RIETI Discussion Paper Series 17-E-039

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RIETI Discussion Paper Series 17-E-039
March 2017

Health-Related Income Gaps and the Effectiveness of Redistributive Policies in Japan[1]

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Abstract
Previous studies have well documented that individuals with poorer health tend to be economically disadvantaged. This study focuses on the income difference between individuals with reported poor health and their healthier counterparts, which is referred to as a health-related income gap. Using rich data from the Comprehensive Survey of Living Conditions collected from 1989 to 2010 in Japan, we adopt the newly developed unconditional quantile regression (UQR) approach (Firpo et al., *Econometrica*, 2009) to analyze the income gap at different points along the income distribution. Furthermore, we investigate various types of income for the working-age population aged 25-59: household and personal income, pre- and post-tax income, as well as income after different types of taxes. The results suggest the following major findings: (a) The gap varies significantly along the distribution of income and by income type. When household per capita income increases, the gap due to ill health shrinks. For personal income, however, a U-shape trend is observed, and the gap first decreases and then increases. (b) Compared to health-related gaps in pre-tax income, the gap is greater after income taxes for the lower-middle and middle income earner, and social security contributions tend to widen the gap for those in the lower end of the tail.

Keywords: Health-related income gap, Redistributive policies, Japan, Regressive social insurance premiums
JEL classification: H23, I14, I18, I38

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[1]This study is conducted as a part of the "Research on the Quality and Measurement of Health and Education" project undertaken at the Research Institute of Economy, Trade and Industry (RIETI). This study utilizes the micro data of the questionnaire information based on the "Comprehensive Surveys of Living Conditions in Japan" which is conducted by the Ministry of Health, Labour and Welfare (MHLW). The author is grateful for helpful comments and suggestions by Shunichiro Bessho (Keio Univ.), Kyoji Fukao (Hitotsubashi Univ.), and Discussion Paper seminar participants at RIETI.

1 Introduction

Previous studies have well documented that individuals with poorer health tend to be economically disadvantaged. Similar patterns are also observed in Japan well-known for her healthy population and universal coverage of health insurance. For example, among working individuals aged 25-59, age-sex specific annual personal income was JPY245,000 higher for those with good health than their counterparts with poor health in 2010, even controlling for their education level. And this gap has been increasing, 24.8% higher in 2010 compared to the level in 1989. "When low income and poor health go together, the poor are doubly deprived and thus have a greater claim on our attention than is warranted from their incomes alone." (Deaton, 2002) Such concerns differentiate the inequality associated with health from other common poverty issues and drive growing debate on what policy makers can do to reduce the double burden for those in the bottom tail of income distribution.

Two types of measures are often concerned: (a) redistributive instruments such as tax benefits provided to low income groups; (b) direct interventions aiming at improving health or earnings productivity of those with poor health. Many economists believe that this is essentially an economic problem and prefer the former. If income is affected by health status which is further affected by income, this solution, if properly designed, may be an effective way to help those trapped in this negative cycle. Yet since the target is low income rather than poor health, the impact of policy may fail to reduce the gap caused by health. On the other hand, if the relationship between income and health is mainly driven by the causal effect of health or the “third factors” that affect both health and income, the effectiveness of redistributive polices may be smaller than expected, and instruments such as direct health interventions or supports for target population may be more effective. Furthermore, public policies may take effect while interacting with other behavioral choices and lead to unexpected impacts.

There is a voluminous literature on the relationship between income and health. A strand of this literature, mostly epidemiological studies, focus on the impacts of income on health (see Kroger et al., 2015 for a review). On the other hand, economists are more concerned about the effects of health on income through its impacts on productivity, labor supply, employment and retirement and the effects of the "third variables" that affect both health and income (e.g. Fuchs, 2004; Smith, 1999; McGarry, 2004; Shultz, 2005; Disney et al., 2006, Garcia-Gomez et al., 2013). Many studies have carefully addressed the endogeneity problem in health and reported that ill-health is a leading causes of withdrawal from labor market for middle-age population (Bound et al. 1999; Currie and Madrian 1999; Dwyer and Mitchell 1999; French 2005; Disney, Emmerson, and Wakefield 2006, Garcia-Gomez, 2011; Goryakin et al., 2013). and earning losses (Smith, 1998; Riphahn, 1999; Charles Kerwin K., 2003; Wu 2003; Halla, 2011;Garcia-Gomez et al.,2013). In fact, the relationship between income and health is much muted after retirement, suggesting that health has a strong impact on labor incomes (Deaton, 2002).

Although a lot of work has been done on identifying the causal linkages, few studies explicitly examine the distributional difference in income due to ill-health and the effectiveness of redistributive policies in reducing the gap. To this end, this study attempts to contribute to the literature in the following ways. First, this study focuses on the gap in income between healthy and sick individuals, hereinafter referred to as health-related income gap. Although "health-income gradient" that emphasizes the effect of income on health is often analyzed, health-related income gap which has received little attention so far is presumably more suitable for the analysis of the role of health played in determining earnings and to identify the heterogenous income effect of health that may vary by the types and the distribution of income. It is also important for policy designing and monitoring.

Secondly, considering the heterogeneity in the health-related income gap, we adopt the newly developed unconditional quantile regression (UQR) approach (Firpo et al., Econometrica, 2009) to analyze how incomes vary by health status at different points along income distribution. Traditional quantile regression (QR) estimates the effect of a covariate on the quantiles of the conditional distribution, while the UQR allows us to derive more generalizable results as it gets at the impact on the quantiles of the unconditional distribution of income. For example, in the analysis of the income effect of health, measured by a binary variable indicating "poor" or "good" health, the former gets at the change in income one can expect when her health status changes from "poor" to "good", while the latter estimates the combined effect of switching health status and observing the data. The relationship may be stronger for some income groups but weaker for the others.

Thirdly, we empirically investigate the effects of redistribution policies in Japan that involve progressive taxation and social security programs, using rich data collected through a series of national representative household survey in Japan from 1989 to 2010. More specifically, we make use of the rich information on incomes and taxes paid to examine how ill-health is correlated with incomes after various taxes (i.e. incomes taxes, residence taxes and social security contributions).

Lastly, we focus on health-related income gap and the tax effects in Japan which has gained little attention so far. For governments, such as Japan, that worry about shrinking working population and aiming at raising labor productivity, it is an urgent task to develop a better understanding of the role of health in earnings and what policy instruments work. Despite of the relatively equal income distribution and general healthy population, a large variation in health and a positive relationship between income and health are also documented (i.e. Fukuda and Imai, 2007; Fukuda et al., 2014). However, there are few studies that explicitly analyze the impact of health on income as well as health-related income gap. This is probably partly because lifetime employment, highly regulated pay and seniority pay scales may reduce the influence of health on earning capacity. Yet significant changes in Japanese labor market have been made through the past decades of economic depression to vitalize the economy, making individual decisions and human capital more and more important in determining earnings. For example, Bessho and Hayashi (2011) have shown that even prime-age male Japanese labors are responsive to taxation.

In sum, we have obtained the following major findings. (a) Compared to the traditional quantile regression, UQR estimates of the health-related income gap are greater for individuals whose income located in the bottom tail and smaller for those located in the middle and top tail. (b) The gap varies significantly along the distribution of income and by the types of income. When household per capita income increases, the gap due to ill-health gets smaller. When it comes to personal income, however, a U-shape trend is observed: the gap first decreases and then increases. (c) Variations in employment and industry accounts for about 30% of the gap in personal income among formal employees. (d) Compared to health-related gap in pre-tax income, the gap is generally greater after income taxes, especially for the lower middle and middle income earner, and social security contributions tend to widen the gap for those in the bottom tail.

The rest of the paper is organized as follows. Section 2 provides background information and describes the data. Section 3 presents the econometric specifications and estimation strategies. Section 4 discusses the results and Section 5 concludes.

2 Data and Background

2.1 Data

The data used in this study come from the Comprehensive Survey of Living Conditions (CSLC), conducted in Japan by the Ministry of Health, Labour and Welfare every three years since 1989. The repeated cross-sectional and nationally representative data offer several advantages to our study. First, the large sample size renders higher precision for data demanding quantile analysis. In each wave, following a stratified sampling method, approximately 220,000-250,000 households (involving 700,000-800,000 individuals) were randomly selected from 3000-5000 districts defined by National Census to answer questions related to the household and health questionnaires, among whom approximately 15% were randomly surveyed about their incomes. Refer to Tables 1 and 2 for the detailed sample size and major demographic statistics for each wave. The second advantage is that the survey collected extremely rich information on income and taxes. Specifically, for example, detailed information on pre-tax income, income taxes, residence taxes, premiums for the public pension, health insurance and so forth allows us to examine the health-related gap in various types of income and taxes.

2.2 Background and Stylized Facts

Japan is famous for the longevity of her population. The life expectancy of Japanese population now ranks the first in the world. Besides a healthy traditional lifestyle, the universal health insurance is often credited for providing equal health care at a regulated lower cost. In fact, Japanese are much more likely to seek medical services, i.e. Japanese visit their doctors 13 times per year, ranking the highest among all OECD countries and being much higher than the OECD average of 6.5 (OECD, 2011). Despite of the general healthy population and relatively equal access to health care services, increasing health inequality has been reported by many recent epidemiological studies (Fukuda and Imai, 2007; Hiyoshi et al., 2014). Disparity in health may be due to differences in socioeconomic status such as income and education, it may also further affect these factors and lead to a vicious cycle.

In fact, a large income gap has also been found between individuals with good and poor health in our study. As shown in Figure 1, the gap in the median of pre-tax household per capita income has been constant over time and started to increase in more recent years. The gap in the lowest 10th percentile of income distribution is even larger, suggesting that the correlation between income and health is larger for individuals with low income earners. Moreover, the relationship varies by age group (Figure 2): it increases among older people and peaks at age 60 and much muted among retirees after age 60, suggesting that health effect on earnings accounts for a large portion of the correlation.

Although economically ranked the 3rd in the world, unlike U.S. or China, Japan is actually well-known for its relatively low pre-tax income inequality. Because of the seniority pay scales and highly regulated pay, especially executive pay, pre-tax income inequality in Japan is largely compressed. According to the World Bank, in 2008, Japan ranked the 120th out of 154 countries in the ranking of GINI index. Furthermore, progressive individual income taxation and social insurance programs are implemented to redistribute economic resources from the rich to the poor. Personal incomes in Japan are generally subject to three major types of taxes: (1) a national individual income tax; (2) a residence tax paid on the prefectural and municipal level; and (3) social security contributions that mainly include program-specific premiums for public pension, health insurance and long-term care insurance. For example, based on the sample means in Table 3, working-age individuals earned JPY2,560,000 in 2010, with income tax, residence tax and social security contributions accounting for 3.8%, 3.5% and 10%, respectively.

3 Empirical Model and Identification Strategies

Assume that we observe income Y_i in presence of k characteristics X_i for individual $i = 1, ...N$, following a joint distribution $f_{Y,X}(.,.) : \mathbb{R} \times \chi \rightarrow [0,1]$ and $\chi \subset \mathbb{R}^k$. The most common approach to study the relationship between Y and X is the Ordinary Least Squares (OLS) which assumes the following linear relationship:

$$Y_i = \alpha + X_i\beta + \boldsymbol{\varepsilon}_i. \tag{1}$$

The OLS estimate of β captures the effect of X on the conditional mean of Y, $E[Y|X]$, as well as that on the unconditional mean $E[Y]$ thanks to the law of iterated expectation. However, in many cases X may have an impact on not only the mean but also other aspects of the distribution of Y, such as median and other quantiles. Quantile regression (QR) is thus often used to address such concern. The complexity of the interactions between income and health makes quantile regression particularly suitable for this analysis. Define the τth quantile of distribution of Y as $q_Y(\tau) = v_\tau(F_Y) = \inf\{y : F_Y(y) \geq \tau\}$ where $0 < \tau < 1$ and F_Y is the cumulative distribution function of Y. Quantile regression estimates the effect of X on the conditional quantile of the distribution of Y, $q_{Y|X}(\tau)$.Assuming linear conditional quantile function $q_{Y|X}(\tau) = v_\tau(F_{Y|X}) = X\beta_\tau$, quantile regression estimates β_τ by solving the following optimization:

$$\beta_\tau = \arg\min_{\beta \in \mathbb{R}} E[\rho_\tau(Y - X\beta_\tau)]$$

where the loss function $\rho_\tau(y) = |y(\tau - 1_{(y \leq 0)})|$ and $1_{(y \leq 0)}$ is an indicator function. Note that the Least Absolute Deviation (LAD) is a special case of quantile regression, focusing on the impact of X on median, the 0.5 quantile.

Quantile regression has many advantages. It is robust to outliers in the outcome measures and provides more comprehensive analysis of the relationship between the variables. It is particularly useful when Y and X interact in a complex way and the relationship may not necessarily represented by the conditional means of these variables. However, the disadvantage of the method is that it can only predict the impact of X on the quantiles of conditional distribution of Y which significantly restricts the generality of the statistical inferences. For example, if binary variable $X = 0$ for individuals with poor health and $X = 1$ otherwise, estimator of quantile regression β_τ measures the change in Y one can expect when her health status changes from 0 to 1, conditional in observing the data. Yet in many cases the effect of health status on unconditional quantiles is of more interest.

Firpo et al. (2009) propose a new method that overcomes this issue, referred to as unconditional quantile regression (UQR), in comparisons to the classical conditional quantile regression. The method relies on the concept of recentered influence function (RIF). Influence function (IF) is commonly used to represent the influence of an individual observation on a distributional statistics in the robust estimation of econometric models. RIF can be obtained by adding the statistics to the influence function. For the τth quantile, the IF is defined as $IF(Y, q_\tau, F_Y) = (\tau - 1\{Y \leq q_\tau\})/f_Y(q_\tau)$ and the RIF is simply $RIF(Y, q_\tau, F_Y) = q_\tau + IF(Y, q_\tau, F_Y)$. Firpo et al. (2009) propose unconditional quantile regression defined as the conditional expectation of the RIF of the τth quantile modeled as a function of explanatory variables X, or $E[RIF(Y, q_\tau, F_Y)|X] = m_\tau(X)$. It is shown that average derivative of the unconditional quantile regression, $E[m_\tau'(X)]$ is equal to the marginal effect of a small change in X on the unconditional quantiles of Y. Mathematically,

$$E[m_{\tau}^{'}(X)] = c_{1,\tau} \cdot \int \frac{dPr[Y > q_{\tau}|X = x]/dX}{dx} dF_X(x) = c_{1,\tau} \cdot E[dPr[Y > q_{\tau}|X]/dX] \quad (2)$$

where $c_{1,\tau} = 1//f_Y(q_{\tau})$.

To empirically estimate the UQR, as suggested by the equation above, the estimation of three components are involved: (a) the quantile q_{τ}; (b) the density of the unconditional distribution of Y, $f_Y(q_{\tau})$; (c) the average marginal effect $E[dPr[Y > q_{\tau}|X]/dX]$. The first can be calculated as the sample quantile $\widehat{q}_{\tau}$. The second component $f_Y(q_{\tau})$ is estimated by the kernel density estimator. Lastly, the average marginal effect in part (c) can be estimated by both parametric (linear or nonlinear) and nonparametric approaches. In the example of empirical application given by Firpo et al. (2009), all of these estimators provide similar results. We thus adopt the linear specification which assumes that $Pr[Y > q_{\tau}|X = x]$ is linear in X. Empirically, we estimate the UQR using the statistical package $rifreg$ provided on the website of Firpo.

The dependent variable Y is measured by annual income and various measures have been tried for two important reasons. First, we explore per capita household income versus personal income. To make our analysis tighter and more comparable, we focus on working-age population aged 25-59. Even so, using household income and personal income implies rather different mechanisms between income and health and, in fact, results in quite different findings to be discussed in the result section. Due to the household pooling and allocation effects, the productivity and earning effects of health may be much muted in household income. Therefore, we focus more on personal income for working individuals. Secondly, incomes after various taxes have also been used as alternative dependent variables. The taxes considered include income tax, residence tax and social insurance contributions. The comparisons between pre-tax income and after-tax incomes is a novel way to identify the actual impacts of redistributive policies. If a tax favors individuals with poorer health, either through its regulations directly targeting at poor health, such as the medical expenses deductions in income tax, or indirectly through its intermediate effects on income redistribution, a smaller gap should be observed in the income after the tax. Note that there is a possibility that the indirect effect may take a long period of time to take effect. If that is the case, the comparisons between current pre-tax and post-tax income will under-estimate such effects.

The focus of this study is health-related income gap, so health status is included as an explanatory variable in the estimation. Following the literature, we use the self-reported health status as a measure of health. We have used both the 5-level categorical variable, with 1 indicating very poor health and 5 very good health, as well as the dummy variable that equals 0 if health status is poor or very poor and 1 if the health status is average, good or very good. Using the dummy variable provides a clearer and simpler framework to examine income gap due to ill-health along the distribution of Y, but at a cost of lower precision.

The other variables in X includes age, sex, number of children under age 16, family size, employment dummies, industry and year dummies which are often found to have significant impacts on income. Note that education level is not controlled in our model, because the CSLC did not collect information on education until 2010. As education has often been reported to have a separate effect on income, we have tried the estimation that includes education as an explanatory variable for 2010 sample only. In fact, the results do not change much, so our results may not suffer serious bias due to the omitted education.

4 Results

We now turn to the results which are presented in following three subsections. The first subsection provides an overview on the health-related income gap in Japan, pooling all the data from 1989 to 2010 that involves more than 242,000 individuals in total. The second subsection focus on the health-related income gap for the 2007 and 2010 sample which are used for the analysis of the income tax reform. The results of the analysis on the impacts of income tax reform are discussed in the last subsection.

4.1 Health-related Income Gap

We first examine how income generally varies by health status in Japan. As explained in Subsection 3.1, we estimate Equation (2) by a linear unconditional quantile regression (UQR) approach. To obtain an overview of the relationship between health and economic resources, the log of household per capita pre-tax income is first used as the dependent variable. The set of explanatory variables include health status, age, sex, family size, and year dummies. For a detailed comparison, health status is measured by a 5-level categorical variable. and only working age population aged 25-59 are considered. Figure 4 reports the coefficients of health status for pre-tax household incomes at the 10th, 50th and 90th percentiles. For comparison, ordinary least square (OLS), traditional quantile regression (QR), and unconditional quantile regression (UQR) estimates are reported for each percentile, respectively.

The results highlight several major findings. First, in general, health is positively correlated to income at all three percentiles: the health-related income gaps are generally the largest for the 10th percentile, getting smaller for the 50th percentile and the smallest for the 90th percentile. Second, OLS, QR and UQR estimates are significantly different, suggesting that the choice of correct econometric model is critical. As OLS ignores the heterogeneity across different income levels and gets at the effect on the mean, the OLS estimates are generally smaller than the quantile regression results for lower income level, larger for higher income level and relatively closer to the results of the 50th quantile regression, or median regression. However, even quantile regression estimates can be biased as explained in Subsection 3.1. The comparisons of the QR and UQR estimates confirm the limitation of traditional quantile regression. For the 10th percentile, QR results are generally smaller than the UQR estimates, under-estimating the correlation between income and health. This is because individuals with low incomes tend to have some other characteristics that lead to a lower income and quantile regression estimates are conditional in the means of these characteristics. On the other hand, QR estimates for the gradient are larger than UQR estimates for the 50th and 90th percentiles, failing to marginalize out the influences of these characteristics. Thirdly, the income gap between individuals with very poor health and those with poor health is the largest, getting smaller between the poor and average levels and almost null between the good health and very good health levels.

To further examine the heterogeneity of health-related income gap, we estimate the UQR in Table 4 for 18 quantiles from 0.05 to 0.9 and plot them in Figure 3. Without the loss of generality, instead of the 5-level categorical variable, a dummy variable indicating whether one is healthy or sick is used in the analysis hereinafter for a simpler and clearer presentation. Consistent with the discussion above, the health-related income gap, in both pre- and post-tax household incomes, actually varies significantly along the distribution of income: it is the largest at the bottom tail, and gradually flattens out towards the top tail.

4.2 Health-related Income Gap by Types of Income

The results in Subsection 4.1 are based on the pooled sample of 1989-2010. To examine the relationship between income and health in more recent years, only the data collected in 2007 and 2010 are used in this subsection. Moreover, the role of work-related characteristics such as employment status and the industry of major occupation in determining personal income is considered. To reduce the bias due to the correlation between health and possible unobservable factors of incomes of the self-employed and non-working individuals, the sample is further restricted to formal employees only.

Figure 5 reports the UCQ estimates on the health dummy variable. To compare how different the estimates are from those obtained based on the full sample in Figure 3, the estimates for the household p.c. income for all population age 25-59 are reported in the first column. Columns (2) and (3) are the results for personal income based on formal employees, and the difference between these two is that employment and industry dummies are controlled for in the latter.[1] The last column shows the percentage changes in the estimates from (2) to (3). For a clear view of the heterogeneity, the estimated health-related income gap is plotted in Figure 4. The results highlight several important findings. (1) Compared to Figure 3, the health-related gap in household income in the more recent years appears to be larger. (2) When we focus on personal income for formal employees, interestingly, a U-shape health-related gap is observed: health-related income gap is larger among individuals at both the low and top tails of income distribution and decreases as income level moves towards the middle of income distribution. There may be many reasons to explain this pattern. For

[1]Employment status coded as: 1 self-employed (with employees) 2 self-employed (without employees); 3 family business; 4 managerial positions; 5 general employees; 6 part-time workers with a contract period over one month but within one year; 7 part-time workers with a contract period over one year; 8 minor and other works; 9 non-working. The formal employees include those coded as 4 and 5, who are supposed to be eligible for life employment with stable incomes and welfare packages.

2. Dummy variables based on the industry variable coded as: 1 technicians & professionals; 2 managers; 3 clerical support workers; 4 security services workers; 5 sales workers; 6 physical labor; 7 transportation, information and communication workers; 8 forestry and logging workers; 8 service workers; 9 farmers; 10 fishermen.

example, the seniority pay scales reduces the impact of human capital for salary workers located in the middle of the distribution Note that it is unlikely to be driven by the reversal causality, as the health effect of income is generally decreasing as income increases. (3) Controlling for job characteristics such as employment status and industry explains a large portion of the gap, more than 30% averaged across different quantiles. This is probably because poor health may prevent individuals from promoting to managerial positions or entering profitable industry. However, this effect cannot explain the U-shape health-related income gap discussed in (2) which remains even after controlling for the employment and industry dummies.

We now turn to the results for different types of incomes. We estimate the unconditional quantile regressions for (1) personal pre-tax income, (2) personal income after income tax, (3) personal income after both income and residence taxes, and (4) personal income after income tax, residence tax, pension and health insurance premiums. The estimates of health-related gap in these incomes are plotted in Figure 5 for comparisons.[2] The U-shape pattern remains after subtracting various types of taxes and premiums, more or less so for different quantiles. Since individuals located in the bottom tail are mostly exempted from income tax, little difference is observed before and after income tax for them. However, starting from somewhere around the 25th percentile, the health-related gap is larger in income after income tax, mainly among those with middle level incomes. Although individuals with poor

[2] We have also examined property tax and long term care insurance premium. We suppress the results as they do not make much difference in the major findings.

health may enjoy some tax benefits such as medical expense deductions, it appears that income tax limited direct impact on reducing health-related income gap. Furthermore, the gap between the healthy and sick individuals gets even larger after paying social insurance premiums, and it is more so for low income earners. This is probably because the social insurance programs that low income individuals with poor health usually belong to tend to charge a higher premium. This finding is well aligned with the literature that have reported the regressivity of social insurance premiums in Japan (i.e. Abe, 2000; Tajiki and Yashio, 2010).

5 Conclusions

Concerned with the double burden of poor health and low income, this study investigates the health-related income gap empirically. Our findings confirm the large positive correlation between health and per capita household income in Japan among working-age population, especially for those with low incomes. When it comes to personal income, controlling for job characteristics such as employment status and industry explains approximately 30% of the gap, indicating an important role of health in earnings through labor market performance. Lastly, we find a generally larger gap in incomes after income taxes and social security contributions in Japan, especially for low income earners. These findings have important implications for policy makers. Quantifying the scale and the heterogeneity of health-related income gap provides important evidence for identifying the target population and policy monitoring. Moreover, the comparisons between incomes after various taxes suggest that current redistributive policies that target at low income is not sufficient to address the gap due to ill-health. Measures or interventions that directly target poor health may be more efficient.

There is one caveat that is worth mentioning regarding our empirical findings. First, strictly speaking, the health-related income gap we identified should be considered as a correlation, rather than the causal effect of health on income. Although we have controlled various important factors to make the income comparisons between the healthy and sick individuals, as explained in the introduction, income may affect health and the omitted third variables may affect both health and income. Just like the well-known work by Cutler and Lleras-Muney (2010) which focuses on testing how the relationship between health and education changes by including different sets of covariates, without explicitly addressing the endogeneity problem of education, this paper focuses on understand the patterns and heterogeneity of health-related income gap. Another practical reason is that currently no statistical methods have been developed to address endogeneity problem using unconditional quantile regression.

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