National Audit Office

Local government report
by the Comptroller and Auditor General

Local government

Variation in spending by fire and rescue authorities 2011-12 to 2013-14

NOVEMBER 2015

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Variation in spending by fire and rescue authorities 2011-12 to 2013-14

Report by the Comptroller and Auditor General

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Contents

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Summary

Objectives

1 On 4 November 2015 the National Audit Office (NAO) published *Financial sustainability of fire and rescue services*. This report contained analysis of potential factors underlying variation in spend per capita between fire and rescue authorities. This was done to examine the finding in the Knight Review that variation in spend was 'inexplicable'.[1] The purpose of the NAO's analysis was to test this assumption rather than to provide a definitive statement of factors underlying the variation.

2 This current paper sets out the methodology underlying our analysis. Specifically, the analysis tests the proposition that variation in spending can be predicted, in part, by variation in factors that influence how fire and rescue authorities operate.

Methods

3 The amount spent by each fire and rescue authority will be influenced by the character of the area that it serves. This affects both the risk profile for a population, for example the number of vulnerable people in the area, and the costs of providing that cover, for example whether the population is scattered across rural areas. Variation in spending will also reflect the different decisions fire and rescue authorities take about how fire cover is provided. Finally, spending will be influenced by any differences between actual and expected demand.

4 Using a linear regression model, the work quantifies the relative contribution of these different factors to variation in spend per capita by fire and rescue authorities. Five measures have been selected to represent the three influences on variation in spending: one measure each for risk/cost and actual demand and three measures for local decisions.

1 Sir Ken Knight, *Facing the future: Findings from the review of efficiencies and operations in fire and rescue authorities in England,* Department for Communities and Local Government, May 2013, pp. 5, 7, 16–20.

Results

5 Our measure of risk and cost, the fire Relative Needs Formula (RNF), is the single strongest predictor of variation in fire and rescue authorities' spending over the 3-year period.[2] Variation in this measure predicts approximately 46% of variation in spending. The measure of local demand is the weakest predictor of variation. It predicts approximately 8% of variation in spending. The measures for local decisions include variation in the quantity and unit cost of whole-time firefighters and the contribution of retained duty system firefighters.[3] Together these three measures of local decisions predict 26% of variation in spending.

6 Modelling the three different factors sequentially illustrates their additive contribution to variation in spending. The measure of risk and cost factors accounts for 46% of variation in spending. When the measure of actual demand is added, the two together account for 48% of variation. When the measures of local decision factors are added, the proportion of variation explained increases to 62%. This suggests that the local decision factors help predict approximately 14% of variation in spending, over and above the impact of the other factors.

Limitations and mitigation

7 Any analysis of this kind is subject to limitations and these should be kept in mind when assessing the conclusions of the work. For instance, our analysis is constrained by our use of the fire RNF to represent variation in risks and costs, as this measure is also used in the funding allocation model for fire and rescue services. This creates a potentially circular connection between the method used to fund fire and rescue authorities and the amount that they spend.

8 To address this we tested our model using a model that did not include the RNF measure, using an alternative measure of risk and cost instead. This alternative risk and cost measure predicts a lower proportion of variation than the one based on the RNF (27% compared with 46%). Its use also increased the proportion of variation explained by the factor for local decisions (17% compared with 14%). Overall, the alternative measure of risks and costs, together with factors for actual demand and for local decisions, explains nearly half the variation in spending (45%).

2 The fire Relative Needs Formula is developed by the Department for Communities and Local Government and estimates relative need based on a combination of the fire risk and cost characteristics of a locality.

3 Retained firefighters are part-timers who typically do other jobs in the local area, and mobilise when their station receives an emergency call.

Conclusion

9 Taken together, the two models used in this paper indicate that it is possible to explain a large element of the variation in spending per capita by fire and rescue authorities. While it may be possible to do further work to refine the specific contribution of risk, local demand and local decision-making factors, and to address any issues of circularity, our work demonstrates that differences in spend are not wholly 'inexplicable'.

10 It is important to note that the purpose of this work was to test whether it was possible to develop a more detailed understanding of the factors underlying variation in spending per head rather than to assess the scope for efficiencies in the sector. Consequently, our analysis does not invalidate the Knight Review's conclusion that there is scope for the sector as a whole to improve efficiency; in both our models there is unexplained variation, and there is also a clear role for the local decision-making factor. However, our work does suggest that it is possible to develop a more sophisticated understanding of the scale of any potential efficiencies, and a clearer picture of which authorities are more efficient and which are less so.

Part One

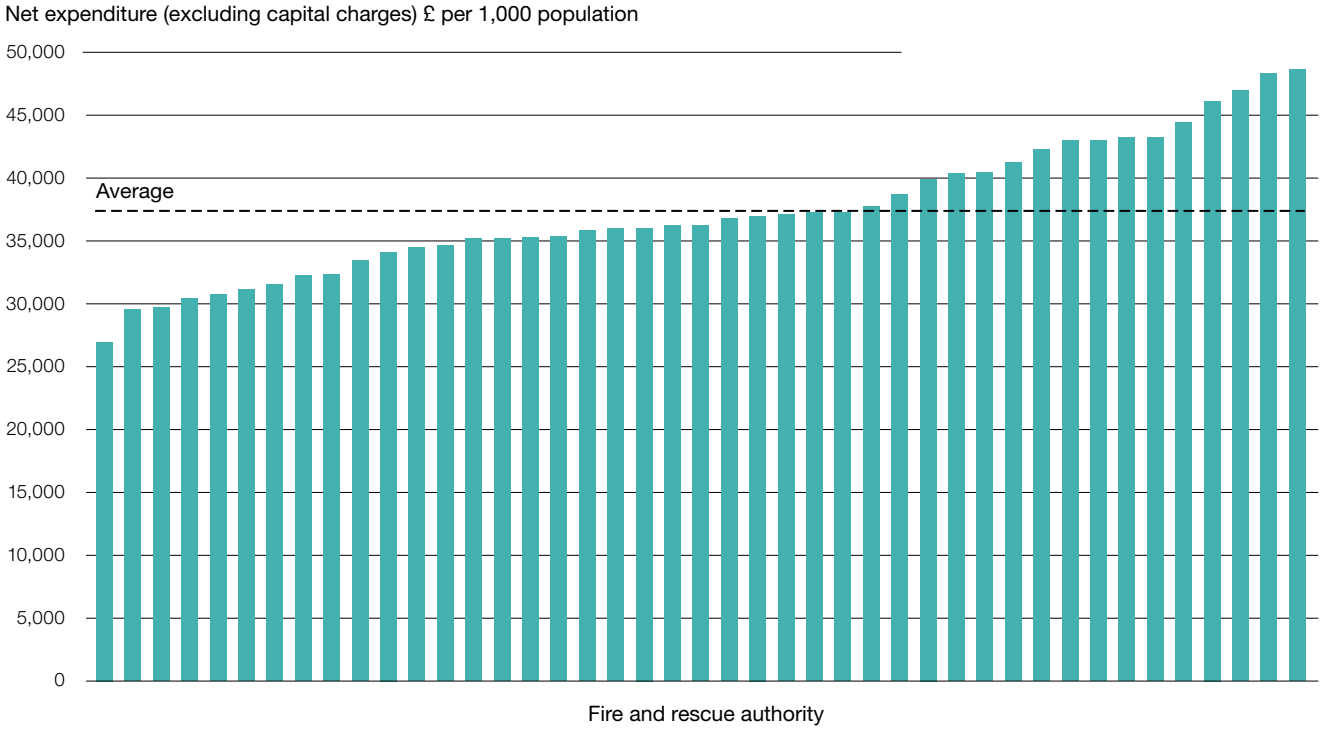
Context and concept

Variation in spend

1.1 Spending by fire and rescue authorities varies substantially. For example, in 2013-14, fire and rescue authorities spent £35,700 per 1,000 population. This amount varied between £26,945 and £48,606 (**Figure 1**). This paper explores the variation in spending and quantifies the role of different evidence in predicting that variation.[4]

Figure 1
Spend per 1,000 population, 2013-14

Spending by fire and rescue authorities varies substantially



Note
1 Data for two authorities are missing.

Source: National Audit Office analysis of the Chartered Institute of Public Finance and Accountancy data

4 Spending refers to net expenditure (excluding capital charges) £ per 1,000 population, from the Chartered Institute of Public Finance and Accountancy subjective analysis.

1.2 Reporting in 2013, the Knight Review found a similar pattern of variation and stated that there were "inexplicable differences in the expenditure of different fire and rescue authorities".[5] The purpose of our current analysis is to test this proposition. Our focus is therefore on assessing whether the variation is genuinely inexplicable, rather than seeking to explain the variation to the fullest extent.

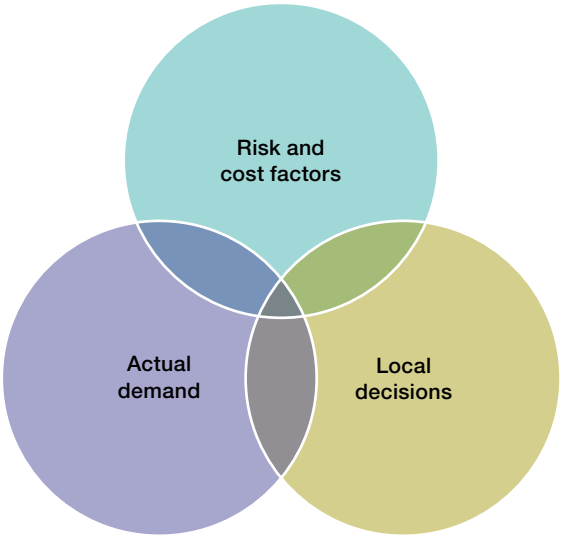
A conceptual model

1.3 This analysis tests the proposition that variation in spending can be predicted, in part, by variation in factors that influence how fire and rescue authorities operate (**Figure 2**). The amount spent by each fire and rescue authority will be influenced by the character of the area that it serves. This affects both the risk of fire within an area, for example the number of vulnerable people in the area, and the costs of providing that cover, for example whether the population is scattered across rural areas. Variation in spending will also reflect the different decisions fire and rescue authorities take about how fire cover is provided. Finally, spending will be influenced by any differences between actual and expected demand.

Figure 2

Influences on variation in spending by fire and rescue authorities

Differences in spending by fire and rescue authorities will reflect the interaction between three groups of factors



Source: National Audit Office

5 Sir Ken Knight, *Facing the future: Findings from the review of efficiencies and operations in fire and rescue authorities in England,* Department for Communities and Local Government, May 2013, pp. 5, 7, 16–20.

Assumptions

1.4 In practice it is far from clear how these different factors interact to predict variation in spending. This analysis uses a statistical approach to quantify the role played by different factors. Any statistical analysis will be a simplification, or model, of what actually happens in practice. It relies on assumptions to reduce complexity to a manageable level. This analysis is based on four assumptions. These are:

- different factors impact on spending sequentially not simultaneously. Risk and cost factors are the first influence on spending, followed by actual demand and then local decisions;
- risk and cost factors and actual demand are not under the control of the fire and rescue authority;
- fire and rescue authorities are responsible for decisions about the costs of providing fire cover, even though some of those costs will be the result of national decisions, for example about terms and conditions of service; and
- fire and rescue authorities are responsible for the costs of providing fire cover, even where some of those costs will be the result of decisions made some time in the past, for example retirement settlements.

Limitations

1.5 Any analysis of this kind is subject to limitations and these should be kept in mind when assessing the conclusions of the work. There are three main limitations of the approach described in this paper. These are:

- missing data – our data set does not include values for all possible measures for all fire and rescue authorities at each point in time. This analysis deals with a fixed group of fire and rescue authorities that reported values for a selected set of measures for each time period. As a result our analysis omits three fire and rescue authorities;
- number of firefighters – our data about numbers of firefighters measures whole-time firefighters in units of full-time equivalents (FTEs) and it measures retained duty system firefighters in units of '24 hours of cover'.[6] These two units of measurement are not consistent. As a result we cannot measure the quantity of retained firefighters directly and have to estimate their contribution based on their share of firefighter pay; and
- measures of risk and cost factors – our analysis uses a measure based on the Relative Needs Formula (RNF) to represent differences in the risk of fire and the costs of fire service cover. The RNF is part of the system for funding fire and rescue authorities therefore there is a potentially circular connection between the method used to fund fire and rescue authorities and the amount that they spend.

6 Retained firefighters are part-timers who typically do other jobs in the local area, and mobilise when their station receives an emergency call.

1.6 The limitations arising from missing data need to be kept in mind. They mean that our conclusions must be treated as indicative of what we would find with data for all fire and rescue authorities rather than definitive. In addition, our conclusions about the impact of retained firefighters on variation in spending are based on indirect measures.

1.7 The limitation arising from our choice of risk and cost factor is potentially more marked. If the measure we have used is one of the determinants of variation in spending then it will limit the additional amount of variation that can be attributed to other factors.

1.8 It is true that the RNF is part of the process for allocating formula funding to fire and rescue authorities. However, the RNF is designed to represent differences in the risks and costs of different fire and rescue authorities and it is only one of the four blocks that helped determine the level of funding to fire and rescue authorities in the period covered in the analysis.

Mitigation

1.9 In order to mitigate this limitation we designed a model with an alternative measure to represent risks and costs (Appendix Three). The measure is not part of the funding distribution. The alternative risk and cost factor predicts a lower proportion of variation than the one based on RNF and it does increase the proportion of variation explained by the factor for local decisions. It remains the case that alternative measure of risks and costs, together with factors for actual demand and for local decisions, explains nearly half the variation in spending.

Part Two

The model

Building the model

2.1 The purpose of the model is to quantify the relative contribution of different factors to variation in spending by fire and rescue authorities. By 'spending' we mean actual 'Net expenditure (excluding capital charges)', relative to population. We calculated our measure for three financial years using data from the Chartered Institute of Public Finance and Accountancy (CIPFA) Fire Services Statistics.[7] Spending figures have not been adjusted to a constant price base. Appendix One describes the steps taken to select a suitable set of data for the analysis. Five measures have been selected to represent the three influences on variation in spending; one measure each for risk/cost factors and actual demand and three measures for local decisions (**Figure 3** overleaf).

2.2 Our measure for risk/cost, fire Relative Needs Formula (RNF) relative to population, is the single strongest predictor of variation in fire and rescue authorities' spending over the 3-year period. It is positively associated with spending. Variation in this measure predicts approximately 46% of variation in spending (Appendix Two, Figure 9).

2.3 By contrast the measure of local demand is the weakest predictor of variation.[8] Like RNF, it is positively associated with variation in spending. It predicts approximately 8% of variation in spending (Appendix Two, Figure 10).

2.4 The three measures of local decisions represent variation in the quantity and unit cost of whole-time firefighters and the contribution of retained duty system firefighters.[9] The measures relating to whole-time firefighters are positively associated with spending and the retained duty measure is negatively associated with spending. Together, the three measures predict 26% of variation in spending (Appendix Two, Figure 11).

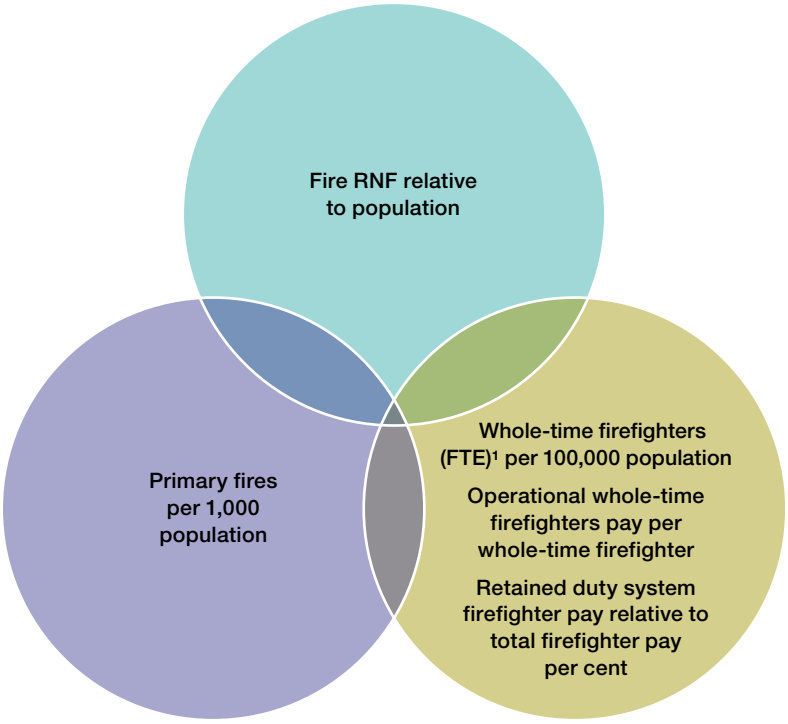
2.5 Modelling the three different factors sequentially illustrates their combined contribution to variation in spending (**Figure 4** on page 13). The measure of risk and cost factors accounts for 46% of variation in spending. When the measure of actual demand is added, the two together account for 48% of variation. When the measures of local decision factors are added to these, the proportion of variation explained increases to 62% (Appendix Two, Figure 12). This suggests that the local decision factors help predict approximately 14% of variation in spending, over and above the impact of the other factors.

7 Available at: www.cipfa.org/policy-and-guidance/publications/f/fire-and-rescue-service-statistics-2014-excel, for 2011-12, 2012-13 and 2013-14.
8 Primary fires per 1,000 population.
9 Retained firefighters are part-timers who typically do other jobs in the local area, and mobilise when their station receives an emergency call.

Figure 3

Predictors of variation in spending by fire and rescue authorities

Five measures have been selected to model variation in spending by fire and rescue authorities



Note

1 FTE = Full-time equivalent.

Source: National Audit Office

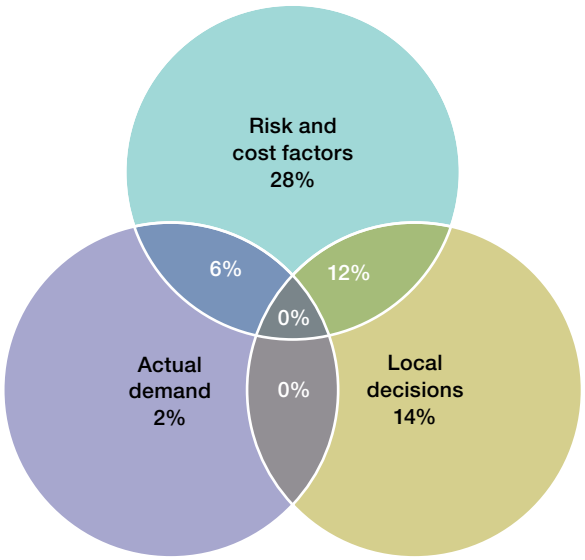
Reviewing the model

2.6 The model predicts approximately 62% of variation in spending and leaves 38% of variation that is not explained. Some of this 'unexplained' variation will not be possible to model because it is due to random variation or error in the measures. However, it is possible that we could explain more variation if we added different measures. Observing the impact of adding different measures to the model provides a good way to better understand how the model works and to test how far the selected measures provide a robust description of variation in spending.

Figure 4

Quantifying influences on variation in spending by fire and rescue authorities

Together, the three groups of factors account for approximately 62% of variation in spending[1]



Note

1 Values are approximate and rounded to zero decimal places.

Source: National Audit Office

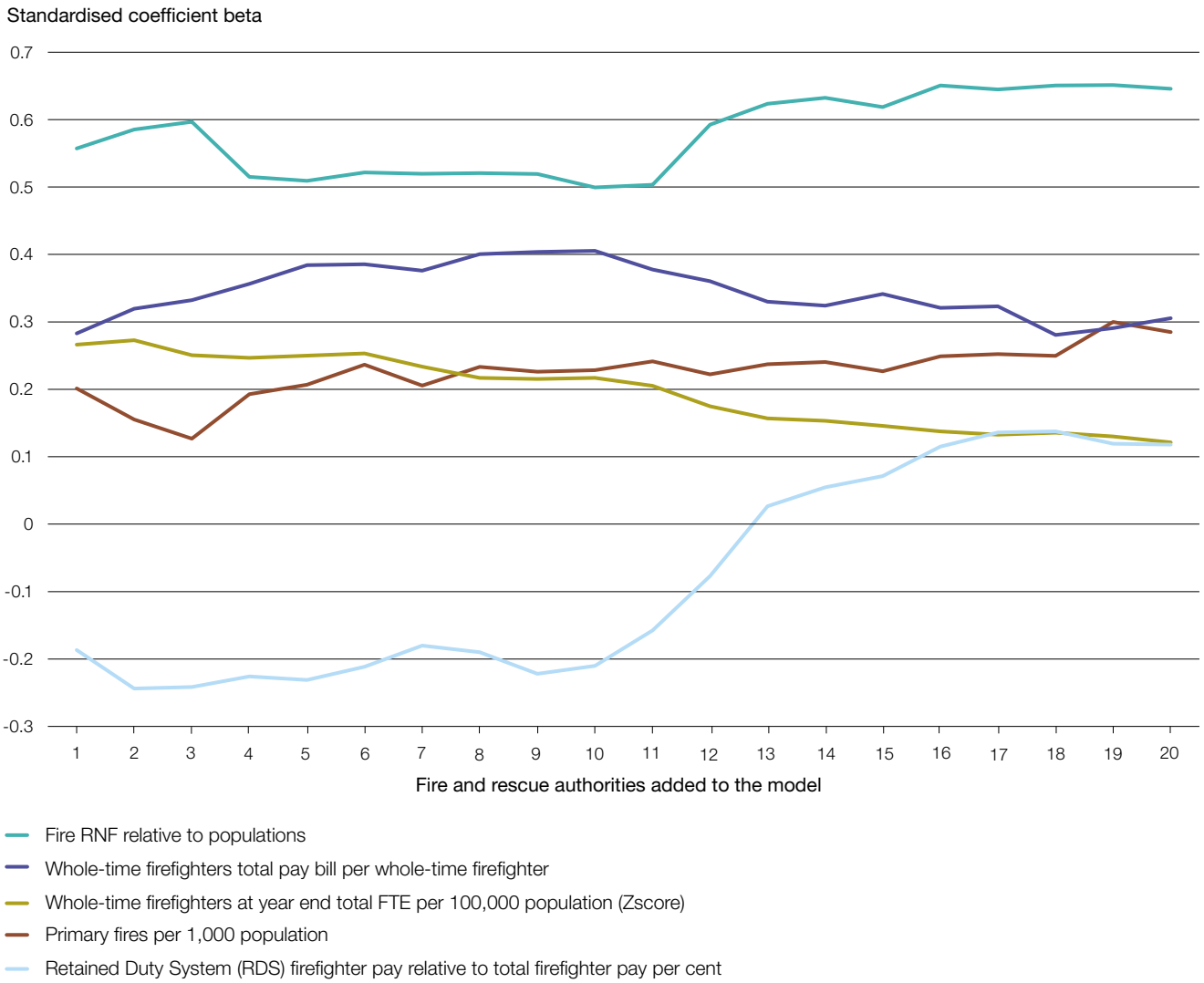
2.7 Appendix One describes the steps taken to select a suitable set of data for the analysis. It would not be appropriate to rebuild the model using measures that were excluded at that stage. However, we can observe the performance of the model if we add variables that isolate the influence of each fire and rescue authority. Theoretically, if we added variables for all fire and rescue authorities we would explain all variation; however, this is not our goal. Adding individual fire and rescue authorities to the model tests if, and how, the behaviour of the variables in the model changes when specific fire and rescue authorities are included. If all fire and rescue authorities had the same influence on variation in spending then the impact of adding any one fire and rescue authority would be the same as the impact of adding any other.

2.8 Under this approach fire and rescue authorities are added to the model based on the amount of extra variation they predict. The process continues until extra fire and rescue authorities do not make a statistically significant contribution to the variation predicted by the model. The contribution of the various measures in the model is sensitive to the first 4 or 5 fire and rescue authorities to be added to the model (**Figure 5** overleaf). This is not unexpected because there are likely to be a number of fire and rescue authorities whose spending diverges substantially from the prediction of the model.

Figure 5

Impact of adding individual fire and rescue authorities to the model

Adding a certain number of individual authorities increases the explanatory power of the model



Source: National Audit Office analysis of Department for Communities and Local Government, Office for National Statistics and Chartered Institute of Public Finance and Accountancy data

2.9 The nature of the contribution of most of the measures remains broadly stable until the 11th fire and rescue authority is added. At this point the model predicts approximately 81% of variation in spending, an increase of 19 percentage points from the initial model.

2.10 Once the 11th fire and rescue authority is added the contribution of certain measures starts to change. For example, the measure of retained duty system firefighters changes in size after 11 fire and rescue authorities are added and it changes direction, from negative to positive, when 13 fire and rescue authorities are added. The fire and rescue authorities added at this stage include those with the highest contributions of retained firefighters to staffing. The change in the contribution of this measure suggests that much of the impact of this factor in the initial model is due to a small number of fire and rescue authorities serving sparsely populated areas.

2.11 The contribution of the measure of whole-time firefighters reduces in importance with each additional fire and rescue authority. This suggests that levels of whole-time firefighter staffing in a minority of fire and rescue authorities is associated with making a distinctive contribution to predicting variation in spending that is not captured in the basic model. The contribution of the three remaining measures – RNF, primary fires and unit cost of whole-time firefighter staffing – remain broadly stable until the 10th and 11th fire and rescue authorities are added.

Conclusions

2.12 This analysis tests the proposition that variation in spending can be predicted, in part, by variation in factors that influence how fire and rescue authorities operate. The amount spent by each fire and rescue authority will be influenced by the character of the area that it serves. This affects both the risk for fire cover for its population, for example the number of vulnerable people in the area, and the costs of providing that cover, for example whether the population is scattered across rural areas. Variation in spending will also reflect the different decisions fire and rescue authorities take about the way fire cover is provided. Finally, spending will be influenced by any differences between actual and expected demand.

2.13 The purpose of the model is to quantify the relative contribution of different factors on variation in spending by fire and rescue authorities. Fire RNF relative to population is the single strongest predictor of variation in fire and rescue authorities' spending over the 3-year period. Variation in this measure predicts approximately 46% of variation in spending. The measure of local demand is the weakest predictor of variation. It predicts approximately 8% of variation in spending. The three measures of local decisions represent variation in the quantity and unit cost of whole-time firefighters and the contribution of retained duty system firefighters. Together, the three measures predict 26% of variation in spending.

2.14 Modelling the three different factors sequentially illustrates their combined contribution to variation in spending. The measures of risk and cost factors accounts for 46% of variation in spending. When the measure of actual demand is added, the two together account for 48% of variation. When the measures of local decision factors are added to these, the proportion of variation explained increases to 62%. This suggests that the local decision factors help predict approximately 14% of variation in spending, over and above the impact of the other factors.

2.15 We reviewed the operation of the model by observing the impact of adding variation associated with specific fire and rescue authorities directly to the model. This identified three things about the model:

- twelve fire and rescue authorities together make a substantial contribution to reducing the variation that is not explained by the model, and any review of outliers should focus on four or five of this group;
- the level of whole-time firefighter staffing in a minority of fire and rescue authorities is associated with making a distinctive contribution to predicting variation in spending that is not captured in the basic model; and
- the impact of the measure of retained duty system firefighter cover appears to be due in part to specific fire and rescue authorities serving sparsely populated areas. However, we do not have direct data about the retained staffing and this conclusion should be treated as tentative.

2.16 Any analysis of this kind is subject to limitations and these should be kept in mind when assessing the conclusions of the work. We do not have data for three fire and rescue authorities and therefore our conclusions must be treated as indicative of what we would find with data for all fire and rescue authorities rather than definitive. Our analysis is also constrained by our use of a measure taken from the RNF to represent variation in risks and costs. We tested our model using a model that did not include the RNF measure. The alternative risk and cost factor predicts a lower proportion of variation than the one based on RNF and it does increase the proportion of variation explained by the factor for local decisions. It remains the case that the alternative measure of risks and costs, together with factors for actual demand and for local decisions, explains nearly half the variation in spending.

Appendix One

Measures used in the analysis

Risk and cost factors

1 The fire Relative Needs Formula (RNF) for 2013-14 calculates a share of a total score based on the size of each fire and rescue authority's population, the characteristics of the population and the nature of the area that it serves. The purpose of the RNF is to help distribute formula funding and it is the latest incarnation of the methods central government has used to distribute funding to local bodies while taking account of local requirements. Using allocation formulae implies a goal of seeking to equalise levels of cover relative to levels of risk and cost.

2 The number of incidents requiring a fire and rescue authority response vary between fire and rescue authorities according to a range of 'need'-related factors. Formula funding seeks to adjust allocations and compensate fire and rescue authorities accordingly.

3 The main determinant of the RNF for the Fire and Rescue service block is projected population. This is topped up based on coastline,[10] population density and sparsity, deprivation, fire risk areas, fire safety enforcement and community fire safety.

4 The elements of the RNF appear to resolve into two components (**Figure 6** overleaf). One component (shown on the horizontal axis) is associated with indicators of risk for a fire service response, for example the risk of dwelling fires, the number of Control of Major Accident Hazards (COMAH) sites and the requirement for community fire safety education.[11]

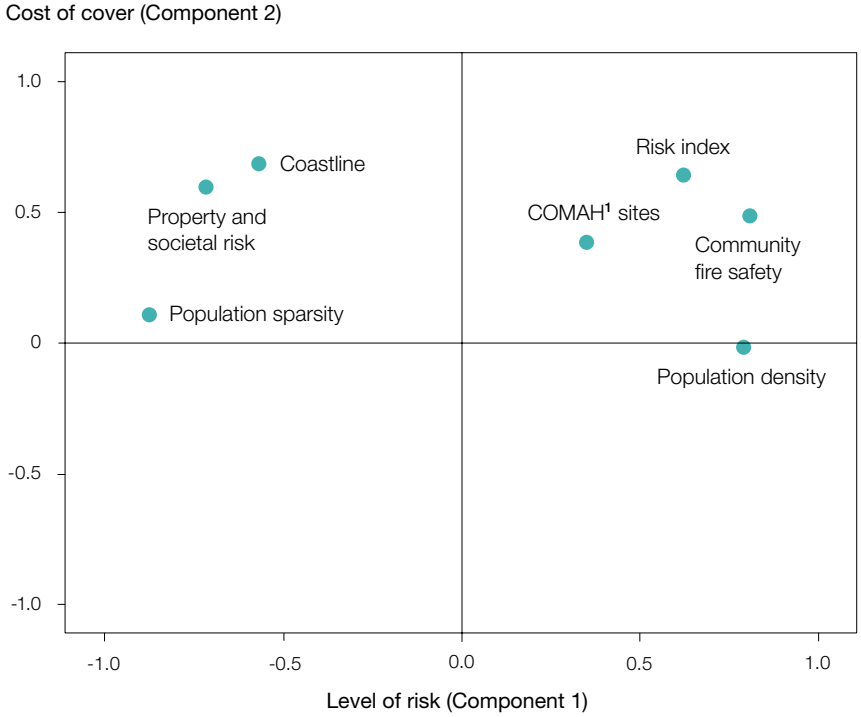
5 The second component is associated with indicators of cost of providing fire service cover, for example population sparsity, length of coastline and the number of buildings of different types.

10 Length of coastline is used as a measure of cost as it provides a proxy for the extent to which an authority can receive mutual aid support from surrounding fire authorities. Those with longer coastlines are less able to benefit from mutual aid and therefore may have to provide additional cover.

11 Control of Major Accident Hazards sites are those, such as oil or chemical refineries, containing dangerous substances of a particular quantity.

Figure 6
The components of Fire RNF 2013-14

The parts of the RNF appear to cluster around indicators of risk and indicators of cost



Note

1 Control of Major Accident Hazards sites are those, such as oil or chemical refineries, containing dangerous substances of a particular quantity.

Source: National Audit Office analysis of Department of Communities and Local Government, Office for National Statistics and Chartered Institute of Public Finance and Accountancy (CIPFA) data

Actual demand factors

6 Fire and rescue authorities respond to a wide range of types of incidents, including primary and secondary fires, road traffic incidents and special services. Individual incidents will also vary in terms of their impact in terms of harm to individuals and loss of property. It is not within the scope of this exercise to create a comprehensive measure. Instead, we need a simple way of capturing differences in the level of demand presented to individual fire and rescue authorities.

7 We selected 15 measures of fire service activity for 2011-12, 2012-13 and 2013-14 and assessed the degree of common variation between the available measures (**Figure 7**). A number of the measures are directly dependent on other measures, for example 'Primary fires in dwellings' is a component of 'Primary fires' and both are directly linked to 'All fires'.

Figure 7
Associations between measures of activity (2013-14)

We assessed the degree of common variation between the measures of activity

Measure of activity	Number of measures sharing an association[1]
Fatal and non-fatal casualties per 1,000 population	10
Non-fatal casualties per 1,000 population	10
Primary fires per 1,000 population	10
All fires per 1,000 population	9
Primary fires in dwellings per 1,000 population	9
Non-fatal casualties, excluding precautionary checks recommended and first aid cases per 1,000 population	8
Non-fatal casualties, hospital slight per 1,000 population	7
Non-fatal casualties, first aid per 1,000 population	6
Secondary fires per 1,000 population	5
Non-fatal casualties, hospital severe per 1,000 population	4
Primary fires in other buildings per 1,000 population	4
Non-fatal casualties, precautionary checks recommended per 1,000 population	3
Primary fires in non-domestic buildings per 1,000 population	3
Primary fires in road vehicles per 1,000 population	2
Fatal casualties per 1,000 population	0

Note

1 Correlation is less than -0.4 or greater than 0.4.

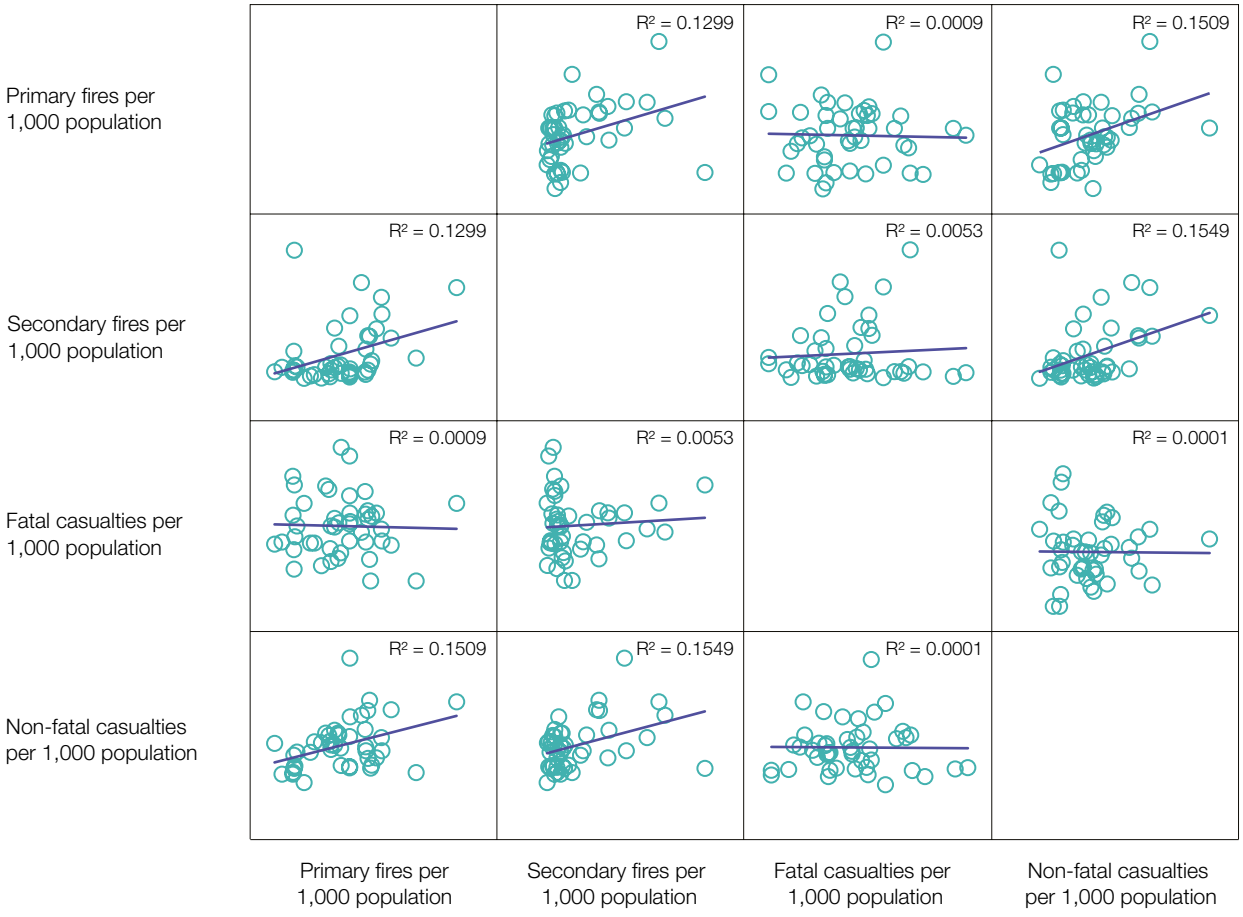
Source: National Audit Office analysis of Department of Communities and Local Government, Office for National Statistics and Chartered Institute of Public Finance and Accountancy data

8 Two indicators of casualty levels and one measure of fire activity share similar levels of association with the other indicators in the set. We have selected 'Primary fires per 1,000 population' as our preferred measure of activity. We selected this measure because it shares associations with many of the other measures and it is less dependent on other measures in the set, when compared with the two measures of casualty levels. The primary fires measure is dependent on four of the other measures in the set, whereas each of the casualty measures is dependent on at least six of the other measures. 'Primary fires per 1,000 population' is positively associated with both secondary fires and non-fatal casualties. None of the measures in the set appear to be associated with fatal casualties (**Figure 8**).

Figure 8

Associations between selected measures of activity (2013-14)

Primary fires per 1,000 population is positively associated with both secondary fires and non-fatal casualties



Source: National Audit Office analysis of Department of Communities and Local Government, Office of National Statistics and Chartered Institute of Public Finance and Accountancy data

Local decision factors

9 Our review of the RNF calculation suggests that spending by fire and rescue authorities, relative to population, will vary principally according to both fixed costs, for example, the level and cost of the fire service cover, and variable costs, for example the marginal costs of responding to incidents. Using data from CIPFA fire services statistics we reviewed the subjective and objective components of fire service activity most closely associated with variation in spending. For the purposes of this analysis 'spending' is defined as actual 'Net expenditure (excluding capital charges)', relative to population.

10 The CIPFA data contain detailed information about fire station crewing, staff structures and numbers, with breakdowns of pay and non-pay costs. Our review of the data indicates that total firefighter pay, relative to population, provides the strongest predictor of variation in spending. This is to be expected given the functions and structure of fire and rescue authorities. It indicates that the local decisions about the number and unit cost of staff are likely to be associated with variation in our measure of spending.

11 Firefighters make up approximately 80% of fire service staffing with the remainder divided between non-uniformed staff (16%) and control room staff (3%).[12] This implies that measures of the quantity and unit cost of firefighter staff should predict most variation in our measure of spending. In practice, the choice of measure is complicated by the fact that whole-time firefighters and retained duty system firefighters are counted on different bases.[13] As a result while we can represent both the quantity and unit costs of whole-time firefighters we have to capture the contribution of retained duty firefighters based on their pay as a percentage of total firefighter pay.

12 Full-time equivalent, all grades.

13 Retained firefighters are part-timers who typically do other jobs in the local area, and mobilise when their station receives an emergency call.

Appendix Two

Regression models

Figure 9

Regression model: Needs and cost factors

Dependent variable: Net expenditure (excluding capital charges) £ per 1,000 population

Adjusted R square value 0.456

	Unstandardised coefficients		Standardised		Sig.	Collinearity statistics	
	B	Std. error	Beta	t		Tolerance	VIF
(Constant)	6,453	3,117		2.070	0.040		
Period is 2012-13	-395	872	-0.034	-0.453	0.652	.753	1.328
Period is 2013-14	-996	877	-0.085	-1.136	0.258	.752	1.329
Fire Relative Needs Formula (RNF) relative to population	33,467	3,188	0.679	10.499	0.000	.999	1.001

Source: National Audit Office analysis of Department for Communities and Local Government, Office for National Statistics and Chartered Institute of Public Finance and Accountancy (CIPFA) data

Figure 10

Regression model: Actual demand factors

Dependent variable: Net expenditure (excluding capital charges) £ per 1,000 population

Adjusted R square value 0.082

	Unstandardised coefficients		Standardised		Sig.	Collinearity statistics	
	B	Std. error	Beta	t		Tolerance	VIF
(Constant)	24,691	3,864		6.390	0.000		
Period is 2012-13	1,829	1,285	0.156	1.423	0.157	.585	1.710
Period is 2013-14	1,342	1,335	0.114	1.006	0.316	.549	1.823
Primary fires per 1,000 population	8,395	2,293	0.370	3.661	0.000	.692	1.444

Source: National Audit Office analysis of Department for Communities and Local Government, Office for National Statistics and Chartered Institute of Public Finance and Accountancy data

Figure 11

Regression model: Local decision factors

Dependent variable: Net expenditure (excluding capital charges) £ per 1,000 population

Adjusted R square value 0.262

	Unstandardised coefficients		Standardised		Sig.	Collinearity statistics	
	B	Std. error	Beta	t		Tolerance	VIF
(Constant)	13,326	6,501		2.050	0.042		
Period is 2012-13	-833	1,020	-0.071	-0.817	0.415	.747	1.339
Period is 2013-14	-2,325	1,052	-0.198	-2.210	0.029	.710	1.408
Operational whole-time firefighters total pay bill per whole-time firefighter	0.630	0.149	0.355	4.236	0.000	.808	1.238
Retained duty system firefighter pay relative to total firefighter pay percentage	-23,076	5,336	-0.352	-4.324	0.000	.856	1.169
Whole-time firefighters at year end total FTE per 100,000 population (Zscore)	1,932	424	0.345	4.553	0.000	.989	1.011

Source: National Audit Office analysis of Department for Communities and Local Government, Office for National Statistics and Chartered Institute of Public Finance and Accountancy data

Figure 12

Regression model: All factors (sequential)

Dependent variable: Net expenditure (excluding capital charges) £ per 1,000 population

Adjusted R square value 0.62

	Unstandardised coefficients		Standardised		Sig.	Collinearity statistics	
	B	Std. error	Beta	t		Tolerance	VIF
(Constant)	-16,235	5,442		-2.984	0.003		
Period is 2012-13	470	840	0.040	0.560	0.577	.566	1.767
Period is 2013-14	-529	896	-0.045	-0.590	0.556	.504	1.985
Fire RNF relative to population	27,457	2,846	0.557	9.647	0.000	.876	1.141
Primary fires per 1,000 population	4,570	1,536	0.201	2.976	0.004	.639	1.566
Operational whole-time firefighters total pay bill per whole-time firefighter	0.502	0.108	0.283	4.661	0.000	.793	1.262
Retained duty system firefighter pay relative to total firefighter pay percentage	-12,236	3,956	-0.187	-3.093	0.002	.801	1.248
Whole-time firefighters at year end total FTE per 100,000 population (Zscore)	1,491	312	0.266	4.785	0.000	.944	1.059

Source: National Audit Office analysis of Department for Communities and Local Government, Office for National Statistics and Chartered Institute of Public Finance and Accountancy data

Appendix Three

An alternative model

Objectives

1 Our analysis uses a measure based on the fire Relative Needs Formula (RNF) to represent differences in the risk of fire and the costs of fire service cover. The RNF is part of the system for funding fire and rescue authorities, therefore there is a potentially circular connection between the method used to fund fire and rescue authorities and the amount that they spend. In an effort to assess the impact of this limitation we analysed the impact of an alternative method for representing variation between fire and rescue authorities in terms of the risk of fire and the cost of providing fire services cover.

Methods

2 As an alternative to the measure of RNF relative to population we used a risk index developed by consultants Greenstreet Berman. In 2010, Greenstreet Berman reported the results of their work to develop a risk index based on the Fire Services Emergency Cover Toolkit. The report tested the feasibility of an alternative to the risk index in the RNF.[14] The RNF risk index is based on six factors such as measures of deprivation. The comparable measure in the Fire Services Emergency Cover Toolkit uses a regression formula that predicts the rate of dwelling fire casualties per million population.

3 We attempted to explore the circularity arising from our use of RNF relative to population as a measure of local risk and cost factors by replacing it with the dwellings risk index developed by Greenstreet Berman. The change in the proportion of variation explained, using the alternative measure, helps quantify the impact of using data that is not part of the funding process.

4 In this model we represented risk and cost factors using two measures. These are the dwellings risk index developed by Greenstreet Berman and a measure of coastline.[15] The measure of coastline is included to represent pressures on the costs of providing fire service cover that are not included in the risk index developed by Greenstreet Berman.

14 Greenstreet Berman Ltd, *FSEC and the FRS relative needs formula: Feasibility and impact (Draft report for the Department for Communities and Local Government)*, February 2010. Available at: http://webarchive.nationalarchives.gov.uk/20140505104649/http://www.local.communities.gov.uk/finance/1112/frfwg/frfwg-10-01.pdf

15 The measure of coastline calculated as length of coastline in metres divided by area of fire and rescue authority in hectares. This is different to the coastline indicator in the RNF, which is a simple measure of the distance of the coastline. This has been done specifically to separate measures in the model from those in the RNF.

Results

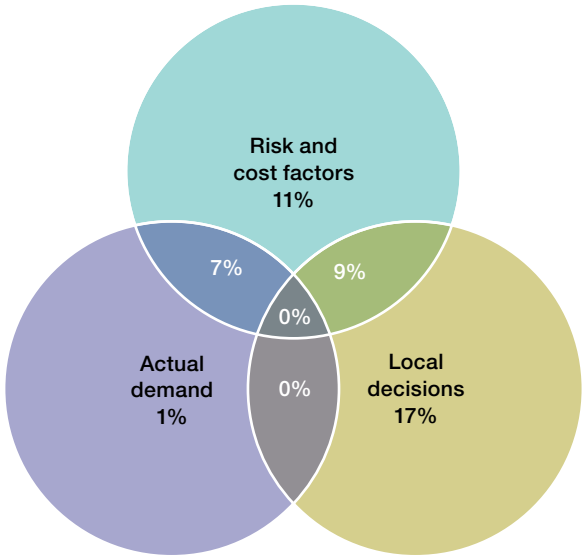
5 The alternative measure of risk and cost is positively associated with spending. Variation in this measure predicts approximately 27% of variation in spending. It explains more variation than the measure of local demand (8%) and the measure of local decisions (26%). When modelled sequentially the discrete contribution of the measure of risk and cost is lower than the discrete contribution of the measure of local decisions (11% compared with 17%) (**Figure 13**).

6 All of the measures used in the alternative model make a statistically significant contribution to explaining variation when used in their own right. However, when the dwellings risk index from the Fire Services Emergency Cover Toolkit is combined with measures of actual demand and measures of local decisions the Fire Services Emergency Cover Toolkit measure ceases to be statistically significant (**Figure 14**).[16]

Figure 13

Quantifying influences on variation in spending by fire and rescue authorities

Together, the three groups of factors account for approximately 45% of variation in spending[1]



Note

1 Values are approximate and rounded to zero decimal places.

Source: National Audit Office

16 At 0.1 level.

Figure 14

Regression model: All factors (sequential)

Dependent variable: Net expenditure (excluding capital charges) £ per 1,000 population

Adjusted R square value 0.45

	Unstandardised coefficients		Standardised		Sig.	Collinearity statistics	
	B	Std. error	Beta	t		Tolerance	VIF
(Constant)	4,900.585	6,414.812		.764	.446		
Period is 2012-13	345.357	1,098.000	.030	.315	.754	.478	2.094
Period is 2013-14	-674.374	1,215.626	-.057	-.555	.580	.394	2.537
FSEC – Dwellings risk index	2,523.452	1,968.533	.144	1.282	.202	.334	2.998
Coastline	3,029.404	739.933	.318	4.094	.000	.696	1.438
Primary fires per 1,000 population	4,251.939	2,394.025	.187	1.776	.078	.378	2.642
Operational whole-time firefighters total pay bill per whole-time firefighter	.565	.139	.319	4.080	.000	.689	1.451
Retained duty system firefighter pay relative to total firefighter pay percentage	-18,281.874	5,582.487	-.279	-3.275	.001	.580	1.725
Whole-time firefighters at year end total FTE per 100,000 population (Zscore)	1,448.230	387.749	.259	3.735	.000	.878	1.139

Source: National Audit Office analysis of Department for Communities and Local Government, Office for National Statistics and Chartered Institute of Public Finance and Accountancy data

Conclusion

7 The alternative measure of risk and cost factors explains less variation in spending than the RNF relative to population; 27% compared with 46%. This suggests that there may be a degree of circularity in the relationship between spending and RNF relative to population in our original model. However, we would note that in an effort to distance this model from the indicators in the fire RNF we have used a relatively limited measure of fire risk and cost. Consequently, while the difference between the risk and cost factors in the two models may reflect circularity in the first model, it may also reflect a less powerful measure of risk and cost in the second model.

8 While this second model has a lower level of explanatory power than the first it nonetheless accounts for 45% of variation. Consequently, even with a substantially weaker measure of risk and cost it is still possible to explain a large element of the variation using the three groups of factors in our model.

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