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WHAT HAS THIRTY YEARS OF FORMULA FUNDING IN THE ENGLISH NHS ACHIEVED?

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Abstract

A formula has been used to guide the distribution of available funds between health care organisations in the NHS in England since 1977. This formula has constantly evolved, becoming more ambitious in breadth and depth. The objective was initially 'that there would eventually be equal opportunity of access to health care for people at equal risk'. Since 1998 the objective has been 'to contribute to the reduction of avoidable inequalities in health'. These are grand objectives, and it is therefore surprising that there has been little analysis of the consequences of its adoption. Using published formula weights and funding allocations and repeated annual cross-sections of the *General Household Survey* over the period 1972-2006, we seek to identify the consequences of the use of formula funding in the English NHS on regional and income-related variations in funding and hospital use. We find that regional funding shares have remained remarkably stable over the last thirty years because of changes to the allocation formula. Between 1977 and 1994 changes to the formula led to its alignment with the pre-existing allocation shares and from 1996 onwards changes to the formula have offset declining population shares in poorer areas. While funding per capita has increased most in poorer areas since 1996, the distributions of daycases has become less pro-rich, of outpatient visits has remained pro-rich and of inpatient stays has become pro-rich. There is only limited evidence that differences in funding affect mean levels and distributions of individual health service use. Our findings suggest that the primary consequence of formula funding has been stability in the relative levels of allocation between areas over time rather than demonstrable reductions in inequity in service use between regions and income groups. Consequently, we propose that funding should be more clearly linked to the contributions of health care organisations to the achievement of the equity objective.

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Introduction

Financial resources have been allocated to NHS organisations in England with reference to a funding formula since the introduction of the Resource Allocation Working Party (RAWP) formula in 1977. The design and calculation of this formula has been the subject of much research, intensive debate and political interest.

The initial fundamental objective of the formula was "[t]o secure, through resource allocation, that there would eventually be equal opportunity of access to health care for people at equal risk" (Department of Health and Social Security (DHSS), 1976, p.7). In 1998 this was revised to be "to contribute to the reduction in avoidable health inequalities".

The failure to define and measure performance against these objectives has led to continuing questions about what the use of this funding formula has achieved. One frequent response was first formulated in the RAWP report:

> "Resource allocation is concerned with the distribution of financial resources which are used for the provision of real resources. In this sense it is concerned with the means rather than the end. We have not regarded our remit as being concerned with how the resources are deployed." (DHSS, 1976, p.8).

Such appeals to the existence value of the formula seem rather weak and a later passage in the same report admits its limitations:

> "If what we propose is accepted, some localities will gain, some will be constrained, while others will suffer a reduction in resource currently available. The inevitable consequences of introducing a fairer method of distribution of resources are likely to gain widespread public support only if they are seen to influence the actual provision of services in the way intended." (DHSS, 1976, p.85).

Surprisingly there has been little research on the consequences of funding formulae. Most attention has been devoted to the design issues and to the financial position of health care organisations. A government review of the English formula in 1986 claimed that: "the increase in activity throughout the country has been greatest in RAWP-gaining Regions, from a lower starting point" (DHSS, 1986, p.5) but provided no evidence to support this claim. Coid and Ogston (2001) provided some evidence that differential reductions in premature mortality over a nineteen-year period across Scottish Health Boards were associated with the changes in per capita funding brought about by adoption of a funding formula in Scotland. However, their analysis did not appear to recognise that premature mortality was the variable used to reflect differences in need in the formula at that time.

Commentators frequently point to the widening area and socio-economic inequalities in health over the time that the formula has operated as evidence of its lack of real effect. The introduction of a fairer funding formula alongside widening inequalities in health may indicate a number of possible explanations:

(i) The formula has not, or only partially, been implemented
(ii) Resources were disproportionately in poor areas prior to the formula's introduction
(iii) Areas gaining more resources under the formula have not produced more NHS output
(iv) NHS output does not influence population health
(v) The beneficial effects of the redistribution of NHS output on population health have been dominated by widening inequalities in other determinants of health.

In this paper we seek evidence on (i)-(iii). Recent evidence suggests that health care supply does influence health (Martin et al, 2008; Gravelle et al, 2008). Therefore, if we find evidence that rejects (i)-(iii), it might suggest that the introduction of a funding formula may have made a marginal contribution to narrowing health inequalities.

Through the use of various administrative and survey datasets we seek to identify the consequences of the use of a formula in the English NHS since 1977 on regional and income-related variations in funding and hospital utilisation. We begin by examining changes in the formula targets for, and financial allocations to, regions and then present the concentration of these with respect to area income. We then use a long series of repeated cross-sections from representative surveys of the population resident in private households to track changes in income-related inequality and inequity in the distribution of health care utilisation. Finally, we seek to identify the effect of changes in regional funding on individual use of health care and the effect of changes in the within-region distribution of finance on the within-region distribution of health care utilisation. Prior to presenting our empirical work we provide a short description of formula funding in the English NHS.

The English funding formula

Between 1971 and 1976, resources were distributed to regions on the basis of the Crossman Formula which was based on regional shares of population, capacity and output. This formula was replaced in 1977 on the recommendations of RAWP. RAWP's report described seven criteria of need that should be quantified to derive formula-based shares for each region: the size of the population; population make-up (meaning age-sex composition); morbidity; cost; health care across administrative boundaries; medical and dental education; and capital investment.

The RAWP review described a structure for the English funding formula that has remained largely unchanged. Target shares for each organisation are based on population shares which, when adjusted for expected utilisation rates (based on demographic composition and additional need factors) generate an expected volume of services. The expected cost is obtained by adjusting for justifiable area variations in the costs of securing the inputs required to produce this volume of services. At its simplest, the typical formulation is:

Target share = Population share * (Age Index) * (Additional Needs Index) * (Additional Cost Index)

in which each of the three index adjustments takes a mean value of one.

Since RAWP's report, the formula has evolved. The main changes to the formula over the last thirty years are summarised in Table 1. In this section we describe some of these developments.

<u>Age index</u>

RAWP recommended an adjustment for population composition based on mean service use in eighteen age-sex groups. DHSS (1988) recommended the introduction of an 85+ age band (previously the top group had been 75+) and abolition of the stratification by sex. In 1995/6 a more sensitive age-cost curve was introduced that gave less weight to the youngest and the three oldest age groups (NHS Executive, 1994). The Age index is now updated regularly.

<u>Additional Needs index</u>

RAWP recommended condition-specific Standardised Mortality Ratios (SMRs) for the morbidity adjustment, except for: conditions unlikely to lead to death e.g. skin diseases; maternity, where fertility rates were used; and inpatient psychiatrics, where marital status was used. In 1989, the additional needs weighting was amended. All expenditure was weighted by the square root of the SMR under 75 years.

The additional needs indices were changed following the 'York review'. Carr-Hill et al (1994) estimated two multivariate needs indices, for acute and psychiatric services. The York needs indices replaced the square root of the SMR but controversially no weight was applied to a large proportion of HCHS spend. In 1997/8 a range of weightings were introduced for community health services, which reduced the proportion of expenditure not weighted from 25.3% to 13.9%. In 1998/9 the data were corrected for community health services and weightings were introduced for people with learning disabilities and for administration and other hospital services. This brought the proportion of HCHS weighted for additional need back up to 100%.

In 1999/2000 additional needs indices were introduced for prescribing as this element of expenditure became part of the unified formula. All of these additional needs indices were replaced in 2003/4 following the 'AREA Review' (Sutton et al, 2002).

<u>Additional Cost index</u>

RAWP recommended a London Weighting and a 'subjective judgement' on the rate at which the Thames Regional Health Authority (RHA) allocations should be adjusted to their target allocations. A report soon after (DHSS, 1980) recommended that revenue targets for the Thames regions should take account of labour market cost differences based on the earnings of occupational groups outside the NHS comparable with staff employed in the NHS. This adjustment led to an increase of 1.5% for the Thames regions and became known as the 'Market Forces Factor'.

The review in 1988 (DHSS, 1988) noted that in 1976-78 average earnings for NHS comparators were 17% higher in London than the rest of the country, but by 1986 this difference had increased to 27% and the earnings differential had increased in the Oxford region as well. Subsequently, supplements of 3% for the North Thames regions and 1% for the South Thames regions were introduced.

In 1995/6 a four zone staff MFF replaced the three existing adjustments (the London Weighting, the Thames MFF and the Thames 3% and 1% supplements). New MFF were also introduced for land and for buildings. The Staff MFF has subsequently continued but been amended regularly. Amendments have included changes to the number of pay zones, whether a minimum 'floor' is applied, the range of staff group expenditure to which the MFF is applied, and the extent to which values are smoothed across proximate areas. The only other identified cost adjustment in the English formula is the Emergency Ambulance Cost Adjustment, which was introduced in 1998.

<u>Special allocations and adjustments</u>

Alongside the main formula there have been a multitude of special allocations and adjustments. A rough sleepers supplement was introduced in 1996/7 and dropped ten years later. An English Language Difficulties Adjustment supplement was introduced in 1999/2000. A Health Inequalities Adjustment was introduced on a non-recurrent basis in 2001/02, widened in 2002/3 and then dropped in 2003/4.

<u>Breadth</u>

An increasing proportion of the NHS budget has come under the aegis of the formula over time. The formula originally applied only to HCHS expenditure. Prescribing and some elements of General Medical Services expenditure became part of the formula from 1999/2000 onwards. All Primary Medical Services expenditure became part of the formula from 2006/7.

Depth

Initially allocations were made to 14 Regional Health Authorities who controlled how that budget was distributed to their District Health Authorities. These RHAs were abolished from 1996/7 and allocations were made directly to 100 Health Authorities. The boundaries of these organisations changed (slightly) through the late 1990s so that, by 1999 there were 99 HAs, and by 2002 there were 95 HAs. In 2003/4 allocations were made directly to 303 Primary Care Trusts (PCTs). This was reduced to 152 PCTs on 1 October 2006.

Implementation

Implementation of the formula has always been through the same process. The formula generates target allocation shares and each organisation's distance from target is calculated based on their actual shares. All organisations receive a minimum level of funding uplift and the residual funds are distributed on the basis of the distances from target. Decisions over the rate of progress towards targets have always been at the judgement of Ministers.

Data

Formula weights and financial data

Figures for the period 1977/8 to 1994/5 are taken from the library of resource allocation reports provided on the Department of Health website[1] and a small number of academic papers. Where no substitute is available, statistics are read off published charts and will be less accurate. We indicate where we have estimated variables from published charts.

Figures for 1996/7 to 2007/8 are taken from the annual exposition books published by the Department of Health. For consistency over time, the figures on populations, formula indices and weighted populations are for HCHS only. With no alternative available, the allocations cover all monies that are distributed to organisations – over time they increase in breadth (see Table 1).

The 'allocations' are in some sense intended distributions, announced mostly six months in advance of the start of the financial year. Subsequent adjustments are made and there are 'in-year allocations'. An alternative measure of the resources distributed to organisations is the 'baselines' that are used in the subsequent year to calculate each organisation's distance from the formula target. As a test of robustness, we constructed an alternative series on resources based on available baseline figures. With this series we also use alternative population figures for 2003-2005 based on the 2001 population Census, which were not known at the time of the allocations but may have influenced subsequent adjustments during this period.

Over the twelve most recent exposition books, figures have been produced for five different geographical configurations. We were provided with files that allowed us to map (sometimes imperfectly) between these geographies. For our analysis we chose the 2002 configuration of

[1] http://www.dh.gov.uk/en/Managingyourorganisation/Financeandplanning/Allocations/index.htm

Health Authorities (of which there are 95) as this involved summing statistics on smaller areas throughout and allowed us to produce statistics for the Government Office Regions that are available in the General Household Survey.

Our measure of income for the area analysis is the income domain of the Index of Multiple Deprivation. This is the percentage of the population receiving state benefits on the grounds of low income. We use the value reported in the 2003/4 exposition book, which was from the Index of Deprivation 2000, throughout the period. To be consistent with the individual-level analysis we use the percentage of the population not claiming low-income benefits.

General Household Survey

For the individual level analysis the main data source was the *General Household Survey (GHS) Time Series Dataset 1972–2004* (ONS, 2007). The dataset combines annual data series from the GHS and contains information on demographics, households, education, employment, health and health service use. For our analysis we also require data on income and region of residence, which are not included in the *GHS Time Series Dataset*. We obtained these extra variables from the individual years of the annual GHS series and merged them with the *Time Series Dataset* using household and person identifiers. The *GHS Time Series Dataset* assembles data from 1972 (the first year of the GHS) up to 2004. Two further years of GHS data are available (2005, 2006) and we appended these to the augmented dataset. We dropped data for Wales and Scotland from the dataset. The assembled dataset is a series of repeated annual cross-sections of the GHS for 1972–2006 containing the following variables:

- Health service use (outpatient in the last 3 months, hospital inpatient in the last 12 months, day patient in the last 12 months, all measured as binary variables [1=yes, 0 otherwise]).
- Age and gender (a cubic function of individual age, and interactions between the age terms and gender).
- Equivalised household income (measured as £ per annum in 2008 prices, adjusted using the Retail Price Index).
- General health (measured as health on the whole in the last 12 months [good, fairly good, not good]).
- Limiting longstanding illness (LLI) or restricted activity (measured in 6 indicators as LLI + restricted activity, restricted activity + non-LLI, LLI only, non-LLI only, restricted activity only, no reported illness).
- Regional indicators (9 indicators).
- Year (33 indicators).

We do not have a comprehensive, uniform data series for the following reasons:

- There was no GHS in 1997 and 1999.
- Data for 1982–1987 and 2005–2006 pertain to calendar years; for 1988–2004 they pertain to financial years.
- Income data are not reported in the GHS for 1983 (they were found to contain errors). In addition, from 1972–1982 the income data are not equivalised. Hence in these years we applied the equivalisation used by Aronson et al (1994)
- Inpatient data were available from 1982 onwards only and day patient data were available from 1992 onwards only.
- General health is available from 1977 onwards only; LLI is not available for 1972; and, both LLI and restricted activity are not available for 1977–1978.

- For 1996–2006 the regional indicators are GORs. For 1972–1995 administrative regions are reported which are similar to, but not the same as, GORs. Notably, there is a “North” category instead of “North East” and there is an “East Anglia” category instead of “East of England”. These changes are also likely to have affected the geographical boundaries of the other regions whose names did not change. For consistency in our data series we relabel the “North” category for 1972–1995 as “North East” and “East Anglia” as “East of England”. This does not affect the within-year analysis but it means that some care is required in interpreting regional variations between years.
- There are difference in the variables reported for children and adults in the GHS; we therefore focus on adults aged 16 years and over only.

Methods

We undertake a range of analyses grouped under four themes.

Regional variations in the formula weights and funding allocations

We begin by examining how the formula weights and funding levels have changed over time at regional level. There is a substantial change in regional organisations in 1995/6. Until 1994/5, figures were published for 14 Regional Health Authorities. From 1996/7 onwards we have derived figures for 9 Government Office Regions to be consistent with the GHS. We calculate the changes in the following statistics between the beginning and end of the two periods (1977/78-1994/5 and 1996/7-2007/8): population shares; composite formula indices; allocation shares; and allocations per head. As a summary statistic of the extent of redistribution we calculate half the value of the sum of the absolute changes in the shares. This represents the proportion of the national total that is redistributed from those who lose to those who gain.

Income-related variations in formula weights and allocations

We also examine the income-related distribution of the formula weights and funding. Here we use the concentration index for grouped data presented by Kakwani et al (1997). We examine the income-related distributions of the age index, need index, MFF index, the composite formula index and resources per head. For these analyses we measure differences from the cumulative share of the national population. We also examine the income-related distributions of population, weighted population and resource levels. In these cases each area contributes equally to the cumulative share calculations.

Variations in the use of services

To identify the determinants of service use we estimated a series of probit models:

$$u_i = \beta_0 + \beta_1 a_i + \beta_2 h_i + \beta_3 y_i + \beta_4 r_i + \beta_5 t_i + e_i \qquad [1]$$

where *u* is health service use, *a* is age and gender, *h* is health, *y* is income, *r* is region, *t* is year, *e* is an error term, the *β*’s are coefficients and *i* indexes individuals. We then calculated the conditional probability of each type of health service use in every region by running annual probit models of the health service use variables against the other covariates (i.e., running [1] for each year but dropping the year indicators *t*) and using the coefficients to compute the predicted probability of use for each region after fixing the other covariates at their sample mean values.

We measured health service use inequality at both the national and regional levels each year by calculating the concentration index (CI) for each type of health service use against income rank using the 'convenient regression' method (O'Donnell et al., 2008). Because the CI may be a misleading measure of the extent to which inequalities in health service use are directly attributable to income if there are other factors that affect use and are correlated with income we also calculated the partial concentration index (Gravelle, 2003) for health service use with respect to income by year both nationally and by region. We use the following formula, given by Gravelle and Sutton (2003):

$$\text{PCI} = \frac{\beta_y \mu_y}{\mu_u} \text{CI}_y^y \qquad [2]$$

where β_y is the coefficient on income from a linear probability model, μ_y is mean income, μ_u is mean health service use, and CI_y^y is the Gini coefficient for income. The sign of the PCI is given by the sign on the income coefficient β_y; positive (negative) values indicate that use is disproportionately concentrated in the rich (poor).

Effect of the formula on levels of, and income-related variation, in the use of services

To investigate the impact of allocations at the regional level on health service use we merged the individual level dataset with the GOR dataset and reran [1] adding additional covariates measuring the resources allocated to each region in each year. We used a number of resource measures: the age-related needs index; the additional needs index; the MFF index; the combined index; actual allocations per head; actual allocations per weighted head (with weights given by the combined index); baseline allocations per head; and baseline allocations per weighted head. The GOR dataset contains data for 1996–2007 (baseline allocations are available for 1997–2005 only) and therefore we ran the individuals models on a reduced sample with fewer years of data.

To investigate the impact of changes in the income-related distribution of allocations within regions we created a panel dataset of CIs for our three measures of health service use and CIs for two resource measures for each of the GORs. The CIs for service use are obtained from individual-level data. The CIs for the resource measures are for the composite formula index and the allocation per head and are obtained from HA-level data. We investigate whether the CIs for the resource measures significantly affect the CIs for service use using four panel data model specifications: random effects; between effects; fixed effects; and fixed effects with year dummies.

We used sample weights reported in the *GHS Time Series Dataset* throughout, and in all the regression models at individual level we adjusted for household level clustering.

Results

Regional variations in the formula weights and funding allocations

The RAWP formula was introduced in 1977. In 1980, the government reported that as a result of the RAWP process the regional average distance from target has fallen from 8.3 percent in 1977-78 to 6.3 percent in 1979-80 (DHSS, 1980). In 1986 the government noted that "by the end of the decade the main thrust of this policy will have been largely achieved at Regional level. There is now a gap of 11 percentage points between the Region furthest above target

(7%) and furthest below target (4%) as compared with a gap of 26 percentage points in 1977-78." (DHSS, 1986, p.5)

By 1988 it was claimed that parity had just about been achieved: "[s]ince the introduction of the formula, disparities between the better provided and less well provided parts of the country have been substantially reduced. Figure 1.1[2] shows each Region's progress towards its target over the period from 1979-80 to 1988-89. Considerable progress has been made in redressing the historic pattern of resource distribution, under which the Midlands and the North had previously received less than their fair share of the available resources." (DHSS, 1988, para 1.2)

The figures we produce in Table 2 show that this may have been true for the Northern and West Midlands RHAs but was not the case for the North West and Yorkshire RHAs. These latter two RHAs, together with the South West, experienced substantial reductions in their formula weightings over time. Rather than actual shares rising to meet the target shares, the target shares were reduced towards the pre-formula actual shares. The correlation between the allocation to target ratios and the changes in the formula index equals 0.734 (p=0.002) and so there is strong evidence that the formula changed to align with the pre-existing allocation shares. The gaps between the allocation shares and the target shares in 1979/80 required a redistribution of 3.28% of total resources from those above target to those below target. But much of this was avoided by the changes in the formula shares. The changes in the composite formula index represented a redistribution of 1.97% of total resources between RHAs.

We do not have statistics on how regional targets and allocations were changed by the reconfiguration of regions and the changes to the formula between 1994/5 and 1996/7. However, the available information suggests that there was little redistribution over this period. Judge and Mays (1994) reported that the gap in 1994/5 between allocations and capitation shares ranged from -0.57% in Wessex to +1.45% in North West Thames. Peacock and Smith (1995) reported that the 1995/6 allocations to Regions were a simple 3.55% cash increase for all Regions. Statistics in the 1995/6 exposition book allow us to calculate the proportion of resources misallocated relative to the formula for the then new 8 Regional Health Authorities. Since this is just 0.58% of the total budget, we can conclude that initially the new formula matched the existing resource shares closely at regional level.

Table 3 shows the changes that occurred at regional level between 1996/7 and 2007/8. As in Table 2, the redistributions are considerable: the changes in population shares constitute a redistribution of 1.51%; and the changes in the composite index represent a redistribution of 2.16%. However, the principal result from these comparisons is the strong negative correlation between the changes in population shares and the changes in the formula index (r=-0.930; p<0.001). This negative correlation has a profound effect on the changes in the resource shares. The correlation between the differences in allocation shares and the differences in population shares is r=+0.255 (p=0.509), even though population is perceived as the main driver of the formula.

The correlation between the difference in population share and the growth in allocation per head (Table 4) is r=-0.841 (p=0.004). Therefore, changes to the formula have protected those GORs with reducing population shares from reductions in their allocation shares. The GORs

[2] Which we reproduce as Figure 1.

with the fastest growing allocations per head are those with the slowest growing (or declining) numbers of heads.

Income-related variations in formula weights and allocations

Figure 2 charts how the HA level distributions of the three component indices of the HCHS formula with respect to area income have changed between 1996, 2002 and 2007. The age index narrows between 1996 and 2002 and then widens to 2007. The needs index shows the widest range of all three indices in all three years and becomes steadily steeper over time. The 1996 and 2002 distributions of the MFF index show clear evidence of the 'floor' that was imposed by the 'rest of England' zone. In the highest income areas there is a positive gradient in the MFF index that becomes more pronounced towards the end of the period.

These changing distributions of the indices across area income are summarised in the concentration indices shown in Figure 3. The age and MFF indices have a pro-rich distribution. Both indices become slightly more pro-rich after 2002. The needs index is considerably more pro-poor. The extent of this increases between 1996 and 1998 and then increases again in 2003. Because the magnitude of both the level of, and the changes in, the pro-poor distribution of the needs index is substantially larger than the pro-rich distributions of the age and MFF indices, the needs index dominates the composite index. The composite index becomes less pro-poor in 2006 when both the age and MFF indices become more pro-rich.

Because richer HAs are generally more populous, the concentration index for population is pro-rich and becomes steadily more so over the period (Figure 4). The distribution of resources per head is pro-poor and becomes more so over the period. Reflecting these conflicting trends, the distribution of resource levels changes relatively little over time.[3] The trends mirror the findings of the regional changes shown in Tables 3 and 4; the pro-poor changes in the formula indices offset the pro-rich changes in population shares and led to little change in the distribution of resource levels with respect to income.

Variations in the use of services

As expected, demographic and health variables exert strong influences on all three types of service use (Table 5). Income has a significant positive effect on the probability of outpatient and daypatient use and no effect on inpatient use. All regions have significantly lower outpatient use probabilities than London, the reference category. The North West and the South East have significantly higher probabilities of inpatient use than London, and Yorks and Humber and the two Midlands regions have significantly lower probabilities of daypatient use than London.

The annual estimates of income-related CIs and PCIs (Figures 5 and 6, respectively) show considerable variability so the general trends are summarised using lowess. The unconditional concentrations of all three types of health service use are generally pro-poor throughout the period and become more pro-poor over time (Figure 5). For inpatient stays, this is primarily because of the increasingly pro-poor concentration of ill-health as the PCI shows a general rise since the mid-1980s (Figure 6). Conditional on indicators of need, daypatient use has become less pro-rich, outpatient use has remained pro-rich and inpatient use has become pro-rich since 1996.

[3] The same is true of the alternative series, baselines per head.

Effect of the formula on levels of, and income-related variation, in the use of services

In Table 4 we present three-year average probabilities of an inpatient stay conditional on respondent age, gender, health and income for each GOR.[4] The conditional probability of an inpatient stay has decreased in all regions. The correlations between the changes in the formula index over the same period (Table 3) and the ratios of conditional inpatient probabilities is positive but not significant (*r*=0.570; p=0.109).[5]

When we do not include regional dummies in our extended versions of model [1], there is some evidence that the formula weights and the funding allocations significantly influence the individual levels of service use (Table 6). The coefficients on most of the formula and resource variables are positive and significant ($p<0.05$) in the daypatient use models, the combined formula index is significant ($p<0.05$) in the outpatient model and the age and additional need indices are significant ($p<0.01$) in the inpatient model. However, none of these variables is significant ($p>0.05$) when we include regional dummies. This indicates that individual service use was higher (conditional on individual characteristics) in regions with higher formula weightings, but was not increased (decreased) when regional formula weightings were increased (decreased).

The within-region distributions of finance are generally positively correlated with the within-region distributions of individual service use (Table 7), but rarely reach conventional levels ($p<0.05$) of statistical significance. With these data, the between-effects regressions show that time-invariant differences between regions in the extent to which their within-region distribution of funding is pro-poor are not significantly correlated with the extent to which their within-region distribution of utilisation is pro-poor. The CI for allocations per head exerts a significant effect on the CI for daypatient use only when we do not include year dummies and is therefore likely to reflect only the general trend towards pro-poor distribution of finance and less pro-rich distribution of daypatient use. The CI for the formula index exerts a significant effect on inpatient use only when we do include year dummies because this effect conditions on the general trend towards pro-rich inpatient use.

Discussion

Our findings suggest that the principal consequence of the formula has been the maintenance of stability in the relative levels of allocation to areas over time. During the first half of the funding formula period this involved reconciliation of the formula targets with the pre-existing funding allocations. During the second half of the funding formula period this involved offsetting declines in population shares with changes to the formula adjustments.

One explanation for our finding that allocations per head have increased disproportionately in areas that have experienced a relative decline in population is that population decline has led to higher average levels of need because those who migrate out of high need areas have lower than average needs. In this case the increased funding formula is commensurate with the increasing level of need among the reduced population and extra funds might not therefore be expected to affect service use conditional on individual need. If, on the other hand, increased

[4] We have also examined these figures for outpatients and day patients. The ratios of the conditional probabilities are positively correlated across types of service use, but only that between inpatients and day patients reaches significance at the 10% level (r=0.584; p=0.099).

[5] Those with outpatients and daypatients are r=0.336 (p=0.377) and r=0.193 (p=0.619) respectively.

funding has more than compensated for the level of need, then this increase in demand-equivalised supply in high need areas should have led to increases in use in these areas.

Our analysis of changes in the distribution of health service use do not indicate a clear link between formula funding and the use of health services. Over the period in which funding became more concentrated in poor areas, we do find evidence of reductions in the pro-rich distribution of daypatient services but the pro-rich distribution of outpatient services remained and the distribution of inpatient services became pro-rich from being pro-poor. Evidence to support a positive relationship between formula funding and levels of service use at regional level only emerges in cross-sectional analysis and does not emerge when we analyse changes over time. Similarly, evidence that changes to the within-region distribution of funding lead to changes in the within-region distribution of utilisation is very patchy.

Inevitably, there are a number of limitations in our analysis. The source of our data on service use, the GHS, relates to residents in private households only and contains information only on hospital use. The only geographical identifiers in the GHS are Government Office Regions and analysis at this level reduces our ability to identify an effect of the formula on patterns of health service use. In common with most analyses relating to the resource allocation formula, we have not been able to consider variations in the quality of care across areas. Finally, we have used a fixed ranking of areas by mean income in 2000.

We think it is most likely that the stability of allocations results from a tendency to prefer (individually or in combination) options that maintain stability in the relative levels of allocations to areas by those responsible for reviewing the formula. The political economy context of the NHS funding formula has been noted before. Smith (2003) highlighted examples of "the considerable leeway available to governments" even within the apparent constraints of formula funding. However, where there is such a preference for the status quo, it is unlikely that formula funding will prove a useful lever for achieving equal use for equal need and a reduction of health inequalities.

Of primary concern, however, is the weak link between funding and service delivery. Commissioning organisations are not rewarded, monitored or regulated on how they distribute the resources they receive to different population groups. Future implementation of the funding formula should link allocations to organisations more clearly to the achievement of equity objectives by linking funding changes to output changes. This does not require a full return to mechanisms such as the Crossman Formula, which was criticised for reinforcing historical inequities in the use of health care. Sutton and Lock (2000), for example, proposed that regional differences in the progressivity of health service use should be taken into account both in the derivation of the national funding formula and in the mechanism used to determine the funding of each region.

As we have shown, it is not necessarily the case that funding organisations on the basis of the expected costs of delivering a common level of service leads to greater equity in service delivery. Funding commissioning organisations to maximise achievement of an equity goal may involve consideration of not only what these organisations are expected to do, but also what recent experience indicates these organisations will do or what these organisations will agree to do, with additional funding.

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Table 1 Principal changes to the NHS formula, 1977-2007

Year	Age Index	Additional Needs Index	MFF Index	Other adjustments	Scope	Areas
1977	Nine age bands	Condition-specific SMRs	London Weighting	Cross-boundary flows, education, capital investment	HCHS	14 Regional Health Authorities
1980			For non-clinical staff			
1990	Additional 85+ age band	Square root of all-cause SMR < 75 years		No need for cross-boundary flows		
1995-6	New age-cost curve	Multivariate needs indices for acute and psychiatric	Four zone staff MFF plus new MFFs for land and buildings	Rough sleepers (1996)		100 Health Authorities
1997		New needs indices for community health services (CHS)	Staff MFF refined to 60 zones			
1998		Data corrected for CHS, need weighting applied to all HCHS expenditure	Staff MFF refined to 50 zones	Emergency Ambulance Cost Adjustment		
1999-2000	Specialty cost weights updated		London Weighting applied to doctors and dentists	English Language Difficulties Adjustment, Targeted funding for HAZs Special allocations for drugs misuse and for HIV prevention	HCHS (82%), Prescribing (15%), GMSCL (3%)	99 Health Authorities
2001				Health inequalities adjustment Cost of living supplement Performance fund	HCHS, Prescribing, Family Health Services	
2002				Earmarked NHS plan funding Primary care performance fund	HIV/AIDS included in unified formula	95 Health Authorities
2003-2005	Updated	All needs indices revised	Staff MFF smoothed over 117 zones. Includes doctors & dentists			303 Primary Care Trusts
2006-2007	Updated		Staff MFF increased from 119 to 303 zones.	Rough sleepers adjustment dropped Growth Area adjustment introduced Choosing Health White Paper	HCHS, Prescribing, Primary Medical Services, HIV/AIDS	152 new Primary Care Trusts from October 2006

Table 2: Changes in formula composite index at RHA level between 1977 and 1994

RHA	Population share 1977	Ratio Allocation:Target 1979/80*	Index 1977	Index 1994†	Change in Index
NE Thames	8.00%	1.115	0.972	1.075	+0.102
NW Thames	7.48%	1.130	0.944	0.988	+0.045
SE Thames	7.76%	1.100	1.018	1.059	+0.041
Northern	6.73%	0.925	1.034	1.047	+0.013
SW Thames	6.20%	1.060	1.005	1.008	+0.002
West Midlands	11.15%	0.940	0.967	0.965	-0.002
Trent	9.78%	0.930	0.993	0.980	-0.013
Wessex	5.69%	0.975	0.967	0.941	-0.026
Mersey	5.38%	0.990	1.044	1.004	-0.040
East Anglian	3.83%	0.950	0.955	0.914	-0.042
Oxford	4.73%	1.005	0.884	0.831	-0.053
Yorkshire	7.70%	0.975	1.046	0.992	-0.053
South Western	6.78%	0.960	1.030	0.973	-0.057
North Western	8.78%	0.910	1.090	1.016	-0.074
England	100.00%	1.000	1.000	1.000	0.000

RHAs are ranked in descending order of the change in the formula composite index. * Source: read off chart in DHSS (1988). † Source: read off chart in Judge and Mays (1994).

Table 3: Population shares, formula composite indices and allocation shares at GOR level, 1996 and 2007

	Population share			Composite Formula Index			Allocation share		
GOR	1996	2007	Difference	1996	2007	Difference	1996	2007	Difference
North East	5.32%	4.98%	-0.34%	1.055	1.125	0.070	5.64%	5.57%	-0.07%
North West	14.18%	13.57%	-0.61%	1.029	1.095	0.067	14.69%	14.70%	0.01%
West Midlands	10.84%	10.60%	-0.24%	0.963	1.016	0.054	10.55%	10.55%	0.00%
East Midlands	8.40%	8.36%	-0.03%	0.939	0.960	0.021	7.83%	7.89%	0.05%
Yorks/Humber	10.29%	10.01%	-0.28%	0.998	1.013	0.015	10.33%	10.15%	-0.17%
East of England	10.78%	11.08%	0.29%	0.933	0.927	-0.006	9.76%	10.12%	0.36%
South West	9.90%	10.11%	0.21%	0.960	0.950	-0.010	9.66%	9.51%	-0.15%
South East	16.00%	16.33%	0.33%	0.968	0.912	-0.056	16.53%	16.50%	-0.03%
London	14.29%	14.96%	0.67%	1.131	1.058	-0.073	15.01%	15.01%	0.00%
England	100%	100%	0.00%	1.000	1.000	0.000			

GORs are ranked in descending order of the change in the formula composite index.

Table 4 Allocations per head and conditional inpatient stay probabilities at GOR level

GOR	Allocation per head 1996	2007	Ratio†	Conditional inpatient probability 1994-1996	2004-2006	Ratio†
North East	£451	£1,551	244%	0.075	0.071	0.954
North West	£441	£1,503	241%	0.084	0.073	0.870
West Midlands	£414	£1,382	234%	0.066	0.065	0.987
Yorks/Humber	£427	£1,407	230%	0.078	0.059	0.755
East Midlands	£397	£1,309	230%	0.080	0.059	0.735
East of England	£385	£1,268	229%	0.087	0.061	0.700
South East	£399	£1,275	219%	0.078	0.059	0.758
South West	£415	£1,305	214%	0.075	0.068	0.902
London	£493	£1,531	211%	0.072	0.056	0.789
England	£426	£1,388	226%	-	-	-

GORs are ranked in descending order of the growth in allocation per head. Conditional inpatient probabilities are derived from annual GHS data models containing the variables listed in Table 5. † Ratios are the latter period values divided by their equivalents in the earlier period.

Table 5 Probit regressions of service use on personal characteristics, region and year

	Outpatient† Coef.	z	Inpatient‡ Coef.	z	Day patient‡ Coef.	Z
Age/100	-3.115	-9.1	-3.302	-6.5	0.894	1.2
Age squared	5.226	7.1	5.725	5.3	-1.886	-1.2
Age cubed	-2.673	-5.4	-2.151	-3.1	1.020	1.0
Female	-0.479	-7.3	-0.624	-6.9	-0.327	-2.3
Female*Age	2.385	5.2	9.771	15.4	3.173	3.2
Female*Age squared	-3.311	-3.4	-24.449	-18.2	-6.913	-3.3
Female*Age cubed	1.165	1.8	16.035	18.3	4.175	3.1
*General Health**						
Fairly good	0.284	45.7	0.312	37.2	0.257	21.0
Not good	0.727	88.5	0.928	83.6	0.547	33.4
Missing health	0.018	1.4	0.304	20.1	-0.006	-0.2
*Health limitations***						
LLI & restricted activity	0.676	71.5	0.391	31.7	0.334	18.5
Non-L LI & restricted activity	0.667	38.6	0.394	16.1	0.321	8.9
LLI only	0.461	62.4	0.142	13.5	0.227	14.3
Non-L LI only	0.379	51.5	0.068	6.4	0.158	10.4
Restricted only	0.475	45.1	0.387	27.0	0.224	9.9
Missing restricted activity	0.421	20.6	0.059	1.7	0.029	0.6
Income/100,000	0.022	3.3	-0.006	-0.5	0.038	3.9
Missing income	-0.002	-0.2	0.010	1.1	-0.014	-0.5
*Region****						
North East	-0.133	-12.2	-0.002	-0.1	0.034	1.4
North West	-0.088	-10.0	0.044	3.4	0.027	1.5
Yorks and Humber	-0.101	-10.7	0.023	1.7	-0.047	-2.2
East Midlands	-0.110	-10.9	0.005	0.3	-0.077	-3.6
West Midlands	-0.108	-11.7	-0.025	-1.8	-0.070	-3.4
East of England	-0.131	-11.1	0.014	0.9	-0.036	-1.7
South East	-0.067	-8.3	0.042	3.6	-0.009	-0.5
South West	-0.114	-11.7	0.023	1.6	0.010	0.5

Sample of adults aged 16+ in England. Regressions contain dummy variables for years (not shown) and cover the periods 1972-2006 for outpatients, 1992-2006 for day patients and 1982-2006 for inpatients. Data for 1988-2004 are financial years. Sampling weights are applied. Standard errors adjusted for household level clustering. † in last three months. ‡ in last year. * Omitted category is good health. ** LLI = limiting longstanding illness. Non-L LI is non-limiting longstanding illness. Omitted category is no longstanding illness and no restricted activity in the last 2 weeks. *** Omitted category is London.

Table 6 Effects of formula index and resource variables on individual use

	Outpatient		Inpatient		Daypatient	
Model	Coeff.	z	Coeff.	z	Coeff.	z
Without GOR dummies						
Age index	0.007	0.0	1.312**	3.0	2.114**	4.7
Additional needs index	0.119	1.4	0.323**	3.1	0.471**	4.5
MFF index	0.069	0.4	0.158	0.8	0.837**	4.4
Combined index	0.138*	2.1	0.052	0.7	0.151*	2.0
Allocations per head	0.0001	1.7	0.0001	0.7	0.0002*	2.2
Allocations per weighted head	0.0001	0.5	-0.0005	-1.5	0.0004	1.1
With GOR dummies						
Age index	1.023	0.9	0.188	0.1	-0.471	-0.4
Additional needs index	-0.327	-0.9	0.635	1.5	0.803	1.8
MFF index	0.766	0.9	0.457	0.5	-0.029	0.0
Combined index	-0.102	-0.4	0.485	1.5	0.513	1.5
Allocations per head	-0.0002	-1.0	0.0003	1.2	0.0002	0.8
Allocations per weighted head	0.0003	0.7	-0.0005	-1.2	-0.0003	-0.7

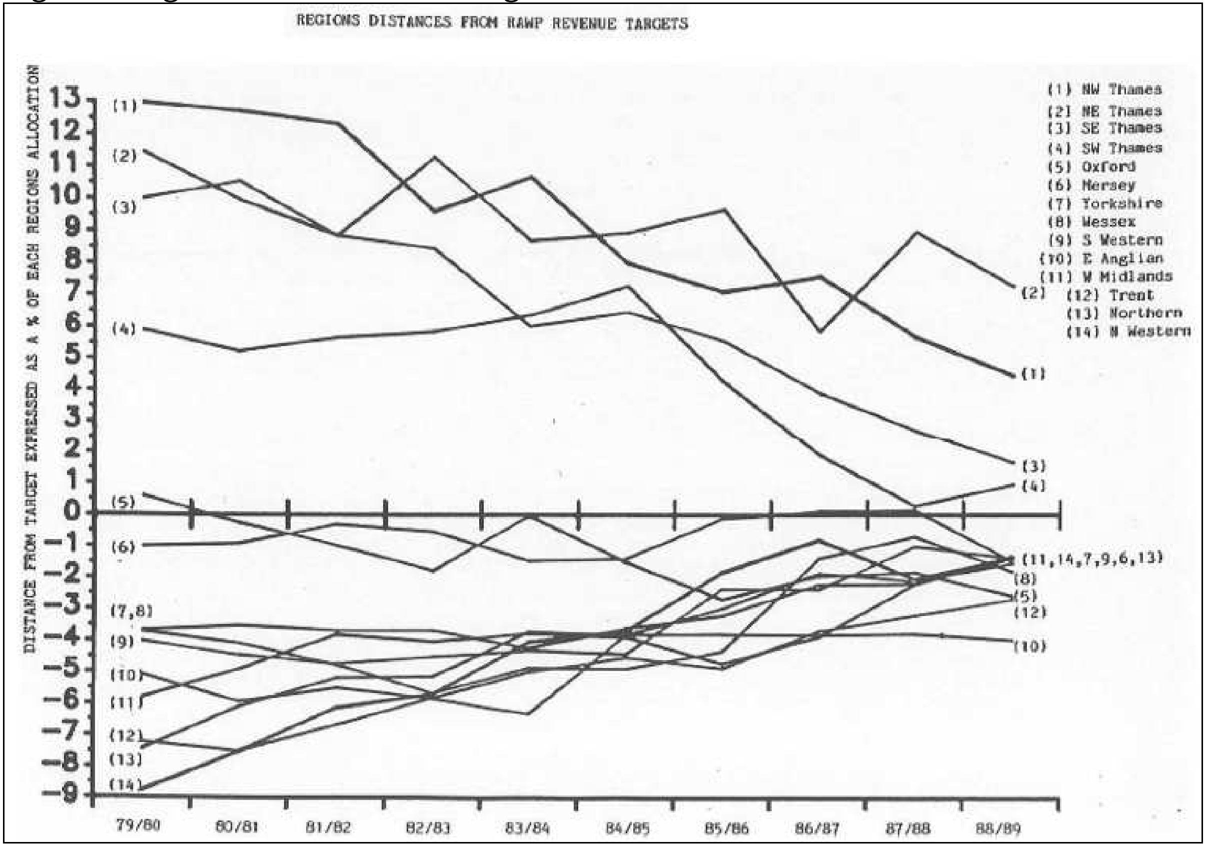
Variables are added to the models shown in Table 5 but restricted to the period 1996-2006. Results shown are from 24 different models. The age, need and MFF index are added together in a single model. The other variables are added individually to separate models. * significant at 5%. ** significant at 1%.

Table 7 Regressions of within-region CIs for use on within-region CIs for finance

Dependent variable		FE (year dummies)	FE	BE	RE
Independent variable is CI for formula index					
Inpatient	Coefficient	2.24	0.99	0.34	0.45
	t-ratio	(2.28)*	(1.60)	(0.89)	(1.34)
Daycase	Coefficient	-0.31	0.84	0.15	0.28
	t-ratio	(0.21)	(0.90)	(0.34)	(0.61)
Outpatient	Coefficient	1.52	0.88	0.07	0.24
	t-ratio	(1.80)	(1.67)	(0.31)	(0.88)
Independent variable is CI for allocation per head					
Inpatient	Coefficient	2.69	1.43	0.31	0.36
	t-ratio	(1.39)	(1.00)	(0.65)	(0.80)
Daycase	Coefficient	3.90	4.19	0.12	0.40
	t-ratio	(1.37)	(2.00)*	(0.21)	(0.66)
Outpatient	Coefficient	2.77	2.28	0.10	0.24
	t-ratio	(1.69)	(1.91)	(0.36)	(0.67)

Notes: Table contains results from 48 regressions (2 measures of distribution of finance x 6 measures of distribution of utilisation x 4 econometric model specifications). In each regression there are 81 observations, being 9 annual observations on 9 GORs. In the fixed effects regressions, GORs are weighted by the number of HAs within the region as this determines the accuracy with which the concentration index for finance can be estimated. * significant at 5%.

Figure 1 Regional distances from target shares 1978/80 to 1988/89



Source: Figure 1-1 DHSS (1988)

Figure 2 Scatterplots of Age, Need and MFF Indices on income: 1996, 2002 and 2007

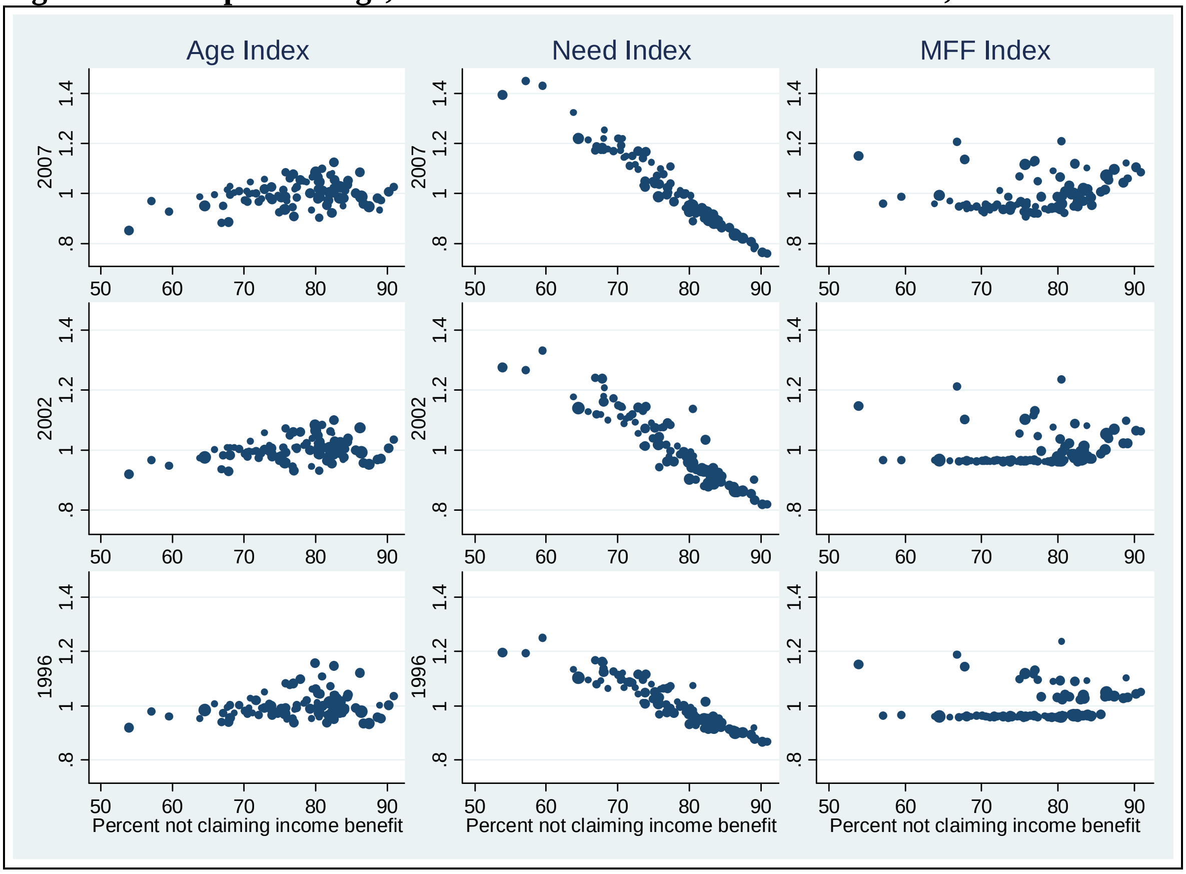


Figure 3 Distribution of HCHS formula composite index and its components, 1996-2007

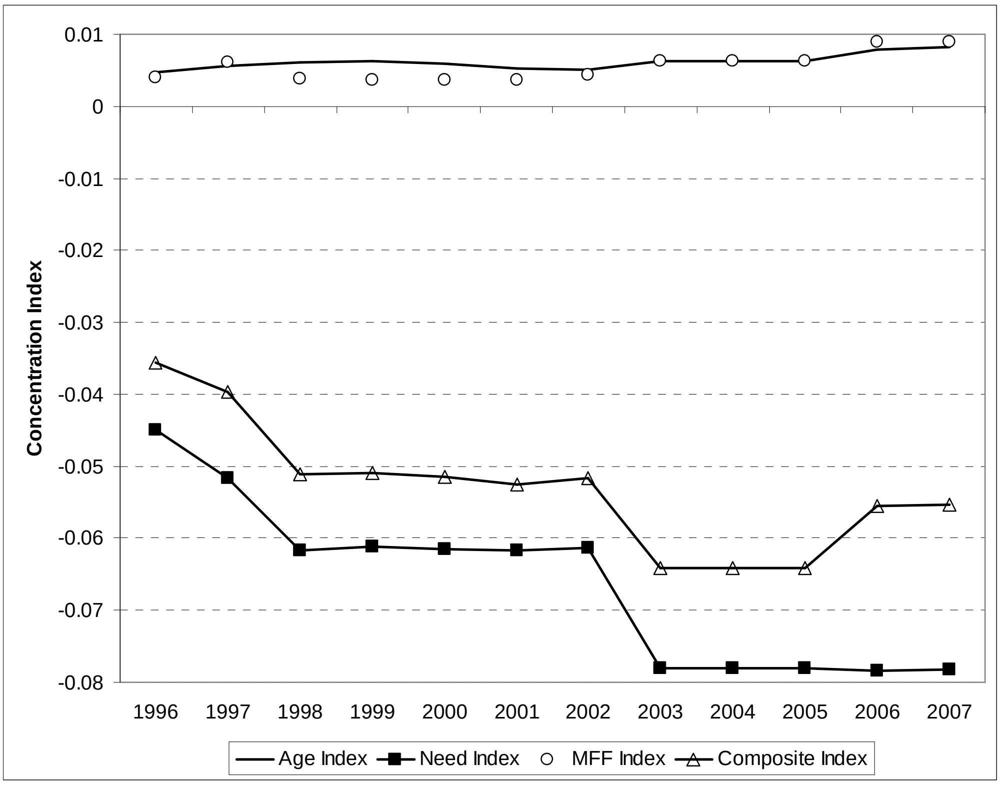
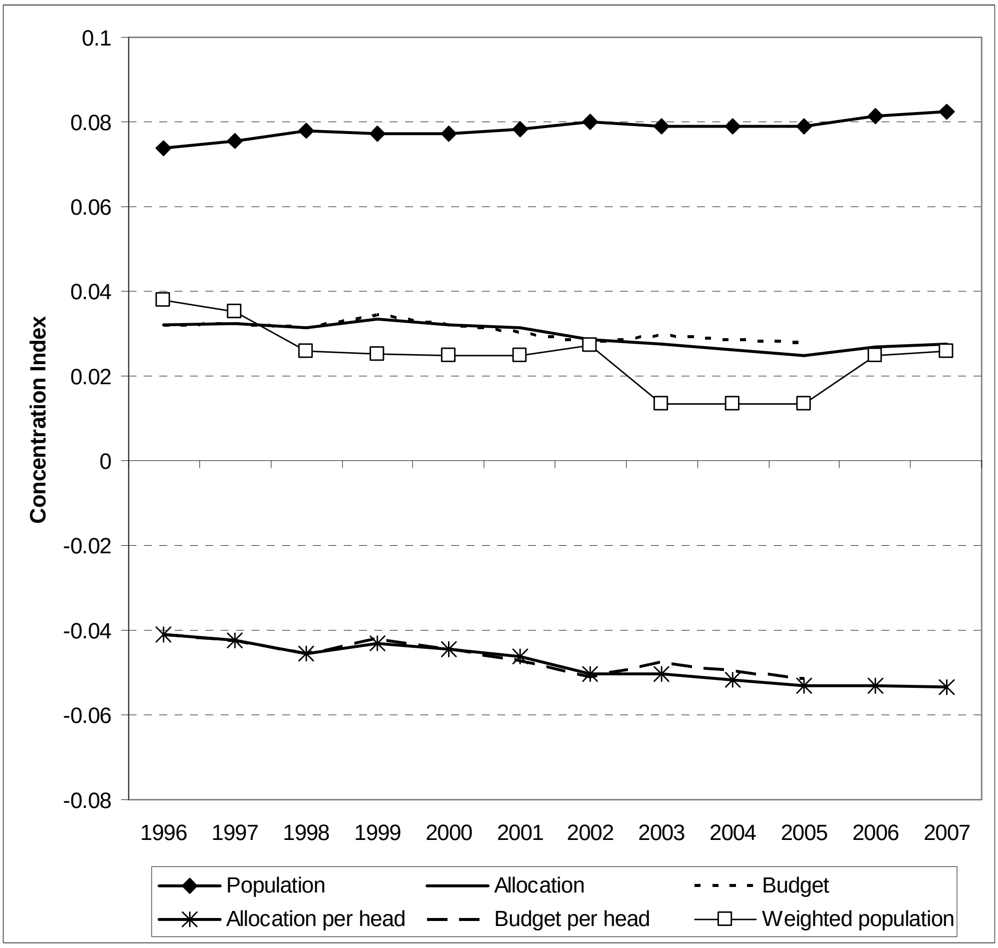


Figure 4 Distribution of populations, resources and resources per capita, 1996-2007



Series are based on the 2002 configuration of 95 Health Authorities. Areas ranked in ascending order of proportion of population not claiming state benefits on the grounds of low income from the IMD1998.

Figure 5 Unconditional Concentration Index of health service use, 1972-2006

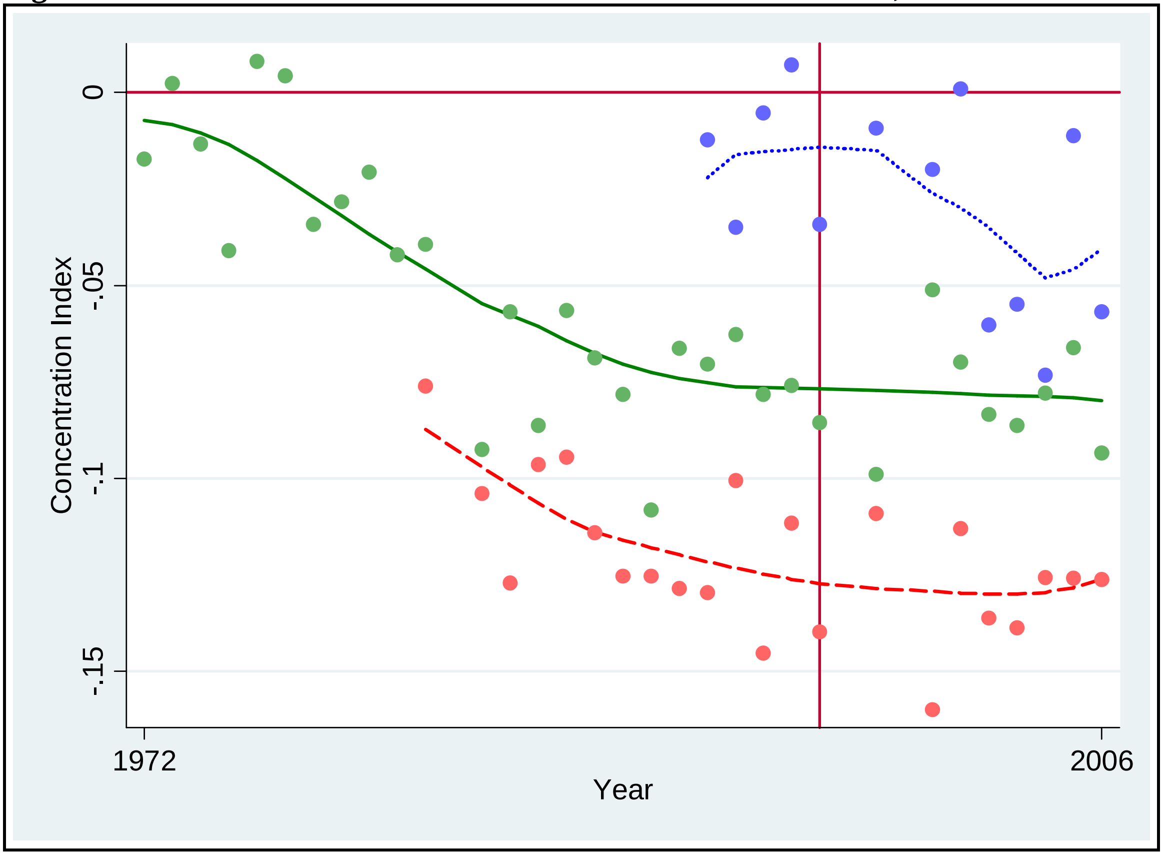
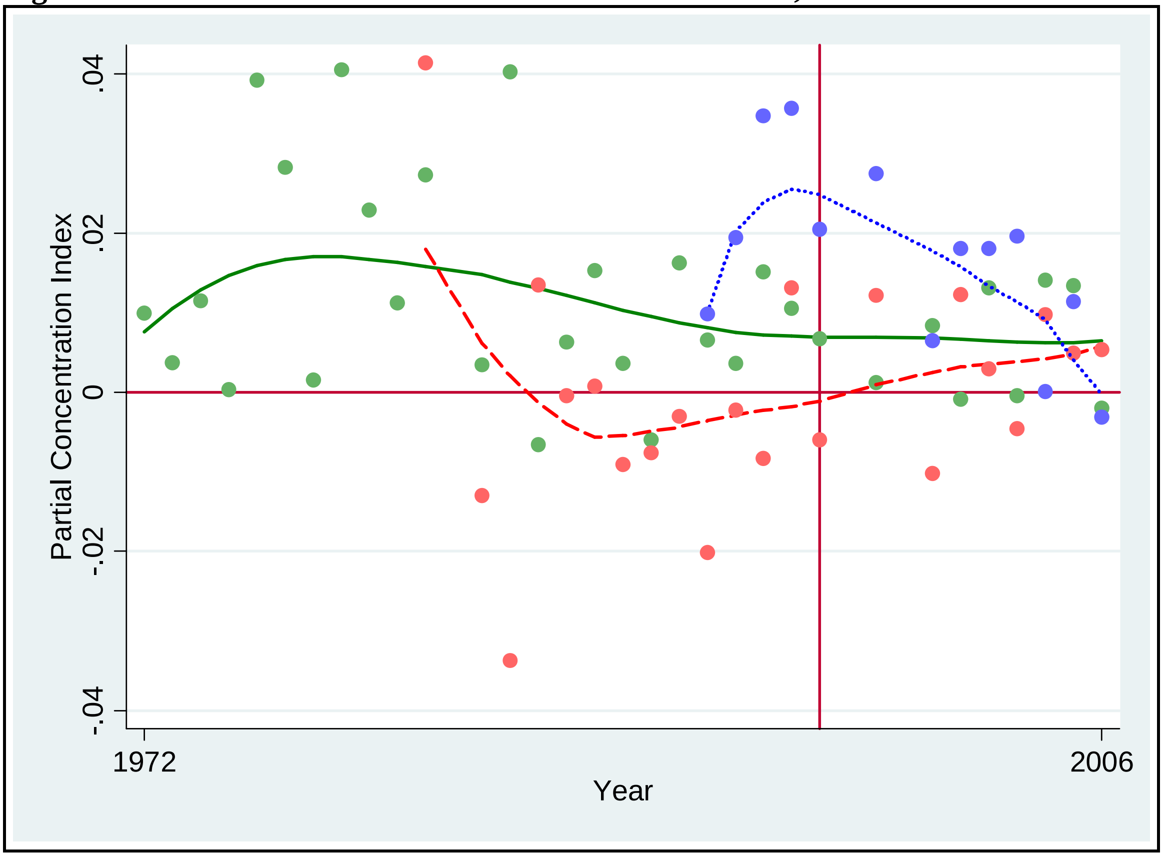


Figure 6 Partial Concentration Index of health service use, 1972-2006



Notes to both Figures: Vertical line = 1996. Lowess bandwidth = 0.8. Daypatients= Dotted, Blue; Outpatients = Solid, Green; Inpatients = Dashed, Red