Dundee Discussion Papers in Economics 214

Allanson, Paul; Gerdtham, Ulf-G.; Petrie, Dennis

Publication date:
2008

Dundee Discussion Papers in Economics

Longitudinal analysis of income-related health inequality

Paul Allanson, Ulf-G Gerdtham and Dennis Petrie

Department of
Economic Studies,
University of Dundee,
Dundee.
DD1 4HN

Working Paper
No. 214
August 2008
ISSN:1473-236X

Longitudinal analysis of income-related health inequality

Paul Allanson,[a, #] Ulf-G Gerdtham,[b,c,d] and Dennis Petrie [a]

[a] Economics Studies, University of Dundee

[b] Department of Economics, University of Aberdeen, Scotland

[c] Health Economics Research Unit (HERU), University of Aberdeen. Scotland

[d] Department of Clinical Sciences, Lund University, Malmö, Sweden

Abstract

This paper considers the characterisation and measurement of income-related health inequality using longitudinal data. The paper elucidates the nature of the Jones and Lopez Nicholas (2004) index of "health-related income mobility" and explains the negative values of the index that have been reported in all the empirical applications to date. The paper further questions the value of their index to health policymakers and proposes an alternative index of "income-related health mobility" that measures whether the pattern of health changes is biased in favour of those with initially high or low incomes. We illustrate our work by investigating mobility in the General Health Questionnaire measure of psychological well-being over the first nine waves of the British Household Panel Survey from 1991 to 1999.

Keywords: income-related health inequality, mobility analysis, longitudinal data

JEL classifications: D39, D63, I18

Acknowledgements. The authors bear sole responsibility for the further analysis and interpretation of the British Household Panel Survey data employed in this study.

[#] Corresponding author. Economics Studies, University of Dundee, Perth Road, Dundee DD1 4HN, UK. Tel: +44 01382 384377 Fax: +44 01382 384691. Email: p.f.allanson@dundee.ac.uk .

1. Introduction

A strong relationship between socioeconomic status and health has been documented in numerous studies: for example, individuals with high income are healthier than those with low income. While there has been an increasing amount of literature on health inequality, income-related health inequality and its determinants (Wagstaff and van Doorslaer 2000), little attention has focused on measuring health mobility or whether the health of the poor is improving relative to the rich over time. This is an important issue since significant income-related inequalities in health have persisted, and even increased, in some western countries over the last decade in spite of considerable improvements in average health status (van Doorslaer and Koolman 2004). As a result, most European governments have recognised the need to tackle income-related health inequalities. For example, England is committed to reduce socioeconomic inequalities in infant mortality and life expectancy at birth by 10% from 1997-99 baseline levels by 2010 (Department of Health 2008).

One pioneering research paper which does seek to bridge the divide between cross-sectional estimates of income-related health inequality and how these evolve over time is by Jones and Lopez Nicholas (2004; hereafter JLN). In their paper they aim to explain the relationship between a set of *T* period-specific or short run concentration indices CI^t (t=1,…T) and the long run concentration index CI^T obtained from income and health data averaged over all *T* periods. In particular, they propose an index of "health-related income mobility", modelled on Shorrocks' (1978) income mobility index, that measures the extent to which income-related health inequality is greater or smaller in the short run than in the long run. JLN illustrate the use of the index with data for the UK and it has since been employed in a number of other empirical studies (Lecluyse 2006; Hernandez-Quevado et al. 2006; Brandrup and Kortt 2007) using health data sets for Belgium, European Union member states and Australia respectively. However, for a number of reasons all these papers struggle to connect their results with meaningful policy implications.

The current paper makes two main contributions. Firstly, the paper further elucidates the nature of the JLN index of health-related income mobility and is thereby able to better explain the results obtained in empirical applications of the measure. In particular, we demonstrate that the value of the index may be expected to be negative simply as a result of the unimodal shape of the income distribution and the strength of the positive association between income and health in the long run compared to the short run. Secondly, the paper questions the value of the JLN index to health policymakers and proposes an alternative index of "income-related health mobility", based on a decomposition of the change in the short run concentration index CI^t over time, that measures whether the pattern of health changes is biased in favour of those with initially high or low incomes. We illustrate our work, like JLN, by investigating mobility in the General Health Questionnaire (GHQ) measure of psychological well-being over the first nine waves of the British Household Panel Survey (BHPS) from 1991 to 1999. The structure of the paper is as follows: Section 2 presents a critical review of the JLN mobility index. Section 3 presents the alternative mobility analysis. Section 4 summarises and concludes the paper.

2. A critical exposition of the JLN health-related income mobility index

We start by providing a brief outline of JLN's measurement framework in order to establish the basis for our subsequent analysis. JLN investigate the relationship between the set of *T* short run CIs:

$$CI^t = \frac{2}{\bar{h}^t}\text{cov}(h_{it}, R_i^t) = \frac{2}{N\bar{h}^t}\sum_i (h_{it} - \bar{h}^t)(R_i^t - 1/2)\,; \quad t = 1,....T \tag{1}$$

and the long run concentration index defined over all *T* periods,

$$CI^T = \frac{2}{\bar{\bar{h}}^T}\text{cov}(h_i^T, R_i^T) = \frac{2}{N\bar{\bar{h}}^T}\sum_i (h_i^T - \bar{\bar{h}}^T)(R_i^T - 1/2) \tag{2}$$

where h_{it} is a cardinal measure of health for individual *i* (*i*=1,….*N*) in period *t*, $\bar{h}^t$ is the average health of the population in period t, h_i^T is the average health of the individual over the T periods and $\bar{\bar{h}}^T$ is the average health of the population over all T periods;[1] R_i^t is the individual's relative rank in the period *t* income distribution and R_i^T is the individual's relative rank in the distribution of total income over all T periods.

JLN show that CI^T can be decomposed into a weighted sum of the CI^t 's and a residual, which they denote "Term 2", that reflects the covariance between levels of health and fluctuations in income rank over time:

$$CI^T = \sum_t w_t C^t - \frac{2}{NT\bar{\bar{h}}^T}\sum_i \sum_t (h_{it} - \bar{h}^t)(R_i^t - R_i^T) \tag{3}$$

[1] Note that JLN denote health as *y*. In contrast, we employ *h*, since *y* is more commonly used to refer to income.

where the weights $w_t = \frac{\bar{h}^t}{T\bar{\bar{h}}^T}$ are the shares of total health in each period. JLN note that "Term 2" will only be non-zero if people switch income ranks over the T periods and these changes are related to health.

JLN use equation (3) to define a measure of "health-related income mobility" M^T that is modelled on Shorrocks' (1978) index of income mobility:

$$M^T = 1 - \frac{CI^T}{\sum_t w_t CI^t} = \left(\frac{2}{NT\bar{\bar{h}}^T} \sum_i \sum_t (h_{it} - \bar{h}^t)(R_i^t - R_i^T) \right) \bigg/ \sum_t w_t CI^t \qquad (4)$$

M^T is defined as one minus the ratio of the concentration index from the longitudinal averages to the weighted average of the short run concentration indexes. JLN observe that M^T will differ from zero as a result of systematic association between health and changes in the income rank of an individual. The larger the difference between the short run and long run inequality measures the larger the value of M^T. If there is no difference between the short run and long run inequality measure, then M^T equals zero.

JLN employ the index to investigate the dynamics of income and mental health, as measured by the GHQ measure of psychological well-being, in the first nine waves of the BHPS. They report a health-related income mobility index over the nine waves of -0.15 and -0.055 for men and women respectively, which implies that long run income-related health inequalities are greater than would be inferred from the short run cross-sectional measures alone. JLN suggest that these negative values imply that "downwardly (income) mobile individuals tend to have below average levels of health compared to upwardly mobile individuals" (JLN, p.1023), where downwardly mobile individuals are defined as those whose income rank is lower in the long run than (it is on average) in the short run.

The JLN index is difficult to interpret as the properties of the measure are not self-evident. In particular, it is not obvious what to make of the negative values of the index that have been reported in all the empirical applications to date. JLN do provide a numerical example (Case 3) to show that a negative value of the health-related income mobility index can arise if downwardly (income) mobile individuals tend to have below average levels of health compared to upwardly mobile individuals. But it is not clear whether this condition is likely to hold in general or what it might signify in reality. We demonstrate below that it will typically hold as a result of the unimodal shape of the income distribution and the positive association between income and health, but that the negativity of the mobility index further requires that this positive association between health and income will be stronger between individuals on average (i.e. in the long term) than for individuals over time (i.e. in the short term).

Our analysis is based on a further decomposition of "Term 2" from (3) into two sub-components that result from the variation in the health of each individual over time and the variation in average health between individuals. First note that:

$$(h_{it} - \bar{\bar{h}}^T) = (h_{it} - h_i^T) + (h_i^T - \bar{\bar{h}}^T) \tag{5}$$

where h_i^T is the average health of individual i over the T periods.

Hence CI^T can be re-written from (3) as:

$$CI^T = \sum_t w_t CI^t - \left[\sum_i s_i CI^i + CI^B \right] = \sum_t w_t CI^t - \left[CI^W + CI^B \right] \quad (6)$$

where the "within" individuals concentration index CI^W is equal to the weighted sum of the individual indices:

$$CI^i = \frac{2}{Th_i^T} \sum_t (h_{it} - h_i^T)(R_i^t - R_i^T) = \frac{2}{T\bar{h}_i} \sum_t (h_{it} - h_i^T)(R_i^t - \bar{R}_i); \quad i = 1, \ldots. n, \quad (7)$$

with $\bar{R}_i = \sum_t R_i^t / T$ defined as the average of the individual's short run income ranks and weights equal to the share of "total" health for each individual:

$$s_i = \frac{h_i^T}{N\bar{\bar{h}}^T}; \quad i = 1, \ldots. N; \quad (8)$$

and CI^B is the "between" individuals concentration index:

$$CI^B = \frac{2}{NT\bar{\bar{h}}^T} \sum_t \sum_i (h_i^T - \bar{\bar{h}}^T)(R_i^t - R_i^T) = \frac{2}{NT\bar{\bar{h}}^T} \sum_t \sum_i (h_i^T - \bar{\bar{h}}^T)(\bar{R}_i - R_i^T) \quad (9)$$

Accordingly, the mobility index M^T may be re-written from (4) as:

$$M^T = \frac{CI^W}{\sum_t w_t CI^t} + \frac{CI^B}{\sum_t w_t CI^t} = M^W + M^B \quad (10)$$

Thus overall mobility is the sum of contributions due to health variation "within" individuals over time, M^W, and "between" individuals on average, M^B. M^W will generally be positive if there is a positive association between short run movements in income and health. In contrast, M^B will generally be negative given the typical shape of the income distribution and the positive nature of the long run association between health and income. To see why this is the case, note that the slope of a cumulative distribution or relative rank function (cdf) is given by the probability density function, so the cdf of the typically unimodal income distribution will be convex below the mode and concave above it. It follows from Jensen's inequality (Greene, 2008, p.1046) that the average of the short run income ranks of individuals with low (high) average incomes will typically be above (below) their long run income rank (see Appendix for further discussion). This combined with the assumption of a positive long run association between health and income results in both the rich and poor contributing negatively to M^B, with the overall value of M^B likely being negative as a result.

JLN consider separately the effects of health variation "within" and "between" individuals in Cases 2 and 3 respectively. Specifically, they provide numerical examples that give rise to a positive value of $M^T = M^W$ in Case 2, in which all individuals have the same health on average in the long run, and a negative value of $M^T = M^B$ in Case 3, in which all individuals have constant health over time. In practice, empirical data will reflect both "within" and "between" variation in health, with the resultant mobility index presumably reflecting some balance of the opposing effects. One can therefore simply conclude, as JLN implicitly do, that the negative value of the mobility index obtained in their empirical application must be due to the dominance of the latter effect. What remains to be explained is why this appears usually to be the case.

To investigate this issue we turn to the observation that the original Shorrocks' measure must be positive given the convexity of the Gini coefficient (Shorrocks 1978). In particular, if we define a (health-related) health mobility index by replacing income ranks with health ranks in (10), then this index will be positive irrespective of the balance of health variation "within" and "between" individuals. Firstly it should be noted that this positive result is not obtained because M^B will be positive in this case, as the argument made above concerning the sign of M^B is equally applicable if ranks are based on health rather than income. The difference is that there is an exact (positive) relationship between health status and health rank whereas there is not an exact relationship between health status and income rank. To see how the strength of the association between health status and income rank may affect the sign of the health-related income mobility index it is useful to define G^W and G^B analogously to CI^W and CI^B, by replacing income ranks with health ranks in (7) and (9). Hence:

$$CI^W = \frac{CI^W}{G^W} G^W = R^W G^W \tag{11}$$

and:

$$CI^B = \frac{CI^B}{G^B} G^B = R^B G^B \tag{12}$$

where R^W and R^B may be interpreted by analogy with the "Gini correlation" of Lerman and Yitzhaki (1985). In particular, R^W and R^B will equal +1 if health is a strictly increasing, non-stochastic function of income, such that the ranking of individuals by income is the same as that by health, and will equal zero if there is no association between health and income rank.[2] Note that M^T will only be negative (as has been reported in all the empirical studies published to date using the JLN measure) if $R^B > R^W \left(G^W / G^B \right)$. Therefore, given that $G^W \geq G^B$ must hold as Shorrocks' measure is always positive, a necessary condition for M^T to be negative is that $R^B > R^W$. We note that R^B may in general be expected to be greater than R^W because the relationship

[2] Note that neither measure is bound to lie in the range -1 to +1.

between health and income is likely to be stronger between individuals on average than for individuals over time, given that persistent health differences between individuals may well be associated with long run or permanent income disparities whereas short run movements in individual health may only be weakly associated with transitory income shocks (Benzeval and Judge, 2001).

We illustrate our analysis by replicating the empirical application in JLN, which investigates mobility in the (transformed) GHQ measure of psychological well-being over the first nine waves of the BHPS from 1991 to 1999. Our results differ slightly from those reported in JLN, possibly due to the use of an updated release of the BHPS data (University of Essex, Institute for Social and Economic Research 2007),[3] though the differences are not of a substantive nature. Table 1 is an expanded version of Table 8(a) in JLN, reporting income-related GHQ concentration and mobility indices for men only. Like JLN we find that "Term 2" is negative in all waves after the first one, but we are able to further show why this is the case. The first point to note is that CI^W is positive in all waves, consistent with the existence of a positive association between health and income in the short run. "Term 2" is therefore negative because CI^B is both negative and larger than CI^W. Examining the contributions to CI^B of each income class shows that the first and last income quartile contribute negatively in all waves as expected on the basis of the argument above. Indeed the contribution of all quartiles is negative in the later waves. The values of the two Gini Correlations, R^W and R^B, imply that the association between health and income rank is consistently stronger in the long

[3] In particular, we obtain an additional six observations for males although we apply the sample restrictions reported in JLN.

Table 1. Income-related GHQ Concentration and mobility indices for men.

	BHPS Wave	1	2	3	4	5	6	7	*8*	*9*
SR Concentration Index	CI^t	0.01017	0.00600	0.00550	0.00402	0.00504	0.00769	0.00745	0.00407	0.00868
LR Concentration Index	CI^T	0.01017	0.00843	0.00739	0.00644	0.00634	0.00667	0.00692	0.00706	0.00744
Term 1	$\Sigma_t w_t CI^t$	0.01017	0.00810	0.00723	0.00643	0.00615	0.00641	0.00656	0.00625	0.00652
Term 2	$CI^W + CI^B$	0	-0.00033	-0.00016	-0.00001	-0.00019	-0.00026	-0.00036	-0.00081	-0.00092
"Within" Concentration Index	CI^W	0	0.00011	0.00018	0.00042	0.00038	0.00043	0.00039	0.00010	0.00018
"Between" Concentration Index	CI^B	0	-0.00044	-0.00034	-0.00043	-0.00057	-0.00069	-0.00075	-0.00091	-0.00110
CI^B which can be attributed to:										
1st income quartile		-	-0.00019	-0.00031	-0.00034	-0.00030	-0.00035	-0.00042	-0.00046	-0.00049
2nd income quartile		-	-0.00005	-0.00005	0.00002	-0.00006	0.00001	-0.00004	-0.00008	-0.00017
3rd income quartile		-	-0.00012	0.00013	0.00015	0.00010	0.00004	-0.00005	-0.00009	-0.00009
4th income quartile		-	-0.00007	-0.00010	-0.00026	-0.00030	-0.00039	-0.00025	-0.00028	-0.00035
"Within" Gini Correlation	R^W	-	0.00475	0.00579	0.01145	0.00963	0.01022	0.00890	0.00218	0.00383
"Between" Gini Correlation	R^B	-	0.03874	0.02308	0.02564	0.03261	0.03741	0.03984	0.04646	0.05560
Mobility Index	M^T	0	-0.04076	-0.02163	-0.00131	-0.03116	-0.04026	-0.05525	-0.12946	-0.14184
"Within" Mobility Index	M^W	0	0.01328	0.02498	0.06495	0.06165	0.06696	0.05951	0.01593	0.02768
"Between" Mobility Index	M^B	0	-0.05403	-0.04661	-0.06626	-0.09282	-0.10722	-0.11477	-0.14538	-0.16952

run giving rise to the uniformly negative values of both "Term 2" and the mobility index M^T. We conclude that the negative result obtained by JLN for what they call health-related income mobility is dependent not only on the typically unimodal shape of the income distribution but also on the strength of the positive association between income and health in the long run compared to the short run.

3. An alternative approach

JLN provide an index that measures the difference between short run and long run income-related health inequality and suggest that it can be interpreted as an index of health-related income mobility. However, it is questionable whether this index is of much value to health policy makers other than to illustrate that income-related health inequalities may be slightly more important than might be inferred from cross-sectional estimates.

For a start, health policy-makers are more likely to be interested in income-related health changes, less so in health-related income changes, especially since a large amount of health-related income changes are likely to be unavoidable. The JLN measure will equal zero if there is no income mobility "regardless of whether there is health mobility" (p.1019, Case 1). Conversely the measure may not equal zero even if "there are no health changes" (p.1019, Case 3). Second, the index provided by JLN is symmetric in the sense of Yitzhaki and Wodon (2004) in that the value of the index is invariant to the ordering of the years. Yet policy makers will want to distinguish between equalising and disequalising income changes since these have diametrically opposed implications for the level of income-related health inequality over time.[4] Finally, as we have shown, the value of the JLN index is likely to be little more than a reflection of the unimodal shape of the income distribution and the strength of the association between income and health in the long run compared to the short run.

To overcome these limitations, we propose an alternative approach based on the simple observation that any change in income-related health inequality over time must arise from some combination of changes in health outcomes and income ranks. By decomposing the change in CI^t between two periods, we provide an index of income-related health mobility that captures the effect on short run income-related health inequality of differences in relative health changes between individuals with different initial levels of income. Thus the measure addresses the question of whether the pattern of health changes is biased in favour of those with initially high or low incomes, providing a natural counterpart to measures of income-related health inequality that address the issue of whether those with better health tend to be the rich or poor. In addition, like JLN, we obtain a health-related income mobility index that captures the effect of the reshuffling of individuals within the income distribution on cross-sectional socioeconomic inequalities in health.

Accordingly, we decompose the change in the short run CI between any initial or start period s and any final period f into two parts:

[4] Benabou and Ok (2001, p.15) make a similar criticism of the Shorrocks measure on which JLN base their index.

$$
\begin{aligned}
CI^{f}-CI^{s} &= \frac{2}{\bar{h}^{f}}\operatorname{cov}(h_{if},R_{if})-\frac{2}{\bar{h}^{s}}\operatorname{cov}(h_{is},R_{is}); \quad s,f=1,.....T; s\leq f\\
&=\left(\frac{2}{\bar{h}^{f}}\operatorname{cov}(h_{if},R_{if})-\frac{2}{\bar{h}^{f}}\operatorname{cov}(h_{if},R_{is})\right)+\left(\frac{2}{\bar{h}^{f}}\operatorname{cov}(h_{if},R_{is})-\frac{2}{\bar{h}^{s}}\operatorname{cov}(h_{is},R_{is})\right) \qquad (13)\\
&=\left(CI^{f}-CI^{fs}\right)+\left(CI^{fs}-CI^{s}\right)\\
&=M^{R}-M^{H}
\end{aligned}
$$

where CI^{s} and CI^{f} are the CI's in periods s and f respectively, and CI^{fs} is the CI obtained when health outcomes in the final period are ranked by income in the initial period. This decomposition is analogous to that provided by Kakwani (1984) of the redistributive effects of taxation, which is generalised to the S-Gini class of indices by Jenkins and van Kerm (2006) in their analysis of income mobility.

In (13), the index $M^{H}=\left(CI^{s}-CI^{fs}\right)$ provides a measure of income-related health mobility, which captures the effect of differences in relative health changes between individuals with different initial levels of income. M^{H} is positive (negative) if health changes are progressive (regressive) in the sense that the poorest individuals either enjoy a larger (smaller) share of total health gains or suffer a smaller (larger) share of total health losses compared to their initial share of health, and equals zero if relative health changes are independent of income. M^{H} in turn depends on the level of progressivity and scale of health changes:

$$
\begin{aligned}
M^{H} &=\left(CI^{s}-CI^{fs}\right)=\left(\frac{2}{\bar{h}^{s}}\operatorname{cov}(h_{is},R_{is})-\frac{2}{\bar{h}^{f}}\operatorname{cov}(h_{if},R_{is})\right)\\
&=\left(\frac{2}{\bar{h}^{s}}\operatorname{cov}(h_{is},R_{is})-\frac{2}{\overline{\Delta h}}\operatorname{cov}(h_{if}-h_{is},R_{is})\right)\left(\overline{\Delta h}/\bar{h}^{f}\right)=\left(CI^{s}-CI^{\Delta s}\right)\left(\overline{\Delta h}/\bar{h}^{f}\right)=Pq
\end{aligned} \qquad (14)
$$

where $CI^{\Delta s}$ is the concentration coefficient of health changes ranked by initial period income[5] and $\overline{\Delta h} = \bar{h}^f - \bar{h}^s$ is the average health change between the two periods. Progressivity is captured by the Kakwani (1977)-type disproportionality index $P = \left(CI^s - CI^{\Delta s}\right)$. Note that if the average health change is negative, then P will be negative if health depreciation is progressive such that relative health losses tend to be larger for rich individuals than poor ones. For any given P, the gross redistributive effect is proportional to the scale of health changes $q = \overline{\Delta h}/\bar{h}^f$, measured as the ratio of average health changes to average final period health.

However, the income-related health mobility index M^H will not exactly equal the change in income-related health inequality because it does not allow for the effect of changes in the ranking of individuals in the income distribution between the initial and final periods. This effect is captured by the health-related income mobility index $M^R = CI^f - CI^{fs}$, which is analogous to the re-ranking index proposed by Atkinson (1980) and Plotnick (1981) but may be negative since the concentration index of final period health outcomes ranked by initial income can exceed that ranked by final income. We further note that M^R will be equal to zero, irrespective of the degree of reshuffling of individuals in the income distribution, if final period health is uncorrelated with changes in income rank.

5 Note that $C^{\Delta s}$ will be negative (positive) if individuals with low initial incomes experience a larger (smaller) share of total health gains or losses than those with high incomes, and will equal zero for a universal flat-rate gain or loss.

To illustrate our proposed approach we repeat the preceding application to BHPS data on the above GHQ measure, treating Wave 1 as the initial period throughout and considering the implications of lengthening the time span over which the change in socioeconomic inequality is measured. Table 2 shows that both average health and income-related health inequality was highest in Wave 1, though there is no clear trend in either measure over subsequent waves. The decline in average health is not unexpected given the balanced nature of the panel. The decline in inequality implies that the change in inequality between Wave 1 and each subsequent wave is negative. The decomposition of this change reveals two main points of interest. First the index of income-related health mobility M^H is positive over all time spans implying that differences in relative health changes experienced on average by individuals with different initial levels of income had the effect of reducing socioeconomic inequalities in health. Accordingly, health depreciation may be deemed to have been progressive, with the negative value of the progressivity index P implying that the concentration of health losses among the better-off in Wave 1 was greater than the concentration of initial health. Second, the health-related income mobility index M^R is positive implying that those who moved up the income ranking tended to be healthier in the final period compared to those who moved down. The effect of income re-ranking was therefore to reduce somewhat the redistributive effect due to the progressive nature of health changes, though not by enough to reverse the overall effect of those changes.

Table 2. Decomposition of changes in income-related health inequality from Wave 1.

	BHPS Wave	1	2	3	4	5	6	7	8	9
Average health	$\bar{h}^t$	26.00	25.68	25.77	25.73	25.74	25.59	25.60	25.55	25.69
Health Concentration Index	CI^t	0.0102	0.0060	0.0055	0.0040	0.0050	0.0077	0.0074	0.0041	0.0087
Average health change	$\overline{\Delta h}$	-	-0.3171	-0.2324	-0.2646	-0.2641	-0.4108	-0.3979	-0.4529	-0.3107
Concentration Index of health changes	$CI^{\Delta s}$	-	0.5340	0.8244	0.7362	0.6138	0.4697	0.3233	0.3084	0.3908
Change in inequality	$CI^f - CI^s$	-	-0.0042	-0.0047	-0.0061	-0.0051	-0.0025	-0.0027	-0.0061	-0.0015
Income-related health mobility	M^H	-	0.0065	0.0073	0.0075	0.0062	0.0074	0.0049	0.0053	0.0046
Progressivity Index	P	-	-0.5238	-0.8142	-0.7260	-0.6036	-0.4595	-0.3131	-0.2983	-0.3807
Scale factor	q	-	-0.0123	-0.0090	-0.0103	-0.0103	-0.0161	-0.0155	-0.0177	-0.0121
Health-related income mobility	M^R	-	0.0023	0.0027	0.0013	0.0011	0.0049	0.0021	-0.0008	0.0031

4. Conclusions

This paper has focused on the characterisation and measurement of the evolution of income-related health inequalities in a population over time. We have extended a key paper in the literature by demonstrating that the common negative result of the JLN health-related income mobility index is likely to be a manifestation of the existence of a stronger association between permanent income and health than between short run changes in income and health.

We further suggest that for a number of reasons this index provides little direction or evaluative purpose for health policies. Instead we attempt to redirect efforts in this field to what we consider to be more meaningful decompositions of changes in short run CI's over time. The advantages of our proposed mobility indices are that they are able to distinguish between equalising and disequalising health and income changes, since the indices are sensitive to the ordering of the years. In particular, the income-related health mobility is potentially useful for evaluative purposes in that it could serve to identify whether health changes are progressive or regressive and, thereby, determine which members of society are the winners and losers from health policies.

The progressive health changes found in the illustrative analysis based on our alternative approach are consistent with the fall in income-related health inequality observed in the sample. Taken at face value, these results might reflect that disparities in health care provision or outcomes have declined over the sample period. However it would be premature to try to draw such policy-relevant conclusions because the results are based on a balanced panel and socioeconomic health differentials may be expected to have changed over the period simply due to the ageing of the sample (Kiula and Mieszkowski, 2007). Moreover, the progressivity index is likely to be biased upward due to non-random sample selection given that the sample excludes those surveyed in wave 1 and dead before wave 9, who are disproportionately likely to have been among the poor in wave 1. In future research, we aim to develop our methodology to standardise our measures to control for factors such as age and deaths.

References

Atkinson, A.B. (1980) Horizontal equity and the distribution of the tax burden, in Aaron, H. and Boskin, M.J. (eds.), *The Economics of Taxation,* Washington D.C., USA: Brookings Institute, pp.3-18.

Benzeval, M. and Judge, K. (2001) Income and health: the time dimension. Social Science & Medicine, 52, 1371–1390.

Brandrup J.D., and Kortt, M.A. (2007). A longitudinal analysis of income-related health inequality in Australia. HILDA survey and Research Projects. Research and Analysis Branch. Department of Families, Community Services and Indigenous Affairs.

Greene, W.H. (2008) *Econometric Analysis* (6e). New Jersey, USA: Prentice Hall.

Department of Health (2008) Health inequalities: Progress and next steps. http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_085307. Accessed on 31/07/08.

Hernandez-Quevado, C., Jones, A.M., Lopez-Nicholas, A. and Rice, N. (2006) Socioeconomic inequalities in health: A comparative longitudinal analysis using the European Community Household Panel. *Social Science and Medicine*, 63, 1246-1261.

Jenkins, S. P. and Van Kerm, P. (2006), Trends in income inequality, pro-poor income growth and income mobility. *Oxford Economic Papers,* 58, 531–548

Jones, A. M., & Lopez Nicolas, A. (2004). Measurement and explanation of socioeconomic inequality in health with longitudinal data. *Health Economics,* 13, 1015-1030.

Kakwani, N.C. (1977). Measurement of Tax Progressivity: An International Comparison, *Economic Journal*, 87, 71-80.

Kakwani, N.C. 'On the measurement of tax progressivity and redistributive effect of taxes with applications to horizontal and vertical equity', *Advances in Econometrics*, Vol. 3, (1984) pp.149-68.

Kiula, O. and Mieszkowski, P. (2007) The Effects of Income, Education and Age on Health, *Health Economics*, 16, 781–798.

Lecluyse, A. (2006). Income-related health inequality in Belgium: a longitudinal perspective. *European Journal of Health Economics*, 8, 237–243

Lerman, R.I. and Yitzhaki, S. (1985) Income inequality effects by income source: a new approach and applications to the United States. *Review of Economics and Statistics*, 67(1), 151-156.

Plotnick, R. (1981) A measure of horizontal equity. *Review of Economics and Statistics*, 63, 283-88.

Shorrocks, A. (1978). Income inequality and income mobility. *Journal of Economic Theory,* 19, 376-393.

University of Essex. Institute for Social and Economic Research (2007) *British Household Panel Survey: Waves 1-15, 1991-2006* [computer file]. *3rd Edition.* Colchester, Essex: UK Data Archive [distributor], June. SN: 5151.

Van Doorslaer, E. and Koolman, X. (2004). Explaining the differences in income-related health inequalities across European countries. *Health Economics,* 13(7), 609-628.

Wagstaff, A. and Van Doorslaer, E. (2000) Equity in health care finance and delivery. In: Culyer, A.J., Newhouse, J.P. (Eds.) *Handbook of Health Economics*. Amsterdam, The Netherlands: North Holland, pp. 1803–1862.

Yitzhaki, S. and Wodon, Q. (2004) Inequality, mobility, and horizontal equity. In: Y. Amiel and J. A. Bishop (eds.), Studies on Economic Well-Being: Essays in Honor of John P. Formby, *Research on Economic Inequality*, 12, 177–98. Elsevier, Oxford.

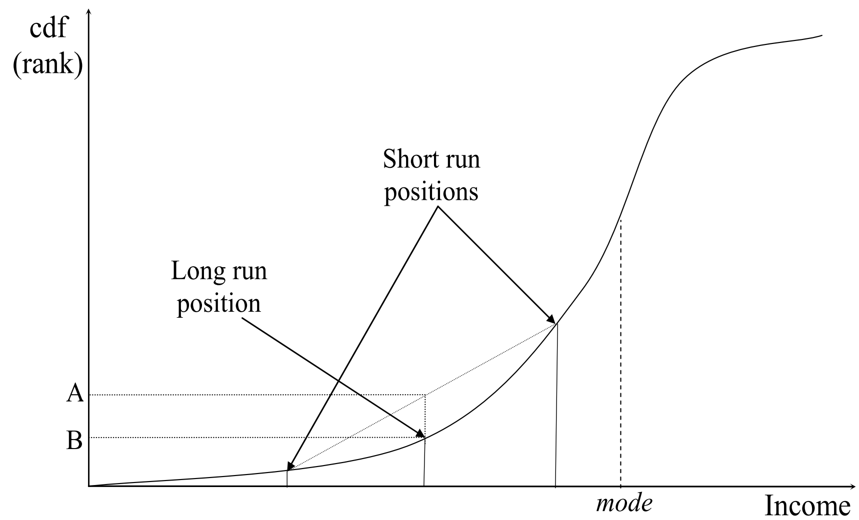
Appendix 1. Technical note on why M^B will generally be negative

We first explain why those with low (high) incomes will tend to have a long run rank which is lower (higher) than the average of their short run ranks in the absence of income growth. We then consider the implications of income growth and show why it is still reasonable to assume that M^B will be negative.

Note that the slope of the cumulative distribution or relative rank function (cdf) is given by the probability density function. Hence, for a unimodal distribution, the cdf will be convex below the mode and concave above it, as shown in Figure 1. Assume T=2 for simplicity (all arguments readily generalise to T>2). Consider the case where individuals experience income fluctuations but where the income distribution is stable over time (so there is a single cdf, common to each period and the long run average). For poor (rich) individuals, with incomes in both periods below (above) the mode, it follows immediately from Jensen's inequality that the average of the short run ranks will be above (below) the long run income rank. This is illustrated in Figure 1 where the average of the short run ranks (A) for a poor individual is above her long run rank (B), such that she will contribute negatively to M^B if her long run health is below the population average.

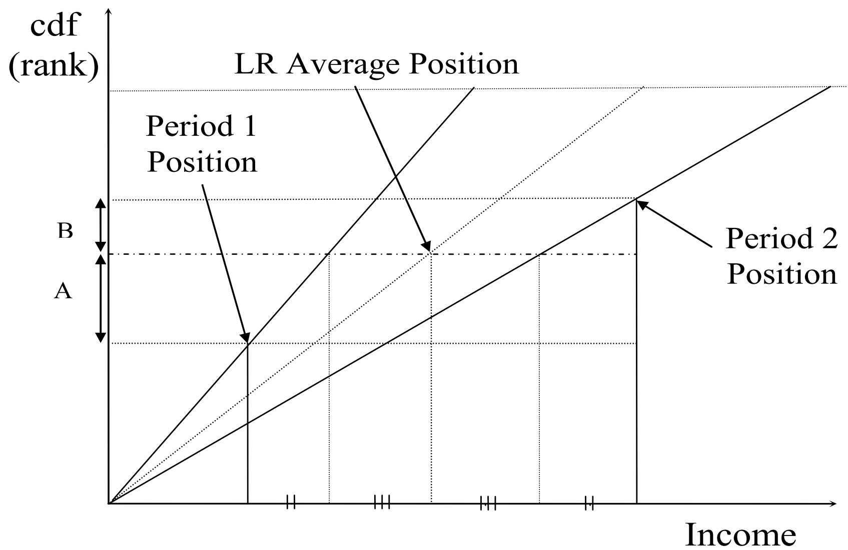
To consider the impact of income growth, first note that the above argument continues to hold if growth is uniform in absolute terms as this will merely result in a parallel shift in the cdf over time. However the more realistic case is that growth will lead to an increase in absolute income dispersion over time (e.g. due to equiproportionate growth),

Figure 1. Short run and long run ranks with a unimodal cdf of income



particularly if incomes are not deflated as in JLN, leading to changes in both the location and shape of the income distribution over time. To think about the implications of disequalising growth, consider a simple model in which income is uniformly distributed and dispersion increases from period 1 to period 2 such that the (uniform) slope of the cdf is lower at every rank in period 2. Hence an individual whose income rank is lower (higher) in period 1 than in period 2 will have an average short run rank that is less (more) than their long run rank. This is illustrated in Figure 2, in which the long run cdf bisects the horizontal distance between the period-specific cdfs by construction, where the average of the short run ranks for an individual who increases her income rank between periods 1 and 2 will be below her long run rank since A is greater than B. In general, the average health of individuals who increase their income rank over time is likely to be better than that of those who are moving down the income distribution. Hence, average health status and movements within the income distribution will tend to be negatively correlated in the sample, further helping to explain the negative value of M^B.

Figure 2. Short run and long run ranks with increasing income dispersion over time



In conclusion, M^B may be expected to be negative as a result of two separate but mutually reinforcing reasons: (i) positive correlation between health status and income, given the shape of the income distribution, and (ii) negative correlation between average health status and changes in short run income rank over time, given the likely increase in income dispersion over time. The second reason is less likely to be a significant factor if incomes are measured in real rather than nominal terms.