Home Office

Refined Police Funding Model Technical Note

28 October 2015

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REFINED POLICE FUNDING MODEL TECHNICAL NOTE

INTRODUCTION

1   In 2012, the previous Coalition Government committed to a review of arrangements for allocating central Government funding to the 43 police force areas in England and Wales, centred on the existing Police Allocation Formula (PAF). This review concluded that the PAF was complex, opaque and out-of-date, reflecting the views which forces and Police and Crime Commissioners (PCCs) have put forward over time. Much of the data underpinning the formula is over a decade old, it relies heavily on Activity Based Costing data which stopped being collected in 2007/08 and is linked to a Local Government funding model that no longer exists (the 'Four Block' model). In addition, 'damping', a means of smoothing funding allocations between years that was only ever intended to be a temporary measure, has become an ingrained part of the system, further eroding the link between funding levels and relative need.

2   On 21 July the Home Office launched a public consultation on the *principles* of a new police funding model. The consultation proposed a simplified model which uses population levels, the underlying characteristics of that population and environmental characteristics to determine force level allocations. The consultation closed on 15 September and over 1,700 responses were received.

3   Following analysis of those responses and other feedback received, the Home Office has proposed a set of refinements to the proposed model, on which it is engaging further with policing partners before finalising the model. The refined model:

- retains population volume and households with no adults employed and dependent children as core indicators;

- clarifies that the second population characteristic we intend to use is the updated 'urban adversity' version of the Acorn 5 indicator which has replaced the old 'hard pressed' version (this ensures that the model is in line with CACI Limited's current Acorn classifications);

- revises the bar density measure so that it takes account of bar volume as well as bar density, reflecting strong consultation feedback that this better captures scale and the impact of clusters of bars and the night-time economy within a force area;

- removes 'Band D equivalent properties' as a core indicator, reflecting strong consultation feedback that this variable did not adequately capture the ability to raise additional precept income as intended;

- adds an Area Cost Adjustment (ACA) to the model to reflect regional variations in the cost base.

4   The four indicators in the model are used to compare the characteristics of each PFA and represent proxies for police demand. They are based on objective, robust and reliable data that can be compared across all force areas. As proxy measures of demand they should also be seen as measuring characteristics that go wider than the indicators themselves, for example the bar indicator can also represent areas where there are likely to be other risk factors for policing e.g. responding to incidents related to retail and other entertainment activities.

5   This document provides technical detail of this refined model, which retains the overall approach originally outlined and continues to adhere to the five guiding principles which the Government set out in its consultation. The model remains structurally and statistically robust using four relative need indicators, it is easier to understand, and it takes into consideration changes in funding across all force areas.

THE POPULATION INDICATOR

6   The volume of population in a PFA is an important indicator for determining police workload as it is highly correlated with levels of police recorded crime as well as the existing distribution of funding across PFAs. We considered sub sets of the population e.g. based on age groups (15-29, 65 and over) as well as ethnicity. Shares for age groups are broadly consistent with those already used for total population for the majority of force areas although we recognise there are some differences in some force areas. We also concluded that ethnicity would be broadly captured by other socio-economic indicators in the model, in particular the categories in the Urban Adversity indicator.

7   For resident population data we use Office for National Statistics (ONS) projections which make annual adjustments for natural change (i.e. births and deaths) and migration. We use a three year moving average of the data to smooth annual changes to address the fact there will always be some uncertainty with projections and to ensure the highest level of stability for the indicator across all PFAs. In general shares of population data across force areas did not significantly change over time but using a moving average allows some changes to filter through.

8   Annex A sets out the correlation coefficients for population and the other three indicators in the model. Annex B sets out population shares for each PFA (as well as the shares for the other indicators in the model).

WHY USE TWO SOCIO-ECONOMIC INDICATORS?

9   Socio-economic indicators are used as further risk factors to identify where levels of crime and wider demand are likely to be higher and put more pressure on police resources. In the existing PAF a number of socio economic indicators proved to be good predictors of police recorded crime – and non-crime demands - when

using regression models. We therefore concluded it was appropriate to consider similar indicators in the new funding model.

10   A wide range of alternative models were tested to understand the impacts on allocations across force areas when using different socio-economic indicators, as well as how many should be included in the model. For example we tested single indicators, up to ten different indicators as well as combinations using a weighted index approach. In general these models produced broadly consistent results in terms of allocating the majority of police funding. The use of two socio economic indicators in the model helped us to refine the allocations further ensuring full consideration was given to funding impacts across all force areas.

11   Statistical tests - using reliability analysis which is often used to check consistency across indicators when constructing reliable measurement scales - broadly demonstrated that different combinations of two socio economic indicators could have been used in the funding model. This is because they are all highly correlated with each other. The test statistic, Cronbach's Alpha, did suggest some combinations of indicators had more consistency than others (e.g. indicators that are more closely related such as different measures of unemployment) but the final decision to select one type of indicator above another was often very marginal. When the socio-economic indicators were tested there was always a sufficiently high value for Cronbach's Alpha (e.g. values above 0.7) for many combinations of the indicators.

12   Selecting unemployed households with dependent children and a measure that more broadly describes relative levels of deprivation (in this case, CACI Limited's updated ACORN 5 classification, Urban Adversity) ensured that the model accounted for a wider set of socio-economic characteristics than would be the case if a single specific indicator (e.g. employment, education or household related) had been used. This also ensured that the indicators have the potential to cover wider risk factors, including for non-crime demands e.g. Urban Adversity can be considered a proxy for low income, employment, ethnicity and family structures.

13   When comparing different socio economic indicators we also observed that the proportions for each indicator were broadly consistent across PFAs as well as over time. This supported the conclusion to select the final two socio economic indicators.

14   Annex A provides the correlation coefficients for the indicators selected for the refined model and with police recorded crime. Annex B provides the shares across force areas for the two socio-economic indicators selected. These shares are subject to change when the data for the final model is updated.

WHY RETAIN THE CENSUS INDICATOR 'UNEMPLOYED HOUSHOLDS WITH DEPENDENT CHILDREN'?

15   The indicator for unemployed households with dependent children has remained stable across the majority of PFAs when comparing 2001 and 2011 Census data. Annex C shows that 41 force areas experienced changes of less than 0.5% over the period, including 17 force areas at less than 0.1%. Given the long time period in between each Census we cross-checked with other related data for consistency, for example on the number of workless households and the number of children living in workless households (two separate sources) and on unemployment related indicators more generally. The unemployment related indicators come from a sample-boosted version of the Labour Force Survey. This is a useful source of data but the estimates for many local authority areas need to be treated with caution given the size of some of the relative standard errors on the estimates.

 16   We concluded that all of the unemployment related indicators are highly correlated with each other. In addition, although there are some differences across PFAs, the shares for the majority of the unemployment related indicators are broadly consistent. We will continue to monitor other data sources in between Census years to check on these trends.

WHY RETAIN THE ACORN 5 INDICATOR?

17   CACI has now revised their measure for the indicator known as 'Acorn5'. The original 'Hard Pressed' category is now called 'Urban Adversity'. Although the two categories are not direct matches, they are highly correlated with each other and shares across most PFAs for the two definitions are very similar. Annex D sets out the full definition for each of these measures and shows there is a good coverage of socio-economic characteristics in the new category, covering a range of different household characteristics using a number of different data sources. CACI have future-proofed the Acorn classifications as far as possible taking into account the current data environment. However should there be any future planned changes to Acorn classifications, CACI will provide early notification of this.

WHY USE BAR DENSITY AND VOLUME AT POLICE FORCE AREA LEVEL?

18   The Home Office has identified alcohol as one of the six key drivers of crime and there is a strong association between alcohol and violent crime and disorder. The bar indicator attempts to capture this link as well as the night time economy pressure on policing more generally, and also indirectly potential demands on policing related to other activities taking place around the geographical area of bars (e.g. retail, other entertainment). We have considered and tested the following alternative measures: volume of bars, density of bars, both volume and density of

bars and a 'weighted' bar measure that is equivalent to the measure used in the PAF (bar density at Local Authority/Community Safety Partnership (CSP) level multiplied by the number of bars in a CSP area as a share of the number of bars in the PFA). Force area shares for all of these measures are estimated at the PFA level as well as at the CSP level which is then summed to the PFA level.

19   When comparing the different bar measures we considered their impact on allocations across all force areas when used in combination with other indicators in the model. We recognise there will always be some anomalies when using data at different levels of aggregation, for example where bar volume is spread over a wider or smaller geographic area, and also when considering the number of local authorities in a PFA varies from two to 32 local authorities. We will, however, continue testing alternative options for the bar measure before the final model is complete.

20   In terms of other measures of alcohol consumption, although there is some limited evidence to suggest that drinking at home/pre-loading is an issue, there is no suitable data available to capture this. However it is reasonable to conclude that any impact on police resources for this aspect is captured in the existing model indicators which are also highly correlated with Accident and Emergency alcohol-related hospital admissions.

21   On this basis we concluded that bar volume and density estimated at PFA level provided a measure that best captures the night time economy and wider potential impacts on police workloads. Annex B sets out the shares for each force area when using a combined density and volume measure.

22   We also considered other environmental characteristics but concluded the bar measure was still the best indicator. For example, population density correlated very highly with the population indicator; a specific indicator for sparsity did not generally benefit force areas with more sparsity, i.e. more rural forces, mainly because it would have a small weight in the model and take weight away from the remaining indicators; and data on roads is not collected at a sufficient level of aggregation to ensure statistical robustness as it is only available at upper tier local authority level.

WHY REMOVE THE TAX BASE INDICATOR?

23   The tax base indicator included in the consultation model - the volume of Band D equivalent properties in a PFA - is a DCLG measure that is constructed to capture ability to raise precept revenue. 'Equivalent' means the indicator is already a standardised measure (it converts all banded properties into band D using a standard DCLG scale), and when it is expressed in terms of per head of the population the data across PFAs is fairly evenly distributed across force areas – see Annex E. This means the measure is less effective in capturing the ability to raise

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precept income than was intended as it effectively distributed around 16% of total police funding fairly evenly across all force areas. This meant that, contrary to what was intended, lower precept force areas did not necessarily benefit from inclusion of the measure within the model.

24   We have tried alternative measures of including a direct tax base indicator in the funding model (e.g. including the indicator but with a lower and fixed weight) but this did not resolve the issue for lower precept forces. This is largely because including a tax base indicator directly in the model will always take some of the weighting away from the remaining indicators (e.g. a force area might gain funding from the tax base indicator but lose funding as a result of a lower weight on the population).

25   We therefore concluded that it was virtually impossible to include an indicator in the model to directly address the ability to generate precept income, especially when the main objective of a funding model is to allocate funding based on relative need. In addition, the tax base indicator correlates strongly with existing socio-economic indicators in the model (which is why it resulted in a high 16% weight) which already helps to direct more funding to areas with higher levels of deprivation which tend to have a lower tax base.

26   Determining future levels of precept is out of scope for the funding model and is a local decision for Police and Crime Commissioners. It will also depend on decisions around council tax referendum thresholds which are being discussed as part of Spending Review negotiations.

WHY EXCLUDE NON-CRIME DEMAND INDICATORS?

27   We have collected data on a number of different non-crime related measures that were suggested in the consultation responses, for example children looked after, in need or subject to a child protection plan; mental health admissions episodes; A&E alcohol related admissions; as well as Multi-Agency Public Protection Arrangement (MAPPA) and Multi-Agency Risk Assessment Conference (MARAC) caseloads. In general we observe that the data are not always aggregated to the level we require for statistical robustness (i.e. at CSP level to estimate weights of importance and at PFA level to estimate shares of data across forces). More importantly, we find that apart from MARAC cases (which are non-statutory and where numbers of cases are partly determined by local decision making and so a poor measure of demand) all of the remaining non-crime indicators are highly correlated with the existing indicators in the model.

28   This means the existing indicators in the model already capture the relative risk of this type of demand for each PFA. When two indicators are highly correlated they would be assigned a similar weight of importance in the model (so the

combined weight for two highly correlated indicators would broadly equate to the weight that one of those indicators would receive if included as a standalone in the model). In addition, PFA shares across the existing indicators in the model and the non-crime indicators are fairly consistent. In general this means that allocations for PFAs may not significantly change when switching to different types of indicators, especially when moving average data is used. However, we recognise there will always be some differences across indicators for PFAs. Annex F provides correlation coefficients for the non-crime indicators considered and the indicators included in the funding model.

29   In response to the consultation process, we considered other indicators (including different cuts of population data and education and tourism data) but concluded that they were not suitable for inclusion in the funding model for a number of reasons, including lack of statistical robustness, insufficient coverage/geographical breakdown across England and Wales, less comparability across all PFAs, as well as high levels of correlation with the population and /or population characteristics data already included in the model.

WHY INCLUDE AN AREA COST ADJUSTMENT?

30   An Area Cost Adjustment (ACA) has been applied to police funding allocations since 1991/92 and is widely used across Local Government. The ACA was introduced to take into account local wage levels and local rents to reflect the fact that local authorities need to compete for these resources within the local economy. DCLG calculate the ACA which reflects two kinds of differences between areas: labour costs (around 80% of weighting in the index) and business rates paid on local authority premises. We originally considered applying a specific uplift to force areas that have wage costs significantly above the national trend (for example in London where mandatory weightings are added to all salaries) but this proved difficult to fully substantiate in the absence of robust data. We therefore concluded that it would be best to use the established ACA index - see Annex G.

31   The process for applying the index is: 1) estimate initial PFA allocations using the four weighted factors in the model, 2) apply the index so that any force area with a value above 1 will have their allocation inflated to reflect their regional cost pressure, and 3) rescale all force level allocations back so that total funding remains the same (when the ACA index is applied this inflates total funding because the minimum value on the index is 1). The indicative force level shares based on the 2015/16 funding envelope set out in the Policing Minister's letter of 8 October are *after* the application of the ACA.

ADDITIONAL INFORMATION ON THE WEIGHTING PROCESS FOR INDICATORS

32   To estimate force allocations a weight of importance is needed for each of the four indicators in the model. A standard statistical technique called Principal Component Analysis is used to do this.

33   When the four indicators are entered into the PCA process, the first principal component is strongly correlated with the population and socio-economic indicators (as expected) and to a lesser extent for the bar measure as this is in part a density measurement. The component matrix estimates factor loadings for each of the indicators that can then be converted into weights. These factor loadings are in effect correlations between the four indicators after a normalisation process has taken place. That is, the data have been transformed so they have a zero mean and one standard deviation which allows a comparison to be made across the indicators otherwise the differences in scale and distribution for each of the indicators would have undue influence on the factor loadings.

34   To illustrate the process in more simple terms, if 10 highly correlated indicators were entered into the PCA process it would recognise the close relationship between them and estimate factor loadings that would convert into weights that are fairly equal i.e. close to 10% each. If only five indicators were entered the factor loadings would convert into weights that are fairly close to 20% each. When an indicator is different to other indicators, for example the bar density and volume measure PCA will recognise this variance and assign it a lower factor loading and consequently a lower weight.

35   To test whether the PCA process is assigning weights which are sufficiently robust to be used as the basis for a funding model we also calculated weights directly converted from correlation coefficients for each of the indicators with police recorded crime (without normalisation). There is a general level of consistency between correlation and PCA weights (see Annex H).

36   The use of PCA to derive weights of importance on objective indicators to represent police demand has been subject to a peer review process by independent academic experts who have carried out a wider review of the funding model. They recognise the new model is a departure from one that relies on using police demand data but have been supportive of our approach. Annex H provides the factor loadings and weights for the four indicators in the funding model.

FINALISING THE FUNDING MODEL

37   To date we have used the new funding model to allocate the 2015/16 funding envelope between force areas. The funding model will be further refined as follows:

> ➢ The latest data available for the indicators – we will use a three year moving average for population (2016/17, 2015/16 and 2014/15); a three year moving average for Urban Adversity and the bar measure (2015, 2014 and 2013). As the unemployed households with dependent children is a census variable we will continue with the 2011 Census data.
> ➢ Final weightings - using the latest data for the indicators.
> ➢ Any refinements in light of further comments through the post consultation period and the peer review process.
> ➢ Further quality assurance processes.
> ➢ Final allocations and the transition process can only be completed once the outcome of the Spending Review is known, including decisions around National and International Capital City (NICC) grant funding for London forces.

38   A graphic to summarise the refined model is provided in Annex I and Annex J provides detail on the data sources used for the model indicators. Finally Annex K sets out the mathematical equation to represent the new model.

ANNEX A: CORRELATIONS BETWEEN MODEL INDICATORS AND CRIME

Correlations

		mid15pop_movingav	acorn5	noadultsemp_depkids	barssqperhec	PRC
mid15pop_movingav	Pearson Correlation	1	.828**	.916**	.118*	.893**
	Sig. (2-tailed)		.000	.000	.029	.000
	N		344	344	344	344
acorn5	Pearson Correlation	.828**	1	.917**	.175**	.842**
	Sig. (2-tailed)	.000		.000	.001	.000
	N	344	344	344	344	344
noadultsemp_depkids	Pearson Correlation	.916**	.917**	1	.166**	.919**
	Sig. (2-tailed)	.000	.000		.002	.000
	N	344	344	344	344	344
barssqperhec	Pearson Correlation	.118*	.175**	.166**	1	.380**
	Sig. (2-tailed)	.029	.001	.002		.000
	N	344	344	344	344	344
PRC	Pearson Correlation	.893**	.842**	.919**	.380**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	344	344	344	344	344

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Key:

'mid15pop_movingav = population

'acorn5' = Urban Adversity

'noadultsemp_depkids' = unemployed households with dependent children

'barssqperhec' = bar density and volume measure

'PRC' = Police Recorded Crime

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ANNEX B: INDICATOR SHARES FOR POLICE FORCE AREAS

Police force area	Population volume	Households with no adults employed and dependent children	Urban adversity	Volume and density of bars
	(weighting of 30%)	(weighting of 31%)	(weighting of 31%)	(weighting of 8%)
Avon & Somerset	2.9%	2.3%	2.0%	1.6%
Bedfordshire	1.1%	1.0%	0.7%	0.4%
Cambridgeshire	1.4%	1.0%	0.9%	0.3%
Cheshire	1.8%	1.5%	1.7%	1.2%
City of London	-	-	-	-
Cleveland	1.0%	1.5%	1.7%	0.9%
Cumbria	0.9%	0.6%	0.9%	0.2%
Derbyshire	1.8%	1.7%	2.0%	1.5%
Devon & Cornwall	3.0%	2.2%	1.9%	1.1%
Dorset	1.3%	0.8%	0.7%	0.5%
Durham	1.1%	1.3%	1.7%	0.5%
Dyfed Powys	0.9%	0.8%	0.6%	0.2%
Essex	3.1%	2.6%	2.1%	1.1%
Gloucestershire	1.1%	0.6%	0.7%	0.4%
Greater Manchester	4.8%	6.1%	6.7%	10.4%
Gwent	1.0%	1.3%	1.4%	0.6%
Hampshire	3.4%	2.6%	2.3%	1.6%
Hertfordshire	2.0%	1.4%	1.3%	1.3%
Humberside	1.6%	1.8%	1.9%	0.6%
Kent	3.1%	2.9%	2.2%	1.7%
Lancashire	2.6%	2.6%	1.9%	1.7%
Leicestershire	1.8%	1.5%	1.5%	0.8%
Lincolnshire	1.3%	1.0%	0.9%	0.3%
Merseyside	2.4%	3.5%	3.9%	5.0%
MOPAC	14.9%	18.8%	15.9%	36.1%
Norfolk	1.5%	1.3%	1.3%	0.3%
North Wales	1.2%	1.1%	1.2%	0.3%
North Yorkshire	1.4%	0.8%	0.9%	0.4%
Northamptonshire	1.2%	1.0%	1.0%	0.4%
Northumbria	2.5%	3.0%	5.0%	0.9%
Nottinghamshire	1.9%	2.1%	2.6%	1.1%
South Wales	2.3%	2.9%	2.5%	1.9%
South Yorkshire	2.4%	2.9%	4.3%	2.4%
Staffordshire	1.9%	1.7%	2.2%	1.3%
Suffolk	1.3%	1.0%	1.0%	0.4%
Surrey	2.0%	1.0%	0.7%	1.2%
Sussex	2.9%	2.1%	1.6%	1.5%
Thames Valley	4.1%	2.7%	2.1%	1.7%
Warwickshire	1.0%	0.7%	0.6%	0.6%
West Mercia	2.2%	1.6%	1.7%	0.8%
West Midlands	4.9%	7.3%	8.1%	8.5%
West Yorkshire	4.0%	4.4%	4.9%	5.9%
Wiltshire	1.2%	0.9%	0.8%	0.4%

* Table updated to reflect quality assurance processes which are still ongoing; shares are therefore subject to change.

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ANNEX C: CENSUS SHARES FOR UNEMPLOYED HOUSEHOLDS WITH DEPENDENT CHILDREN

Unemployed households with dependent children		
Police Force Area	Census 2001	Census 2011
Avon & Somerset	2.1%	2.3%
Bedfordshire	0.9%	1.0%
Cambridgeshire	0.9%	1.0%
Cheshire	1.5%	1.5%
City of London	0.0%	0.0%
Cleveland	2.1%	1.5%
Cumbria	0.8%	0.6%
Derbyshire	1.7%	1.7%
Devon & Cornwall	2.5%	2.2%
Dorset	0.9%	0.8%
Durham	1.3%	1.3%
Dyfed Powys	1.0%	0.8%
Essex	2.4%	2.6%
Gloucestershire	0.7%	0.6%
Greater Manchester	6.0%	6.1%
Gwent	1.5%	1.3%
Hampshire	2.4%	2.6%
Hertfordshire	1.2%	1.4%
Humberside	1.9%	1.8%
Kent	2.6%	2.9%
Lancashire	2.8%	2.6%
Leicestershire	1.4%	1.5%
Lincolnshire	0.9%	1.0%
Merseyside	4.4%	3.5%
MOPAC	18.7%	18.8%
Norfolk	1.1%	1.3%
North Wales	1.3%	1.1%
North Yorkshire	0.8%	0.8%
Northamptonshire	0.9%	1.0%
Northumbria	2.9%	3.0%
Nottinghamshire	2.3%	2.1%
South Wales	3.2%	2.9%
South Yorkshire	2.9%	2.9%
Staffordshire	1.7%	1.7%
Suffolk	0.9%	1.0%
Surrey	0.9%	1.0%
Sussex	2.1%	2.1%
Thames Valley	2.3%	2.7%
Warwickshire	0.6%	0.7%
West Mercia	1.6%	1.6%
West Midlands	7.0%	7.3%
West Yorkshire	4.4%	4.4%
Wiltshire	0.7%	0.9%

ANNEX D: DEFINITIONS OF URBAN ADVERSITY AND HARD PRESSED (ACORN 5)

Hard Pressed	Urban Adversity
Low income, larger families, semis	Young families in low cost private flats
Low income, older people, small semis	Struggling younger people in mixed tenure
Low income, routine jobs, terraces and flats	Young people in small, low cost terraces
Low income families, terraced estates	Poorer families, many children, terraced housing
Families and single parents, semis and terraces	Low income terraces
Large families and single parents, many children	Multi-ethnic, purpose-built estates
Single elderly people, council flats	Deprived and ethnically diverse in flats
Single parents and pensioners, council terraces	Low income large families in social rented semis
Families and single parents, council flats	Social rented flats, families and single parents
Old people, many high-rise flats	Singles and young families, some receiving benefits
Singles and single parents, high-rise estates	Deprived areas and high-rise flats
Multi-ethnic purpose built estates	

* For details of CACI Ltd's classifications refer to:
www.acorn.caci.co.uk/downloads/Acorn-User-guide.pdf

ANNEX E: SHARES FOR THE TAX BASE INDICATOR

Police Force Area	Tax base	Tax base per head
Avon & Somerset	3.0%	2.4%
Bedfordshire	1.1%	2.2%
Cambridgeshire	1.5%	2.4%
Cheshire	2.0%	2.5%
City of London	0.0%	0.0%
Cleveland	0.8%	1.9%
Cumbria	0.9%	2.5%
Derbyshire	1.7%	2.2%
Devon & Cornwall	3.2%	2.5%
Dorset	1.6%	2.7%
Durham	0.9%	2.0%
Dyfed Powys	1.2%	3.1%
Essex	3.4%	2.5%
Gloucestershire	1.2%	2.6%
Greater Manchester	3.9%	1.9%
Gwent	1.2%	2.8%
Hampshire	3.6%	2.5%
Hertfordshire	2.4%	2.8%
Humberside	1.4%	2.0%
Kent	3.3%	2.5%
Lancashire	2.3%	2.1%
Leicestershire	1.7%	2.1%
Lincolnshire	1.2%	2.2%
Merseyside	1.9%	1.8%
MOPAC	15.0%	2.4%
Norfolk	1.5%	2.3%
North Wales	1.6%	3.1%
North Yorkshire	1.6%	2.6%
Northamptonshire	1.2%	2.3%
Northumbria	2.1%	1.9%
Nottinghamshire	1.7%	2.0%
South Wales	2.7%	2.7%
South Yorkshire	1.9%	1.8%
Staffordshire	1.8%	2.2%
Suffolk	1.3%	2.4%
Surrey	2.7%	3.1%
Sussex	3.3%	2.7%
Thames Valley	4.7%	2.7%
Warwickshire	1.1%	2.6%
West Mercia	2.3%	2.5%
West Midlands	3.7%	1.8%
West Yorkshire	3.4%	2.0%
Wiltshire	1.3%	2.6%
	100.0%	100.0%

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ANNEX F: CORRELATIONS BETWEEN MODEL INDICATORS AND NON-CRIME INDICATORS

	Population	Households where no adults in employment with dependent children	Acorn 5: Urban Adversity	Volume and density of bars
Total MAPPA offenders	0.978	0.991	0.958	0.966
MAPPA - total level 2 and 3 (management of offenders)	0.870	0.870	0.779	0.888
MARAC cases (high risk cases of domestic abuse)	0.376	0.382	0.443	0.306
Children looked after at 31 March 2014	0.940	0.970	0.967	0.924
Children in need at 31 March 2014	0.984	0.990	0.960	0.963
Children who were the subject of a child protection plan at 31 March 2014	0.968	0.974	0.961	0.942
Finished mental health admissions episodes	0.949	0.939	0.884	0.945
A&E alcohol-related hospital admissions	0.933	0.937	0.929	0.892
Missing persons	0.905	0.919	0.895	0.903

Official - Sensitive

ANNEX G: AREA COST ADJUSTMENT INDEX

Police Force Area	ACA Index
Avon & Somerset	1.032
Bedfordshire	1.0507
Cambridgeshire	1.0424
Cheshire	1.0137
City of London	1.5203
Cleveland	1
Cumbria	1
Derbyshire	1
Devon & Cornwall	1
Dorset	1
Durham	1
Dyfed Powys	1
Essex	1.035
Gloucestershire	1.0223
Greater Manchester	1.0194
Gwent	1
Hampshire	1.0461
Hertfordshire	1.0924
Humberside	1
Kent	1.0133
Lancashire	1
Leicestershire	1
Lincolnshire	1
Merseyside	1.006
MOPAC	1.177
Norfolk	1
North Wales	1
North Yorkshire	1
Northamptonshire	1.0131
Northumbria	1
Nottinghamshire	1.0115
South Wales	1
South Yorkshire	1
Staffordshire	1
Suffolk	1.0027
Surrey	1.1336
Sussex	1.0128
Thames Valley	1.0971
Warwickshire	1.0245
West Mercia	1
West Midlands	1.0134
West Yorkshire	1.0031
Wiltshire	1.025

ANNEX H: FACTOR LOADINGS AND WEIGHTS FOR MODEL INDICATORS

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.814	70.348	70.348	2.814	70.348	70.348
2	.963	24.084	94.432			
3	.170	4.244	98.675			
4	.053	1.325	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Comp...
	1
mid15pop_movingav	.944
acorn5	.950
noadultsemp_depkids	.980
barssqperhec	.243

Extraction Method: Principal
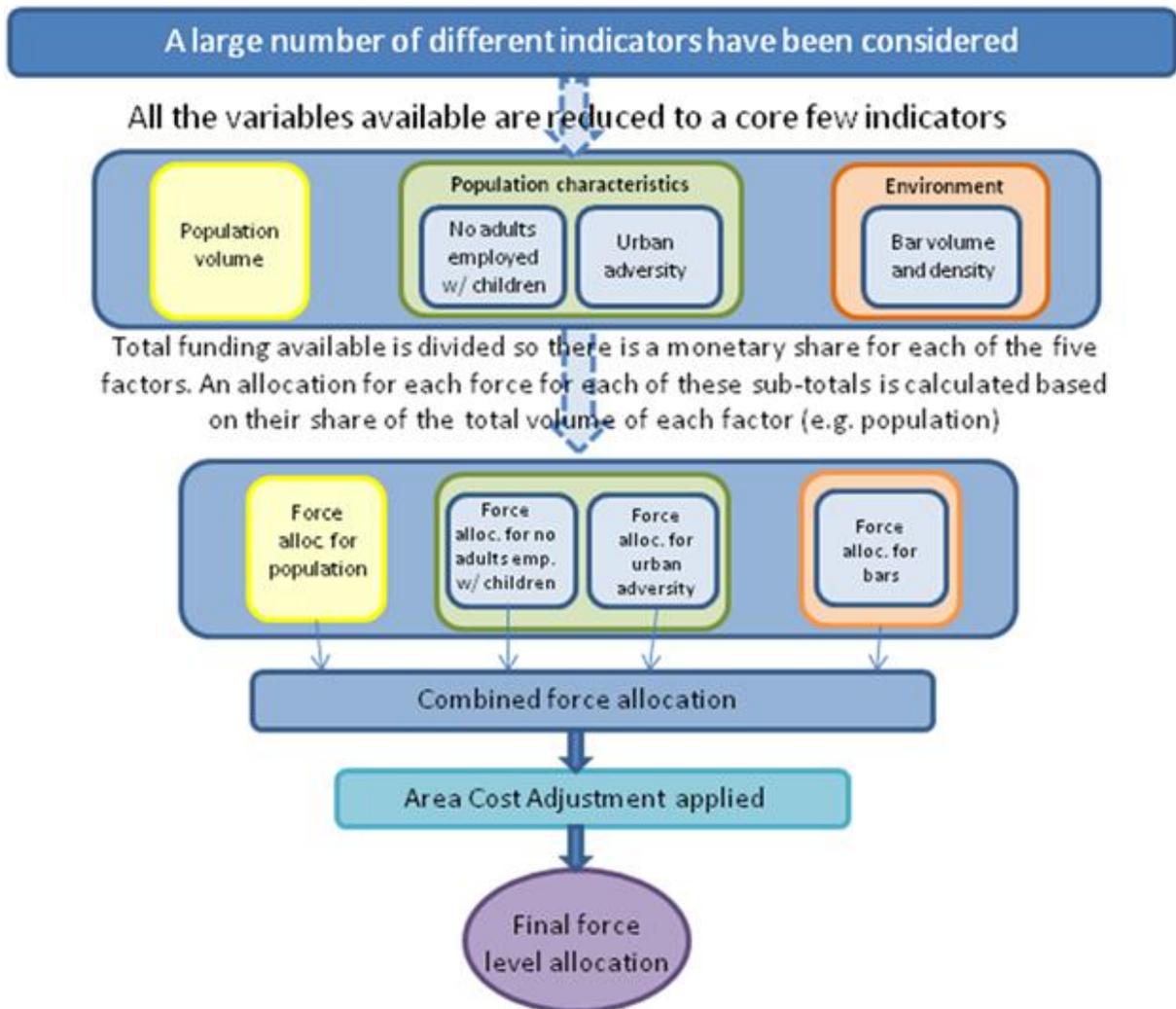Component Analysis.

a. 1 components extracted.

Comparison of PCA weights with correlation coefficient weights (with Police Recorded Crime)

Indicator	Factor loading	PCA weight (normalised)	Correlation coefficient weight (not normalised)
Population	0.94	0.30	0.28
Urban Adversity	0.95	0.31	0.28
Unemployed households with dependent children	0.98	0.31	0.31
Bar density and volume	0.24	0.08	0.13

Note: The three tables show 1) the four indicators in the final model explain just over 70% of the variance in the first component, 2) the component matrix provides the four factor loadings which are correlation coefficients after the data for the indicators is normalised, and 3) the factor loadings converted into weights and compared correlation coefficients weights with police recorded crime.

ANNEX I: A SUMMARY OF THE REFINED POLICE FUNDING MODEL

ANNEX J: DATA SOURCES FOR THE INDICATORS IN THE FUNDING MODEL

Indicator	Source	Frequency of updates
Population	Sub-national population projections produced by the ONS for England and StatsWales for Wales	Every two years for England. Welsh update to be determined
Households with no adults employed and dependent children	Produced by the ONS through the Census	Every ten years
Urban Adversity	Part of the Acorn classifications produced by CACI Limited	Annually
Bar density and bar volume	Draws on: • Units of bars as defined by the 2007 SIC 56.3 (licensed clubs, public houses and bars) from the Inter-Departmental Business Register produced by the ONS • Area in hectares produced by the ONS through the Census	• Data on bars updated annually • Data on area in hectares updated every ten year

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ANNEX K: REFINED POLICE FUNDING MODEL IN EQUATION FORM

Allocation for Force i =

$$\{[(X1_i/\textstyle\sum X1)(Y)(X1^w)] + [(X2_i/\textstyle\sum X2)(Y)(X2^w)] + [(X3_i/\textstyle\sum X3)(Y)(X3^w)] + [(X4_i/\textstyle\sum X4)(Y)(X4^w)]\} \times [(V_i)(Y/Y^v)]$$

Where

i represents 1 to 42 PFAs and $\sum$ represents the sum of PFAs 1 to 42 for any one indicator (City of London Police is excluded)

$X1_i$ = Population for Force i

$X2_i$ = Unemployed households with dependent children for Force i

$X3_i$ = Urban Adversity for Force i

$X4_i$ = Bar density and volume for Force i

Y = Total Police Grant to be put through funding model

$X1^w$ = Weight for population

$X2^w$ = Weight for unemployed households with dependent children

$X3^w$ = Weight for urban adversity

$X4^w$ = Weight for bar density and volume

V_i = Area Cost Adjustment weight for Force i

Y^v = Total police grant when inflated by ACA