**Contribution to the** ‘**Consultation on reform of police funding arrangements in England and Wales’**

*Para. 1*: I am responding as a UCL professor of statistics and former head of its Department of Statistical Science. I ‘strongly agree’ for Question 1 (*To what extent do you agree or disagree that current funding arrangements for the police in England and Wales need to be reformed?*) and ‘strongly disagree’ for Question 9 (*To what extent do you agree or disagree with the methodology behind a simplified model?*). I have no expertise that might entitle me to respond to any other question—except Question 4 (*What other principles for a good funding model, if any, should be considered?*) where **I would like to see more emphasis on logic as the key element in any technical argument** (as I hope the following critique of the proposed ‘simplification’ makes clear).

*Para. 2*: In 2000, I was asked by the Research Development &Statistics section of the Home Office to advise on a by-then well-advanced idea for measuring individual police force efficiency. The advice led to the rejection of the prematurely-published Spottiswoode Report, and then to a publication1 in the methodology journal of the Royal Statistical Society (RSS). A readable account of the whole engagement fills four pages of a Civitas book2. I consider that both publications are relevant to the reform now being proposed. (There may be something in the RDS archive of my critical analysis of the Police Allocation Formula, whose defects were tangential to, and somewhat less glaring than, those of the Spottiswoode Report.)

*Para. 3*: The proposed reform of the Police Allocation Formula relies on sensible application of two statistical procedures—a computerized *variable selection* (constrained by L.J.Cronbach’s Alpha statistic) and a *linear combination* of five selected variables (‘indicators’). The coefficients of the proposed linear combination involve the corresponding ‘weights’ or ‘factor loadings’ from the first component of a computerized Principal Component Analysis (PCA) of the five variables *when these have been* *scaled to have unit standard deviation* (making the PCA one that is on the 5 x 5 correlation matrix). **Without any logical justification, the weights are taken to be shares of total funding attributable to the corresponding variables.** With somewhat greater justification, these shares are then, for each variable, allocated to individual forces in proportion to the force values of that variable, when each variable has been *scaled to have a sum of unity* over the 43 forces. The final allocation to an individual force is the sum of the five individual allocations. That is my clarification of sections 6.11-6.14.

*Para. 4*: The last sentence of Annex B explains that on many occasions the Cronbach method *resulted in 2 socio-economic indicators being used.*  Did the analysts proceed to the PCA stage on these occasions and inspect the resulting computer output? If they did, they appear not to have noticed that the weights were always the same at 50% & 50%—reflecting the symmetry of the PCA for a 2 x 2 correlation matrix with only one parameter (a single correlation coefficient). **If they had noticed the constancy, would they have recommended without question that the weights of the five actually-selected variables be taken as shares of total funding?**

*Para. 5*: If the PCA weights are not to be used as suggested, how might they be used? They come out of the first PCA component, which can be defined as the linear combination of scale-standardized variables that has maximum variance over the 43 forces. There is a broad but neglected hint in Annex B that it is this very combination that could be used to determine the allocation:

*By reducing a dataset from a group of interrelated variables to a smaller set of factors, a new overarching factor is then able to explain the maximum amount of common variance in a correlation matrix using a smaller set of variables.*

The issue comes down to whether the variables are to be scaled by their sum or by their standard deviation. The difference could have serious consequences for allocations to individual forces. **Unfortunately, there is no strong underlying logic for saying that one of these choices is better than the other.**  Specifically, there is no objective criterion among the worthy principles of Chapter 3, whose optimization would provide theoretical underpinning for either formula.

*Para. 6*: There is unquestionably a need for administrative solution of the allocation problem and therefore some compromise with principle may be necessary. In his book *Formula Funding of Public Services*, Professor Peter Smith alluded to such compromise when he claimed that *the procedure for deriving an allocation of funds often has a vital importance over and above any consideration of the outcome of the allocation*. (That was in defence of weighted capitation formulas still used by NHS England.) The Home Office document is rightly concerned that its allocation formula should not provide the kind of perverse incentives that a formula would have if it were based directly on the output profile of a force. The current Police Allocation Formula does appear to respect such concern. Its complexity and subjectivity would be reduced if the socio-economic indicators were restricted to the five of the now-proposed model and it is just possible that, **if the force-by-force relationship of these to a reasonably exhaustive and distinct set of measurable outputs were analysed in a properly multivariate fashion, the results of the analysis could be made into a formula that would make some sort of bridge over the black hole of logic in the current proposal.**

*Para. 7*: Annex E could have referred to **recent critques3,4 of the Revenue Support Grant and Clinical Commissioning Group formulas**. I fear that, if the outlined proposal were adopted and implemented, there would be a fresh round of ultimately futile contestation.

**References in the contribution to the discussion**

1. Stone, M (2002), How not to measure the efficiency of public services (with Discussion). *Journal of the Royal Statistical Society, Series* B, vol. 165.

2. Stone, M (2009), *Failing to Figure: Whitehall’s Costly Neglect of Statistical Reasoning* (Civitas book).

3. Stone, M (2012), Getting to grips with England’s formula for local authority support. March 2012 issue of *Public Money & Management*.

4. Stone, M (2015), New development: the remarkable insignificance of NHS England’s CCG funding formula. July 2015 issue of *Public Money & Management*.