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Choice of Contracts for Quality in Health Care: Evidence from the British NHS

CHE Research Paper 85

Choice of contracts for quality in health care: Evidence from the British NHS

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Abstract

We examine how public sector third-party purchasers and hospitals negotiate quality targets when a fixed proportion of hospital revenue is required to be linked to quality. We develop a bargaining model linking the number of quality targets to purchaser and hospital characteristics. Using data extracted from 153 contracts for acute hospital services in England in 2010/11, we find that the number of quality targets is determined by the purchaser's population health and its budget, the hospital type, whether the purchaser delegated negotiation to an agency, and the quality targets imposed by the supervising regional health authority.

Keywords: Contracts; quality; financial incentives; pay for performance; hospitals; Nash bargaining.

JEL classification: I11, I18, L51, C35.

1 Introduction

Pay for performance (P4P) schemes to improve quality have been introduced in many healthcare systems (Emmert et al (2012), Houle et al (2012), Ryan and Blustein (2012), Scott et al (2011), Werner et al (2013)). There is considerable variation in the design of these schemes including the number of quality measures used, their type (structure, process or outcome), the magnitude of the financial rewards, and the way they are linked to quality measures.

In the English National Health Service (NHS) the Commissioning for Quality and Innovation (CQUIN) payment framework requires all local NHS purchasers to link payments to hospitals to measures of quality. Purchasers were given considerable autonomy under the CQUIN framework in choosing which aspects of quality to incentivise, which quality indicators to use, and how they were to be linked to payment. In this paper we examine how the complexity of local CQUIN P4P schemes - measured by the number of different quality targets - varies with the characteristics of hospitals and purchasers, including their size, the type of hospital, their financial positions, and the health of purchaser populations. The Department of Health has increasingly given lower level local decision makers greater contractual discretion, recognising that local decision makers have better information about local conditions. Given the limited data we do not attempt to judge whether local contracts are welfare maximising given local conditions. Instead we investigate how local decision makers have used their discretion in designing quality incentive contracts. If variations in quality contracts are associated with variations in local conditions which might be expected to affect the welfare benefits and costs of more or less complex contracts then this would provide some evidence on the use of local flexibility.

Only two papers have empirically analysed contract choice in healthcare. Csaba and Fenn (1997) and Chalkley and McVicar (2008) examine how characteristics of local purchasers and hospitals influence contracts in the English NHS in the 1990s. They consider how the contracts related payment to the volume of activity. In this paper, by contrast, we focus on the design of incentive contracts for quality. We develop a Nash contract bargaining model and use it to motivate the empirical analysis. We then test the empirical implications of the model, using a data set of 153 contracts for acute hospitals in England (about 91% of hospitals) from the second year (2010/11) of the CQUIN scheme, to determine whether and how the choice of the number of quality targets is related to hospital and purchaser characteristics. We find that the number of locally negotiated quality targets varies with whether the contract was negotiated by an agency, the purchaser's population's health,

the generosity of its budget relative to need, the type of hospital, and the quality targets imposed by the purchaser's supervising regional authority.

In the next section we explain the contractual arrangements in the NHS and the characteristics of the CQUIN scheme. Section 3 briefly describes the previous literature on contract choice. Our model of bargaining between purchaser and hospital is set out in section 4. Section 5 describes our data sets and methods. and results are reported in section 6. Section 7 concludes.

2 Contractual arrangements in the NHS

2.1 The contracting parties

Since 1991 the National Health Service in England has been organised as an internal market in which local purchasers negotiate contracts with hospitals. Until 1997, purchasers and hospitals had considerable freedom to determine the form of the contract. The main structural difference between the resulting contracts was whether or not payments varied with volume of treatment (Chalkley and McVicar, 2008). From 2003/04, activity-based financing (called Payment by Results) was introduced nationally and hospitals were reimbursed on a casemix-adjusted tariff determined by the Department of Health and based on the average costs of procedures across all hospitals (Street and Maynard, 2007).

At the same time further market-oriented reforms were introduced (Department of Health, 2002): patients were given the right to a wider choice of hospitals for elective care and the purchasing of healthcare services becoming the responsibility of local purchasers called Primary Care Trusts (PCTs). Secondary and specialist care hospitals were encouraged to compete to attract individual patients for elective treatment. The introduction of Foundation Trust (FT) status was also intended to further stimulate competitive quality improvement amongst hospitals. Upon meeting certain clinical quality and financial standards, hospital trusts could apply to become FTs. As FTs, hospitals become independent, not-for-profit organisations; they could reinvest their profits in services and could access private capital. Hospitals were overseen by two regulators: Monitor for FTs and the Care Quality Commission which inspected the quality of all hospitals.

Purchasing of NHS healthcare is organised geographically. In 2010/11 there were 151 PCTs, responsible for planning, purchasing and securing health services for their local population. They received a budget based on a weighted capitation formula which reflected the demographic structure and need characteristics of their populations (Morris, et al, 2007) and variations

in input prices (Elliott et al., 2009). PCTs were managed by ten higher-level, regional Strategic Health Authorities (SHAs) which were the link between the central Department of Health (DH) and the NHS. SHAs were responsible for implementing national policy, monitoring the performance of the local purchasers and the hospitals that had not achieved FT status, and managing the healthcare market.

2.2 NHS Standard Contract and the CQUIN scheme

The annual process of contracting is the focal point of the split between PCTs and hospitals. An NHS Standard Contract for acute services was introduced in 2007 to be used for all hospitals providing services to the NHS. The contracts are legally binding (Petsoulas et al., 2011).

Although there was no evidence that quality was adversely affected by the introduction of activity based payments to hospitals from 2003/4 (Farrar et al., 2009), the Department of Health became concerned that hospitals might reduce quality to keep costs below the tariff (Department of Health, 2009). In 2009 the DH therefore introduced the Commissioning for Quality and Innovation (CQUIN) framework under which purchasers and hospitals had to link a proportion of hospital revenue to quality (Department of Health, 2009). In the first year, 2009/10 the CQUIN scheme was mandatory for contracts for acute hospital services and optional for contracts for community, mental health and ambulance services. In 2009/10, 0.5% of revenue was linked to quality and many of the CQUIN contracts were concerned with improving data collection.

From 2010/11, all NHS contracts had to include a CQUIN scheme and the proportion of the contract value linked to quality improvement increased to 1.5%. At least 0.3% had to be linked to two nationally mandated quality indicators,[1] and up to 1.2% to other quality indicators. SHAs could require their PCTs to include specific quality indicators in their contracts with hospitals, so that PCTs could differ in the extent to which their negotiations with hospitals over the quality content of the contract were constrained. In 2010/11 PCTs were instructed not to pay for data collection and were advised that outcome measures were preferable, though process indicators could be used if there was a direct link to better outcomes. Within these constraints, the local elements of the CQUIN scheme were completely flexible and determined by negotiations with hospitals. The CQUIN quality targets were specified as topics (e.g. disease areas such as stroke) and as specific indica-

[1] The national targets were for risk assessment of admitted patients for venous thromboembolism and for patient satisfaction.

tors within topics (e.g. proportion of stroke patients treated on a dedicated stroke unit).

Although hospitals typically serve patients from several PCTs, each hospital negotiated with a single purchaser. Usually this was a single PCT which was designated by the SHA as the negotiating PCT on behalf of the NHS. Although the content of the CQUIN scheme was negotiated between the hospital and the lead PCT, achievement of the quality indicators was measured on the activity undertaken by the hospital for all PCTs which purchased care from it. In some cases responsibility for negotiating hospital contracts was passed to an NHS agency which acted on behalf of a cluster of local PCTs.

Guidance on the NHS Standard Contract set out the expectation that the PCT and the hospital would co-operate to reach agreement on the CQUIN scheme with disputes resolved by the SHA. The lead PCT and hospital had to negotiate a number of aspects of their CQUIN scheme: i) the local topics (disease areas) to be covered; ii) the indicators to be used to measure performance on these local topics; iii) the target levels of quality for the nationally mandated patient experience[2], and for regional and local indicators; and iv) the proportion of hospital revenue contract to be attached to achievement of each local indicator. In this paper we focus on the negotiation of the most salient local aspects of the CQUIN scheme contracts: the number and type of locally negotiated quality targets.

3 Related literature

Contractual choice has been the focus of a large theoretical and empirical literature for other sectors, particularly agriculture, procurement and the oil industry (see, for example, Shaban (1987); Corts and Singh (2004); Shepard (1993); Joskow (1987); Williamson (1983)). Although there is an extensive normative theoretical literature on the design of contracts in healthcare (Chalkley and Malcomson, 2000), there have been only two empirical papers which analyse the factors determining the content of healthcare contracts. Both exploit the local flexibility in contract setting in the first round of NHS internal market reforms in 1990-1997.

Csaba and Fenn (1997) analyse the share of total contracted hospital income accounted for by block or cost and volume contracts in which payment did not vary with the volume of services provided, compared with the share

[2]The target level of quality for the venous thromboembolism national goal was set nationally.

accounted for by cost per case contracts. They argue, drawing on a theoretical model (Fenn et al, 1994), that with uncertain demand and fixed hospital capacity, purchasers would prefer to earmark more of local hospital capacity for their patients the more likely the hospital was to find itself facing excess demand from patients. They use data on 71 major district acute hospitals, representing about a third of acute hospitals in England in the financial year 1992/93.[3] They find that the share of hospital revenue accounted for by contracts with volume dependent payment is increased when the hospital has more spare capacity (empty bed days) and reduced when the local population is more deprived (which they argue implies a greater opportunity cost to unmet local demand) and the hospital has a bigger share of its revenue from private patients, which they interpret as a proxy for quality.

Chalkley and McVicar (2008) consider how hospital and purchaser characteristics were related to the choice between block contracts with a lump sum payment from purchaser to hospital, sophisticated block contracts with a combination of lump sum and extra-payment if costs fall outside a stated range, and volume dependent contracts.[4]. They outline a model of contract choice by the purchaser which allows for the provider's decisions on cost reducing effort, volume, and quality to be affected by the contract. They use data on 236 contracts from 52 purchasers in 1991/92 and 464 contracts from 106 purchasers in 1993/94. Consistent with the predictions of their theoretical model, they find that contracts for acute services for which there was a significant variation in demand, small variation in costs, and low monitoring costs were more likely to entail sophisticated block or volume-dependent contracts. Hospitals that were more distant from the purchaser were more likely to have block contracts, probably because of higher monitoring costs. There was no significant effect of the hospital's acquisition of NHS Trust status on the choice of the contract.

[3] Amongst hospitals' characteristics they consider the mean number of empty bed days between consultant episodes, the number of people in the hospital's district waiting more than one year as a proportion of those treated, unit costs and the percentage of total revenue generated from private patient care. Purchasers' characteristics are the per capita budget and the Jarman underprivileged area score.

[4] Hospital characteristics included service type (acute/non acute, mental health or community health, and multiple services), NHS Trust status and whether the hospital is outside the Health Authority boundary. The only purchaser characteristic is whether the purchaser is a GP. Market structure proxies are the number of hospitals of similar services within 10 miles and number of GP fundholders per 100,000 population.

4 Bargaining model

We set out a simple bargaining model which captures some of the strategic considerations behind the determination of the number of local hospital quality targets negotiated between PCTs and hospitals under the CQUIN scheme.[5] The model yields some clear predictions about the effect of certain factors and is also useful because it explains why apparently intuitively obvious propositions about the effects of certain PCT or hospital characteristics may not be valid.

4.1 The model

The PCT receives a budget from the Department of Health which is derived from a formula which includes measures of the health needs of the PCT's population. From this budget the PCT must purchase both acute hospital care and mental health, community, and primary care. Under the CQUIN scheme a fixed percentage of the hospital's revenue must be linked to the achievement of local and regional quality targets. We focus on the PCT and the hospital bargain over the number of local quality targets n. We take n to be continuous and assume that quality targets are always met.[6]

The objective function of the PCT is

$$V(n; n^S, x^{HP}, \alpha_P, y, h) = \alpha_P B^{HP}(n; n^S, x^{HP}, y, h) - m(n; n^S) \qquad (1)$$

B^{HP} is the welfare of patients of the PCT treated at the hospital and m is the effort cost of monitoring the targets. α_P is a weight measuring the altruism of the PCT negotiators relative to their effort costs. Patient welfare is increasing in n and more targets increase monitoring costs. We assume that V is concave in n. n^S is the number of targets imposed by the Strategic Health Authority. x^{HP} is the volume of treatment provided by the hospital to the PCT's patients. Patient welfare is increasing in the number of patient

[5] Barros and Martinez-Giralt (2011) review the healthcare bargaining literature. Barros and Martinez-Giralt (2008) consider the purchaser's choice of the negotiation mechanism between simultaneous (Nash) bargaining with two different hospitals and Any Willing Provider (AWP), where the purchaser offers a contract which hospitals can only accept or reject. The authors show that AWP is preferred by the payer when the surplus to be shared is sufficiently high. Siciliani and Stanciole (2008) consider the choice between bargaining over the price, over the level of activity, or simultaneous negotiations over price and activity level. They show that a purchaser will prefer to negotiate on both price and activity only when she has sufficiently high bargaining power.

[6] More generally, but equivalently for model specification purposes, we can assume that the choice of the number of targets has a predictable monotonic increasing effect on quality and consequently on patient benefit.

treated and the marginal gain from targets is larger with more patients: $B^{HP}_{nx^{HP}} > 0$.

h is an index of the underlying pre-treatment health of the PCT's population and $B^{HP}_{h} > 0$, but healthier patients gain less from more quality targets ($B^{HP}_{nh} < 0$). A greater PCT budget relative to the health need of the population y increases the welfare of hospital patients ($B^{HP}_{y} > 0$) and reduces the marginal welfare gains from more hospital targets ($B^{HP}_{ny} < 0$).

SHA and PCT quality targets are partial substitutes. More SHA targets increase the welfare from treatment ($B^{HP}_{n^s} > 0$) but reduce the patient gain from local targets ($B^{HP}_{nn^s} < 0$). PCT monitoring costs m are increasing and convex in local and SHA targets and the marginal monitoring costs of local targets increase with the number of SHA targets ($m_{nn^s} > 0$).

The hospital objective function

$$U(n; n^S, x^H, \delta, R^H, y, h) = \delta B^H(n; n^S, x^H, y, h) + R^H - C(n; n^S, x^H, \theta) \quad (2)$$

is also concave in n. x^H is the total volume of patients from all PCTs treated at the hospital. The hospital cares about the welfare of patients it treats but not which PCT the patients belong to. $\delta \geq 0$ measures the hospital's altruism. R^H is total revenue for the hospital and C is total cost, which is increasing and convex in n. θ is a shift parameter which increases hospital costs and the marginal hospital cost of local targets ($C_\theta > 0$, $C_{n\theta} > 0$). Increases in total output and in SHA targets increase hospital cost and increase the marginal cost of local targets ($C_z > 0$, $C_{nz} > 0$, $z = x^H, n^S$). Since total benefit to all patients treated is the sum of benefits to patients of the negotiating PCT and patients from other PCTs, increases in the health of the negotiating PCT's population health and the generosity of its budget affect the marginal benefits from local targets: $B^H_z = B^{HP}_z$,$B^H_{nz} = B^{HP}_{nh}$ $(z = h, y)$.

The PCT and hospital bargain over the number of local targets, taking all other variables (such as the hospital's output or its total revenue as fixed). We assume that the bargain struck is the Nash bargaining solution (Binmore et al (1986)) which maximises the weighted product of the utility gains

$$L = [V(n; \cdot) - V^o]^\beta [U(n; \cdot) - U^o]^{(1-\beta)} \quad (3)$$

where V^o and U^o are the utilities they would received if there is no agreement. $\beta \in [0, 1]$ is a bargaining power parameter.

We assume that if there is no agreement, the number of local targets is zero and the PCT and hospital suffer an additional utility cost of disagreement, perhaps because of sanctions imposed by the Strategic Health

Authority. Thus $V^o = V(0;\cdot) - \gamma^P$, $U^o = U(0;\cdot) - \gamma^H$ where γ^P, γ^H are the additional penalties for failure to agree.

The bargain thus maximises

$$\begin{aligned}\ell = \ln L &= \beta \ln[V - V^o] + (1-\beta)\ln[U - U^o] \\ &= \beta \ln\left\{\alpha_P B^{HP}(n;\cdot) - m(n;\cdot) - [\alpha_P B^{HP}(0;\cdot) - m(0;\cdot) - \gamma^P]\right\} \\ &\quad \times (1-\beta)\ln\{\delta B^H(n;\cdot) - C(n;\cdot) - [\delta B^H(0;\cdot) - C(0;\cdot) - \gamma^H]\} \qquad (4)\end{aligned}$$

Notice that R^H cancels from the utility gain to the hospital. With an interior solution, the first order condition is[7]

$$\ell_n = \beta \frac{V_n(n;\cdot)}{V(n;\cdot) - V^o(0;\cdot)} + (1-\beta)\frac{U_n(n;\cdot)}{U(n;\cdot) - U^o(0;\cdot)} = 0 \qquad (5)$$

We assume that, even though the hospital is partially altruistic, it would prefer a smaller number of targets than the PCT because it bears all the cost of meeting the targets. Hence in (5) $V_n > 0$ and $U_n < 0$.

4.2 Comparative statics

We consider first the case in which the PCT has all the bargaining power ($\beta = 1$) and n is chosen so that

$$V_n = \alpha_P B_n^{HP}(n; n^S, x^{HP}, y, h) - m_n(n; n^s) = 0 \qquad (6)$$

Table 1 reports the comparative static responses. The sign of the comparative static effects of an exogenous factor z on n depends on the sign of V_{nz}. An increase in SHA imposed targets (n^S) reduces the marginal gain from local targets and increases marginal monitoring costs and so reduces the number of local targets. An increase in the generosity of the PCT's budget relative to need (y) reduces patient gains from additional targets and so the effect of greater budgets is negative. An increase in population health (h) reduces the number of targets because of our assumption that the gain from additional targets is smaller when the population is healthier. The benefit from additional targets is greater when more patients are affected so the number of targets increases if the volume of treatments of PCT patients at the provider x^{HP} increases. Increases in PCT altruism (α_P) unsurprisingly increase the number of local targets.

When the hospital has all the bargaining power ($\beta = 0$) n satisfies

$$U_n = \delta B_n^H(n; n^S, x^H, y, h) - C_n(n; n^S, x^H, \theta) = 0 \qquad (7)$$

[7] V and U are concave in n so that $\ln V$ and $\ln U$ are also concave in n and since, the sum of concave functions is concave, the first order condition is also sufficient.

and the comparative static predictions are determined by U_{nz}. The qualitative predictions for the effects of the number of SHA targets n^S, the generosity of the PCT budget y, and population health h are the same as when the PCT sets n. Increases in provider altruism and increases in provider efficiency (reductions in θ) increase the number of targets. The marginal benefit from local targets is greater when the hospital treats more patients since the targets are set for all patients, but the marginal cost of local targets will be greater since they will apply to more patients. Thus the effect of the hospital treating more patients x^H is ambiguous.

When neither party has complete bargaining power ($\beta \in (0,1)$), the sign of the effect of an exogenous parameter z on the number of local targets is determined by the sign of ℓ_{nz}. Since the PCT prefers higher n and the hospital lower n, an increase in PCT bargaining power (β) unsurprisingly increases the number of targets.

Determining the effect of other parameters is less straightforward than in the cases where $\beta = 1$ or $\beta = 0$. Differentiating (5) with respect to z (where z is any of the parameters entering $V - V^o$ or $U - U^o$) gives[8]

$$\operatorname{sgn} \frac{\partial n}{\partial z} = \operatorname{sgn} \left\{ \left[\frac{V_{nz}}{V_n} - \frac{V_z - V_z^o}{V - V^o} \right] - \left[\frac{U_{nz}}{U_n} - \frac{U_z - U_z^o}{U - U^o} \right] \right\} \tag{8}$$

In the cases where $\beta = 1$ or $\beta = 0$ the number of targets is determined by first order conditions which depend only on first derivatives of the objective function of the PCT or hospital. In these models comparative static properties depend only on second order partial derivatives (V_{nz} or U_{nz}).[9] But the Nash bargaining solution with $\beta \in (0,1)$ maximises the product of objective functions (or the sum of their logarithms) and so the first order conditions involve the products of the level of objective functions and their first derivatives. Hence the comparative statics properties, which are determined by the derivative of the first order condition, depend in an essential way on both first and second derivatives of the objective functions and on their levels. The detailed derivation of the results for this case are in the Appendix.

When γ^H increases the hospital is worse off if there is no agreement ($U^o_{\gamma^H} < 0$) but γ^H does not affect U. Hence (8) reduces to sgn $-U^o_{\gamma^H}/(U - U^o) > 0$, and so n increases when the hospital's disagreement utility is reduced. The rationale is that at the solution the hospital would prefer fewer targets and so a weakening of its bargaining position leads it to concede more

[8] $\ell_{nz} = \beta(V - V^o)^{-2}[V_{nz}(V - V^o) - V_n(V_z - V_z^o)]$ $(1 - \beta)(U - U^o)^{-2}[U_{nz}(U - U^o) - U_n(U_z - U_z^o)]$. Substituting for $(1 - \beta)$ from (5) and rearranging gives (8).

[9] Taking the logarithm or other increasing monotonic transformation of an objective function has no effect on the optimal solution and hence no effect on the comparative statics.

targets. The effect of an increase in the disagreement utility of the PCT (a reduction in γ^P) is similarly easy to determine since $V^o_{\gamma^P} > 0$ and $V_{\gamma^P} = 0$.

An increase in hospital altruism δ increases the contribution of B^H to L. Since B^H is strictly increasing in n, an increase in δ has a straightforward positive effect of the number of local targets. θ increases the provider's cost ($C_\theta > 0$) and the marginal cost of local targets ($C_{n\theta} > 0$). Consequently an increase in θ implies a reduction in n.

We have assumed that better population health reduces the marginal benefit of locally negotiated quality, i.e. $B^{HP}_{nh} < 0$, $B^H_{nh} < 0$. In the appendix we show that with $z = h$, (8) is

$$\text{sgn}\left\{\left[\frac{\alpha_P B^{HP}_{nh}}{V_n} - \frac{\alpha_P(B^{HP}_h(n;\cdot) - B^{HP}_h(0;\cdot))}{V - V^o}\right] - \left[\frac{\delta B^H_{nh}}{U_n} - \frac{\delta(B^H_h(n;\cdot) - B^H_h(0;\cdot))}{U - U^o}\right]\right.$$

The assumption that $B^{HP}_{nh} < 0$, $B^H_{nh} < 0$, implies that $B^{HP}_h(n;\cdot) < B^{HP}_h(0;\cdot)$ and $B^H_h(n;\cdot) < B^H_h(0;\cdot)$, so the first square bracketed term is ambiguously signed and the second is negative. In the special case where h has no effect on the disagreement utility of the PCT ($V^o_h = 0$), PCTs with better population health would negotiate solutions with fewer targets. Note also that if the PCT has greater bargaining power, so that its utility gain $V - V^o$ is larger, it is more likely that increases in h reduce n.

Similar reasoning can be applied when considering the effects of an increase in y. An increase in the PCT's budget relative to health care need has a negative effect on the marginal benefit of locally negotiated quality, $B^{HP}_{ny} < 0$ and $B^H_{ny} < 0$. With $z = y$, (8) is

$$\text{sgn}\left\{\left[\frac{\alpha_P B^{HP}_{ny}}{V_n} - \frac{\alpha_P(B^{HP}_y(n;\cdot) - B^{HP}_y(0;\cdot))}{V - V^o}\right] - \left[\frac{\delta B^H_{ny}}{U_n} - \frac{\delta(B^H_y(n;\cdot) - B^H_y(0;\cdot))}{U - U^o}\right]\right.$$

The second square bracketed term has the opposite sign to B^H_{ny}. The first square bracketed term has ambiguous sign since B^{HP}_{ny} has the same sign as $B^{HP}_y(n;\cdot) - B^{HP}_y(0;\cdot)$. The first square bracketed term is ambiguously signed and the second is negative. Again, if the PCT has greater bargaining power, so that its utility gain $V - V^o$ is larger, it is more likely that increases in y reduce n.

The effect of other parameters, such as the level of PCT altruism, the exogenous levels of hospital output and regionally defined targets are ambiguous without much stronger assumptions. It is perhaps surprising that greater PCT altruism has an ambiguous effect. The explanation is that although greater altruism increases the PCT's marginal gain from targets (the numerator in (5)) it also increases the PCT's utility gain (the denominator in (5)) and so the first term in the first order condition may increase or decrease.

5 Data and methods

5.1 Data sources

Information on 153 CQUIN contracts agreed for acute hospitals in 2010/11 was obtained from the NHS Institute for Innovation and Improvement website[10] (see NHS, 2009). We use the information on the locally negotiated targets and those mandated by the PCT's Strategic Health Authority and omit the nationally mandated targets which did not vary across contracts.

Hospital teaching and specialist status was obtained from the Compendium Indicators of the NHS Information Centre for health and social care.[11] The volume of patients treated at the hospital in 2009/10 and its Reference Cost Index for 2009/10 were taken from the Department of Health Exposition Book.[12] The Index measures how the hospital's costs compare to national average costs, adjusted for patient case-mix and input prices.

We use the ratings of quality and financial competence of hospitals from the Annual Health Check published by the Care Quality Commission for 2008/09.[13] We compare hospitals rated "weak or fair" to those rated "good or excellent". Information on Foundation Trust status at December 2009 was obtained from the Monitor website.[14]

For PCTs we have information from the NHS Institute for Innovation and Improvement website (see NHS, 2009) on which PCT delegated nego-

[10]Data contains 91% of all acute hospitals. Details of CQUIN contracts for the other 16 English acute hospital trusts was not available on the website.

[11]https://indicators.ic.nhs.uk

[12]http://webarchive.nationalarchives.gov.uk/+/www.dh.gov.uk/en/Managingyourorganisation/Financeandplanning/Allocations/DH_091850

[13]http://archive.cqc.org.uk/_db/_documents/The_annual_health_check_2008_09_Assessing_and_rating_the_NHS.pdf

[14]http://www.monitor-nhsft.gov.uk/about-nhs-foundation-trusts/nhs-foundation-trust-directory

tiation to an agency. We also obtained each PCT's rating in the 2009/10 World Class Commissioning process from the Health Service Journal.[15] This commissioning assurance system involved an annual review by the Strategic Health Authority of each PCT's progress towards achieving better health outcomes, competencies and governance. We use the financial competence rating, which is measured on a scale from zero to one with one representing the highest level of financial competence.

The 2010/11 DH Exposition Book provided the expenditure by the lead PCT at the hospital with which it negotiated,[16] the size of the population served by the PCT, its disability-free life expectancy (which is used by government to monitor geographical health inequalities), and a measure of the generosity of the PCT's budget relative to its need. This latter variable (the distance from target) measures the extent to which the PCT's financial allocation for 2010/11 differs from the target allocation needed as calculated by the national resource allocation formula.

5.2 Matching empirical and theoretical variables

Table 2 summarises the parameters in the theoretical model and their correspondent proxies in the empirical model. The free-text nature of the much of the dataset describing the CQUIN contracts precludes meaningful quantitative analysis beyond the number of topics and indicators. We examine four measures of the number of quality targets (n in the theoretical model). We use the the number of locally negotiated topics and the number of locally negotiated indicators, and we also classify the locally negotiated indicators as either outcome indicators measuring outcome improvement indicators measuring process improvement.

Hospital inefficiency (θ) is proxied by the Reference Cost Index. We also expect that the costs of a hospital will be affected by their teaching or specialist status, though we are agnostic about the effects of this status on the cost function. Teaching hospitals undertake more activities than non-teaching hospitals and may attract better qualified staff but more complex patients. Specialist hospital undertake a smaller range of activities but again may attract better qualified staff and patients with conditions requiring specialised intervention.

Hospital altruism (δ) is captured by the Care Quality Commission's quality score which reflects the level of quality produced by the provider in a pe-

[15] http://www.hsj.co.uk/topics/world-class-commissioning-scores-2010/world-class-commissioning-league-table/5018174.article

[16] If an agency negotiated the contract we take the total expenditure of each individual PCT for whom it negotiates.

riod when there were no direct financial incentives for quality. The volume of treated patients proxies the parameter x^H in the theoretical model.

The generosity of the PCT's budget (y) is represented by its distance from target at the start of the year and the health of its population (h) by its disability-free life expectancy. The PCT's altruism (α_P) is captured by whether or not the PCT passed responsibility for negotiating the contract to an agency: we assume that agencies are less altruistic than the PCT.

Foundation Trusts arguably attract better managers and are less reliant on their contracts with PCTs for their income, so we assume that when the hospital is Foundation Trust, the PCT's bargaining power (β) is smaller. Conversely, we assume that PCTs with larger populations can attract better managers and so β is larger for PCTs with larger populations.

We interpret the reservation utilities of the hospital and the PCT (i.e. V^0 and U^0 in the theoretical model) as the reputational consequences of intervention by the Strategic Health Authority if the parties fail to agree on the CQUIN contract. For hospitals we use the Care Quality Commission's rating of the hospitals financial position as a proxy and assume that V^o is higher when the rating is higher. For PCTs we use the World Class Commissioning rating as a proxy for how vulnerable the reputation of the PCT is to failure to reach agreement. PCTs with higher ratings are assumed to be less vulnerable to bargaining breakdown so that U^o is higher.

5.3 Econometric methods

We estimate count data models for each of the four dependent variables. In the standard Poisson regression model (Maddala, 1986) the number of quality indicators n has a distribution determined by the conditional mean $\mu(\mathbf{x}) \equiv E(n|\,\mathbf{x})$

$$f(n|\,\mathbf{x}) = \frac{exp[-\mu(\mathbf{x})][\mu(\mathbf{x})^n]}{n!} \qquad n = 0, 1, ..., N$$

Since the basic assumption of variance-mean equality required by the standard Poisson model is rejected for all our dependent variables, we consider two generalisations which make different assumptions about the variance. The Poisson GLM variance assumption (Wooldridge, 2001) is

$$Var(n|\,\mathbf{x}) = \tau_P E(n|\,\mathbf{x})$$

where $\tau_P > 0$ is the variance-mean ratio or over dispersion parameter. Over-dispersion occurs whenever $\tau_P > 1$ as is the case in our data. The negative

binomial distribution (Cameron and Trivedi, 1998) is a popular alternative to the Poisson in case of over-dispersion and has variance:

$$Var(n|\,\mathbf{x}) = E(n|\,\mathbf{x}) + \tau_{NB}[E(n|\,\mathbf{x}]^2$$

with $\tau_{NB} \geq 0$.

In both the Poisson GLM and negative binomial models the conditional mean number of quality targets is specified as $\mu(\mathbf{x}) = \exp(\boldsymbol{\beta}\mathbf{x})$. We report the estimated effect of an explanatory variable x_k as an incident rate ratio (IRR), rather than as a coefficient β_k. Letting $\mathbf{I}_k = (0, .., 1, ...0)$ denote a vector with 1 in the k'th posititon and 0 elsewhere, the incident rate ratio is the proportionate change in the mean number of quality targets due to a one unit increase in x_k

$$\frac{\mu(\mathbf{x} + \mathbf{I}_k)}{\mu(\mathbf{x})} = \frac{\exp(\boldsymbol{\beta}(\mathbf{x} + \mathbf{I}_k)}{\exp(\boldsymbol{\beta}\mathbf{x})} = \exp(\beta_k)$$

We estimate both generalised Poisson and negative binomial models for all the measures of n and graphically compare the distribution of the variables with the Poisson and negative binomial distributions to choose the preferred specification. We report two models for each measure of n. The first has the full set of explanatories. For the second we sequentially delete the least significant variable until we have a parsimonious model containing only variables statistically significant at $p < 0.05$. In the models for the numbers of outcome and process quality indicators, we retained variables that were significant for at least one of these dependent variables.

6 Results

6.1 Descriptive statistics

The CQUIN schemes varied widely in the type of care targeted and the ways in which performance was measured. The local CQUIN schemes in our data set between them covered 92 disease areas (topics) and included 1,546 distinct indicators.

Table 3 shows that on average there are three regionally mandated topics and outcome/process indicators in each contract. The locally negotiated elements of the contracts contain, on average, five topics or clinical areas and eight indicators. On average, locally negotiated contracts contain more process than outcome indicators. This is not surprising as outcome indicators are riskier for the hospital and more costly to monitor for the PCT. Some contracts did not contain any locally negotiated quality targets. Eighteen

contracts had no locally negotiated topics or indicators, 53 had no outcome indicators, and 33 had no process indicators.

About 15% of contract negotiations were led by an agency representing the PCT. 15% of hospitals were teaching hospitals, 12% had specialist status, and 53% were Foundation Trusts.

6.2 Regression results

Results for the Poisson GLM and negative binomial indicators were very similar for all four measures of n. Graphical inspection suggested that the GLM Poisson was a better specification than the negative binomial for the number of locally negotiated topics and the number of indicators and that the negative binomial was better for the number of outcome indicators and the number of process indicators.[17]

Table 4 displays the results for the number of locally negotiated topics and indicators. The number of indicators mandated by the Strategic Health Authority does not influence the amount of local content. Contracts with Teaching Trusts have numbers of locally negotiated topics and indicators that are respectively 1.35 and 1.51 times greater than other Trusts. Specialist Trusts have contracts with 1.45 times as many indicators as other Trusts.

PCTs with a more generous budget relative to their need and PCTs with better population health negotiate fewer topics and indicators.

Table 5 has the results for the numbers of locally negotiated outcome and process indicators. Contracts in regions with more SHA-mandated outcome indicators negotiated local contracts containing more outcome indicators. Teaching Trusts have more process indicators included in their contract while Specialist Trust contracts have more outcome indicators. When PCTs have more generous budgets relative to their need and have better population health the contracts contain fewer outcome indicators and fewer process indicators. The number of outcome indicators is a little more sensitive to the PCT's budget and health level. When the contract is negotiated by an agency it has substantially fewer process indicators.

7 Discussion

Table 6 provides a qualitative summary of the regression results. The number of indicators mandated by the supervising Strategic Health Authority does not affect either the number of disease topics targeted or the total number of

[17] Results for the models not reported and the distribution graphs are available from the authors.

indicators. However, an increase in the number of SHA mandated outcome indicators does increase the number of locally mandated outcome indicators. This may indicate that there are economies of effort in monitoring outcome indicators: once the PCT has made the investment necessary to monitor the SHA mandated outcome indicators it becomes easier to monitor additional outcome indicators.

Contracts with Teaching Trusts and Specialist Trusts had more quality targets. This may be because of the effect of Teaching Trust and Specialist Trust on the marginal cost of additional quality targets. Since the altruism parameter in our theory model measures the rate at which the hospital is willing to trade off patient benefit and cost, we could equivalently regard Teaching Trust and Specialist Trust status as indicating greater altruistic concern for patient benefits. In the case of Teaching Trusts this could reflect the type of staff attracted to them. For Specialist Trusts, the benefits from better quality are concentrated on more specific types of patients so that staff find it easier to empathise with them.

We explain the consistently negative effects of better PCT population health and the generosity of its budget relative to need by the plausible assumption that when the PCT population is healthier or better resourced the marginal gain from quality improvement is smaller. The explanation for contracts negotiated by agencies having fewer quality targets may be because agencies which negotiate on behalf of a cluster of PCTs will place a lower weight on the patient benefits because they have less direct responsibility for patients wellbeing.

The objectives of public purchasers and hospitals and the extent to which they reflect the interests of their local populations are unclear. Despite this, delegating discretion to over 150 local purchasers and hospitals produced contracts in which the number of quality targets was systematically related to features of the organisations and their populations. The contracts are, in other words, not entirely driven by unobservable local idiosyncracies. We cannot test whether the number of quality targets was welfare maximising for any given population, but it is somewhat encouraging that the variation in the number of quality targets in contracts negotiated on their behalf appears to be at least partly explained by the health of local populations and their funding relative to need.

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Appendix

Derivation of comparative static results

With $z = \delta$, the sign of $\partial n/\partial z$ (8) is

$$\operatorname{sgn}\left\{-\left[\frac{B_n^H(n;\cdot)}{U_n} - \frac{B^H(n;\cdot) - B^H(0;\cdot)}{U - U^o}\right]\right\} > 0$$

since that $U_n < 0$ and $B_n^H > 0$.

With $z = \alpha_P$, (8) is

$$\operatorname{sgn}\left[\frac{B_n^{HP}}{V_n} - \frac{B^{HP}(n;\cdot) - B^{HP}(0;\cdot)}{V - V^o}\right]$$

and since $B_n^{HP} > 0$ implies that $B^{HP}(n;\cdot) - B^{HP}(0;\cdot) > 0$, the effect of the altruism parameter α_P is ambigous.

With $z = \theta$, (8) is

$$\operatorname{sgn}\left\{-\left[\frac{-C_{n\theta}}{U_n} + \frac{C_\theta(n;\cdot) - C_\theta(0;\cdot)}{U - U^o}\right]\right\} < 0$$

where the sign follows since $C_{\theta n} > 0$ implies $C_\theta(n;\cdot) > C_\theta(0;\cdot)$.

With $z = h$, (8) is

$$\operatorname{sgn}\left\{\left[\frac{\alpha_P B_{nh}^{HP}}{V_n} - \frac{\alpha_P(B_h^{HP}(n;\cdot) - B_h^{HP}(0;\cdot))}{V - V^o}\right] - \left[\frac{\delta B_{nh}^H}{U_n} - \frac{\delta(B_h^H(n;\cdot) - B_h^H(0;\cdot))}{U - U^o}\right]\right\}$$

The assumption that $B_{nh}^{HP} < 0$,$B_{nh}^H < 0$, implies that $B_h^{HP}(n;\cdot) < B_h^{HP}(0;\cdot)$ and $B_h^H(n;\cdot) < B_h^H(0;\cdot)$, so the first square bracketed term is ambiguously signed and the second is negative.

With $z = y$, (8) is

$$\operatorname{sgn}\left\{\left[\frac{\alpha_P B_{ny}^{HP}}{V_n} - \frac{\alpha_P(B_y^{HP}(n;\cdot) - B_y^{HP}(0;\cdot))}{V - V^o}\right] - \left[\frac{\delta B_{ny}^H}{U_n} - \frac{\delta(B_y^H(n;\cdot) - B_y^H(0;\cdot))}{U - U^o}\right]\right\}$$

The second square bracketed term has the opposite sign to B_{ny}^H. The first square bracketed term has ambiguous sign since B_{ny}^{HP} has the same sign as $B_y^{HP}(n;\cdot) - B_y^{HP}(0;\cdot)$.

With $z = x^H$, (8) is

$$\operatorname{sgn}\left\{\left[\frac{\alpha_O B^{HO}_{nx^H}}{V_n} - \frac{\alpha_O(B^{HO}_{x^H}(n;\cdot) - B^{HO}_{x^H}(0;\cdot))}{V - V^o}\right] - \left[\frac{\delta B^H_{nx^H} - c_{nx^H}}{U_n} - \frac{\delta(B^H_y(n;\cdot) - B^H_y(0;\cdot)) - \left(c_{x^H}(n;\cdot) - c_{x^H}(0;\cdot)\right)}{U - U^o}\right]\right\}$$

The first square bracketed term has ambiguous sign since $B^{HO}_{nx^H}$ has the same sign as $B^{HO}_{x^H}(n;\cdot) - B^{HO}_{x^H}(0;\cdot)$. The sign of the second square braketed term depends of the magnitude of the effect of an increase in x^H on the marginal benefit of local quality B^H and the cost function c.

With $z = x^{HP}$, (8) is

$$\operatorname{sgn}\left\{\left[\frac{\alpha_P B^{HP}_{nx^{HP}} - \alpha_O B^{HO}_{nx^{HP}}}{V_n}\right] - \left[\frac{\left(\alpha_P B^{HP}_{x^{HP}}(n;\cdot) - \alpha_O B^{HO}_{x^{HP}}(n;\cdot)\right) - \left(\alpha_P B^{HP}_{x^{HP}}(0;\cdot) - \alpha_O B^{HO}_{x^{HP}}(0;\cdot)\right)}{V - V^o}\right]\right\}$$

The sign is ambiguous and it depends on the sign and magnitude of $B^{HP}_{nx^{HP}}$ and $B^{HO}_{nx^{HP}}$.

With $z = n^S$, (8) is

$$\operatorname{sgn}\left\{\left[\frac{\alpha_P B^{HP}_{nn^S} + \alpha_O B^{HO}_{nn^S} - m_{nn^S}}{V_n}\right] - \left[\left(\frac{\alpha_P(B^{HP}_{n^S}(n;\cdot) - B^{HP}_{n^S}(0;\cdot)) + \alpha_O(B^{HO}_{n^S}(n;\cdot) - B^{HO}_{n^S}(0;\cdot))}{V - V^o}\right) - \left(\frac{m_{n^S}(n;\cdot) - m_{n^S}(0;\cdot)}{V - V^o}\right)\right] - \left[\frac{\delta B^H_{nn^S} - c_{nn^S}}{U_n} - \frac{\delta(B^H_{n^S}(n;\cdot) - B^H_{n^S}(0;\cdot)) - \left(c_{n^S}(n;\cdot) - c_{n^S}(0;\cdot)\right)}{U - U^o}\right]\right\}$$

The first square bracketed term is negative given the assumption that n and n^S are substitutes. But this assumption also implies that the second square bracketed term is negative. Similarly the first and second components of the third square bracketed term are also negatively and so the third square bracketed term has an ambiguous sign. If the PCT has high bargaining power, so that $V - V^o$ is very large, then an increase in regional quality n^S would have a negative effect on n.

Table 1. Comparative statics: effect of exogenous factors on number of locally negotiated quality targets

		Solution type		
Exogenous variable		$\beta = 1$	$\beta = 0$	$\beta \in (0,1)$
Regional targets	n^S	–	–	?
Hospital inefficiency	θ	0	–	–
Hospital altruism	δ	0	+	+
Hospital output	x^H	0	sgn $B^H_{nx^H} - c_{nx^H}$	?
Hospital reservation utility	U^o	na	na	–
PCT bargaining power	β	na	na	+
PCT budget generosity	y	–	–	?
PCT population health	h	–	–	?
PCT patients treated at hospital	x^{HP}	+	0	?
PCT altruism	α_P	+	0	?
PCT reservation utility	V^0	na	na	+

Table 2. Variables in theoretical and empirical models

Variables in bargaining model		Proxies in empirical model
Number of locally negotiated targets	n	Locally negotiated topics; Locally negotiated indicators; Locally negotiated, outcome indicators; Locally negotiated process indicators;
Regional targets	n^S	SHA imposed topics; SHA imposed outcome indicators; SHA imposed process indicators;
Hospital inefficiency	θ	Reference Cost Index; Teaching hospital (positively or negative related); Specialist Trust (positively or negatively related);
Hospital altruism	δ	CQC quality score 2009/10
Hospital output	x^H	Volume of treated patients 2009/10
Hospital reservation utility	U^o	CQC financial rating
PCT bargaining power	β	Hospital's Foundation Trust status (negatively related); PCT population
PCT budget generosity	y	Distance from target (budget minus target budget)
PCT population health	h	Disability free life expectancy
PCT patients treated at hospital	x^{HP}	PCT's expenditure at hospital
PCT altruism	α_P	Contract negotiation not delegated to agency
PCT reservation utility	V^o	World Class Commissioning financial competency score

Note: proxies are positively related to the bargaining model variable except where stated.

Table 3. Summary statistics

	Mean	SD.	Min.	Max.
Number of locally negotiated quality targets:				
Topics	5.46	3.89	0.00	18.00
Indicators	8.61	8.29	0.00	50.00
Outcome indicators	2.75	4.25	0.00	24.00
Process indicators	5.42	5.74	0.00	27.00
Number Regional mandated quality targets:				
Topics	3.73	3.13	0.00	13.00
Outcome indicators	2.87	3.27	0.00	18.00
Process indicators	2.31	3.83	0.00	15.00
Hospital characteristics				
Reference Cost Index 2009/10	100.77	9.05	80.00	157.00
Teaching Trust	0.12	0.33	0.00	1.00
Specialist Trust	0.15	0.36	0.00	1.00
CQC quality score (2008/09)	0.29	0.45	0.00	1.00
Patients treated (2009/10, 10,000s)	0.98	0.54	0.00	2.79
CQC finance score (2008/09)	0.18	0.38	0.00	1.00
Foundation Trust by 2009	0.53	0.50	0.00	1.00
PCT characteristics				
Population size (2009/10, 100,000s)	5.67	4.35	1.42	19.10
Generosity of budget relative to need (2010)	0.49	5.52	-7.40	21.30
Population health (2010)	62.71	3.10	55.80	68.10
Expenditure at hospital (£100Ms; 2009/10)	3.12	1.99	0.00	10.58
Contract negotiated by an agency	0.15	0.36	0.00	1.00
WCC financial competency rating (2009/10)	0.71	0.21	0.00	1.00

Table 4. Models for number of local topics and local indicators

	Local topics				Local indicators			
	Full Model		Parsimonious Model		Full Model		Parsimonious Model	
	IRR	z	IRR	z	IRR	z	IRR	z
Regional content[i]	1.00	0.03			0.99	-0.70		
Hospital characteristics:								
Reference cost index	1.01	1.34			0.99	-0.20		
Hospital is a Teaching Trust	1.35*	1.80	1.35**	2.20	1.45*	1.91	1.51**	2.45
Hospital is a Specialist Trust	0.85	-0.65			1.60*	1.79	1.45*	1.93
CQC quality rating 2008/9	0.87	-1.06			0.81	-1.25		
Patients treated 2009/10	0.93	-0.47			1.01	0.05		
CQC financial rating 2008/9	1.08	0.41			1.23	0.97		
Hospital is a Foundation Trust	0.90	-0.79			0.84	-1.11		
PCT characteristics:								
PCT's population size	0.99	-0.13			1.01	0.29		
PCT's generosity of budget	0.97**	-2.24	0.97**	-2.92	0.97***	-1.44	0.96**	-2.48
PCT's population health	0.94***	-2.84	0.93***	-4.15	0.91***	-3.79	0.90***	-4.99
PCT's expenditure at this hospital	1.00	0.11			1.05	0.85		
Contract negotiated by agency	0.87	-0.44			0.74	-0.76		
WCC financial competency 2009/10	1.13	0.40			1.86	1.55		
Constant	112***	2.68	376***	5.74	2356***	3.86	4386***	6.54
Akaike Information Criterion	5.62		5.54		8.25		8.40	

N =153 all models. Generalised Poisson models. z stats are scaled using standard errors corrected for over dispersion using square root of Pearson χ^2 dispersion. [i] Number of regional topics in the models for topics; number of regional indicators in the models for indicators.

Table 5. Models for number of locally negotiated outcome and process indicators

	Outcome indicators				Process indicators			
	Full Model		Parsimonious Model		Full Model		Parsimonious Model	
	IRR	z	IRR	z	IRR	z	IRR	z
Regional content:								
Regional content[i]	1.10***	2.71	1.12***	3.61	1.03	0.82	1.03	1.00
Hospital characteristics:								
Reference cost index	1.00	0.25			1.01	0.44		
Hospital is a Teaching Trust	0.82	-0.54	0.76	-0.88	1.51	1.48	1.66**	2.19
Hospital is a Specialist Trust	2.57**	2.10	2.17**	2.18	0.99	-0.02	1.05	0.18
CQC quality rating 2008/9	0.90	-0.42			0.72*	-1.65		
Patients treated 2009/10	0.63	-1.35			1.18	0.68		
CQC financial rating 2008/9	0.98	-0.05			1.06	0.22		
Hospital is a Foundation Trust	0.78	-1.02			0.92	-0.43		
PCT characteristics:								
PCT's population size	0.94	-1.17			1.05	1.25		
PCT's generosity of budget	0.93**	-2.37	0.94**	-2.16	0.97	-1.48	0.97	-1.58
PCT's population health	0.89***	-2.77	0.89***	-2.94	0.95*	-1.65	0.95*	-1.70
PCT's expenditure at this hospital	1.15	1.47			0.97	-0.49		
Contract negotiated by an agency	1.99	1.23	1.34	0.83	0.28***	-2.71	0.45***	-2.70
WCC financial competency 2009/10	0.86	-0.25	1.08	0.15	2.99**	2.13	2.61*	1.92
Constant	3551**	2.46	2337***	2.84	38.35	1.38	57.28*	1.91
χ^2 over dispersion test	41.89		36.80		44.73		40.20	
χ^2 p value	<0.001		<0.001		<0.001		<0.001	

N = 153. Negative binomial regressions. ***p < 0:01; **p < 0:05; *p < 0:1. [1]No. of regional outcome indicators in models for local outcome indicators and regional process indicators in models for local process indicators

Table 6: Summary: statistically significant explanatory factors in models of number of locally negotiated indicators

	N local topics	N local indicators	N local outcome indicators	N local process indicators
Regional content			+	
Hospital characteristics:				
Reference cost index				
Hospital is a Teaching Trust	+	+		+
Hospital is a Specialist Trust		+	+	
CQC quality rating 2008/9				
Patients treated 2009/10				
CQC financial rating 2008/9				
Hospital is a Foundation Trust				
PCT characteristics:				
PCT's population size				
PCT's generosity of budget	–	–	–	–
PCT's population health	–	–	–	–
PCT's expenditure at this hospital				
Contract negotiated by agency				–
WCC financial competency 2009/10				+