Regional variation in the productivity of the English National Health Service

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Abstract

Aims

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. By linking together large scale and routinely collected datasets we produce and compare quality-adjusted productivity estimates across the ten Strategic Health Authorities in England in 2007/08.

Methods

Productivity is measured as a ratio of outputs delivered in each SHA resident population to inputs used. We analyse data from Hospital Episode Statistics, the Reference Costs, Financial Returns, workforce census and the Electronic Staff Record. Outputs are weighted for cost and adjusted for quality (captured by survival rates and waiting times). Inputs are adjusted for the market forces factor and we apply a "migration factor" to our estimates to account for movement of patients between SHAs.

Results

Productivity ratios across SHAs vary from 8% above the national average to 6% below indicating substantial variation across SHAs. Productivity is highest in South West SHA and lowest in East Midlands, South Central and Yorkshire & the Humber SHAs. These relative positions hold irrespective of how the index is constructed.

Conclusions

The variation observed in ratios across SHAs indicates substantial differences in productivity that were hitherto unknown, raising immediate policy questions. Future research intends to measure changes in productivity over time, to incorporate Patient Reported Outcome Measures, extend the analysis to PCTs and NHS providers and to account for the contributions of the primary care sector. We would welcome any input from health economists to refine what should be a useful tool for NHS decision makers.

Introduction

"The National Health Service will not be spared the efficiency savings which the Government will impose on the entire public sector, Andrew Lansley, the Health Secretary, has warned" .[1]

Although the new coalition government has promised to increase spending on the NHS in real terms (though not to the extent seen under the previous administration) it would be incorrect to assume that the NHS will be free from the scrutiny that other public sectors will face in the drive to address the current public sector deficit. Indeed, of the £12 billion in efficiency savings that the Conservatives outlined pre-election, almost half was expected to come from the NHS and the post-election coalition has already stated that it wishes to cut the cost of NHS administration by a third.

This HESG paper therefore represents a timely and ongoing research project which seeks to combine large and complex but routine datasets (Hospital Episode Statistics, Hospital Trust financial returns, Workforce Census, etc.) to obtain measures of quality-adjusted outputs, inputs, and productivity estimates across NHS bodies and over time. This paper describes the methods we use in producing regional measures of productivity, including the discussion of the issues that arise out of the limitations of the datasets used, and presents results comparing performance across SHAs using data for 2007/8.

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[2]. 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. It has not been possible to account for primary care and prescribing activity because of a lack of accurate data across SHAs. 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. 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.

Methods

This paper focuses on comparing productivity across SHAs using data for a single year, 2007/8. 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 [3], adapting this for use in a cross-sectional context.

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). 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.

In order to calculate total output, it is necessary to add the activity in each of the healthcare output categories together in a meaningful manner. This is because 100 patients given [4] 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…N, weighted by an index capturing each category's relative cost, $\bar{c}_j$.

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

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

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.[5]

- 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 (h^0) before and after (h^*) treatment for each treatment, $k_j = {h_j^0}/{h_j^*}$. For patients treated on an elective basis we assume that $k_j = 0.8$, and for non-electives we assume that $k_j = 0.4$ [6]

- 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 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. [2] 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 of patients experiencing 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. Outpatient waiting times are not currently provided by type of outpatient activity. We use a SHA specific average waiting time and adjust for remaining life expectancy set at 26 years.

Thus, 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. A benchmark wage is used to weight staff of different types in order to construct a measure of total staffing input. The non-NHS staff, intermediate goods and services and capital used in each SHA is derived from the expenditure data from each NHS organisation in the ten SHAs. These expenditure data are adjusted for geographical differences in factor prices by applying a labour Market Forces Factor (MFF) and an amalgam of the land and buildings MFF for each organisation.

Healthcare organisations treat patients from other SHAs as well as local residents. 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.

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 and iView data 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 $\overline{w}_n = w_n/\widehat{w}$ where w_n is the national average wage for staff of type *n* and $\widehat{w}$ 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 organisations in the SHA. Hence, total SHA expenditure is:

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

Where *p*=1…*P* represents all the organisations 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, non-NHS staff, intermediate inputs, and capital expenditure. Expenditure on primary care is omitted, recognising 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 organisational 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 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 2008/9 financial year. The MFF adjusted measure of SHA expenditure, then, is calculated as:

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

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

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

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:

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

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:

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

Thus, 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

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

There are 6,551 healthcare output categories. These include version 4 Healthcare Resource Groups to describe care provided in hospitals and numerous categories used in the Reference Costs data to describe care provided in other settings.

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. There are 417 different types of staffing categories.

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.

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.

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]

Expenditure on staff and capital is adjusted for geographical differences in factor prices by applying the labour Market Forces Factor (MFF) and an amalgam of the land and buildings MFF for each organisation. Concerns about the 2007/08 MFF led to a revised formulation being used to calculate the 2008/9 MFF and this is what we have used. The data comes from the PCT recurrent revenue allocations exposition book.

Results

Outputs

There are many categories to describe health care output provided across and within different settings. Table 1 reports actual and quality adjusted Hospital and Community Care outputs by SHA. Three sets of figures are presented for Hospital patients and Non-Admitted patients respectively. The first set, headed 'unadjusted activity', is a simple measure of volumes of activity. In the Hospital sector this is defined as a Continuous Inpatient Spell (CIPS), whilst in the community care sector this is variously defined.

The second set scales output according to each patient's quality of care. In the Hospital sector this is captured by our measure of QALYs and waiting times, measured at the 80th percentile of the distribution. Summaries of the constituent quality adjustors for each SHA are shown in Figure 1. 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. The quality adjustment for the community care sector has a minor impact as it applies only to outpatient attendances (waiting time) and to inpatient mental healthcare activity (full quality adjustment as for the hospital sector). Further, all activities are weighted by their cost relative to a benchmark cost of £1,167, which is 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.

We explore the implications of applying a value of £15,095 rather than £1,167 to value mental health care provided in hospital. This new value of mental health cost is obtained 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. The impact will be to raise considerably the amount of cost-weighted activity. The resulting amounts of quality adjusted output are reported in the last column of Table 1. This will yield slightly different estimates of standardised productivity, as shown in the Productivity section.

Figure 1 shows deviations across SHAs from the national average for 30-day survival rates, separately for elective and non-elective hospital activity, 80th percentile waiting times for elective hospital activity and average waiting times for outpatient visits.

The first quadrant shows 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. The deviation in survival rates for non-elective patients is shown in the second quadrant with rates in London SHA and South Central SHA better than elsewhere.[1] Consideration of survival effects, therefore, will raise the amount of non-elective output above cost-weighted counts of output for these two SHAs.

The bottom two graphs show 80th percentile waiting times for hospital elective activity and for outpatient visits respectively[2]. Hospital 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. South East Coast, London and West Midlands have lower average waiting times for outpatient visits than the national average, so

[1] Note that the scale of 30-day survival rate for elective hospital activity differs from that for non-elective hospital activity.

[2] Note that hospital 80th percentile waiting times are expressed in days and that average outpatient waiting times are expressed in weeks.

we expect that outpatient output in these SHAs will appear higher when outpatient waiting times are taken into consideration.

Inputs

Table 2 shows the total expenditure of each SHA based on the indirect measures of labour, intermediates and capital i.e. actual expenditure deflated by the relevant Market Forces Factor such that figures represent different resource use between SHAs rather than a mix of different prices and different resource use. Within the hospital and ambulance trust expenditure labour costs account for around 65% of expenditure. Around 20% of expenditure is on intermediate inputs, though this varies from 18% in the North West to 24% in London. Expenditure on capital includes depreciation and a proportion of current capital outlays, and averages 14% of total expenditure.

Expenditure by organisations within an SHA is not spent solely on residents of that SHA, but also includes expenditure on patients who have travelled to providers in that SHA from other SHAs. We allow for such movement of patients across SHAs by constructing our measure to equal the input devoted to the residents of each SHA. If there are proportionately more patients coming into the SHA for treatment than leaving, the expenditure of those organisations is adjusted downwards by a migration factor to reflect this additional spend. Migration factors are constructed from HES which contains data on the SHA of residence as well as the SHA of treatment. There is substantial variation in the degree of migration across SHAs ranging from 0.886 in London to 1.132 in East Midlands. Broadly speaking this indicates that 13% of East Midlands resident patients are treated outside the East Midlands, whereas around the same percentage of patients treated in London, are not resident in London. These migration factors are applied to Hospital and ambulance trusts expenditure only. Column 4 of Table 2 represents the migration-adjusted expenditures.

Expenditure by PCTs within each SHA is approximately a third of that spent in hospital and ambulance trusts and is characterised by a higher degree of expenditure on intermediate inputs that accounts for on average around 50% of expenditure, most of which is due to purchasing of healthcare from non-NHS bodies.

Table 3 shows the adjusted total spend as a result of using direct measures of labour cost. These are calculated by replacing the indirect expenditure on labour with figures based on Workforce Census data reporting FTEs multiplied by national average wages. This affects staff in both trusts and PCT.

Rather surprisingly, the biggest impact of the change in calculating labour costs occurs in PCTs although labour costs form a smaller proportion of expenditure. The pattern is however rather mixed and increases in one sector tend to be paired with decreases in the other. The overall effect ranges from an increase of approximately 4% in London to a decrease of 4% in the North East.

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. These are presented in Figure 2. Baseline estimates are obtained using the quality adjusted output figures 'Baseline' from Table 1 and comparing them with the input figures, where the contribution of NHS staff using Census data rather than expenditure data is used. This involves replacing reported expenditure on NHS staff with an equivalent figure based on weighted FTEs, but converted into monetary units. The baseline figures show that productivity is highest in South West SHA, at 5.30%

above the national average and lowest in the East Midlands where it is 6.59% below the national average.

The second measure of productivity estimates uses the quality adjusted output figures 'Variant' from Table 1, which uses different unit costs for hospital mental health activity. This produces slightly less variation although the overall relative positions remain the same. Again South West is the best performing SHA at 4.52% above the average with East Midlands the worst performing at 6.21% below the national average.

Our final sensitivity analysis measures inputs using the expenditure data. This variant of the productivity measure has a favourable impact on the estimates for London, 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 North East, North West, 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 due to the fact that 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 to pay higher wages but to recruit more staff.

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.

Productivity ratios across SHAs vary from 8% above to 6% below the national average. Productivity is highest in South West SHA and lowest in East Midlands, South Central and Yorkshire & the Humber SHAs. These relative positions hold irrespective of how the index is constructed, although the actual ratios are sensitive to how the input index is constructed. The variation observed in productivity ratios across SHAs raises questions about the cause of these differences.

We plan to extend the research to examine differences across NHS providers at Trust level, to produce measures over time and to use econometric methods to attempt to explain differences in performance which may then be used to inform policy. This initial look into regional variation in productivity is therefore indicative of a research area that is likely to produce a new, fruitful and policy-relevant perspective on the structure and performance of the NHS.

Table 1 Actual and quality adjusted Hospital and Community Care outputs by SHA

SHA	Hospital Patients		Non-Admitted Patients		All Patients Quality adjusted Activity	
	Unadjusted Activity	Quality adjusted Activity	Unadjusted Activity	Quality adjusted Activity	Baseline	Variant
East Midlands	1,114,322	1,109,450	32,170,186	1,294,924	2,404,374	2,541,523
East of England	1,274,314	1,281,547	45,814,273	1,639,640	2,921,187	3,051,677
London	1,775,889	1,793,668	70,471,792	3,200,102	4,993,770	5,283,765
North East	746,253	756,550	29,869,462	1,017,301	1,773,851	1,833,698
North West	2,007,332	1,981,711	77,195,840	2,891,726	4,873,437	5,186,252
South Central	914,525	935,473	38,699,591	1,146,411	2,081,883	2,179,824
South East Coast	954,435	975,841	37,964,415	1,296,464	2,272,304	2,388,092
South West	1,352,352	1,357,267	53,430,412	1,867,984	3,225,251	3,370,188
West Midlands	1,337,197	1,345,970	54,416,577	1,949,656	3,295,626	3,478,204
Yorkshire and the Humber	1,362,947	1,314,987	54,885,175	1,834,236	3,149,223	3,312,826
Total	*12,839,566*	*12,852,464*	*494,917,723*	*18,138,443*	*30,990,907*	*32,626,050*

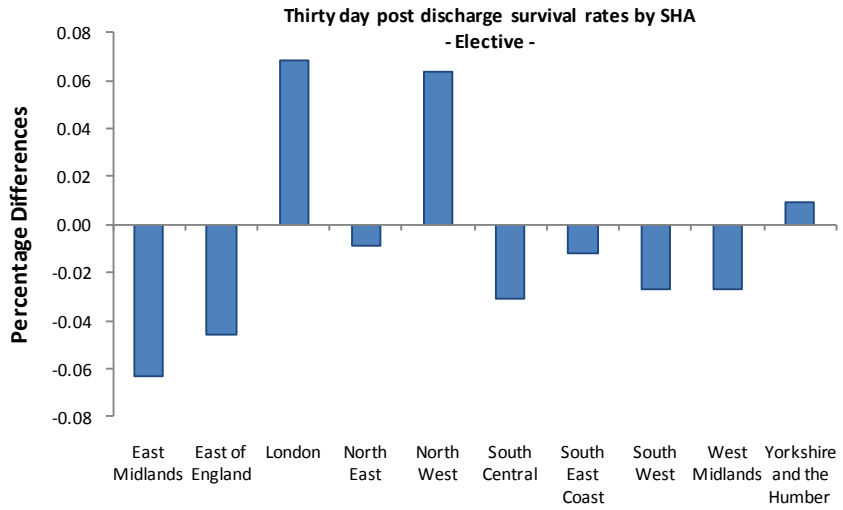
Table 2 : Indirect Measures of Resource Use

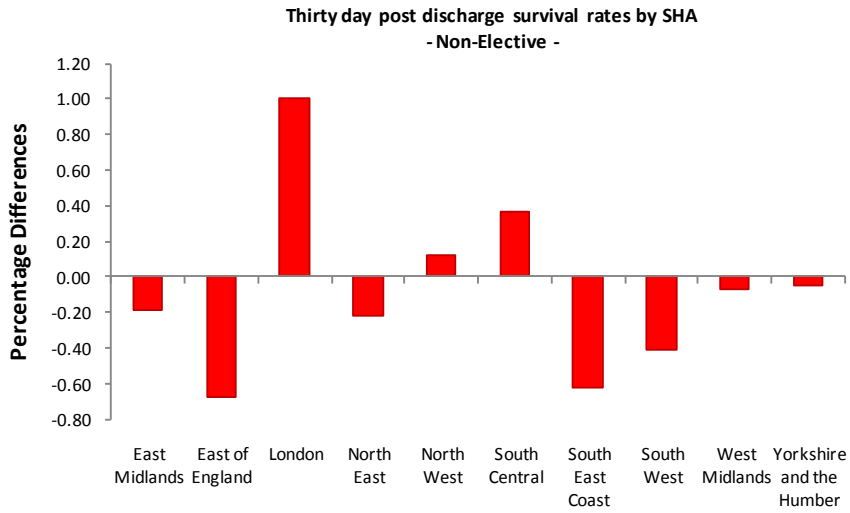
SHA	Hospital & ambulance Trusts	Migration factor	Migration adjusted spend on hospital and ambulance trusts	PCTs	Total Spend
East Midlands	£3,531,639	1.132	£4,027,389	£1,309,710	£5,337,100
East of England	£4,200,711	1.044	£4,419,676	£1,501,316	£5,920,992
London	£8,533,870	0.886	£7,615,404	£2,221,932	£9,837,336
North East	£2,996,066	0.950	£2,868,401	£883,494	£3,751,894
North West	£7,460,337	0.998	£7,499,720	£2,562,523	£10,062,243
South Central	£2,914,278	1.051	£3,086,196	£1,281,345	£4,367,541
South East Coast	£3,139,621	1.066	£3,371,240	£1,338,606	£4,709,846
South West	£4,571,123	0.984	£4,531,073	£1,592,145	£6,123,218
West Midlands	£5,087,103	0.996	£5,102,754	£2,022,022	£7,124,775
Yorkshire & the Humber	£5,247,362	0.976	£5,160,256	£1,654,009	£6,814,265
Total	*£47,682,107*	*1*	*£47,682,107*	*£16,367,105*	*£64,049,212*

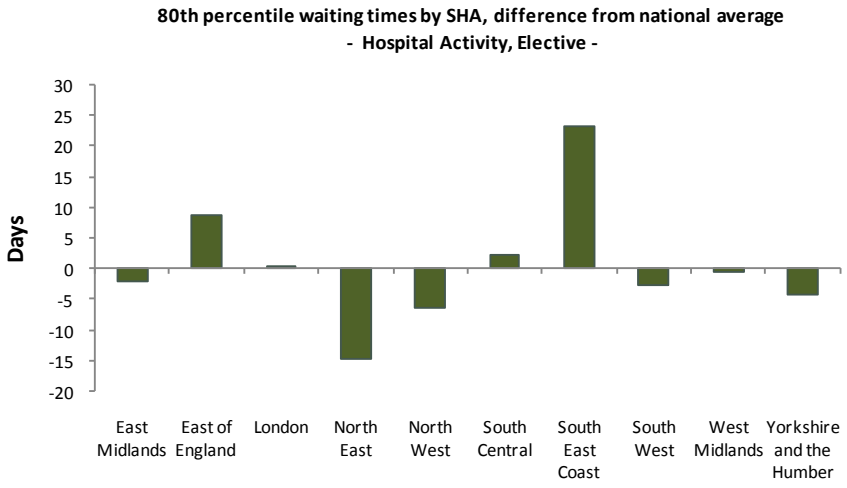
Table 3 : Mixed Measure of Resource Use

SHA	Migration adjusted spend on hospital and ambulance trusts (mix)	% change to direct measure H&A Trust spend	PCT Spend (mix)	% change to direct measure PCT spend	Total Spend (mix)	% change to direct measure total spend
East Midlands	£4,007,712	-0.49%	£1,312,080	0.18%	£5,319,792	-0.32%
East of England	£4,371,484	-1.09%	£1,544,021	2.84%	£5,915,505	-0.09%
London	£7,567,808	-0.62%	£2,634,964	18.59%	£10,202,772	3.71%
North East	£2,701,943	-5.80%	£909,782	2.98%	£3,611,725	-3.74%
North West	£7,567,850	0.91%	£2,366,804	-7.64%	£9,934,654	-1.27%
South Central	£3,119,128	1.07%	£1,331,385	3.91%	£4,450,513	1.90%
South East Coast	£3,461,760	2.69%	£1,263,125	-5.64%	£4,724,885	0.32%
South West	£4,842,366	6.87%	£1,487,507	-6.57%	£6,329,873	3.37%
West Midlands	£5,124,736	0.43%	£1,820,396	-9.97%	£6,945,132	-2.52%
Yorkshire & the Humber	£4,917,322	-4.71%	£1,697,094	2.60%	£6,614,416	3.02%
Total	*£47,682,107*		*£16,367,105*		*£64,049,267*	

Figure 1 Quality adjustors for Hospital activity and community care by SHA







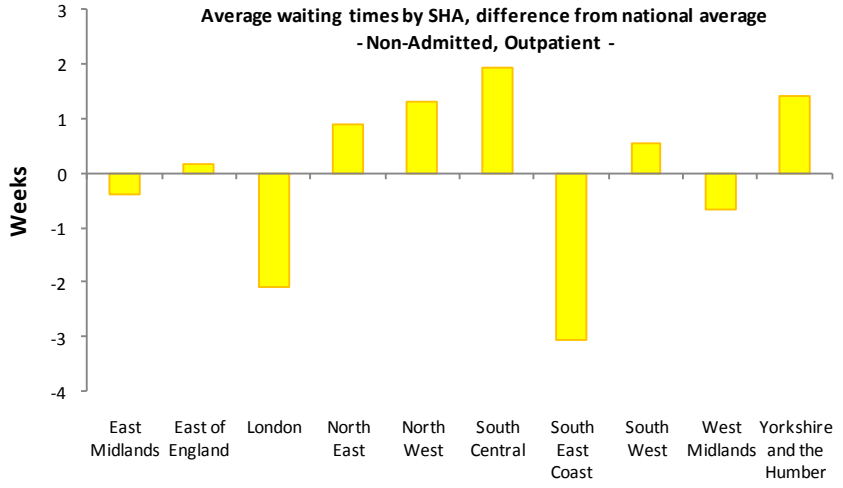
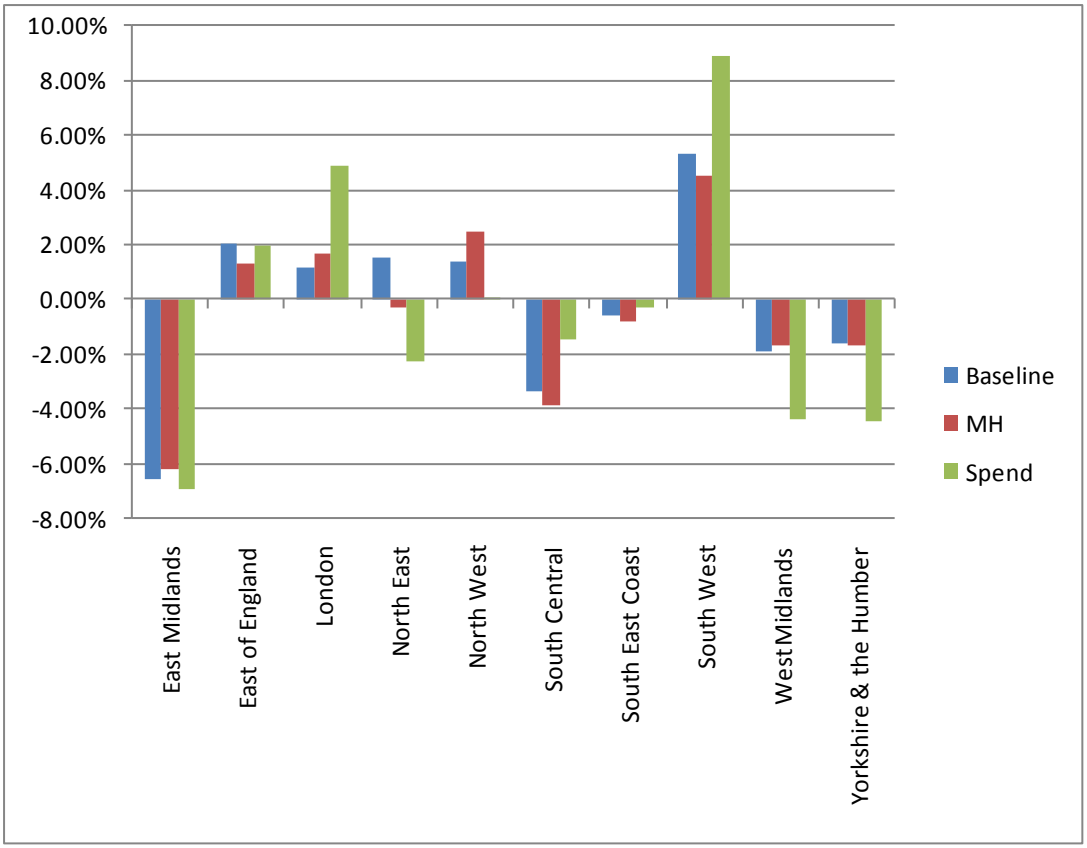


Figure 2 Standardised productivity by SHA



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