Joint Decomposition of Pure and Socioeconomic Health Inequalities in Québec

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Abstract

The decomposition of health inequality is important for health care policy making. In this paper, based on the CCHS 2007-2008, we use the measure proposed by Makdissi and Yazbeck (2011), which is associated with the socioeconomic health inequality aversion parameter and the pure health inequality aversion parameter to estimate the achievement index and health inequality index, and disaggregate Québec's inequality in health into contributions from health inequality index within and between health areas in the province and the residual term. We find that the rankings of achievement index and health inequality index vary with the change of values of the socioeconomic health inequality aversion and the pure health inequality aversion. The within-region inequality in health explains most of the total health inequality in Québec and this holds for all values of v, the parameter of socioeconomic health inequality aversion and ε, the parameter of the pure health inequality aversion.

Key Words: health inequality; achievement index; inequality decomposition; socioeconomic health inequality aversion; pure health inequality aversion; Québec

1. Introduction

Health equity has been discussed for a long time and has been a hot topic in the last 20 years. The literature provides various measurements of health inequality, such as the range, Gini coefficient and the slope index of inequality. This last was proposed by Wagstaff, van Doorsaler and Paci (1989), together with the concentration index[1], and incorporates the socioeconomic dimension into the measure of health inequality. Later on, Wagstaff (2002) suggests using the achievement index[2] and inequality index to modify the defects of concentration index. Based on the work of Wagstaff (2002), Makdissi and Yazbeck (2011) move forward a step. They argue that, considering the preferences of the planner, the Wagstaff's achievement index, by focusing on the socioeconomic dimension of health inequality, overlooks totally the pure health inequality aversion of the planner. For instance, if the planner transfers health from a richer person with bad health to a poorer person with good health, the achievement index will increase. Thus they develop a general class of achievement index and inequality index, to introduce the parameter of socioeconomic health inequality aversion and the pure inequality aversion into the Wagstaff's achievement index and inequality index. In this paper, we will apply this method to measure the health inequality in Quebec.

Another purpose of this paper is to decompose inequality in health of Québec. There are plenty of empirical studies in this issue. Wagstaff (2001) offers a way to achieve this goal ---- to decompose health inequality into the contributions from the socioeconomic determinants. Clarke et al. (2002) use health data of England and Australia to get the concentration index and find that different dimensions of health has different concentration indices. Pradhan et al. (2003) decomposes the global pure health

[1] Health concentration index measures the concentration degree of the distribution of people's health.

[2] Achievement index measures the score of health equality in a region. This index will be explained in more details later on.

inequality into inequality within each country and between countries and find that the inequality within each country mostly has contributed to the overall inequality in health. Wagstaff and van Doorslaer (2004) disaggregate the concentration index into health inequality concentration indices within socioeconomic groups and that between groups. They conclude that socioeconomic health inequality explains little of the overall inequality in health.

Clarke et al. (2003) decomposes the overall concentration index in two ways. One is to disaggregate the health concentration index into ten weighted concentration indices of each health dimension. He uses this method in his analysis with Australian data. The other is to decompose the integrated concentration index into contributions of the concentration indices within the separated groups and that between the groups and residuals. He finds that the contributions of health concentration index between groups are much larger than that of concentration index within groups. We will follow this approach in this paper to disaggregate the inequality in health of one province of Canada.

This paper uses the Canadian Community Health Survey (CCHS) 2007-2008, and the latest methodology to measure the inequality of health in Province Québec which is divided into 15 health regions. The main objective is to find out how the change of socioeconomic health inequality aversion or pure health inequality aversion affects the class of health inequality index and the class of health achievement index. Then this paper decomposes the health inequality into contributions of inequality in health within health regions and residuals.

Next we will provide an overview of all sections. In section 2, we give a particular review of the measurement of health inequality and introduce the specific approach we use in this paper. In section 3, we offers–the background of study of health care in Canada and the data we use. In so doing, we will present the empirical analysis using the data in section 4.

2. Method

2.1. Measurement of health inequality

There is a large literature discussing how to measure health inequality. The Black Report (1982), the first paper focusing on this problem, uses the range[3] to measure health inequality. But many researchers consider it is inappropriate since it overlooks the group share and the affect of the intermediate groups. Le Grand (1989) and Le Grand and Rabin (1986) introduces the Gini coefficient and Lorenz curve as one measurement which are usually used to measure the wealth inequality. In this case, individuals are ranked by health status. The area between the Lorenz curve and the 45° line measures the degree of health inequality. The Gini coefficient is equal to twice the area between the Lorenz curve and the diagonal. It reflects all the people in all groups but fail to take the socioeconomic dimension into consideration, measuring only pure health inequalities. Preston, Haines and Pamuk (1981) and Leclerc, Lert and Fabien (1990) make a few improvements on Le Grand (1989)'s work, which is called Pseudo Lorenz curves. They divide people in different groups with respect to occupational classes. Although in this approach people are ranked by their health status and socioeconomic dimension, it is not linked to the health inequalities.

Wagstaff, van Doorslaer ,Paci (1989), Wagstaff, Paci and van Doorslaer (1991) adress this problem and argue that the concentration index and the slope index of inequality are good measurements of health inequality because they reflect the situations of all groups and take the group size and the socioeconomic status of people into account. In Wagstaff, Paci and van Doorslaer (1991), the concentration index is given by:

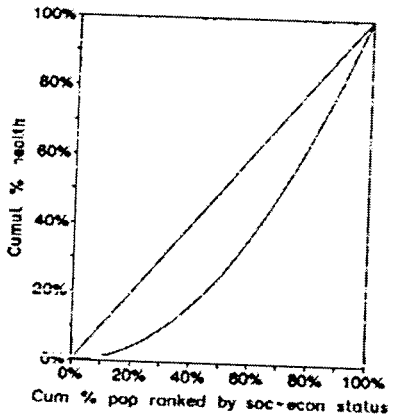
$$C = \frac{2}{N\mu}\sum_{i=1}^{N} h_i r_i - 1 \qquad (1)$$

Where μ is average health status and r_i is the socioeconomic status rank of

[3] Range: compare the experiences of the top and bottom socioeconomic groups.

individual *i*. Clearly, the concentration index can reflect population health status over their socioeconomic distributions. h_i is the health status of individual. *N* is the size of population. The associated concentration curve for health links the population's health and their socioeconomic status. Here we use income as proxy of socioeconomic status. And the concentration curve starts with the most disadvantaged people.

Figure 1: Health concentration curve



The concentration curve describes the cumulative percentage of population ranked by socioeconomic status against the cumulative percentage of health. And the rank starts from the person with lowest socioeconomic status and health. When there is health equality, the concentration curve will be the diagonal. When there is health inequality, the more inequality of the health distribution, the further away the concentration curve is from the diagonal. In the presence of health inequality (health share of richer population is larger, C<0), the concentration curve will be lower than the diagonal.

The domain of C is [-1,1] by definition. We can see from Figure 1 that when the most disadvantaged person has health of all the people, the concentration index is equal to -1. On the contrary, when the most advantaged person has health of all the people, C is equal to 1.

The concentration index is equal to twice the area between the diagonal and the concentration curve. The larger the concentration index is, or in other words, the larger

the area between the diagonal and the concentration curve is, the greater the degree of health inequality.

Several researchers have challenged the rationality of using the concentration index. Wagstaff (2002) suggests that the average level of health should play a role in the assessment of health inequality. When using the concentration index, the planner will not have enough reason to choose a policy which aims for the average level of health with the distribution of health unchanged. There is one simple modification: the generalized concentration index, written as:

$$GC = \mu \cdot C = \frac{2}{N}\sum_{i=1}^{N} h_i r_i - 1 \tag{2}$$

Wagstaff (2002) proposes the achievement index that is sensitive to both the average level of health and the socioeconomic dimension. Makdissi and Yazbeck (2011) argue that there exists blindness to health status (the achievement index will increase when health is transferred from an individual in bad health to an individual in good health if the former has a higher socioeconomic status) when using Wagstaff's achievement index. They provide a new class of achievement index and inequality index which could capture the pure health inequality and socioeconomic dimensions at the same time, based on Wagstaff's contribution.

Although there are many ways to evaluate the health inequality such as the range, the pseudo-Gini coefficient, the slope index of inequality and the concentration index, in this context, we focus on a modified version of the concentration index which includes the socioeconomic dimension.

2.2. Health achievement index and health inequality index

Consider the class of health achievement index and health inequality index. Wagstaff (2002) gave the class of health achievement index as

$$A(v) = \int_0^1 v(1-p)^{v-1} h(p)dp, v > 1 \tag{3}$$

and the class of health inequality index as

$$I(v) = 1 - \frac{A(v)}{\mu} \text{ , where } \mu = \int_0^1 h(p)dp \tag{4}$$

Apparently, Wagstaff's class of health inequality index captures both the average level of health (μ) and the socioeconomic dimension. But Makdissi and Yazbeck (2011) point out the important defect of Wagstaff's index, which is that when the planner transfers health from the person who is richer but in bad health to the person who is poorer but in good health, the achievement health index would increase (blindness to health status). However, this may not be preferable for planners. Makdissi and Yazbeck (2011) propose a new class of health achievement and health inequality index which avoid the problem. They define an index of social preferences over the health distribution:

$$S = \int_0^1 w(p)u(h(p))dp \tag{5}$$

where *u(h(p))* is interpreted as the expected utility of the life of a person with health status h and *w(p)* represents the socioeconomic weight.

Five assumptions are imposed on this index: monotonicity, pure health transfer (PHT), socioeconomic health transfer (SHT), pure health transfer sensitivity (PHTS) and socioeconomic health transfer sensitivity (SHTS). Monotonicity implies that given other things unchanged, when one individual's health status increases, the index above will also increase. PHT says that with other things unchanged, when pure transfer health from an individual "*i*" to an individual "*n*" with health status $h_n<h_i$ and $Y_n=Y_i$, where *Y* is income, the health achievement index will increase. SHT means that given other things unchanged, when pure transfer health from an individual "*i*" to an individual "*n*" with health status $h_n=h_i$ and $Y_n<Y_i$, the health achievement index will increase. PHTS says that under the PHT, the lower *hi*, the larger the magnitude of increase of the health achievement index. And similarly, SHTS says that under SHT, the lower Y_i, the larger the magnitude of increase of the health achievement index.

If v represents a parameter of socioeconomic health inequality aversion and ε represents a parameter of pure health inequality aversion, as Yitzhaki (1983) and Atkinson (1970) define, one parametric class which satisfy all the assumptions is

$$S(v,\varepsilon)=\begin{cases}\int_0^1 v(1-p)^{v-1}\dfrac{h(p)^{1-\varepsilon}}{1-\varepsilon}dp & \text{for } v\geq 1,\varepsilon\geq 0 \text{ and } \varepsilon\neq 1\\ \int_0^1 v(1-p)^{v-1}\ln h(p)dp & \text{for } v\geq 1,\varepsilon=1\end{cases} \tag{6}$$

then we can get the class of health achievement index by:

$$A(v,\varepsilon)=\begin{cases}[\bar{S}(v,\varepsilon)]^{\frac{1}{1-\varepsilon}} & \text{for } v\geq 1,\varepsilon\geq 0 \text{ and } \varepsilon\neq 1\\ \exp\bar{S}(v,\varepsilon) & \text{for } v\geq 1,\varepsilon=1\end{cases} \tag{7}$$

where $\bar{S}(v,\varepsilon)$ is the average of index of social preferences over the health distribution. Thus we find the parametric class of health achievement index as:

$$A(v,\varepsilon)=\begin{cases}[\int_0^1 v(1-p)^{v-1}h(p)^{1-\varepsilon}dp]^{\frac{1}{1-\varepsilon}} & \text{for } v\geq 1,\varepsilon\geq 0 \text{ and } \varepsilon\neq 1\\ e^{\int_0^1 v(1-p)^{v-1}\ln h(p)dp} & \text{for } v\geq 1,\varepsilon=1\end{cases} \tag{8}$$

and according to Wagstaff's definition (equation 4), the form of the class of health inequality index is given by:

$$I(v,\varepsilon)=\begin{cases}1-\dfrac{1}{\mu}[\int_0^1 v(1-p)^{v-1}h(p)^{1-\varepsilon}dp]^{\frac{1}{1-\varepsilon}} & \text{for } v\geq 1,\varepsilon\geq 0 \text{ and } \varepsilon\neq 1\\ 1-\dfrac{1}{\mu}e^{\int_0^1 v(1-p)^{v-1}\ln h(p)dp} & \text{for } v\geq 1,\varepsilon=1\end{cases} \tag{9}$$

This class of A(v,ε) and I(v,ε) satisfy PHT and PHTS if $\varepsilon>0$, satisfy SHT if $v>1$ and satisfy SHTS if $v>2$.

We can easily find Wagstaff's achievement index and inequality index when $\varepsilon=0$. This form of the class of health achievement index and the class of health inequality index reflect both the pure health inequality and socioeconomic health inequality. And

from Wagstaff's definition, the health achievement index will rise with the increase of the average health status and fall with the increase of the health inequality index.

2.3. Inequality decomposition

The decomposition of health inequality is to answer this question: is the overall health inequality mainly driven by the gap between people within each health region or by the gap between regions? Rao (1969) provides a measure to decompose the concentration indices and it is applied by Clarke et al. (2003) to the decentralization of health concentration index. He proposes two ways to this problem. Firstly, the decomposition by components. If the integrated health inequality index is obtained by the combination of situations from different components such as vision, hearing, speech, emotion and pains, it may be disaggregated into these components to find their respective contributions. Let CI_H be the health concentration index and CI_S be the health concentration index of each component, then:

$$CI_H = \sum_{s=1}^{S} w_s CI_s \qquad \text{where} \quad w_s = \frac{\mu_s^h}{\mu^h} \tag{10}$$

Secondly, the decomposition by subgroups. If the population was divided into different groups by age, socioeconomic status, or sex, the health concentration index can be decentralized into contributions from the within-group inequality and that from the between-group inequality and a residual term. It is proven in the following equation:

$$CI_H = CI_B + CI_W + R \tag{11}$$

where $CI_W = \sum_{j=1}^{J} w_j p_j CI_j$, w_j is the health share and p_j is the population share. The residual term is non-zero whenever subgroup income ranges overlap. However, this approach has an unavoidable defect-----the residual term is ambiguous when considering the socioeconomic status in the measure of health inequality.

Wagstaff and van Doorslaer (2004) follow this approach to decompose the Gini coeffient. And Wagstaff (2005) make a geographic decomposition of the health

concentration index, using the data of China and Vietnam. In this paper, we will use a method which is similar to the way Wagstaff used in 2005 to decentralize the health inequality index in the province of Québec, Canada.

2.4. The decomposition of the health inequality index

When the whole population is divided into geographic groups, we can get the sources of overall health inequality index by:

$$I(v,\varepsilon) = I_w + I_B + residual \tag{12}$$

where $I_w = \sum_{i=1}^{I} \frac{\mu_{h\_\varepsilon i}}{\mu_{h\_\varepsilon}} \pi_i I_i(v,\varepsilon)$, π_i is the group share of separate group "*i*" of all the data and $\sum_{i=1}^{I} \pi_i = 1$. If every individual "*j*" in group "*i*" has a health status "h_{ij}", we suppose:

$$h_{ij\_\varepsilon} = \frac{h_{ij}^{1-\varepsilon}}{1-\varepsilon} \tag{13}$$

It's a weighted health status of each individual. The average level of this weighted heath status for group "*i*" is $\mu_{h\_\varepsilon_i}$, where

$$\mu_{h\_\varepsilon i} = \frac{1}{J} \sum_{j=1}^{J} h_{ij\_\varepsilon} \tag{14}$$

The average level of this weighted heath status for the population *N*, is μ_{h_ε}, where

$$\mu_{h\_\varepsilon} = \frac{1}{N} \sum_{i=1}^{I} \sum_{j=1}^{J} h_{ij\_\varepsilon} \tag{15}$$

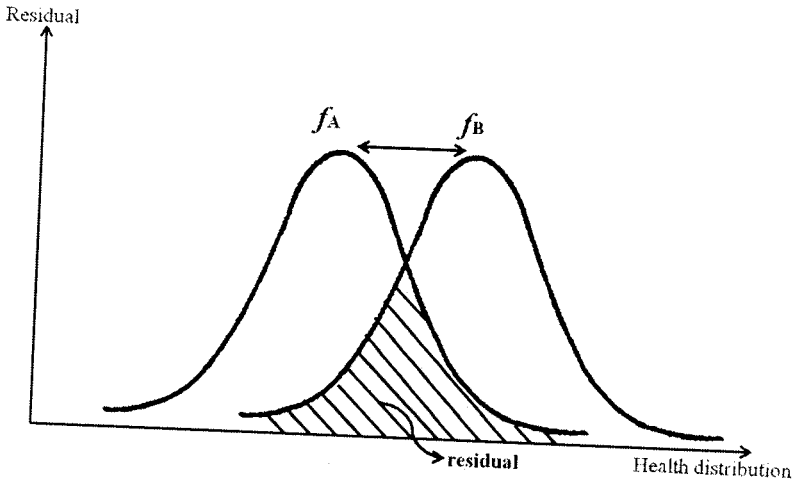
Therefore, $\sum_{i=1}^{I} \frac{\mu_{h\_\varepsilon i}}{\mu_{h\_\varepsilon}} \pi_i$ is the joint-weight.

$I_i(v,\varepsilon)$ represents the health inequality index of group *i*. $I_B(v,\varepsilon)$ indicates the health inequality index between all the groups. We get $I_B(v,\varepsilon)$ by replacing each individual's health status h_{ij} in group "*i*" equal to the average health status of group *i*.

Then $\sum_{i=1}^{I} \frac{\mu_{h\_\varepsilon i}}{\mu_{h\_\varepsilon}} \pi_i I_i(v,\varepsilon)$ is the weighted sum of all the health inequality indices of each area. It is the within-region health inequality index. In other words, the health inequality index of the total population, $I(v,\varepsilon)$, is given by the summation of all the weighted health inequality indices within every single group plus the health inequality index between all the groups plus the residuals.

The residual here, as Figure 2 illustrates, is reflected by the overlapped area of different health distributions over socioeconomic status. This area captures both within-region and between-region inequalities in health.

Figure 2



The empirical analysis of decentralization of health inequality index will tell us the sources of overall health inequality and the magnitude of contributions made by each source of $I_i(v,\varepsilon)$. We will also find how these parts react when the socioeconomic health inequality aversion and pure health inequality aversion vary.

3. Background & Data

Canada's publicly financed health care system is called single-payer system. It offers universal and comprehensive coverage insurance for medically necessary services.

During the service, there are no premiums or co-payments imposed to the individual; the federal and provincial governments pay for it. These medical services are provided privately by hospitals and physicians and limited to necessary medical services. Unessential services such as dental care, vision care services and cosmetic surgeries must be paid by private insurance or service recipients themselves. These rights and interests are officially guaranteed by the provisions of the *Canada Health Act*. About 70% of the cost in health-care in Canada was funded by taxation from provincial and federal governments. Near 30% was financed by individual insurance or out-of-pocket money.

According to the *Constitution Act,* the administration of this health-care system is disaggregated to Canada's ten provincial and three territorial governments. Provinces are responsible for the health-care of their jurisdiction. They can make health-care plans and financing plans, regulate hospitals and health institutions, negotiate salaries of health sector workers and physician service fees and make health related regulations and legislation to supplement the *Canada Health Act (CHA).* The provincial or territorial government can get the full share of the transfer from federal government revenues only when the health regulations or plans made by them meet the CHA, which mainly includes 5 basic principles: universality (everyone should be covered), comprehensiveness (all medically necessary services should be covered), accessibility (no financial or other barriers to access health care services), public administration and portability of coverage outside the province. The central government's role in this system is to conduct the health services to specific sectors of population, such as military personnel, native residents living in the reserves, and the Royal Canadian Mounted Police; direct disease prevention, health promotion and other health protection activities. The general revenue funds of provincial governments and the transfers from central government are the main source of provincial health costs. Alberta, British Columbia and Ontario use reserved taxes to supplement health funds.

Since all the publicly insured services are "free", the demand of these services grew

up fast and so did the expenditure of health. The federal government decreased the block amounts to provinces[4]. In 1996, the central government wiped out the Established Programs Financing and the Canadian Assistance Plan and started to use the Canadian Health and Social Transfer (CHST) which contains a cash payment related to per capita entitlement and a tax transfer that combined a particular share of individual's income tax with the corporate income tax of central government. The Equalization program was used to solve the problem of the inequality in tax-related transfer. The transfer payments from federal government falls after the CHST came into effect. However, from another angle, the provincial governments stared to have more autonomy in the determination of their health-care budgets which is guided by local needs.

As the second largest province in Canada, Province Québec has developed a public health system, called Regie de l'assurance maladie du Québec (RAMQ). Québec's policy has advanced concepts, relative legal basis, well organization and good programs. When other English provinces made efforts on "core public health functions", Québec already proposed "new public health" which linked health status with lifestyles and living conditions (Bernier, 2006). Québec provincial government set up the Institut national de la santé publique (INSPQ) in 1998 to collect and promote the public health expertise and to give advices to the Ministry of Health and Social Services (MHSS). The Public Health Act (2001) offered a legal basis of public health interventions. This involved most of the government sectors into public health issues. When other government agencies or sectors are making a determination or issuing a new law or regulation which would have an important affect on public health, they have to turn to the Ministry of Health and Social Services to ensure its justifiability. In 2003, the provincial government carried out

[4] References: Jimenez-Rubio & Dolores, Smith, Peter C. & van Doorslaer, E. (2008), Equity in health and health care in a decentralized context: Evidence from Canada, *Health Economics*, 17: 377-392; Zhong, Hai (2010a), The impact of decentralization of health care administration on equity in health and health care, *Int J Health Care Finance Econ*, 10: 219-237; Bernier, N.F. (2006), Québec's Approach to Population Health: An Overview of Policy Content and Organization, *Journal of Public Health Policy*, Vol. 27, No. 1 (2006), pp. 22-37.

a ten-year program to improve the distribution of the public health care services, especially for vulnerable groups, and then reduce the health inequalities. Québec has a leading position in building the public health infrastructure and it is an interesting case study.

There is a lot of literature on the analysis of Canada's health care. Cross-country comparison is one of the useful ways to investigate the efficiency of health care system of one country. Since Canada and the United States have much in common, many studies made comparisons of health care systems of these two countries: the publicly funded single-payer system and the mixed system. Evans and Roos (1999) find the average health status of Canadian people is higher than that of the Americans. Studies of Torrey and Haub (2004), Evans and Roos (1999) and Kunitz and Pesis-Katz (2005) show that in the area of health care access and the degree of income related and racial-related health inequalities, Canada and the U.S. differ a lot. Armstrong & Clement & Lin & Prus (2006) compare the strength of the relationship between factors such as sex, age, income, education, marital situation, birth country and race or ethnicity, and the health status of Canadian and Americans, using the *2002-2003 Joint Canada/United States Survey of Health (JCUSH)*. They find a similar phenomenon about health care access and income/racial-related inequalities to Torrey and Haub (2004), Evans and Roos (1999) and Kunitz and Pesis-Katz (2005) and find that the relative relationship between these factors and health situations is stronger in the U.S. than in Canada. They give approbation to the universal access to health care services and the equitable distribution of health resources.

O'Neill and O'Neill (2007) use the JCUSH to examine different health status measurements and find that the incidence of chronic diseases in the U.S. is larger than in Canada and American people used health care services more frequently. The average levels of health status are almost the same. Income has a greater effect on health inequality in Canada than in the U.S., and Canadian citizens wait longer than Americans

for the health treatment. Also, Canadians are less satisfied with the health care services than the Americans.

Many researchers focused on the study of the health inequality in Canada and they got different results. Jimenez-Rubio et al. (2008), using the data from the 2001 CCHS, made an empirical analysis of spatial dimension of health inequality in decomposed Canada. They decomposed the health concentration index of Canada in the same way of Wagstaff (2005). The result is that the health inequality in Canada is mainly driven by the within-provinces health inequality rather than the between-provinces health differences and suggests a caution on the statement of results when the residual term is large. Because there are some other factors affecting the overall inequality if residual term is large. He uses the indirect standardization procedure (IS), based on the horizontal inequalities (Wagstaff and van Doorslaer 2000) to define the equity in the use of health care. The horizontal health equity means that people who have the same need of health care services would receive the same amount of health services. And the IS procedure is to compare the actual use of health care with the expected use as follows:

$$y_i^{IS} = y_i - \hat{y}_i + y^m \tag{16}$$

where $\hat{y}_i$ is the need-adjusted measure of health care utilization, y_i is the actual health care utilization and y^m is the sample mean of the use of health care. He found that the between-provinces differences made the most contribution to the inequality in health care utilization.

Hai Zhong (2010a) explores the decomposition of health care administration on health-care access inequality in Canada. He expands the Jimenez-Rubio et al. (2008)'s work and uses the health concentration index and the Theil index (Theil 1967) to measure the health inequality. The Theil index indicates how the distribution of health care use over groups differs from the population distribution over the same groups and it does not reflect the socioeconomic dimension of inequality. Using the Theil index can

avoid the problem of unexplainable residual terms when using the health concentration index. In his paper, the Theil index is used to evaluate the overall inequality in health care access, and health concentration index is used to measure the socioeconomic-related inequality in that area. Then he compares the extent of decomposition before and after the CHST was introduced in Canadian health care system in 1996. His result is that the within-provinces inequality is the largest contributor of the inequality in health services utilization. This conclusion contradicts that of Jimenez-Rubio et al. (2008). The lower extent of integrated, within-province inequality in the use of general practitioner (GP) services and the inequality of the utilization of GP services, medical specialist and hospital services between different provinces lead to the rise of the extent of decomposition. Hai Zhong (2010a) also mentions 3 limitations of his study: no statistical inferences of the disaggregation; limited policy results and the comparison lack of comprehensiveness.

Wagstaff et al. (2003) offers an approach to decompose the differences in inequality in a health variable into the differences of the means, changes of inequalities in the components which constitute the health variable and changes of the components of the health variable.

Another paper by Zhong (2010b) discusses the relationship between financing arrangements of health care and the inequality in the health care utilization. He believes that while the CI evaluates the inequality over the income distribution of health or a particular aspect of health, it cannot differentiate the inequality in mean utilization rates and the distribution of the health variable of interest. The changes of inequality in health or health variables may be due to the changes of the mean. Therefore, he uses the health concentration index (CI) to measure the health inequality and used the horizontal inequality index (HI) to evaluate the inequality in the use of health care services, both defined by the indirectly standardization procedure (IS). Then he provides a way to decentralize these two health indices into two components: the variation in means and

the distributional effect. His results are: first, the changes in means or in distributions can contribute to the variation in the differences of between-group inequality; second, the changes in means which do not contribute to the inequality may lead to the variation in inequality measure; finally, some correlations may exist in the use of different health services and the differences of HIs changes of two periods may be driven by the mean health care utilizations. The important contribution of his paper is that, unlike many studies, he proposes an approach emphasizing on the health variable itself which contributes to the inequality. There are a few shortcomings of his method: it cannot reflect the contributions of each health variables and it does not provide statistical inferences.

We use the Canadian Community Health Survey (CCHS) 2007-2008 and focus on the province of Québec. This survey is cross-sectional and provides information about Canadian's health status, health utilization and determinants of health. It targets people over 12 years old (12-year-old people are included) living in their own house. People who were surveyed do not include people living on Indian Reserves and on Crown Lands, full-time members of the Canadian Forces, institutional residents and people living in some specific remote areas. These exceptions only account for less than 2% of Canadian population who are 12 years old and over. This survey covers all provinces which were divided into a few health regions and every territory is set as an individual health region. In total, almost 130,000 residents living in 121 health regions are surveyed and the sample size is 132,080.

In this context, the socioeconomic status of every individual is represented by their household income. The Health Utilities Index (HUI) illustrates people's health situation. The Health Utilities Index was originally proposed by researchers in McMaster University. The CCHS use the improved version of HUI------the Health Utility Index Mark 3 (HUI3), to represent individual's health status. HUI3 demonstrates totally 8 attributes: vision, hearing, speech, ambulation, dexterity, emotion, cognition and pain. Each attribute

makes a contribution to the overall score of individual's health utility which infers the people's health-related quality of life. If the score of a single attribute ranges from 0 to 1, in other words, from normal to disabled, the total score of health utility ranges from 1 to -0.36, intuitively, from perfect health to health situation worse than death (0 : health status is equal to death).

4. Empirical Results

In this survey, our subject province --- Québec, contains 15 health regions: Bas-St-Laurent, Saguenay-Lac-St-Jean, Capitale-Nationale, Mauricie et du Centre-du-Québec, L'Estrie, Montréal, Outaouais, Abitibi-Témiscamingue, Côte-Nord, Gaspésie-Îles-de-la-Madeleine, Chaudière-Appalaches, Laval, Lanaudière, Laurentides and Montérégie, including 24,290 samples. The sample share and average health status of each health region are showed in the table and figure below.

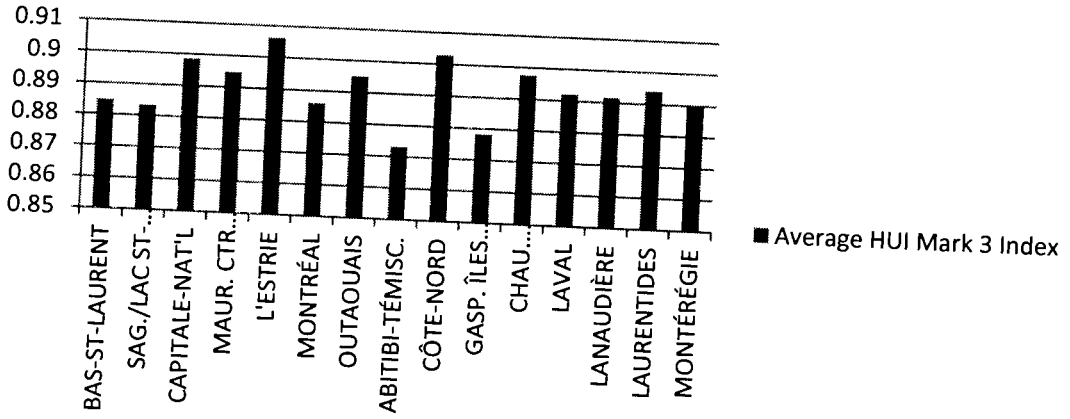
Table 1

Health Region	Sample Share	Sample Size
BAS-ST-LAURENT	5.23%	1,049
SAG./LAC ST-JEAN	5.29%	1,061
CAPITALE-NAT'L	8.18%	1,641
MAUR. CTR QUEBEC	7.12%	1,428
L'ESTRIE	4.69%	941
MONTRÉAL	12.57%	2,521
OUTAOUAIS	5.59%	1,121
ABITIBI-TÉMISC.	5.73%	1,150
CÔTE-NORD	5.29%	1,061
GASP. ÎLES MADE.	5.15%	1,033
CHAU. APPALACHES	6.05%	1,214
LAVAL	5.64%	1,132
LANAUDIÈRE	6.24%	1,251
LAURENTIDES	6.18%	1,240
MONTÉRÉGIE	11.03%	2,212

We can see from the table that Montréal and Montérégie hold the largest sample sizes in Québec and L'Estrie has the smallest sample size. As shown in Figure 3, people in Abitibi-Témiscamingue have the lowest health status while residents in L'Estrie have the

highest utilities of health status. The average health utility index of the whole province is 0.8909. There are 6 health regions did not reach the average level of the province: Bas-St-Laurent, Saguenay-Lac-Saint-Jean, Montréal, Abitibi-Témiscamingue, Gaspésie-Îles-de-la-Madeleine, Montérégie. Residents in the smallest-sample-size region, L'Estrie, have the highest health status, while people in the largest-sample-size region, Montréal, have lower-than-province-average level. There exists inequality of health status between health regions. The differences of average health status are not good enough to show the inequalities of health situation among the 15 health regions because it overlooks the health inequality within each region. We use achievement index and inequality index to evaluate the contributions made by those regions according to individual's health status.

Figure 3 Average HUI Index



We assign different values to the parameter of socioeconomic health inequality aversion, v, and the parameter of pure health inequality aversion, ε in equation (8) and equation (9). We assign $v=1,2,3$ and $\varepsilon=0,1,2$ to satisfy the following 3 conditions: firstly, the domains of v and ε for the achievement index (equation 8) and inequality index (equation 9) are $v\geq 1$ and $\varepsilon\geq 0$, $\varepsilon\neq 1$ respectively; secondly, we can get the Wagstaff's achievement and inequality index (equation 3 and 4) if there is no pure health inequality aversion; the inequality index for $v=2$ and $\varepsilon=0$ is equal to the generalized health concentration index and achievement index for $v=1$ and $\varepsilon=0$, which means there is no

pure health inequality aversion ($\varepsilon=0$) and there is no socioeconomic health inequality aversion ($v=1$), is equal to the average health status; lastly, the health achievement index $A(v,\varepsilon)$ and the health inequality index $I(v,\varepsilon)$ should satisfy PHT, PHTS, SHT and SHTS . We use equation 8 and equation 9 to calculate the achievement index and inequality index. The result is showed in the following 3 tables.

Table 2

Health Region	$A_i(v=1,\varepsilon)$			$I_i(v=1,\varepsilon)$		
	ε=0	ε=1	ε=2	ε=0	ε=1	ε=2
Bas-St-Laurent	0.8847216	0.8471403	0.6424572	0	0.0424782	0.2738312
SAG./LAC ST-JEAN	0.8833054	0.8367423	0.5753527	0	0.0527145	0.3486367
CAPITALE-NAT'L	0.8985606	0.8654922	0.6647121	0	0.0368015	0.2602479
MAUR. CTR QUEBEC	0.8947122	0.8591025	0.6507002	0	0.0398002	0.2727268
L'ESTRIE	0.9062008	0.8869269	0.8467897	0	0.0212689	0.0655606
MONTRÉAL	0.886017	0.8344926	0.4684269	0	0.058153	0.4713117
OUTAOUAIS	0.8950276	0.8520127	0.5806179	0	0.0480599	0.351285
ABITIBI-TÉMISC.	0.8730896	0.8029572	0.3749693	0	0.0803266	0.570526
CÔTE-NORD	0.9028162	0.8669574	0.5833571	0	0.0397189	0.3538474
GASP. ÎLES MADE.	0.8781355	0.8230336	0.4768554	0	0.0627487	0.4569683
CHAU. APPALACHES	0.8975593	0.8626187	0.6238187	0	0.0389285	0.3049833
LAVAL	0.8919691	0.8516409	0.5933422	0	0.0452125	0.3347951
LANAUDIÈRE	0.891486	0.8499799	0.5703983	0	0.0465583	0.3601713
LAURENTIDES	0.8940096	0.8509992	0.4183737	0	0.0481096	0.5320255
MONTÉRÉGIE	0.8895497	0.8467759	0.5636161	0	0.0480848	0.3664029

Table 3

Health Region	$A_i(v=2,\varepsilon)$			$I_i(v=2,\varepsilon)$		
	ε=0	ε=1	ε=2	ε=0	ε=1	ε=2
BAS-ST-LAURENT	0.861307	0.8144008	0.6019027	0.0264655	0.0794836	0.31967
SAG./LAC ST-JEAN	0.8604715	0.798025	0.4758068	0.0258505	0.0965469	0.4613338
CAPITALE-NAT'L	0.8769819	0.8297375	0.5624318	0.0240148	0.0765926	0.3740747
MAUR. CTR QUEBEC	0.869775	0.8205711	0.5482737	0.0278718	0.0828658	0.3872066
L'ESTRIE	0.8912556	0.8665694	0.8159564	0.0164922	0.0437336	0.0995854
MONTRÉAL	0.8664722	0.7967126	0.3761801	0.0220593	0.1007932	0.5754256
OUTAOUAIS	0.8747767	0.8162332	0.4971651	0.0226261	0.0880357	0.4445254
ABITIBI-TÉMISC.	0.8414923	0.7471603	0.2986668	0.0361902	0.1442342	0.6579196
CÔTE-NORD	0.8861197	0.8411983	0.522845	0.0184939	0.0682508	0.4208732
GASP. ÎLES MADE.	0.8522285	0.782444	0.4107496	0.0295023	0.1089713	0.532248
CHAU. APPALACHES	0.8804708	0.8362651	0.5580786	0.0190389	0.0682898	0.3782264
LAVAL	0.8731955	0.8192167	0.4928801	0.0210473	0.0815638	0.4474247
LANAUDIÈRE	0.8684776	0.8126314	0.4806103	0.025809	0.0884529	0.4608886
LAURENTIDES	0.8695512	0.8121452	0.3098935	0.0273582	0.09157	0.6533666
MONTÉRÉGIE	0.8670051	0.8104849	0.4869938	0.0253439	0.0888818	0.4525389

Table 4

Health Region	$A_i(v=3,\varepsilon)$			$I_i(v=3,\varepsilon)$		
	ε=0	ε=1	ε=2	ε=0	ε=1	ε=2
BAS-ST-LAURENT	0.8337089	0.7936509	0.574089	0.0576596	0.1029371	0.3511078
SAG./LAC ST-JEAN	0.8381736	0.777845	0.4289025	0.0510942	0.1193929	0.5144346
CAPITALE-NAT'L	0.8526723	0.8078432	0.511903	0.0510687	0.1009586	0.4303078
MAUR. CTR QUEBEC	0.8435859	0.7984326	0.4969043	0.0571427	0.1076096	0.4446211
L'ESTRIE	0.8703157	0.8545429	0.8065037	0.0395995	0.057005	0.1100167
MONTRÉAL	0.8443989	0.7754347	0.3359994	0.0469723	0.1248084	0.6207755
OUTAOUAIS	0.8503184	0.7977575	0.4726093	0.0499529	0.1086784	0.4719612
ABITIBI-TÉMISC.	0.8121487	0.7146365	0.2644554	0.0697991	0.1814854	0.6971039
CÔTE-NORD	0.8656422	0.8284881	0.5031254	0.0411756	0.0823292	0.4427156
GASP. ÎLES MADE.	0.8274197	0.7682401	0.4055829	0.057754	0.1251463	0.5381318
CHAU. APPALACHES	0.8602475	0.8232237	0.5203082	0.0415703	0.0828197	0.4203077
LAVAL	0.8499655	0.80155	0.4477404	0.0470909	0.1013702	0.4980314
LANAUDIÈRE	0.8421888	0.7878013	0.4302686	0.0552978	0.1163055	0.517358
LAURENTIDES	0.8447841	0.7891554	0.2547387	0.0550615	0.1172854	0.7150605
MONTÉRÉGIE	0.8427691	0.7901998	0.4525462	0.0525891	0.1116857	0.4912637

We first look at the achievement index. When the socioeconomic health inequality aversion is equal to 1 and the pure health inequality aversion $\varepsilon=0$, L'Estrie has the largest health achievement index which is 0.9062008 and Abitibi-Témiscamingue gets the smallest achievement index, 0.8730896. When we increase the pure health inequality aversion to $\varepsilon=1$, the achievement index for L'Estrie falls to 0.8869269 and it is smaller (0.8467897) when the further increase of ε happens. The same thing happens to

Abitibi-Témiscamingue and other health regions even for different values of socioeconomic health inequality aversion. We now look at the tables from another angle. When the parameter of pure health inequality aversion is kept constant and the socioeconomic health inequality aversion changes from 1 to 2 and 2 to 3, the achievement index for each health region falls. For example, for Bas-St-Laurent, $A(1,0)$=0.8847216, $A(2,0)$=0.861307 and $A(3,0)$=0.8337089. However, when $v=1$, the changes of ε (also when $\varepsilon=0$, the changes of v) does not change the first place of L'Estrie and the last place of Abitibi-Témiscamingue in the ranking of achievement index. This fact is also true when socioeconomic health inequality aversion is equal to 2 and 3 and pure health inequality is equal to 1 and 2. In terms of other health regions, we need to check the ranking of achievement index of all health regions.

Then we consider the inequality index. When the socioeconomic health inequality aversion is equal to 1 and pure health inequality aversion is equal to 0, the achievement indexes of all health regions in Québec are 0. When $v=1$ and $\varepsilon=1$, Abitibi-Témiscamingue gets the greatest inequality index, 0.0803266 and L'Estrie gets the least inequality index, 0.0212689. When $v=1$ and $\varepsilon=2$, Laurentides is the health region where the degree of health inequality is greatest while L'Estrie is still the least unequal region in health. For single health region, when the socioeconomic health inequality aversion remains, the rise of the pure health inequality aversion may increase the inequality index. For instance, for Bas-St-Laurent $I(1,1)$=0.0424782 and $I(1,2)$=0.2738312, the inequality index ambitiously goes up and for Saguenay-Lac-Saint-Jean $I(1,1)$=0.0527145 and $I(1,2)$=0.3486367, the inequality index increases substantially. If we hold the pure health inequality aversion, $\varepsilon=1$, $I_i(1, 1) < I_i(2, 1) < I_i(3, 1)$ and it's true for $\varepsilon=0$ and $\varepsilon=2$ in our result tables.

From the discussion above, we find that when given the socioeconomic health inequality aversion, the rise of the pure health inequality aversion increases the health inequality index and decreases the health achievement index and when given the pure

health inequality aversion, the rise of the socioeconomic health inequality aversion also increases the health inequality index and decreases the health achievement index. Intuitively, it's reasonable that given all health care policies and income distribution, when people are more health inequality, the extent of health inequality they feel increases. Similarly, given all health care policies and income distribution, when health inequality aversion increases, the achievement of reducing the health inequality falls relatively. Then the reverse relationship between achievement index and inequality index is obvious. This can be seen from the definition of health inequality index:

$$I(v) = 1 - \frac{A(v)}{\mu} \tag{4}$$

Let's see the ranking of achievement index and inequality index among the 15 health regions when different values are assigned to the socioeconomic health inequality aversion and pure health inequality aversion. The results are showed in Table 5.1, Table 5.2 and Table 5.3.

Table 5.1

Rank	AI(v=1,ε)			Ii(v=1,ε)		
	ε=0	ε=1	ε=2	ε=0	ε=1	ε=2
1	ABITIBI-TÉMISC.	ABITIBI-TÉMISC.	ABITIBI-TÉMISC.		L'ESTRIE	L'ESTRIE
2	GASP. ÎLES MADE.	GASP. ÎLES MADE.	LAURENTIDES		CAPITALE-NAT'L	CAPITALE-NAT'L
3	SAG./LAC ST-JEAN	MONTRÉAL	MONTRÉAL		CHAU. APPALACHES	MAUR. CTR QUEBEC
4	BAS-ST-LAURENT	SAG./LAC ST-JEAN	GASP. ÎLES MADE.		CÔTE-NORD	BAS-ST-LAURENT
5	MONTRÉAL	MONTÉRÉGIE	MONTÉRÉGIE		MAUR. CTR QUEBEC	CHAU. APPALACHES
6	MONTÉRÉGIE	BAS-ST-LAURENT	LANAUDIÈRE		BAS-ST-LAURENT	LAVAL
7	LANAUDIÈRE	LANAUDIÈRE	SAG./LAC ST-JEAN		LAVAL	SAG./LAC ST-JEAN
8	LAVAL	LAURENTIDES	OUTAOUAIS		LANAUDIÈRE	OUTAOUAIS
9	LAURENTIDES	LAVAL	CÔTE-NORD		OUTAOUAIS	CÔTE-NORD
10	MAUR. CTR QUEBEC	OUTAOUAIS	LAVAL		MONTÉRÉGIE	LANAUDIÈRE
11	OUTAOUAIS	MAUR. CTR QUEBEC	CHAU. APPALACHES		LAURENTIDES	MONTÉRÉGIE
12	CHAU. APPALACHES	CHAU. APPALACHES	BAS-ST-LAURENT		SAG./LAC ST-JEAN	GASP. ÎLES MADE.
13	CAPITALE-NAT'L	CAPITALE-NAT'L	MAUR. CTR QUEBEC		MONTRÉAL	MONTRÉAL
14	CÔTE-NORD	CÔTE-NORD	CAPITALE-NAT'L		GASP. ÎLES MADE.	LAURENTIDES
15	L'ESTRIE	L'ESTRIE	L'ESTRIE		ABITIBI-TÉMISC.	ABITIBI-TÉMISC.

Table 5.2

Rank	Ai(v=2,ε)			Ii(v=2,ε)		
	ε=0	ε=1	ε=2	ε=0	ε=1	ε=2
1	ABITIBI-TÉMISC.	ABITIBI-TÉMISC.	ABITIBI-TÉMISC.	L'ESTRIE	L'ESTRIE	L'ESTRIE
2	GASP.ÎLES MADE.	GASP.ÎLES MADE.	LAURENTIDES	CÔTE-NORD	CÔTE-NORD	BAS-ST-LAURENT
3	SAG./LAC ST-JEAN	MONTRÉAL	MONTRÉAL	CHAU.APPALACHES	CHAU. APPALACHES	CAPITALE-NAT'L
4	BAS-ST-LAURENT	SAG./LAC ST-JEAN	GASP.ÎLESMADE.	LAVAL	CAPITALE-NAT'L	CHAU. APPALACHES
5	MONTRÉAL	MONTÉRÉGIE	SAG./LAC ST-JEAN	MONTRÉAL	BAS-ST-LAURENT	MAUR.CTR QUEBEC
6	MONTÉRÉGIE	LAURENTIDES	LANAUDIÈRE	OUTAOUAIS	LAVAL	CÔTE-NORD
7	LANAUDIÈRE	LANAUDIÈRE	MONTÉRÉGIE	CAPITALE-NAT'L	MAUR.CTR QUEBEC	OUTAOUAIS
8	LAURENTIDES	BAS-ST-LAURENT	LAVAL	MONTÉRÉGIE	OUTAOUAIS	LAVAL
9	MAUR.CTR QUEBEC	OUTAOUAIS	OUTAOUAIS	LANAUDIÈRE	LANAUDIÈRE	MONTÉRÉGIE
10	LAVAL	LAVAL	CÔTE-NORD	SAG./LAC ST-JEAN	MONTÉRÉGIE	LANAUDIÈRE
11	OUTAOUAIS	MAUR.CTRQUEBEC	MAUR.CTR QUEBEC	BAS-ST-LAURENT	LAURENTIDES	SAG./LAC ST-JEAN
12	CAPITALE-NAT'L	CAPITALE-NAT'L	CHAU. APPALACHES	LAURENTIDES	SAG./LACST-JEAN	GASP.ÎLES MADE.
13	CHAU. APPALACHES	CHAU. APPALACHES	CAPITALE-NAT'L	MAUR.CTR QUEBEC	MONTRÉAL	MONTRÉAL
14	CÔTE-NORD	CÔTE-NORD	BAS-ST-LAURENT	GASP.ÎLES MADE.	GASP.ÎLES MADE.	LAURENTIDES
15	L'ESTRIE	L'ESTRIE	L'ESTRIE	ABITIBI-TÉMISC.	ABITIBI-TÉMISC.	ABITIBI-TÉMISC.

Table 5.3

Rank	Ai(v=3,ε)			Ii(v=3,ε)		
	ε=0	ε=1	ε=2	ε=0	ε=1	ε=2
1	ABITIBI-TÉMISC.	ABITIBI-TÉMISC.	LAURENTIDES	L'ESTRIE	L'ESTRIE	L'ESTRIE
2	GASP.ÎLES MADE.	GASP.ÎLES MADE.	ABITIBI-TÉMISC.	CÔTE-NORD	CÔTE-NORD	BAS-ST-LAURENT
3	BAS-ST-LAURENT	MONTRÉAL	MONTRÉAL	CHAU.APPALACHES	CHAU.APPALACHES	CHAU.APPALACHES
4	SAG./LACST-JEAN	SAG./LAC ST-JEAN	GASP. ÎLES MADE.	MONTRÉAL	CAPITALE-NAT'L	CAPITALE-NAT'L
5	LANAUDIÈRE	LANAUDIÈRE	SAG./LAC ST-JEAN	LAVAL	LAVAL	CÔTE-NORD
6	MONTÉRÉGIE	LAURENTIDES	LANAUDIÈRE	OUTAOUAIS	BAS-ST-LAURENT	MAUR.CTRQUEBEC
7	MAUR.CTR QUEBE	MONTÉRÉGIE	LAVAL	CAPITALE-NAT'L	MAUR.CTR QUEBEC	OUTAOUAIS
8	MONTRÉAL	BAS-ST-LAURENT	MONTÉRÉGIE	SAG./LACST-JEAN	OUTAOUAIS	MONTÉRÉGIE
9	LAURENTIDES	OUTAOUAIS	OUTAOUAIS	MONTÉRÉGIE	MONTÉRÉGIE	LAVAL
10	LAVAL	MAUR.CTR QUEBEC	MAUR.CTR QUEBEC	LAURENTIDES	LANAUDIÈRE	SAG./LACST-JEAN
11	OUTAOUAIS	LAVAL	CÔTE-NORD	LANAUDIÈRE	LAURENTIDES	LANAUDIÈRE
12	CAPITALE-NAT'L	CAPITALE-NAT'L	CAPITALE-NAT'L	MAUR.CTR QUEBEC	SAG./LAC ST-JEAN	GASP.ÎLES MADE.
13	CHAU.APPALACHES	CHAU.APPALACHES	CHAU.APPALACHES	BAS-ST-LAURENT	MONTRÉAL	MONTRÉAL
14	CÔTE-NORD	CÔTE-NORD	BAS-ST-LAURENT	GASP.ÎLES MADE.	GASP.ÎLES MADE.	ABITIBI-TÉMISC.
15	L'ESTRIE	L'ESTRIE	L'ESTRIE	ABITIBI-TÉMISC.	ABITIBI-TÉMISC.	LAURENTIDES

We first focus on the ranking of achievement index. It is obvious that achievement indices for Abitibi-Témiscamingue and L'Estrie rank the first place and the last place respectively whatever the socioeconomic health inequality aversion and the pure health inequality aversion are, except for the case when $\varepsilon=2$ and $v=3$. When there is socioeconomic health inequality aversion but no pure health inequality aversion, $\varepsilon=0$ and $v=2$, the ranking of achievement index is: Abitibi-Témiscamingue, Gaspésie-

Îles-de-la-Madeleine, Saguenay-Lac-Saint-Jean, Bas-St-Laurent, Montréal, Montérégie, Lanaudière, Laurentides, Mauricie et du Centre-du-Québec, Laval, Outaouais, Capitale-Nationale, Chaudière-Appalaches, Côte-Nord and L'Estrie. When the pure health inequality aversion is included, such as $\varepsilon=1$, the ranking changes: Saguenay-Lac-Saint-Jean falls from the third to the forth, Bas-St-Laurent falls from the forth to the eighth and Mauricie et du Centre-du-Québec falls from the ninth to the eleventh; on the other hand, Montréal rises 2 places to the third, Laurentides and Outaouais also goes up 2 places to the sixth to the ninth respectively and Montérégie enjoys one upward move. Other health regions stay the same places. If we increase ε again to 2, more changes on the ranking happens: compared with the ranking for $\varepsilon=1$ and $v=2$, Laurentides and Côte-Nord make the largest upward move, from the forth to the second and from fourteenth to the tenth respectively; Lanaudière and Chaudière-Appalaches both go up one place and Laval climbs up 2 places; however, Bas-St-Laurent suffers a substantial decline from the eighth to the fourteenth; Gaspésie -Îles-de-la-Madeleine, Saguenay-Lac-Saint-Jean, Montérégie and Capitale-Nationale also slip one or two places. Similar changes happen in Table 5.1 and Table 5.3.

If start from $\varepsilon=1$ and $v=2$, we increase the socioeconomic health inequality to 3, the ranking also changes: Montérégie and Laval slip from fifth to seventh and from tenth to eleventh respectively; Lanaudière and Mauricie et du Centre-du-Québec climb up one place. Similar changes occur when change from Table 5.2 to Table 5.1.

Clearly, the variation of parameters of socioeconomic health inequality aversion and of pure health inequality aversion changes the ranking of achievement index.

Let's see the ranking of inequality index. When $v=2$ and $\varepsilon=0$ (concentration index) the ranking of health inequality index is: L'Estrie, Côte-Nord, Chaudière-Appalaches, Laval, Montréal, Outaouais, Capitale-Nationale, Montérégie, Lanaudière, Saguenay -Lac-Saint-Jean, Bas-St-Laurent, Laurentides, Mauricie et du Centre-du-Québec, Gaspésie-Îles-de-la-Madeleine and Abitibi-Témiscamingue. We use the same way we

analyzed the changes in ranking of achievement index here. If ε increases to 1, the ranking changes: Laval, Outaouais, Montérégie and Saguenay-Lac-Saint-Jean go down 2 places and Montréal slips from fifth to thirteenth; on the other hand, both Mauricie et du Centre-du-Québec and Bas-St-Laurent climb up 6 places; Capitale-Nationale and Laurentides climb up 3 and 1 places respectively. If we keep the pure health inequality aversion ($\varepsilon=0$) and increase the socioeconomic health inequality aversion, v, to 3, the health inequality index ranking changes: Laval and Montréal exchange their ranking in $I_i(2,0)$; Montérégie, Lanaudière and Bas-St-Laurent slip down 1, 2 and 2 places respectively; Saguenay-Lac-St-Jean, Laurentides and Mauricie et du Centre-du-Québec rise up 2, 2 and 1 place.

Similarly, the variation of parameters of socioeconomic health inequality aversion and of pure health inequality aversion changes the ranking of health inequality index.

Table 5.4

Rank	II(v=2,ε)			Rank	AI(v=2,ε)		
	ε=0	ε=1	ε=2		ε=0	ε=1	ε=2
1	L'ESTRIE	L'ESTRIE	L'ESTRIE	15	L'ESTRIE	L'ESTRIE	L'ESTRIE
2	CÔTE-NORD	CÔTE-NORD	BAS-ST-LAURENT	14	CÔTE-NORD	CÔTE-NORD	BAS-ST-LAURENT
3	CHAU.APPALACHES	CHAU.APPALACHES	CAPITALE-NAT'L	13	CHAU.APPALACHES	CHAU.APPALACHES	CAPITALE-NAT'L
4	LAVAL	CAPITALE-NAT'L	CHAU.APPALACHES	12	CAPITALE-NAT'L	CAPITALE-NAT'L	CHAU.APPALACHES
5	MONTRÉAL	BAS-ST-LAURENT	MAUR.CTRQUEBEC	11	OUTAOUAIS	MAUR.CTRQUEBEC	MAUR.CTRQUEBEC
6	OUTAOUAIS	LAVAL	CÔTE-NORD	10	LAVAL	LAVAL	CÔTE-NORD
7	CAPITALE-NAT'L	MAUR.CTRQUEBEC	OUTAOUAIS	9	MAUR.CTRQUEBEC	OUTAOUAIS	OUTAOUAIS
8	MONTÉRÉGIE	OUTAOUAIS	LAVAL	8	LAURENTIDES	BAS-ST-LAURENT	LAVAL
9	LANAUDIÈRE	LANAUDIÈRE	MONTÉRÉGIE	7	LANAUDIÈRE	LANAUDIÈRE	MONTÉRÉGIE
10	SAG./LAC ST-JEAN	MONTÉRÉGIE	LANAUDIÈRE	6	MONTÉRÉGIE	LAURENTIDES	LANAUDIÈRE
11	BAS-ST-LAURENT	LAURENTIDES	SAG./LAC ST-JEAN	5	MONTRÉAL	MONTÉRÉGIE	SAG./LAC ST-JEAN
12	LAURENTIDES	SAG./LACST-JEAN	GASP.ÎLES MADE.	4	BAS-ST-LAURENT	SAG./LAC ST-JEAN	GASP.ÎLESMADE.
13	MAUR.CTRQUEBEC	MONTRÉAL	MONTRÉAL	3	SAG./LAC ST-JEAN	MONTRÉAL	MONTRÉAL
14	GASP.ÎLES MADE.	GASP.ÎLES MADE.	LAURENTIDES	2	GASP.ÎLES MADE.	GASP.ÎLES MADE.	LAURENTIDES
15	ABITIBI-TÉMISC.	ABITIBI-TÉMISC.	ABITIBI-TÉMISC.	1	ABITIBI-TÉMISC.	ABITIBI-TÉMISC.	ABITIBI-TÉMISC.

In Wagstaff's definition of achievement index, the health inequality index and the achievement index are negatively correlated: the larger achievement is made, the lower degree of health inequality. How about the relationship between the rankings of these two indices? Let's see Table 5.4, the ranking of inequality index (from the least

advantaged to the most advantaged) for $v=2$ and $\varepsilon=1$: L'Estrie, Côte-Nord, Chaudière-Appalaches, Capitale-Nationale, Bas-St-Laurent, Laval, Mauricie et du Centre-du-Québec, Outaouais, Lanaudière, Montérégie, Laurentides, Saguenay-Lac-Saint-Jean, Montréal, Gaspésie-Îles-de-la-Madeleine and Abitibi-Témiscamingue. The corresponding ranking of achievement index, from the most advantaged to the least advantaged, is not exactly the same as the ranking of inequality index we listed above. There are 5 differences between the reversed ranking of achievement index and the ascending ranking of inequality index in Table 5.4: basing on the inequality ranking, Bas-St-Laurent falls 3 places and Montérégie drops 1 place; Mauricie et du Centre-du-Québec, Outaouais and Laurentides rise 2, 1 and 1 places respectively. The reason why these differences exist is that, from Wagstaff's definition, the ranking of average health status, which does not change with the variation of the socioeconomic and the pure health inequality aversion, also affects the ranking of achievement index.

Therefore, the changes on the parameters of the socioeconomic health inequality aversion and the pure health inequality aversion will change the ranking of achievement index and of health inequality index. Notwithstanding the negative correlated relationship between achievement index and health inequality index, the ranking of inequality index (from the least advantaged to the most advantaged) is not exactly the same as the reversed ranking of achievement index (from the most advantaged to the least advantaged).

Among the 15 health regions in Province Québec, L'Estrie is the area which is the most lacking of health equity and has the least achievement in reducing health inequality. The variety of the socioeconomic health inequality aversion and the pure health inequality aversion do not change this phenomenon. On the other hand, Abitibi-Témiscamingue looks like the most fair region on health, except for the case when $v=3$ and $\varepsilon=2$.

The health inequality index of Province Québec, the summation of weighted health

inequality indexes of each health region and the health inequality index between health regions are showed in the following 3 tables.

Table 6

I(v=1,ε)		
ε=0	ε=1	ε=2
0	0.0479953	0.3841344
I(v=2,ε)		
ε=0	ε=1	ε=2
0.0245027	0.0885136	0.4838361
I(v=3,ε)		
ε=0	ε=1	ε=2
0.0507243	0.1113937	0.5309154

Table 7

∑h_ε*πi*Ii(v=1,ε)		
ε=0	ε=1	ε=2
0	0.0493875	0.383997378
∑h_ε*πi*Ii(v=2,ε)		
ε=0	ε=1	ε=2
0.024489228	0.0907066	0.477600785
∑h_ε*πi*Ii(v=3,ε)		
ε=0	ε=1	ε=2
0.051450933	0.1136784	0.519518188

Table 8

IB(v=1,ε)		
ε=0	ε=1	ε=2
0	4.01E-05	0.0000803
IB(v=2,ε)		
ε=0	ε=1	ε=2
0.0002276	0.000269	0.000311
IB(v=3,ε)		
ε=0	ε=1	ε=2
0.0116536	-0.00088	-0.0109288

In Table 6, when there are no socioeconomic health inequality aversion and no pure health inequality aversion, *I (1,0)*, there is no health inequality. The index of health inequality of the overall data has the same property as that of group data which we discussed before. Given one kind of health inequality aversion, the rise of another kind

of health inequality aversion will increase the index of health inequality of all the regions. Compared with Table 5.1, Table 5.2 and Table 5.3, some health areas' health inequality indices are larger than the provincial level and some are smaller. For instance, when $v=3$ and $\varepsilon=2$, the degree of health inequality of Montréal, Abitibi-Témiscamingue, Gaspésie-Îles-de-la-Madeleine and Laurentides are higher than that of Québec; when ε falls from 2 to 1, the above-provincial-level regions are: Montréal, Abitibi-Témiscamingue, Gaspésie-Îles-de-la-Madeleine, Laurentides, Saguenay -Lac-Saint-Jean, Lanaudière and Montérégie; when ε decreases again to 0, the above-provincial-level regions become: Abitibi-Témiscamingue, Gaspésie-Îles-de -la-Madeleine, Laurentides, Saguenay-Lac-Saint-Jean, Lanaudière, Montérégie, Bas-St-Laurent, Capitale-Nationale and Mauricie et du Centre-du-Québec. Given socioeconomic health inequality aversion, the number of the above-provincial-level regions may rise with the decrease of the pure health inequality aversion.

The summation of weighted health inequality index of each health area in Table 7 reflects the extent of health inequality within health regions. The specific values of this weighted summation are very close to the respective health inequality index of all health areas.

From Table 8, we can see the health inequality index between health regions is really small. It is a good signal that there is not much difference on health level between different health regions. The good inner-provincial equity in health may be due to the perfect implementation of provincial public health-care policies in Québec.

There may be other factors influencing the health inequality index of entire data, apart from the weighted health inequality index and the inequality index between regions. These factors are attributed to residuals.

Table 9

Residual(v=1,ε)		
ε=0	ε=1	ε=2
0.00E+00	-0.001432303	5.67217E-05
Residual(v=2,ε)		
ε=0	ε=1	ε=2
-0.000214128	-0.002462181	0.005924315
Residual(v=3,ε)		
ε=0	ε=1	ε=2
-0.012380233	-0.001403223	0.022326012

The health inequality of Québec is decomposed into 3 parts: inequality within regions, inequality between regions and residuals. Which part makes the most contribution to the whole inequality?

Table 10

IB/I(v=1,ε)			Residual/I(v=1,ε)			∑μh_εi*ni*Ii(v=1,ε)/I(v=1,ε)		
ε=0	ε=1	ε=2	ε=0	ε=1	ε=2	ε=0	ε=1	ε=2
0	0.084%	0.021%	0	-2.984%	0.015%	0	102.901%	99.964%
IB/I(v=2,ε)			Residual/I(v=2,ε)			∑μh_εi*ni*Ii(v=2,ε)		
ε=0	ε=1	ε=2	ε=0	ε=1	ε=2	ε=0	ε=1	ε=2
0.929%	0.304%	0.064%	-0.874%	-2.782%	1.224%	99.945%	102.478%	98.711%
IB/I(v=3,ε)			Residual/I(v=3,ε)			∑μh_εi*ni*Ii(v=3,ε)		
ε=0	ε=1	ε=2	ε=0	ε=1	ε=2	ε=0	ε=1	ε=2
22.974%	-0.791%	-2.058%	-24.407%	-1.260%	4.205%	101.433%	102.051%	97.853%

From Table 10 we find that the weighted inequality of each health region makes the absolute majority of contributions to the health inequality of Québec, no matter how the socioeconomic health inequality aversion and the pure health inequality aversion change. And the inequality between health regions and residuals makes much less contribution to the health inequality of entire data. The negative percentage of IB or of residual reflects the positive effects of health inequality between regions or of residuals on reducing the health inequality.

In other words, the health inequality of Québec is mostly driven by the health inequality of each health region in that province. The differences in health status

between regions have little influence on the provincial health inequality.

5. Conclusions

In this paper, based on the CCHS 2007-2008, we found the distribution of average HUI Mark 3 index among the 15 health regions in Québec. We have estimated the health achievement index and health inequality index of each health region and of the integrated Québec, using the measure propose by Makdissi and Yazbeck (2011) which is associated with the socioeconomic health inequality aversion parameter and the pure health inequality aversion parameter. And then we disaggregated the Québec's inequality in health into contributions from health inequality index of within and between health areas in that province and the residual term.

There are two useful results. Firstly, we can use different values of the socioeconomic health inequality aversion and the pure health inequality aversion to change the achievement index ranking and health inequality index ranking. Notwithstanding the negative correlated relationship between achievement index and health inequality index, the ranking of inequality index (from the least advantaged to the most advantaged) is not exactly the same as the achievement index ranking in reverse order. Secondly, within-region inequality in health explains most of total health inequality in Québec and this holds for all values of v and ε. The between-region inequality and residual term make little contributions to the health inequality in Québec.

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