MEETING: Advisory Committee on Resource Allocation
DATE OF MEETING: 18 September 2015
TITLE OF REPORT/PAPER: ACRA(2015)18: Unavoidable smallness due to remoteness
AUTHORS: Allocations project team
ACTIONS REQUIRED: We recommend that ACRA supports a remoteness adjustment for allocations, quantified using the model outlined. If this recommendation is supported we would welcome advice on the nature of a remoteness adjustment (e.g. the most appropriate scope of services (urgent care only or all services) and the degree of specificity of the adjustment (a single adjustment for all sites or a site-specific adjustment)).

Remoteness

Estimating the unavoidable cost associated with remoteness

1. INTRODUCTION

For the 2016/17 allocation round, NHS England is considering updating the allocations formula to take into account the unavoidable costs associated with providing health care services in remote areas.

In principle, remote providers may be operating at low scale therefore incurring higher unit costs than other providers. Further, remote providers may face higher staff costs if difficulties in recruiting and retaining permanent staff result in a need for greater utilisation of agency staff. Such sites may also have less ability to take advantage of shared rotas between sites. However, it is expected that the main component of the unavoidable cost is associated with providers operating at sub-scale (i.e. operating below minimum efficient scale).

Patient access to emergency services and clinical safety considerations can require commissioners to commission, and providers to deliver, services even if they operate below minimum efficient scale (MES). This requirement is more critical for emergency care relative to elective care.

This paper:

- Describes the methodology used to test the hypothesis that remote providers face higher costs,
- Quantifies the unavoidable cost of remoteness; and
- Sets out points of discussion for the basis of a remoteness adjustment (e.g. scope of services subject to application, degree of specificity of adjustment)

2. METHODOLOGY

Two hypotheses are tested:

Hypothesis 1: Remote providers have higher unit costs due to sub-scale; and

Hypothesis 2: Remote providers face additional unavoidable costs (e.g. costs associated with higher utilisation of agency staff).

Both hypotheses are tested using econometric techniques as described in section 2.3.

2.1 Sub-scale effects

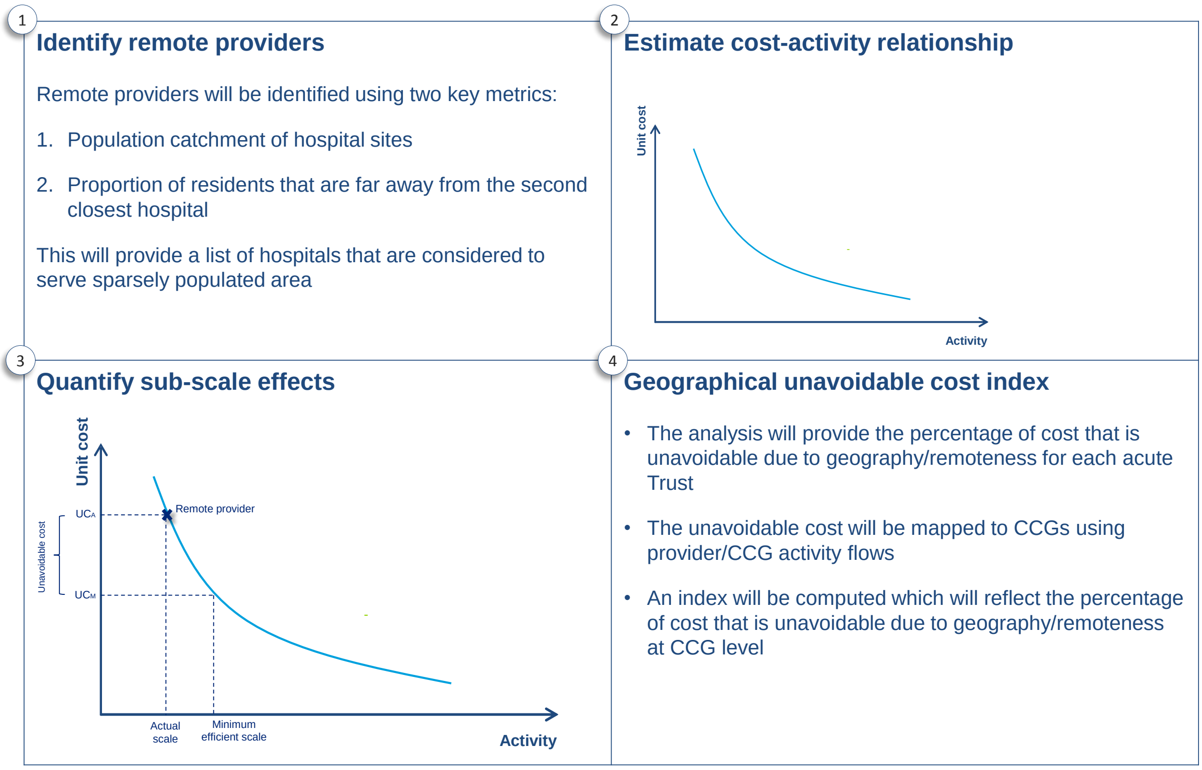
Figure 1 summarises the four steps involved in the estimation of unavoidable sub-scale cost.

1. Identify providers that serve remote populations. A separate paper has been written on this by the allocations team.

2. Estimate the relationship between cost and activity (while controlling for confounding factors).
3. Each remote provider is mapped on the cost-activity curve. The unavoidable cost is computed as the difference between actual cost and cost of the minimum efficient provider.
4. Provider-specific cost uplifts are mapped to CCGs.

The key aspect of the methodology is Step 2. This step effectively involves estimation of an econometric model between provider cost and activity after controlling for a wide range of confounding effects (e.g. case-mix heterogeneity).

Figure 1: Quantifying sub-scale effects



2.2 Other factors

The hypothesis that remote providers face higher unit costs (other than sub-scale) is tested by augmenting the econometric model with a “remoteness” variable. This is further discussed in the next section.

2.3 Econometric model

The econometric framework is similar to the approach Deloitte and Monitor utilised to assess the efficiency factor in the 2015/16 National Tariff. A high-level description of the econometric model is shown in Figure 2. The model is estimated by panel Random Effects using data across acute providers over the period 2009/10 to 2013/14.

Effectively, provider cost is regressed on the following factors.

- **Activity, case-mix adjusted.** Number of episodes, admissions, attendances, etc. For each provider, the activity variable is the sum of weighted HRG-level activity. The weights reflect the national unit cost of an HRG relative to the national unit cost across all HRGs (See appendix for more details).

- **Activity concentration**. This reflects the concentration of activity between sites. Trusts with two equally sized sites might have different unit costs relative to trusts that have, for instance, one large and one small site. This variable effectively tests this hypothesis.

- **Remoteness**. Two alternative variables are considered. The first one is a dummy variable that identifies remote sites. The second is a remoteness index which reflects the percentage of population served that is more than 60' away from the second nearest provider.[1]

- **Case-mix complexity**. Primarily captured by case-mix adjusted activity. Notwithstanding, a number of variables reflecting patient age, gender and ethnicity are included in the model to capture any additional effects.

- **Input prices.** Given the time-series dimension of the sample, variation of prices over time is captured by the cost uplift factor. Variation in input prices between providers is controlled through the MFF.

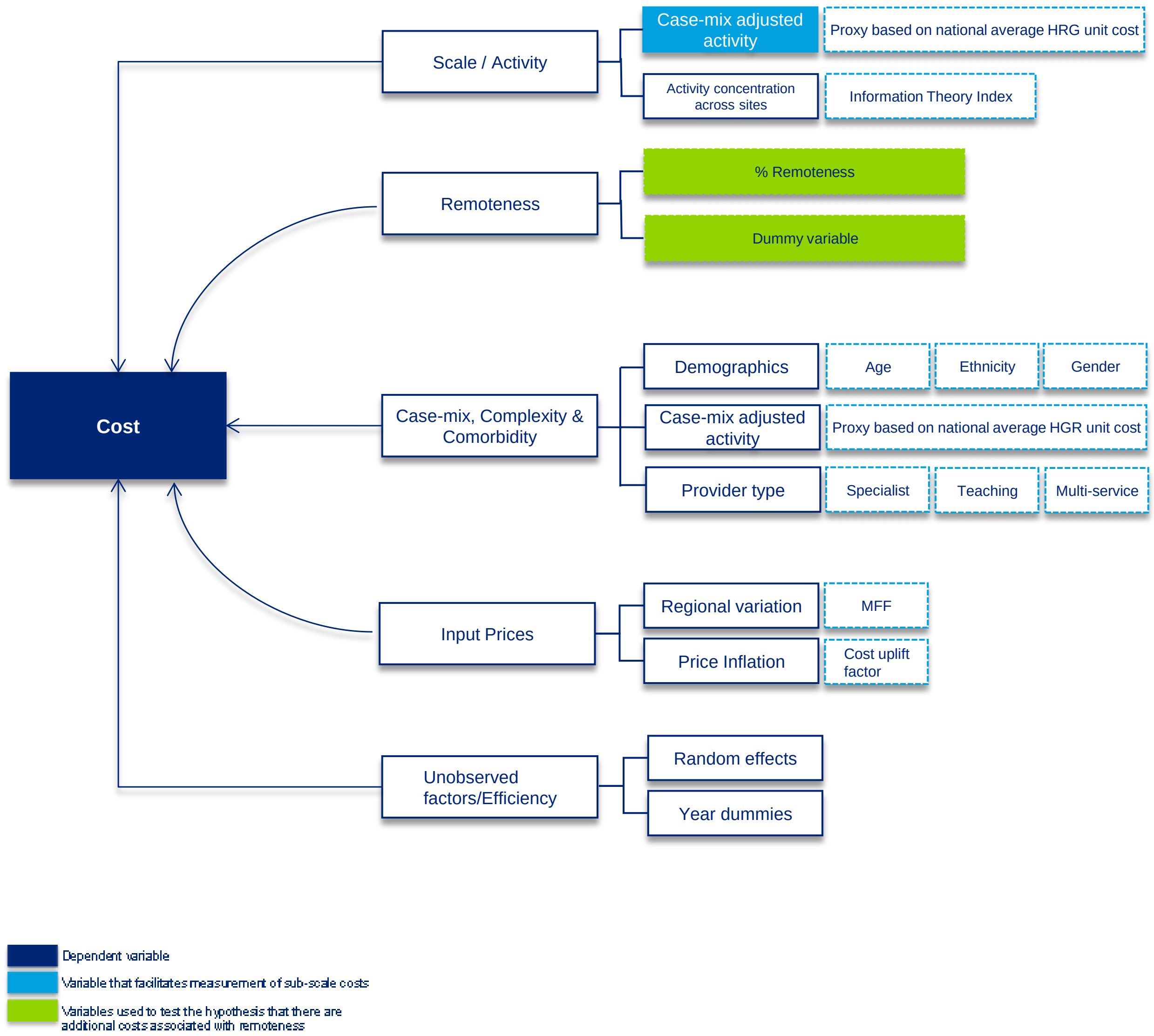
- **Unobserved factors and efficiency**. Any time-invariant unobserved heterogeneity is captured through the Random Effects. Year dummies are also included in the model to control for time-varying factors that are common across providers.

2.4 Data sources

- Cost and activity data: Reference costs
- Remoteness: calculations from the allocations team
- Demographic information: HES
- Provider type: Hospital Estates and Facilities Statistics
- Number of sites: Hospital Estates and Facilities Statistics
- MFF: Reference costs

[1] Remote hospitals are identified on the basis of two criteria: (1) hospitals which serve a population of fewer than 200,000 people; and (2) the proportion of the population they serve for whom the next nearest hospital is more than 60 minutes away. The proportion of the population served which is more than 60 minutes away from the next nearest hospital provides an indication of whether the hospital is serving a population of fewer than 200,000 for reasons of remoteness.

Figure 2: Model specification



2.5 Scope of services

Two models are estimated – an "emergency services model" and a "total services model". The emergency model is estimated using only emergency services and maternity. In particular the following reference cost service codes are considered:

- Non-Elective services (Department code==NEL, NEL_XS);
- Accidents and Emergency (Department code==EM); and
- Obstetrics (Service code==501).

The total cost model includes all department and service codes.[2]

2.6 Limitations, risks and mitigations

Issues	Description	Risks and mitigations
Are suitable data available?	The unavoidable cost should be estimated at hospital/site level as opposed to Trust level. However, cost data by site is not widely available. Site-level activity data are available from HES, however, they don't cover A&E. Further, data quality is questionable as Trusts are not required to provide site level information	**Risks** – Using Trust level data to estimate the economies of scale at site level is challenging **Mitigations** – Use Reference Cost data by Trust. Average hospital size and concentration of activity by site will be proxied using HES site-level activity data
What are the implication of imperfect cost allocation methodologies when modelling service-level cost-activity relationships	The core model focuses on service-level cost (i.e. emergency services) sourced from reference costs and therefore relies on the accuracy of the cost allocation methodology	**Risks** – Imperfect cost allocation may bias the cost-activity elasticity estimates **Mitigations** – Triangulate results with models that use total costs and activity
Are reference cost data robust enough?	We envisage using cost data from Reference cost, which are considered robust enough to set national prices	**Risks** – Possible outliers might bias the results **Mitigations** – Carry out statistical tests to identify and remove potential outliers

[2] For both total and emergency services models, community and mental health facilities are excluded from the sample. The final econometric estimation is conducted for 4 acute organisation types – small, medium, large, and teaching.

Can we capture the impact of economies of scope?	The unit cost of providing emergency services depends on the scale of provision (economies of scale) but also on the scale of provision of other services (economies of scope) - e.g. through shared consultant rotas	**Risks** – If economies of scope are not accounted for the modelling may underestimate the cost associated with operating below minimum efficient scale **Mitigations** – It is challenging from an econometrics point of view to control for economies of scope. We will test the sensitivity of the results by using aggregate service data

3. MODEL RESULTS

Table 1 sets out the econometric model estimates. "Total services model" regresses total costs on total activity whereas "emergency services model" covers cost and activity for non-elective services and maternity. The dependent variable is the logarithm of cost deflated by the cost uplift factor.

The model results show that:

- The elasticity of cost with respect to activity is less than one suggesting economies of scale and potential sub-scale unavoidable costs for remote providers. Economies of scale are greater in the emergency services model compared to the total cost model.
- The hypothesis that there are additional costs associated with remoteness (other than sub-scale) is rejected as the remoteness variable is not statistically significant.

Table 1: Model output

Independent Variables	Total services model	Emergency services model
Activity, case-mix adjusted (log)	0.890***	0.814***
Remoteness dummy	-0.0115	-0.0279
Activity concentration	-0.0853	-0.227
% patients > 75 years old	-0.00165	-0.00354
% female patients	-0.00587***	-0.00640**
% patients BAME	0.00157**	0.00195*
% patients emergency	-0.00271***	-
Small provider dummy	-0.0228**	-0.0295

Independent Variables	Total services model	Emergency services model
Large provider dummy	0.0120	0.00720
Teaching provider dummy	0.0681***	0.0611**
MFF	0.643***	0.571***
Time indicator (2010/11)	0.000700	-0.0131
Time indicator (2011/12)	-0.0482***	-0.00687
Time indicator (2012/13)	-0.0453***	0.0238*
Time indicator (2013/14)	-0.0651***	0.0554***
** p-value<.10 ** p<0.05 *** p<0.01*		

***Notes*:** Due to data availability, trust-level data are used. Cost and activity are divided by number of sites, therefore, they reflect average cost and activity per site. Medium provider dummy is the base against which, Small, Large and Teaching dummies are evaluated.

4. SUB-SCALE EFFECTS

Figure 4 and Table 3 show the unavoidable cost associated with remote sites operating below minimum efficient scale. This is computed using the methodology described in Figure 1 (Step 3).

Figure 3: Cost uplift of remote sites - %

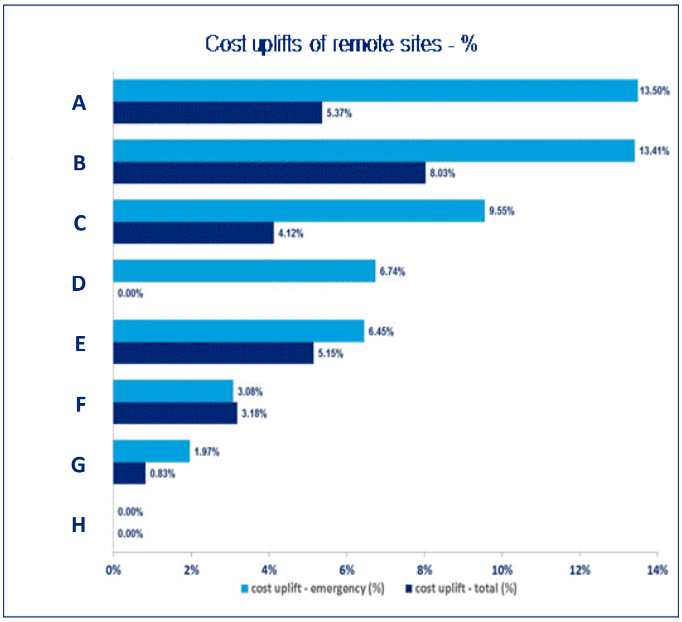


Table 2: Cost uplift of remote sites - £

Provider (sites)	Total model uplift (£)	Emergency model uplift (£)
I (B & G)	7,164,590	5,660,429
II (A)	5,432,874	4,849,514
III (C)	4,062,780	3,781,498
IV (D)	0	2,766,251
V (E)	4,406,951	2,752,932
VI (F)	2,958,817	1,384,194
VII (H)	0	0

Cost uplift estimation is conducted for sites which are identified as remote. The identification criteria used (as outlined in separate ACRA papers) are:

1. Maximum population catchment = 200,000
2. Travel time from the second nearest provider = 60 minutes

The baseline remote sites are identified by the above conditions and satisfy an additional criterion:

3. The "remoteness index" of the site is greater than 10%

The cost uplift (%) is higher in the emergency model than that in the total model. This occurs because emergency services experience higher economies of scale.

5. APPLICATION QUESTIONS

ACRA's advice on the following options and issues would be appreciated:

1. Scope of services for remoteness adjustment application:
    a. Emergency services including maternity
    b. Total acute services

2. Degree of specificity of remoteness adjustment application:
    a. Site-specific adjustment on the basis of analysis set out in this paper
    b. One-size fits all application
    c. Options on the spectrum between (a) and (b)

3. Are there particular perverse incentives on providers or commissioners which should be considered when structuring a remoteness adjustment?

APPENDIX

A.1 Case-mix adjusted activity

The case-mix adjusted activity has been computed in three steps.

1. Deflate providers' costs by the market forces factor.

$$C_{MFF_{i,j}} = \frac{C_{i,j}}{MFF_j}$$

2. Compute complexity weights for each HRG.

$$w_i = \frac{\dfrac{\sum_j^N C_{MFF_{i,j}}}{\sum_j^N A_{i,j}}}{\dfrac{\sum_i^k \sum_j^N C_{MFF_{ij}}}{\sum_i^k \sum_j^N A_{ij}}} = \frac{National\ average\ \cos t\ \ for\ HRGi}{National\ average\ \cos t}$$

3. Apply weights to the raw activity measure.

$$ACM_j = \sum_i^k w_i A_{i,j}$$

where

i : HRG i

j : Provider j

ACM : Activity, case - mix adjusted

A : Unadjusted activity

$C_{i,j}$: Total cost incurred by provider j for HRG i

C_{MFF} : Cost deflated by MFF

The weights have been computed separately for each year due to temporal changes in HRG coding.

A.2 Model sensitivity

The sensitivity of the econometric model is tested with respect to various criteria. Sensitivity along two key dimensions is presented.

1. **Trust data.** The baseline models regress total trust cost divided by number of sites on total trust activity divided by number of sites. The same specification is estimated without adjusting for the number of sites.

Table 3: Sensitivity – Trust cost and activity

Independent Variable	Total model	Emergency model
Activity, case-mix adjusted (log)	0.869***	0.818***
Remoteness dummy	0.0327*	0.0331
Activity concentration	0.0974	0.183
% patients > 75 years old	-0.00421***	-0.00922***
% female patients	-0.00626***	-0.00780***
% patients BAME	0.000839	0.000347
% patients emergency	-0.00152**	N/A
Small provider dummy	-0.0408***	-0.0550***
Large provider dummy	0.0673***	0.0822***
Teaching provider dummy	0.127***	0.103***
MFF	0.743***	0.724***
Time indicator (2010/11)	0.00221	-0.0120
Time indicator (2011/12)	-0.0442***	-0.00575
Time indicator (2012/13)	-0.0356***	0.0370**
Time indicator (2013/14)	-0.0580***	0.0569***
** p-value<.10 ** p<0.05 *** p<0.01*		

2. **Sensitivity to time dimension.** The baseline specification is estimated by excluding specific years from the sample.

Table 4: Sensitivity to time dimension

Variable	All years considered	Dropping 2009	Dropping 2010	Dropping 2011	Dropping 2012	Dropping 2013
Activity elasticity – total services model	0.89***	0.91***	0.90***	0.90***	0.92***	0.88***
Activity elasticity - emergency services model	0.81***	0.83***	0.83***	0.83***	0.85***	0.81***

A.3 Minimum Efficient Scale ("MES")

The estimation of sub-scale cost depends on the definition of the minimum efficient scale. The majority of studies define MES in terms of number of beds and suggest no significant economies of scale beyond 200-300 beds. Most of these studies are based on international data and hence may not be applicable to NHS England as the majority of NHS hospitals have more than 400 beds (see Figure 3).

MES in this study is defined in terms of population served. Following Monitor's (2014) work on small hospitals, MES is assumed to be 200K population catchment.

Figure 4: Relationship between population catchment and beds

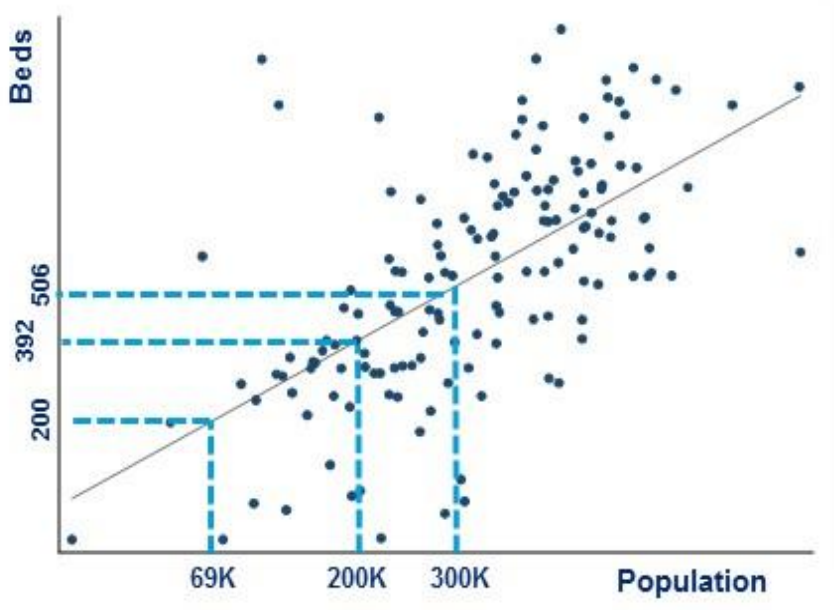


Table 5: Minimum efficient scale studies

Source	Sample	Purpose	Scale variable	Insights
Monitor (2014)	142 general acute trusts	Identify characteristics of "smallest" hospitals	Revenue	"Smallest" hospitals are defined as those having less than £200m annual revenue. Smallest hospitals have, on average, 195K population catchment and 396 beds
BCG – Frontier economics (2012)	A&E, obstetrics, and orthopaedics	Estimate Economies of Scale at specialty level	Attendances, procedures, operating hours	Significant economies of scale identified, however, results are not applicable to the remoteness study as they are specialty focused
Kristensen et. al (2008)	c.50 Danish hospitals over 2004-06	Determine MES	Beds	Optimum hospital size = 275 beds
Gaynor et al. (2015)	320 US hospitals	Determine MES	Beds	MES = 228 – 277 beds