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Quality target negotiation in health care: evidence from the English 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 associated with 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 and type (structure, process or outcome) of quality measures used, 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 (Kristensen et al, 2013). In this paper we investigate how local decision makers used their discretion in designing these quality incentive contracts. It is not possible, given available data, to judge whether local contracts are welfare maximising given local conditions. Rather, we examine whether variations in the complexity of pay for performance contracts, as measured by the number of quality targets they contain, are associated with variations in local conditions which might be expected to affect the welfare benefits and costs of more or less complex contracts.

We develop a Nash contract bargaining model to motivate the empirical analysis. We use a data set of 153 CQUIN contracts for 2010/11 for acute hospitals in England to determine whether the choice of the number of quality targets is related to hospital and purchaser characteristics. The average number of locally negotiated quality targets in a contract was nine. We find that this number varies with whether the contract was negotiated by an agency, the health of the local population, the generosity of the purchaser's budget relative to the need of its population, the type of hospital, and the quality targets imposed by the purchaser's supervising regional authority.

There is an extensive normative theoretical literature on the design of contracts in healthcare comparing the welfare implications of different types of contract (Chalkley and Malcomson, 2000). This literature is mainly concerned with how and whether payment to providers should be linked to the volume of treatment. There is a small theoretical literature on bargaining

between providers and purchasers of healthcare over contractual form (Barros and Martinez-Giralt, 2011). For example, Siciliani and Stanciole (2013) consider the choice between bargaining over the price, over the level of activity, or simultaneous negotiations over price and activity level. Neither of these literatures considers contracting for quality.

The empirical literature on healthcare contracting is almost entirely US-based (Gaynor and Town, 2012). Much of the empirical literature on bargaining in the healthcare sector is based on models in which pairs of purchasers and providers bargain bilaterally and simultaneously over prices, taking quality as exogenous (see, for example, Brooks et al (1997) and Grennan (2013)). Under the CQUIN scheme each purchaser could bargain only with a single, exogenously determined, single provider. Thus, in our model of bargaining over quality, each party can bargain with only one other party.

Two papers have investigated factors affecting contract design in the English NHS during a period (the 1990s) when there was little central control over contracting. Csaba and Fenn (1997) and Chalkley and McVicar (2008) examine how characteristics of local purchasers and hospitals influence the extent to which contracts related payment to the volume of activity. We use data from a later period during which there was greater central NHS control over the form of contract and we focus on the way in which quality concerns were embodied in the contracts.

In the next section we describe the contractual arrangements in the NHS and the characteristics of the CQUIN scheme. Our model of bargaining between purchaser and hospital is set out in section 3. Section 4 describes our data and methods and results are reported in section 5. Section 6 concludes.

2 Hospital contracts in the NHS

2.1 The contracting parties

The hospital sector in the National Health Service in England is organised as an internal market in which local purchasers contract with hospitals. In 2010/11 there were 151 purchasers and 169 acute hospitals. The purchasers, Primary Care Trusts (PCTs), were

responsible for planning, purchasing and securing health services for their local population. They received a budget from the Department of Health financed out of general taxation. The budget was based on a weighted capitation formula which reflected the demographic structure and need characteristics of their populations and variations in input prices (Morris et al, 2008; Elliott et al., 2009). PCTs were managed by ten regional Strategic Health Authorities (SHAs), which were responsible for implementing national policy, monitoring the performance of the local purchasers and managing the healthcare market.

Most of the hospital care purchased by PCTs is produced by two types of large public hospitals: Foundation Trusts and NHS hospital trusts. Foundation Trusts have greater autonomy than standard hospital trusts: in particular they can retain any profit, though they must reinvest it in patient services (Verzulli et al, 2011). They can also access capital markets directly. Standard NHS hospital trusts must demonstrate that they meet clinical quality and financial standards before they can become Foundation Trusts. The quality of care provided by both types of trust is regulated by a national body, the Care Quality Commission.

2.2 NHS Standard Contract and the CQUIN scheme

A legally binding NHS Standard Contract for acute services is used for all hospitals providing services to the NHS (Petsoulas et al., 2011). Around 40% of hospital care bought by PCTs is covered by prospective activity-based financing (called Payment by Results). The casemix-adjusted tariff is set nationally by the Department of Health and is based on the average costs of procedures across all hospitals (Street and Maynard, 2007). The remainder of hospital care is covered by locally negotiated prices and by block contracts between PCTs and hospitals in which hospitals deliver a pre-specified volume of care in exchange for an agreed sum.

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), there was concern that fixed prices might lead hospitals to reduce costs by lowering quality. In 2009 the Department of Health introduced the Commissioning for Quality and Innovation (CQUIN) framework which required that contracts between PCTs and hospitals had to link a proportion of hospital revenue to quality indicators (Department of Health, 2008). In the 2009/10 preparatory year

many of the CQUIN contracts were concerned with improving data collection and 0.5% of hospital revenue was linked to achievement.

In 2010/11 the proportion of the contract value linked to quality improvement increased to 1.5%, and this was further increased to 2.5% in April 2012. In 2010/11 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 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 between PCTs and hospitals. The CQUIN quality targets were specified as topics (e.g. disease areas such as stroke) and as specific indicators within topics (e.g. proportion of stroke patients treated on a dedicated stroke unit).

Although hospitals typically treat patients from several PCTs, each hospital negotiated its CQUIN scheme with a single party. Usually this was the single PCT designated by the SHA as the negotiating PCT. In some cases the SHA gave responsibility for negotiating hospital contracts to an NHS agency which acted on behalf of a group, called a 'cluster', of local PCTs. Achievement of the quality indicators was measured on the activity undertaken by the hospital for all PCTs which purchased care from it.

The Department of Health's 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 indicator,[2] and for regional and local indicators; and iv) the proportion of hospital revenue to be linked to achievement of each

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

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

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 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. The model yields clear predictions about the effect of certain factors and is also useful because it explains why some apparently intuitive propositions about the effects of certain PCT or hospital characteristics may not be valid.

3.1 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. With this budget the PCT purchases 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 bargaining between the PCT and the hospital over the number of local quality targets (n). (Table 1 summarises the notation in the bargaining model.) We take n to be continuous and assume that quality targets are always met.[3]

The objective function of the PCT is

$$V(n;s,x,\alpha,y,h) = \alpha B(n;s,x,y,h) - m(n;s) \qquad (1)$$

B is the welfare of patients treated at the hospital. Patient welfare is increasing and concave in n ($B_n > 0$, $B_{nn} < 0$).[4] m is the effort cost to the PCT's managers of monitoring the targets and is increasing and convex in the number of local targets ($m_n > 0$, $m_{nn} > 0$). $\alpha > 0$ is a weight measuring the concern for patient welfare of the PCT negotiators relative to their effort costs.

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

[4] Here and elsewhere subscripts on functions denote partial derivatives, so, for example, $B_n = \partial B/\partial n$, $B_{nx} = \partial(\partial B/\partial n)/\partial x$.

s is the number of targets imposed by the Strategic Health Authority. More SHA targets increase the welfare from treatment ($B_s > 0$) and increase PCT monitoring costs ($m_s > 0$). The way regional targets affect the marginal benefit of quality targets and marginal monitoring costs is a priori ambiguous. In other words regional and local targets may be complements or substitutes. For example, n and s may be complements ($B_{ns} > 0$, $m_{ns} < 0$) because, once the PCT has invested in monitoring for Regional targets, it may be less costly to monitor additional targets. In addition Regional targets may tend to direct a hospital to allocate resources from untargeted dimensions to targeted dimensions allowing the possibility that more SHA targets increase the patient gain from local targets. Nonetheless n and s may also be partial substitutes ($B_{ns} < 0$, $m_{ns} > 0$). This would be the case when marginal monitoring costs of local targets increase in the number of regionally mandate targets and Regions choose the dimensions with the biggest marginal benefits so that additional local targets reduce the marginal benefit.

x is the volume of treatment provided by the hospital and patient benefit increases in x ($B_x > 0$). The marginal benefit from local targets also increases with the volume of treatment as the targets affect more patients ($B_{nx} > 0$.) A greater PCT budget y, given the health need of the population, increases the welfare of hospital patients ($B_y > 0$). Since the volume of the patients x treated at the hospital is already accounted for in B, an increase in the PCT budget affects hospital patients via improvements in care outside hospital, such as primary care or rehabilitation services. These services may be complements ($B_{ny} > 0$) or substitutes ($B_{ny} < 0$) for hospital targets. h is a measure of the underlying pre-treatment health of the PCT's population and so $B_h > 0$. Healthier patients have less health to gain as result of improvements in care and so we assume $B_{nh} < 0$.

The hospital objective function

$$U(n;s,x,\delta,R,y,h) = \delta B(n;s,x,y,h) + R - C(n;s,x,\theta) \qquad (2)$$

is also concave in n. R is total revenue for the hospital and C is total cost, which is increasing and convex in n ($C_n > 0$, $C_{nn} > 0$). The hospital cares about the welfare of patients it treats and $\delta \geq 0$ measures its concern for patients relative to profit.

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 increase hospital cost and increase the

marginal cost of local targets ($C_x > 0$, $C_{nx} > 0$,). Similarly increases in Region targets increase hospital cost ($C_s > 0$) but, due to forms of complementarity or substitutability in the provision of care, the marginal cost of local targets may decrease ($C_{ns} < 0$) or increase ($C_{ns} > 0$).

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[5] as fixed). We assume that the negotiated number of local targets is the Nash bargaining solution (Binmore et al (1986)) which maximises the weighted product of the utility gains

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

where V^o and U^o are the utilities the PCT and hospital would receive 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 $V^o = V(0;\cdot) - \gamma^P$ and $U^o = U(0;\cdot) - U^o$ where γ^P ,γ^H are the additional penalties for failure to agree.

The bargain maximises

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

Notice that R cancels from the utility gain to the hospital since it does not vary with the number of targets. With an interior solution, the Nash bargain n^* satisfies the first order condition[6]

[5] Hospital revenue R includes the CQUIN incentive payment which is a fixed proportion of the total payment for treating patients.

[6] 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.

$$\ell_n\left(n^*\right)=\beta\frac{V_n(n^*;\cdot)}{V\left(n^*;\cdot\right)-V\left(0;\cdot\right)+\gamma^P}+(1-\beta)\frac{U_n(n^*;\cdot)}{U\left(n^*;\cdot\right)-U\left(0;\cdot\right)+\gamma^H} \quad (5)$$

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 at the Nash Bargain defined by (5) we have $V_n(n^*;\cdot) > 0$ and $U_n(n^*;\cdot) < 0$.

3.2 Comparative statics

We first consider the case in which the PCT has all the bargaining power (β=1) and the number of targets n is chosen so that

$$V_n(n^*;\cdot)=\alpha B_n\left(n^*;s,x,y,h\right)-m_n\left(n^*;s\right)=0 \quad (6)$$

Table 1 reports the comparative static responses. The sign of the comparative static effects of an exogenous factor z on the number of locally negotiated targets n depends on the sign of V_{nz}. If SHA imposed targets (s) and locally negotiated targets are complements (substitutes), then the number of locally negotiated targets increases, $V_{nz} > 0$ (decreases, $V_{nz} < 0$).

The effect of an increase in the generosity of the PCT's budget relative to need (y) depends on whether it increases or reduces patient gains from additional targets (i.e. whether B_{ny} is positive or 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 ($B_{nh} < 0$). The benefit from additional targets is greater when more patients are affected ($B_{nx} > 0$) so the number of targets increases if the volume of treatments of patients at the provider increases. Increases in PCT concern for patient welfare (α) unsurprisingly increase the number of local targets when the PCT has all the bargaining power.

[TABLE 1 HERE]

When the hospital has all the bargaining power ($\beta = 0$) the number of local targets satisfies

$$U_n\left(n^*;\cdot\right)=\delta B_n\left(n^*;s,x,y,h\right)-C_n\left(n^*;s,x,\theta\right)=0 \quad (7)$$

and the comparative static predictions are determined by U_{nz}. In both (6) and (7) the generosity of the PCT budget y, and population health h only enter via $B_n(n;s,x,y,h)$ and so have the same qualitative effect on $V_n(n^*;\cdot)$ and $U_n(n^*;\cdot)$. Hence the comparative static

predictions for increases in y and h have the same sign as when the PCT sets n. The qualitative predictions for the effects of the number of SHA targets s once again depend whether the local and regional targets are complements or substitutes.

Increases in provider concern for patient welfare (δ) and increases in provider efficiency (reductions in θ) increase the number of targets since they either increase the gain from more local targets or reduce their marginal cost. The marginal benefit from local targets is greater when the hospital treats more patients ($B_{nx} > 0$) but the marginal cost of local targets will be greater since they will apply to more patients ($C_{nx} > 0$). Thus the effect of the hospital treating more patients x is ambiguous when the hospital has all the bargaining power.

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 at the optimal bargain ($V_n(n^*;\cdot\ ) > 0$, $U_n(n^*;\cdot) < 0$), we see from (5) that an increase in PCT bargaining power (β) unsurprisingly increases the number of targets.

The effect of a decrease in the disagreement utility of the PCT (an increase in γ^P) is to reduce V^o and so to increase the denominator in the first term in (5). Since the numerator in the first term is positive and not affected by γ^P, $\ell_n(n^*;\cdot\ )$ is reduced and the Nash bargain n is smaller. Analogously, when γ^H increases the denominator in the second term is reduced, and since the numerator $U_n(n^*;\cdot\ )$ is negative at the Nash bargain, $\ell_n(n^*;\cdot\ )$ is increased and so hence the bargain n^* is increased. The rationale for these results is that a reduction in the disagreement utility of a negotiator increases their utility *gain* from any agreement. The Nash Bargain shares out the total gain and so if one party's gain has an exogenous increase the bargain n^* will adjust so that the other party also gains. When the PCT's utility gain is increased by a reduction in its disagreement utility the hospital's gain must be increased, and this requires a reduction in n since $U_n(n^*;\cdot) < 0$. And vice versa: when the hospital's disagreement utility is reduced it gains and the PCT utility must be increased which requires an increase in n since $V_n(n^*;\cdot) > 0$.

Hospitals with higher input prices or worse technology have higher θ and so have higher costs ($C_\theta > 0$) and higher marginal costs of targets ($C_{n\theta} > 0$). Thus in (5) the numerator

$U_n(n^*;\cdot)$ in the second term becomes more negative since $U_{n\theta} = -C_{n\theta} < 0$. The denominator is positive and becomes smaller since $U_\theta(n;\cdot) - U_\theta(0;\cdot) = -C_\theta(n^*;\cdot) + C_\theta(0;\cdot)$ is negative if $C_{n\theta} > 0$. Hence $\ell_{n\theta} < 0$ and the number of local targets falls when input prices are higher.

An increase in the concern for patient welfare of either the hospital or the PCT has the intuitively plausible effect of increasing the number of targets since the marginal benefit from targets gets a higher weight relative to their marginal costs to the hospital or the PCT. Thus in (5) an increase in δ makes the numerator $U_n(n^*;\cdot)$ in the second term less negative ($U_{n\delta} = B_n > 0$) and the positive denominator becomes larger ($U_\delta(n^*;\cdot) - U_\delta(0;\cdot) = B(n^*;\cdot) - B(0;\cdot) > 0$. The proof that an increase in the concern for patient welfare of the PCT (α) increases the number of negotiated targets is less straightforward as an increase in α increases the numerator and the denominator of the first term in (5). However, it is possible to show that the concavity of B and convexity of m in n ensure that the increase in the numerator more than offsets the increase in the denominator.[7]

The effect of parameters which enter both terms in (5), such as the exogenous levels of hospital output, population health, regionally defined targets, and budget generosity, are ambiguous without much stronger assumptions. In (5) the marginal effects of n on the bargainers ($V_n(n^*;\cdot)$, $U_n(n^*;\cdot)$) are inversely weighed by their utility gain (the denominators). Thus, with an increase in say h which increases both $V_n(n^*;\cdot)$ and $U_n(n^*;\cdot)$, the overall effect is ambiguous because the gains to both parties (the numerators in (5)) will also increase.[8] The Nash bargain requires that exogenous gains in utility are shared via an adjustment in n^*. A parameter change alters the negotiated n^* in two ways. First, the parameter changes the marginal costs and benefits of n. Second, it changes the utility gains from the bargain and induces an adjustment in n^* to share out the gains.

[7] Proof available from authors on request.

[8] The assumption that $B_{nh} = B_{hn} > 0$ implies that $B_h(n^*;\cdot) > B_h(0;\cdot)$

4 Data and methods

4.1 Data

Information on 153 CQUIN contracts for acute hospitals in 2010/11 was obtained from the NHS Institute for Innovation and Improvement website (see NHS, 2009).[9] 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. The free-text nature of the descriptions of 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 number of locally negotiated topics (disease areas) and the number of locally negotiated process quality indicators, outcome indicators, and the total number of indicators.

We examine the association between the number of quality targets and characteristics of PCTs and hospitals which we relate to the parameters in the bargaining model. To measure the hospital's inefficiency (θ in the bargaining model) we use the Reference Cost Index for 2009/10 from the Department of Health Exposition Book.[10] The index measures how the hospital's costs compare to national average costs after allowing for its patient case-mix and local input prices. The index compares a hospital to other hospitals of the same type and so allows for differences between standard hospitals and teaching or specialist hospitals. The Reference Cost Index is a measure of inefficiency. We can also interpret θ in the bargaining model as unavoidable factors, such as local input prices, which affect the hospital's cost function. Hence we use the Market Forces Factor (also available in the Exposition Book) which measures local input prices as a further proxy for θ. The volume of patients (x) treated at each hospital in 2009/10 was obtained from Hospital Episode Statistics.

Hospital teaching and specialist status were obtained from the Compendium Indicators of the NHS Information Centre for health and social care.[11] The Reference Cost Index compares

[9] This covers 91% of acute hospitals. Details of CQUIN contracts for the other 16 English acute hospital trusts were not available.

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

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

hospitals of the same type and thus will not reflect differences in the cost structure between different types of hospital. It is possible that teaching hospitals and specialised hospitals attract better qualified or more extrinsically motivated staff than standard acute hospitals. This may reduce the marginal cost to these hospitals of targets or may lead, equivalently, to a greater weight being placed on patient benefit relative to cost. Thus we include indicators for teaching and specialist hospitals in the analysis, though we are agnostic about whether they will reflect differences in cost structure (θ) or differences in concern for patient welfare (δ).

We have information on the pre-CQUIN level of quality of hospitals in 2008/9 from the Care Quality Commission.[12] We expect that hospitals with higher pre-CQUIN quality either place a higher value on patient benefit (higher δ) or have lower marginal costs of quality (lower θ). We distinguish hospitals with quality rated as good or excellent from those rated as weak or fair. We also use the CQC 2008/9 ratings of hospital financial competence as a proxy for the reputational consequences of a failure to agree on a CQUIN contract with their negotiating PCT. We argue that hospitals which are rated as more financially competent are better able to withstand a failure to agree on CQUIN and so have higher reservation utility (U^o).

Information on Foundation Trust status at December 2009 was obtained from Monitor, the body that regulates Foundation Trusts.[13] Foundation Trusts have greater autonomy with respect to the use of any profit, so that they may place a lower weight (δ) on patient welfare relative to profit. Foundation Trust status may also enable them to attract better managers and, because they have greater freedom to sell their services to private patients, they are less reliant on their contracts with PCTs for their income. This suggests that when the hospital is a Foundation Trust, the PCT's bargaining power (β) is smaller.

The 2010/11 DH Exposition Book provided the expenditure by the lead PCT at the hospital with which it negotiated.[14] Since we also include in the empirical model the total number of patients treated, an increase in lead PCT expenditure at the hospital implies that a higher proportion of patients treated were resident in the lead PCT. We therefore expect that the

[12] http://archive.cqc.org.uk/_db/_documents/The_annual_health_check_2008_09 _Assessing_and_rating _the_NHS.pdf

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

[14] If an agency negotiated the contract we take the total expenditure of the PCTs for whom it negotiates.

PCT will place a higher value (α) on patient benefit the greater is its expenditure at the hospital.

The Exposition Book has information on the disability-free life expectancy of the PCT population which we take as the measure of PCT population health (h). The Exposition Book provides a measure of the generosity of the PCT's budget relative to the need of its population (y). We use the difference between the budget the PCT should have received in 2010/11 according to the national resource allocation formula and its actual budget. Finally, the Exposition Book has data on the PCT population. We assume that PCTs with larger populations can attract better managers who are better negotiators (implying a higher β) and who put the PCT in a better position if there is a failure to agree (implying a higher V^o).

For PCTs we have information from the NHS Institute for Innovation and Improvement website (NHS, 2009) on whether the CQUIN contract was negotiated by a lead PCT or by an agency acting on behalf of several PCTs. We include this as an additional proxy for the concern for patient welfare (α) of the purchaser. The negotiating agency has no responsibility for health or other outcomes and so is likely to place a lower weight on patient benefit.

We 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 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 better negotiators, and so have higher β, and to be less vulnerable to bargaining breakdown, so that V^o.

Where the purchaser-side negotiator was an agency acting for several PCTs, we aggregate the characteristics of the PCTs represented by the agency, using either the sum (population size,

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

hospital expenditure) or the weighted mean (health, generosity of the budget, financial competency).

4.2 Econometric methods

4.2.1 Models

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 $\mu(\mathbf{x}) \equiv \mathrm{E}(n|\mathbf{x}) = \exp(\mathbf{x}\boldsymbol{\beta})$

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

where $\mathbf{x}$ is a vector of explanatory variables. Since the assumption of variance-mean equality required by the standard Poisson model is rejected for all our dependent variables, we used negative binomial regression (Cameron and Trivedi, 1998) in which the variance is a quadratic function of the mean:

$$Var(n \mid \mathbf{x}) = E(n \mid \mathbf{x}) + \tau[E(n \mid \mathbf{x}]^2 \text{ with } \tau \geq 0.$$

We report the estimated coefficients β_k which are the proportionate change in the mean number of quality targets due to a one unit increase in x_k.[16]

4.2.2. Robustness checks

First, we estimate a nonlinear least squares model $n = \exp(\boldsymbol{x\vartheta}) + \varepsilon$ which has the advantage of avoiding the requirement to specify the error distribution. The coefficients ϑ_k again are the proportionate change in the number of targets due to a one unit increase in x_k.

Second, we attempt to allow for the possibility that hospitals which are less effective in improving quality may be more likely to prefer process indicators which are easier to achieve compared with outcome indicators. PCTs may consequently seek to require more process

[16] Letting $\mathbf{I}_k = (0,..,1,...0)$ denote a vector with 1 in the k^{th} position and 0 elsewhere, the coefficient on the k^{th} explanatory variable is

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

indicators. To allow for selection, we estimate a probit model $y^* = \alpha + z\gamma + \eta$ where $y^* = 1_{[y>0]}$ is the latent propensity to choose an outcome indicator and z is a vector of covariates. We then use the inverse of its prediction $(1/\hat{y})$ as a probability weight in the negative binomial regression. We also estimate a two-step Heckman selection model where the second stage is a linear model of the number of outcome indicators.[17]

5 Results

5.1 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 2 HERE]

Table 2 shows that, on average, the SHA mandates 3.7 topics, 2.9 outcome indicators and 2.3 process indicators for each CQUIN contract. The locally negotiated elements of the contracts contain, on average, 5.5 topics or clinical areas and 8.6 indicators, of which 2.8 are outcome indicators and 5.4 are process indicators. The remainder of the indicators are for audits or new data collection. The greater number of process indicators 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.

[17] We also attempted to estimate a count variable sample selection model (Miranda and Rabe-Hesketh, 2006; Greene, 2009), but the model did not converge.

5.2 Regression results

The regression results for the four dependent variables (measures of the number of locally negotiated targets) are shown in Table 3. The pattern of coefficients on the explanatory variables and the measures of goodness-of-fit are broadly similar for all four measures.

[TABLE 3 HERE]

Regions with more SHA-mandated outcome indicators negotiated local contracts containing more outcome indicators. Hospitals with higher costs (as indicated by their Reference Cost Index and Market Forces Factor) tended to receive more quality targets covering more topics. Specialist Trusts had contracts with nearly twice as as many outcome indicators as other Trusts, perhaps reflecting the higher specificity of their outputs. Hospitals with a higher baseline quality rating and Foundation Trusts had fewer of each of the types of quality targets, though the differences were not statistically significant. The number of targets was not associated with the number of patients treated at the hospital or its financial rating.

The CQUIN contract had fewer topics and indicators of all types where PCTs had a more generous budget relative to their need and where their populations were in better health. Contracts negotiated by agencies had more outcome indicators and fewer process indicators, though this association was significant only for local process indicators. The PCT's financial competency rating was associated with more of each type of quality target, significantly so for the number of process indicators. PCT's with larger populations negotiated a greater number of process indicators. The proportion of the PCT's expenditure to the hospital was not associated with the number of quality targets.

Table 4 has the results from the non-linear least squares models. We estimated these models using only the explanatories which were significant at 5% or better in any of the negative binomial models of Table 3. We also report the results from the negative binomial model with the same restricted set of explanatories. The size and statistical significance of most of the coefficients are similar in the negative binomial and non-linear least squares models. Again, PCTs with a healthier population negotiated CQUIN contracts with fewer topics and indicators of all types. Agencies negotiated CQUIN contracts with fewer process indicators.

[TABLE 4 HERE]

Table 5 reports results from the negative binomial model for the number of outcome indicators with weighting by the inverse probability that the contract has outcome indicators. The results are very similar to those for the same model in Table 3. None of the explanatories for selection into a contract with outcome indicators were statistically significant. When we used the results from this probit model in a two stage Heckman selection correction model with a linear second stage we found no evidence of selection bias: the inverse Mills ratio was not statistically significant in the second stage. These results are available from the authors.

[TABLE 5 HERE]

6 Discussion

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 idiosyncrasies. This is in line with earlier studies of NHS purchaser-provider contracting which examined the extent to which contracts related payment to the volume of activity (Csaba and Fenn, 1997; Chalkley and McVicar, 2008).

We find that the number of indicators mandated by the supervising Strategic Health Authority is not associated with the number of disease topics targeted, the total number of indicators or the number of process indicators. However, in line with the intuition provided by our bargaining model, an increase in the number of SHA mandated outcome indicators is associated with the number of local negotiated outcome indicators. Outcomes are harder to measures than processes. The positive association between the numbers of SHA mandated outcome measures and locally negotiated outcome measures 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 their prestige attracts higher quality or more intrinsically motivated staff and they therefore find it easier to achieve targets.

The consistently negative associations between better PCT population health and the generosity of their budget relative to need with the number of CQUIN quality targets may be because 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 that agencies which negotiate on behalf of a group of PCTs will place a lower weight on the patient benefits, because they have less direct responsibility for patient wellbeing.

We find no evidence that better hospitals negotiate outcome indicators indicating that selection might not be an issue in this sample. We cannot test whether the number of quality targets was welfare maximising for any given population. Nor, in a cross section study, can we assert that observed regularities are causal. However, it is encouraging that the number of quality targets in contracts negotiated on their behalf is associated with the health of local populations and their funding relative to need.

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Derivation of comparative static results

(For referees only. To be available from authors)

Increase in PCT concern for patient welfare (α). From (5)

$$\frac{\partial n^*}{\partial \alpha} \gtrless 0 \Leftrightarrow \frac{V_{n\alpha}\left(n^*;\cdot\right)}{V_n\left(n^*;\cdot\right)-V_n\left(0;\cdot\right)} \gtrless \frac{V_n\left(n^*;\cdot\right)}{V\left(n^*;\cdot\right)-V\left(0;\cdot\right)+\gamma^P}$$

$$\Leftrightarrow \frac{B_n\left(n^*;\cdot\right)}{B\left(n^*;\cdot\right)-B\left(0;\cdot\right)} \gtrless \frac{\alpha B_n\left(n^*;\cdot\right)-m_n(n^*;\cdot)}{\alpha B\left(n^*;\cdot\right)-m(n^*;\cdot)-\alpha B\left(0;\cdot\right)+m(0;\cdot)+\gamma^P}$$

$$\Leftrightarrow \frac{B_n\left(n^*;\cdot\right)}{B\left(n^*;\cdot\right)-B\left(0;\cdot\right)} \gtrless \frac{B_n\left(n^*;\cdot\right)-m_n(n^*;\cdot)\alpha^{-1}}{B\left(n^*;\cdot\right)-B\left(0;\cdot\right)-\left[m(n^*;\cdot)-m(0;\cdot)-\gamma^P\right]\alpha^{-1}}$$

Multiplying both sides of the inequality condition by the product of the denominators and cancelling $B_n\left(n^*;\cdot\right)\left[B\left(n^*;\cdot\right)-B\left(0;\cdot\right)\right]$ from both sides we have

$$\frac{\partial n^*}{\partial \alpha} \gtrless 0 \Leftrightarrow -B_n\left(n^*;\cdot\right)\left[m(n^*;\cdot)-m(0;\cdot)-\gamma^P\right]\alpha^{-1} \gtrless -\left[B\left(n^*;\cdot\right)-B\left(0;\cdot\right)\right]m_n(n^*;\cdot)\alpha^{-1}$$

Hence if the penalty for disagreement (γ^P) is sufficiently large that $m(n^*;\cdot) - m(0;\cdot) \leq \gamma^P$ then $\partial n^*/\partial\alpha > 0$. If $m(n^*;\cdot) - m(0;\cdot) > \gamma^P$ then

$$\frac{\partial n^*}{\partial \alpha} \gtrless 0 \Leftrightarrow \frac{B_n\left(n^*;\cdot\right)}{B\left(n^*;\cdot\right)-B\left(0;\cdot\right)} \gtrless \frac{m_n(n^*;\cdot)}{\left[m(n^*;\cdot)-m(0;\cdot)-\gamma^P\right]}$$

$$\Leftrightarrow \frac{B_n\left(n^*;\cdot\right)}{\left[B\left(n^*;\cdot\right)-B\left(0;\cdot\right)\right]n^{-1}} \gtrless \frac{m_n(n^*;\cdot)}{\left[m(n^*;\cdot)-m(0;\cdot)-\gamma^P\right]n^{-1}}$$

Because B is concave in n and m is convex in n we have

$$\frac{B_n\left(n^*;\cdot\right)}{\left[B\left(n^*;\cdot\right)-B\left(0;\cdot\right)\right]n^{-1}} < 1 < \frac{m_n(n^*;\cdot)}{\left[m(n^*;\cdot)-m(0;\cdot)\right]n^{-1}} < \frac{m_n(n^*;\cdot)}{\left[m(n^*;\cdot)-m(0;\cdot)-\gamma^P\right]n^{-1}}$$

and so $\partial n^*/\partial\alpha > 0$.

General comparative statics

Differentiating (5) with respect to z (where z is any of the exogenous parameters which enter both $V - V^o$ and $U - U^o$) gives

$$\ell_{nz} = \beta(V-V^o)^{-2}[V_{nz}(V-V^o)-V_n(V_z-V_z^o)] \quad + (1-\beta)(U-U^o)^{-2}[U_{nz}(U-U^o)-U_n(U_z-U_z^o)]$$

Substituting for (1-β) from (5) and rearranging gives

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

With $z = h$

$$\operatorname{sgn}\frac{\partial n^*}{\partial z} = \operatorname{sgn}\left\{\alpha\left[\frac{B_{nh}}{V_n} - \frac{B_h\left(n^*;\cdot\right) - B_h\left(0;\cdot\right)}{V - V^o}\right] - \delta\left[\frac{B_{nh}}{U_n} - \frac{B_h\left(n^*;\cdot\right) - B_h\left(0;\cdot\right)}{U - U^o}\right]\right\}$$

The numerators in the second square bracketed term have the same sign but the denominator of the first ratio is negative ($U_n(n^*;\cdot) < 0$) and the denominator of the second ratio is positive. Thus the second square bracketed term has the opposite sign to B_{nh}. But even with assumptions about the sign of B_{nh} the first square bracketed term has ambiguous sign. The numerators in the two parts of this term have the same sign and the denominators are both positive since $V_n(n^*;\cdot) > 0$. We require similarly detailed assumptions to sign the effects of changes in the PCT budget (y), total hospital output (x), and the number of regional targets (s).

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	s	?	?	?
Hospital input prices	θ	0	–	–
Hospital concern for patients'welfare	δ	0	+	+
Hospital output	X	+	sgn $\delta B_{nx} - C_{nx}$	?
Hospital reservation utility	U^o	0	0	+
PCT bargaining power	β	Na	na	+
PCT budget generosity	Y	sgn B_{ny}	sgn B_{ny}	?
PCT population health	H	sgn B_{nh}	sgn B_{nh}	?
PCT concern for patients'welfare	α	+	0	+
PCT reservation utility	V^o	0	0	–

Table 2. Summary statistics

	Mean	Std. Dev.	Min	Max
Number of locally negotiated quality targets:				
Topics	5.46	3.89	0	18
Indicators	8.61	8.29	0	50
Outcome indicators	2.75	4.25	0	24
Process indicators	5.42	5.74	0	27
Number of regional mandated quality targets:				
Topics	3.73	3.13	0	13
Outcome indicators	2.87	3.27	0	18
Process indicators	2.31	3.83	0	15
Hospital characteristics:				
Reference Cost Index (2009/10)	100.77	9.16	80.00	157.00
Hospital Market Forces Factor (2009/10)	100.00	6.75	92.47	119.60
Teaching Trust	0.15	0.36	0	1
Specialist Trust	0.12	0.33	0	1
CQC quality score (2008/09)	0.29	0.45	0	1
Patients treated (2009/10, 100,000s)	0.98	0.55	0.04	2.79
CQC finance score (2008/09)	0.18	0.38	0	1
Foundation Trust by 2009	0.53	0.50	0	1
PCT characteristics:				
Population size (2009/10, 100,000s)	5.70	4.33	1.42	19.10
Generosity of budget relative to need (2010/11)	0.63	5.54	-7.40	21.30
Population health (2010)	62.75	3.12	55.80	68.10
Proportion of expenditure to this hospital	0.45	0.29	0.00	0.98
Contract negotiated by an agency	0.15	0.36	0	1
WCC financial competency rating (2009/10)	0.71	0.21	0	1

Table 3. Negative Binomial models for number of local quality topics and indicators

	Local topics		Total local indicators		Local outcome indicators		Local process indicators	
	Coeff.	z	Coeff.	z	Coeff.	z	Coeff.	z
Number of regional targets	-0.003	-0.13	-0.013	-0.79	0.123***	3.28	0.021	0.71
Hospital characteristics:								
Reference Cost Index	0.012*	1.66	0.005	0.61	0.005	0.37	0.005	0.47
Hospital Market Forces Factor	0.025	1.51	0.036*	1.77	-0.014	-0.46	0.028	1.10
Hospital is a Teaching Trust	0.198	1.12	0.243	1.08	-0.114	-0.31	0.294	1.06
Hospital is a Specialist Trust	-0.238	-0.96	0.178	0.59	0.860*	1.84	0.047	0.13
CQC quality rating 2008/9	-0.146	-1.12	-0.239	-1.49	-0.123	-0.49	-0.290	-1.45
Patients treated 2009/10	-0.013	-0.09	0.100	0.53	-0.218	-0.69	0.077	0.34
CQC financial rating 2008/9	0.013	0.08	0.153	0.75	0.106	0.33	-0.063	-0.25
Hospital is a Foundation Trust	-0.137	-1.06	-0.200	-1.25	-0.247	-1.01	-0.148	-0.74
PCT characteristics:								
PCT's population size	-0.002	-0.08	0.014	0.41	-0.039	-0.72	0.070*	1.67
PCT's generosity of budget	-0.046***	-2.90	-0.052***	-2.68	-0.063**	-2.03	-0.034	-1.42
PCT's population health	-0.074***	-2.95	-0.105***	-3.39	-0.101**	-2.15	-0.083**	-2.17
Proportion of expenditure at hospital	-0.117	-0.38	-0.052	-0.14	0.216	0.33	0.178	0.39
Contract negotiated by agency	-0.397	-1.08	-0.574	-1.34	0.704	1.03	-1.784***	-3.20
WCC financial competency 2009/10	0.090	0.29	0.484	1.25	0.144	0.25	0.914*	1.74
Constant	2.835	1.38	4.279*	1.77	8.026**	2.14	2.536	0.80
Pseudo-R^2	0.0467		0.0493		0.0639		0.0513	
χ^2 over-dispersion test	51.4	p<0.001	296.4	p<0.001	182.8	p<0.001	225.7	p<0.001
N	153		153		153		153	

Notes. Coefficients are proportionate changes in dependent variable per unit increase in the explanatory variable. *** p<0.01, ** p<0.05**, * p < 0.10.**

Table 4. Nonlinear Least Squares models for number of local quality topics and indicators

	Local topics		Total local indicators		Local outcome indicators		Local process indicators	
	NLS	NB	NLS	NB	NLS	NB	NLS	NB
Number of regional targets	0.004	0.01	-0.02	-0.001	0.03	0.08***	0.01	0.03
	(0.19)	(0.53)	(-1.29)	(-0.03)	(0.84)	(2.65)	(0.23)	(1.15)
PCT's generosity of budget	-0.01	-0.03**	0.01	-0.03	0.02	-0.04	-0.01	-0.03
	(-0.84)	(-2.09)	(0.76)	(-1.82)	(0.79)	(-1.65)	(-0.35)	(-1.32)
PCT's population health	-0.08***	-0.07***	-0.15***	-0.11***	-0.21***	-0.14***	-0.11***	-0.09***
	(-4.98)	(-4.15)	(-6.14)	(-5.42)	(-4.15)	(-4.60)	(-4.72)	(-3.56)
Contract negotiated by agency	-0.21	-0.12	-0.36	-0.07	-0.11	0.38	-1.15***	-0.76**
	(-0.94)	(0.19)	(-1.29)	(-0.29)	(-0.30)	(1.07)	(-3.27)	(-2.56)
Constant	6.94***	6.04***	11.85***	8.87***	13.83***	9.34***	8.87***	7.12***
	(6.66)	(5.66)	(7.57)	(7.09)	(3.09)	(4.96)	(5.96)	(4.60)
N	153	153	153	153	153	153	153	153

Notes. NLS: non-linear least squares. NB: negative binomial. Coefficients are proportionate changes in dependent variable per unit increase in the explanatory variable. Models only contain variables that were significant at $p<0.05$ in Table 3. Robust t-stats or z-stats in ().
*** $p<0.01$, ** $p<0.05$.

Table 5. Inverse probability weighted negative binomial model for number of outcome indicators

	P(y*>0)		Model I	
	Coeff.	z	Coeff.	z
Number of regional targets	0.005	0.12	1.131***	3.26
Hospital characteristics:				
Reference Cost Index	-0.002	-0.12	0.008	0.59
Hospital Market Forces Factor	-0.018	-0.49	-0.035	-1.04
Hospital is a Teaching Trust	0.487	1.14	-0.085	-0.23
Hospital is a Specialist Trust	0.746	1.39	1.137**	2.47
CQC quality rating 2008/9	-0.309	-1.15	-1.179	-0.65
Patients treated 2009/10	0.052	0.16	-0.214	-0.56
CQC financial rating 2008/9	0.536	1.42	0.102	0.35
Hospital is a Foundation Trust	-0.327	-1.22	-0.214	-0.96
PCT characteristics:				
PCT's population size	-0.078	-1.22	-0.055	-1.06
PCT's generosity of budget	-0.047	-1.39	-0.076***	-2.65
PCT's population health	-0.061	-1.10	-0.089*	-1.87
Proportion of expenditure at hospital	0.098	0.15	0.551	0.91
Contract negotiated by agency	1.303	1.44	1.190*	1.91
WCC financial competency 2009/10	-0.060	-0.10	-0.124	-0.22
Constant	6.621	1.42	9.025**	2.11
Mills ratio	-		-	
N	153		153	

Notes. Probit model for $P(y^{*} > 0)$: probability that scheme has at least one outcome indicator. *** p<0.01, ** p<0.05, * p < 0.10.