Impact of the NHS reforms on English hospital productivity: an analysis of the first three years

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Abstract

Objectives: To evaluate the effect of purchaser mix, market competition, and trust status on hospital productivity within the NHS internal market.

Methods: Hospital cost and activity data were taken from routinely collected data for acute NHS hospitals in England for 1991-2 to 1993-4. Cross sectional and longitudinal regression methods were used to estimate the effect of trust status, competition, and purchaser mix on average hospital costs per inpatient, after adjusting for outpatient activity levels, casemix, teaching activity, regional salary variation, hospital size, scale of activity, and scope of cases treated.

Results: Real productivity gains were apparent across the study period for NHS hospitals on average. Casemix adjustment drastically improved cross sectional comparisons between hospitals. Gaining trust status and increasing host district purchaser share were associated with productivity increases after adjustment for casemix, regional salary differences, and hospital size and scope. Hospitals that became trusts during the study period were on average less productive at the beginning of the period than those that did not, and there were no significant productivity differences between trust waves at the end of the period in 1993-4. Market concentration was not associated with productivity differences.

Conclusion: Further analysis is needed to determine whether overall and trust associated productivity gains are transient effects, one off shifts, or self perpetuating reorientations of organisational behaviour. Hospitals may have chosen to become trusts because they anticipated being able to increase productivity. Increases in the proportions of small purchasers were associated with increasing costs. Importantly, this study could not adjust for changes in the quality of care.

Introduction

The NHS internal market aimed to make hospitals more efficient and responsive to local needs through various organisational changes. Yet their impact has hardly been evaluated. We examined changes in hospital productivity, defined as the changes in cost per inpatient episode, adjusted for several other factors, for the first three years of the NHS internal market, looking particularly at the impact of the reforms.

Methods in brief

To make the results accessible to a broad range of readers we have kept mathematical formulas and economic jargon to a minimum. The full methods and sources of information are available on the *BMJ*'s website (www.bmj.com), and more details of the methods and results are available from the authors on request. Here we outline the methods in brief.

Full methods appear on the *BMJ*'s website

We used a set of cost function analyses: a cost function expresses the relation between what hospitals spend on the one hand and what they produce on the other, after adjustment for differences in the prices of inputs. Following Evans[1] we included several environmental factors, in addition to outputs and factor prices, which may have influenced productivity. These include elements of the NHS reforms.

We hypothesised that NHS hospital costs per inpatient episode are a function of the levels of other outputs produced, the costs of hospital inputs, and a set of environmental constraints which reflect the hospital's internal structure and position in the "quasi-marketplace." One aspect of hospital output, quality, was not measurable, and our approach assumes that on average this is relatively constant across hospitals and over time.

We used average hospital cost per inpatient in 1991-2 pounds sterling (total costs/numbers of inpatient episodes), including a notional capital charge, as the dependent variable in the model. The variables used to explain hospital cost variation, their derivation, postulated effect on costs, and year of collection are described in table A (www.bmj.com). The postulated relationship is: average cost per inpatient = a function of (average casemix, average long stay days per inpatient (the mean length of stay of episodes above the average for their healthcare resource group), % multiple episodes, outpatient attendances per inpatient, accident and emergency attendances per inpatient, day attendances per inpatient, student teaching units per inpatient, prices of capital items, wage prices, scale of activity, hospital size, degree of specialisation, trust status, competition from other hospitals, mix of purchasers).

We postulated a simple linear relation between average costs per inpatient and the explanatory variables. To capture the differences both between providers and within providers over time we analysed all three years' data simultaneously. The model was estimated using two approaches. The first—the pooled cross sectional model—pooled all observations together and adjusted for other unmeasured effects that affect all providers, using dummy variables for the second and third study years. It examined the relation between absolute levels of the dependent and explanatory variables for each provider year with each treated as a unique data point. Thus there was no link between successive years for the same provider. The second approach—a fixed effects longitudinal model—examined the association between changes in explanatory variables from one year to the next and corresponding changes in the dependent variable.

Additionally, overall hospital productivity by wave of trust status was assessed. Hospitals that had still not become trusts by the third year were labelled persistent directly managed units. This model was identical to the pooled cross sectional model except that the trust and year dummy variables were replaced by 11 dummy variables representing each trust wave for each of the study years (4 waves × 3 years – 1). The adjusted costs

per inpatient episode for each trust wave for each year were estimated. Only hospitals that had complete data for all three years were used for this analysis (510).

The main sources of data were Hospital Episodes Statistics and Hospital Financial Returns. SAS software was used for all computation.[2] Final sample sizes for the three years were 198, 219, and 221 hospitals. The unit of analysis was the NHS provider, which may have included one or more hospital sites.

Results

Table 1 gives summary statistics for the three years of data used, after excluding hospitals with large discrepancies between different sources of total recorded activity. Table 2 shows regression results for the pooled cross sectional model and the fixed effects longitudinal model. The coefficient represents the change in average costs per inpatient episode associated with a unit change in the respective explanatory variable. Confidence intervals (95%) for the slope coefficient are estimated as: slope ± 1.96 × standard error of slope.

In the pooled cross sectional model the most significant influence on costs was the casemix index variable. Episode inflation showed a significantly negative effect on costs. All remaining output variables showed significantly positive effects on cost. The positive coefficient on the inverse of patient episodes indicated decreasing costs per episode when patient numbers increase while capacity is held constant. This should not be interpreted as showing economies of scale, however. Specialisation (a narrower range of cases) and increased capacity (bed numbers) were associated with higher costs, whereas trust status and host purchaser share had negative effects, although these last two effects were not statistically significant at the 5% level.

In the longitudinal model the effects of casemix, long stay days, wage prices, and specialisation were significantly reduced and did not contribute significantly to the model, probably because they changed little over the three years. The same phenomenon probably affected the market concentration index and the % of multiple episodes. In the longitudinal model, however, trust status and proportion of patients from the host district purchaser had a significant negative effect on average costs. The period dummy variables in both models indicate that overall productivity of the hospitals improved over the three years and that improvements between years 1 and 3 were significant at the 5% level. Tests for heteroskedasticity[3] and multicollinearity[4] showed that these were not significant problems for the models estimated.

Table 1 Descriptive statistics for 170 hospitals with data for all three years. Values are means (SD)

	1991-2	1992-3	1993-4
Ouputs			
Average cost per inpatient episode	1497.5 (471.6)	1436.0 (427.5)	1311.3 (385.4)
Total inpatient episodes	37325.5 (17125.5)	38744.1 (18008.9)	40905.0 (19070.6)
Casemix index	98.0 (19.3)	101.0 (19.5)	100.7 (18.6)
Long stay days/inpatient	5.65 (11.53)	5.00 (9.08)	4.91 (8.81)
% Of multiple episodes	5.63 (5.84)	4.61 (2.68)	4.54 (2.60)
Outpatient attendances/inpatient	4.03 (1.50)	3.96 (1.26)	3.89 (1.53)
Accident and emergency attendances/inpatient	1.38 (0.76)	1.36 (0.66)	1.31 (0.65)
Day attendances/inpatient	0.315 (0.382)	0.317 (0.382)	0.291 (0.325)
Student whole time equivalents/inpatient	0.0007 (0.0011)	0.0007 (0.0011)	0.0007 (0.0011)
Inputs			
Capital price index	0.88 (0.72)	0.88 (0.72)	0.88 (0.72)
Wage price index	287.3 (35.8)	280.7 (37.2)	279.9 (35.7)
Internal factors			
Average No of beds	773.1 (345.6)	742.0 (341.1)	727.2 (325.9)
Specialisation index	0.53 (0.58)	0.48 (0.60)	0.42 (0.58)
Trust status (proportion)	0.18 (0.39)	0.39 (0.49)	0.71 (0.46)
External factors			
Market concentration index	0.18 (0.19)	0.18 (0.19)	0.18 (0.19)
% Of patients from host district purchaser	71.77 (21.47)	75.55 (22.02)	71.14 (20.74)

Table 2 Regression analysis results

	Pooled cross sectional model				Fixed effects longitudinal model			
Sample size	638				510			
Adjusted R^2	0.70				0.60			
	95% Confidence interval				95% Confidence interval			
	Coefficient	Lower	Upper	P value	Coefficient	Lower	Upper	P value
Intercept	–699.39	–988.86	–409.92	0.0001	26.64	4.09	49.18	0.021
Casemix index	9.25	7.99	10.51	0.0001	–1.19	–2.99	0.60	0.1923
Long stay days/inpatient	5.31	3.07	7.54	0.0001	0.43	–1.13	1.99	0.5912
% Of multiple episodes	–6.46	–11.59	–1.32	0.0140	2.23	–0.77	5.22	0.1457
Outpatient attendances/inpatient	22.97	8.63	37.32	0.0018	59.33	40.88	77.78	0.0001
Accident and emergency attendances/inpatient	35.57	1.24	69.89	0.0427	118.29	72.11	164.47	0.0001
Day attendances/inpatient	325.80	259.21	392.40	0.0001	285.15	214.55	355.74	0.0001
Student whole time equivalents/inpatient	88266	64845	111687	0.0001				
Capital price index	31.89	–10.69	74.48	0.1427				
Wage price index	2.53	1.65	3.40	0.0001	–0.42	–3.44	2.60	0.7857
Inverse of inpatient episodes	2742914	1886546	3599282	0.0001	5645558	3812005	7479111	0.0001
Average No of beds	0.19	0.11	0.28	0.0001	0.37	0.24	0.50	0.0001
Specialisation index	102.45	42.32	162.58	0.0009	–52.82	–140.28	34.65	0.2372
Trust status	–38.80	–84.89	7.28	0.0994	–120.22	–150.26	–90.19	0.0001
Market concentration index	15.71	–97.94	129.36	0.7865	–411.81	–2478.72	1655.09	0.6963
% Of patients from host district purchaser	–0.99	–2.29	0.32	0.1381	–1.58	–2.67	–0.49	0.0046
Year 2 dummy	–35.99	–87.63	15.64	0.1723	–8.48	–39.05	22.09	0.5869
Year 3 dummy	–114.18	–171.30	–57.06	0.0001	–74.05	–110.65	–37.45	0.0001

Table 3 Adjusted average costs per episode by trust wave and year of study (£ 1991-2) and 95% confidence intervals compared with persistent directly managed group in 1991-2

	1991/2			1992/3			1993/4		
		95% CI			95% CI			95% CI	
Trust wave	Estimate	Low	High	Estimate	Low	High	Estimate	Low	High
1st wave trust	62	–44	168	–14	–120	91	–111	–216	–5
2nd wave trust	161	61	261	–3	–105	99	–63	–165	38
3rd wave trust	167	77	257	93	2	184	–78	–169	13
Persistent directly managed unit	0			–4	–95	87	–54	–145	37

Table 3 shows the results of the analysis where trust wave and period interaction terms replaced the trust and period dummy variables. Only the coefficients for the effects of interest are shown, together with 95% confidence intervals. At the beginning of the internal market, directly managed units about to become trusts—that is, second and third wave trusts—were significantly less productive than the persistent directly managed group. By 1993-4 there was no significant difference between each trust wave and the persistent directly managed units, although the latter were the least productive on average. For second and third wave trusts the steeper observed decline in costs was in the year immediately after becoming a trust compared with the other year for which they were studied.

Discussion

Existing evaluations of the effect of reforms on hospital care tend to be politically polarised and poorly supported by data.[5] This discussion deals mainly with evaluating individual aspects of the NHS reforms, and the results implied by the coefficients on other terms are not dealt with in detail. The use of a patient level casemix adjustment is, however, unique in NHS hospital cost studies: its effect on results obtained in the cross sectional model was profound and suggests that previous studies that have compared hospitals without such adjustment[6-9] might be significantly biased. Although no prereform years were included in the analysis, the first year of the internal market (1991-2) was a steady state year, so it is reasonable to treat it as a control year.

The two main data sources we used, the Hospital Episodes Statistics and the Hospital Financial Returns, are infrequently used for research. Apart from the KP70 reconciliation statistics to validate the Hospital Episode Statistics, no routine validation sources were available. Two sources of error may have influenced our results: random errors, and biases. Random errors in the Hospital Episodes Statistics would have been unlikely to affect substantially the results because of the large sample sizes (about 10 million episodes per year). Furthermore, providers had no incentives to inflate their recorded casemix since this was not being used for reimbursement. They may well have increased their apparent volume of activity, however, by discharging and readmitting patients or by reclassifying outpatients or day attenders as inpatients, and we have no way of detecting this.

Errors in cost data may well occur in departmental costs because of different cost allocation mechanisms, and other studies have suggested discrepancies at this level.[10] This study used mainly total cost data, however, which is less susceptible to allocation errors. Furthermore, hospital accounts are audited annually, and the data we used were compiled and cleaned by the Audit Commission.

The three main areas whereby the NHS internal market reforms might be expected to influence hospital productivity are trust status, and the managerial changes and incentives that that implies; competition between providers; and the establishment of small, discretionary purchasers in the form of fundholders.

Trust status

The adjusted costs for trusts and non-trusts were not significantly different over the period studied. Costs decreased significantly, however, with the change from directly managed to trust status. The discrepancy between these results lies in the fact that early trust waves started out less productive than directly managed units. This is the opposite of what Bartlett and Le Grand found in an earlier analysis which failed to adjust for casemix.[7] It is possible that hospitals were intentionally unproductive before becoming trusts, so that large gains could be shown on changing status. Alternatively, the restructuring required in preparation for trust status might have been costly, thus raising average costs in the pretrust year, although this was not apparent for third wave trusts, whose costs dropped in the year before gaining trust status.

The Radical Statistics Group has suggested that some of the apparent efficiency gains in the internal market may be due to one off disposal of fixed assets or so called "episode inflation" within a single admission.[5] The latter is included in the model, and does indeed appear to inflate productivity gains, but the trust effect persists even after adjustment for multiple episodes. Some of the cost decreases associated with trusts may have been due to disposal of capital stock. In an unpublished analysis, however, we found significant trust related decreases in several non-capital costs.

Analyses of the effect of trust status by trust wave (table 3) sheds more light on the timing of productivity changes. For second and third wave trusts the largest gain in productivity was in the year of gaining trust status (1992-3 and 1993-4 respectively), suggesting that whatever changes occurred, they were relatively immediate. Interestingly, however, third wave trusts were improving productivity more rapidly in the year before obtaining trust status (1992-3) than were persistent directly managed units in the same year. There is thus some evidence that hospitals who already had effective cost control mechanisms in place might have been more likely to become trusts, so some of the trust productivity gains may well have happened anyway. Since directly managed hospitals have disappeared, there will be no suitable control group for future comparisons to test this hypothesis. Importantly, average costs for each of the trust waves were not statistically significantly different at the end of the study period.

Competition

The number of providers within a 25 mile radius was not significantly associated with costs. Several possible explanations exist. Insufficient time may have elapsed for competition to affect productivity, and competitive effects may emerge later. Evidence suggests that it took some time, for example, for competition based reforms to influence costs in California.[11] The second suggestion is that hospitals do compete, but not on the basis of price. This seems more likely for general practitioner fundholders and private purchasers. Surveys of fundholders suggest that price comes fairly low on their list of priorities and that factors such as perceived competence of specialists, waiting times, and access are more important.[12 13] Thus there is no consistent direct relation between competition and costs because there is little pressure on prices. In fact, competition may be expected to increase costs if providers have to increase aspects of quality to attract patients. The presence of non-price competition has been well demonstrated in the American healthcare market.[14]

Purchaser shares

There are two ways of interpreting the fact that high proportions of host district patients are associated with lower costs. The first interpretation views host district share as an index of relative purchaser power. Host districts are generally the largest single purchaser of a hospital's services. As proportions of patients from other purchasers increase, the relative power of the host diminishes, leading to less pressure on provider costs. This phenomenon has been described with large purchasers in the US.[15-18] Secondly, the higher costs associated with many patients from smaller purchasers might result from higher transaction costs.

Conclusion

A high proportion of NHS hospital cost variation, particularly in cross sectional analyses, can be explained by variation in outputs produced, wage and property costs, and elements of the internal market reforms. Gaining trust status and increasing host district purchaser shares were associated with greater productivity. We cannot, however, exclude the possibility that some of the trust hospital effect was due to selection. The number of hospitals in a given market area had no detectable effect on overall productivity. Nevertheless, the evidence remains circumstantial, given the short duration of the internal market, the absence of comparable prereform control data, and our inability to measure the quality of hospital output. Standardised measures of hospital quality must be the priority for students of hospital performance comparison. We also hope that this study prompts further studies, both of the overall trends in NHS hospitals with time and of the determinants of provider behaviour that might underlie the effects we observed. The effects of purchaser share and market concentration on productivity still warrant additional study, and study of the practical mechanics of the internal market might shed light on these factors.

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Key messages

- Comparisons of performance between hospitals should take casemix into account, as failure to do so could significantly bias results
- Gaining independent trust status was associated with significant productivity gains for NHS hospitals, although some of the effect may have been due to self selection; and at the end of the study period productivity differences between trust waves were non-significant
- Competition between hospitals had no significant effect on productivity during the first three years of the internal market
- Hospitals that contract with many smaller purchasers other than their host district are more costly, other factors being equal

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Correction

Risk of testicular cancer in cohort of boys with cryptorchidism

An author's error occurred in this paper by A J Swerdlow et al (24 May, pp 1507-11). The number of person years for cancer incidence during follow up of the cohort should have been 20 160 (not 26 389). The correct person years were used in calculation of risk in the study; there are no errors in the risks presented and no consequences for any of the results.