Report to Department of Health

Payment by Results: Consequences for key outcomes measures and variations across HRGs, providers and patients

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We would like to acknowledge advice from Professor Matt Sutton, School of Community Based Medicine, University of Manchester on the econometric strategy used in this report.
Executive Summary

In 2003/4 the Department of Health introduced a new way of paying hospitals. Under Payment by Results (PbR) prospective based tariffs are used to pay hospitals for spells of care. This has been extended to cover much of acute hospital care.

In 2007 we reported on the impact of PbR in its earliest years of implementation. In this report we extend the analysis contained in our previous report in three main ways: first, by analysing additional years of data up to 2007/08; second by undertaking subgroup analysis, investigating the impact of PbR across patient, provider and HRG groups and third by developing our methodology to better exploit the multiple years of data and present the results in a more accessible form.

We consider whether there is evidence that PbR resulted in a reduced length of stay and increased the proportion of daycases, as both of these measures can be interpreted as measures of real resource use. We also investigate whether there have been any adverse effects on measures of quality of care that might be attributable to PbR and we examine whether there has been an increase in activity as a consequence of PbR. We perform all of these analyses both overall and across patient, provider and HRG groups.

Research questions, methods and data

The motivation for this research is a concern to determine whether PbR met the objectives set for it at its inception. We argue in Section 2 that these objectives can be stated as:

- to deliver health care making better use of the available real resources / inputs and thus
- to increase the quality and volume of treatments delivered within the available resources,

and on this basis we formulate specific research questions in terms of the impact of PbR on six outcome variables. The first two outcome variables – length of stay and proportion of daycases – capture any impact on resource use, a further three variables are used to measure any impact on quality and the remaining variable is the volume of treatments. The details are set out in Section 2.

We draw on a substantial body of theoretical research that suggests that a prospective payment system such as PbR will result in real resource reductions. The same body of literature is ambivalent as to whether there will be reductions or increases in quality and is relatively silent on the expected impact on volume of treatments. Further details are provided in Appendices F and G and briefly summarised in Section 3. We note that the link between the theory and our empirical research is strongest for real resource variables and that this should be taken account of when interpreting the results.

Our empirical method uses the phased introduction of PbR in England and the absence of any such policy in Scotland to define control groups against which the impact of PbR on the performance of the relevant treatment groups (specific providers supplying particular HRGs in particular years) can be assessed. We formulate a generalisation of multiple difference-in-differences specifically for this task. Further details are provided in Appendix E and are briefly summarised in Section 3.
The data for our study are very extensive, being the combination of records of hospital spells in both England (HES) and Scotland; the details of the data sources and variables used are contained in Section 4.

Results and Conclusions

We find strong evidence of reductions in length of stay and increases in the proportion of daycases as a consequence of PbR. With some minor exceptions which are detailed in Section 5 these effects are spread across most groups of patients, providers and HRGs. The magnitude of the coefficient in the length of stay equations suggests real savings (in resources / inputs) of between 1% and 3% which can be attributed to the introduction of PbR. These reductions are for the whole period from PbR’s introduction in 2003/04 to 2007/08.

Our measures of quality of health care are consistent with those used elsewhere but are necessarily somewhat crude. It is thus not possible to confidently assert whether there have been quality changes as a result of PbR, but we do not find any evidence of deterioration in the measures of quality investigated that can be attributed to PbR. There is some limited evidence that small improvements in some of the indicators may be attributable to PbR and again with some minor exceptions these findings hold across most groups of patients, providers and HRGs.

We find that there are increases of between 3% and 9% in the numbers of spells, coincident with, and persisting following the introduction of PbR. We are less confident that these can be viewed as being caused by PbR because our underlying theoretical framework does not suggest that this is necessarily the effect of PbR and also the data are less detailed. Nevertheless there is support here too for the view that PbR has met its objectives and again with some minor exceptions these findings hold across most groups of patients, providers and HRGs.

The details of these results can be found in Section 5.
1. Introduction

In 2003/4 the Department of Health first introduced a new way of paying hospitals. Under Payment by Results (PbR) prospective based tariffs are used to pay hospitals for spells of care. This has been extended to cover much of acute hospital care; in 2002/03 no spells were covered by tariff, by 2005/6 around 50 per cent were covered by tariff, and by 2007/8 this has increased to 94 per cent.

There were expectations that the policy would have beneficial effects on the cost and volume of care, with at worst no negative impact on the quality of care and perhaps some positive effects there too.

In 2007 we reported on the impact of PbR on a set of key outcome variables used to measure cost, volume and quality of care (National Evaluation of Payment by Results, December 2007, Farrar et al, 2009) and found that costs proxied by length of stay and proportion of daycases had fallen, the number of spells had increased and there was no effect on the outcomes used to measure quality of care. The results were strongest when Scottish hospitals rather than non-tariffed English activity were used as a control.

Those results were concerned with the impact of PbR in its earliest years of implementation, 2004/05 and 2005/06. There are reasons why it might not be appropriate to extrapolate these findings to the medium and longer term impact of the policy and hence, why it is important to continue to measure the impact of the policy on the provision of hospital care.

In this report we present our findings on the medium term effects of PbR and extend the analysis contained in our previous report in three main ways: first, by analysing two additional years of data up to 2007/08; second by undertaking subgroup analysis which investigates the impact of PbR across patient, provider and HRG groups and third by developing our methodology to better exploit the multiple years of data and present the results in a more accessible form.

For this report we focus on three specific issues. We consider whether there is still evidence that PbR reduced length of stay and increased use of daycase in the provision of care; we investigate whether the means by which these reductions have been achieved have had an adverse affect on the quality of care, and we examine whether there has
been an increase in activity as a consequence of PbR. We maintain these three avenues of investigation within our subgroup analysis to consider effects of PbR across different patient groups, different types of hospitals and different HRGs.

The report is set out as follows: in the next section we outline the policy objectives and how they motivate the project. We follow this with the aims of the project and the specific research questions that emerge from those aims. We next present the methodological framework used to address the questions, outline the difference between the approach we have taken in this report and that of previous reports, and present the econometric models to be estimated. In the following section we describe the data and the variables used. We then present results for the aggregate and subgroup analysis showing the variation in the impact of PbR across patient, provider and HRG characteristics. The results section is organised by the variables of interest: length of stay, proportion of daycases, hospital mortality, 30 day mortality following CABG and 28-day emergency readmission following emergency treatment for hip fracture. We then interpret the results in relation to the key concerns of efficiency, quality of care and activity.

2. PbR policy, its objectives and our research

2.1 Key elements of PbR

Payment by Results policy was first introduced in 2003/04 as a new way of paying hospitals in England. The details of the policy, its refinement and adjustment over the ensuing years have been set out in various policy and technical documents produced by the Department of Health. The key documents are listed under the reference section and can be accessed via the Department of Health website (http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/index.htm, accessed June 2010).

For the purpose of this report two key elements of the PbR policy are:

- hospitals under PbR are paid according to the number and type of patients that they treat through a system in which prices are determined in advance and
- PbR has been introduced in a phased fashion in England but has not been implemented at all in Scotland.
The first element is relevant because there is a respected and widely held theoretical literature on fixed price prospective payment systems which informs our analysis. This theoretical underpinning is summarised in Section 3 and presented more fully in Appendix F.

The second element is important because when examining the impact of a change in policy, the challenge is to determine whether any observed changes in performance over time are attributable to the change in policy. A valid method of achieving this is by comparing the outcomes of the group subject to the change with a group not subject to the change. The phasing in of the policy and its restriction to the NHS in England facilitated the construction of a quasi-experiment using various naturally occurring control groups including Scotland.

2.2 Policy objectives and motivation

The main objectives in introducing PbR are set out in ‘Reforming NHS Financial Flows’ (Department of Health, 2002a). They were (Page 13):

- To ‘enable PCT commissioners to focus on the quality and volume of services provided’
- To ‘incentivise NHS Trusts to manage costs efficiently’.
- To ‘create greater transparency and planning certainty in the system.’

In our evaluation of the early impact of PbR we considered evidence relating to the experience of stakeholders that was relevant to assessing the third of these objectives (Farrar et al, 2007). In this report, as in the greater part of our original evaluation, our focus is upon the first two objectives. It is inevitable that in translating from the objectives of policy to the objects of analysis there is a degree of interpretation. In particular as our understanding of PbR has advanced, and as both the volume and complexity of data has grown, it has become necessary to consider carefully the phrase ‘manage costs efficiently’. The underlying economic theory suggests that one implication of a fixed price payment mechanism, such as PbR, is that it increases incentives to control costs. In our earlier study we interpreted length of hospital stay as a proxy for unit cost and concluded that there was evidence that PbR had reduced costs in this sense. It is clear from the text of the relevant documentation that it was intended that PbR should result in better
management of health care inputs (hospital beds, medical and allied staff, capital equipment and so on) so that more treatments (of a given or higher quality) would be produced for a given set of inputs. This is close to saying that health care delivery should move towards (technical) efficiency. We therefore choose to focus more on the term ‘efficiently’ than on ‘costs’ for the purposes of this report and interpret reductions in length of hospital stay, that are not associated with any reduction in quality as consistent with the second objective above. Accordingly, the first two objectives of PbR listed above can be restated as;

- To deliver health care making better use of the available real resources / inputs and thus
- To increase the quality and volume of treatments delivered within the available resources.

One focus for our evaluation is establishing whether PbR led to a treatment being delivered with fewer real resources (evidenced by lower LOS and a greater proportion of daycases), and with higher (or at least not demonstrably lower) quality, and whether there was an accompanying increase in activity. Hence, we focus on technical efficiency in the sense of measuring inputs used to produce a given output. The output considered is the treatment of a particular patient with a particular condition at a given quality of care. The inputs for this treatment are multi-dimensional (for example, physician time, nursing time, hospital space and equipment) and are proxied by a single measure, length of stay.

Although policy objectives relate to the overall impact of PbR on the delivery of care, there are concerns about the distributional impact of the policy. One response to fixed-price financing identified in other countries is ‘cream-skimming’, in which providers have an incentive to focus on patients with characteristics whose expected costs are lower than the tariff. In such circumstances it may be that, for example, younger patients benefit more under PbR by being given better access to treatment. It is also to be expected that the impact of the introduction of PbR on providers will be non-uniform; since some providers may be inherently better organised than others, we might expect that a fixed-price regime will magnify the consequences of variability across providers in their underlying performance. Alternatively, PbR may impact most on previously poor-performing Trusts and reduce the degree of variability in performance. Our previous report indicated reasons why the impact of PbR might vary across HRGs according to whether the tariff creates a greater or lesser margin over marginal cost and according to whether capacity constraints
operate in respect of particular treatments. Whilst we do not have access to detailed data on marginal costs and capacity constraints, we are able to consider whether the nature of the HRG spell makes some spells more amenable to changes in the use of resources brought about by the introduction of the tariff.

Thus the second focus of this report is on the potential variation of the impact of PbR across different patient groups, providers and HRGs.

2.3 Research questions

Our overall goal is to investigate whether PbR has achieved the policy objectives as outlined in the previous section. We approach this goal by formulating specific research questions concerning observable outcome variables.

The six key outcomes variables are:

1. Length of stay. This is used as a measure of the inputs consumed, and hence the real cost of a spell of care. The use of this measure is common in the study of prospective price systems – see Chalkley and Malcomson (2000).
2. Proportion of daycase spells among elective admissions. Treatment by daycase, in place of a traditional stay in hospital, is another means by which providers can respond to reduce the inputs used and hence cost of an admission.
3. Number of spells. This is the unit of output at which providers are reimbursed and is therefore a measure of activity.
4. Hospital mortality. Used as a proxy for the quality of hospital care.
5. 30-day mortality following CABG. Used as a proxy for the quality of hospital care.
6. 28-day emergency readmission following treatment for hip fracture. Used as a proxy for the quality of hospital care.

We have used outcome measures 4, 5 and 6 as our three proxies for quality of care. Other measures are possible, but the benefit of these measures are; they have been widely used in the analysis of changes in reimbursement in other health care systems, and they are directly computable from the raw datasets used for the analysis allowing the construction of individual patient level data unlike other quality indicators, such as patient satisfaction.
and complication rates which are published as hospital performance indicators and thus only available at the hospital level.

For each of these six outcomes we address the following questions.

Q1. What changes in these outcomes are associated with the introduction of PbR?
   Q1a. What is the overall impact of PbR?
   Q1b. Has the impact of PbR changed over time?

Q2. Does the impact of PbR vary by patient characteristics?
   Q2a. Age.
   Q2b. Gender.
   Q2c. Socio-economic status.
   Q2d. Rural/urban residence.

Q3. Does the impact of PbR vary by organisational characteristics?
   Q3a. Low/high reference cost index providers
   Q3b. Low/high market forces factor providers.
   Q3c. Foundation Trust status.
   Q3d. Gainer or loser under PbR.

Q4. Does the impact of PbR vary by HRG characteristics?
   Q4a. High/low price tariff.
   Q4b. Long/short length of stay before PbR was introduced.
   Q4c. Degree of variation of length of stay within an HRG.

3. Research methods

Our research draws on both economics and econometrics. The more technical aspects of the theoretical underpinnings of our research, the methodological basis of our model formulation and the relationship between our empirical strategy and a more conventionally utilised Difference-in-Differences framework are set out in Appendices F, G and E respectively. In this section we provide a brief summary of theoretical underpinnings and empirical strategy of our research.
3.1 Theoretical underpinning

The theoretical underpinning of our empirical examination derives from the literature on contract theory as applied to the purchase of health services. The theory suggests that PbR, which specifies a fixed price per treatment – in contrast with pre-existing arrangements where budgets could respond to variation in hospital costs -- provides incentives to economise on the resources used in delivering treatment. The theory thus provides a foundation for considering a causal link between the adoption of PbR and reductions in measures of the real resources used during treatment, such as length of stay or the proportion of treatments delivered as daycases.

A frequently expressed concern considered in the theoretical literature is that resource savings may have adverse consequences for what is termed the quality of care. In respect of the direction of impact on quality of care the theoretical literature is rather less clear. Whilst there is a possibility that hospitals will economise on quality in order to reduce resource use, and hence costs, that may be mitigated by either health carers’ intrinsic concern for their patients, or by mechanisms by which patients choose where to be treated according to the quality they perceive; that ‘mitigation’ may go so far as to lead to an improvement in quality and so the theory does not provide any clear prediction in respect of the likely impact of PbR on quality of care. Furthermore quality is not directly measurable. In the real world of hospital services quality can have a vast number of disparate manifestations only a few of which we can ever hope to observe. In summary, the link between theory and an empirical relationship associating our somewhat crude proxies for quality of care with the adoption of PbR is more tenuous than in the case of length of stay.

Contract theory models have not generally examined the impact of fixed price mechanisms on activity levels. When we extended a simple model to examine this question in the context of our original evaluation of PbR we discovered that no general conclusions could be drawn; whilst PbR might establish a margin of price over marginal costs which other things equal might be expected to act as an incentive to increase activity, there are many other variables to consider. In particular in the face of capacity or demand constraints it is the margin of price to cost for one treatment relative to that margin for other treatments that constitutes the incentive to increase a particular activity. There is another gap between theory and the empirical examination of our outcome measure for activity. Where the theoretical models are strongest is at the level of predicting a hospital’s responses to
different payment mechanisms in the treatment of individual patients; activity is measured at the level of the hospital and thus reflects many additional market level constraints and incentives. Thus our empirical formulation of the relationship between activity levels and the introduction of PbR has less of a theoretical underpinning and should, on that account, be treated more cautiously.

It should be noted that there are no obvious theoretical predictions from a contractual model regarding the differential impact of PbR across patient providers or HRGs; the theory indicates that our empirical implementation should allow for any impact to vary across these groups, but does not specify how that variation will manifest itself. This observation motivates the inclusion of provider and HRG fixed effects and controls for patient characteristics in our empirical models and suggests that in an ideal world we would allow for an interaction between a PbR effect and every one of these fixed effects and controls. For the reasons set out in Appendix E this ideal is not attainable but our empirical strategy which is detailed below moves as close to it as the data currently allow.

3.2 Empirical strategy

We use an econometric framework which is analogous to difference-in-differences (DiD) analysis to estimate the impact of PbR on our various outcome variables. The approach is presented in more technical detail in Appendix E. We exploit differences in the timing of the introduction of PbR within England (between Trusts, between types of admissions, between HRGs) and the fact that PbR has been implemented in England but not in Scotland.

Our econometric method previously used a series of DiD estimates which examined the effects of PbR using subsets of the data in terms of years, hospital groups and types of admissions. This gave us a series of estimates of the impacts of PbR but it was difficult to get a sense of the overall impact over the period of introduction for all providers and all types of HRGs, especially when the coefficients were not of the same sign.

We have developed a new general model in which the estimate of policy impact appears directly, and where our pre-existing results are simple instances of this estimate subject to different assumptions or restrictions. There are two sources of benefit to the approach we are now using. First, it enables us to make better use of data. Our dataset has expanded
considerably since the original evaluation. This general model utilises multiple years of data allowing us to move beyond simple two year based before and after assessments. The richer longitudinal structure of data we now have available permits identification of purely temporal shifts in health care outcomes (i.e. through the use of year dummies) and using appropriate models we can test for the confounding influence of those on our estimated policy impacts. We can also test for the impacts of other confounding effects on the key outcomes, such as other policy changes.

Starting with a general model we can refine the estimates to answer the more specific questions of the effect of policy within FTs or the effect of policy within a specific financial year or the effect of policy within a specific year of the application of the policy. Hence, we will still have the opportunity to examine the detail of the policy but starting from a general position which will subsume the piecemeal models to give an overall impact. A detailed consideration of the general policy evaluation question and how the new approach compares with that used previously can be found in Appendix E.

By way of example, we estimate the impact of PbR on length of stay, using

\[
\ln (\text{los})_{ijkt} = a_i + m_j + \delta_j + v_k + \theta_t + \beta D_{ijkt} + \gamma F_{kt} + \varepsilon_{ijkt},
\]  

where \(\ln(\text{los})\) is the natural log of length of stay, \(i\) indexes spells, \(j\) indexes HRGs, \(k\) indexes providers and \(t\) indexes financial years. The variable \(a\) is the age-gender of the patient (measured in categories), \(D\) is a dummy variable indicating whether PbR applied to the spell, \(F\) is a dummy variable indicating foundation Trust status, \(m\) is the admission method (elective or non-elective). \(\delta_j\) is a vector of dummies for the HRG, \(v_k\) are provider dummies and \(\theta_t\) are (annual) time dummies.

The estimated impact of the policy \(\beta\) may vary across each of the dimensions. Thus we investigate how the impact varies across providers, HRGs and patient characteristics.

The coefficient \(\beta\) represents the impact of PbR only if there were no differences in policy between those spells affected by PbR and those not affected by PbR. There are differences in policies between Scotland and England which are outlined in the Appendix C. To capture these differences we include a number of dummy variables: one is for the Patient Choice Policy introduced from January 2006, a second is for the A&E four hour treatment target and a third is an indicator of FT status of the hospital at spell level.
For two of the quality indicator variables (30-day mortality following CABG and 28-day emergency readmission after treatment for hip fracture), we estimated models with provider fixed effects due to the limited number of HRGs in related spells.

The effect of PbR on the number of spells was estimated at provider level using

\[
\ln (\text{the number of spells})_{jkt} = \delta_j + v_k + \theta_t + \beta D_{jkt} + \gamma F_{kt} + \varepsilon_{jkt}, \tag{2}
\]

where \(\delta_j\) is a vector of dummies for the HRG, \(v_k\) are provider dummies and \(\theta_t\) are (annual) time dummies. Means of some independent variables (for example \(F\) and \(D\)) of each provider were used. Organizational changes such as merger and demerger were reflected in the estimation by including an indicator variable. A dummy variable was defined 1 if the provider had experienced merger or demerger and 0 otherwise.

The analysis was undertaken separately on elective and non-elective spells

4. Data

Data from HES and SMR1 and SMR2 for years 2002/03-2007/08 have been used to undertake the analysis.

All years of the HES data have been revised using the new personal identifier obtained from the NHS Information Centre (NHSIC). We used the revised identifier to follow the same individuals within and across years. The new personal identifier is considered to enhance the quality of data, regarding episodes for the same individuals, which would lead to more accurate identification of spells. However, the changes noted were not large. Summary tables of the outcome variables are shown in Appendix B.

To summarise these briefly;

The number of spells has increased in England and Scotland for elective and non-elective activity; for both countries the growth in activity has not been steady and has fluctuated considerably over the period; overall growth in both elective and non-elective activity has been higher in England than in Scotland; for elective activity the difference between the
two countries was most marked in the last three years to 2007/08 and for non-elective activity growth was higher in England in the earlier years of the period to 2005/06.

*Length of stay* has fallen in England and Scotland over the period covered by the data for both elective and non-elective care; the percentage reductions in England have been larger than those in Scotland – around 25 per cent over the whole period compared with around nine per cent.

The *proportion of spells treated as daycases* was higher in England than Scotland at the beginning of the period and both countries have increased the rate of daycase provision with the percentage increase greater for England.

*Hospital mortality* is generally lower in England than in Scotland over the period 2002/03 to 2007/08 and reductions in mortality have been larger for England for both elective and non-elective activity.

*30 day post CABG mortality* was higher at the beginning of the period for England but Scotland has experienced smaller reductions, so that the two countries now have the same rate.

*28 day emergency readmission following emergency treatment for hip fracture* has increased in England compared with a reduction in Scotland over the period. We note the discrepancy between the levels of this variable in England and Scotland. If this is simply a matter of differences in the denominators it will not affect our results (since we are concerned only in differences about the trends) but this is an issue that will require further investigation.

**4.1 Outcome variables**

All variables are defined at the spell level unless otherwise stated.

*Length of stay*. For inpatient spells with LOS greater than zero, LOS is defined as the number of days from admission to discharge. 48.31 per cent of spells are elective admissions, of which 68.53 per cent are daycases and a further 13.56 per cent of elective inpatient admissions are identified as having zero length of stay. These spells use resources and are assigned the equivalent of 0.7 days LOS. This assumption is based on
the reference cost index of a daycase relative to that for an inpatient. The rationale for this approach is that we are seeking to measure the change in resource use that results from the adoption of PbR. A positive LOS is assigned to all inpatient and daycase spells and included in the LOS analysis.

The probability of being treated as daycase for elective spells. HES and SMR01/02 data has the information on all admissions whether or not the episode was treated as a daycase or inpatient. The dependent variable we use is dichotomous being 1 if the patient was admitted as a daycase and 0 otherwise for elective spells.

Hospital mortality. HES and SMR01/02 has the variable showing the destination at discharge. One destination is ‘death’ and we consider death on discharge or hospital mortality as one of the quality of care measurements. A dichotomous variable is used as a dependent variable.

30 day mortality after CABG. This variable is constructed to conform to the definition of NHS mortality rate Performance Indicator 6(xi) used by the Healthcare Commission in 2001/2. It counts the percentage of heart bypass operation ending in deaths within 30 days of eligible surgery, including deaths occurring in hospital and after discharge. It covers all spells where there is at least one coronary artery bypass surgery (CABG) procedure (OPCS 4 code K40-46) but excluding the spell if the CABG took place after a percutaneous transluminal coronary angioplasty (PTCA).

28 day Emergency readmission after emergency hip fracture treatment. This variable corresponds to NHS emergency readmission Performance Indicator 6(v) defined by the Healthcare Commission in 2001/02, counting the proportion of emergency hip fracture treatments where the patient was discharged live and was readmitted via emergency admission within 28 days. Spells coded under mental health specialties are excluded. Hip fracture spells are identified using ICD 10 codes S72.0, S72.1, S72.2. Where there is more than one readmission within 28 days, each readmission is counted once.

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1 For HRGs provided as both daycase and inpatient care, the daycase reference cost is on average 0.7 of the inpatient reference cost.
Volume of activity. The number of spells at provider-HRG level was calculated for each year of the data, considering other controlling variables, of which the natural log was used as the dependent variable.

4.2 Explanatory and control variables

PbR. The PbR variable is the key explanatory variable in the analysis. It is a binary variable indicating whether the spell is funded by tariff under PbR or not; it is the imputed analogue of the variable $D$ in equation (1). PbR status is defined by a combination of the year in which the spell was provided, the Trust in which the patient was treated, the type of care the patient received categorised by HRG type and whether the care was elective or non-elective.

For instance, an elective spell provided by an FT in 2004/05 is defined as ‘under PbR’; a non-elective spell provided by a NHS Trust in 2005/06 would be defined as ‘not under PbR’, and an elective spell provided by a Scottish hospital in 2006/07 is defined as ‘not under PbR’. Table 4.1 shows the percentage of spells in the data set which are subject to PbR by year.

Table 4.1 The number of spells and the proportion of spells under PbR.

<table>
<thead>
<tr>
<th>Year</th>
<th>SMR</th>
<th>HES</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002/03</td>
<td>1,143,043</td>
<td>10,940,242</td>
</tr>
<tr>
<td>PbR</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2003/04</td>
<td>1,149,070</td>
<td>11,368,504</td>
</tr>
<tr>
<td>PbR</td>
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<tr>
<td>2004/05</td>
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<tr>
<td>PbR</td>
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<tr>
<td>2005/06</td>
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<tr>
<td>PbR</td>
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<tr>
<td>2006/07</td>
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<td>PbR</td>
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<tr>
<td>2007/08</td>
<td>1,235,382</td>
<td>12,916,505</td>
</tr>
<tr>
<td>PbR</td>
<td>0</td>
<td>0.94</td>
</tr>
</tbody>
</table>

Year is defined as the fiscal year (1st April-31st March in the following year) of the discharge date of a spell.

Age is defined at the spell level using the month of birth of a patient at admission. Age is in years and is grouped into 18 categories for the general model. For the across patient
characteristics analysis, age is grouped into three categories (Age 0-19; age 20-64; and age 65 and above).

Gender (female) is defined using the variable SEX in HES and SMR. It is used as a control variable in the general model. It is also used to define gender groupings for across patient characteristics analysis.

Patient Choice Policy was introduced in England in January 2006. The patient choice variable is 1 for all spells occurring 6 months after this date and 0 otherwise. There is also a maximum wait target of 6 months in effect so this allows all patients waiting and not being offered choice to have worked through the system. We used the admission date of the spell to create this variable.

Accident and emergency four hour target. From January 2005 onwards an NHS target was introduced in England which required 98 per cent of patients to spend four hours or less in any type of A&E from arrival to admission, transfer or discharge. The same target was introduced in Scotland in December 2007. This variable is 1 if a spell is non-elective and admitted after these dates and 0 otherwise.

4.3 Subgroup variables

Socio-economic status of the patient is defined using indices of multiple deprivation variables from the HES and SMR data. The SMR Scottish Index of Multiple Deprivation (SIMD) is defined by decile. This categorisation divides the Scottish population into ten equal categories based on the range of SIMD scores. These categories were combined to create quintiles. The English Index of Multiple Deprivation (IMD) overall ranking was used to define quintile for the HES data. This variable is used to define socio-economic groupings for analysis across patient characteristics.

Urban/rural categorisation refers to the individual patients’ residency and is defined using HES variables. HES has a variable with nine categories of urban/rural and cities or towns with more than 10,000 population were defined as urban. SMR was defined using Scottish Executive Urban Rural classification, which identifies cities or town with more than 10,000 population as urban. This variable is used to define patient groups by residence for analysis across patient characteristics.
Reference cost index in 2004/05 is used as an indicator of whether a hospital Trust is a high, medium or low cost provider. Trusts established after 2004/05 were not included in the analysis.

Trust specific Market Forces Factor in 2004/05 is used as an indicator of whether a hospital Trust has received a premium on account of low, medium or high unavoidable local costs. Trusts established after 2004/05 were not included in the analysis.

HRG average length of stay for elective spells in 2002/03 is calculated by HRG. HRGs are categorized into three groups based on average length of stay.

Foundation Trust status is equal to 1 if a trust has ever been awarded FT status by the end of the financial year 2007/08 and 0 otherwise.

Variation in length of stay. A coefficient of variation of LOS was calculated for each HRG in 2004/05. HRGs are categorized into three groups based on the coefficient of variation.

Gainer or loser under PbR. A trust is defined as a gainer if it generates larger revenue from PbR than block contracts during the first three years of PbR implementation. A loser is vice versa.²

5. Results

5.1 Model selection

We estimated a series of 12 models for each research question. The variables included in each model are presented in Table 5.1. For illustrative purposes we present all twelve models estimated for length of stay in Appendix A. Only those which included HRG fixed effects (either alone or in conjunction with provider fixed effects) produced a high explanatory power indicated by R-squares. Model 9 using provider fixed effects, estimates the impact of PbR on the average change in length of stay within a given provider within a given year. In not controlling for HRGs, it omits an important set of variables which control for heterogeneity across HRGs and explain differences in lengths of stay. Model 9 using

² Prior to the introduction of PbR hospitals were paid by block contracts where a set amount of money was paid. Each pair of PCTs and hospital trusts negotiated on the composition of treatments, the volume, and the total value of the block contract. With the introduction of PbR the payments to hospital trusts are based on the volume of activities per HRG at the national tariff, it was found that in some cases there were great discrepancies between the amount of money hospitals received from block contracts and under PbR.
HRG fixed effects estimates the impact of PbR controlling for these factors. The high R-squares give one indication that controlling for HRG effects is important. We thus prefer specifications that include both provider and HRG fixed effects.

A further elaboration is to allow for interactions between provider and HRG effects. Model 11 does precisely this. Hence it estimates the impact of PbR within a given provider within a given HRG within a given year. Although this model provides the most explanatory power, it relies on a specific set of circumstances to produce estimates: that an HRG is switched from non-tariffed to tariffed within a Trust. The only circumstances under which this occurs are those occasions when Trusts gain Foundation Trust status and where the HRG in question comes under tariff. The Scotland observations are not used as a control in this model as PbR is not switched on at any point in time in Scotland. Therefore, although model 11 is more general the data available to estimate it are limited and the precision and reliability of any estimated effects are restricted.

In balancing these various considerations our model of choice, where it is feasible, is model 12 which includes separately (but not in combination) provider and HRG fixed effects. This has the advantage of utilising the high explanatory power of the HRG controls without the restrictions of model 11. Scotland observations are utilised as a control as are observations in years prior to PbR being introduced. With this model we make use of more observations.

Table 5.1 Model specification

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<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Notes: 1. Patient Choice dummy was used in models for elective spells. 2. A&E 4 hr dummy was used in models for non-elective spells. 3. Fixed effects.
We report the results from the pooled difference in difference analysis and sub group analyses by provider, patient, and HRG level characteristics and practical issues further restrict our selection of model. We have used model 12 to estimate models of the impact of PbR on the number of spells and hospital mortality. For length of stay and daycase proportion we were obliged to use HRG fixed effects only (model 10) for computational reasons. Analysis of samples of the data show that the coefficients are the same sign and similar to those obtained using provider and HRG fixed effects (model 12). For 30-day mortality following CABG and 28-day emergency readmissions following emergency treatment for hip fracture we estimated provider only fixed effects (model 9). HRG fixed effects were inappropriate given the restricted range of HRGs included in the treatment specific analysis.

In interpreting the coefficient estimates for $\beta$ – the PbR effect – it is important to distinguish causality from correlation. If a coefficient is statistically significantly different from zero then in conventional language there is a *relationship* between the outcome variable and PbR. The question remains as to whether PbR causes the change. Statistical significance in itself does not establish causality and a number of auxiliary judgements come into play; whether there is a plausible model that links the variables, how many controls have been included to avoid confounding, whether there is a consistent ‘dose-response’ to the intervention and so on. We are more confident about inferring causality for models which are estimated using spell level data and for those which have the strongest theoretical underpinning.

Hence, it is our view that a causal effect is more robustly indicated in relation to the outcome variables length of stay and daycase proportion; these effects are well supported by our underlying economic model (Appendix F) and are estimated on spell level data using a rich set of controls. We would place the quality outcome variables next in terms of confidence of causality; there is a well-founded model but it does not make firm predictions, but the estimates are based on spell level data. The outcome measure, number of spells, is measured at the hospital level and there are many possible influences on the number of spells that may constitute omitted variables from the model. As a result we suggest that least weight is placed upon these findings in asserting an impact attributable to PbR.

---

3 A combination of both HRG- and provider- fixed effects has too few observations in certain sub-groups categorized by HRGs and providers, and leads to singular variance-covariance matrix in estimating models.
5.2 What are the changes in the key outcomes associated with the introduction of PbR over the years 2004/5-2007/08?

Q1. What is the overall impact of PbR?

The coefficients in Table 5.2.1a represent an average impact of PbR across all controls for each period indicated. As such they provide an indication of the overall or average impact of the introduction of the tariff on length of stay. For example, utilising data from the full period (2002/03–2007/08) PbR is estimated to reduce the average length of stay of elective spells by 2.5 per cent (-2.48E-02) and of non-elective spells by 1.7 per cent (-1.67e-02). The estimates for the earlier years show that, for example, the impact of PbR up to 2005/06 reduced length of stay for elective care by 1.6 per cent (1.56E-02). Length of stay for non-elective care has also fallen, though less than that of planned care.

As we move to the columns to the right of the table, the change in the coefficients estimated reflects two things: first, more spells are subject to tariff and second, some types of spells are subject to tariff for longer. The change from the penultimate to the last column mainly reflects the second of these changes. It should be noted that the coefficients are not cumulative. They provide a useful indication of the robustness of the results: they are consistently negative, statistically significant, stable for the full sample period and relate closely to our previous estimates. It is thus possible to have increasing confidence in the finding that PbR has had the effect of reducing LOS, other things equal, including in that caveat the implementation of the Patient Choice policy.

The proportion of elective admissions treated as daycases has increased in response to the introduction of PbR. The average effect over all years to 2007/08 was to increase the probability of being treated by daycase by 0.2 per cent (2.37E-03).

PbR is associated with increases in the number of elective and non-elective admissions over the full period of analysis. The increase is greater for non-elective spells at 9.9 per cent (9.06E–02) compared with elective care at 3.1 per cent (9.06E–02) when we estimate the impact from 2002/03 to 2007/08.

There have been very small but statistically significant reductions in hospital mortality associated with the introduction of PbR. 30-day mortality following CABG was reduced for
all the samples estimated. The overall effect to 2007/08 was to reduce CABG mortality by 2.2 per cent (−2.16E−02).

During the early years of PbR the 28-day emergency readmission rate following emergency treatment for hip fracture was reduced. For the later years this relationship disappeared.

Overall the analysis of the proxies used for quality of care suggests that PbR has not had a detrimental effect on the quality of care.

It should be noted that the coefficients presented for the non-elective spells for the first two years of PbR are estimated on a small number of providers (FTs) for which the tariff applied to non-elective activity. In our interpretation of the non-elective results in Table 5.2.1a we focus on the results which include later years of data as these are more robust to changes in the composition of hospitals subject to tariff.

Table 5.2.1a. Impact of PbR on key outcomes

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LOS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elective</td>
<td>β</td>
<td>−9.37E−03***</td>
<td>−1.56E−02***</td>
<td>−2.08E−02***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>5.74E−04</td>
<td>4.35E−04</td>
<td>3.95E−04</td>
</tr>
<tr>
<td>Non-elective</td>
<td>β</td>
<td>1.03E−01***</td>
<td>1.77E−01***</td>
<td>−4.28E−03***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>9.32E−03</td>
<td>6.65E−03</td>
<td>9.60E−04</td>
</tr>
<tr>
<td><strong>Daycase Proportion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elective</td>
<td>β</td>
<td>2.08E−03***</td>
<td>3.10E−03***</td>
<td>9.62E−04***</td>
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<tr>
<td>Non-elective</td>
<td>β</td>
<td>1.77E−01***</td>
<td>6.53E−02***</td>
<td>4.36E−02***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>1.56E−02</td>
<td>1.07E−02</td>
<td>9.87E−03</td>
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<tr>
<td># Number of spells</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Elective</td>
<td>β</td>
<td>4.09E−01***</td>
<td>4.26E−01***</td>
<td>8.42E−02***</td>
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<tr>
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<td>4.14E−02</td>
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<tr>
<td>Non-elective</td>
<td>β</td>
<td>1.77E−01***</td>
<td>6.53E−02***</td>
<td>4.36E−02***</td>
</tr>
<tr>
<td></td>
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<td>9.87E−03</td>
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<tr>
<td><strong>Hospital mortality</strong></td>
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<tr>
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<td>−1.93E−04***</td>
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<td>Non-elective</td>
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<td><strong>30-day mortality for CABG</strong></td>
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<td></td>
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<tr>
<td>All</td>
<td>β</td>
<td>−2.33E−02***</td>
<td>−2.26E−02***</td>
<td>−2.18E−02***</td>
</tr>
<tr>
<td></td>
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<td><strong>Emergency readmission for hip</strong></td>
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<td></td>
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<tr>
<td>All</td>
<td>β</td>
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<td>−2.99E−02***</td>
<td>1.01E−03</td>
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<td>9.79E−03</td>
<td>6.41E−03</td>
<td>2.83E−03</td>
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</table>

Notes: ** p<0.01, *** p<0.001. ¹ HRG fixed effects, ² HRG plus provider fixed effects, ³ Provider fixed effects.
5.3 Does the impact of PbR vary by patient characteristics?

**Q2a. Does the impact vary by patient age?**

There is a clear gradient of the impact of PbR on length of stay for non-elective care and elective spells. The 0-19 age group have experienced the smallest reductions in LOS and the highest reductions have been in the older age groups.

Conversely younger patients have had statistically significant greater increases in the daycase rate than older patients attributable to PbR.

All age groups have seen increases in the volume of elective spells. There is little difference across the age groups. The increase in non-elective spells was greater for the older age groups.

Given the very small changes observed in the hospital mortality rate we are unlikely to see statistically significant differences across groups and this is generally borne out in the analysis by age group. The exception is the higher reduction in hospital mortality for the oldest age group.

30-day mortality following CABG fell for the two age groups for which we have estimates. The reduction was larger for the oldest group and the difference between the two age groups is statistically significant.

There is no statistically significant relationship between PbR and 28-day emergency readmissions following treatment for hip fracture when we analyse the effects by age group.
Table 5.3.2a. The impact of PbR by patient age, 2002/03 to 2007/08

<table>
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<th>Variable</th>
<th>Age group</th>
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<td>4.49E–04</td>
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<td>1.26E–03</td>
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<td>Non-elective</td>
<td>$\beta$</td>
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<td>-6.09E–04***</td>
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<td>s.e.</td>
<td>8.75E–05</td>
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<td>30-day mortality for All</td>
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<td>-3.21E–02***</td>
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<tr>
<td></td>
<td></td>
<td>s.e.</td>
<td>1.82E–03</td>
<td>3.34E–03</td>
</tr>
<tr>
<td>Emergency readmission CABG</td>
<td>All</td>
<td>$B$</td>
<td>2.49E–02</td>
<td>-1.47E–03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s.e.</td>
<td>2.35E–02</td>
<td>6.21E–03</td>
</tr>
</tbody>
</table>

Notes: ** p<0.01, *** p<0.001. ¹ HRG fixed effects, ² HRG plus provider fixed effects, ³ Provider fixed effects.

Figure 5.3.2a1. Impact of PbR on LOS by age group
Figure 5.3.2a2. Impact of PbR on daycase proportion by age group

Figure 5.3.2a3. Impact of PbR on number of spells by age group

Figure 5.3.2a4. Impact of PbR on hospital mortality by age group
**Q2b. Does the impact of PbR vary by patient gender?**

There is little difference between the impact of PbR on length of stay of male and female patients—both male and female patients experienced reductions in the length of stay of elective and non-elective spells.

The increase in the proportion of daycase admissions attributable to PbR is restricted to female patients. The probability of being treated as a daycase has fallen for males whilst increased for females. These changes are small for each group, around 0.01 per cent (-5.23E-04 and 7.70E-04, respectively). However, the difference is statistically significant.

Both males and females have had increases in admissions associated with the introduction of PbR for elective and non-elective care. There is no statistically significant difference between the genders.
Changes in hospital mortality are small and the same for males and females. 30-day mortality following CABG was reduced following the introduction for PbR for males and females. The reduction was greater for females but the difference is not statistically significant. We observe no statistically significant impact on emergency readmissions following treatment for hip fracture.

Table 5.3.2b. Impact of PbR by gender, 2002/03 to 2007/08

<table>
<thead>
<tr>
<th>Variable</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LOS</strong></td>
<td><strong>Elective</strong></td>
<td><strong>Non-elective</strong></td>
</tr>
<tr>
<td></td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td>s.e.</td>
<td>5.81E–04</td>
<td>4.91E–04</td>
</tr>
<tr>
<td></td>
<td>1.08E–03</td>
<td>9.00E–04</td>
</tr>
<tr>
<td><strong>Daycase proportion</strong></td>
<td><strong>Elective</strong></td>
<td><strong>Non-elective</strong></td>
</tr>
<tr>
<td></td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td>s.e.</td>
<td>3.42E–04</td>
<td>2.96E–04</td>
</tr>
<tr>
<td></td>
<td>7.47E–03</td>
<td>7.42E–03</td>
</tr>
<tr>
<td><strong>Number of spells</strong></td>
<td><strong>Elective</strong></td>
<td><strong>Non-elective</strong></td>
</tr>
<tr>
<td></td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td>s.e.</td>
<td>9.45E–03</td>
<td>9.38E–03</td>
</tr>
<tr>
<td></td>
<td>7.47E–03</td>
<td>7.42E–03</td>
</tr>
<tr>
<td><strong>Hospital mortality</strong></td>
<td><strong>Elective</strong></td>
<td><strong>Non-elective</strong></td>
</tr>
<tr>
<td></td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td>s.e.</td>
<td>5.17E–05</td>
<td>3.96E–05</td>
</tr>
<tr>
<td></td>
<td>2.33E–04</td>
<td>1.70E–04</td>
</tr>
<tr>
<td><strong>30-day mortality for CABG</strong></td>
<td><strong>All</strong></td>
<td><strong>All</strong></td>
</tr>
<tr>
<td></td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td>s.e.</td>
<td>1.85E–03</td>
<td>4.35E–03</td>
</tr>
<tr>
<td><strong>Emergency readmission hip</strong></td>
<td><strong>All</strong></td>
<td><strong>All</strong></td>
</tr>
<tr>
<td></td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td>s.e.</td>
<td>5.38E–03</td>
<td>2.95E–03</td>
</tr>
</tbody>
</table>

**Notes:** **p<0.01, ***p<0.001. ¹HRG fixed effects, ²HRG plus provider fixed effects, ³Provider fixed effects.

Figure 5.3.2b1 Impact of PbR on LOS by gender
Figure 5.3.2b2 Impact of PbR on daycase proportion by gender

Figure 5.3.2b3 Impact of PbR on number of spells by gender

Figure 5.3.2b4 Impact of PbR on hospital mortality by gender
Q2c. Does the impact of PbR vary by socio-economic status?

For elective and non-elective spells there is no clear gradient of the impact of PbR on length of stay across the quintiles of multiple deprivation and no statistical difference between the lowest and highest quintiles – all experienced reductions. For elective care and non-elective spells, LOS was reduced most in the 3rd and 4th quintiles of deprivation. For non-elective spells the difference is statistically significant.

The impact of PbR on the use of daycase admissions across the quintiles of deprivation shows the least deprived groups having a larger increase in the probability of being treated as a daycase. The increase for this group is statistically significantly different to all the other groups.

The estimates of the relationship between PbR and the number of elective spells by IMD quintile were not statistically significant for any group.
All quintiles of the IMD experienced increases in the volume of non-elective admissions. This was statistically significantly higher for the more deprived groups.

Hospital mortality was reduced across all five groups following the introduction of PbR. Although small these were statistically significant.

Reductions in 30-day mortality following CABG were statistically significant for all groups. There was no difference across the groups.

Estimates of the relationship between PbR and emergency readmissions following treatment for hip fracture across groups of multiple deprivation were not statistically significant.
Table 5.3.2c. Impact of PbR by Index of Multiple Deprivation (IMD) quintiles, 2002/03 to 2007/08

<table>
<thead>
<tr>
<th>Variable</th>
<th>Elective</th>
<th></th>
<th>Non-elective</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I (least deprived)</td>
<td>II</td>
<td>III</td>
<td>IV</td>
<td>V (most deprived)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LOS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elective</td>
<td>β</td>
<td>–2.21E–02***</td>
<td>–2.14E–02**</td>
<td>–2.54E–02***</td>
<td>–2.66E–02***</td>
<td>–2.38E–02***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>7.83E–04</td>
<td>7.88E–04</td>
<td>8.27E–04</td>
<td>8.84E–04</td>
<td>9.51E–04</td>
<td></td>
</tr>
<tr>
<td>Non-elective</td>
<td>B</td>
<td>–1.19E–02***</td>
<td>–2.01E–02**</td>
<td>–2.67E–02***</td>
<td>–2.34E–02***</td>
<td>–1.27E–02***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>2.09E–03</td>
<td>2.06E–03</td>
<td>1.98E–03</td>
<td>1.81E–03</td>
<td>1.59E–03</td>
<td></td>
</tr>
<tr>
<td><strong>Daycase Proportion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elective</td>
<td>β</td>
<td>4.96E–03***</td>
<td>1.88E–03**</td>
<td>1.89E–03***</td>
<td>5.86E–04</td>
<td>1.39E–03</td>
<td></td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>4.94E–04</td>
<td>4.92E–04</td>
<td>5.10E–04</td>
<td>5.44E–04</td>
<td>5.89E–04</td>
<td></td>
</tr>
<tr>
<td><strong>Number of Spells</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elective</td>
<td>β</td>
<td>1.04E–02</td>
<td>n/a</td>
<td>1.69E–02</td>
<td>1.94E–02</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>9.61E–03</td>
<td>n/a</td>
<td>8.76E–03</td>
<td>8.79E–03</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>Non-elective</td>
<td>β</td>
<td>3.67E–02***</td>
<td>3.06E–02**</td>
<td>5.61E–02***</td>
<td>6.65E–02***</td>
<td>8.78E–02***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>7.73E–03</td>
<td>7.08E–03</td>
<td>7.03E–03</td>
<td>7.17E–03</td>
<td>7.96E–03</td>
<td></td>
</tr>
<tr>
<td><strong>Hospital mortality</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>6.55E–05</td>
<td>6.61E–05</td>
<td>7.06E–05</td>
<td>7.57E–05</td>
<td>8.23E–05</td>
<td></td>
</tr>
<tr>
<td>Non-elective</td>
<td>β</td>
<td>–2.11E–03***</td>
<td>–2.09E–03**</td>
<td>–2.08E–03***</td>
<td>–1.65E–03**</td>
<td>–1.71E–03**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>3.94E–04</td>
<td>3.95E–04</td>
<td>3.73E–04</td>
<td>3.27E–04</td>
<td>2.75E–04</td>
<td></td>
</tr>
<tr>
<td><strong>30-day mortality for CABG</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>β</td>
<td>–2.14E–02***</td>
<td>–2.00E–02**</td>
<td>–1.82E–02**</td>
<td>–2.54E–02**</td>
<td>–1.94E–02**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>3.69E–03</td>
<td>3.69E–03</td>
<td>3.75E–03</td>
<td>4.19E–03</td>
<td>4.29E–03</td>
<td></td>
</tr>
<tr>
<td><strong>Emergency readmission hip</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>β</td>
<td>2.06E–03</td>
<td>4.12E–03</td>
<td>1.13E–02</td>
<td>1.13E–02</td>
<td>–4.13E–03</td>
<td></td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>5.62E–03</td>
<td>5.53E–03</td>
<td>5.83E–03</td>
<td>6.08E–03</td>
<td>6.48E–03</td>
<td></td>
</tr>
</tbody>
</table>

Notes: ** p<0.01, *** p<0.001. ¹ HRG fixed effects, ² HRG plus provider fixed effects, ³ Provider fixed effects, ⁴ Not estimated due to the singular variance-covariance matrix.
Figure 5.3.2c1. Impact of PbR on LOS by IMD quintiles

Figure 5.3.2c2. Impact of PbR on daycase proportion by IMD quintiles

Figure 5.3.2c3. Impact of PbR on number of spells by IMD quintiles
Figure 5.3.2c4 Impact of PbR on hospital mortality by IMD quintiles

Figure 5.3.2c5. Impact of PbR on 30 day mortality for CABG by IMD quintiles

Figure 5.3.2c6 Impact of PbR on emergency readmission for hip fracture by IMD quintiles

Q2d. Does the impact of PbR vary by patient location of residence?

PbR has had a slightly larger impact on the LOS of patients residing in urban locations. This holds for elective and non-elective care. For elective care there are statistically significant differences between urban and rural patients.
Similarly the proportion of patients treated as daycases has increased more in the group of patients residing in urban areas. Again the difference between the two groups is statistically significant.

The increase in the number of elective spells has been higher for patients residing in urban areas. However, the difference is not statistically significant.

Hospital mortality was reduced for both locations of residence. There is no difference between the two groups.

30-day mortality following CABG fell following the introduction of PbR for both urban and rural residents. There is little difference between the two groups.

There is no statistically significant relationship between PbR and emergency readmissions following treatment for hip fracture when estimated by patient residence.

Table 5.3.2d. Impact of PbR by rural/urban location of residence, 2002/03 to 2007/08

<table>
<thead>
<tr>
<th>Variable</th>
<th>Location of residence</th>
<th>Rural</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOS</td>
<td>Elective</td>
<td>β</td>
<td>–2.23E–02***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>7.61E–04</td>
<td>4.33E–04</td>
</tr>
<tr>
<td></td>
<td>Non-elective</td>
<td>β</td>
<td>–1.75E–02***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>1.90E–03</td>
<td>9.28E–04</td>
</tr>
<tr>
<td>Daycase Proportion</td>
<td>Elective</td>
<td>β</td>
<td>–2.44E–04</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>4.83E–04</td>
<td>2.66E–04</td>
</tr>
<tr>
<td>Number of spells</td>
<td>Elective</td>
<td>β</td>
<td>7.75E–03</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>9.48E–03</td>
<td>9.61E–03</td>
</tr>
<tr>
<td></td>
<td>Non-elective</td>
<td>β</td>
<td>6.02E–02***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>7.53E–03</td>
<td>7.72E–03</td>
</tr>
<tr>
<td>Hospital mortality</td>
<td>Elective</td>
<td>β</td>
<td>–3.43E–04***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>6.81E–05</td>
<td>3.61E–05</td>
</tr>
<tr>
<td></td>
<td>Non-elective</td>
<td>β</td>
<td>–2.27E–03***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>3.81E–04</td>
<td>1.67E–04</td>
</tr>
<tr>
<td>30-day mortality for CABG</td>
<td>All</td>
<td>β</td>
<td>–1.98E–02***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>3.72E–03</td>
<td>1.97E–03</td>
</tr>
<tr>
<td>Emergency readmission for hip</td>
<td>All</td>
<td>β</td>
<td>9.23E–03</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>5.30E–03</td>
<td>2.98E–03</td>
</tr>
</tbody>
</table>

Notes: ** p<0.01, *** p<0.001. † HRG fixed effects, ‡ HRG plus provider fixed effects, § Provider fixed effects.
Figure 5.3.2d1. Impact of PbR on LOS by location of residence

Figure 5.3.2d2. Impact of PbR on daycase proportion by location of residence

Figure 5.3.2d3. Impact of PbR on number of spells by location of residence
5.4 Does the impact of PbR vary by organisational characteristics?

Q3a. Does the impact of PbR vary by whether the Trust has low/high costs?
Trusts were identified as low, middle or high cost using the 2004/05 reference cost index. PbR has had more of an impact on the length of stay of elective care for low cost Trusts. For non-elective admissions, the middle and high costs Trusts had a larger reduction in LOS. The differences between the groups are significant.

High cost Trusts have increased the proportion of daycase admissions in response to the tariff. However, Trusts which are categorised as medium cost Trusts have reduced the proportion of patients treated as daycases.

Low and middle RCI Trusts increased the number of elective and non-elective spells following the introduction of PbR. There is no statistically significant difference between the groups.

Elective care hospital mortality has fallen in low, middle and high cost Trusts. The effect has been very small and there is no difference between the categories.

30-day mortality following CABG was reduced by all three Trust types. There is no clear gradient across the types and no statistically significant difference between the groups.

There is no statistically significant relationship between PbR and emergency readmissions following treatment for hip fracture when analysed by RCI trust type.
### Table 5.4.3a. Impact of PbR by low/high cost Trust (RCI), 2002/03 to 2007/08

<table>
<thead>
<tr>
<th>Variable</th>
<th>Low/high cost trust by RCI</th>
<th>Low</th>
<th>Middle</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LOS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elective</td>
<td>β</td>
<td>-3.01E–02***</td>
<td>-2.40E–02***</td>
<td>-2.60E–02***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>5.78E–04</td>
<td>5.37E–04</td>
<td>6.27E–04</td>
</tr>
<tr>
<td>Non-elective</td>
<td>β</td>
<td>-5.53E–03***</td>
<td>-2.75E–02***</td>
<td>-3.59E–02***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>1.16E–03</td>
<td>1.06E–03</td>
<td>1.24E–03</td>
</tr>
<tr>
<td><strong>Daycase Proportion</strong></td>
<td>Elective</td>
<td>β</td>
<td>n/a§</td>
<td>-2.57E–03***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>n/a§</td>
<td>3.48E–04</td>
<td>4.14E–04</td>
</tr>
<tr>
<td><strong>Number of spells</strong></td>
<td>Elective</td>
<td>β</td>
<td>5.09E–02***</td>
<td>3.06E–02***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>1.43E–02</td>
<td>1.31E–02</td>
<td>n/a§</td>
</tr>
<tr>
<td>Non-elective</td>
<td>β</td>
<td>8.25E–02***</td>
<td>1.04E–01***</td>
<td>n/a§</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>1.11E–02</td>
<td>1.01E–02</td>
<td>n/a§</td>
</tr>
<tr>
<td><strong>Hospital mortality</strong></td>
<td>Elective</td>
<td>β</td>
<td>-3.29E–04***</td>
<td>-5.02E–04***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>5.60E–05</td>
<td>5.12E–05</td>
<td>n/a§</td>
</tr>
<tr>
<td>Non-elective</td>
<td>β</td>
<td>n/a§</td>
<td>-2.07E–03</td>
<td>-1.63E–03</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>n/a§</td>
<td>1.96E–04</td>
<td>2.26E–04</td>
</tr>
<tr>
<td><strong>30-day mortality for CABG</strong></td>
<td>All</td>
<td>β</td>
<td>-2.31E–02***</td>
<td>-1.73E–02***</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>4.11E–03</td>
<td>2.56E–03</td>
<td>2.52E–03</td>
</tr>
<tr>
<td>Emergency</td>
<td>All</td>
<td>β</td>
<td>6.25E–03</td>
<td>6.92E–03</td>
</tr>
<tr>
<td></td>
<td>s.e.</td>
<td>4.27E–03</td>
<td>3.92E–03</td>
<td>5.00E–03</td>
</tr>
</tbody>
</table>

**Notes:** ** p<0.01, *** p<0.001. † HRG fixed effects, ‡ HRG plus provider fixed effects, § Provider fixed effects. § Not estimated due to the singular variance-covariance matrix.

---

Figure 5.4.3a. Impact of PbR on LOS by low/high cost Trust (RCI)
Figure 5.4.3a2. Impact of PbR on daycase proportion by middle/high cost Trust (RCI)

Figure 5.4.3a3. Impact of PbR on number of spells by low/high cost Trust (RCI)

Figure 5.4.3a4. Impact of PbR on hospital mortality by low/high cost Trust (RCI)
Q3b. Does the impact of PbR vary by whether the Trust has a low/high Market Forces Factor?

We have used the 2004/05 MFF as an indicator of whether the Trust is operating in an area where they are compensated for low, middle and high local unavoidable costs.

There is a clear gradient of the effect of PbR on the LOS of elective spells across the three groups of Trusts. The higher MFF Trusts have experienced greater reductions in length of stay; a reduction of 4.1 per cent (4.05E-02) compared to a reduction of 2.0 percent (1.96E–02). This pattern is repeated in the non-elective care. For both elective and non-elective care the higher MFF Trusts have had statistically significant larger reductions in LOS.

We see a similar pattern for daycases across the MFF groups as we observed for the grouping by Reference Costs. Trusts facing high unavoidable local costs have increased
the proportion of patients treated as daycases. In contrast, the Trusts with the lowest MFF have reduced the proportion of daycase spells.

PbR is associated with an increase in the number of elective spells for the highest MFF group of Trusts. Due to singular variance-covariance matrices we were unable to produce estimates for the other groups.

As with most of the sub group analysis, hospital mortality has been reduced by very small amounts and there is no difference across the Trust types.

30-day mortality following CABG fell for all three groups of Trusts. The reduction was greatest for the middle group of Trusts and statistically significantly larger than the other two groups.

The relationship between PbR and 30-day emergency readmissions following treatment for hip fracture was not statistically significant.

Table 5.4.3b. Impact of PbR by low/high cost Trust (MFF), 2002/03 to 2007/08

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value of MFF Adjustment</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOS(^1)</td>
<td>Elective</td>
<td>(\beta)</td>
<td>(-1.96E-02^{***})</td>
<td>(-2.44E-02^{***})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s.e.</td>
<td>5.11E-04</td>
<td>5.87E-04</td>
</tr>
<tr>
<td></td>
<td>Non-elective</td>
<td>(\beta)</td>
<td>(-1.17E-02^{***})</td>
<td>(-3.18E-02^{***})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s.e.</td>
<td>1.08E-03</td>
<td>1.13E-03</td>
</tr>
<tr>
<td>Daycase Proportion(^1)</td>
<td>Elective</td>
<td>(\beta)</td>
<td>(-5.13E-03^{***})</td>
<td>(-4.03E-04)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s.e.</td>
<td>3.47E-04</td>
<td>3.75E-04</td>
</tr>
<tr>
<td>Number of spells(^2)</td>
<td>Elective</td>
<td>(\beta)</td>
<td>n/a(^$)</td>
<td>n/a(^$)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s.e.</td>
<td>n/a(^$)</td>
<td>n/a(^$)</td>
</tr>
<tr>
<td></td>
<td>Non-elective</td>
<td>(\beta)</td>
<td>n/a(^$)</td>
<td>n/a(^$)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s.e.</td>
<td>n/a(^$)</td>
<td>n/a(^$)</td>
</tr>
<tr>
<td>Hospital mortality(^2)</td>
<td>Elective</td>
<td>(\beta)</td>
<td>(-4.64E-04^{***})</td>
<td>n/a(^$)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s.e.</td>
<td>4.97E-05</td>
<td>n/a(^$)</td>
</tr>
<tr>
<td></td>
<td>Non-elective</td>
<td>(\beta)</td>
<td>(-2.34E-03)</td>
<td>(-1.62E-03^{***})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s.e.</td>
<td>2.10E-04</td>
<td>2.10E-04</td>
</tr>
<tr>
<td>30-day mortality for CABG(^3)</td>
<td>All</td>
<td>(\beta)</td>
<td>(-1.36E-02^{***})</td>
<td>(-3.11E-02^{***})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s.e.</td>
<td>3.23E-03</td>
<td>3.36E-03</td>
</tr>
<tr>
<td>Emergency readmission for hip(^3)</td>
<td>All</td>
<td>(\beta)</td>
<td>1.05E-03</td>
<td>1.05E-02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s.e.</td>
<td>3.95E-03</td>
<td>4.37E-03</td>
</tr>
</tbody>
</table>

Notes: ** \(p<0.01\), *** \(p<0.001\). \(^1\) HRG fixed effects, \(^2\) HRG plus provider fixed effects, \(^3\) Provider fixed effects. \(^\$\) Not estimated due to the singular variance-covariance matrix.
Figure 5.4.3b1. Impact of PbR on LOS by low/high cost Trust (MFF)

Figure 5.4.3b2. Impact of PbR on daycase proportion by low/high cost Trust (MFF)

Figure 5.4.3b3. Impact of PbR on hospital mortality by low/high cost Trust (MFF)

Figure 5.4.3b4. Impact of PbR on 30-days mortality of CABG by low/high cost Trust (MFF)
Q3c. Does the impact of PbR vary by whether or not the provider is a Foundation Trust?

Length of stay was reduced by both FT and non-FTs following the introduction of PbR, 2.7 per cent (2.92E-02) for FTs and 2.9 per cent (2.7E-02) for non-FTs. The difference is not statistically significant. The larger reduction in LOS for FTs is more pronounced for non-elective care and the difference statistically significant.

Only the FT group experienced increased a statistically significant increase in the number of elective spells associated with PbR. There was no difference in the increases in non-elective activity between the two types of Trusts.

We estimate very small statistically significant reductions in hospital mortality and no difference between the groups.
PbR has a statistically significant relationship with 30-day mortality following CABG for both types of Trust. The impact was larger for the non-FTs but not significantly different.

The estimates of the association with PbR and emergency readmissions following treatment for hip fracture were not statistically significant for either type of Trust.

Table 5.4.3c. Impact of PbR by type of Trust, FT and non-FT, 2002/03 to 2007/08

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type of Trust</th>
<th>FT</th>
<th>Non-FT</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOS¹</td>
<td>Elective</td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s.e.</td>
<td>s.e.</td>
</tr>
<tr>
<td></td>
<td>Non-elective</td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s.e.</td>
<td>s.e.</td>
</tr>
<tr>
<td>Daycase</td>
<td>Elective</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s.e.</td>
<td>s.e.</td>
</tr>
<tr>
<td>Number of</td>
<td>Elective</td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td>spells²</td>
<td></td>
<td>s.e.</td>
<td>s.e.</td>
</tr>
<tr>
<td></td>
<td>Non-elective</td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s.e.</td>
<td>s.e.</td>
</tr>
<tr>
<td>Hospital</td>
<td>Elective</td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td>mortality²</td>
<td></td>
<td>s.e.</td>
<td>s.e.</td>
</tr>
<tr>
<td></td>
<td>Non-elective</td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s.e.</td>
<td>s.e.</td>
</tr>
<tr>
<td>30-day</td>
<td>All</td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td>mortality for</td>
<td></td>
<td>s.e.</td>
<td>s.e.</td>
</tr>
<tr>
<td>CABG³</td>
<td>Elective</td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td></td>
<td>Non-elective</td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td></td>
<td></td>
<td>s.e.</td>
<td>s.e.</td>
</tr>
</tbody>
</table>
| Notes: ** p<0.01, *** p<0.001. ¹HRG fixed effects, ²HRG plus provider fixed effects, ³Provider fixed effects, § Not estimated due to the singular variance-covariance matrix.

Figure 5.4.3c1. Impact of PbR on LOS by type of Trust, FT and non-FT
Figure 5.4.3c2. Impact of PbR on number of spells by type of Trust, FT and non-FT

Figure 5.4.3c3. Impact of PbR on hospital mortality by type of Trust, FT and non-FT

Figure 5.4.3c4. Impact of PbR on 30 Days Mortality of CABG by type of Trust, FT and non-FT
Figure 5.4.3c5. Impact of PbR on emergency readmission for hip fracture by type of Trust, FT and non-FT

Q3d. Does the impact of PbR vary by whether the Trust is a gainer or loser under PbR?

PbR has had a greater impact on the elective and non-elective LOS of Trusts which have been consistently financial ‘losers’ under the PbR system. The differences are statistically significant.

Consistent gainers increased the proportion of daycases in response to the PbR while consistent losers experienced a reduction.

Both groups of Trusts increased the volume of elective and non-elective admissions following the introduction of PbR.

Both types of Trust had a reduction in non-elective hospital mortality. The reduction in 30-day mortality following CABG was only statistically significant for the consistent losers under PbR. Neither group had a statistically significant change in emergency readmissions following treatment for hip fracture.
Table 5.4.3d. Impact of PbR by type of Trust, gainer/loser under PbR, 2002/03 to 2007/08

<table>
<thead>
<tr>
<th>Variable</th>
<th>Gainers / Losers under PbR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Consistent loser</td>
</tr>
<tr>
<td><strong>Elective</strong></td>
<td></td>
</tr>
<tr>
<td>LOS¹</td>
<td>β</td>
</tr>
<tr>
<td>Consistent Loser (47 trusts)</td>
<td>Consistent Gainer (26 trusts)</td>
</tr>
<tr>
<td>Elective</td>
<td>$-1.07E-02^{***}$</td>
</tr>
<tr>
<td>Non-elective</td>
<td>$-2.73E-02^{***}$</td>
</tr>
<tr>
<td>Daycase Proportion¹</td>
<td>Elective</td>
</tr>
<tr>
<td>Elective</td>
<td>$-4.52E-03^{***}$</td>
</tr>
<tr>
<td>Non-elective</td>
<td>$-3.71E-02^{***}$</td>
</tr>
<tr>
<td>Number of spells²</td>
<td>Elective</td>
</tr>
<tr>
<td>Elective</td>
<td>$2.11E-02$</td>
</tr>
<tr>
<td>Non-elective</td>
<td>$1.05E-01^{***}$</td>
</tr>
<tr>
<td>Hospital mortality²</td>
<td>Elective</td>
</tr>
<tr>
<td>Elective</td>
<td>n/a$^$</td>
</tr>
<tr>
<td>Non-elective</td>
<td>$-1.04E-03^{***}$</td>
</tr>
<tr>
<td>30-day mortality for CABG³</td>
<td>All</td>
</tr>
<tr>
<td>Elective</td>
<td>$-2.21E-02^{***}$</td>
</tr>
<tr>
<td>Non-elective</td>
<td>$-2.03E-03^{***}$</td>
</tr>
<tr>
<td>Emergency readmission hip³</td>
<td>All</td>
</tr>
<tr>
<td>Elective</td>
<td>$3.50E-03$</td>
</tr>
<tr>
<td>Non-elective</td>
<td>$6.69E-03$</td>
</tr>
</tbody>
</table>

**Notes:** ** $p<0.01$, *** $p<0.001$. ¹ HRG fixed effects, ² HRG plus provider fixed effects, ³ Provider fixed effects, $^\$ Not estimated due to the singular variance-covariance matrix.

Figure 5.4.3d1. Impact of PbR on LOS by type of Trust
Figure 5.4.3d2. Impact of PbR on daycase proportion by type of Trust

Figure 5.4.3d3. Impact of PbR on number of spells by type of Trust

Figure 5.4.3d4. Impact of PbR on hospital mortality by type of Trust
5.5 \textbf{Does the impact of PbR vary by HRG characteristics?}

\textit{Q4a. Does the impact of PbR vary with the price of the tariff?}

Using 2004/05 elective care prices, treatments were grouped into high, middle and low cost tariff HRGs.

Higher priced HRGs have experienced greater reductions in length of stay than medium priced HRGs for elective care. For non-elective care the medium priced HRGs had greater reductions than the other two groups.

For the proportion of daycase admissions there is no clear gradient across the tariff level. The middle tariff group of HRGs experienced an increase in the proportion of daycase spells compared to reductions in the other two groups. The differences are statistically significant.
PbR is associated with an increase in the number of elective spells in the medium and high tariff HRGs. The increases are statistically significant.

Hospital mortality increased for the low and medium priced HRGs. Reductions in non-elective hospital mortality were statistically significantly higher for the high price tariff HRGs.

Due to the lack of variation in CABG and hip treatment, sub group analysis by HRG tariff model was not estimated for these two outcome variables.

Table 5.5.4a Impact of PbR by tariff level, 2002/03 to 2007/08

<table>
<thead>
<tr>
<th>Variable</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Price of HRG Tariff</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>LOS(^1)  Elective</td>
<td>(\beta) 1.45E–02***</td>
<td>–4.66E–02***</td>
<td>–6.76E–02***</td>
</tr>
<tr>
<td></td>
<td>s.e. 3.78E–04</td>
<td>1.08E–03</td>
<td>1.52E–03</td>
</tr>
<tr>
<td>Non-elective</td>
<td>(\beta) –1.95E–02***</td>
<td>–5.64E–02***</td>
<td>–1.34E–02***</td>
</tr>
<tr>
<td></td>
<td>s.e. 8.00E–04</td>
<td>1.47E–03</td>
<td>1.89E–03</td>
</tr>
<tr>
<td>Daycase(^2) Elective</td>
<td>(\beta) –5.92E–03***</td>
<td>1.93E–03*</td>
<td>–7.09E–03***</td>
</tr>
<tr>
<td></td>
<td>s.e. 3.08E–04</td>
<td>7.55E–04</td>
<td>5.90E–04</td>
</tr>
<tr>
<td>Number of spells(^2)</td>
<td>Elective  (\beta) –3.15E–03</td>
<td>4.76E–02***</td>
<td>5.28E–02***</td>
</tr>
<tr>
<td></td>
<td>s.e. 1.57E–02</td>
<td>1.39E–02</td>
<td>1.54E–02</td>
</tr>
<tr>
<td>Non-elective</td>
<td>(\beta) 1.82E–02</td>
<td>1.10E–01***</td>
<td>7.70E–02***</td>
</tr>
<tr>
<td></td>
<td>s.e. 1.05E–02</td>
<td>1.10E–02</td>
<td>1.15E–02</td>
</tr>
<tr>
<td>Hospital mortality(^2)</td>
<td>Elective  (\beta) n/a§</td>
<td>n/a§</td>
<td>n/a§</td>
</tr>
<tr>
<td></td>
<td>s.e. n/a§</td>
<td>n/a§</td>
<td>n/a§</td>
</tr>
<tr>
<td>Non-elective</td>
<td>(\beta) 4.23E–04***</td>
<td>–2.96E–03***</td>
<td>–1.40E–02***</td>
</tr>
<tr>
<td></td>
<td>s.e. 1.21E–04</td>
<td>3.06E–04</td>
<td>5.22E–04</td>
</tr>
<tr>
<td>30-day mortality for CABG(^3)</td>
<td>All  (\beta) n/a§</td>
<td>n/a§</td>
<td>n/a§</td>
</tr>
<tr>
<td></td>
<td>s.e. n/a§</td>
<td>n/a§</td>
<td>n/a§</td>
</tr>
<tr>
<td>30-day mortality for hip(^3)</td>
<td>All  (\beta) n/a§</td>
<td>n/a§</td>
<td>n/a§</td>
</tr>
<tr>
<td></td>
<td>s.e. n/a§</td>
<td>n/a§</td>
<td>n/a§</td>
</tr>
</tbody>
</table>

Notes: ** \(p<0.01\), *** \(p<0.001\). \(^1\) HRG fixed effects, \(^2\) HRG plus provider fixed effects, \(^3\) Provider fixed effects, § Not estimated due to the singular variance-covariance matrix.
Figure 5.5.4a1. Impact of PbR on LOS by tariff level

Figure 5.5.4a2. Impact of PbR on daycase proportion by tariff level

Figure 5.5.4a3. Impact of PbR on number of spells by tariff level
Q4b. Does the impact of PbR vary by whether the HRG is short or long length of stay before PbR was introduced?

HRGs with a long average LOS in 2002/03 have had a greater reduction in LOS associated with PbR than the HRGs with middle average LOS; a reduction of 6.6 per cent (-6.58E-02) compared with 1.0 per cent (-1.01E-02). This is observed for both elective and non-elective spells. The differences between the LOS groups are statistically significant.

HRGs with the shortest and longest lengths of stay experienced similar sized increases in the number of spells in response to the introduction of PbR. For non-elective care the middle and high length of stay groups experienced increases in the number of spells. None of the differences between the subgroups are statistically significant.

All three groups of HRGs experienced statistically significant but small reductions in hospital mortality. There were no differences between the groups.
Table 5.5.4b. Impact of PbR by HRG average LOS prior to PbR, 2002/03 to 2007/08

<table>
<thead>
<tr>
<th>Variable</th>
<th>Elective</th>
<th>Non-elective</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOS¹</td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td></td>
<td>2.33E–03***</td>
<td>1.67E–03***</td>
</tr>
<tr>
<td></td>
<td>–1.01E–02***</td>
<td>–2.02E–02***</td>
</tr>
<tr>
<td></td>
<td>–6.58E–02***</td>
<td>–6.74E–02***</td>
</tr>
<tr>
<td></td>
<td>4.92E–04</td>
<td>5.08E–04</td>
</tr>
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<td>5.08E–04</td>
<td>6.82E–04</td>
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<td></td>
<td>1.02E–03</td>
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<td>1.02E–03</td>
<td>1.23E–03</td>
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<td>Daycase</td>
<td>Elective</td>
<td>Non-elective</td>
</tr>
<tr>
<td>Proportion¹</td>
<td>β</td>
<td>β</td>
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<tr>
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<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Number of</td>
<td>Elective</td>
<td>Non-elective</td>
</tr>
<tr>
<td>spells²</td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td></td>
<td>5.57E–02***</td>
<td>1.67E–03***</td>
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<td>n/a$</td>
<td>1.15E–01***</td>
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<td></td>
<td>9.74E–03</td>
<td>1.24E–02</td>
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<td>Hospital</td>
<td>Elective</td>
<td>Non-elective</td>
</tr>
<tr>
<td>mortality²</td>
<td>β</td>
<td>β</td>
</tr>
<tr>
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<td>–3.12E–04</td>
<td>–1.79E–03</td>
</tr>
<tr>
<td></td>
<td>–2.99E–04***</td>
<td>–2.08E–03***</td>
</tr>
<tr>
<td></td>
<td>–4.73E–04***</td>
<td>–2.14E–03***</td>
</tr>
<tr>
<td></td>
<td>5.20E–05</td>
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<td>2.13E–04</td>
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<tr>
<td>30-day</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>mortality for</td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td>CABG³</td>
<td>n/a$</td>
<td>n/a$</td>
</tr>
<tr>
<td></td>
<td>n/a$</td>
<td>n/a$</td>
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<tr>
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<tr>
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<td>n/a$</td>
<td>n/a$</td>
</tr>
</tbody>
</table>
| Notes: ** p<0.01, *** p<0.001. ¹ HRG fixed effects, ² HRG plus provider fixed effects, ³ Provider fixed effects. $ Not estimated due to the singular variance-covariance matrix.

Figure 5.5.4b1. Impact of PbR on LOS by HRG ALOS prior to PbR
Figure 5.5.4b3. Impact of PbR on number of spells by HRG ALOS prior to PbR

Figure 5.5.4b4. Impact of PbR on hospital mortality by HRG ALOS prior to PbR

Q4c. Does the impact of PbR vary with the degree of variation of length of stay?

Length of stay fell for HRGs with high, medium and low variations in LOS. PbR had a greater impact on LOS in those HRGs with least variation in LOS for elective spells. For non-elective spells PbR had the greatest impact on the middle and high variation HRGs. The differences between the subgroups are statistically significant.

The proportion of admissions treated as daycases has increased significantly in the HRG groups with the least and most variation in LOS. The growth in the proportion of daycases is statistically significantly higher for the HRGs with the least variation in LOS.

All three groups of HRGs have experienced increases in the number of spells following the introduction of PbR although the effect is only significant for the high and low groups for elective care. For non-elective care the increases are significant across all three groups and not significantly different from one another.
There is some variation in the impact of PbR on hospital mortality. The impacts are

<table>
<thead>
<tr>
<th>Variable</th>
<th>HRG degree of variation in LOS</th>
<th>Low</th>
<th>Middle</th>
<th>High</th>
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<tr>
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<td></td>
<td>Non-elective</td>
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<td>8.74E-02***</td>
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<td>Hospital mortality</td>
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<td>7.74E-04***</td>
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Notes: ** p<0.01, *** p<0.001. ¹ HRG fixed effects, ² HRG plus provider fixed effects, ³ Provider fixed effects, § Not estimated due to the singular variance-covariance matrix.

Figure 5.5.4c1. Impact of PbR on LOS by HRG degree of variation in LOS
6. Summary and interpretation of results

6.1 The overall impact of PbR

Our estimates suggest that the introduction of PbR has been associated with reductions in length of stay and increases in the proportion of spells treated as daycase admission in a way that is consistent with hospitals using fewer resources to treat a given cohort of patients. This is an impact that is consistent with a large tranche of theoretical research concerning the incentives of fixed price prospective payment systems for hospitals.

Length of stay is being used as a proxy for the resource inputs required for a spell of care and the reduction of 2.5% from 2002/3 to 2007/8 is equivalent to a 0.043 days saved per spell. This equates to around 271,000 fewer elective bed days in 2007/08 than there would have been without the tariff or a bed day saved for around every 23 spells of care provided.
There are differences in the effects on length of stay for elective and non-elective spells of care. However, the effects we observe are always in the same direction. Although we do not have a theoretical basis to understand these differences, they are worth noting. The reduction in length of stay for non-elective spells was smaller than elective. This difference may reflect the uncertainty in the demand for non-elective care and the complexities of increasing the efficiency of care which follow from this characteristic.

A key concern is how resource savings indicated by reductions in length of stay and increases in the proportion of day cases have been achieved: through greater efficiency or via reductions in the quality of care. We do not have plausible measures of efficiency and we only have broad proxies for the quality of care. Nevertheless our investigations of those proxies suggest that PbR has not had an adverse impact on the quality of care. We find evidence of small but significant reductions in hospital mortality attributable to PbR, of reductions in 30-day post CABG mortality and of no change in emergency readmissions following treatment for hip fracture.

Our third area of investigation addresses the issue of whether PbR incentivised greater activity. We have found evidence consistent with the view that activity increased as a result of PbR.

We also observe a larger increase in the number of non-elective admissions associated with the introduction of PbR. This difference persists after controlling for the introduction of the A&E four hour wait target, which is considered to have increased emergency admissions, and including year dummies, which controls for other policy effects. In addition our estimates indicate a greater reduction in hospital mortality for non-elective care. This difference and that in the number of admissions may reflect changes in the threshold for emergency admissions noted elsewhere (Blunt, 2010).

As outlined in Section 3.1, we consider the results on volume to carry the least weight of our empirical analysis for two reasons. First, there is no theoretical basis for assuming that the introduction of PbR will lead to an increase in activity and second th volume analysis has been undertaken at the level of the hospital and changes may reflect additional market level constraints and incentives not included in the models. As such we present these results with some caution.
The aim of this research has been to investigate whether there is evidence to support for the view that PbR has met its objectives. Our findings provide such evidence and with some minor exceptions they hold across most groups of patients, providers and HRGs. There is a wider question when evaluating policy which we do not address here and that is whether the policy has been worthwhile.

6.2 Patient characteristics

We have examined the impact of PbR on the key indicators across patient characteristics in order to determine whether there is evidence of an uneven or inequitable impact on groups of patients. A concern is that overall reductions in length of stay might mask a strong distributional shift -- some patients being favoured by more resources and other being disadvantaged through a withdrawal of resources, perhaps accompanied by significant reductions in quality of care. Overall we do not find any strong evidence of a marked distributional impact of PbR.

6.2.1 The impact by age group

Variation in the impact of PbR across different age groups might imply that the policy favoured some groups at the expense of others. For example, health care resources might be skewed in favour of younger (older) patients at the expense of older (younger) ones.

The analysis by age group provides evidence that reductions in length of stay and increases in daycase treatment are experienced by all age groups but in a different manner. The older age groups have had larger reductions in length of stay and the younger age groups have had larger increases in the probability of being treated as daycase. There is no evidence that these changes have adversely affected the quality of care of any of the three age groups. Finally, all age groups have experienced increases in the number of spells and these have been evenly spread.

6.2.2 Impact by patient gender

Analysing the impact of PbR by gender reveals that although reductions in length of stay are evenly spread, increases in the probability of treatment as daycase were larger for females. Neither gender experienced an adverse impact on the quality of care. The number of spells increased with no difference between males and females.
6.2.3 Impact of PbR by socio-economic status

All groups of patients categorised by quintile of multiple deprivation experienced reductions in length of stay as a result of PbR. These reductions are generally higher in the third and fourth quintile, although differences between the groups are generally not statistically significant. The lowest quintile had a larger increase in the proportion of daycase admissions. We do not observe that the lower or upper quintile has disproportionately benefited from the impact of PbR. This is confirmed when we examine the evidence on the change in quality across the quintiles of deprivation: there is no difference across the groups. Increases in activity are also distributed across the groups.

6.2.4 Impact of PbR by location of patient residence

Patients resident in urban and rural locations experienced similar reductions in length of stay as a result of PbR. However, urban residents were more likely to have a higher probability of daycase care as a result of PbR. Neither group of patients experienced reductions in the three quality measures.

Differences between the two groups were apparent when we examined the change in activity levels: increases in the number of spells were concentrated in the urban residents.

6.3 Organisational characteristics

We are interested in whether the effects of PbR are experienced across all hospitals. We have analysed by key characteristics which help us distinguish between different types of hospital. We have included characteristics which might act as an indicator of whether the hospital was previously a strong performer, e.g. Trusts with a low reference cost index and a short length of stay prior to PbR.

6.3.1 Impact of PbR by high/low cost hospitals

Reductions in length of stay are observed across all three types of Trusts. The low cost Trusts on average have reduced length of stay more than the higher cost Trusts.
There is no difference in the changes in the quality of care across the groups. Low, medium and high reference cost Trusts have had no adverse changes in their quality of care outcome variables.

Only the low and medium cost hospitals exhibit increases in the number of spells.

6.3.2 Impact of PbR by high/low MFFs

The differences in MFFs reflect differences in local labour market conditions and building costs.

Reductions in length of stay and increased use of treatment as daycase have been largest in the Trusts with high MFFs.

PbR did not have an adverse impact on the quality of care of any of the groups.

We cannot identify differences in activities across the three groups except that for the high MFF group for which the volume of activities has increased.

6.3.3 Impact of PbR by whether or not the Trust has Foundation status

We might expect Foundation Trusts to respond differently to the incentives created by PbR. They have greater financial freedoms and there may be other unobservable reasons for differences.

Reductions in length of stay were greatest for Foundation Trusts. However, we do not have valid results for changes in the proportion of daycases.

Neither type of hospital Trust experienced adverse effects on the quality of the care they provided.

Only the Foundation Trusts exhibit significant increase in the number of spells associated with PbR for elective care. For non-elective care both groups have exhibited increase in activity.
6.3.4 Impact of PbR by whether the Trust is a consistent gainer or loser under PbR.

Trusts which have been consistent losers under PbR have had larger reductions in length of stay associated with the policy. Both groups of Trusts have a small increase in the proportion of daycases.

The evidence on quality of care is restricted to two of the variables. These suggest that there has been no adverse affects on quality for either group.

Trusts which are consistent losers under PbR have increased activity. The increase by the gainers is not statistically significant. For non-elective care both groups have exhibited increase in activity.

6.4 Impact of PbR by HRG characteristics

We would not expect the impact of PbR to be even across all types of HRGs. We cannot measure characteristics such as complexity, directly, so we have used a number of proxies.

6.4.1 Impact of PbR by level of the tariff

The level of the tariff is used as an indicator of the cost or complexity of the HRG.

Reductions in length of stay were largest in the middle and high priced HRGs.

We observed no adverse affect on the quality of care across HRGs

Increases in activity were confined to those groups of HRGs for which lengths of stay reduced most: the middle and high tariff HRGs.

6.4.2 Impact of PbR on short/long LOS HRGs

For this analysis the average length of stay of HRG is used as an indicator of the cost or complexity of the HRG.

Reductions in length of stay were experienced in the middle and high length of stay HRGs. These effects were greatest in the high length of stay group of HRGs.
There was no adverse effect on the quality of care for any of the three groups of HRG.

The growth in the number of spells is found to be the same for the high and low groups.

6.4.3 Impact of PbR by degree of variation in LOS

The degree of variation in length of stay within an HRG is used as indicator of the predictability and/or the manageability of the cases.

Reductions in length of stay and increases in the proportion of daycases were largest for those HRGs with the least variability.

There is no variation in the effect on quality across the groups.

Despite resource savings across all three types of HRG, activity has increased only in the HRGs with the lowest and highest variation in resource use.

7. Conclusion

Translating the objectives of PbR into a form that is amenable to theoretical and empirical investigation, we have suggested they can be written as;

- To deliver health care making better use of the available real resources / inputs and thus
- To increase the quality and volume of treatments delivered within the available resources.

Taking ‘better use’ to mean delivering equivalent treatments using less inputs then it is natural to focus on measures of resource use such as length of stay and the proportion of daycases. Both of these measures would seem, ceteris paribus, to provide an indication of more efficient use of inputs in the delivery of a treatment. We have found strong evidence of reductions in length of stay and increases in the proportion of daycases as a consequence of PbR. With some minor exceptions which are detailed above these effects are spread across most groups of patients, providers and HRGs. The magnitude of the
coefficient in the length of stay equations suggests real savings (in resources / inputs) of between 1% and 3%.

Measures of quality of health care are generally crude. It is thus not possible to confidently assert whether there have been quality changes as a result of PbR. We have examined three widely used proxies of quality and have not found any evidence of deterioration in these that can be attributed to PbR; there is some limited evidence that small improvements in some of the indicators may be attributable to PbR and again with some minor exceptions these findings hold across most groups of patients, providers and HRGs.

We find that there are increases of between 3% and 9% in the numbers of spells, coincident with and persisting following the introduction of PbR. We are less confident that these can be viewed as being caused by PbR because our underlying theoretical framework is less developed and the data less detailed. Nevertheless, there is support for the view that PbR has met its objectives and again with some minor exceptions these findings hold across most groups of patients, providers and HRGs.
8. References


*Department of Health. Payment by Results guidance 2007-08. December 2006*

