The Fantasy of Fair Funding of Primary Care Trusts

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Introduction

Funding of Primary Care Trusts (PCTs) has been based on the ideal of equal access for equal need. Since 1999 an additional aim has been to achieve equal health outcomes. The National Health Service (NHS) in England distributes money to Primary Care Trusts in accordance with a formula, the Target Index, phased in to avoid abrupt changes. When a new formula is introduced it is important that PCTs losing out have some short-term protection from changes in resources available. But PCTs due to gain will complain that the transition to the new formula is too slow and that they are being denied funds that fairness dictates should be theirs.
But how would we know whether the new formula is fair?

Philosophical and Practical Considerations

Equal access for equal need is a sound bite in need of critical analysis. How does one compare the needs arising from a young man's schizophrenia with those arising from breast cancer in a young woman? How does the need to inoculate a baby against Measles, Mumps and Rubella compare with the need of safe sex education for a teenager? In the last two examples is it the individual's or the community's need?
If it is appropriate for the NHS to provide a particular treatment for a particular medical condition then it should be equally accessible to all without too long a wait. But should equal access take into account barriers such as age, language and social class which may result in differential take-up of treatments? Should access include providing unsolicited advice, for example, to stop smoking? Should the obese, smokers, or alcoholics be offered surgical treatment only if they change their lifestyle. Would requiring them to change their lifestyle be giving them fuller access to healthcare (since a change in lifestyle is likely to result in a better outcome) or reducing their

access (since those who do not succeed in changing would not get the surgery)?
In conclusion, need and access to healthcare cannot be determined purely objectively. Value judgements are needed.

Formulae, 2006/08 and earlier

Since 1971 new formulae for allocating resources have been introduced periodically. Each new formula is promoted as being fairer than the preceding one. Currently the formula is devised and revised by the Advisory Committee on Resource Allocation with input from academic consultants. This has the political advantage that the Government can (although unjustifiably) claim that it is independent and (therefore) fair. The specified aims are vague and general (such as to reduce health outcome inequalities and to take account of unmet need). Detailed, explicit value judgements that might affect the electoral support for politicians are avoided. A major revision was made for 2004/06 allocations and this formula was slightly revised for 2006/08.

The formula used for allocation in 2006-7 is explained through a worked example in Appendix 13 of "Resource allocation: Weighted Capitation Formula" (Department of Health, 2005) and an outline (with more detail for the Additional Needs component) is given in the Appendix to this paper. The formula is complicated and may be criticised in many ways. For example, Asthana and Gibson (House of Commons Health Select Committee, 2006) have thought that it might give too low a weight to the age profile as compared to the socio-economic deprivation profile of a PCT.

The formula or Target Index was put together by the Department of Health using results published in "Allocation of Resources to English Areas", Sutton at al. (2002). I refer to these authors as the AREA team. Mervyn Stone and I have published a critique of the 2004/06 formula (Stone and Galbraith, 2006).

Evaluating the formula

Three possible ways of judging the appropriateness of a resource allocation formula are: to judge whether the component parts of the formula and their relative weights appear sensible; to assess whether the resulting allocations to PCTs are fair; and to examine the methodology used to derive it.

The Appendix sets out the main components of the 2006/08 Target Index, with more detail on the Age Profile Index and the Additional

Need Index. The Reader is invited to use his or her own judgement as to whether the chosen proxies for need of health care expenditure and the manner of their combination would appear at face value to provide a satisfactory formula for distributing funds to PCTs. Whilst the Age Profile Index is based on past expenditure for different age groups the Additional Needs Index is a function of selected socio-economic variables. Are these adequate measures of need? Are they combined so that allocated resources will increase by an appropriate amount with increasing deprivation? (Your PCT's need may be greater than my PCT's need but does that entitle yours to 1%, 10% or 100% more resources than mine?)

Stone (2006) provides a graphical method for investigating how the Target Index 2004/06 for individual PCTs arises from its constituent parts, and how these differ between PCTs. An example is given in Asthana and Gibson (2008) Figure 1.

Although we do not know what a fair allocation would be, we can still examine the outcomes for different PCTs and question whether the large discrepancies in capitation (allocation per person) could be justified.

Below I argue that the methodology used in developing the formula does not ensure that it is fairer than other arbitrary allocations such as equal capitation.

A Misuse of Regression

Until recently, it was not thought possible to measure need for health care expenditure either by measuring morbidity directly or by estimating it epidemiologically and then costing the treatments (see, for example, Asthana et al., 2004, Asthana and Gibson, 2008). Therefore health economists have tried to deduce from current expenditure what appropriate expenditure would be. The AREA team, Sutton et al. (2002), did this by fitting multiple regressions of age-standardised utilisation on selected socio-economic variables (to measure need) and variables thought to measure (constraints on) supply of health care. The units of analysis were the 8414 electoral wards in England.

Gravelle et al. (2003) describe the methodology used by the AREA team but the argument is so complicated that it is difficult to

disentangle the flaws. I shall concentrate on the problem of how to determine what would be the correct age-standardised utilisation or expenditure of a PCT from observed age-standardised utilisation and imperfect measures of need and supply for wards in England. How can one move from a descriptive relationship for wards to a prescriptive one for PCTs?
My short answer is that one cannot unless the form of the true relationship is known (and is the same for wards as for PCTs), measures of need and supply are perfect and the average level of expenditure is appropriate .

My long answer starts with a situation ideal for the regression approach of the AREA team (Sutton et al., 2002) and then looks at how the methodology fails with departures from the ideal. To make it more comprehensible I shall illustrate my argument using the determination of the correct body weight for a person.

We are told that our Body Mass Index should be about 21, so I shall take the prescriptive formula, C = A + B1 X1, as the correct specification of C, the logarithm of the correct weight in kilograms, for given X1, the logarithm of the height in metres, where A = log 21 and B1 = 2.

Can we estimate C accurately from an equation fitted to sample data?

The ideal situation.
Suppose that we had a perfect measure, X2, of excess calories consumed per week (adjusted for height), where excess implies more (or if negative less) than would be required to maintain the correct weight. (Assume it is possible to scale X2 so that the value zero is appropriate for people of all heights).
Let Y be the logarithm of the actual weight in kilograms and suppose the true relationship in a population is
$Y = C + B2\ X2 + E = A + B1\ X1 + B2\ X2 + E,$
where the residual, E, is uncorrelated with X1 and X2 and has zero mean and constant variance.

Given an independent random sample from the population the fitted value of Y would be (a + b1 X1 + b2 X2). The fitted regression coefficients a, b1 and b2 would be unbiased estimates of A, B1 and B2, so C* = (a + b1X1) would be an unbiased estimate of C since,

by construction, X2 = 0 corresponds to the correct calorie intake (adjusted for height).

First problem, the wrong average level.
Suppose that the population tends to be overweight or underweight, then an extra term, D, the average excess weight on log scale, needs to be added, giving

Y = A + B1 X1 + D + B2 X2 + E

Now the least squares intercept, a, will be an unbiased estimate of (A + D) and C* will be too high when D is positive and too low when D is negative. This is as if the medical establishment, instead of advising that we aim for a body mass index of 21, recommended we aim for exp(a) which depends on the average weight in the sample rather than on what might be good for our health.

In the context of the Acute and Maternity and Mental Health need indices this problem arises because supply variables are fixed at their mean values rather than at some optimal values.

Second problem, imperfect measure of X1.
If, instead of measuring log height, we measured only the proxy, log shoe size, Z1, and assumed that the regression of log height on log shoe size is given by X1 = F + G Z1 + E1, where E1 is a residual with zero mean and constant variance. Then, assuming for simplicity that D = 0, Y = A + B1 F + B1 G Z1 + B2 X2 + B1 E1 + E.

Now, the fitted equation regression coefficients, a', b1' and b2', say, will be unbiased estimates of (A + B1 F), (B1 G) and B2. So that C* = a' + b1' Z1 will be an unbiased estimate not of C but of (C – B1 E1). In this situation it is not clear whether C** = Y – B2 X2, might not give better estimates than C*. (It depends on whether the variation in E is smaller or greater than the variation in B1 E1.)

Econometricians refer to this as the problem of endogeneity. Gravelle et al. (2003) discusses some ad hoc and unconvincing adjustments in an attempt to get round it.

Third problem, imperfect measure of X2.
Using a proxy for X2 would add an extra residual term, B2 E2, and make the adjustment for X2 inadequate.

Fourth problem, wrong model.
Using the wrong model, for example regressing weight on height (or shoe size) on a linear scale not a log scale, could result in wildly unreasonable estimates, especially for people with extreme values of X1 and X2.

Returning to the allocation of resources to Primary Care Trusts, Y would be the age-standardised utilisation for, say, Mental Health, and, rather than the single proxy, Z1, there would be several proxies for need and similarly there would be several proxies for supply.

One would need great confidence in the models for the Acute and Maternity and the Mental Health Need indices, and in the adequacy of the proxy socio-economic variables to believe that the Additional Need Index justified the large differences in the Target Index for distributing resources to PCTs.

Further Problems with Regression Analyses used to develop the Additional Need Index

1. The units of analysis, electoral wards, used for fitting the regressions were neither the units receiving care (people) nor the units to which the formula was applied for the distribution of resources (PCTs). The ecological fallacy and/or its reverse could arise when units at the wrong level of aggregation are analysed.

2. The response variable for each regression was the estimated age-standardised utilisation or expenditure. But this was estimated for each ward using information on hospital expenditure only. This might have given rise to a bias against PCTs which made relatively greater use of community services (which could be particularly important for the Mental Health Index).

3. Variable selection was carried out initially in three steps: what was available at electoral ward level; what was judged by the AREA team to be relevant; and stepwise least squares regression. On inspection, the fitted regressions were judged unsatisfactory (see 6 below) so extra “Morbidity Indices” (themselves functions of socio-economic and demographic variables) were added. The final

formula is the result of various more-or-less arbitrary decisions, had different decisions been made the allocations would have been different. (As far as I know no sensitivity analyses have been carried out comparing the allocations arising from different decisions.)

4. The multiple regressions for Acute and Maternity utilisation and for Mental Health utilisation, did not have adequate explanatory power (R-squareds of 0.76 and 0.38 respectively) for fitted values to be preferred to observed values.

5. Rather than considering what would be appropriate values at which to fix, for example, the waiting time for hospital treatment, the AREA team arbitrarily put the supply and other conditioning variables at their average values over all electoral wards in England. The effect of this is to make the intercepts (adjusting constants) in the partial regressions smaller and hence to increase the variability of the Target Index across PCTs by making the formula more responsive (maybe too responsive) to changes in the remaining variables.

6. Initially some variables thought to measure need, such as the proportion of ethnic (non-white) minority, had negative (counter-intuitive) regression coefficients. This was interpreted as indicating unmet need, and the morbidity indices were added in the hope that they would pick up this unmet need. Variables with counter-intuitive signs were then interpreted as (constraint on) supply variables, rather than as need variables, and fixed at their average values. Thus, for example, the proportion (non-white) ethnic minority does not enter explicitly into the Acute and Maternity Index and the Mental Health Index given in the Appendix, but it does affect the weights given to the other variables and the adjusting constants. Again this treatment (of variables with counter-intuitively signed regression coefficients) is an arbitrary response to an unexpected analytical outcome, whether it makes the formula more fair or less fair than some alternative arbitrary response I do not know.

7. Not all wards were included in the regression analyses due to missing data, and, in the case of the Mental Health Index, to the inclusion of a variable, “provider effects”, which was not defined unless the ward had “some inpatient mental health service activity” (Sutton et al. 2002 page 110). Thus 432 wards (just over 1 in 20)

were excluded because they were atypical in their use (or non-use) of mental hospitals. Wow!

Consequences

The target formula developed by the Department of Health, redistributed resources to the north and to inner cities which is not surprising since the choice of need proxies was motivated by the desire to take account of unmet need and to decrease the huge differentials in health outcome. Readers of Radical Statistics will be in favour of reducing differentials in health outcome, but might prefer this to be done efficiently by explicit funding of public health programmes rather than by the uncertain route of arbitrary unequal funding of Primary Care Trusts.

References

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Appendix: The formula 2006/08

This outline of the formula for the Target Index 2006/08 with more detail on some selected components may be useful to readers not only of my article but also of Asthana and Gibson (2008). In particular it lists the socio-economic proxies for need which are used in Asthana and Gibson's Figure 1. It is adapted from Stone (2008) using additional information from Department of Health (2005).

Repeated indexation (standardisation or normalisation) is used so that each component term is converted to an index, represented by *I{.}*, for example,

I{Proportion of over-75s living alone} = (Proportion of over-75s living alone) in the given PCT divided by the weighted average over all PCTs of *(Proportion of over-75s living alone)*, where the weights are the estimated PCT population sizes. This indexation is applied equally to individual variables and to sums and products of variables. Each index, including the Target Index has weighted average or mean equal to one.
The Target Index for 2006/7 is given by the formula
Target Index
= *0.691* x *Hospital and Community Health Services (HCHS) Index*
+ *0.118* x *Prescribing Index*
+ *0.079* x *Primary medical services Index*
+ *0.005* x *HIV/AIDS Index*
+ *0.082* x *Growth Area Adjustment Index*
+ *0.025* x *English Language Difficulties Adjustment Index.*

The Hospital and Community Health Services (HCHS) Index is
HCHS Index = I{Age Profile Index x *Additional Needs Index* x *Market Forces Factor (MFF) Index* x *Emergency Ambulance Cost Adjustment (EACA) Index}.*

The Age Profile Index is a weighted sum of the costs of treatment converted to an index. The amounts in £s are the estimated average costs for England per person in each age group. The weights are

the (estimated) population sizes for the given PCT in each age group.

Age Profile Index
= I{£542 x *number of under-5s*
+ £269 x *number of 5-14s*
+ £526 x *number of 15-44s*
+ £655 x *number of 45-64s*
+ £1245 x *number of 65-74s*
+ £1976 x *number of 75-84s*
+ £2799 x *number of over-85s}.*

The Additional Need Index has two components: the Acute and Maternity Need Index and the Mental Health Need Index. These were obtained by a complicated multiple regression procedure, ending with the conversion of fitted partial regression equations to indices.

Additional Need Index = I{(0.8535 x *Acute and Maternity Need Index + 0.1465* x *Mental Health Need Index)},*
where
Acute and Maternity Index
= I{0.008 x *Education Deprivation Index*
+ 0.013 x *I{Proportion of low birth-weight babies}*
+ 0.070 x *I{Standardised mortality ratio for under-75s}*
+ 0.026 x *I{Proportion of over-75s living alone}*
+ 0.108 x *I{standardised birth ratio}*
+ 0.103 x *Income deprivation index*
+ 0.225 x *1st Morbidity proxy index*
+ 0.548 x *2nd Morbidity proxy index*
+ 0.375 x *3rd Morbidity proxy index*
+ Adjusting constant},
and
Mental Health Index
= I{0.358 x *I{Comparative mortality factor for under-65s}*
+ 0.338 x *I{Proportion of over-60s claiming income support}*
+ 0.034 x *Housing deprivation index*
+ 0.636 x *4th Morbidity proxy index*
+ Adjusting constant}.

The adjusting constants are the intercepts for the partial regressions when the conditioning variables (in the full multiple regressions) are replaced by chosen fixed values. The conditioning

variables are the "supply" variables; counter-intuitively signed "need" variables; Health Authority effects (for Acute and Maternity Index); "provider" effects (for Mental Health Index). Details are given in Sutton et al. (2002). The chosen fixed values are the population-weighted means. The size of the adjusting constant is crucial. If it is large then the index will be approximately constant across PCTs, if it is small (and even more so if it is negative) then the index will vary widely across PCTs.

The four Morbidity proxy indices are derived from logistic regressions of individuals' self-reported morbidity on selected demographic and socio-economic variables measured at electoral ward level. Details are given in Sutton et al. (2002).

The1st Morbidity proxy index (for nervous system disease) is a function of age and sex profiles, the percentage of university "participants", and the percentage of attendance allowance claimants over 60.

The 2nd Morbidity proxy index (for circulatory disease) is a function of age and sex profiles, the percentage of university "participants", the percentage of ethnic (non-white) minorities, and the percentage of invalidity or severe disability allowance claimants.

The 3rd Morbidity proxy index (for musculo-skeletal disease) is a function of age and sex profiles, the percentage of ethnic (non-white) minorities and the percentage of under-65s with limiting long-term illness, and the health deprivation index.

The 4th Morbidity proxy index (for psycho-social disease) is a function of age and sex profiles, the percentage of ethnic (non-white) minorities and the percentage of under-75s with limiting long-term illness, and the income deprivation index.

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