DEPARTMENT OF HEALTH, SOCIAL SERVICES AND PERSONAL SAFETY

UNCERTAINTY INTERVALS AND THE REGIONAL CAPITATION FORMULA

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1. EXECUTIVE SUMMARY

The Capitation Formula Review Group (CFRG) is due to produce the first draft of its Fourth Report in Summer 2004. It is intended that the Fourth Report will contain a chapter which investigates the issue of possible error and uncertainty in capitation allocations for Hospital, Community Health and Personal Social Services. The CFRG wishes to address this issue because of the recent changes in the organisation of the HPSS in Northern Ireland.

This reorganisation has led to the establishment of Local Health and Social Care Groups (LHSCGs). These new groups are relatively small, covering populations of around 100,000, and the regional capitation formula is increasingly being used at this sub Board area level to investigate issues of locality equity. It is therefore relevant for the CFRG to reconsider how robust the new capitation formula will be at various population levels and in particular at Health Board, LHSCG or Local Government District level.

In this report we estimated the robustness of the capitation formula at various population levels, conceptualising robustness in two ways:

- uncertainty caused by unpredictable variations in health care expenditure or use; and
- uncertainty inherent in the construction of the statistical models used to determine budgets (specifically the estimated needs coefficients).

The size of both types of uncertainty was quantified using non-parametric simulation techniques.

Uncertainty in health care use varied substantially by PoC and was strongly related to population size. For an average sized LHSCG we would expect that healthcare use across all PoCs would fall within a 7% (±3.5%) range of the predicted budget. The budget holder could manage this risk by pooling budgets over a number of years and ensuring flexibility in the health and social care system to meet variations in the use of healthcare. These estimates of uncertainty should be considered an upper limit because not all of the variation in the residual term is inherently random. Whilst upper and lower confidence limits have been presented the mid-point represents the best estimate.

The impact of uncertainty caused by statistical variation in the needs coefficients also varies by PoC. However, the impact of this variation is very small indicating that budget setters (the CFRG) can be confident that statistical variations in the needs coefficients will have little impact on budget allocations. At a Board level we can be 90% confident that financial allocations will fall with a £4.7m (±£2.3m) range of the predicted budget. Whilst upper and lower confidence limits have been presented the mid-point represents the best estimate.

The analysis of uncertainty indicates that at a sub-Board level we can be confident in the robustness of the capitation formula. However, caution should be used when interpreting results from certain PoC models, including the Mental Illness and Family and Child Care PoCs.

Whilst the analysis has concentrated on determining upper and lower bound uncertainty interval estimates it should be noted that the mid point estimate still represents the best, and most, likely result.

2. INTRODUCTION

2.1 Background

The Capitation Formula Review Group (CFRG) is a multi-disciplinary group drawn from the Department of Health, Social Services and Public Safety (the 'Department') and the Health and Social Services Boards (the 'Boards'). The Group is tasked with reviewing the methodology for allocating Hospital, Community Health and Personal Social Services revenue resources to Boards. The Group is due to produce the first draft of its Fourth Report in Summer 2004.

It is intended that the Fourth Report will contain a chapter which investigates the issue of possible error and uncertainty in capitation allocations for Hospital, Community Health and Personal Social Services. The CFRG wishes to address this issue because of the recent changes in the organisation of the HPSS in Northern Ireland.

This reorganisation has led to the establishment of Local Health and Social Care Groups (LHSCGs). These new groups are relatively small, covering populations of around 100,000, and the regional capitation formula is increasingly being used at this sub Board area level to investigate issues of locality equity. It is therefore relevant for the CFRG to reconsider how robust the new capitation formula will be at various population levels and in particular at Health Board, LHSCG or Local Government District level.

Robustness can be conceptualised in a variety of ways. In this report we concentrate on two forms of robustness:

- uncertainty caused by unpredictable variations in health care expenditure or use; and
- uncertainty inherent in the construction of the statistical models used to determine budgets (specifically the estimated needs coefficients).

We have measured the robustness of the new capitation formula using uncertainty intervals constructed at different population sizes. These calculations have been based on the statistical model used to estimate the needs index for each Programme of Care (PoC).

2.2 Terms of Reference

The terms of reference for this research envisaged that the project will feature detailed consideration of:

- uncertainty caused by unpredictable variations in health care expenditure;
- uncertainty inherent in the construction of statistical models used to determine budgets;
- the relationship between the level of risk of budgetary over- or under-spend at various population sizes (including consideration of confidence intervals); and
- any other issues which the researcher(s) considers relevant.

It was also envisaged that the research will include statistical modelling on the datasets which are used by the DHSSPS to allocate HCHPSS resources.

2.3 Structure of the Report

This report is structured into four main sections:

- **section 3** provides a conceptual overview of the implications of uncertainty in the capitation formula;
- **section 4** describes in more detail the technical methods used to construct the uncertainty intervals used to measure robustness;
- **section 5** outlines the key results illustrating the size of the uncertainty intervals for each PoC and the relationship with population size;
- **section 6** provides a summary of the research and outlines a number of conclusions.

A series of appendices provide further information and tables illustrating uncertainty intervals for each PoC at LHSCG and Local Government District (LGD) level.

3. CONCEPTUAL FRAMEWORK

The robustness of the capitation formula can be conceptualised in a variety of ways. In this report we consider two forms of robustness as identified by Sutton et al (2003) and Lock (2003):

- uncertainty caused by unpredictable variations in health care expenditure or use; and
- uncertainty inherent in the construction of the statistical models used to determine budgets (specifically the estimated needs coefficients).

In this section we provide a brief overview of the causes and consequences of each of these types of uncertainty.

3.1 Uncertainty in the Use of Health Care

This form of uncertainty relates to random variation in the use of health care and its impact on planning by health service organisations.

It is known that the use of healthcare varies enormously across individuals, with some individuals using very high quantities of resources and others not using any at all. These variations are due to both predictable and random elements. The extent to which random factors influence variations in health care use are difficult to quantify. However, in the context of the statistical models used to develop each PoC needs index, it is possible to identify the important explanatory factors that influence health care use and treat the remaining variation as inherently random.

Equation [1] illustrates the current functional form of each PoC statistical model:

$$U_i = \alpha_i + \beta_i X_i + \varepsilon_i \qquad [1]$$

where U_i represents the utilisation of healthcare, X_i a vector of needs variables and ε_i represents the error term in the PoC model. It is this error term which we assume represents the inherently random variation in the use of healthcare because it is not explained by the observable needs variables (X_i).

This unexplained variation could be due to a number of factors as outlined by Martin et al (1998):

- an element of this variation could be due to patient characteristics which are not captured by the formula because certain variables may not be measurable or available, for example the presence of diabetes;
- an element could be due to variations in clinical practice (which we would not use as a basis for allocating resources within a needs driven model); and
- an element that is totally random.

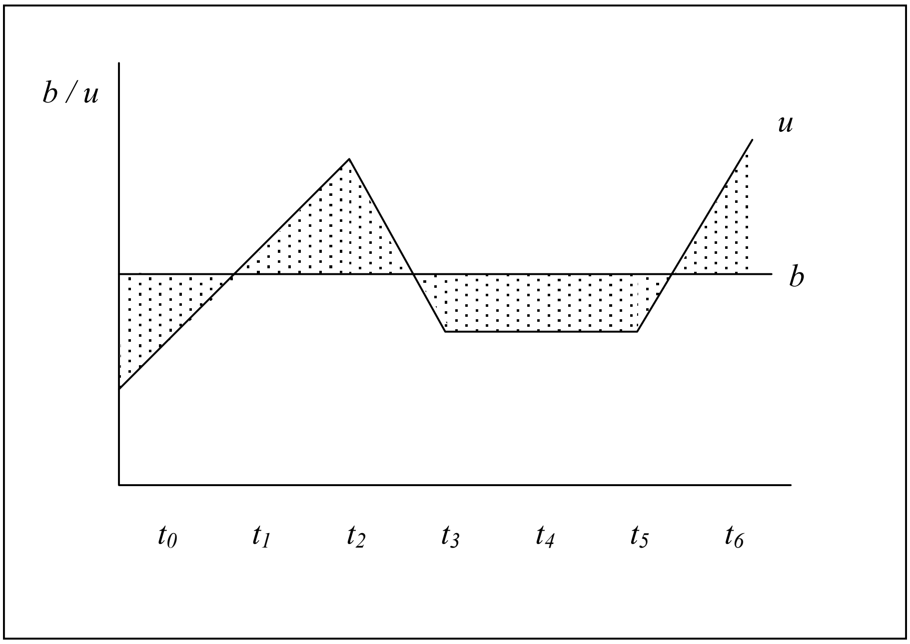
It is impossible to determine what proportion of the error term is made up by each of these factors. Therefore estimating robustness by treating all unexplained variation as reflecting the inherent level of randomness in healthcare use may substantially overestimate the impact of randomness.

This type of uncertainty is likely to be strongly related to population size because larger populations offer the opportunity to 'pool' risk and reduce the effect of random variations in healthcare use on budgets. Figure 3.1 illustrates that random variation is also a function of time. Healthcare use fluctuates from year to year but on average the sum of this variation would be expected to tend to zero (Equation [2]).

$$\sum_{t=1}^{T} b_t - u_t \to 0 \quad \text{as} \quad t \to \infty \qquad [2]$$

where b_t represents the budget at time period t, and u the level of healthcare use.

Figure 3.1 Uncertainty in the Use of Health Care over time



This type of uncertainty is important for a *budget holder* to consider because random variation in the use of healthcare will influence expenditure and the likelihood expenditure will over- or under- shoot the budget. A budget holder will need to manage this risk and manage demand during peak periods.

3.2 Uncertainty in the Needs Coefficients

The second form of uncertainty relates to the inherent uncertainty in the estimated needs coefficients that are generated by the process of statistical modelling. The size of this level of uncertainty is a function of the quality of the statistical model and accuracy of the estimated relationship between the needs variables and the use of healthcare.

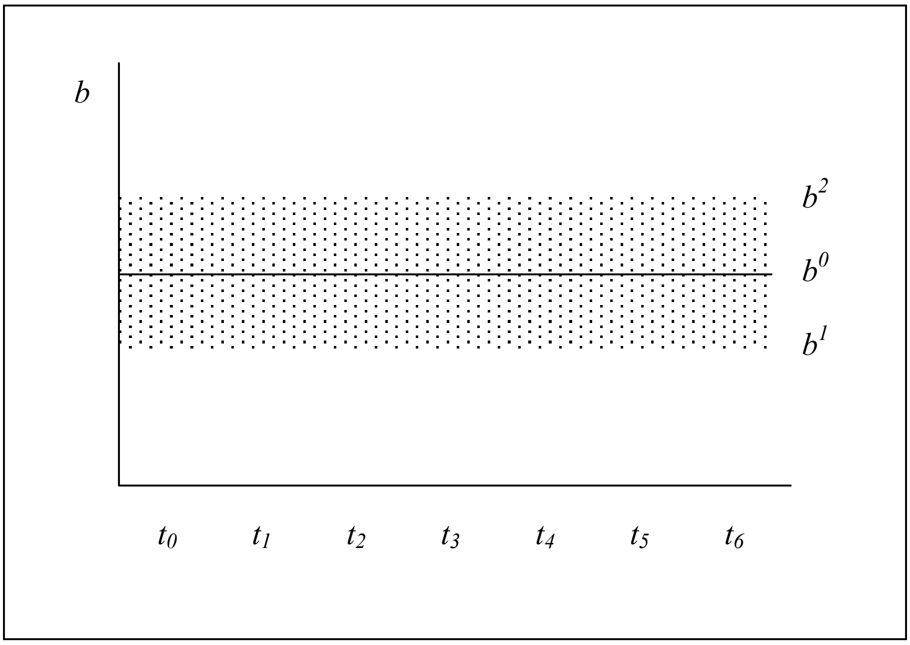
This type of uncertainty relates to the accuracy with which the β_i coefficients are estimated in equation [3]:

$$U_i = \alpha_i + \beta_i X_i + \varepsilon_i \qquad [3]$$

where the $\beta_i X_i$ component is used to calculate the PoC needs index. The larger the standard error around the β_i terms the greater the degree of uncertainty in the model.

It is less likely that this type of error is related to population size, although the estimated precision of the β_i terms may be influenced by the number of observations in the statistical model. Figure 3.2 illustrates that the size of this error is independent of the timeframe considered because it reflects the accuracy with which the budget is set. It illustrates that variation in the estimated needs coefficients can influence the estimated budget, where b^1 and b^2 represent a potential range of budgets.

Figure 3.2 Uncertainty in the Needs Coefficients over time



This type of uncertainty is of greater importance to the *budget setter* (the CFRG) because it illustrates the accuracy of the needs element of each POC formula.

4. DATA AND METHODS

4.1 Data

We used the data from each of the PoC models identified within the CFRG's Fourth Report. Each PoC model was estimated using slightly different techniques at slightly different population levels which has restricted the analysis we have been able perform on each model. Table 4.1 illustrates the data and level of analysis conducted by each POC.

Table 4.1 Programme of Care definitions and level of analysis

Programme of Care	Uncertainty in Needs Coefficients			Uncertainty in Healthcare Use
	Board	LHSCG	LGD	
Acute	✓	✓*	✓*	✓
Elderly	✓	✓	✓	✓
Mental Illness	✓	✓	✓	✓
Maternity**	✓	-	-	-
Family & Child Care	✓	✓	✓	✓
Learning Disability	✓	✓	✓	✓
Physical Disability	✓	✓	✓	✓

* based on 1991 ward level data (SMR not updated)

** birth numbers not available at a LGD level and individual level data hindered the application of uncertainty in healthcare use intervals

The methods, functional form and needs variables included within each PoC formula are described elsewhere.

4.2 Uncertainty in the Use of Health Care

We adopt a non-parametric approach to estimating the relationship between uncertainty and population size (Sutton et al, 2002, Mikkola et al, 2002). Previous analysis has used a parametric approach to the measurement of this risk (Martin et al, 1998). We assume that the residual (ε_i) in each PoC equation reflects the inherent level of randomness in healthcare use. The residuals were back transformed into natural units and then centred around zero ensuring that the sum of residuals tends to zero[1]. The ward level residuals were then aggregated at various different population levels using a repeated sampling process.

Pseudo population groups were created by taking repeated samples of wards and creating 1,000 pseudo groups at six different population sizes between 10,000 and 500,000. Wards were sampled with replacement so that particular wards may appear more than once in any particular pseudo group. The probability of selection of each ward was proportional to the population size in that ward. For each replication we calculated an aggregate level residual representing the average residual for the pseudo population group. This process calculated a vector of 1,000 aggregate level residuals for each of the six population sizes which is approximately centred around zero.

[1] the back transformed residuals were not always centred around zero, a problem relating to the 'back transformation problem'. We re-centred the ward level residuals by subtracting the mean residual value.

A 90% uncertainty interval was then calculated for each population grouping based on the 5th and 95th percentile of the vector of residuals[2], such that:

$$w_i = \varepsilon_i^{95} - \varepsilon_i^{5} \qquad [4]$$

in which, ε_i^{95} is the value of the residual at the 95th percentile and ε_i^{5} is the value at the 5th percentile. It represents the range within which healthcare use will fall relative to the expected budget. 90% uncertainty intervals have been used throughout this report to represent uncertainty.

We estimated the aggregate affect of uncertainty due to variation in healthcare use across each PoC using the same approach of creating pseudo population groups. However, for each replication we selected a ward level residual for each PoC model, and then calculated a weighted average residual across each PoC (based on the PoC expenditure weight). These weighted residuals were then averaged for each pseudo population group.

4.3 Uncertainty in the Needs Coefficients

We used non-parametric bootstrapping techniques to estimate the degree of uncertainty in the estimated needs coefficients for each of the PoC models (Sutton et al, 2002, Lock 2003). We created pseudo datasets based on random samples of the ward data. Wards are sampled with replacement so that some wards will not appear in the pseudo dataset and other wards will appear more than once.

We then constructed 100 pseudo datasets and re-estimated the PoC model. The resulting matrix of estimated needs coefficients was then applied to the ward level dataset to estimate a ward level needs index. The needs index was then aggregated to a Board, LHSCG and LGD level, resulting in a matrix of needs indices, containing 100 needs indices for each of the 4 Boards, 15 LHSCGs and 26/27 LGDs.

A 90% uncertainty interval was then calculated for each Board, LHSCG and LGD based on 5th and 95th percentile of the distribution of the needs index, such that:

$$w_i = \frac{\left(N_i^{95} - N_i^{5}\right)}{N_i^{m}} \qquad [5]$$

in which N_i^m is the actual estimated value of the *i*th Board, LHSCG or LGD needs index, N_i^{95} is the value at the 95th percentile and N_i^{5} is the value at the 5th percentile. It represents the range within which the Board, LHSCG or LGD needs index will lie on 90% of occasions, expressed as a percentage relative to the mean.

In order to estimate the aggregate effect of uncertainty in the needs coefficients across all of the PoC models we expressed each Board level needs index as a normal distribution with a mean of N_i^m and standard error of N_i^{se}. These values were then placed in the spreadsheet used by the Department to calculate aggregate Board shares[3]. We then used Monte Carlo simulation analysis to run 1,000 iterations of the model, simultaneously varying the Board level needs indices within their distribution. The output of the simulation was a matrix of 1,000 possible aggregate resource shares by Board. A 90% uncertainty interval was then calculated for each Board share calculated as in equation [5]. The width of the aggregate intervals was expressed in monetary terms based on a 2004/05 capitation budget of £1,946m.

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[2] 90% uncertainty intervals have been used throughout this report, consistent with the methods used recently in England. They can be considered analogous to a one-sided 95% confidence test, where we are 95% certain that the result will below the upper bound and 95% certain the result will be above the lower bound.

[3] the spreadsheet was provided by the Department (2004_2005 Board Model.xls). The Board shares were based on 'Final Allocation incorporating Rurality Adjustment'.

5. RESULTS

5.1 Uncertainty in the Use of Health Care

Table 5.1 illustrates the size of the uncertainty intervals for various population sizes for each PoC model. It illustrates the strong correlation between population size and the size of the uncertainty intervals.

It also illustrates the substantial variation in the uncertainty interval size by PoC. For example, there is a reasonably high degree of uncertainty in the use of resources in the Mental Illness and Family and Child Care models. Even with a population size of 500,000, we would only be 90% certain that resource use would fall with a 13% range (±6.5%) of the actual Family and Child Care budget.

Table 5.1 Uncertainty Intervals related to variations in the use of Health Care

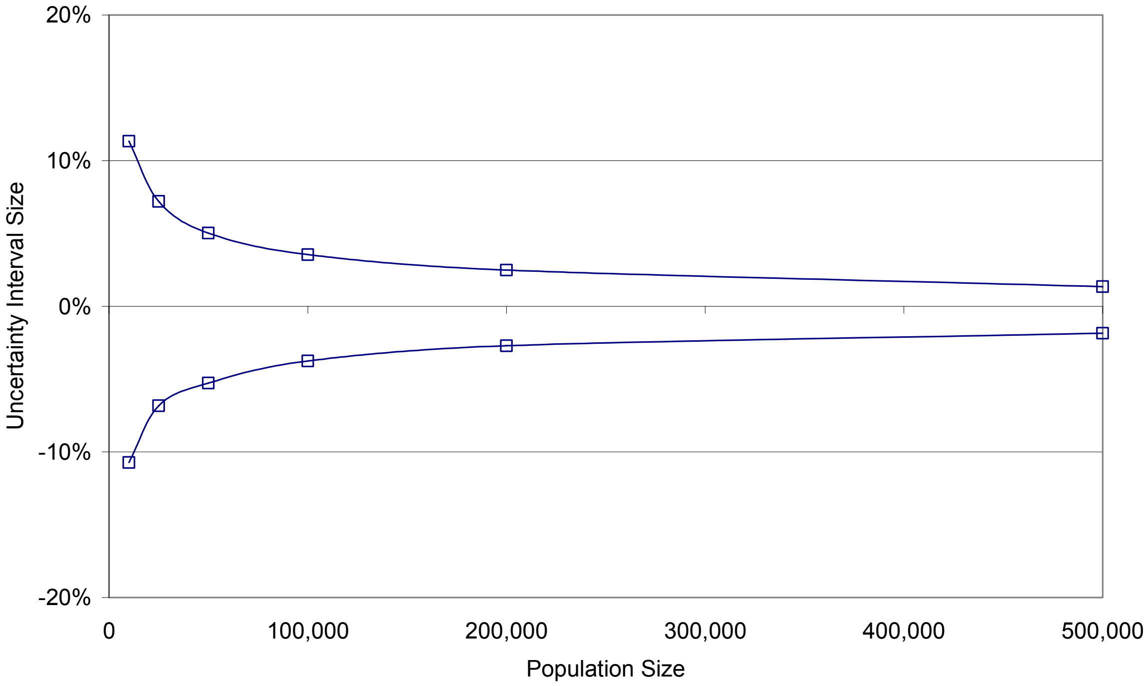
Uncertainty Interval (w_i)	Population Size					
	10,000	25,000	50,000	100,000	200,000	500,000
Acute	23%	15%	11%	7%	5%	3%
Elderly	58%	39%	28%	20%	14%	9%
Mental Illness	110%	72%	53%	36%	27%	15%
Family and Child Care	96%	62%	45%	30%	22%	13%
Learning Disability	81%	54%	39%	29%	20%	13%
Physical Disability	43%	29%	21%	15%	10%	6%
Aggregate	22%	14%	10%	7%	5%	3%
Aggregate (excl. Acute)	32%	20%	15%	11%	8%	5%

The aggregate uncertainty intervals across each PoC are substantially smaller than at an individual PoC level. The impact of aggregating across PoCs is to pool the risk of random variation in healthcare use. At a population size of 10,000 we would be 90% certain that resource use would fall within a 22% range (±11%) of the actual budget, this reduces to a 3% range (±1.5%) at 500,000. The range would be 7% (±3.5%) for an average sized LHSCG.

Figure 5.1 overleaf illustrates the relationship between population size and the aggregate uncertainty intervals. The area between the upper and lower uncertainty bounds (the funnel shape) represents the range of uncertainty. It illustrates that the size of the 90% uncertainty intervals increase exponentially as the population size tends to zero.

It is important to note that these uncertainty intervals are likely to overestimate the impact of variations in the use of healthcare because some of the variation may be ‘explainable’ rather than random. The intervals should therefore be considered a conservative estimate of the amount of uncertainty. The size of the aggregate and PoC specific uncertainty intervals would be reduced further by aggregating budgets over a number of years.

Figure 5.1 Aggregate 90% Uncertainty Interval by Population Size



5.2 Uncertainty in the Needs Coefficients

Table 5.2 illustrates the size of the uncertainty interval around the needs index at a Board and LGD level for each PoC model.

Table 5.2 Uncertainty Intervals related to variations in the needs coefficients

Uncertainty Interval	Eastern	Northern	Southern	Western	Board average	LHSCG average	LGD average
Acute	0.8%	0.9%	0.6%	1.5%	0.9%	1.6%	1.8%
Elderly	1.1%	2.1%	1.2%	1.6%	1.5%	2.6%	3.2%
Mental Illness	4.9%	4.1%	5.6%	8.0%	5.3%	7.7%	8.3%
Maternity	0.2%	0.2%	0.2%	0.2%	0.2%	-	-
Family & Child Care	8.2%	8.0%	10.0%	4.4%	7.8%	9.8%	10.4%
Learning Disability	3.4%	5.3%	1.3%	4.9%	3.7%	6.8%	7.8%
Physical Disability	1.5%	2.6%	0.9%	2.1%	1.8%	3.0%	3.4%
Aggregate	0.6%	0.8%	0.8%	1.0%	0.8%	-	-
Aggregate (ex Acute)	0.6%	0.8%	0.8%	0.9%	0.7%		

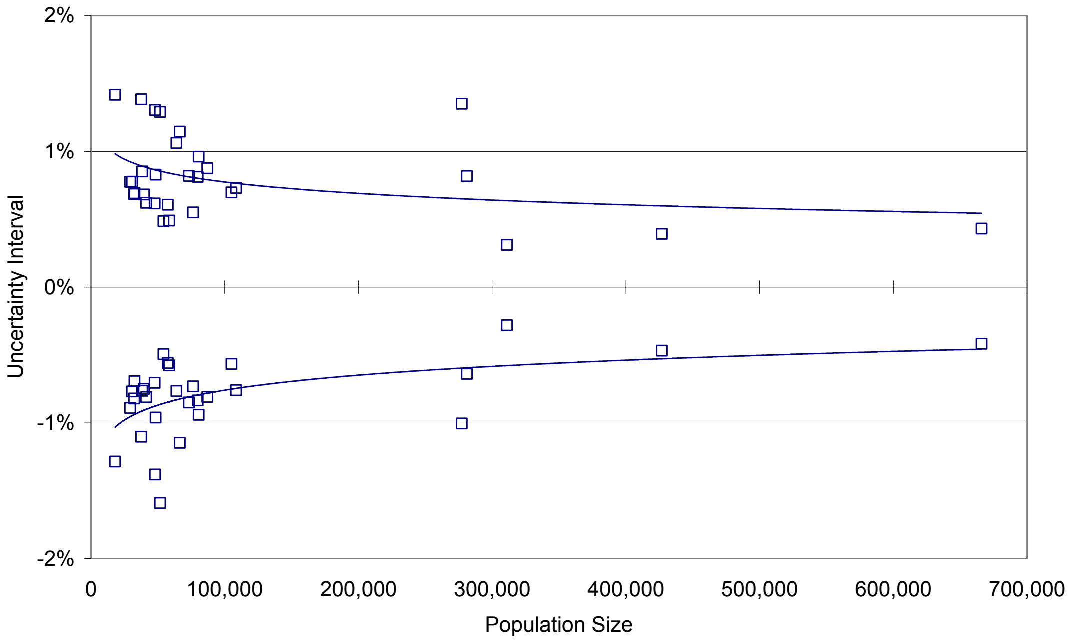
Table 5.2 illustrates that the 90% uncertainty intervals are very tight for some PoCs and less so in others. For example, we can be 90% confident that the needs index falls within a 0.8% range (±0.4%) of the actual needs index for the Acute PoC in the Eastern Board. The widest uncertainty intervals are again in the Family and Child Care PoC where we can be 90%

confident that the needs index falls within a 10% range (±5%) of the actual needs index in the Southern Board.

The Board average figures represent the average uncertainty intervals for each PoC (the average is weighted by each Board's population). It illustrates that the Acute and Maternity models have the tightest uncertainty intervals (0.9% and 0.2% respectively). The LHSCG and LGD average figures represent a population weighted average uncertainty interval at a sub-Board area (further data are presented in Appendix 1). They illustrate that the size of the uncertainty intervals are slightly larger than at Board level. Appendix 2 provides details of the uncertainty intervals expressed as need indices for each Board, LHSCG and LGD by PoC.

Figure 5.2 illustrates the relationship between population size and the uncertainty intervals around the needs coefficients (the area between the upper and lower bound uncertainty intervals). It illustrates a significant, if weak relationship between population size and uncertainty. Overall the uncertainty intervals are very tight.

Figure 5.2 Acute PoC 90% Uncertainty Interval by Population Size



The aggregation of the uncertainty intervals produces surprisingly tight aggregate uncertainty intervals (approximately 1%) at a Board level. At this stage we were unable to produce an aggregate of the uncertainty interval at a LHSCG or LGD level. This would be feasible once an equivalent to the Board level excel model is available at a sub-Board level.

Table 5.3 illustrates that the size of the uncertainty intervals can be expressed in monetary terms at a Board level. It illustrates that at most, the width of the 90% uncertainty intervals is £4.7m (±£2.3m) from the predicted budget mid point. At a Board level we can be confident that the financial allocations are robust to potential statistical error in the estimated needs coefficients.

Table 5.3 Variations in Board Shares and Financial Allocations

Board	Share*	5% Percentile	95% Percentile	Financial Allocation £'000m	5% Percentile	95% Percentile	Difference £'000m
Eastern	40.73%	40.61%	40.86%	793	790	795	4.7
Northern	24.02%	23.92%	24.12%	467	465	469	3.8
Southern	18.21%	18.13%	18.28%	354	353	356	2.9
Western	17.04%	16.96%	17.13%	332	330	333	3.3
Total				1,946			

* note rounding errors may apply

6. SUMMARY AND CONCLUSIONS

In this report we have estimated the robustness of the capitation formula at various population levels, conceptualising robustness in two ways:

- uncertainty caused by unpredictable variations in health care expenditure or use; and
- uncertainty inherent in the construction of the statistical models used to determine budgets (specifically the estimated needs coefficients).

The size of both types of uncertainty was quantified using non-parametric simulation techniques.

Uncertainty in health care use varied substantially by PoC and was strongly related to population size. For an average sized LHSCG we would expect that healthcare use across all PoCs would fall within a 7% (±3.5%) range of the predicted budget. The budget holder could manage this risk by managing demand over a number of years and ensuring flexibility in the health and social care system to meet variations in the use of healthcare. These estimates of uncertainty should be considered an upper limit because not all of the variation in the residual term is inherently random. Whilst upper and lower confidence limits have been presented the mid-point represents the best estimate.

The impact of uncertainty caused by statistical variation in the needs coefficients also varies by PoC. However, the impact of this variation is very small indicating that budget setters (the CFRG) can be confident that statistical variations in the needs coefficients will have little impact on budget allocations. At a Board level we can be 90% confident that financial allocations will fall with a £4.7m (±£2.3m) range of the predicted budget. Whilst upper and lower confidence limits have been presented the mid-point represents the best estimate.

The analysis of uncertainty indicates that at a sub-Board level we can be confident in the robustness of the capitation formula. However, caution should be used when interpreting results from certain PoC models, including the Mental Illness and Family and Child Care PoCs.

Whilst the analysis has concentrated on determining upper and lower bound uncertainty interval estimates it should be noted that the mid point estimate still represents the best, and most, likely result.

7. APPENDIX 1 – NEED COEFFICIENT UNCERTAINTY INTERVALS

Table A1.1 LHSCG 90% Uncertainty Intervals

	Acute	Elderly	Mental Illness	Family and Child Care	Learning Disability	Physical Disability
North & West Belfast	2.4%	4.2%	7.7%	11.6%	11.4%	4.7%
South & East Belfast	2.0%	2.4%	9.4%	10.3%	5.1%	2.1%
North Down	2.7%	4.7%	11.6%	10.1%	9.9%	4.3%
Ards	1.7%	1.8%	7.8%	12.0%	6.7%	2.9%
Lisburn	1.4%	1.8%	5.4%	13.4%	5.8%	1.6%
Down	1.3%	2.7%	5.8%	9.7%	6.8%	3.2%
Antrim/Ballymena	1.3%	1.8%	6.8%	9.0%	9.0%	2.8%
Causeway	1.2%	2.9%	4.7%	4.9%	6.2%	5.3%
East Antrim	1.4%	2.9%	7.8%	10.5%	6.6%	3.2%
Mid-Ulster	2.3%	2.5%	9.6%	13.2%	6.5%	2.6%
Armagh & Dungannon	0.9%	3.0%	7.8%	10.0%	3.9%	2.1%
Craigavon & Banbridge	1.0%	2.5%	5.6%	8.3%	4.6%	2.4%
Newry & Mourne	1.6%	1.4%	9.3%	14.0%	6.5%	2.9%
Northern Group	1.7%	3.1%	8.0%	3.8%	4.3%	2.1%
Southern Group	1.4%	1.1%	8.0%	10.2%	10.9%	4.2%
Weighted Mean	1.6%	2.6%	7.7%	9.8%	6.8%	3.0%

Table A1.2 LGD 90% Uncertainty Intervals

	Acute	Elderly	Mental Illness	Family and Child Care	Learning Disability	Physical Disability
ANTRIM	1.8%	3.8%	8.2%	10.5%	8.4%	2.7%
ARDS	1.7%	1.8%	7.8%	12.0%	6.7%	2.9%
ARMAGH	1.0%	3.4%	7.2%	10.5%	5.1%	2.4%
BALLYMENA	1.1%	2.4%	6.4%	7.5%	11.0%	4.3%
BALLYMONEY	1.7%	3.6%	6.6%	11.3%	8.8%	2.6%
BANBRIDGE	1.4%	4.0%	6.6%	13.4%	5.3%	3.2%
BELFAST – NW*	2.4%	4.2%	7.7%	11.6%	8.3%	3.2%
BELFAST - SE	2.5%	4.1%	9.4%			
CARRICKFERGUS	2.3%	3.0%	9.0%	12.1%	4.8%	3.5%
CASTLEREAGH	2.9%	3.4%	13.6%	9.2%	9.9%	4.9%
COLERAINE	1.4%	3.3%	6.8%	5.9%	7.0%	6.7%
COOKSTOWN	1.9%	3.1%	8.9%	15.2%	6.5%	1.4%
CRAIGAVON	1.3%	2.9%	6.2%	6.6%	6.5%	3.1%
DERRY	1.8%	3.8%	8.0%	6.6%	5.3%	2.2%
DOWN	1.3%	2.7%	5.8%	9.7%	6.7%	3.2%
DUNGANNON	1.2%	3.5%	9.9%	11.8%	5.9%	2.3%
FERMANAGH	1.5%	1.6%	8.4%	12.7%	15.4%	5.7%
LARNE	1.5%	2.2%	7.9%	11.6%	8.1%	3.8%
LIMAVADY	1.5%	3.9%	9.6%	7.0%	8.0%	2.9%
LISBURN	1.4%	1.8%	5.4%	13.4%	5.8%	1.6%
MAGHERAFELT	2.7%	2.6%	9.8%	12.0%	6.9%	6.2%
MOYLE	1.7%	3.4%	7.2%	8.8%	10.0%	6.1%
NEWRY AND MOURNE	1.6%	1.4%	9.3%	14.0%	6.6%	2.9%
NEWTOWNABBEY	1.3%	4.0%	9.1%	8.8%	8.2%	3.0%
NORTH DOWN	2.7%	4.7%	11.6%	10.1%	9.9%	4.3%
OMAGH	1.6%	0.9%	8.0%	8.8%	7.8%	5.5%
STRABANE	1.8%	5.0%	9.9%	4.2%	11.7%	2.4%
Weighted Mean	1.8%	3.2%	8.3%	10.4%	7.8%	3.4%

* Belfast NW = combined Belfast LGD for Family and Child Care, Learning Disability and Physical Disability due to LDG boundary changes.

8. APPENDIX 2 – NEED COEFFICIENT PERCENTILE VALUES

Table A2.1 Board Level 90% Uncertainty Intervals around Need Indices

	Acute			Elderly			Mental Health			Family and Child Care			Learning Disability			Physical Disability		
	Mean	5% P	95% P	Mean	5% P	95% P	Mean	5% P	95% P	Mean	5% P	95% P	Mean	5% P	95% P	Mean	5% P	95% P
Eastern	0.986	0.982	0.990	1.008	1.003	1.014	0.993	0.967	1.015	1.178	1.139	1.236	0.960	0.945	0.977	0.997	0.992	1.007
Northern	0.966	0.962	0.970	0.952	0.942	0.962	0.919	0.905	0.942	0.799	0.760	0.824	0.927	0.898	0.947	0.837	0.826	0.848
Southern	1.024	1.021	1.027	1.010	1.003	1.015	1.027	1.001	1.058	0.852	0.803	0.888	1.043	1.037	1.050	1.063	1.058	1.068
Western	1.059	1.053	1.068	1.045	1.036	1.053	1.119	1.071	1.160	1.059	1.036	1.083	1.155	1.129	1.185	1.190	1.177	1.203

	Maternity		
	Mean	5% P	95% P
Eastern	1.022	1.021	1.023
Northern	0.994	0.993	0.995
Southern	0.993	0.992	0.994
Western	0.971	0.970	0.972

Table A2.2 LHSCG 90% Uncertainty Intervals around Need Indices

	Acute			Elderly			Mental Health			Family and Child Care			Learning Disability			Physical Disability		
	Mean	5% P	95% P	Mean	5% P	95% P	Mean	5% P	95% P	Mean	5% P	95% P	Mean	5% P	95% P	Mean	5% P	95% P
North & West Belfast	1.135	1.124	1.150	1.155	1.129	1.177	1.529	1.461	1.578	1.962	1.866	2.094	1.442	1.357	1.521	1.659	1.627	1.705
South & East Belfast	0.925	0.916	0.934	1.004	0.992	1.016	0.866	0.829	0.910	1.028	0.981	1.088	0.832	0.811	0.853	0.847	0.838	0.856
North Down	0.888	0.876	0.900	0.870	0.852	0.893	0.642	0.612	0.686	0.556	0.528	0.584	0.693	0.657	0.725	0.628	0.613	0.640
Ards	0.934	0.926	0.941	0.958	0.950	0.967	0.789	0.761	0.823	0.743	0.688	0.777	0.840	0.811	0.868	0.774	0.763	0.786
Lisburn	0.972	0.965	0.979	0.972	0.963	0.980	0.889	0.866	0.915	1.137	1.080	1.232	0.864	0.840	0.891	0.889	0.882	0.897
Down	1.000	0.993	1.006	0.948	0.937	0.963	0.925	0.898	0.952	0.871	0.818	0.902	0.925	0.895	0.957	0.953	0.938	0.969
Antrim/Ballymena	0.958	0.951	0.963	0.951	0.942	0.959	0.889	0.865	0.925	0.796	0.752	0.824	0.880	0.843	0.922	0.764	0.751	0.773
Causeway	0.978	0.972	0.984	0.942	0.929	0.957	0.963	0.942	0.987	0.855	0.827	0.869	0.970	0.937	0.998	0.846	0.822	0.866
East Antrim	0.945	0.938	0.951	0.947	0.932	0.959	0.875	0.842	0.911	0.782	0.730	0.812	0.849	0.820	0.876	0.778	0.767	0.791
Mid-Ulster	1.006	0.995	1.018	0.983	0.970	0.995	0.997	0.951	1.047	0.776	0.716	0.819	1.100	1.069	1.141	1.066	1.052	1.079
Armagh & Dungannon	1.034	1.030	1.039	1.028	1.011	1.042	1.015	0.978	1.058	0.787	0.744	0.823	1.029	1.006	1.046	1.040	1.028	1.050
Craigavon & B'bridge	0.997	0.991	1.001	0.990	0.978	1.003	0.977	0.953	1.007	0.863	0.818	0.889	0.999	0.975	1.021	1.021	1.012	1.036
Newry & Mourne	1.047	1.038	1.055	1.013	1.006	1.021	1.108	1.060	1.163	0.911	0.842	0.969	1.124	1.087	1.160	1.152	1.134	1.167
Northern Group	1.090	1.081	1.100	1.089	1.070	1.104	1.217	1.165	1.262	1.269	1.249	1.298	1.120	1.093	1.141	1.277	1.263	1.290
Southern Group	1.019	1.011	1.026	1.003	0.997	1.009	0.994	0.959	1.038	0.752	0.716	0.793	1.205	1.141	1.272	1.074	1.050	1.096

Table A2.3 Local Government District 90% Uncertainty Intervals around Need Indices

	Acute			Elderly			Mental Health			Family and Child Care			Learning Disability			Physical Disability		
	Mean	5% P	95% P	Mean	5% P	95% P	Mean	5% P	95% P	Mean	5% P	95% P	Mean	5% P	95% P	Mean	5% P	95% P
ANTRIM	0.984	0.974	0.992	0.958	0.942	0.978	0.942	0.907	0.985	0.806	0.758	0.842	0.810	0.758	0.827	0.826	0.815	0.837
ARDS	0.934	0.926	0.941	0.958	0.950	0.967	0.789	0.761	0.823	0.743	0.688	0.777	0.840	0.812	0.868	0.774	0.763	0.786
ARMAGH	1.011	1.006	1.016	0.992	0.974	1.008	0.945	0.915	0.983	0.683	0.648	0.720	0.988	0.961	1.012	0.944	0.931	0.954
BALLYMENA	0.938	0.932	0.942	0.947	0.937	0.960	0.850	0.826	0.880	0.787	0.753	0.813	0.939	0.889	0.993	0.712	0.695	0.725
BALLYMONEY	0.987	0.979	0.995	0.972	0.955	0.990	0.879	0.850	0.908	0.785	0.735	0.824	1.042	0.974	1.066	0.937	0.923	0.947
BANBRIDGE	0.934	0.926	0.939	0.934	0.915	0.953	0.824	0.800	0.854	0.657	0.603	0.691	0.902	0.878	0.926	0.870	0.856	0.884
BELFAST - NW	1.135	1.124	1.150	1.155	1.129	1.177	1.529	1.461	1.578	1.663	1.590	1.783	1.160	1.114	1.211	1.295	1.279	1.320
BELFAST - SE	0.946	0.936	0.959	1.015	0.994	1.035	0.939	0.900	0.988									
CARRICKFERGUS	0.973	0.962	0.984	0.965	0.952	0.981	0.888	0.852	0.932	0.781	0.720	0.815	0.845	0.823	0.864	0.767	0.754	0.782
CASTLEREAGH	0.880	0.866	0.891	0.972	0.956	0.989	0.708	0.658	0.754	0.596	0.568	0.623	0.754	0.718	0.793	0.741	0.722	0.759
COLERAINE	0.960	0.954	0.967	0.931	0.918	0.948	0.975	0.940	1.007	0.883	0.849	0.901	0.889	0.857	0.920	0.764	0.738	0.789
COOKSTOWN	1.028	1.019	1.038	1.000	0.983	1.014	1.010	0.962	1.052	0.880	0.804	0.938	1.211	1.174	1.252	1.263	1.255	1.272
CRAIGAVON	1.025	1.019	1.032	1.017	1.003	1.033	1.047	1.016	1.082	0.966	0.926	0.990	1.049	1.013	1.081	1.099	1.085	1.119
DERRY	1.105	1.097	1.117	1.125	1.100	1.143	1.303	1.248	1.353	1.364	1.322	1.411	1.062	1.033	1.089	1.331	1.316	1.346
DOWN	1.000	0.993	1.006	0.948	0.937	0.963	0.925	0.898	0.952	0.871	0.818	0.902	0.925	0.895	0.958	0.953	0.938	0.969
DUNGANNON	1.060	1.054	1.066	1.073	1.052	1.089	1.095	1.046	1.155	0.902	0.844	0.950	1.075	1.045	1.109	1.152	1.137	1.163
FERMANAGH	0.987	0.979	0.994	0.983	0.975	0.991	0.952	0.918	0.998	0.644	0.604	0.686	1.153	1.073	1.250	0.896	0.865	0.916
LARNE	0.961	0.953	0.967	0.972	0.961	0.983	0.913	0.884	0.956	0.798	0.739	0.832	0.931	0.884	0.960	0.756	0.742	0.771
LIMAVADY	1.047	1.039	1.054	0.991	0.971	1.010	0.975	0.926	1.019	0.952	0.909	0.975	1.050	1.010	1.093	1.011	0.995	1.025
LISBURN	0.972	0.965	0.979	0.972	0.963	0.980	0.889	0.866	0.915	1.137	1.080	1.232	0.864	0.841	0.891	0.889	0.882	0.897
MAGHERAFELT	0.987	0.974	1.001	0.968	0.956	0.981	0.986	0.942	1.039	0.691	0.647	0.730	1.010	0.976	1.046	0.901	0.873	0.929
MOYLE	1.021	1.013	1.030	0.936	0.922	0.954	1.057	1.025	1.101	0.896	0.856	0.935	1.085	1.029	1.138	0.931	0.902	0.959
NEWRY & MOURNE	1.047	1.038	1.055	1.013	1.006	1.021	1.108	1.060	1.163	0.911	0.842	0.969	1.124	1.087	1.161	1.152	1.134	1.167
NEWTOWNABBEY	0.926	0.920	0.931	0.928	0.909	0.946	0.854	0.817	0.894	0.776	0.734	0.802	0.820	0.784	0.851	0.792	0.781	0.805
NORTH DOWN	0.888	0.876	0.900	0.870	0.852	0.893	0.642	0.612	0.686	0.556	0.528	0.584	0.693	0.657	0.725	0.628	0.613	0.640
OMAGH	1.042	1.034	1.051	1.019	1.014	1.023	1.026	0.989	1.071	0.808	0.775	0.846	1.119	1.072	1.159	1.190	1.155	1.221
STRABANE	1.080	1.070	1.089	1.062	1.033	1.085	1.147	1.086	1.199	1.173	1.144	1.193	1.554	1.466	1.648	1.410	1.394	1.427

* Belfast NW = combined Belfast LGD for Family and Child Care, Learning Disability and Physical Disability due to LDG boundary changes.