.65) | (-2.38) | (3.86) | (5.85) | (-2.17) |
| *YEAR9902* | 0.006** | 0.005** | 0.006** | 0.006** | 0.005** | 0.006** |
| | (6.01) | (4.90) | (5.21) | (6.37) | (5.23) | (5.29) |
| Sample | 690 | 690 | 690 | 690 | 690 | 690 |
| Groups | 46 | 46 | 46 | 46 | 46 | 46 |
| Adj R-square | 0.73 | 0.75 | 0.56 | 0.72 | 0.75 | 0.56 |

*Note*: Numbers in parentheses are t-statistics. * and ** indicate significance at 5 and 1 per cent levels respectively (one-sided tests). Numbers are the elasticity which was evaluated at the sample mean values of the variables.

Table 3
Determinants of death caused by chronic illnesses as a percentage of the population (Fixed Effects 2SLS Model)

| | (1) All | (2) Male | (3) Female | (4) All | (5) Male | (6) Female |
|---|---|---|---|---|---|---|
| *HOSPITAL* | -0.36* | -0.38* | -0.20 | -0.35* | -0.37* | -0.16 |
| | (-2.26) | (-2.15) | (-1.45) | (-2.15) | (-2.07) | (-1.08) |
| *DENS* | -0.10* | -0.12* | 0.06 | | | |
| | (-1.83) | (-1.90) | (1.10) | | | |
| *POP* | | | | 0.006 | -0.01 | 0.10* |
| | | | | (0.11) | (-0.22) | (1.86) |
| *HC* | -0.06** | -0.009 | -0.21** | -0.06* | -0.01 | -0.21** |
| | (-2.45) | (-0.34) | (-6.37) | (-2.56) | (-0.41) | (-6.70) |
| *GINI* | 0.02 | 0.02 | 0.06 | 0.03 | 0.02 | 0.07 |
| | (0.49) | (0.41) | (1.08) | (0.53) | (0.42) | (1.28) |
| *INCOM* | 0.10** | 0.10** | -0.05 | 0.09** | 0.10** | -0.05 |
| | (2.78) | (2.64) | (-1.42) | (2.69) | (2.54) | (-1.49) |
| *SC* | -0.04** | -0.06** | -0.02** | -0.04** | -0.06** | -0.02** |
| | (-3.50) | (-3.82) | (-1.91) | (-3.52) | (-3.82) | (-1.86) |
| *BOOZE* | 0.28** | 0.28** | 0.04 | 0.28** | 0.28** | 0.04 |
| | (7.03) | (6.38) | (1.04) | (6.99) | (6.36) | (1.14) |
| *SERVICE* | 0.24** | 0.28** | 0.08 | 0.23** | 0.26** | 0.10 |
| | (2.96) | (3.08) | (0.97) | (2.82) | (2.91) | (1.21) |
| *AGE4059* | 0.07** | 0.05* | -0.03 | 0.05* | 0.04 | -0.04 |
| | (2.96) | (1.73) | (-0.39) | (1.78) | (1.28) | (-0.47) |
| *AGE60_* | 0.04** | 0.002 | 0.44** | 0.04** | 0.002 | 0.43** |
| | (2.35) | (1.44) | (7.93) | (3.67) | (1.33) | (7.76) |
| *YEAR9702* | 0.006** | 0.01** | -0.004** | 0.006** | 0.01** | -0.004* |
| | (3.51) | (5.24) | (-2.48) | (3.69) | (5.38) | (-2.27) |
| *YEAR9902* | 0.009** | 0.009** | 0.007** | 0.009** | 0.009** | 0.006** |
| | (4.98) | (4.40) | (4.61) | (5.09) | (4.51) | (4.46) |
| Sample | 690 | 690 | 690 | 690 | 690 | 690 |
| Groups | 46 | 46 | 46 | 46 | 46 | 46 |
| R-square | 0.65 | 0.70 | 0.57 | 0.65 | 0.70 | 0.58 |
| Over-identification test | Chi=1.94 p<0.37 | Chi=1.07 p<0.58 | Chi=1.52 p<0.46 | Chi=3.40 p<0.18 | Chi=1.93 p<0.38 | Chi=0.73 p<0.69 |

*Note*: Numbers in parentheses are t-statistics. * and ** indicate significance at 5 and 1 per cent levels respectively (one-sided tests). Numbers are the elasticity which was evaluated at the sample mean values of the variables. The instruments for *HOSPITAL* were inhabited land area (HABLAND), its square ($HABLAND^2$), and its log-form (lnHABLAND).

APPENDIX

Table A1
Determinants of death caused by chronic illnesses as a percentage of the population, excluding the most densely populated urban areas (Fixed Effects Model)

| | (1) All | (2) Male | (3) Female | (4) All | (5) Male | (6) Female |
|---|---|---|---|---|---|---|
| *HOSPITAL* | -0.01 | -0.01 | -0.05* | -0.01 | -0.01 | -0.05* |
| | (-0.68) | (-0.52) | (-1.96) | (-0.61) | (-0.44) | (-1.83) |
| *DENS* | -0.12** | -0.11* | 0.009 | | | |
| | (-2.49) | (-2.06) | (0.17) | | | |
| *POP* | | | | 0.04 | 0.04 | 0.09* |
| | | | | (1.03) | (0.87) | (2.11) |
| *HC* | -0.09** | -0.05* | -0.19** | -0.10** | -0.05** | -0.20** |
| | (-4.83) | (-2.18) | (-7.65) | (-4.57) | (-2.40) | (-8.13) |
| *GINI* | 0.16** | 0.16** | 0.13** | 0.16** | 0.16** | 0.13** |
| | (4.31) | (3.86) | (2.94) | (4.28) | (3.85) | (2.96) |
| *INCOM* | 0.12** | 0.14** | -0.04 | 0.12** | 0.14** | -0.04 |
| | (4.49) | (4.40) | (-1.46) | (4.53) | (4.44) | (-1.22) |
| *SC* | -0.03** | -0.04** | -0.02 | -0.03** | -0.04** | -0.02 |
| | (-3.09) | (-3.59) | (-1.53) | (-3.20) | (-3.67) | (-1.49) |
| *BOOZE* | 0.26** | 0.27** | 0.01 | 0.26** | 0.27** | 0.12 |
| | (8.76) | (7.88) | (0.41) | (8.56) | (7.80) | (0.76) |
| *SERVICE* | 0.39** | 0.44** | 0.12* | 0.35** | 0.40** | 0.12* |
| | (7.32) | (7.27) | (1.76) | (6.48) | (6.58) | (1.77) |
| *AGE4059* | 0.13** | 0.11** | 0.02 | 0.08** | 0.07** | -0.04 |
| | (5.49) | (4.11) | (0.19) | (3.35) | (2.44) | (-0.42) |
| *AGE60_* | 0.06** | 0.006** | 0.43** | 0.06** | 0.006** | 0.42** |
| | (7.01) | (4.60) | (7.64) | (6.98) | (4.60) | (7.54) |
| *YEAR9702* | 0.006** | 0.01** | -0.003 | 0.007** | 0.01** | -0.002 |
| | (4.37) | (6.27) | (-1.57) | (4.70) | (6.55) | (-1.43) |
| *YEAR9902* | 0.007** | 0.007** | 0.006** | 0.008** | 0.007** | 0.006** |
| | (7.04) | (6.03) | (5.08) | (7.75) | (6.62) | (5.31) |
| Sample | 615 | 615 | 615 | 615 | 615 | 615 |
| Groups | 41 | 41 | 41 | 41 | 41 | 41 |
| Adj R-square | 0.74 | 0.76 | 0.55 | 0.73 | 0.75 | 0.55 |

*Note*: Numbers in parentheses are t-statistics. * and ** indicate significance at 5 and 1 per cent levels respectively (one-sided tests). Numbers are the elasticity which was evaluated at the sample mean values of the variables. Urban areas, which comprised Tokyo, Kanagawa, Aichi, Osaka, and Hyogo prefectures, were excluded from the samples.

Table A2

Determinants of death caused by chronic illnesses as a percentage of population, excluding the most densely populated urban areas (Fixed Effects 2SLS Model)

| | (1) All | (2) Male | (3) Female | (4) All | (5) Male | (6) Female |
|---|---|---|---|---|---|---|
| *HOSPITAL* | -0.42** | -0.45** | -0.25* | -0.39** | -0.43** | -0.21 |
| | (-2.53) | (-2.47) | (-1.66) | (-2.41) | (-2.37) | (-1.36) |
| *DENS* | -0.14* | -0.13* | 0.006 | | | |
| | (-2.24) | (-1.98) | (-0.12) | | | |
| *POP* | | | | 0.03 | 0.01 | 0.08 |
| | | | | (0.51) | (0.29) | (1.60) |
| *HC* | -0.13** | -0.08** | -0.22** | -0.13** | -0.09** | -0.22** |
| | (-4.61) | (-2.74) | (-6.66) | (-4.80) | (-2.89) | (-6.95) |
| *GINI* | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.09* |
| | (1.52) | (1.31) | (1.58) | (1.61) | (1.37) | (1.76) |
| *INCOM* | 0.19** | 0.20** | -0.01 | 0.18** | 0.20** | -0.01 |
| | (4.38) | (4.37) | (-0.32) | (4.40) | (4.38) | (-0.33) |
| *SC* | -0.05** | -0.06** | -0.02** | -0.05** | -0.06** | -0.02* |
| | (-3.30) | (-3.68) | (-1.79) | (-3.37) | (-3.74) | (-1.69) |
| *BOOZE* | 0.32** | 0.33** | 0.04 | 0.31** | 0.32** | 0.04 |
| | (7.35) | (6.87) | (0.95) | (7.27) | (6.84) | (1.11) |
| *SERVICE* | 0.23** | 0.26** | 0.03 | 0.20* | 0.23** | 0.05 |
| | (2.52) | (2.60) | (0.37) | (2.22) | (2.33) | (0.55) |
| *AGE4059* | 0.09** | 0.07* | -0.008 | 0.05 | 0.03 | -0.06 |
| | (2.78) | (1.92) | (-0.08) | (1.54) | (0.95) | (-0.57) |
| *AGE60_* | 0.05** | 0.004** | 0.46** | 0.05** | 0.004** | 0.45** |
| | (4.40) | (2.43) | (7.27) | (4.50) | (2.46) | (7.13) |
| *YEAR9702* | 0.007** | 0.01** | -0.003 | 0.008** | 0.01** | -0.003 |
| | (4.10) | (5.62) | (-1.60) | (4.39) | (5.89) | (-1.49) |
| *YEAR9902* | 0.01** | 0.01** | 0.008** | 0.01** | 0.01** | 0.008** |
| | (5.52) | (5.06) | (4.57) | (5.82) | (5.30) | (4.59) |
| Sample | 615 | 615 | 615 | 615 | 615 | 615 |
| Groups | 41 | 41 | 41 | 41 | 41 | 41 |
| R-square | 0.63 | 0.67 | 0.55 | 0.64 | 0.68 | 0.56 |
| Over-identification test | Chi=0.57 p<0.74 | Chi=0.33 p<0.84 | Chi=0.99 p<0.60 | Chi=2.95 p<0.22 | Chi=1.55 p<0.45 | Chi=0.90 p<0.63 |

*Note*: Numbers in parentheses are t-statistics. * and ** indicate significance at 5 and 1 per cent levels respectively (one-sided tests). Numbers are the elasticity which was evaluated at the sample mean values of the variables. The instruments for *HOSPITAL* were inhabited land area (HABLAND), its square (HABLAND$^2$), and its log-form (lnHABLAND). Urban areas, which comprised Tokyo, Kanagawa, Aichi, Osaka, and Hyogo prefectures, were excluded from the samples.