Does health spending need to outpace GDP per head?

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Decisions on health spending depend ultimately on the valuation of human life in the country concerned. Previous attempts in the UK have been linked to the one-size-fits-all "value of a prevented fatality" (VPF), now shown to be based on a fundamentally flawed method. An objective and validated alternative is available in the J-value (J for "judgment"), which addresses the improved life expectancy a treatment offers. The J-value sheds important light on what Man chooses to spend on life-extending measures, allowing lessons to be drawn for the desirable relationship between GDP and spending on health.

Keywords: economics, GDP, health, J-value, life expectancy, life quality index

1. Introduction

Health services in the UK cost more than £150,000 million each year, making up 9% of the country's GDP, a level of expenditure that is comparable with the turnover of an oil major such as BP. The UK's health market is dominated by the National Health Service (NHS), which accounts for 83% of health spending. This is more than the corresponding fraction for either France or Germany, where publicly financed health care accounts for 77% of total provision, although it falls short of the 85% allocated by both Holland and Denmark.[1]

Health spending in the UK has increased very significantly in real terms during the past 20 years, over 50% in terms of GDP per head, but there is a continuing pressure to increase health budgets, accompanied by a desire to get better value from the money available. Comparing health systems from ten major developed countries, the Washington-based Commonwealth Fund found that the UK came 10th (out of 11) in the category of healthy lives but nevertheless it

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[1] *Total Health Expenditure of OECD Countries as a Share of GDP (2013)*. Nuffield Trust (2016) [accessed November 2016 at http://www.nuffieldtrust.org.uk/data-and-charts/total-health-expenditure-oecd-countries-share-gdp-2013]

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rated the NHS the overall most impressive healthcare system in 2014.[2] Such positive endorsement is certainly not unanimous, however, and the Euro Health Consumer Index Report[3] puts the UK in 14th place in Europe. This may reflect that, in terms of purchasing-power-parity-preserving international dollars (Int$), the UK's annual health spending per person, at Int$3,377,[4] is much less than comparable figures for Holland (Int$5,202) or Germany (Int$5,182) or Denmark (Int$4,782) or France (Int$4,508). It is striking that all the last-named countries are spending at least a third more per person than the UK, with Holland and Germany spending about 50% more—see Table 1, which also shows the UK's European neighbours spending about 20% more in terms of GDP per head.[5] This immediately raises the question: how much ought the UK to be spending?

Table 1. World Bank Figures for health spending per head in 2014 (expressed in 2011 international dollars).

	Health care spending per head in 2014/ 2011 Int$	Percentage of GDP per head
Netherlands (Holland)	5,202	10.90
Germany	5,182	11.30
Denmark	4,782	10.80
France	4,508	11.54
UK	3,377	9.12

The Judgment- or J-value[6–8] can offer a degree of illumination. Based on the life quality index,[9, 10] the J-value is an objective method for determining when life-extending measures are sensible. It is assumed that a rational trade-off is made between an increase in life expectancy

2 Davis, K., Stremikis, K., Squires, D. and Schoen, C. *Mirror, Mirror on the Wall. How the Performance of the U.S. Health Care System Compares Internationally*. Washington DC: The Commonwealth Fund (2014) [accessed February 2017 at http://www.commonwealthfund.org/~/media/files/publications/fund-report/2014/jun/1755_davis_mirror_mirror_2014_exec_summ.pdf]

3 Björnberg, A. *Euro Health Consumer Index 2014 Report*. Health Consumer Powerhouse Ltd (2015) [accessed February 2017 at http://www.healthpowerhouse.com/publications/euro-health-consumer-index-2014/]

4 Health expenditure per capita, PPP (constant 2011 international $), updated 14.10.2016. World Bank (2016) [accessed November 2016 at http://data.worldbank.org/indicator/SH.XPD.PCAP.PP.KD]

5 Health Expenditure, total (% of GDP), updated 17.11.2016. World Bank (2016) [accessed November 2016 at http://data.worldbank.org/indicator/SH.XPD.TOTL.ZS]

6 Thomas, P.J., Stupples, D.W. and Alghaffar, M.A., The extent of regulatory consensus on health and safety expenditure. Part 1: Development of the J-value technique and evaluation of regulators' recommendations. *Trans IChemE, Part B, Process Safety and Environmental Protection* **84(B5)** (2006) 329–336.

7 Thomas, P.J., Stupples, D.W. and Alghaffar, M.A., The extent of regulatory consensus on health and safety expenditure. Part 2: Applying the J-value technique to case studies across industries. *Trans IChemE, Part B, Process Safety and Environmental Protection* **84(B5)** (2006) 337–343.

8 Thomas, P.J., Jones, R.D. and Kearns, J.O., The trade-offs embodied in J-value analysis. *Process Safety and Environmental Protection* **88** (2010) 147–167.

9 Nathwani, J.S. and Lind, N.C., *Affordable Safety by Choice: the Life Quality Method*. Waterloo, Ontario: Institute for Risk Research, University of Waterloo (1997).

10 Nathwani, J.S., Pandey, M.D. and Lind, N.C., *Engineering Decisions for Life Quality: How Safe is Safe Enough?* London: Springer (2009).

and the cost of the measure that brings about that increase, with an overall aim of maintaining or improving life quality.

The J-value has the considerable advantage over conventional cost–benefit analysis that no explicit assumptions have to be made about the difficult issue of the monetary value to be attached to "saving" a human life, which is self-evidentially impossible in the long term as none of us will live for ever. A lack of rigorous thinking about what can actually be preserved by a health and safety intervention seems to have led to other confusions. The approach currently adopted by almost all the UK Government's departments and agencies,[11] including the National Health Service,[12, 13] relies on the use of the so-called "value of a prevented fatality" (VPF). This is the maximum amount that it is notionally reasonable to pay for a safety measure that will reduce by one the expected number of preventable premature deaths in a large population.

The VPF, valued at £1.83 million in 2016, is based on a series of small-scale opinion surveys carried out 20 years ago by essentially the same team. That team dismissed its first attempt[14] in favour of its second.[15] However, the Carthy approach has been proved to be invalid.[16] Thomas and Waddington[17] provide a discussion of the Carthy study, the numerous problems and inconsistencies it implies, the attempted defences by the Carthy authors[18, 19] and the rebuttal of their counterarguments by Thomas and Vaughan[20, 21].

Rather than being reliant on the subjective opinions of a small group of people, the J-value is, instead, grounded in objective actuarial and economic statistics that characterize the lives

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[11] *Review of the Highways Agency Value of Life Estimates for the Purposes of Project Appraisal: A Report to the NAO*. Deloitte LLP (2009) [accessed August 2016 at https://www.gov.uk/government/publications/report-about-the-value-of-prevented-injuries-and-fatalities]

[12] Glover, D. and Henderson, J., *Quantifying Health Impacts of Government Policies: A How-to Guide to Quantifying the Health Impacts of Government Policies*. London: Department of Health (2010) [accessed October 2016 at www.gov.uk/government/uploads/system/uploads/attachment_data/file/216003/dh_120108.pdf]

[13] *Judging Whether Public Health Interventions Offer Value for Money* (local government briefing LGB10). NICE (National Institute for Health and Care Excellence) (2013) [accessed September 2016 at https://www.nice.org.uk/guidance/lgb10/resources/judging-whether-public-health-interventions-offer-value-for-money-60521139708613]

[14] Beattie, J., Covey, J., Dolan, P. Hopkins, L., Jones-Lee, M., Loomes, G., Pidgeon, N., Robinson, A. and Spencer, A., On the contingent valuation of safety and the safety of contingent valuation: Part 1 – Caveat investigator, *J. Risk Uncertainty* **17** (1998) 5–25.

[15] Carthy, T., Chilton, S., Covey, J., Hopkins, L., Jones-Lee, M., Loomes, G., Pidgeon, N. and Spencer, A., On the contingent valuation of safety and the safety of contingent valuation: Part 2 – The CV/SG chained approach. *J. Risk Uncertainty* **17** (1999) 187–213.

[16] Thomas, P.J. and Vaughan, G.J., Testing the validity of the "value of a prevented fatality" (VPF) used to assess UK safety measures. *Process Safety and Environmental Protection* **94** (2015) 239–261.

[17] Thomas, P. and Waddington, I., What is the value of life? A review of the value of a prevented fatality used by regulators and others in the UK. *Nuclear Future* **13** (2017) issue 1, pages 32–39.

[18] Chilton, S., Covey, J., Jones-Lee, M., Loomes, G., Pidgeon, N. and Spencer, A., Response to Thomas and Vaughan. *Process Safety and Environmental Protection* **93** (2015) 293–298.

[19] Jones-Lee, M. and Loomes, G., Final response to Thomas and Vaughan. *Process Safety and Environmental Protection* **94** (2015) 542–544.

[20] Thomas, P.J. and Vaughan, G. J., Testing the validity of the "value of a prevented fatality" (VPF) used to assess UK safety measures: Reply to the comments of Chilton, Covey, Jones-Lee, Loomes, Pidgeon and Spencer. *Process Safety and Environmental Protection* **93** (2015) 299–306.

[21] Thomas, P.J. and Vaughan, G.J., Pitfalls in the application of utility functions to the valuation of human life. *Process Safety and Environmental Protection* **98** (2015) 148–169.

and behaviours of millions of citizens. The parameter is thus suitable for assessing health and safety measures across all industries, from oil and gas, chemical and nuclear through transport to the National Health Service in the UK. Moreover, unlike other approaches, the J-value allows immediate fatalities and loss of life in the longer term (e.g., after exposure, either of workers or of the general public, to a carcinogen) to be differentiated but measured on the same scale.

An ethical principle of J-value analysis is that the next day of life should be valued the same for everyone in the nation, old or young, rich or poor. This principle is reflected in the use of the gross domestic product (GDP) per head as the baseline annual income used in the definition of life quality. Its relevance to the question of the desirable total expenditure on health comes from the explanation it provides for the Bristol curve and the closely related Preston curve.

Preston[22] highlighted the fact that there is a clear, positive correlation between GDP per head in different countries in the world and life expectancy at birth. Figure 1 shows results from 180 out of the 193 nations affiliated to the United Nations. A similar curve, represented in log–log form in Figure 2, may be drawn for the population-average life expectancy versus GDP per head; this is known as the "Bristol curve". The population-average life expectancy is, in a real sense, the "proof of the pudding" as regards health and safety interventions made by the nation in question. The generality that the J-value offers in assessing such decisions means that it is possible to investigate these two curves using a J-value model and, in fact, to explain their shape.[23] The explanatory model holds implications for how much should be spent on life-extending activities and, therefore, on health services in any given country.

The next section outlines the basics of the J-value.

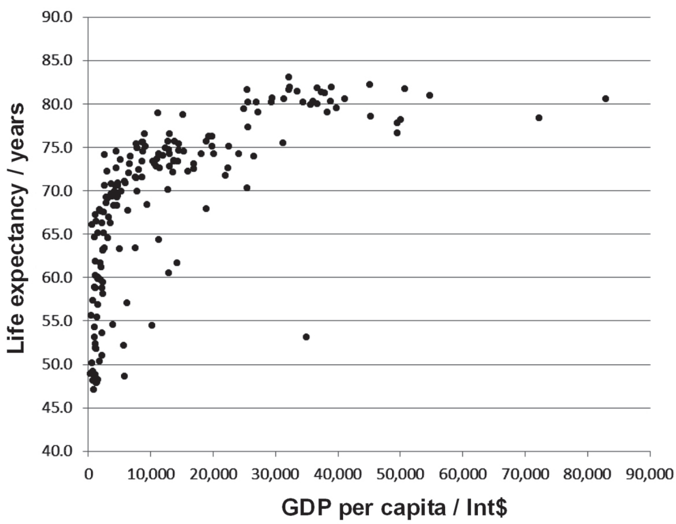

Figure 1. The Preston curve—life-expectancy at birth (years) as a function of GDP per capita (international dollars) for the 180 countries for which both required datasets are available for 2009.

[22] Preston, S.H., The changing relation between mortality and level of economic development. *Population Studies* **29** (1975) 231–248.

[23] Thomas, P.J. and Waddington, I., Validating the J-value safety assessment tool against pan-national data. Submitted to *Process Safety and Environmental Protection* (2017).

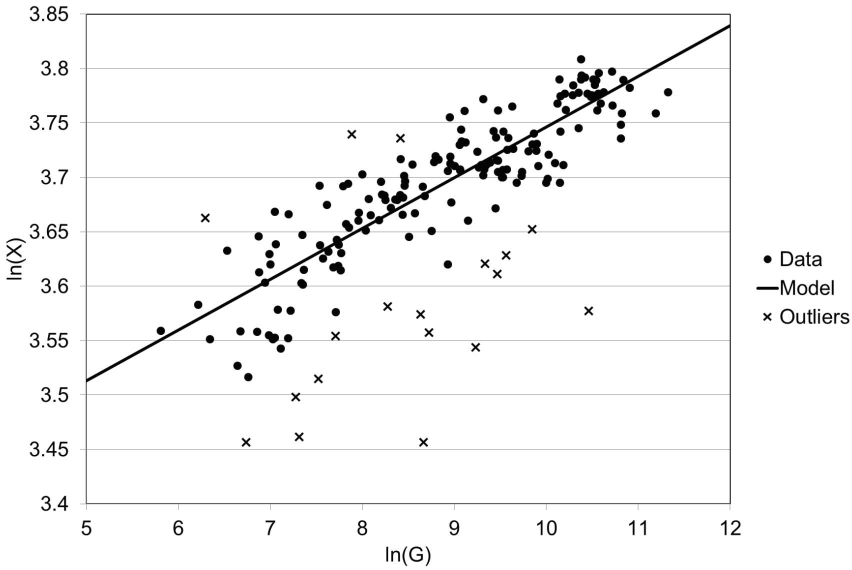

Figure 2. Ln X vs ln G for 180 nations in 2009 (the Bristol curve). 18 outliers (marked with crosses) were excluded from the final fit. X is population-average life expectancy while G is GDP per head.

2. The life quality index and the J-value

The J-value is derived from the life quality index (LQI) Q:[9, 10, 6, 8]

$$Q = G^{1-\varepsilon} X \tag{1}$$

where G is the income per person, normally taken to be GDP per head and thus the same for everyone in the same national jurisdiction, while ε is the risk-aversion associated with measures that will extend life expectancy, estimated as 0.91 for the UK.[23] Risk-aversion is well correlated with what is meant by aversion to risk in normal language, but it also benefits from a rigorous mathematical definition. Risk-aversion is defined as the negative of the normalized derivative of marginal utility, m, with respect to income:

$$\varepsilon = -\left(G/m\right)\mathrm{d}m/\mathrm{d}G = -Gu''/u'. \tag{2}$$

Here $u = G^{1-\varepsilon}$ is the utility of income, while $m = \mathrm{d}u/\mathrm{d}G = u'$. It may be seen from equation (1) that the LQI is the expected sum of utility from now on. See Thomas[24] for a fuller discussion of the history since the 18th century of utility functions and risk-aversion.

Previous formulations have suggested that discounted life expectancy should be used (which would tend to lower the health and safety spend), but Thomas and Waddington[23] have shown recently that the net discount rate is best represented as zero, equivalent to an absence of discounting.

A condition for a life-extending measure to be rationally and scientifically justified is that the life quality index should not fall as a result of a person spending on that measure a positive amount, δG, each year for the rest of his expected lifetime, decreasing his annual income to $G - \delta G$.

[24] Thomas, P.J., Measuring risk-aversion: The challenge. *Measurement* **79** (2016) 285–301.

In line with the Kaldor–Hicks compensation principle,[25, 26] while the individual should be prepared to fund such an amount, the annual payment might actually be made (and in many, if not most, cases will be made) by some other person or body. From equation (1), the change in LQI due to small changes in income and life expectancy, δX, will be

$$\delta Q = \frac{\partial Q}{\partial G} \times \left(-\delta G\right) + \frac{\partial Q}{\partial X}\delta X = -\left(1-\varepsilon\right)G^{-\varepsilon}X\delta G + G^{1-\varepsilon}\delta X. \tag{3}$$

Dividing by equation (1), we find

$$\frac{\delta Q}{Q} = -\left(1-\varepsilon\right)\frac{\delta G}{G} + \frac{\delta X}{X}. \tag{4}$$

The maximum rational annual expenditure on a particular scheme providing life extension will occur when $\delta Q = 0$ and, for the non-zero LQI, Q, that it is reasonable to assume, this will occur when

$$\frac{\delta X}{X} = \left(1-\varepsilon\right)\frac{\delta G}{G}. \tag{5}$$

Equation (5) defines δG as the maximum spend per person to achieve the gain in life expectancy, δX. If the actual annual expenditure, $\delta \hat{G}$, is less than δG but the same life extension, δX, is gained, then it is clear from equation (4) that $\delta Q > 0$ and life quality will increase.

Let the Judgment- or J-value be defined as:

$$J = \frac{\delta \hat{G}}{\delta G}. \tag{6}$$

$J = 1$ defines the locus of a curve in the plane of G versus X where life quality, Q, is maintained constant, $\delta Q = 0$ (see Figure 3). J-values less than one, $J < 1$, correspond to $\delta Q > 0$, which implies that life quality will increase and so the measure should be implemented. The J-value may be used on a case-by-case basis to assess on an objective, scientific and economic foundation whether a health or a safety measure is justified, when $J \leq 1$. An approach that builds on this premiss will be discussed in the next section.

3. Applying the J-value to explain pan-national life expectancies

Thomas and Waddington[23] tested the explanatory power of the J-value by assuming that a typical nation in the world will attempt to improve the quality of life of each of its citizens by taking a rationally balanced view of measures to increase the the population-average life expectancy. Specifically, it was assumed that in all nations:

(i) people will decide to spend the same fraction, a, of their national income per head on life-extending measures (which will include not only medical services but also, for example, the supply of plentiful and clean drinking water, the installation and maintenance of effective

[25] Kaldor, N., Welfare propositions and interpersonal comparisons of utility. *Economic Journal* **49** (1939) 549–552.
[26] Hicks, J.R., *Value and Capital*. Oxford: University Press (1939).

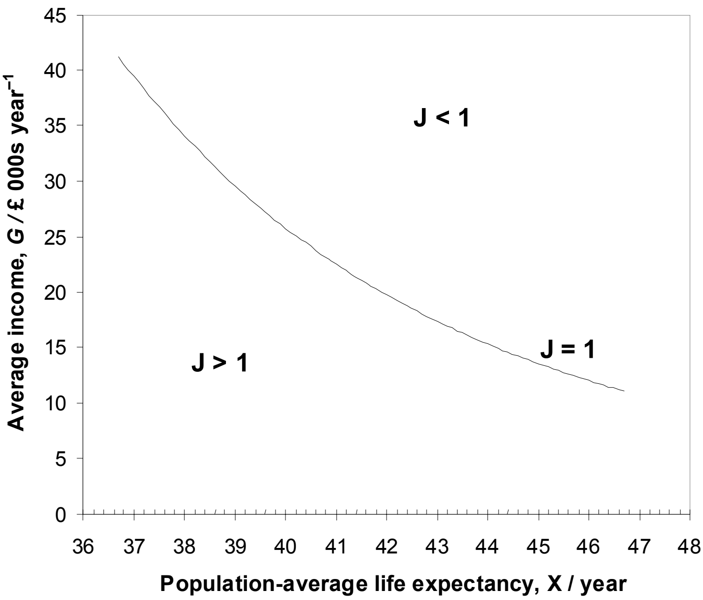

Figure 3. J = 1 defines the locus of the line in the plane of G vs X that maintains the life quality index constant.

sewage disposal systems and the regulation of safe transport systems). The sum spent per person is then

$$y = aG. \tag{7}$$

The value of a will lie in the interval $0 < a \leq 1.0$, but it is not necessary to specify the fraction, a, further for the purposes of this paper other than to say that it is likely to lie at the lower end of its range;

(ii) within the budget defined by equation (7), the average person in the nation will spend on health and safety measures resulting in life extension an overall amount such that a J-value of unity will result, implying that this spending will just maintain the life quality index: $\delta Q = 0$;

(iii) the value of risk-aversion applicable when decisions on life extension are being made will remain constant as wealth and life expectancy increase in tandem and will be the same for all nations in the world.

It was also assumed that the net discount rate, r, applied to life expectancy will remain constant as wealth and life expectancy increase in tandem. In fact, Thomas and Waddington[23] found from the data available that the optimal value of r was zero.

Health and safety measures may be assumed, in view of the many and various demands on resources, to take up a relatively low proportion of the average person's income. Moreover, the average life extension generated is likely to be a small fraction of the average person's current life expectancy. Hence, equation (5) may be written in differential form, thus giving the rate of change of life expectancy with GDP per head:

$$\frac{\mathrm{d}X}{\mathrm{d}G} = (1 - \varepsilon)\frac{X}{G}. \tag{8}$$

Differentiating equation (7) gives

$$\frac{\mathrm{d}y}{\mathrm{d}G} = a = \frac{y}{G}, \tag{9}$$

while formally:

$$\frac{\mathrm{d}X}{\mathrm{d}G} = \frac{\mathrm{d}X}{\mathrm{d}y}\frac{\mathrm{d}y}{\mathrm{d}G} = \frac{\mathrm{d}X}{\mathrm{d}y}\frac{y}{G}. \tag{10}$$

Substituting from equation (10) into equation (8) yields:

$$\frac{\mathrm{d}X}{\mathrm{d}y}\frac{y}{G} = (1-\varepsilon)\frac{X}{G}. \tag{11}$$

Now consider nation A, where the average individual has an income (taken to be GDP per head) G_A, a corresponding annual health and safety spend $y = aG_A$, and a life expectancy X_A. The effect of the GDP per head in nation A increasing above this level may be found by integrating equation (11) according to

$$\int_{x=X_A}^{X} \frac{1}{x}dx = (1-\varepsilon)\int_{y'=y_A}^{y} \frac{1}{y'}dy' \tag{12}$$

where x and y' are variables of integration. This gives

$$\ln\frac{X}{X_A} = (1-\varepsilon)\ln\frac{y}{y_A} \tag{13}$$

or

$$\frac{X}{X_A} = \left(\frac{y}{y_A}\right)^{1-\varepsilon}. \tag{14}$$

But from equation (7),

$$\frac{G}{G_A} = \frac{y}{y_A}. \tag{15}$$

Hence

$$\frac{X}{X_A} = \left(\frac{G}{G_A}\right)^{1-\varepsilon}. \tag{16}$$

Thus the population-average life expectancy scales with GDP per head according to equation (16), parameterized by the risk-aversion, ε. Equation (16) constitutes the "J-value model" of the growth in national life expectancy: as GDP per head rises from an initial value, G_A, to a higher figure, G, so population-average life expectancy will rise from X_A to X. Alternatively, if another country has a greater GDP per head, G_B, that country's life expectancy is predicted to take the higher value,

$$X_B = (G_B/G_A)^{1-\varepsilon} X_A. \tag{17}$$

By its nature, the model is constrained to be a steady-state description, as big changes in national income might require structural change before feeding through into changes in life expectancy. Hence one would expect its predictions to be best when a country's conditions are settled and to be less satisfactory the further they are from a steady state. Unsatisfactory predictions could thus be expected if the nation's GDP per head has undergone a major change or if it is experiencing war or major unrest. For example, the discovery of significant mineral wealth might boost GDP per head very quickly but not be reflected in improved health and, hence, life expectancy for many years.

Equation (16) may be written in logarithmic form:

$$\ln X = (1-\varepsilon)\ln\left(\frac{G}{G_{\mathrm{A}}}\right) + \ln X_{\mathrm{A}}. \tag{18}$$

Given that risk-aversion, ε, is constant in the model, equation (18) has the linear form $y = mx + c$. Once a reference nation, A, with GDP per head G_{A} and life expectancy X_{A} has been selected, it is possible to fit a regression line to find the slope and hence the risk-aversion ε. It is found from the data of 180 countries out of 193 registered with the United Nations that $\varepsilon = 0.95$, with the square of the correlation coefficient (R^2) = 0.6. When the number of countries is reduced to 162, the risk-aversion stays the same, but R^2 rises to 0.8. This is the line shown in Figure 2, which explains 80% of the variation in the logarithm of population-average life expectancy of the 162 nations in terms of the logarithm of GDP per head.

The 18 outliers marked in Figure 2 are: Afghanistan, Angola, Botswana, Cameroon, Chad, Congo, Cote d'Ivoire, Equatorial Guinea, Eritrea, Gabon, Guinea-Bissau, Lesotho, Malawi, Namibia, Nicaragua, South Africa, Swaziland and Zambia. Arguments might be made for why many of these countries should be regarded as being in an unsteady state, but are beyond the scope of this paper.

Meanwhile a theoretical development of the Bristol curve allows the form of the Preston curve,[22] applicable to life expectancy at birth, $X(0)$, to be derived as

$$\frac{X(0)}{X_{\mathrm{A}}(0)} = \left(\frac{G}{G_{\mathrm{A}}}\right)^{1-\varepsilon_{\mathrm{P}}}, \tag{19}$$

where $\varepsilon_{\mathrm{P}} = \varepsilon - \theta_0$, in which the small variation in risk-aversion, θ_0, can be justified theoretically as $\theta_0 = 0.04$.[23]

Writing equation (19) in logarithmic form:

$$\ln X(0) = (1-\varepsilon_{\mathrm{P}})\ln\frac{G}{G_{\mathrm{A}}} + \ln X_{\mathrm{A}}(0) \tag{20}$$

allows a straight line to be fitted to the data, analogously to the Bristol curve. It is found from the data on the 180 countries that $\varepsilon_{\mathrm{P}} = 0.91$, confirming the theoretical value of $\theta_0 = 0.04$ for the 180 nations. The R^2 correlation statistic for the Preston curve is then 0.41. Reducing the number of countries to 162 has no effect on the value of risk-aversion, ε_{P}, applicable to the Preston curve, but increases the R^2 value to 0.78, almost identical to the value found for the Bristol curve.

The theoretical variation is found to disappear, viz. $\theta_0 = 0$, for developed nations such as the UK. Further arguments adduced in Thomas and Waddington[23] suggest that $\varepsilon = \varepsilon_{\mathrm{P}} = 0.91$ for developed nations.

The J-value model for life expectancy has been validated previously against pan-national data,[23] and a paper[27] supplementary to this article provides validation for the J-value model when used to forecast future life expectancy within the same nation. After introducing an allowance for the gap between male and female life expectancies at birth diminishing over the past 50 years in industrialized countries, the J-value model incorporating "male catch-up" has been validated against actual UK data on life expectancy.[28] Projecting life expectancy at birth 20 years ahead, the predictions from the J-value model came within 3 months of the actual numbers recorded for males, females and combined genders. A close correspondence has also been found between forecasts for life expectancy at birth in 35 countries made by the J-value model incorporating male catch-up and those produced in a recent study,[28, 29] which applied Bayesian model averaging to 21 demographic projection models.

4. The implications of the J-value model of life expectancy

A number of implications flow from the successful application of the J-value model to predict population-average life expectancy from GDP per head. At the intuitive level, it affirms a strong degree of commonality in human judgment and decision-making across all nations, in that while people's decisions on life-extending measures will be strongly influenced by the national resources at their disposal, such decisions will be taken at similar levels of risk-aversion in all countries in the world. But nations with greater GDP per head will have a larger capacity to spend on health and safety measures before life quality is impaired. Hence, they will be able to extend the lives of their citizens further. This is the basis of the Bristol curve and its extension, the Preston curve.

Health and safety spend per head in any given country i may be split into expenditure, $a_{HCi}G_i$, on healthcare and expenditure, $a_{Oi}G_i$, on other health and safety measures, such as the provision of clean water sanitation, transport and factory regulation and so on. Here a_{HCi} is the fraction of GDP per head, G_i, in country i devoted to healthcare, while a_{Oi} is the fraction spent on other life-extending activities. Thus

$$a_{HCi} + a_{Oi} = a, \tag{21}$$

where a is the total fraction of expenditure devoted to life-extending activities, assumed in the J-value model to be uniform across the nations of the world.

World Bank data[5] show that the world-average fraction of GDP per head devoted to health services has remained broadly steady at 10% for the past ten years or so, having grown to this level from 8.5% in 1995 (Figure 4). This prompts the policy query as to whether it would be sensible for each country to keep constant over time the fraction of GDP per head it assigns to health services, a_{HCi}.

It is not, however, clear whether this condition of health spending rising linearly with GDP can be expected to be valid universally. For example, while the installation of clean water

[27] Thomas, P., Corroboration of the J-value model for life-expectancy growth in industrialized countries. *Nanotechnology Perceptions* **13** (2017) 31–44.

[28] Kontis, V., Bennett, J.E., Mathers, C.D., Li, G., Foreman, K. and Ezzati, M., Future life expectancy in 35 industrialised countries: projections with a Bayesian model ensemble. *The Lancet* **389** (2017) 1323–1335.

[29] Supplement to ref. 28.

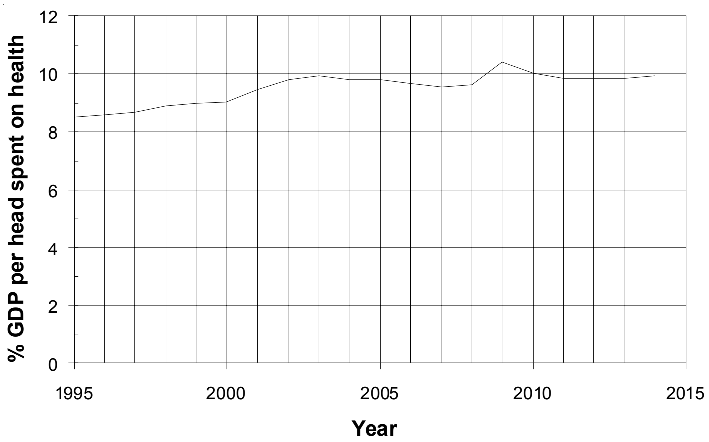

Figure 4. World average fraction of GDP per head devoted to healthcare.

supplies might offer better opportunities in a developing country, interventions in healthcare might provide better prospects in a highly developed country. The latter might be expected to already have a reasonably good infrastructure, and the investment needed for its maintenance and improvement would be much less than if the whole network of utilities had to be established from a low base. Similarly, reasonably effective regulation systems for industrial processes and transport might be expected to be largely in place in a developed nation. This would allow such a nation to put a greater emphasis on healthcare, especially as new healthcare technology becomes available.

Such a picture might well apply to developed countries in their current state of development. The growth in healthcare spending per person as a fraction of GDP per head for five European countries is illustrated in Figure 5. It is clear that healthcare spending is outpacing the growth in GDP per head by some margin. Moreover, as shown in Figure 6, the health spending in terms of GDP fraction shows a similarly rising trend (from a higher starting level in 1995) for the USA, the richest of the world's large countries.[30]

However, such a move towards a greater fraction of GDP being spent on healthcare does not appear to be a universal phenomenon, as is shown by Figure 7. The fraction of GDP per head devoted to health for five less developed countries in Africa and Asia can be seen to undergo strong variations over the period. However, little or no sustained growth of healthcare is visible in terms of GDP per head.[5]

Graphs 5, 6 and 7 tend to confirm the hypothesis that it is reasonable for more highly developed nations to want to devote an increasing fraction of their GDP per head to healthcare in future years while, at the same time, less developed nations may wish for their healthcare spending to rise only linearly with GDP (implying a constant fraction of GDP per head).

[30] GDP per capita, PPP (current international $), updated 17.11.2016. World Bank (2016) [accessed November 2017 at http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?view=map]

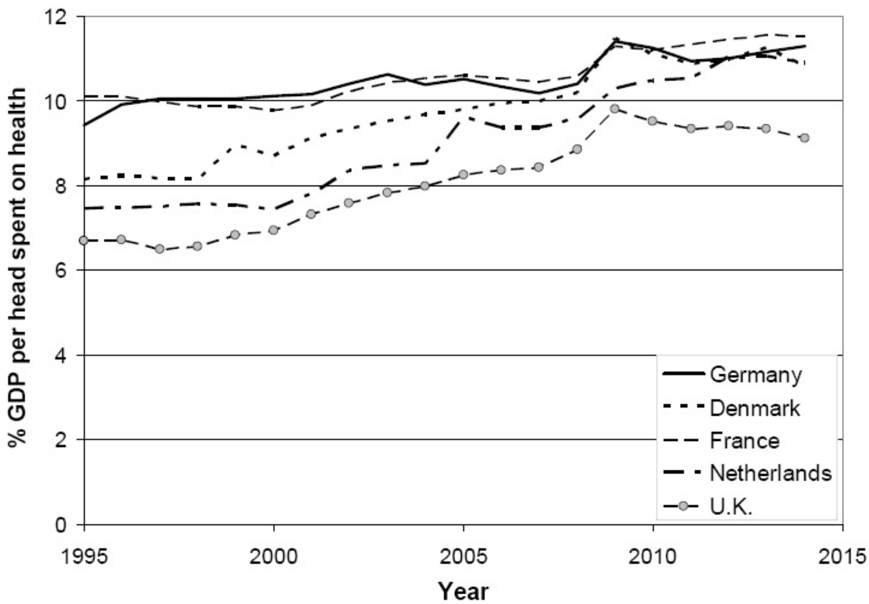

Figure 5. Growth in healthcare funding over 20 years: 5 European countries.

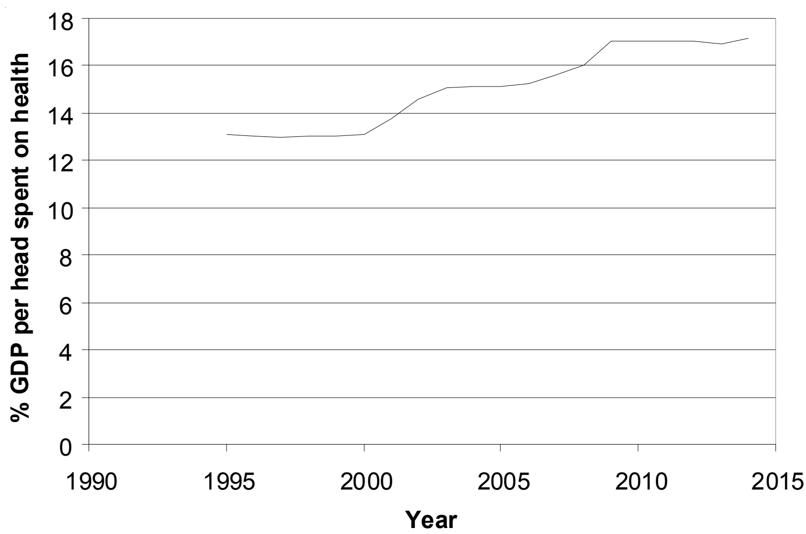

Figure 6. U.S. growth in healthcare funding over 20 years.

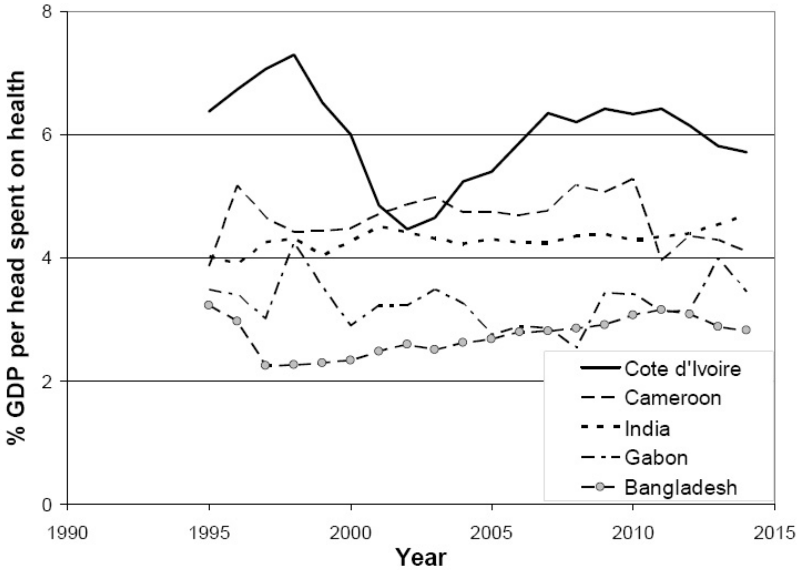

Figure 7. Healthcare funding over 20 years: Cote d'Ivoire, Cameroon, Gabon, India and Bangladesh.

5. Conclusions

It is possible to explain a large part of the variation in population life expectancy and life expectancy at birth with GDP for most of the world's countries using a J-value model. Adopting the J-value life expectancy model assumption that a roughly constant fraction of GDP per head may be devoted to total health and safety spending per person, a qualitative argument can be made for developed countries devoting an increasing fraction of GDP to healthcare spending in future years. The situation may be different in less developed nations, where better life extension opportunities may exist in the provision of enhanced infrastructure and safety regulation.

The argument appears to be borne out by the differing healthcare spending trends observed in developed and developing nations. The former have tended to increase the fraction of GDP per head devoted to healthcare spending over the past twenty years, while several of the latter have kept health spending at a roughly constant percentage of GDP per person. Both policies imply an increase in health spending per person as GDP per head rises, but the rise will be steeper in the case of developed countries.

The view is sometimes expressed that demand for healthcare is effectively infinite, which might be taken to imply that any limit set on healthcare spending must be arbitrary. It is important to realize that the J-value model does not support such a view: health and safety spending per person will increase only to the point where any further rise would cause life quality to fall, as measured by the life quality index.

The UK has conformed to the rising trend in health spending identified for developed countries over the past 20 years, and there are good arguments for UK citizens' demand for healthcare to increase at a greater rate than UK GDP per head in the future purely on the basis that it is a developed nation. It is also striking that the UK's percentage of GDP per head devoted to healthcare is currently two percentage points below that of near-neighbours in Europe with comparable levels of GDP per head. One can easily envisage calls for this sizeable healthcare spending gap to be closed.

Thus, there appear to be two drivers for UK health spending per head to increase at a faster rate than the growth in GDP per head. Increasing healthcare spending as a fraction of GDP is likely to be a priority route to improving quality of life in developed countries and the attraction of increased health provision is only enhanced by the UK's lagging position compared with other similarly developed nations.

Devising mechanisms for facilitating this growth in healthcare provision over and above the growth in GDP at a time when public finances continue to be highly constrained may well present a considerable and continuing challenge for politicians. As with all cases for more spending, the source of the funding is the problem. The European health model allows for more private funding, and the UK may need to consider increasing private provision if it is to satisfy the legitimate demands for better healthcare from citizens well aware that they live in a developed nation.

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