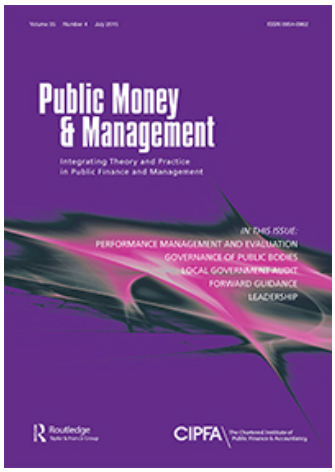

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New development: The remarkable insignificance of NHS England's CCG funding formula

Mervyn Stone

This article resolves a long-standing question about the financial performance of small-area funding bodies in England's National Health Service—whether or not surpluses or deficits are due to over- or under-provision of funds relative to what is thought necessary to fund healthcare, in line with targets set by a funding formula. Multivariate regression of per capita surplus on the two variables (actual allocation and target allocation), for the first year of operation of 211 clinical commissioning groups (CCGs), revealed a decisively insignificant P-value for the target variable—once account had been taken of the distance of allocation from target. To help statisticians maintain that the target formula has no rational basis, this article conjectures that the correlation of surplus and 'distance from target' is a managerial artefact divorced from the costs of healthcare provision.

Keywords: Clinical commissioning groups (CCGs); distance from target; financial performance; managerial artefact; PBRA3 formula.

At the heart of the House of Commons Health Committee's inquiry into NHS deficits in 2006 was the unresolved question of whether primary care trust (PCT) deficits could be due, at least in part, to an unfair funding formula rather than poor financial management. The question was extensively analysed, but was left unresolved, in two papers (Stone and Galbraith, 2006; Galbraith and Stone, 2011). Judging by the neglect of statistical reasoning in the complex construction of empirical formulas from a multitude of variables acting as proxies for healthcare need, these papers concluded that the formulas lacked both rational and evidence-based justification. If they were indeed fair, as too many judged them to be on purely subjective grounds, that could only be as a result of chance. In line with the committee's recommendation (Health Committee, 2007), the Department of Health commissioned (and NHS England has now implemented) a completely different funding formula whose final acronym 'PBRA3' stands for 'Person-based resource allocation (3rd formulation)'—the final Nuffield Trust version. Stone and Williams (2013) question the arguments by which defenders of PBRA3 attempted to justify the surprising sign and size of many of the formula's least-squares estimated coefficients.

First-year performance of 211 clinical commissioning groups (CCGs)

By December 2012, each of the 211 CCGs replacing PCTs knew what its actual allocation of funds, A, would be for the financial year 2013/14. They also knew the target allocation, T: namely, what the allocation A would have been if the PBRA3 formula had been strictly implemented. The arithmetic difference D = A - T is the widely-contested 'distance from target'. Finance officers of CCGs with negative values of D are in favour of NHS England moving quickly to an endurable equality of allocations and targets, but those blessed with a positive value of D remain discreetly silent about that prospect. By the end of the financial year 2013/14, each CCG had either spent more than its actual allocation, thereby acquiring a deficit, or it had spent less, thereby ending with a surplus.

In September 2014, the National Audit Office produced a report (NAO, 2014a) for the Department of Health and NHS England, which plotted the CCG surplus S against D as in figure 1. The chief finance officer of NHS England saw the NAO's report as sufficient ground for action: 'There is some correlation between CCG financial performance and the distance from target allocation, which we began to address in allocations for 2014/15 and 2015/16' (Baumann, 2014).

Mervyn Stone is Emeritus Professor of Statistics at University College London, UK.

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In this quotation, there is no questioning of the role of T—targets appear to be unquestionable, as if they were fixed compass points in a sea of swirling allocations. The NAO's report, however, cautiously presented figure 1 as factual observation—not as a guide to what a CCG's surplus would have been if it had been given a different allocation with the same target value. The report encouraged realism when it said that: 'the relationship between financial position and distance from target allocation is likely to be complex and vary from area to area', as well as in its recommendation that the Department of Health and NHS England should:

> *…develop an evidence base to inform their decisions about how quickly to move commissioners towards their fair share of funding and take account of previous changes in local spending patterns, evidence on the effect of distance from target and the views of local commissioners.*

For the NAO, the allocations and targets are presumably numbers for which others are responsible, and the NAO's report is wisely silent about the provenance and acceptability of the target formula: 'Given the lack of consensus on the best way to measure need, we do not offer judgement on which is the most appropriate method'.

Figure 1. NAO plot of surplus on distance from target (R^2 = 23%).

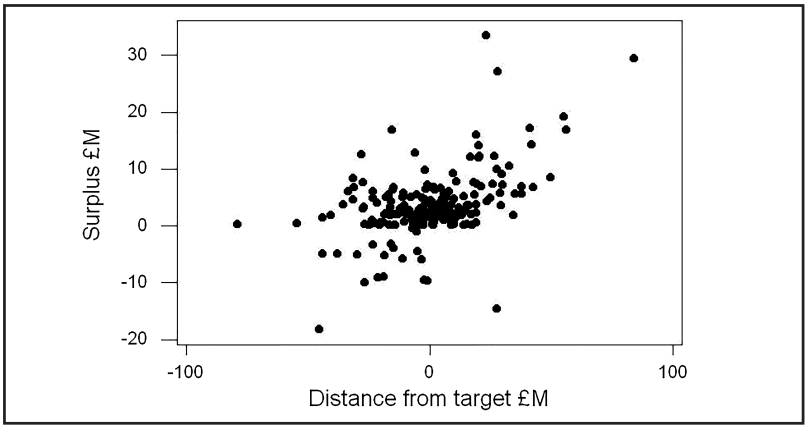
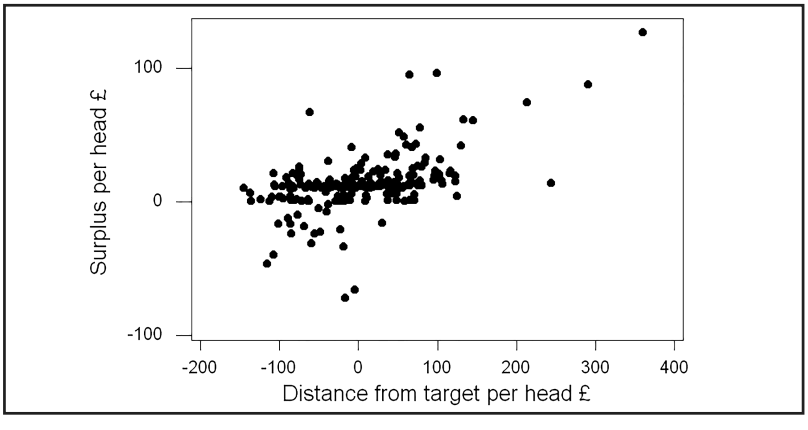


Figure 2. With *per capita* variables, R^2 increases to 29%.



The key message from a bivariate regression analysis of *per capita* variables

The NAO's report did not consider the possible influence on the observed correlation in figure 1 of the big variations in CCG populations, which range from 67,000 to 870,000 patients per CCG. Figure 2 shows that the correlation is very unlikely to be an artefact due to population differences.

Henceforth in this article, the symbols A, T and S denote the per head values of allocation, target and surplus—more appropriate to comparisons of financial performance. Their distributions and correlations are shown in figure 3, in which the first plot shows the wide variation in per head allocation over the 211 CCGs.

With an R^2 of only 14%, the first plot is also an immediate challenge to anyone who regards any target formula based on PBRA3 as unproven (see, for example, Stone and Williams, 2013). If T were indeed not much better than random noise, its removal from the explanatory variable A-T would be expected to appreciably increase the correlation in figure 2, increasing R^2 instead of halving it. Does this purely factual finding mean that Jane Galbraith and I should withdraw our decade-long dismissal of the target formula as a concoction only tenuously related to any true measure of healthcare need and hence to any concept of fairness? The answer (a definite 'no') is based on further analysis of the NAO data—the bivariate linear regression of S on the two variables D and T that uncovers crucial evidence of the irrelevance of T to the financial performance of the 211 CCGs. The ordinary least-squares fit is:

$$S = 11.55 + 0.1557\ D + 0.00089\ T$$

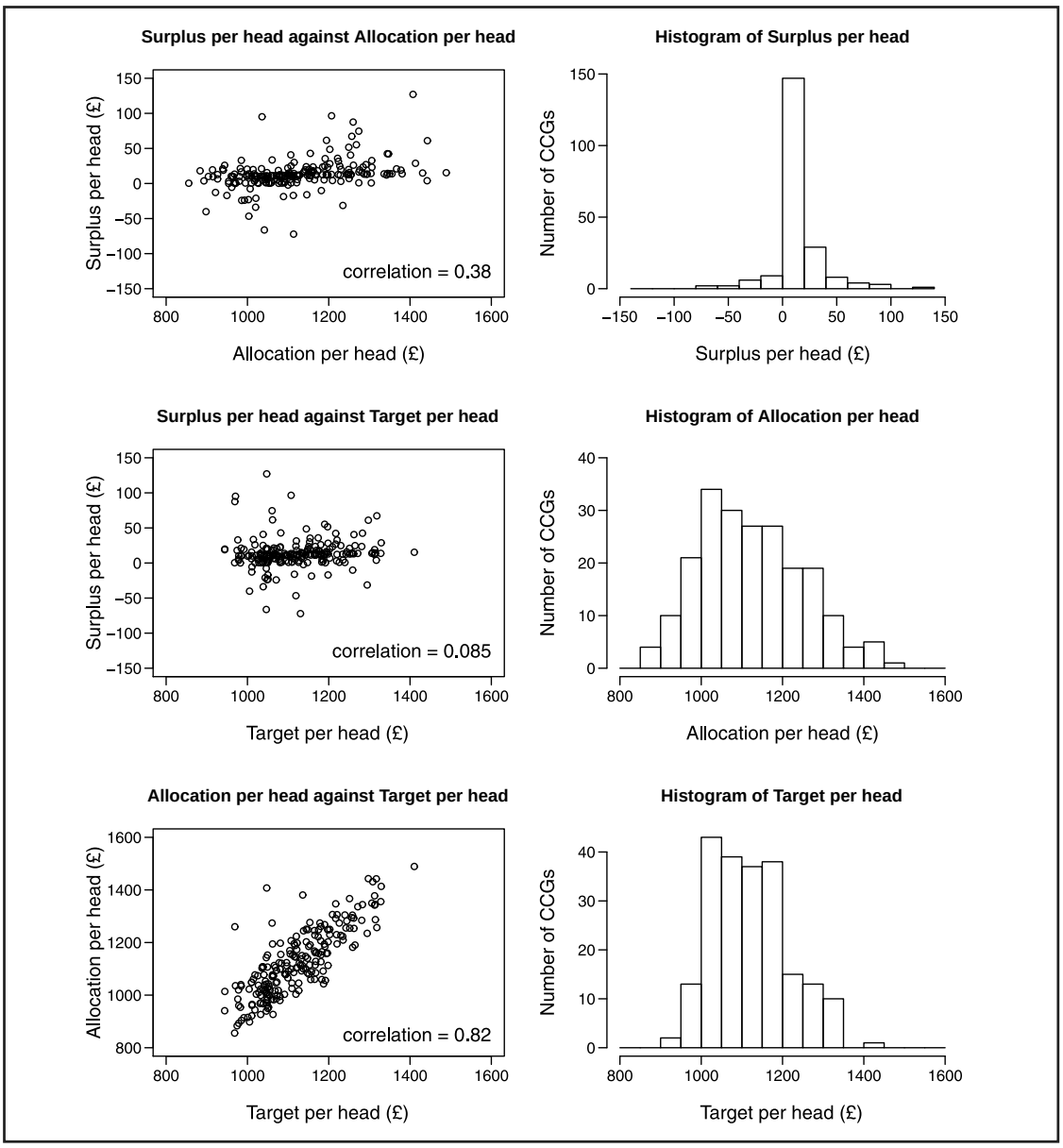
with an R^2 of 29% (the same as for the regression of S on D alone) and with residuals that look almost random when plotted against A, T or the CCG population. Crucially, the t-value of the coefficient of T is only 0.06 with a P-value of 0.95. In a regression with as many as 211 observations and only two explanatory variables, a plausibly-relevant variable such as T might be expected to reach at least the 5% significance level. The increase in R^2 is minute

shows that T has a negligible influence on the financial performance represented by S, once the size of the gap between allocation per head and target per head is on the management white-board. (If D is taken to be A/T rather than A-T, the message of the regression stays the same as far as the contribution of T is concerned—not surprisingly, since the two measures of distance from target are very strongly correlated.) The message is both robust and strong: *the target formula T has little or no influence on the surplus/deficit S other than through A-T*.

Explaining the particular insignificance of targets

One of the above quotations from the NAO's report claims that the influence of finance officers' prior knowledge of both A and T on the end-of-year balance, S, is 'likely to be complex and vary from area to area'. If that is so, is it likely that the plethora of day-to-day expenditures on health services throughout 2013/14 somehow colluded so that, as we have seen, the end-of-year balance contained no statistical trace of the huge variation of T between CCGs shown in figure 3 once proper account had been taken of the influence of the distance from target variable that NAO chose as their variable to explain deficits? This article offers an explanation for this remarkable finding in the form of a somewhat embarrassing conjecture—that, knowing their assigned target and allocation values for the year, CCGs managed their accounts to produce broadly acceptable outcomes, whatever two values were

Figure 3. The correlations and distributions of the basic per head variables.



assigned. (Such management skills could also account for the pronounced 'abnormality' of the two frequencies for the intervals next to the zero in the surplus histogram of figure 3.) It should be no surprise that accountants like to do what accountants are trained to do—or that CCG executives, boards and financial directors receiving above-target funding may feel obliged to end the year with surpluses or at least break-even, whereas those with below-target funding would feel comfortable to present deficits.

There is another piece of evidence that favours this, or similar, management conjecture. Paragraph 2.24 of the NAO's report says that the NAO had:

> *…sought to investigate whether receiving funding that is above or below target allocation appears to affect a local area's health services or outcomes. Given the multiple factors that affect health outcomes, we explored the relationship between distance from target at a local level and measures of how health services are provided, namely the number of GPs, hospital beds and hospital-based NHS staff.*

The NAO found that the 'exploratory analysis did not identify any significant associations between the resourcing of health services by NHS providers and commissioners' distances from target allocations'. These negative findings may have surprised the NAO—but they are fully consistent with the management conjecture.

Recommendation

If NHS England could be persuaded to see figure 1 as an artefact of managers' prior knowledge of distance from target and nothing more, its chief finance officer might with profit look again at the problem that he began to address in response to the figure 1 correlation (how quickly should allocations move to their targets?)—even if he excludes any questioning of the target formula that could raise the question of which direction to move the allocation.

The gist of this article was submitted as unsolicited written evidence to the Parliamentary Accounts Committee (PAC) hearing on the NAO's report (Stone, 2014). There is no evidence that the submission dented the trust that the PAC placed in the target formula as a sturdy benchmark. Nor was there evidence that it influenced either the questions that the PAC put to witnesses from NHS England and the Department of Health, or the answers the PAC got out of them. The statistics profession is therefore left with the task of drawing attention to its well-documented objections to the damage that has been wrought by a handful of econometricians. It was not enough for the late Professor Lindley (a highly respected Bayesian) to state his objections in a foreword to the book *Failing to Figure* (Stone, 2009) or for Professor Sir David Cox (probably the world's top statistician) to recommend that the book be sent to all MPs and members of the House of Lords.

Acknowledgements

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