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Regional Variation in the Productivity of the English National Health Service

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Regional variation in the productivity of the English National Health Service

Report for the Department of Health

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Executive summary

Objectives

At a time when there are severe pressures on reducing public spending there is increasing emphasis on determining which parts of the country secure best value for money in the NHS. By linking together large scale and routinely collected datasets we produce and compare productivity estimates across the ten Strategic Health Authorities in England in 2007/08.

Methods

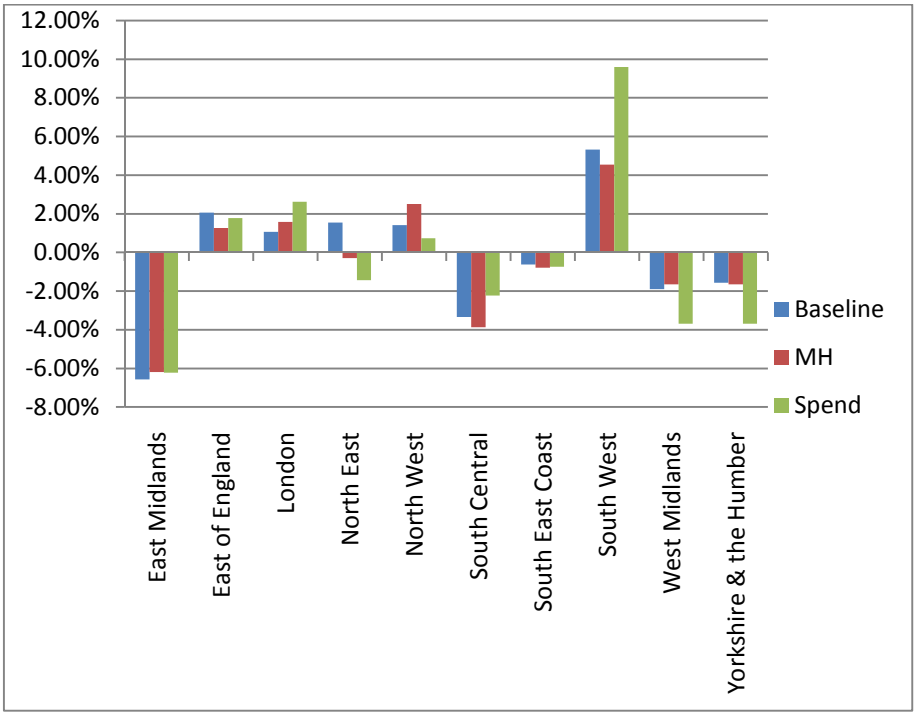
Productivity is measured for each SHA by comparing the total amount of health care 'output' provided for the SHA's resident population to the total amount of 'input' used to produce this output.

Output consists of all health care services provided to NHS patients in the acute and community care sectors. The output measure also takes account of quality improvements by measuring changes in hospital survival rates and health outcomes, and inpatient and outpatient waiting times.

Inputs include the staff, intermediate goods and services, and capital resources that contribute to the production of health care. Staff and capital inputs are adjusted by the relevant market forces factor and we account for movement of patients between SHAs.

Data

We analyse data from Hospital Episode Statistics, the Reference Costs, Financial Returns, and workforce census. Data about patients seen in primary care are not available. Other than primary care, the data cover all patients treated by all organisations in each SHA.



Standardised productivity by SHA

Results

Productivity ratios across SHAs vary from 5% above to 6.5% below the national average. As the figure above shows, productivity is highest in South West SHA and lowest in East Midlands, South Central, West Midlands and Yorkshire & the Humber SHAs. These positions are not sensitive to alternative formulations of the productivity index. If it were as productive as South West, East

Midlands could deliver the current amount of hospital and community care for £4.7billion rather than the £5.3billion actually spent. If all parts of the country were as productive as the South West the NHS could cut expenditure by £3.2billion without reducing the number of patients treated

Conclusion

The geographical variations in productivity are not due to differences in the types of patients treated; nor to differences in quality of care as captured by inpatient and outpatient waiting times and hospital survival rates; nor to regional differences in the prices that organisations pay for staff, buildings and capital. All of these are taken into account. Part of the explanation may lie in where patients seek treatment, in the stability of the workforce, and the amount of activity undertaken in primary care.

Even though the budget is ring-fenced the NHS has to make substantial efficiency improvements over the next five years. Our analysis indicates in which parts of the country there may be greatest scope for improvement.

Introduction

As we enter a more resource constrained period there is a danger that across-the-board 'efficiency' savings may translate simply into commensurate reductions in the number of patients being treated or in the quality of care they receive. To guard against this, it is important to examine variations in productivity in different parts of the country so that efforts can be targeted to where most gains are to be made. In this report we compare productivity across the ten English Strategic Health Authorities (SHAs), by adapting the method developed to measure productivity for the NHS as a whole. The focus of the productivity analysis is on patients and organisations within geographical areas defined by SHA boundaries, rather than on SHAs themselves.

Productivity is measured for each SHA by comparing the total amount of health care 'output' provided for the SHA's resident population to the total amount of 'input' used to produce this output. Hence, we measure:

$$Productivity = \frac{Output}{Input}$$

Output consists of all health care services provided to NHS patients in the acute and community care sectors. The output measure also takes account of quality by measuring differences across SHAs in hospital survival rates and health outcomes, and inpatient and outpatient waiting times. It has not been possible to account for primary care activity because of a lack of accurate data across SHAs.

Inputs include the staff, intermediate goods and services, and capital resources that contribute to the production of health care. The contribution of NHS staff is captured through the Workforce Census. The use of other health care inputs is assessed using the financial returns for all NHS organisations.

Before we address productivity measurement across SHAs, by way of context we first summarise productivity growth for the NHS as a whole.

The national picture

We have produced annual updates of the output, input and overall productivity series for the NHS as a whole.[1, 2] The full series now extends from 1998/9 to 2007/8, and is summarised in the figure below.

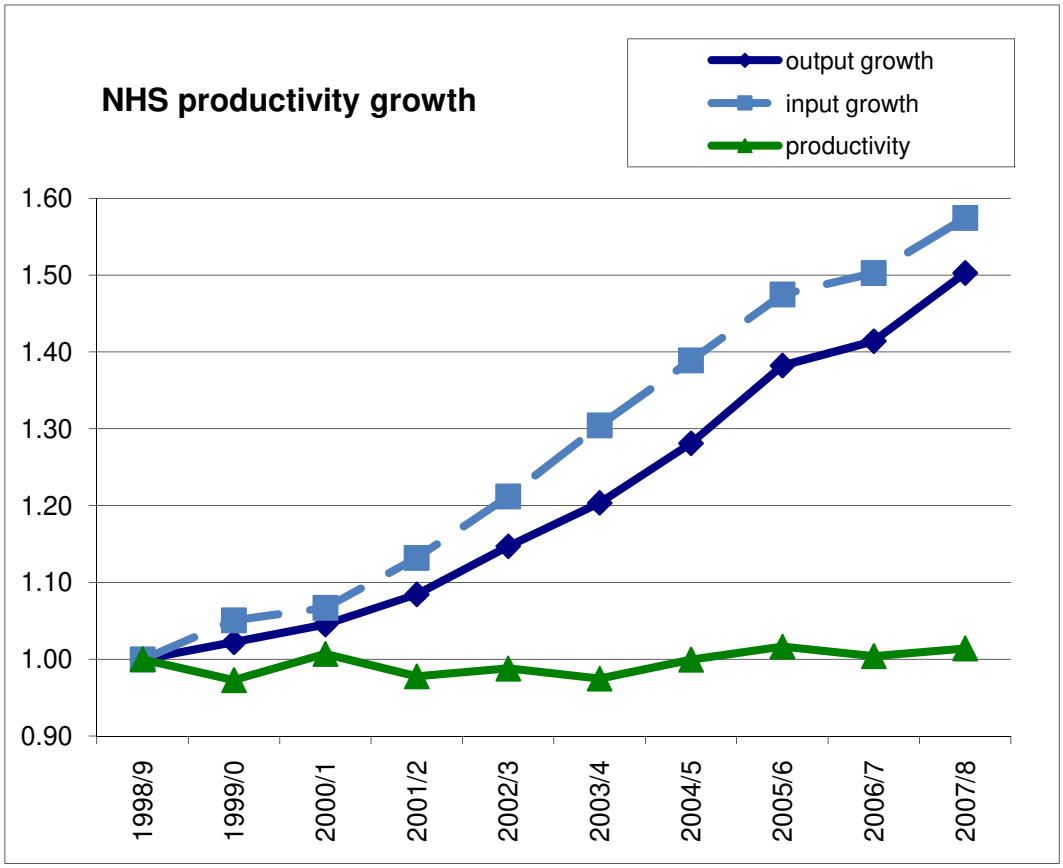


Figure 1 NHS productivity growth 1998/9 – 2007/8

Figure 1 presents three series:

- An index of output growth which measures changes in the number and quality of care of patients treated by the NHS across different settings, such as hospitals, outpatient departments, mental health care trusts and in primary care.
- An index of input growth which measures changes in the volume of the various inputs used in the provision of care, including staff, drugs, clinical supplies, medical equipment, and buildings.
- Productivity growth, calculated by comparing the ratio of output growth to input growth.

Between 1998/9 and 2003/4 there was strong input growth, particularly after 2000/1, averaging 5.5% a year. Recruitment increased, in part to satisfy the European Working Time Directive, and staff received new pay awards. There was greater investment in equipment and buildings.

Over the same period output growth lagged behind input growth. This is unsurprising. The EWTD placed limits on working hours, entailing reductions in the number of patients per doctor, and investments are not realised immediately. Even so, year-on-year increases in the number of patients treated meant that output growth averaged more than 3.8% per year up to 2003/4. The net effect, though, was slightly negative productivity growth between 1998/9 and 2003/4.

This has since changed. NHS output has continued to rise, but at the faster rate of 5.7% a year. Not only are more patients being treated, but the quality of the care they receive has been improving. For example:

- Survival rates have been improving for patients admitted to hospital whether as electives or non-electives, as shown in Figure 2.
- Waiting times have been falling, both for outpatient appointments and for admission to hospital.
- Figure 3 summarises the hospital waiting time at the 80th percentile, which provides an indication of 'excessive' waiting times, and for first outpatient appointments.

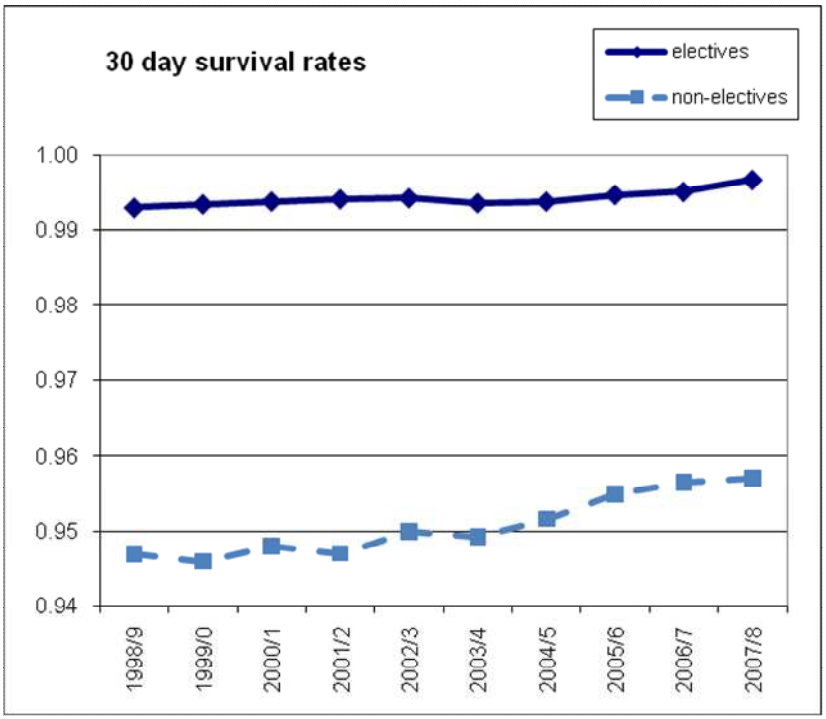


Figure 2 Survival rates thirty days after hospital discharge

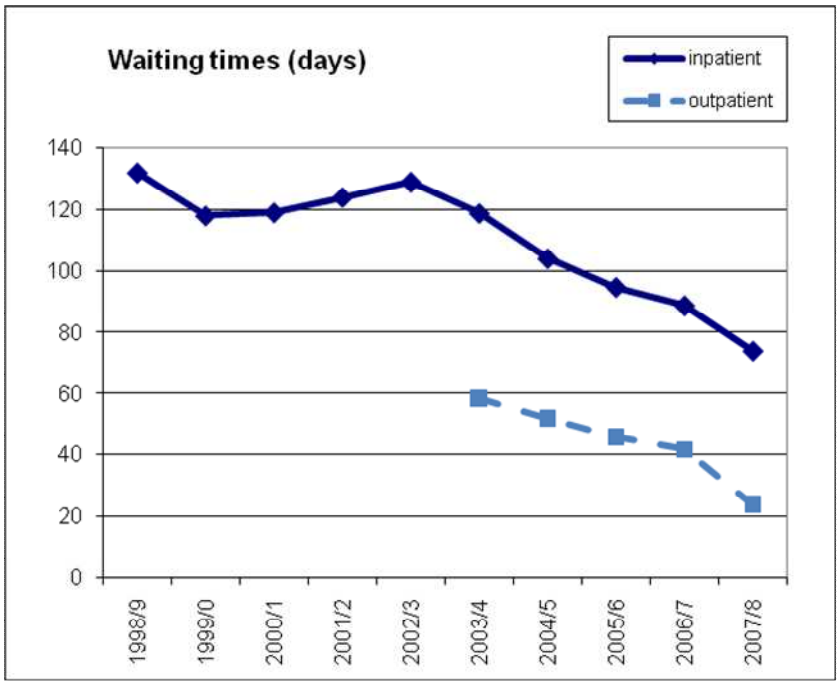


Figure 3 Waiting times

The index of input growth suggests a slowdown in input growth since 2004/5, which has been increasing at a rate of 4.8% a year, compared to 5.5% previously. This slowdown is due to a levelling off in staff recruitment and reduced reliance on agency staff.

Since 2004/5 growth in inputs has been matched or slightly exceeded by growth in outputs, so recent NHS productivity growth has been slightly positive.

Our estimates differ from those of the Office for National Statistics, which estimates that productivity fell by 0.3% in 2007 and by 0.7% 2008.[3] The main reasons for the differences are that:

- The ONS measure of output is not comprehensive, capturing around 80% of activity.[4] In particular much community care activity is omitted, where growth has been above average. This biases the ONS productivity measure downwards.
- The ONS measure of labour inputs does not account for the contribution of non-NHS (eg agency) staff.[5] There have been recent reductions in the use of non-NHS staff. Omitting their reducing contribution biases the ONS productivity measure downwards.
- The ONS estimates of productivity for 2008 are based on projections based on the first quarter's data. The accuracy of these projections will not be established until the actual data are available.

Methods

This report focuses on comparing productivity across SHAs using data for a single year, 2007/8. The analysis forms a baseline against which future calculations of productivity growth can be made. The analytical task is in constructing comprehensive and accurate measures of the volumes of output and input. We follow the approach adopted in the construction of the national productivity index, adapting this for use in a cross-sectional context. In what follows we provide a brief description of the output and input measures. Technical details of these measures are provided in the appendix.

Measuring output

The volume of output includes all health care services provided to NHS patients resident in each SHA (with the exception of primary care services about which reliable data are unavailable). Of course, the NHS provides care to people with diverse needs and there are a great many different types of health services. It is necessary to take this diversity into account when measuring the total volume of healthcare output provided to the residents of each SHA. Put simply, measurement involves the following steps:

1. Categorisation of the diverse types of healthcare output. We use 6,551 output categories to reflect this diversity, including version 4 Healthcare Resource Groups to describe care provided in hospitals and the numerous categories used in the Reference Costs data to describe care provided in other settings.
2. Quantification of the number of patients in each output category in each SHA. This information is derived from the Hospital Episode Statistics and Reference Cost data.
3. A means of determining the relative 'value' of each output category, so that activity across all categories can be aggregated into a single measure of total output. We use national average costs to reflect the relative value of different health care services. This is consistent with the convention in the national accounts.
4. A means of allowing for differences in the quality of care across SHAs. Consistent with the national productivity measure, we account for differences in hospital survival rates and in inpatient and outpatient waiting times.

Total output will be higher than the national average in SHAs that have:

- Higher volumes of activity
- More complex or costly activities
- Higher rates of hospital survival
- Lower inpatient and outpatient waiting times

Measuring input

Inputs into the health care system consist of:

- Labour, such as doctors, nurses, technicians and managers;
- Intermediate goods and services, such as drugs and clinical supplies;
- Capital, such as buildings and equipment with an asset life of more than a year.

We use Workforce Census data to assess the number of NHS staff working in each SHA using 417 staffing categories. A benchmark wage is used to weight staff of different types in order to construct a measure of total staffing input.

Details about staff, intermediate goods and services and capital are derived from the expenditure data from each NHS organisation in the ten SHAs. Expenditure on staff is adjusted for geographical differences in factor prices by applying the staff MFF to all non medical staff and the medical and dental MFF to medical and dental staff.[6] The medical and dental MFF adjustment is the same for the entire country apart from London. Capital expenditure is adjusted using an amalgam of the land and buildings MFF. Concerns about the 2007/8 MFF led to a revised formulation being used to calculate the 2008/9 MFF, and this is what we have used.

Healthcare organisations treat local residents as well as patients from other SHAs. This means that part of an organisation's expenditure will be devoted to patients resident in other SHAs. We allow for movement of patients across SHAs in constructing our measure of the total input devoted to the residents of each SHA. If there are proportionately more patients coming into the SHA for treatment than leaving the SHA for treatment elsewhere, the expenditure of those organisations in the SHA is adjusted downwards to reflect that their resources are not utilised solely by the resident population. We construct a 'migration factor' in order to allow for this movement of patients, identifying where hospital patients are treated from the Hospital Episode Statistics.

Total input will be lower than the national average in SHAs that:

- Employ fewer staff, whether NHS or agency
- Employ relatively fewer staff in higher pay bands
- Spend less on intermediate goods and services
- Have lower levels of capital expenditure
- Have a positive net flow of patients into the SHA

Measuring productivity

For a single year productivity is defined as the ratio of the volume of output produced to the volume of input utilised in the production process. We compare these ratios across the ten SHAs. The health service is more productive in those SHAs where the ratio of output to input is higher.

Productivity is measured as the ratio of output over input:

$$Productivity\ of\ SHA\ j = \frac{Output\ in\ SHA\ j}{Input\ in\ SHA\ j}$$

The value of this ratio has no inherent interpretation, being dependent on how the units of output and input are measured and scaled. To aid interpretation and comparison of productivity across SHAs, therefore, the output/input ratio for each SHA can be standardised against the average output/input ratio across SHAs, and converted into a percentage:

$$Standardised\ Productivity\ of\ SHA\ j = \left\{\left[\left(\frac{Output\ in\ SHA\ j}{Input\ in\ SHA\ j}\right)\Big/\left(\frac{Average\ Output\ across\ SHAs}{Average\ Input\ across\ SHAs}\right)\right] - 1\right\} \times 100$$

Thus if standardised productivity in SHA *j* is 10%, this means that productivity is 10% higher than the national average.

Data

Outputs

Hospital episode statistics

The hospital episode statistics (HES) are the prime data source for identifying the provision of hospital (inpatient and day case) services to NHS patients. HES covers all medical and surgical specialities and includes private patients treated in NHS hospitals. In addition, HES captures hospital care funded by the NHS but provided by the private sector – although the quality of data from some private providers is poor. [7, 8]

HES now comprises over 15 million patient records each year. Records are stored according to the financial year in which the period of care finished and each includes a number of data fields, containing demographic data (e.g. age, gender), waiting times, clinical information (e.g. diagnoses, procedures performed) and details of the hospital and specialty where the patient received treatment. We are also able to link HES data to death registry records, so deaths following discharge can be measured.

Each HES record is defined as a 'finished consultant episode', which is the time that a patient spends under the care of a single consultant. During their course of treatment a patient may be treated by more than one consultant and may be transferred to another hospital, with a new record being created each time this happens. To account for this we construct continuous inpatient spells (CIPS) which track patients when transferred between consultants and hospitals as part of their care pathway.[9, 10] We then count the number of patients (ie CIPS) in each HRG for each SHA.

The cost of each CIPS is calculated on the basis of the most expensive FCE within the CIPS, with costs for each HRG derived from the Reference Cost data. We then calculate the national average cost per patient in each HRG.

Reference Cost data

The Reference Costs capture data about activities conducted in mental health and community care settings, outpatient and accident and emergency departments, and diagnostic facilities. These activity data are reported in various ways, including attendances, contacts, bed days, and number of tests. By using costs to weight these diverse activities we are able to convert them into a common metric that permits aggregation.

Inputs

NHS Staff Data

Data on the number of NHS staff employed are taken from Workforce Census data provided by the NHS Information Centre. The Census data show headcounts and full time equivalents (FTEs) of staff employed in the NHS as at the 30th of September 2007. We use FTEs in our calculations of labour input.

Earnings data are taken from a database called iView again provided by the Information Centre. iView data contain earnings data by occupation for both medical and non medical staff employed in the NHS. The data are disaggregated by occupation code and SHA and report national average figures for each occupation. We map the Census and iView data together according to occupational code. We use the national average earnings for each occupational group to construct a wage index by which to aggregate the total number of FTEs across occupational codes into a measure of total NHS labour input in each SHA. Details are provided in Appendix 2.

Expenditure data

To assess the inputs used in producing health services for each SHA, we analyse financial data for all NHS providers, including acute hospitals, Foundation Trusts, mental health care and community trusts, and ambulance trusts; and for PCTs. We do not include expenditure on SHA headquarters

because of difficulties in identifying costs reported in the SHA financial returns that are associated with national bodies hosted by some SHAs, such as NHS Direct and the Workforce Review Team, and because of apparent differences in accounting practices among SHAs.

The financial returns detail expenditure on both NHS and agency staff by broad categories of labour input, including medical, dental and nursing staff, scientific, therapeutic and technical staff, healthcare assistants, maintenance and works staff, ambulance staff, administrative and clerical staff, managers, and non-executive directors and chairs. As a sensitivity analysis we compare estimates of productivity when NHS labour is measured using Census data or expenditure data.

Intermediate inputs include drugs and gases, clinical supplies, catering, hotel services, uniforms, laundry, bedding, energy, establishment and premises costs. This category also includes purchases of health care from non-NHS bodies. This category accounts for the largest share of PCT expenditure, capturing care purchased from the voluntary sector and local authorities for older people and those with mental or physical disabilities, and acute care for NHS patients purchased from the private sector.[11]

The financial returns contain two forms of information about capital expenditure: current outlays on equipment and past expenditure reported as depreciation on assets. We make assumptions according to the asset in question about what proportion of current expenditure is employed in the current period.[12]

Results

Outputs

As mentioned, there are many categories to describe health care output provided across and within different settings. The number of distinct categories employed in HES and the Reference Costs in each setting is reported in Table 1. Note that during 2007/8, while the majority of HES activity was coded to v4 HRGs, some activity was coded using v3.5 HRGs.

Table 1 Number of output categories by healthcare setting

Setting	Types of Activity (e.g. HRGs)	Date source
Hospital Elective exc. Mental Health	1725	HES
Hospital Non-Elective exc. Mental Health	1709	HES
Hospital Elective Mental Health	20	HES
Hospital Non-Elective Mental Health	20	HES
Non-Admitted Mental Health	109	RC
A&E Services	190	RC
Diagnostic Tests	56	RC
Hospital/Patient Transport Scheme	6	RC
Outpatient	1419	RC
Chemotherapy/Radiotherapy & High Cost Drugs	257	RC
Radiology	119	RC
Renal Dialysis	28	RC
Specialist Services	36	RC
Community Care	138	RC
Rehabilitation	143	RC
Other including Day Care Facilities Regular Attendances, Regular Day and Night Admissions, Hospital at Home, Audiological Services, etc	576	RC

Hospital activity

The output of the hospital sector accounts for the number and type of patients treated, and the quality of their care. Table 2 shows the number of SHA residents treated in hospital on an elective or non-elective basis.[a]

Three sets of figures are presented for these two admission types. The first set, headed 'unadjusted activity', is a simple count of the number of patients, each defined as a Continuous Inpatient Spell (CIPS). The second set weights these numbers by the cost of the HRG to which each patient is allocated relative to a benchmark cost. Arbitrarily we have chosen £1,167 as the benchmark, this being the average cost of HES activity. The benchmark is used to establish the cost weights for all activities, including those provided to non-admitted patients.

As elective activity is generally less costly than the benchmark and to non-elective activity, the amount of cost weighted elective activity appears lower than the straightforward count of patients, while the opposite is true for non-elective activity. The extent to which the simple count and the weighted amounts of activity diverge varies across SHAs according to the particular composition of activity across each of the HRGs.

[a] These figures do not include treatments provided to patients receiving renal replacement therapy or suffering chronic kidney disease, this activity being omitted for the reasons explained in Appendix 3.

Table 2 Actual, cost weighted and quality adjusted hospital activity by SHA

SHA	Admission Type					
	Elective			Non-Elective		
	Unadjusted Activity	Cost weighted activity	Quality adjusted activity	Unadjusted Activity	Cost weighted activity	Quality adjusted activity
East Midlands	591,163	566,077	563,651	523,159	546,939	545,799
East of England	702,976	685,033	669,463	571,338	634,830	612,084
London	904,398	807,524	847,980	871,491	900,633	945,688
North East	392,370	372,995	379,847	353,883	371,370	376,703
North West	1,031,592	979,699	994,518	975,740	967,830	987,192
South Central	472,474	464,528	464,043	442,051	468,609	471,430
South East Coast	501,778	506,771	490,008	452,657	508,564	485,833
South West	774,067	764,474	737,372	578,285	641,167	619,895
West Midlands	688,024	681,178	685,900	649,173	662,783	660,069
Yorkshire & the Humber	716,513	652,005	658,188	646,434	656,555	656,799
Total	*6,775,355*	*6,480,284*	*6,490,971*	*6,064,211*	*6,359,279*	*6,361,492*

The third set of figures scales output according to each patient's quality of care, captured by our measure of QALYs and waiting times, measured at the 80th percentile of the distribution as is consistent with the national figures. Summaries of the constituent information for each SHA, derived from analysis of all HES records, are reported in Table 3. Note that differences in life expectancy across SHAs are due solely to differences across SHAs in the age and gender composition of patients in each HRG.

Table 3 Mean life expectancy, survival rates and 80th percentile waiting times by SHA

SHA	Admission Type				
	Elective			Non-Elective	
	Average life expectancy	Average 30 days survival rate	80th percentile waiting time	Average life expectancy	Average 30 days survival rate
East Midlands	23.1	0.996	80	32.6	0.954
East of England	23.0	0.996	91	30.7	0.949
London	26.1	0.997	83	33.8	0.966
North East	23.7	0.996	68	31.1	0.953
North West	23.7	0.997	76	32.8	0.957
South Central	23.8	0.996	85	34.3	0.959
South East Coast	22.5	0.996	105	30.4	0.949
South West	22.8	0.996	79	30.4	0.951
West Midlands	23.7	0.996	82	33.0	0.955
Yorkshire & the Humber	24.3	0.996	78	32.0	0.955

The formula for making the quality adjustment involves comparing each SHA's position relative to the national average for each particular HRG. The use of the national average means that the adjustment has virtually no impact on the overall 'volume' of output at national level but volumes in each SHA will be scaled up (down) if quality is higher (lower) than the national average. Deviations across SHAs from the national average 80th percentile waiting times are shown in Figure 4. For example, waiting times are higher than the national average in the South East Coast SHA so, all else equal, hospital 'output' in this SHA will appear lower if waiting times are accounted for than if output were merely a count of activity.

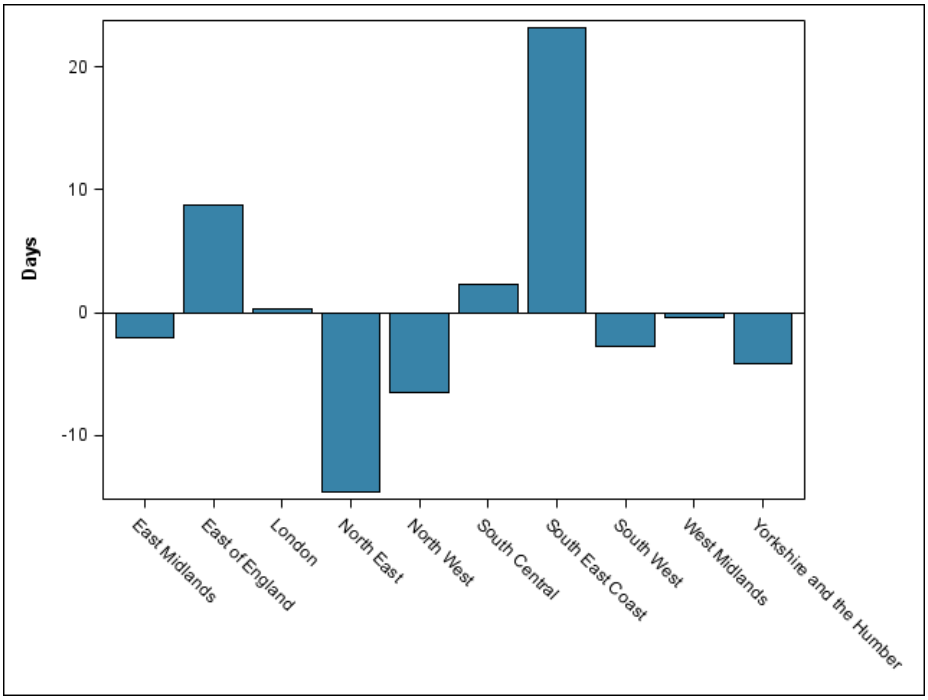


Figure 4 80th percentile waiting times by SHA, difference from national average

Figure 5 shows the deviation in 30-day survival rates from the national average for patients admitted on an elective basis, with survival rates being higher in the North West SHA and London SHA. Thus, all else equal, quality-adjusted output in these SHAs will appear higher than cost-weighted output.

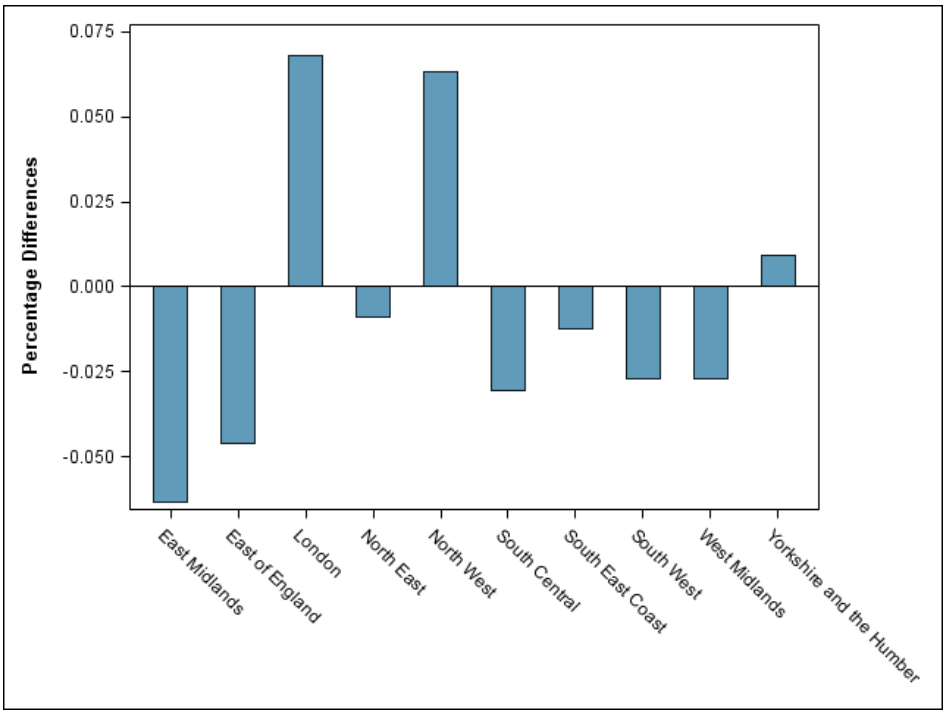


Figure 5 Thirty day post discharge survival rates by SHA, difference from national average, electives

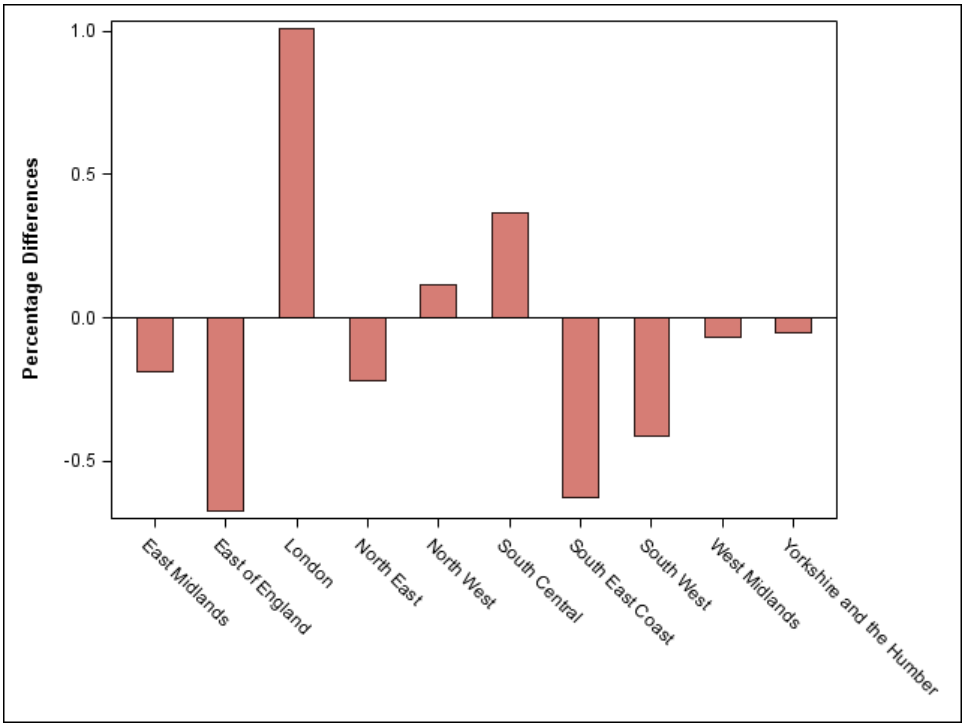


Figure 6 Thirty day post discharge survival rates by SHA, difference from national average, non-electives

The deviation in survival rates for non-elective patients is shown in Figure 6 with rates in London SHA and South Central SHA better than elsewhere.[b] Consideration of survival effects, therefore, will raise the amount of non-elective output above cost-weighted counts of output for these two SHAs.

The combined impact of allowing for QALYs and waiting times in measuring elective output is reported in the third column of Table 2 while the impact of accounting for QALYs on the measure of non-elective output is reported in the final column of the same table. In general, the impact of allowing for quality is greater when considering elective activity than non-elective activity because survival rates are higher for elective patients and waiting times are also considered. The relative impact of the quality adjustment differs across SHAs according to the differential survival rates, life expectancy and waiting times experienced by their residents allocated to each HRG.

Mental health care

The numbers of patients receiving care for mental health problems in each SHA are reported in Table 4. Activity is presented separately for patients admitted to hospital on an elective and a non-elective basis, and for care provided in non-hospital settings. The same quality adjustments as applied to other hospital patients are used to assess the quality of hospital care provided to mental health patients.

[b] Note that the scale of figure 6 differs from that of figure 5.

Table 4 Actual, cost weighted and quality adjusted mental health care activity by SHA, baseline figures

	Admission Type							
	Elective			Non-Elective			Non-admitted	
SHA	Activity	Cost weighted Activity	Quality adjust activity	Activity	Cost weight activity	Quality adjust activity	Activity	Cost weight activity
East Midlands	3,310	3,314	3,156	8,795	8,806	8,688	1,133,994	206,637
East of England	3,672	3,676	3,662	8,002	8,012	7,608	1,669,854	214,707
London	5,602	5,609	5,944	18,215	18,237	19,100	3,924,379	617,170
North East	1,113	1,114	1,053	4,137	4,142	4,115	1,108,196	147,420
North West	3,982	3,987	4,248	22,430	22,457	22,767	4,065,130	498,146
South Central	2,415	2,418	2,348	6,281	6,289	6,111	1,291,482	181,091
South East Coast	2,786	2,789	2,484	7,462	7,471	7,516	1,532,909	188,148
South West	5,296	5,302	5,389	7,329	7,338	7,128	2,269,121	265,885
West Midlands	4,275	4,280	4,498	11,367	11,381	11,269	2,228,098	291,793
Yorkshire & the Humber	3,738	3,743	4,069	10,215	10,227	10,060	1,838,739	226,472
Total	*36,189*	*36,233*	*36,851*	*104,233*	*104,359*	*104,363*	*21,061,902*	*2,837,471*

While Reference Costs are reported for non-admitted mental health care patients, they are not reported for patients admitted to hospital but rather by bed days. This makes it difficult to determine the complexity of mental health care relative to other activities. To overcome this, in our baseline analysis we assume that the cost of a mental health CIPS is equivalent to the benchmark CIPS, ie £1,167. The implication here is that 'cost-weighted' activity is virtually equivalent to a straightforward count of patients with mental health problems. This is evident when comparing the 'activity' and 'cost weighted activity' columns for elective and non-elective patients. Note that cost-weighted activity is considerably lower than counts of activity for non-admitted patients, the reason being that the types of mental health care delivered outside hospital tend to be less costly than the types delivered in hospital.

If SHAs have a similar balance of inpatient mental health to all other activities, the above assumption about the cost of inpatient care will not alter comparisons of total output across SHAs. But the balance may well differ. To consider what effect this might have on SHA comparisons our second approach is to apply a cost of £15,095 to each inpatient mental health CIPS. This value is calculated by dividing the total spend on inpatient mental health care as reported in Reference Costs by the total number of mental health CIPS recorded in HES. Obviously, the impact will be to raise considerably the amount of cost-weighted activity above the straightforward counts of mental health activity and this is demonstrated by the figures reported in Table 5. These figures are used in a sensitivity analysis of the measurement of total output for each SHA.

Table 5 Actual, cost weighted and quality adjusted mental health care activity by SHA, alternative figures

	Admission Type							
	Elective			Non-Elective			Non-admitted	
SHA	Total Activity	Cost weighted activity	Quality adjusted activity	Total Activity	Cost weighted activity	Quality adjusted activity	Total Activity	Cost weighted activity
East Midlands	3,310	41,687	39,704	8,795	110,767	109,289	1,133,994	206,637
East of England	3,672	46,247	46,062	8,002	100,780	95,697	1,669,854	214,707
London	5,602	70,554	74,772	18,215	229,406	240,267	3,924,379	617,170
North East	1,113	14,018	13,247	4,137	52,103	51,768	1,108,196	147,420
North West	3,982	50,151	53,435	22,430	282,492	286,396	4,065,130	498,146
South Central	2,415	30,415	29,533	6,281	79,105	76,866	1,291,482	181,091
South East Coast	2,786	35,088	31,249	7,462	93,979	94,539	1,532,909	188,148
South West	5,296	66,700	67,785	7,329	92,304	89,669	2,269,121	265,885
West Midlands	4,275	53,841	56,587	11,367	143,160	141,759	2,228,098	291,793
Yorkshire & the Humber	3,738	47,078	51,184	10,215	128,651	126,548	1,838,739	226,472
Total	*36,189*	*455,777*	*463,559*	*104,233*	*1,312,748*	*1,312,798*	*21,061,902*	*2,837,471*

A&E and outpatient attendances, diagnostic tests and hospital transport

As Table 1 shows, activity is reported in many diverse categories in the Reference Costs. Table 6 summarises this information for activity undertaken in four broad 'settings': A&E, diagnostic tests, the hospital transport scheme, and outpatients. The figures showing total activity give an inaccurate impression of the volume of output, simply because aggregation is across dissimilar types of service. Weighting by costs allows for this diversity, so that a unit of cost weighted activity is comparable across different types of activity and across SHAs.

After weighting these activities by cost it is notable that the volumes of output are lower than the simple counts. This is because the costs of these services are weighted relative to the average cost of hospital activity (ie the benchmark of £1,167), and activities in the settings considered here are less costly than hospital care. So, for example, the 258m diagnostic tests conducted nationally are equivalent – in terms of cost – to 620k patients treated in hospital; and 69m outpatient attendances are equivalent to 5.7m patients treated in hospital. The ratios of simple counts of activity to cost-weighted output differ across SHAs according to the mix of activity across each of the various categories listed for the particular setting (see Table 1).

Table 6 A&E, diagnostic tests, transport services and outpatient attendances by SHA

	A&E Service		Diagnostic Tests		Hospital Patient Transport Scheme		Outpatient	
	Total Activity	Cost weight Activity	Total Activity	Cost weight Activity	Total Activity	Cost weighted Activity	Total Activity	Cost weighted Activity
East Midlands	1,623,818	172,872	14,873,183	33,301	781,314	18,966	4,998,738	378,999
East of England	2,066,646	211,468	24,251,191	59,944	729,514	17,521	6,332,670	523,389
London	4,545,685	408,190	32,854,101	86,165	1,361,645	31,311	11,444,988	1,060,926
North East	1,324,175	127,266	14,600,205	34,583	744,244	17,960	3,975,337	314,706
North West	4,097,774	375,270	38,207,399	90,267	656,982	16,244	11,235,076	903,604
South Central	1,442,516	126,448	23,726,193	54,937	496,322	12,021	4,213,883	354,769
South East	1,989,089	199,170	20,959,304	50,193	510,870	11,998	5,077,311	390,041
South West	2,306,496	228,633	29,624,550	71,249	586,174	13,984	7,067,161	530,070
West Midlands	2,562,784	253,855	29,656,997	68,069	891,500	21,070	7,141,006	577,238
Yorkshire & the Humber	2,287,863	219,099	29,564,412	71,446	895,725	21,621	8,208,435	622,357
Total	*24,246,846*	*2,322,271*	*258,317,535*	*620,155*	*7,654,290*	*182,697*	*69,694,605*	*5,656,097*

Chemotherapy, radiotherapy, radiology, renal dialysis and specialist services

The volumes of activity involving chemotherapy, radiotherapy, radiology, renal dialysis and specialist services are reported in Table 7. As for the types of services considered in the previous section, these services tend to be less costly than hospital activity, hence the lower volumes of cost weighted activity than the simple counts of activity.

Table 7 Chemotherapy, radiotherapy, radiology, renal dialysis and specialist services by SHA

	Chemo/Radiotherapy & High Cost Drugs		Radiology		Renal Dialysis		Specialist Services	
	Total Activity	Cost weight Activity	Total Activity	Cost weight Activity	Total Activity	Cost weight Activity	Total Activity	Cost weight Activity
East Midlands	278,576	65,449	648,788	50,482	361,368	34,307	203,940	60,505
East of England	342,313	78,749	947,751	77,731	331,031	35,272	247,317	74,366
London	521,451	109,057	1,370,408	110,152	842,727	88,224	533,429	170,325
North East	139,034	29,167	548,838	47,680	153,029	15,521	172,885	46,145
North West	470,784	105,851	1,420,527	111,650	585,934	55,216	412,391	133,541
South Central	311,780	52,620	1,014,634	52,581	269,414	23,457	178,875	58,096
South East	250,876	58,568	736,074	54,664	167,052	15,246	188,755	52,870
South West	570,052	117,443	1,001,043	81,137	337,982	31,808	253,953	88,400
West Midlands	504,756	117,421	1,147,140	100,320	534,449	51,659	285,793	90,202
Yorkshire & the Humber	351,925	*94,343*	1,130,908	81,594	403,826	40,983	320,049	101,023
Total	*3,741,547*	*828,667*	*9,966,111*	*767,991*	*3,986,812*	*391,694*	*2,797,387*	*875,471*

Community care, rehabilitation and other services

Finally the volumes of community care, rehabilitation and all other activities reported in Reference Costs are presented in Table 8. These 'other' activities include such things as regular attendances at day care facilities, Hospital at Home, and audiological services. Again, activities in these settings tend to be less costly than hospital care. So, for instance, 85.5m patients seen in community care settings are equivalent, in terms of cost, to 3m patients treated in hospital.

Table 8 Community care, rehabilitation and other services

	Community Care		Rehabilitation		Other	
	Total Activity	Cost weighted Activity	Total Activity	Cost weighted Activity	Total Activity	Cost weighted Activity
East Midlands	6,676,370	246,748	279,294	36,634	298,698	15,485
East of England	8,202,332	306,895	256,379	52,441	425,601	24,880
London	12,194,902	463,284	348,952	76,197	505,308	42,700
North East	6,551,584	217,312	193,960	29,293	273,725	15,049
North West	14,895,042	548,033	355,339	70,782	767,050	38,124
South Central	5,090,955	186,003	285,979	46,003	368,862	23,088
South East	5,967,712	228,641	318,286	52,805	255,929	22,182
South West	8,113,322	290,219	727,517	157,577	560,416	34,152
West Midlands	8,631,712	324,616	346,093	66,728	470,607	27,825
Yorkshire & the Humber	9,171,091	325,496	222,835	44,508	475,414	26,396
Total	*85,574,022*	*3,137,246*	*3,334,634*	*632,967*	*4,401,610*	*269,880*

Total output by SHA

Details about the total amount of output recorded in the Reference Costs are reported in Table 9. The first column reports a crude count of activity, while the second weights activity by costs. The third column includes the quality adjustment, which has a minor impact as it applies only to waiting times for outpatient attendances.

Table 9 Activity reported in the Reference Costs by SHA

	Non-Admitted Patients		
SHA	Unadjusted Activity	Cost weighted Output	Quality adjusted Output
East Midlands	32,170,186	1,295,199	1,294,924
East of England	45,814,273	1,640,059	1,639,640
London	70,471,792	3,198,900	3,200,102
North East	29,869,462	1,017,389	1,017,301
North West	77,195,840	2,891,156	2,891,726
South Central	38,699,591	1,146,660	1,146,411
South East Coast	37,964,415	1,296,722	1,296,464
South West	53,430,412	1,868,107	1,867,984
West Midlands	54,416,577	1,949,548	1,949,656
Yorkshire & the Humber	54,885,175	1,834,078	1,834,236
Total	*494,917,723*	*18,137,820*	*18,138,443*

Finally, the amount of total output, adjusted for quality, by SHA is reported in Table 10, remembering that data about primary care output is unavailable. The first column reports figures that aggregate elective and non-elective activity delivered in hospital settings, the second reproduces the final column of Table 9, and the third column reports the total amount of quality adjusted output provided to the residents of each SHA. The final column reports quality-adjusted output when inpatient mental healthcare activity is 'valued' at a cost of £15,095 rather than the benchmark of £1,167. These figures are used in a sensitivity analysis of SHA productivity.

Table 10 Quality-adjusted output by SHA

SHA	Elective & Non-elective patients	Non-Admitted patients	Total Quality adjusted output - baseline	Total Quality adjusted output -variant mental health costs
East Midlands	1,109,450	1,294,924	2,404,374	2,541,523
East of England	1,281,547	1,639,640	2,921,187	3,051,677
London	1,793,668	3,200,102	4,993,770	5,283,765
North East	756,550	1,017,301	1,773,851	1,833,698
North West	1,981,711	2,891,726	4,873,437	5,186,252
South Central	935,473	1,146,411	2,081,883	2,179,824
South East Coast	975,841	1,296,464	2,272,304	2,388,092
South West	1,357,267	1,867,984	3,225,251	3,370,188
West Midlands	1,345,970	1,949,656	3,295,626	3,478,204
Yorkshire & the Humber	1,314,987	1,834,236	3,149,223	3,312,826
Total	*12,852,464*	*18,138,443*	*30,990,907*	32,626,050

Inputs

NHS staffing across SHAs

Information is available from the Workforce Census about the number of FTEs in each of 417 occupational groups for each NHS organisation in each SHA. In order to assess the total staffing complement in each SHA it is necessary to apply a weight to each occupational group so that staff of different types can be aggregated into a single index of labour input. These weights should reflect the differential productive input provided by doctors, nurses, technicians, and so on. As is conventional, the weights used here are based on relative earnings, the assumption being that wages reflect the marginal productivity of labour. We divide the earnings for each medical and non-medical occupational group by £76,000, in order to create the wage index, this benchmark being the average wage across medical staffing groups.

Summarised from the iView data, the average earnings for broad categories of NHS staff are reported in Table 11. Within each category there will be various occupational groups, and a mix of junior and senior staff, this mix varying across categories. For instance, the apparently high average earnings enjoyed by pathologists and radiologists are due to more than 60% of these staff being on consultant grades. Taken as a whole, around 35% of medical staff are on consultant grades.

Table 11 National average earnings, by staff type

Medical staff	Average Earnings	Non medical staff	Average earnings
Accident and emergency	£62,268	Qualified nursing, midwifery & health visiting staff	£31,162
Anaesthetics	£88,382	Qualified Allied Health Professions	£32,823
Clinical Oncology	£81,100	Qualified Healthcare Scientists	£37,984
Dental	£75,729	Qualified ambulance service staff	£34,619
General medicine	£70,610	Qualified Scientific, therapeutic & technical staff	£35,281
Obstetrics and Gynaecology	£75,765	Support to doctors & nursing staff	£18,453
PHM and CHS	£62,592	Support to Qualified Healthcare Scientists	£36,148
Paediatric	£73,880	Support to ambulance staff	£21,651
Pathology	£93,202	Support to ST&T staff	£18,276
Psychiatry	£76,853	Central functions	£22,840
Radiology	£96,464	Hotel, property & estates	£18,995
Surgical	£77,337	Managers & senior managers	£49,007
		Other staff or those with unknown classification	£32,078

Table 12 reports for each SHA the numbers of medical and non-medical FTEs and these numbers weighted by relative earnings. A more detailed breakdown of staffing according to broad staff categories is provided in Appendix 5. Note that, overall, the FTEs and weighted FTEs of medical staff are similar because of the use of average medical earnings as the benchmark wage.[c] There are slight differences across SHAs in the relationship between unweighted and weighted FTEs, which reflect the particular composition of medical staff across occupational groups in each SHA.

The use of average medical earnings as the benchmark wage means that the weighted numbers of non-medical staff are considerably lower than the numbers of unweighted FTEs, as shown in the third and fourth columns on Table 12. The fifth and sixth columns of Table 12 report the total unweighted and weighted FTEs in each SHA. The data in this final column are used to measure the complement of NHS staff in each SHA in the calculation of input use.

[c] The national figures would be identical is we had used the average wage of all medical staff, rather than the average across medical staffing groups.

Table 12 Medical and non-medical staff: FTEs and weighted FTEs by SHA

SHA	Medical FTEs	Medical Weighted FTEs	Non-Medical FTEs	Non-Medical Weighted FTEs	Total FTEs	Total Weighted FTEs
East Midlands	6,019	6,111	70,408	24,840	76,426	30,951
East of England	7,740	7,810	78,069	27,740	85,810	35,550
London	17,861	18,057	139,904	51,118	157,765	69,175
North East	4,789	4,833	54,615	19,151	59,404	23,984
North West	11,809	11,906	138,119	48,065	149,928	59,971
South Central	6,052	6,131	57,520	20,531	63,572	26,662
South East Coast	5,978	5,996	58,603	20,421	64,582	26,417
South West	8,336	8,399	91,845	32,537	100,181	40,936
West Midlands	8,679	8,770	93,249	32,842	101,927	41,612
Yorkshire & the Humber	8,968	9,060	98,324	34,279	107,291	43,339
Total	*86,230*	*87,073*	*880,657*	*311,524*	*966,886*	*398,597*

Figure 7 compares the number of weighted medical and non-medical FTEs for each SHA. Overall, medical staff account for 21.8% of all staff, but the proportion differs across SHAs, ranging from 19.7% in East Midlands SHA to 26.1% in London SHA.

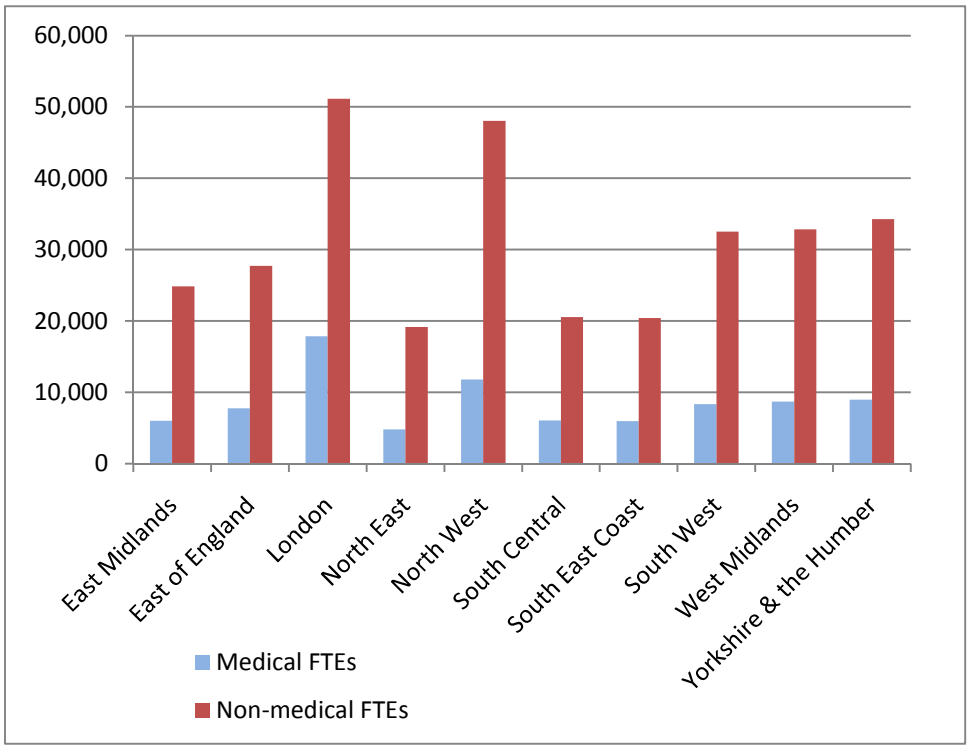


Figure 7 Medical and non-medical FTEs by SHA

Expenditure across SHA

Table 13 reports expenditure, adjusted for MFF, by hospital and ambulance trusts in each SHA, broken down by the main input categories. Labour accounts for around 65% of expenditure, and hospitals in London and South Central spend proportionately less on NHS staff but proportionately more on agency staff. Around 20% of expenditure is on intermediate inputs, though this varies from 18% in the North West to 28% in London. Expenditure on capital includes depreciation and a proportion of current capital outlays, and averages 14% of total expenditure.

Table 13 Expenditure by hospital and ambulance trusts in each SHA adjusted for MFF, £000

SHA	NHS Staff	%	Agency Staff	%	Intermediate Inputs	%	Capital	%	Total
East Midlands	£2,264,783	65	£47,002	1	£657,391	19	£529,642	15	£3,498,818
East of England	£2,678,603	64	£64,204	2	£929,930	22	£537,015	13	£4,209,752
London	£5,324,002	61	£228,706	3	£2,418,793	28	£791,334	9	£8,762,835
North East	£1,916,464	65	£59,457	2	£606,945	20	£379,827	13	£2,962,693
North West	£4,669,884	63	£117,475	2	£1,318,041	18	£1,292,673	17	£7,398,073
South Central	£1,766,580	60	£84,690	3	£668,721	23	£422,725	14	£2,942,715
South East	£2,019,984	64	£68,863	2	£635,389	20	£433,859	14	£3,158,096
South West	£2,920,348	64	£63,843	1	£905,242	20	£641,132	14	£4,530,566
West Midlands	£3,092,433	61	£72,379	1	£993,187	20	£880,175	17	£5,038,174
Yorkshire & the Humber	£3,350,854	65	£60,194	1	£968,385	19	£812,505	16	£5,191,938
Total	*£30,003,935*	63	*£866,815*	2	*£10,102,026*	21	*£6,720,887*	14	*£47,693,663*

Expenditure by PCTs within each SHA is reported in Table 14. Most striking is that expenditure on intermediate inputs averages around 50% of PCT expenditure, most of which is due to purchasing of healthcare from non-NHS bodies.

Table 14 PCT expenditure adjusted for MFF by SHA, £000

SHA	NHS Staff	%	Agency Staff	%	Intermediate Inputs	%	Capital	%	Total
East Midlands	£528,806	40	£15,894	1	£648,584	50	£113,941	9	£1,307,225
East Of England	£566,394	38	£25,724	2	£807,450	54	£100,970	7	£1,500,537
London	£811,629	36	£78,648	4	£1,217,471	55	£125,308	6	£2,233,057
North East	£380,853	43	£8,602	1	£442,972	50	£49,063	6	£881,490
North West	£1,031,662	40	£37,303	1	£1,289,041	50	£199,748	8	£2,557,755
South Central	£509,079	40	£19,719	2	£645,156	50	£109,002	8	£1,282,956
South East Coast	£459,447	34	£19,156	1	£771,278	58	£88,701	7	£1,338,582
South West	£675,730	43	£17,705	1	£768,374	48	£127,037	8	£1,588,845
West Midlands	£863,547	43	£33,891	2	£955,472	47	£162,697	8	£2,015,608
Yorkshire & The Humber	£716,724	43	£19,282	1	£815,669	49	£97,818	6	£1,649,492
Total	*£6,543,872*	40	*£275,924*	2	*£8,361,467*	51	*£1,174,287*	7	*£16,355,549*

Table 15 reports total expenditure by all the organisations within each SHA.

Table 15 Total expenditure, adjusted for MFF, by SHA, £000

SHA	Hospital & ambulance Trusts	PCTs	Total Spend
East Midlands	£3,498,818	£1,307,225	£4,806,043
East of England	£4,209,752	£1,500,537	£5,710,289
London	£8,762,835	£2,233,057	£10,995,892
North East	£2,962,693	£881,490	£3,844,183
North West	£7,398,073	£2,557,755	£9,955,828
South Central	£2,942,715	£1,282,956	£4,225,672
South East	£3,158,096	£1,338,582	£4,496,677
South West	£4,530,566	£1,588,845	£6,119,411
West Midlands	£5,038,174	£2,015,608	£7,053,782
Yorkshire & the Humber	£5,191,938	£1,649,492	£6,841,430
Total	£47,693,663	£16,355,549	£64,049,212

As mentioned earlier, expenditure by organisations within an SHA is not spent solely on residents of the same SHA. Hence in comparing expenditure across SHAs we need to take account of the fact that patients are not always treated in their SHA of residence. The Hospital Episode Statistics allow us to identify where hospital patients are treated, and details are reported in Table 16.

Table 16 Movements of hospital patients across SHAs

SHA	Treated residents	Residents treated in their own SHA	Residents treated in other SHAs	Residents from other SHAs treated in this SHA	Migration factor	Total SHA expenditure £000	Total SHA expenditure, adjusted for migration £000
East Midlands	1,307,860	1,111,127	196,733	24,365	1.132	£4,806,043	£5,299,155
East of England	1,585,720	1,452,838	132,882	62,778	1.044	£5,710,289	£5,931,911
London	2,162,190	2,116,122	46,068	293,293	0.886	£10,995,892	£10,056,642
North East	851,724	846,484	5,240	47,668	0.950	£3,844,183	£3,719,339
North West	2,488,345	2,448,798	39,547	45,232	0.998	£9,955,828	£9,998,553
South Central	1,107,759	980,956	126,803	70,281	1.051	£4,225,672	£4,400,805
South East Coast	1,074,726	918,029	156,697	86,094	1.066	£4,496,677	£4,731,333
South West	1,729,396	1,694,958	34,438	62,488	0.984	£6,119,411	£6,081,932
West Midlands	1,657,348	1,608,899	48,449	55,858	0.996	£7,053,782	£7,071,777
Yorkshire & the Humber	1,616,732	1,559,448	57,284	96,084	0.976	£6,841,430	£6,757,763
Total	*15,581,800*	*14,737,659*	*844,141*	*844,141*		£64,049,212	£64,049,212

The first column shows the number of SHA residents who receive hospital treatment, and the second reports the number of these who were treated in their SHA of residence. The third column reports the difference between these two numbers, these being those patients resident in the SHA who are treated in other SHAs. The fourth column reports the number of patients resident in other SHAs that come into the SHA for treatment. Comparison of these two columns shows considerable variability among SHAs where patients are treated, with a great many more patients from elsewhere in the country coming to London hospitals for treatment than London residents going to hospitals elsewhere. In contrast, many residents in East Midlands travel to hospitals elsewhere, with relatively few residents of other SHAs coming to hospitals in the East Midlands for treatment.

The fifth column reports the 'migration factor', calculated as the outflow minus inflow of patients as a proportion of the total residents treated. The sixth column shows the total expenditure, adjusted for MFF, in each SHA. Hospital expenditure (reported in the first column of Table 15) is weighted by this factor and aggregated with expenditure in PCTs and SHAs, in order to calculate expenditure on inputs for each SHA's residents, scaled according to total national expenditure. The expenditure figures are reported in the final column of Table 16.

Productivity

We calculate three measures of standardised productivity, in order to assess the sensitivity of the estimates to assumptions about the construction of the measures of output and input. Our baseline estimates use the figures for quality adjusted output reported in the third column of Table 10. The input figures measure the contribution of NHS staff using Census data rather than expenditure data. This involves replacing reported expenditure on NHS staff with an equivalent figure based on weighted FTEs, but converted into monetary units. Expenditure data are used to measure the use of agency staff, intermediate inputs and capital. Both staffing levels and expenditure are adjusted by the migration factor.

The output and input figures used to construct baseline productivity are reported in Table 17. This shows that productivity is highest in South West SHA, at 5.32% above the national average and lowest in the East Midlands where it is 6.57% below the national average.

Table 17 Standardised SHA productivity, baseline figures

SHA	Quality adjusted Output baseline	Input (£000s) Mixed Index	Standardised productivity
East Midlands	2,404,374	£5,318,502	-6.57%
East of England	2,921,187	£5,915,565	2.06%
London	4,993,770	£10,211,007	1.07%
North East	1,773,851	£3,610,429	1.54%
North West	4,873,437	£9,932,337	1.41%
South Central	2,081,883	£4,451,396	-3.34%
South East Coast	2,272,304	£4,725,555	-0.62%
South West	3,225,251	£6,328,724	5.32%
West Midlands	3,295,626	£6,943,081	-1.90%
Yorkshire & the Humber	3,149,223	£6,612,667	-1.57%
Total	*30,990,907*	£64,049,212	-

Our second set of productivity estimates explore the implications of applying a value of £15,095 rather than £1,167 to value mental health care provided in hospital. The resulting amounts of quality adjusted output are reported in the first column of Table 18. This yields slightly different estimates of standardised productivity, shown in the final column.

Table 18 Standardised SHA productivity, sensitivity to costing of mental health care

SHA	Quality adjusted Output Variant	Input (£000s) Mixed Index	Standardised productivity
East Midlands	2,541,523	£5,318,502	-6.19%
East of England	3,051,677	£5,915,565	1.27%
London	5,283,765	£10,211,007	1.58%
North East	1,833,698	£3,610,429	-0.29%
North West	5,186,252	£9,932,337	2.51%
South Central	2,179,824	£4,451,396	-3.87%
South East Coast	2,388,092	£4,725,555	-0.79%
South West	3,370,188	£6,328,724	4.54%
West Midlands	3,478,204	£6,943,081	-1.66%
Yorkshire & the Humber	3,312,826	£6,612,667	-1.65%
Total	32,626,050	£64,049,212	-

Our final sensitivity analysis measures inputs using the expenditure data reported in the final column of Table 16. In essence, this means that the contribution of NHS staff is captured by expenditure rather than by FTEs. These estimates of inputs are reproduced in the second column of Table 19 and the resulting estimates of standardised productivity are reported in the third column.

Table 19 Standardised SHA productivity, sensitivity to measurement of labour input

SHA	Quality adjusted Output Baseline	Input (£000) Indirect Index	Standardised productivity
East Midlands	2,404,374	£5,299,155	-6.23%
East of England	2,921,187	£5,931,911	1.78%
London	4,993,770	£10,056,642	2.63%
North East	1,773,851	£3,719,339	-1.43%
North West	4,873,437	£9,998,553	0.73%
South Central	2,081,883	£4,400,805	-2.23%
South East Coast	2,272,304	£4,731,333	-0.74%
South West	3,225,251	£6,081,932	9.60%
West Midlands	3,295,626	£7,071,777	-3.69%
Yorkshire & the Humber	3,149,223	£6,757,763	-3.69%
Total	*30,990,907*	£64,049,212	-

This variant of the productivity measure has a favourable impact on the estimates for South Central and South West SHAs, implying that – after accounting for MFF - these are paying relatively less than the national average per member of staff. The opposite is the case for West Midlands and Yorkshire & the Humber SHAs. For the other SHAs, productivity estimates are not particularly sensitive to the choice of how to measure inputs. The sensitivity of productivity estimates to the choice of input index is probably because organisations receiving above average MFF allocations are constrained by national wage bargaining in the wages they offer. In effect, therefore, these organisations are using the additional monies received through MFF not so much to pay higher wages but rather to recruit more staff.

Figure 8 illustrates the impact of these sensitivity analyses on the estimates of each SHA's productivity relative to the national average. As can be seen, irrespective of how the index is constructed, productivity is highest in South West SHA and lowest in East Midlands, South Central, West Midlands and Yorkshire & the Humber SHAs. The relative position of each SHA is little affected by the choice of index.

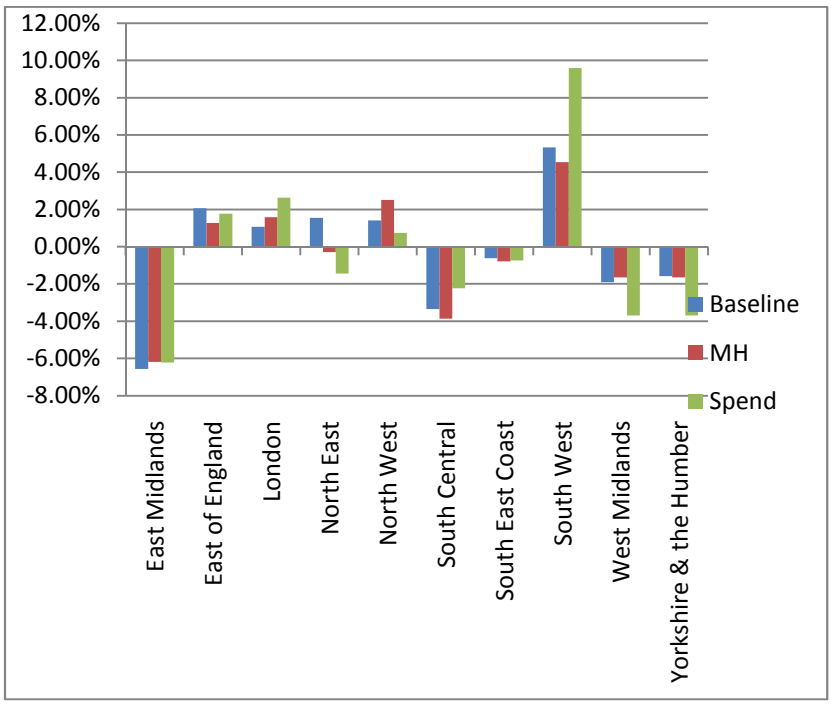


Figure 8 Standardised productivity by SHA

Conclusions

We have measured productivity for each SHA by comparing the total amount of health care 'output' provided for the SHA's resident population to the total amount of 'input' used to produce this output. Output consists of all health care services provided to NHS patients in the acute and community care sectors. The output measure also takes account of quality improvements by measuring changes in hospital survival rates and health outcomes, and inpatient and outpatient waiting times. Inputs include the staff, intermediate goods and services, and capital resources that contribute to the production of health care. Inputs are adjusted for the market forces factor and we account for movement of patients between SHAs.

By linking together large scale and routinely collected datasets we produce and compare productivity estimates across the ten Strategic Health Authorities in England in 2007/08. We analyse data from Hospital Episode Statistics, the Reference Costs, Financial Returns, and workforce census. Data about patients seen in primary care are not available. Other than primary care, the data cover all patients treated by all organisations in each SHA.

Baseline productivity ratios across SHAs vary from 5% above to 6.5% below the national average. Productivity is highest in South West SHA and lowest in East Midlands, South Central, West Midlands and Yorkshire & the Humber SHAs. These positions are not sensitive to alternative formulations of the productivity index, even though the actual ratios are sensitive to how the input index is constructed.

If it were as productive as South West, East Midlands could deliver the current amount of hospital and community care for £4.7billion rather than the £5.3billion actually spent. If all parts of the country were as productive as the South West the NHS could cut expenditure by £3.2billion without reducing the number of patients treated.

The variation observed in productivity ratios across SHAs raises questions about the cause of these differences. The geographical variations in productivity are not due to differences in the types of patients treated; nor to differences in quality of care as captured by inpatient and outpatient waiting times and hospital survival rates; nor to regional differences in the prices that organisations pay for staff, buildings and capital. All of these are taken into account. Part of the explanation may lie in where patients seek treatment. 15% of patients who live in the East Midlands are treated in hospitals outside their own region. This is the case for only 2% patients living in the South West. Of the 2.4m patients treated in London, 12% are from other parts of the country. South West may also benefit from a more stable workforce, vacancy rates for non-medical staff being well below the national average.[d] Lower productivity in the hospital and community sectors may be because more work is undertaken in primary care. The absence of comprehensive data about the activities undertaken in general practice makes it difficult to establish what GPs are doing in different parts of the country.

Future research intends to measure changes in productivity over time, to incorporate Patient Reported Outcome Measures, to extend the analysis to NHS providers, and to account for the contributions of the primary care sector.

[d] http://www.ic.nhs.uk/webfiles/publications/Vacancies%20Survey%202007/Vacancies%20in%20the%20NHS%20Report.pdf

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Appendix

Appendix 1: Specification of the output measure

In order to calculate total output, it is necessary to add the activity in each of the 6,551 activity categories together in some way. This is because 100 patients given (say) a coronary bypass graft is not equivalent to 100 patients having their varicose veins removed or 100 A&E attendances. Consistent with the convention in the national accounts, costs are used to reflect the relative value of different health care services provided within and across different settings. This means that each SHA is compared in terms of the cost-weighted volume of health services delivered to the resident population. Formally for each SHA, *s*=1…10, we add the amount of activity (x) in each output category, *j*=1…6551, weighted by an index capturing each category's relative cost, $\bar{c}_j$. Hence, we define total output X_s in SHA *s* as:

$$X_s = \sum_{j=1}^{J} x_{js}\bar{c}_j$$

where $\bar{c}_j = c_j/\hat{c}_j$ and $\hat{c}_j$ is an arbitrarily chosen benchmark cost. We have chosen £1,167 as the benchmark, this being the average cost of hospital treatment.

We also take account of the quality of health outputs by measuring differences in hospital survival and health outcomes, and inpatient and outpatient waiting times across SHAs. This involves scaling cost-weighted output according to differences in the quality of health services across SHAs. Put simply the output index becomes:

$$X_s = \sum_{j=1}^{J} x_{js}\bar{c}_j\bar{q}_{js}$$

where $\bar{q}_{js} = q_{js}/\hat{q}_j$, q_{js} is the quality of output *j* in SHA *s* and $\hat{q}_j$ is the national average quality of output *j*.

There is no general definition of the quality of health care activities and the form of quality adjustment is specific to particular types of output. In populating this index, we allow the characterisation of quality to vary across healthcare settings, partly because activities in different settings have different quality characteristics and partly because the available data differ by setting.

The quality adjustment that applies to hospital care provided to elective and non-elective patients and to those admitted to hospital with mental health problems takes the form:

$$X_s^{hosp} = \sum_{j=1}^{h} x_{js}\bar{c}_j\bar{q}_{1js}$$

where

$$\bar{q}_{1js} = \left(\frac{a_{js} - k_j}{\widehat{a_j - k_j}}\right)\left[\frac{\frac{\left(1 - e^{-r_Q LE_{js}^{In}}\right)}{r_Q} - \frac{\left(e^{r_w W_{js}} - 1\right)}{r_w}}{\frac{\left(1 - e^{-r_Q \widehat{LE}_j^{In}}\right)}{r_Q} - \frac{\left(e^{r_w \widehat{W}_j} - 1\right)}{r_w}}\right]$$

This quality adjustment captures differences across SHAs in quality-adjusted life years (QALYs) and in the time patients wait prior to hospital admission.

Making the QALY calculation for each hospital output is not straightforward simply because information on the QALYs gained from treatment is unavailable – neither is the change in each patient's health status measured nor is it known for how long this change is experienced. To address this information deficit, we create the equivalent of a QALY profile for each type of hospital output.[13]

- Firstly, we account for whether or not the patient survives treatment by measuring the 30-day post discharge survival rates for each output in each SHA, a_{js}.
- Secondly, we measure the ratio of average health status before (h^0) and after (h^*) treatment for each treatment, $k_j = {h_j^0}/{h_j^*}$. For patients treated on an elective basis we assume that $k_j = 0.8$, for non-electives we assume that $k_j = 0.4$.
- Thirdly, we capture the duration of treatment benefit by estimating the life expectancy associated with each output, LE_{js}, by considering the age and gender profiles of patients having each treatment at in each SHA. r_Q is the discount rate applied to future life years.

The final term in the above equation captures changes in waiting times for each output, w_{js}, in recognition of the welfare loss associated with not being treated immediately. This formulation implies that the marginal disutility of waiting increases as the delay increases.[1] This is similar to charging interest on the cost of waiting, captured by the discount rate, r_w. Waiting time is measured at the 80th percentile of the waiting time distribution for each type of treatment. This recognises that reductions in relatively long waiting times confer benefits on all patients by reducing the risk of having to face a very long wait.

Hats in the denominators indicate the national average value. This means that the quality adjustment applied to the outputs of each SHA is measured relative to the national average. In effect, output is scaled up (down) in those SHAs where quality is higher (lower) than the national average.

We also make a quality adjustment to outpatient attendances in recognition that patients experience increasing disutility the longer they have to wait for an outpatient appointment. As for hospital outputs, this involves scaling up outpatient activity in SHAs where waiting times are lower than the national average:

$$X_s^{out} = \sum_{j=h+1}^{o} x_{js}\bar{c}_j\bar{q}_{2s}$$

The specific form of this quality adjustment is as follows:

$$\bar{q}_{2s} = \left[\frac{LE^{out} - \dfrac{(e^{r_w W_s} - 1)}{r_w}}{LE^{out} - \dfrac{\left(e^{r_w \hat{W}_s} - 1\right)}{r_w}}\right]$$

The mean outpatient waiting time in each SHA is used as a value for w_s and LE^{out} captures the remaining life expectancy of someone attending the outpatient attendance, which is assumed to be 26 years.

Appendix 2: Specification of the input measure

Inputs into the health care system consist of labour, intermediate goods and services, and capital. The use of these 'factors of production' can be calculated directly or indirectly. A 'direct' measure of input can be calculated when data on the volume and price of inputs are available, as they are from the Workforce Census for NHS staff.

The direct measure aggregates the total number of full-time equivalent staff, weighted by their wages, in each SHA. This total labour input in each SHA amounts to:

$$Z_s^D = \sum_{n=1}^{N} z_{ns} \overline{w}_n$$

Where z_n is the volume of staff of type *n* and $\overline{w}_n$ is an index of wages, with $\overline{w}_n = w_n/\hat{w}$ where w_n is the national average wage for staff of type *n* and $\hat{w}$ is an arbitrary benchmark wage. We have chosen £76,000 as the benchmark, this corresponding to the average earnings of doctors as reported in the iView data.

When information on the physical amount of input is lacking the alternative is to employ an indirect measurement approach that relies on expenditure data. At SHA level, this expenditure data can be built up from the financial returns and accounts of each of the organizations in the SHA. Hence, total SHA expenditure is:

$$E_s = \sum_{p=1}^{P} E_{ps}$$

Where *p*=1…*P* represents all the organizations within the SHA, namely hospital (and foundation) trusts, community and mental health trusts, ambulance trusts and PCTs. We provide a breakdown of expenditure according to broad categories of input: NHS staff, agency staff, intermediate inputs, and capital expenditure. Expenditure on primary care is omitted, recognizing that primary care outputs are not captured in the output measure.

To make valid comparisons of input use across SHAs using financial data we need to acknowledge that some of the reasons for expenditure differences are outside organizational control. The English Department of Health uses the Market Forces Factor (MFF) to take account of the differential prices of labour, buildings and land across the country. We adjust expenditure to allow for these differential costs when making comparisons across SHAs by applying the sub-indices of the MFF to expenditure on labour and capital inputs. Denote the staffing MFF in organisation *p*, to be applied to labour input as θ_p^L. We apply the M&D MFF θ_p^{MD} to medical and dental staff and the Staff MFF $\theta_p^{NM}$to all other labour inputs based on the proportions of these staff in each SHA such that $\theta_p^L = \beta_{1s}\theta_p^{MD} + \beta_{2s}\theta_p^{NM}$ and $\beta_{1s} + \beta_{2s} = 1$.

We apply a weighted average of the buildings MFF θ_p^{Bld} and land MFF θ_p^{Lnd} indices to capital inputs, such that $\theta_p^K = w_{1p}\theta_p^{Bld} + w_{2p}\theta_p^{Lnd}$ and $w_{1p} + w_{2p} = 1$. These weights are taken from the net book values of land and buildings for trusts and PCTs for the 2007/8 financial year. The MFF adjusted measure of SHA expenditure, then, is calculated as:

$$E_s^{MFF} = \sum_{p=1}^{P} \{\theta_p^L E_{ps}^L + \theta_p^L E_{ps}^A + \theta_p^K E_{ps}^K + E_{ps}^M\}$$

Where E^L is expenditure on NHS labour, E^A is expenditure on agency staff, E^K is expenditure on capital, and E^M is expenditure on intermediate inputs.

Finally we take account of the fact that resources in each SHA are used both to treat residents of the SHA and residents of other SHAs. We calculate a 'migration factor' that measures the number of patients coming to the SHA for treatment net of those living in the SHA who are treated elsewhere as a proportion of the total number of SHA residents treated in hospital. If there are more patients

coming to the SHA than leaving then $\sigma < 1$. The expenditure of hospitals within the SHA is adjusted downwards to reflect the fact that their observed expenditure is higher than it would be if their resources were devoted solely to the care of the SHA's residents. This adjustment applies only to hospital expenditure, given that (i) the migration factor is based only on those moving for hospital care and (ii) patients are less likely to move for other health services. Thus we have:

$$E_s^{Ind} = \sigma_s \sum_{p=1}^{f} E_{ps}^{MFF} + \sum_{p=f+1}^{P} E_{ps}^{MFF}$$

Where hospitals are referenced *p*=1…*f* and all other organisations are referenced *p*=*f*+1…*P.*

The input index that substitutes expenditure on NHS staff with the direct measure of labour input requires that FTEs in each SHA are converted into monetary terms, so that they appear in the same metric as expenditure on other inputs. We calculate:

$$\pi_1 = \sum_{p=1}^{f} \theta_p^L E_p^L \Big/ \sum_{p=1}^{f} Z_p^D$$

for *p*=1…*f* where $\sum_{p=1}^{f} \theta_p^L E_p^L$ is national MFF adjusted expenditure on NHS staff working in hospitals and $\sum_{p=1}^{f} Z_p^D$ is national NHS staffing input in hospitals as calculated using the direct method.

For PCTs we calculate:

$$\pi_2 = \sum_{p=f+1}^{P} \theta_p^L E_p^L \Big/ \sum_{p=f+1}^{P} Z_p^D$$

where the numerator is national MFF adjusted expenditure on NHS staff working in PCTs and the denominator is national PCT staffing input.

The mixed 'direct and indirect' index, is specified as:

$$E_s^{Mix} = \sigma_s \sum_{p=1}^{f} \left[\pi_1 Z_{ps}^D + \left\{\theta_p^L E_{ps}^A + \theta_p^K E_{ps}^K + E_{ps}^M\right\}\right] + \sum_{p=f+1}^{P} \left[\pi_2 Z_{ps}^D + \left\{\theta_p^L E_{ps}^A + \theta_p^K E_{ps}^K + E_{ps}^M\right\}\right]$$

Appendix 3: Renal replacement therapy/chronic kidney disease

In our examination of the hospital output index, it became apparent that renal replacement therapy was exercising an undue influence on the index. On further inspection we found that this was due to the wide variation across SHAs in both activity and waiting times, which are summarised in Table 20. These figures are based on all activity coded to the version 3.5 HRGs, L47 and L48 (Renal replacement therapy), and the version 4 HRGs to which these patients are now being coded, LA08A, LA08B, LA08C and LA08D (Chronic kidney disease). Most striking are the very low amounts of activity recorded for residents of North East SHA (381 patients treated) and South East Coast SHA (6,383) and the high amounts of activity recorded for residents in North West SHA (159,766). Waiting times are also substantially higher in North West SHA, with the 80th percentile wait being 712 days. These high waiting times are almost exclusively due to those recorded for patients at Aintree University Hospitals NHS Foundation Trust, where the 80th percentile wait for this hospital's 14,828 patients coded to L48 amounted to 876 days. These waiting times may be accurate but the fact that they differ so markedly to those recorded for patients treated elsewhere suggests differences in coding practice at Aintree. Given these variations in activity and questions about coding practice, we elected to omit renal replacement therapy and chronic kidney disease from the output index.

Table 20 Renal replacement therapy

SHA	Elective	80th percentile	Non-Elective
	Activity	waiting time	Activity
East Midlands	20,859	4	649
East of England	111,215	3	760
London	143,219	4	1,408
North East	381	33	427
North West	159,766	712	1,391
South Central	54,569	3	630
South East Coast	6,383	6	649
South West	116,971	3	767
West Midlands	127,361	3	1,271
Yorkshire & the Humber	60,551	5	880

Appendix 4: Problematic Reference Cost data

The sheer scale of the data collection across numerous Reference Cost categories inevitably brings some variation in coding quality and consistency as well as a high likelihood of errors. In dealing with such issues we have adopted a pragmatic policy that first identifies outliers in terms of either cost or quality which then prompts further investigation into whether they are likely to be genuine outliers or indicative of data errors/consistency issues. In the event that they are considered as being errors they are removed from the analysis dataset. This appendix details this limited number of cases.

Analysis of the top cost activities in the reference cost financial returns uncovered a single activity costed at £1,297,669, more than twenty-five times higher than the next highest cost and with only a single occurrence in the entire data set. This activity is described as multi-professional, non-admitted, non face to face first attendance cancer treatment. However inspection of reference cost data from other years show no correspondingly high value. We conclude that this was a data error and the observation was excluded from the final dataset. This was the only observation excluded on cost grounds.

Analysis of the top frequency activities highlighted apparent non-systematic practices in coding 'XD05' – Blood products band 1. If coded as an outpatient activity then one SHA accounted for over 99% of the 8 million observations costed at £1.86 (note that cost-weighting these activities reduces the influence of this activity on overall output). Other SHAs had far fewer amounts of 'XD05' activity with higher proportions coded as inpatient (£6.79) or other (£46,716), and some SHAs had no instances of 'XD05' coding at all. Given the seeming inconsistencies in coding and the cost differentials observed, the decision was made to omit these cases from the final analysis. There were no other exclusions on these grounds.

Appendix 5: Staff numbers by occupational category

The following tables report numbers of full time equivalents by broad categories of occupational type, together with 'weighted' FTEs, where the weight takes account of the average earnings of staff in each occupational code relative to average earnings of medical staff. Data for medical staff precede the data for non-medical staff.

Table 21 Doctors working in A&E, anaesthetics, clinical oncology and dentistry by SHA

	Accident and emergency		Anaesthetics		Clinical Oncology		Dental	
SHA	FTEs	Weighted FTEs	FTEs	Weighted FTEs	FTEs	Weighted FTEs	FTEs	Weighted FTEs
East Midlands	254	208	735	855	83	88	110	110
East of England	414	340	901	1,048	125	134	131	130
London	986	808	1,991	2,315	193	206	400	398
North East	264	216	567	660	45	48	91	90
North West	692	567	1,399	1,627	110	117	242	241
South Central	266	218	702	816	91	97	84	84
South East Coast	353	289	691	804	43	46	128	127
South West	396	324	939	1,092	102	109	179	178
West Midlands	449	368	1,031	1,200	81	86	156	155
Yorkshire & the Humber	493	404	1,053	1,225	106	113	215	214
Total	*4,568*	*3,742*	*10,010*	*11,640*	*978*	*1,044*	*1,734*	*1,728*

Table 22 Doctors working in general medicine, obstetrics & gynaecology, PHM & CHS, and paediatrics by SHA

	General medicine		Obstetrics and gynaecology		PHM and CHS		Paediatrics	
SHA	FTEs	Weighted FTEs	FTEs	Weighted FTEs	FTEs	Weighted FTEs	FTEs	Weighted FTEs
East Midlands	1,428	1,327	350	349	107	88	479	466
East of England	1,825	1,696	421	420	240	198	556	540
London	4,325	4,018	1,008	1,005	346	285	1,629	1,584
North East	1,157	1,075	244	244	105	86	375	364
North West	2,767	2,571	657	655	470	387	800	777
South Central	1,509	1,402	352	351	169	139	454	441
South East Coast	1,433	1,332	345	344	219	180	450	437
South West	2,190	2,034	382	381	410	337	498	485
West Midlands	2,004	1,862	448	447	253	209	634	617
Yorkshire & the Humber	2,216	2,058	503	501	215	177	725	705
Total	*20,854*	*19,375*	*4,710*	*4,696*	*2,533*	*2,087*	*6,600*	*6,416*

Note: Public health medicine (PHM) and Community health services (CHS)

Table 23 Doctors working in pathology, psychiatry, radiology and surgery by SHA

	Pathology		Psychiatry		Radiology		Surgery	
SHA	FTEs	Weighted FTEs	FTEs	Weighted FTEs	FTEs	Weighted FTEs	FTEs	Weighted FTEs
East Midlands	255	313	662	670	222	282	1,334	1,358
East of England	293	360	815	824	266	338	1,752	1,783
London	839	1,029	2,117	2,141	678	861	3,349	3,408
North East	197	242	552	558	147	186	1,045	1,063
North West	488	598	1,039	1,051	453	575	2,691	2,738
South Central	275	337	616	623	241	305	1,295	1,318
South East Coast	210	257	578	585	155	197	1,373	1,397
South West	438	537	699	707	297	377	1,806	1,838
West Midlands	367	450	936	947	284	360	2,034	2,070
Yorkshire & the Humber	386	474	734	743	332	421	1,990	2,025
Total	*3,748*	*4,596*	*8,750*	*8,848*	*3,075*	*3,902*	*18,670*	*18,998*

Table 24 Professionally qualified non-medical staff by SHA

	ST&T staff		Allied Health Professions		Healthcare Scientists		Ambulance service staff		Nursing, midwifery & health visiting staff	
SHA	FTEs	Weighted FTEs	FTEs	Weighted FTEs	FTEs	Weighted FTEs	FTEs	Weighted FTEs	FTEs	Weighted FTEs
East Midlands	2,597	1,206	4,459	1,926	1,719	818	451	206	25,496	10,454
East of England	3,064	1,423	5,089	2,198	2,176	1,035	2,450	1,116	26,694	10,945
London	6,362	2,953	9,322	4,026	5,267	2,505	1,493	680	55,445	22,734
North East	1,778	826	3,185	1,375	1,493	710	1,910	870	18,542	7,603
North West	4,715	2,189	8,821	3,810	3,722	1,770	712	324	48,206	19,765
South Central	1,778	825	3,753	1,621	1,767	840	1,599	728	20,150	8,262
South East Coast	2,056	955	4,329	1,870	1,442	686	104	47	19,743	8,095
South West	2,954	1,371	6,123	2,644	4,445	2,114	2,415	1,100	29,995	12,299
West Midlands	3,098	1,438	5,803	2,506	2,724	1,296	3,179	1,448	30,757	12,611
Yorkshire & the Humber	3,723	1,728	6,161	2,661	2,894	1,376	2,500	1,139	31,986	13,115
Total	*32,126*	*14,913*	*57,043*	*24,636*	*27,649*	*13,151*	*16,813*	*7,659*	*307,014*	*125,882*

Table 25 Staff working in support to clinical staff by SHA

	Healthcare Scientists		ST&T staff		Ambulance staff		Doctors & nursing staff	
SHA	FTEs	Weighted FTEs	FTEs	Weighted FTEs	FTEs	Weighted FTEs	FTEs	Weighted FTEs
East Midlands	1,210	287	1,374	330	124	35	18,264	4,435
East of England	2,049	485	2,048	493	633	180	20,323	4,934
London	3,525	835	2,496	600	512	146	31,729	7,704
North East	1,073	254	1,264	304	1,010	288	13,829	3,358
North West	3,511	831	2,924	703	1,158	330	36,305	8,815
South Central	1,381	327	1,379	332	1,061	302	14,153	3,436
South East Coast	1,478	350	1,446	348	587	167	15,951	3,873
South West	3,280	777	2,056	494	1,045	298	22,218	5,395
West Midlands	2,418	573	2,942	707	1,901	541	23,037	5,594
Yorkshire & the Humber	2,736	648	2,385	574	1,601	456	23,846	5,790
Total	*22,661*	*5,366*	*20,313*	*4,885*	*9,632*	*2,744*	*219,655*	*53,333*

Table 26 Other staff by SHA

	Central functions		Hotel, property & estates		Managers & senior managers		Staff with unknown classification	
SHA	Weighted FTEs	Weighted FTEs	Weighted FTEs	Weighted FTEs	Weighted FTEs	Weighted FTEs	Weighted FTEs	Weighted FTEs
East Midlands	6,898	2,073	4,961	1,240	2,816	1,816	38	16
East of England	6,530	1,962	3,897	974	3,051	1,967	66	28
London	12,253	3,682	5,466	1,366	6,016	3,880	17	7
North East	5,056	1,519	3,756	939	1,705	1,100	13	5
North West	13,844	4,160	9,567	2,391	4,577	2,952	57	24
South Central	4,659	1,400	3,308	827	2,517	1,623	16	7
South East Coast	4,738	1,424	4,374	1,093	2,335	1,505	21	9
South West	7,896	2,373	6,059	1,514	3,320	2,141	40	17
West Midlands	8,278	2,488	5,646	1,411	3,440	2,218	25	11
Yorkshire & the Humber	9,438	2,836	8,005	2,001	2,997	1,933	52	22
Total	*79,591*	*23,919*	*55,039*	*13,756*	*32,775*	*21,134*	*346*	*146*