Hospital Choices, Hospital Prices and Financial Incentives to Physicians: Appendices for Online Publication

Kate Ho and Ariel Pakes

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Appendix 1: Details on the Market and the Data

This paper focuses on hospital referrals for pregnant women who are enrolled in private HMO plans in California. The referring physician is an obstetrician who is often a member of a large physician group. There are two types of physician groups: medical groups and Independent Practice Associations (IPAs). On average they each cover 50,000 lives and contain between 200-300 physicians per group. Approximately two-thirds of patients covered by non-Kaiser physician organizations are in IPAs and one-third are in medical groups (see Rosenthal et al (2001)). Physicians in medical groups are either employees or partners of the group. IPAs are administrative organizations that contract with independent physicians or clinics and sign network contracts with health plans on behalf of their physicians. They exist primarily to negotiate and manage capitation contracts for their member physicians. As discussed in the paper, capitation contracts generate incentives at the physician group level to utilize low-cost hospitals.

If capitation arrangements are to influence hospital referral choices, however, cost-control incentives must be passed from the physician group to the individual physician. The connection is clear when the physician is a partner in a medical group since his or her own income is directly linked to the group's profitability but less clear for other physicians. Rosenthal et al (2002) consider this issue, tracking the flow of financial incentives from physician organizations to physicians in California. They find that the majority of physician groups receiving capitation payments pass financial risk on to individual physicians, for example in the form of cost-of-care bonuses or profit sharing.[1]

Our model assumes that hospitals are reimbursed on a fee-for-service basis. In reality different insurers may use different payment mechanisms to reimburse different hospitals in their networks. The major possibility, in addition to fee-for-service payments, is a per-diem payment arrangement under which the hospital receives a fixed number of dollars per day of inpatient stay. We have some information at the hospital and insurer level on the payment mechanisms used but this information is not provided at the discharge level. The weighted average percent of payments that are made

[1] Grumbach et al (1998a) survey California IPAs and have similar findings. They also note that IPAs that are paid on a fee-for-service basis make fee-for-service payments to their member physicians.

on a per-diem basis (where the weight is the number of enrollees in the plan) is fairly low at 21%. Two of the six carriers in our data, Aetna and Health Net, report no per-diem payments in 2003[2].

We note in Section 4 that our dataset does not precisely identify HMO enrollees for every insurer. Instead it groups together all Knox Keene enrollees for a particular insurer, defined as enrollees in plans that are overseen by the California Department of Managed Health Care (DMHC) and subject to the Knox Keene Act. All California HMOs are Knox Keene plans. In addition, Blue Cross and Blue Shield PPO products were Knox Keene plans in 2003, the year of our data. 63% of Blue Shield's Knox Keene enrollees, and 72% of those for Blue Cross, were in the PPO rather than HMO product. We cannot distinguish between PPO and HMO enrollees for these two insurers at the individual discharge level. Capitation rates are also reported for the full Knox Keene plan. This likely generates some of the cross-insurer variation in capitation rates in the data: PPOs usually pay their physicians on a fee-for-service basis, unlike HMOs, consistent with Blue Shield and Blue Cross having the lowest capitation payment rates in our data.[3] Provided we control for other differences between HMO and PPO plan types this is not a problem: in fact it provides helpful variation to assist us in identifying the effect of capitation on physician behavior. We note that PPOs use the same mechanism for hospital referrals as HMOs except that patients have more discretion: by paying a relatively high out-of-pocket price they can choose to visit an out-of-network hospital or physician. Pricing policies can also be different. While an HMO enrollee probably pays the same small copay whatever hospital she chooses, approximately 15% of PPO enrollees pay a coinsurance rate (a fixed percentage of the total price) that is lower if they choose an in-network hospital than if they go outside.[4] We drop hospitals to which very few patients are admitted for these two insurers, expecting thereby to remove out-of-network hospitals from the data.[5] Any remaining difference in pricing strategies for PPO plans biases our estimates towards finding no difference in price coefficients between high- and low-capitation insurers, since patients presumably have a higher sensitivity to price than do physicians and our model conflates the price coefficients of patients and physicians for Blue Cross and Blue Shield.

We make several assumptions to define hospital prices for the logit analysis that are not needed for the inequality analysis. If discount information is missing we fill it in for the logit analysis using

[2] Case-based or D.R.G. payments are also possible: our data do not distinguish between them and fee-for-service payments but we expect case-based payments to be less common since they are predominately used by Medicare rather than private payors. Capitation payments to hospitals are possible but uncommon. Only 24 of the 195 hospitals in the full dataset (e.g. in Table 2) have over 5% of revenues from capitation. 104 report zero capitation payments. Our logit analysis includes all hospitals, including those that receive capitation payments. In a robustness test we redefine price to be price*(1-percent of revenues received on a capitated basis). The results are very similar to those from the baseline logit analysis. The inequalities analysis excludes the hospitals reporting that more than 5% of their revenues are paid on a capitation basis.

[3] However this is not the only reason for variation in the percent capitation variable across insurers. Interviews with officials at the DMHC indicate that not all PPO plans are exclusively fee-for-service and not all HMOs in California are exclusively capitated.

[4] The Kaiser Family Foundation Employer Health Benefits Survey 2003 shows that the difference in pricing strategies was not large in that year. 14% of covered workers in a PPO plan paid a coinsurance rate, 26% paid a dollar copay and 59% paid neither. In contrast 5% of HMO enrollees paid a coinsurance rate and 49% paid a copay.

[5] The inequalities analysis drops hospitals with fewer than 150 switches with other hospitals in the data. This implies dropping approximately 10% of hospitals for each of Blue Shield and Blue Cross.

regression analysis. (These observations are excluded from the inequalities analysis.) For approximately 5% of the hospitals in the sample we do not observe the discount for the calendar year but do observe discount data for both relevant fiscal years (from the annual financial statements; fiscal years vary across hospitals). We fill in the missing calendar year information using the predictions from a regression of calendar year discounts on fiscal year discounts and hospital characteristics (fixed effects for hospital systems, service type, control type, Hospital Referral Region, teaching hospitals and particular services provided and lagged numbers of doctors and beds, all as reported in the American Hospital Association data for 2003). The R^2 of the regression is 0.61. A few other hospitals have missing discount data for the relevant fiscal years and the calendar year; in this case we use the predictions of a regression of calendar year discounts on hospital characteristics which has a R^2 of 0.49.

In addition, for the logit analysis, if the set of patients to be used to determine a patient's price in a particular hospital is empty, we expand the group of "similar" patients to include women in the same age category and with the same Charlson score and principal diagnosis. If this is also empty we expand it to include all same-age category same-principal diagnosis patients, then all same-principal diagnosis women. If this group is also empty we take the mean of the non-missing prices already calculated for the particular patient. (This is not an issue for the inequality analysis: we only compare hospitals where prices can be calculated for both switching patients.)

Appendix 2: Estimation of the Discount Variation Across Insurers

This appendix provides details of the method discussed in Section 7.3 that was used to estimate the variation in discounts across insurers. We begin with the average negotiated discount at the hospital level, d_h.[6] This is a weighted average of the discounts for both inpatient and outpatient services to both Knox Keene and Point of Service (POS) insurers. We assume for the moment that the discount at the hospital-insurer level, $d_{\pi,h}$, does not differ across diagnoses for a given (π, h) pair; we relax this assumption in the following section. We use data from the OSHPD hospital discharge and financial records for 2003 that are not used in the main analysis. First, we have discharge data covering all Knox Keene inpatient events in the year 2003, including diagnoses other than delivery and births. We observe a list price for every discharge. Second, the hospital financial reports include data on hospital h's total charges (sum of list prices) for managed care (Knox Keene and POS) inpatient services and separately for managed care outpatient services.

If $s_{\pi,h}$ ($s^o_{\pi,h}$) is the share of Knox Keene π's inpatient (outpatient plus POS inpatient) charges in hospital h we know that:

$$d_h = \sum_\pi s_{\pi,h} d_{\pi,h} + \sum_\pi s^o_{\pi,h} d^o_{\pi,h} \tag{1}$$

where $\sum_\pi (s_{\pi,h} + s^o_{\pi,h}) = 1$. We are constrained by lack of data on $s^o_{\pi,h}$. We therefore assume that $d^o_{\pi,h} = d_{\pi,h}$. We can always write $s^o_{\pi,h} = s_h s_{\pi,h} + e_{\pi,h}$ where $s_h \equiv \sum_\pi s^o_{\pi,h} / \sum_\pi s_{\pi,h}$, and can be calculated from the observed data, and $\sum_\pi e_{\pi,h} = 0$. Substituting we have:

$$d_h = \sum_\pi (1 + s_h)\, s_{\pi,h} d_{\pi,h} + \tilde{e}_h \tag{2}$$

where $\tilde{e}_h = \sum_\pi e_{\pi,h} d_{\pi,h}$.

To proceed we need a specification for HMO inpatient discounts at different hospitals. We begin by writing

$$d_{\pi,h} = d_0 + \tilde{d}_h + \tilde{d}_{\pi,h}$$

where $\forall h$, $\sum_\pi \tilde{d}_{\pi,h} = 0$, so that $d_0 + d_h$ is the mean hospital discount, and $\sum_h \tilde{d}_h = 0$ so that d_0 is the mean of the (mean) hospital discount (across hospitals). Our reduced form model for the mean hospital discount is

$$\tilde{d}_h = \left(\frac{\exp(X_{h,m}\beta^h)}{1 + \exp(X_{h,m}\beta^h)} - d_0 \right) + v_h \equiv \Big(f(X_{h,m}, \beta^h) - d_0 \Big) + v_h \tag{3}$$

where $X_{h,m}$ are hospital characteristics or their interactions with market characteristics and v_h is mean independent of $X_{h,m}$. The reduced form model for an insurer's deviation from the mean

[6] We conduct this analysis using the discount d_h rather than one minus the discount, which is defined above as $\delta^o_h = 1 - d_h$.

discount is

$$\tilde{d}_{\pi,h} = \frac{\exp(X_{\pi,h,m}\beta^{\pi}) - \frac{1}{N_{\pi,h}}\sum_{\pi}\exp(X_{\pi,h,m}\beta^{\pi})}{\frac{1}{N_{\pi,h}}\sum_{\pi}\exp(X_{\pi,h,m}\beta^{\pi})} + v_{\pi,h} \equiv f(X_{\pi,h,m}\beta^{\pi}) + v_{\pi,h} \tag{4}$$

where $X_{\pi,h,m}$ are insurer characteristics and their interactions with market and hospital characteristics and $N_{\pi,h}$ is the number of insurers contracting with hospital h and where $v_{\pi,h}$ is mean independent of $X_{\pi,h,m}$ and $\forall h$, $\sum_{\pi} v_{\pi,h} = 0$ (since $\sum_{\pi} \tilde{d}_{\pi,h} = 0$).

Substituting these specifications into equation (2) generates the following equation which can be estimated using nonlinear least squares:

$$d_h = f(X_{h,m}, \beta^h) + \sum_{\pi}(1 + s_h)\, s_{\pi,h} f(X_{\pi,h,m}\beta^{\pi}) + e_h \tag{5}$$

where $e_h = \sum_{\pi}(1 + s_h)\, s_{\pi,h} v_{\pi,h} + v_h + \tilde{e}_h$.

The estimates, set out in Tables 1 and 2 of this Appendix, are intuitive. Table 1 sets out the results when $X_{h,m}$ includes both hospital characteristics and market fixed effects. Model 1 includes insurer fixed effects; in Model 2 we collapse these into a fixed effect for high-capitation insurers (Pacificare together with Aetna, Health Net and Cigna), a fixed effect for Blue Cross and a continuous variable defined as the insurer's share of HMO enrollment in California.[7] In both cases we find that for profit hospitals and hospitals that are members of systems (groups of providers that bargain jointly with insurers) have significantly higher discounts than other hospitals. At first sight this is surprising since a higher discount implies a lower price paid to the hospital. However, this is likely to be explained by the substantial variation in list prices across hospitals. We show in Table 6 of Ho and Pakes (2011) that for profit hospitals have higher prices net of discounts than not-for-profit hospitals. If we add an indicator for hospitals in systems to the regression we find that system hospitals, too, have significantly higher prices than other hospitals.[8] These results indicate that, while discounts are high for system and for profit hospitals, list prices are higher, so that the net price paid conditional on severity is also relatively high for these providers.

Other hospital characteristics such as indicators for teaching hospitals and hospitals that provide transplants (a measure of high-tech hospitals) are not significant in our analyses. The coefficient on a variable measuring the hospital's share of beds in the market, a potential measure of hospital bargaining power, is negative as expected but not significant at p=0.05. The insurer fixed effects in Model 1 are all statistically insignificant and the magnitudes demonstrate no particular correlation between insurer capitation levels and discounts. In Model 2 the coefficient for high-capitation insurers is slightly negative, and that for Blue Cross is somewhat more negative compared to the

[7] We use the share of enrollment at the state level rather than the market level to help avoid endogeneity problems due to insurers with high discounts in a particular market attracting high enrollment in that market.

[8] The analysis controls for patient severity by using as a price measure the price ratio $p_i^{ratio} = \frac{p_i}{\bar{p}_{s_i}}$ where p_i is the price (list price multiplied by δ_h) for patient i and $\bar{p}_{s_i}$ is the average price for same-severity patients across all hospitals in the sample. The results of these regressions are excluded from this paper to conserve space. They are available from the authors on request.

excluded plan (Blue Shield) although neither coefficient is significant at p=0.05. The coefficient on HMO market share is positive (although again insignificant), consistent with a bargaining power story. We use the results in Model 2 to calculate the predicted $\hat{\delta}_{\pi,h}$ that are used in the inequalities analysis since they provide a somewhat smoother prediction of the variation in discounts across insurers than the results in Model 1. The hypothesis that Model 2 fits the data as well as Model 1 cannot be rejected in an F-test of size 0.05.[9]

In Table 2 we replace the market fixed effects with market characteristics. We view this as an exploratory exercise to check that our results are consistent with the previous literature on the impact of hospital and insurer concentration on prices. Our results are similar to those in previous papers: we find that variables likely to be positively correlated with hospital bargaining power are negatively related to hospital discounts, while those positively related to insurer bargaining power are positively correlated with discounts. For example, in Model 3 we find that when market fixed effects are removed the positive coefficient on the insurer market share variable and the negative coefficient on hospital market share both become significant at p=0.05. Models 4-5 demonstrate that discounts are significantly higher in markets with more hospitals per thousand population and lower in markets with more insurers per 1000 population.

The final step is to use these estimates to generate a prediction for $d_{\pi,h}$. There are two possibilities. First, since:

$$d_{\pi,h} \approx f(X_{h,m}, \hat{\beta}^h) + f(X_{\pi,h,m}\hat{\beta}^\pi) + (v_{\pi,h} + v_h)$$

we define

$$\hat{d}^1_{\pi,h} = f(X_{h,m}, \hat{\beta}^h) + f(X_{\pi,h,m}\hat{\beta}^\pi) \tag{6}$$

and incur the error $e^1_{\pi,h} = v_{\pi,h} + v_h$. Second, since

$$d_{\pi,h} \approx d_h - \sum_\pi (1+s_h)\, s_{\pi,h} f(X_{\pi,h,m}\hat{\beta}^\pi) + f(X_{\pi,h,m}\hat{\beta}^\pi) + \left(v_{\pi,h} - \tilde{e}_h - \sum_\pi (1+s_h)\, s_{\pi,h} v_{\pi,h} \right)$$

we define

$$\hat{d}^2_{\pi,h} = d_h - \sum_\pi (1+s_h)\, s_{\pi,h} f(X_{\pi,h,m}\hat{\beta}^\pi) + f(X_{\pi,h,m}\hat{\beta}^\pi) \tag{7}$$

and incur the error $e^2_{\pi,h} = v_{\pi,h} - \tilde{e}_h - \sum_\pi (1+s_h)\, s_{\pi,h} v_{\pi,h}$. We use the predictions to define price measures $p^1(.) = (1-\hat{d}^1_{\pi,h}) lp^o(c_i,h)$ and $p^2(.) = (1-\hat{d}^2_{\pi,h}) lp^o(c_i,h)$ and use these in the inequalities analysis. The errors $(1-e^1_{\pi,h}) lp^o(c_i,h)$ and $(1-e^2_{\pi,h}) lp^o(c_i,h)$, together with estimation error from this step and measurement error from the expected list price calculation, will be inputs into the error term $\varepsilon_{i_h,\pi,h}$ defined in Section 7.2.

[9] We also estimated the inequalities analysis using the discounts predicted by Model 1; the results were very similar to the main analyses reported in Table 6.

While use of $p^1(.)$ and/or $p^2(.)$ as our price variable mitigates the problems that could arise from using a price variable that does not account for insurer-specific discounts, it probably does not eliminate them. To the extent that doctors know $\nu_{\pi,h}$ and select hospitals based on its value there will still be a selection bias in both of these price variables[10] , and if doctors know ν_h and select based on its value there will be an additional source of selection bias in $p^1(\cdot)$[11].

Allowing Discounts to Differ Across Diagnoses

As an additional robustness test we modify the analysis above to allow discounts for deliveries to differ from those for other diagnoses, and to allow the extent to which they differ to depend on hospital characteristics:

$$d_{\pi,h} = (1 - s^{birth}_{\pi,h}) d^{non-birth}_{\pi,h} + s^{birth}_{\pi,h} \gamma_h d^{non-birth}_{\pi,h}.$$

We parametrize $d^{non-birth}_{\pi,h}$ using the same reduced form expressions and explanatory variables as those used for $d_{\pi,h}$ above. We write γ_h as a linear combination of a constant, an indicator for teaching hospitals, the hospital's share of beds in the market and a variable summarizing the quality of delivery services offered by the hospital, . Under the assumptions that (a) there are no births in outpatient units, (b) the share of π's POS inpatient charges in hospital h that are births is the same as its share of Knox Keene inpatient charges that are births, and (c) the share of outpatient plus POS inpatient charges that are outpatient is the same for all insurers, we can derive an estimating equation similar to equation (5). The results are set out in Appendix 2 Table 3. In Model 1 we include just a constant term in γ_h. Its coefficient is statistically significant with a magnitude of 1.06, indicating that on average discounts for deliveries are 6 percent higher than those for other diagnoses. The coefficients on the hospital and insurer characteristics in $d^{non-birth}_{\pi,h}$ differ very little from the baseline specification (Model 2 of Appendix 2 Table 1). Models 2, 3 and 4 include different combinations of hospital characteristics in γ_h; none of these have significant coefficients at p=0.05.

We complete the robustness test by recomputing the prediction for $d_{\pi,h}$ using the estimates in Model 1 of Appendix 2 Table 3 and repeating the inequalities analysis using this prediction to generate the price variable. The results differ very little from those reported in Table 6.

[10] Only the component of $(1 - e_{\pi,h}) lp^o(c_i, h)$ that differs across c_i groups within a hospital-severity pair will be absorbed into the error term rather than into $g_\pi(.)$. However, the interaction with the list price implies that there will be some such variation and if decision-makers observe it this will cause endogeneity bias. We assume that $\tilde{e}_h$ is unrelated to discounts and therefore not problematic here.

[11] We did investigate the magnitude of the errors through a regression analysis. Note from equation (5) that

$$H^{-1} \sum_h e_h^2 \to_P \sigma^2_{\tilde{e}} + \sigma^2_h + \sum_\pi (1 + s_h)^2 s^2_{\pi,h} \sigma^2_{\pi,h}$$

where $\sigma^2_{\tilde{e}}$ is the variance of $\tilde{e}_h$ and similarly for σ^2_h and $\sigma^2_{\pi,h}$. We regress e_h^2 on a constant term and $\sum_\pi (1 + s_h)^2 s^2_{\pi,h}$ and estimate a constant term of 0.0037 (standard error 0.0034) and an estimate of the coefficient on the X variable of 0.0286 (standard error 0.0107). We compare these numbers to the variance in d_h, a lower bound on the unobserved variance in $d_{\pi,h}$, which is 0.022. We conclude that the variance in $v_{\pi,h}$ is likely larger in magnitude that that of v_h.

Appendix 2, Table 1: NLLS Analysis of Discount Variation

	percent capitated	Model 1 Coefft	(S.E.)	Model 2 Coefft	(S.E.)
Hospital Characteristics					
Constant		-0.07	(0.30)	-0.14	(0.29)
Teaching hospital		-0.03	(0.11)	-0.06	(0.11)
Cost per admission		-0.01	(0.01)	-0.01	(0.01)
For profit		0.44**	(0.12)	0.43**	(0.12)
Offers transplants		-0.05	(0.17)	-0.03	(0.17)
System hospital		0.26**	(0.11)	0.26**	(0.12)
Share of beds in mkt		-12.32	(7.83)	-11.46	(8.16)
Insurer Characteristics					
Pcare/Aetna/HN/Cigna				-0.11	(0.07)
Pacificare	0.97	-0.04	(0.13)		
Aetna	0.91	0.09	(0.20)		
Health Net	0.80	0.12	(0.15)		
Cigna	0.75	-0.42	(0.23)		
Blue Shield	0.57	0.11	(0.15)		
Blue Cross	0.38	0.00	(0.12)	-0.36	(0.22)
Share in CA				1.77	(1.32)
Market FEs?		Yes		Yes	
pseudo-R^2		0.46		0.45	
Number hospitals		144		144	

Notes: NLLS analysis of variation in hospital discounts d_h across hospitals, insurers and markets. Equation for estimation is $d_h = f(X_{h,m}, \beta^h) + \sum_\pi (1 + s_h)\, s_{\pi,h} f(X_{\pi,h,m}\beta^\pi) + e_h$ where $f(X_{h,m}, \beta^h) = \frac{\exp(X_{h,m}\beta^h)}{1+\exp(X_{h,m}\beta^h)}$ and $f(X_{\pi,h,m}\beta^\pi) = \frac{\exp(X_{\pi,h,m}\beta^\pi) - \frac{1}{N_{\pi,h}}\sum_\pi \exp(X_{\pi,h,m}\beta^\pi)}{\frac{1}{N_{\pi,h}}\sum_\pi \exp(X_{\pi,h,m}\beta^\pi)}$. "Cost per admission" is average hospital cost per admission in $000. "Share in CA" is insurer's share of HMO enrollment in California. pseudo-R^2 is 1 - (SSR from full model / SSR from model including only a constant). ** = significant at p=0.05; *=significant at p=0.10.

Appendix 2, Table 2: NLLS Analysis of Discount Variation: Market Characteristics

	Model 3		Model 4		Model 5	
	Coefft	(S.E.)	Coefft	(S.E.)	Coefft	(S.E.)
Hospital Characteristics						
Constant	0.54**	(0.20)	0.13	(0.30)	-0.26	(0.32)
Teaching hospital	0.05	(0.09)	0.08	(0.09)	0.01	(0.10)
Cost per admission	-0.03**	(0.01)	-0.02**	(0.01)	-0.02**	(0.01)
For profit	0.50**	(0.12)	0.53**	(0.12)	0.52**	(0.11)
Offers transplants	0.03	(0.15)	0.03	(0.15)	-0.01	(0.15)
System hospital	0.20**	(0.12)	0.20**	(0.12)	0.21**	(0.12)
Share of beds in mkt	-10.17**	(4.55)	-13.87**	(4.69)	-7.56	(6.22)
Market Characteristics						
Hosps per 1000 pop			69.06**	(39.60)	172.39**	(53.61)
Plans per 1000 popln					-81.83**	(36.32)
Insurer Characteristics						
Pcare/Aetna/HN/Cigna	-0.11	(0.07)	-0.07	(0.07)	-0.06	(0.07)
Blue Cross	-0.55**	(0.22)	-0.48**	(0.24)	-0.45	(0.24)
Share in CA	3.48**	(1.45)	3.14**	(1.51)	2.92**	(1.55)
pseudo-R^2	0.33		0.34		0.36	
Number hospitals	144		144		144	

Notes: NLLS analysis of variation in hospital discounts d_h across hospitals, insurers and markets. See notes to Appendix 2 Table 1 for details. ** = significant at p=0.05; *=significant at p=0.10.

Appendix 2, Table 3: NLLS Discount Analysis with Variation Across Diagnoses

	Model 1		Model 2		Model 3		Model 4	
	Coefft	(S.E.)	Coefft	(S.E.)	Coefft	(S.E.)	Coefft	(S.E.)
Hospital Characteristics								
Constant	-0.16	(0.28)	-0.11	(0.28)	-0.15	(0.29)	-0.11	(0.28)
Teaching hospital	-0.05	(0.11)	-0.05	(0.11)	-0.08	(0.23)	-0.08	(0.23)
Cost per admission	-0.01	(0.01)	-0.01	(0.01)	-0.01	(0.01)	-0.01	(0.01)
For profit	0.42**	(0.12)	0.42**	(0.13)	0.42**	(0.13)	0.42**	(0.13)
Offers transplants	-0.04	(0.17)	-0.05	(0.17)	-0.05	(0.18)	-0.05	(0.18)
System hospital	0.26**	(0.12)	0.26**	(0.12)	0.26**	(0.12)	0.26**	(0.12)
Share of beds in mkt	-11.45	(8.06)	-14.86	(8.58)	-11.70	(8.08)	-14.81	(8.52)
Insurer Characteristics								
Pcare/Aetna/HN/Cigna	-0.11	(0.07)	-0.11	(0.07)	-0.11	(0.07)	-0.10	(0.07)
Blue Cross	-0.36	(0.22)	-0.37	(0.22)	-0.36	(0.22)	-0.37	(0.22)
Share in CA	1.76	(1.33)	1.83	(1.32)	1.81	(1.34)	1.84	(1.32)
γ_h parameters								
Constant	1.06**	(0.23)	0.88**	(0.32)	0.96**	(0.32)	0.87**	(0.33)
Delivery services			0.06	(0.26)	0.11	(0.26)	0.06	(0.26)
Share of beds in market			15.27	(21.65)			15.17	(21.64)
Teaching hospital					0.07	(0.58)	0.07	(0.57)
Market FEs?	Yes		Yes		Yes		Yes	
pseudo-R^2	0.45		0.45		0.45		0.45	
Number hospitals	144		144		144		144	

Notes: NLLS analysis of variation in hospital discounts d_h across hospitals, insurers and markets. See notes to Appendix 2 Table 1 for details. γ_h is a linear expression that determines the extent to which discounts for births differ from those for other diagnoses for hospital h. ** = significant at p=0.05; *=significant at p=0.10.

Appendix 3a: Logit Analysis By Severity, Least Sick Patients

	Full subsample		Top 6 severities		Drop small hosp-severities	
Price	-0.014 (0.012)	0.101** (0.017)	-0.010 (0.017)	0.109** (0.022)	-0.003 (0.023)	0.162** (0.028)
Price * % Capitated		-0.173** (0.019)		-0.179** (0.021)		-0.250** (0.025)
Distance	-0.178** (0.001)	-0.178** (0.001)	-0.177** (0.002)	-0.177** (0.002)	-0.167** (0.002)	-0.167** (0.002)
$z_h x_i$ controls	Y	Y	Y	Y	Y	Y
Hospital F.E.s	Y	Y	Y	Y	Y	Y
N	30,873	30,873	27,772	27,772	23,111	23,111

Appendix 3b: Logit Analysis By Severity, Sickest Patients

	Full subsample		Top 6 severities		Drop small hosp-severities	
Price	0.014** (0.003)	0.034** (0.006)	-0.003 (0.021)	0.059 (0.033)	-0.003 (0.063)	0.183** (0.073)
Price * % Capitated		-0.034** (0.010)		-0.092** (0.038)		-0.264** (0.053)
Distance	-0.184** (0.001)	-0.184** (0.001)	-0.185** (0.003)	-0.185** (0.003)	-0.180** (0.004)	-0.180** (0.004)
$z_h x_i$ controls	Y	Y	Y	Y	Y	Y
Hospital F.E.s	Y	Y	Y	Y	Y	Y
N	30,391	30,391	10,775	10,775	5,799	5,799

Notes: N = # of patients. Least sick sample includes patients aged 20-39 with zero Charlson scores and "routine" principal diagnoses and comorbidities (see Appendix 1 and Notes to Table 4). Sickest patients are all other patients. $z_h x_i$: interactions between hospital characteristics and patient characteristics. Analysis includes data for four largest markets: Los Angeles, Orange, San Diego, Bay Area. "Top 6 severities" includes only 6 largest severities as defined in Section 7. "Drop small hosp-severities" drops hospital-severity pairs with < 30 observations.

Appendix 4: Categorization of Co-Morbidities by Severity Rank

We asked obstetrical experts at Columbia Presbyterian Hospital to assign a rank to each co-morbidity listed in our discharge data covering privately insured patients admitted for a labor/birth episode in California in 2003. Ranks were numbered from 1 to 3, where 1 indicated a routine diagnosis that would not affect patient treatment in any significant way, 2 indicated a more severe diagnosis and 3 indicated the most severe conditions that would have a substantial effect on the patient's treatment during the labor/birth admission. The list of diagnoses and their assigned ranks is given below. The number of patients with each co-morbidity is also provided. (A single patient may have more than one co-morbidity.)

Diagnosis	# patients	% patients	Rank (1-3)
1. Tuberculosis	9	0	3
2. Septicemia (except in labor)	42	0.02	2
3. Bacterial infection; unspecified sit	668	0.32	2
4. Mycoses	28	0.01	2
6. Hepatitis	119	0.06	2
7. Viral infection	643	0.3	2
8. Other infections; including parasiti	70	0.03	2
9. Sexually transmitted infections (not	19	0.01	2
10. Immunizations and screening for inf	12,523	5.93	1
22. Melanomas of skin	10	0	3
23. Other non-epithelial cancer of skin	6	0	3
24. Cancer of breast	18	0.01	3
26. Cancer of cervix	14	0.01	3
28. Cancer of other female genital orga	2	0	3
32. Cancer of bladder	1	0	3
33. Cancer of kidney and renal pelvis	2	0	3
35. Cancer of brain and nervous system	5	0	3
36. Cancer of thyroid	24	0.01	3
37. Hodgkins disease	8	0	3
38. Non-Hodgkins lymphoma	5	0	3
39. Leukemias	3	0	3
41. Cancer; other and unspecified prima	4	0	3
44. Neoplasms of unspecified nature or	14	0.01	3
46. Benign neoplasm of uterus	1,110	0.53	1
47. Other and unspecified benign neopla	275	0.13	1
48. Thyroid disorders	1,266	0.6	2
49. Diabetes mellitus without complicat	9	0	2
50. Diabetes mellitus with complication	35	0.02	3
51. Other endocrine disorders	81	0.04	2
52. Nutritional deficiencies	22	0.01	1
53. Disorders of lipid metabolism	11	0.01	2
55. Fluid and electrolyte disorders	554	0.26	2
56. Cystic fibrosis	1	0	3
57. Immunity disorders	8	0	2
58. Other nutritional; endocrine; and m	703	0.33	2
59. Deficiency and other anemia	1,542	0.73	1
60. Acute posthemorrhagic anemia	215	0.1	2
61. Sickle cell anemia	59	0.03	3
62. Coagulation and hemorrhagic disorde	338	0.16	2
63. Diseases of white blood cells	37	0.02	2
64. Other hematologic conditions	9	0	2
76. Meningitis (except that caused by t	9	0	3
77. Encephalitis (except that caused by	1	0	3

Diagnosis	# patients	% patients	Rank (1-3)
78. Other CNS infection and poliomyelit	3	0	3
79. Parkinsons disease	2	0	3
80. Multiple sclerosis	28	0.01	3
81. Other hereditary and degenerative n	10	0	3
82. Paralysis	8	0	3
83. Epilepsy; convulsions	146	0.07	3
84. Headache; including migraine	174	0.08	1
85. Coma; stupor; and brain damage	6	0	3
87. Retinal detachments; defects; vascu	5	0	2
88. Glaucoma	3	0	2
89. Blindness and vision defects	17	0.01	2
90. Inflammation; infection of eye (exc	10	0	1
91. Other eye disorders	4	0	1
92. Otitis media and related conditions	16	0.01	1
93. Conditions associated with dizzines	27	0.01	1
94. Other ear and sense organ disorders	21	0.01	1
95. Other nervous system disorders	103	0.05	2
96. Heart valve disorders	540	0.26	3
97. Peri-; endo-; and myocarditis; card	19	0.01	3
98. Essential hypertension	581	0.27	2
99. Hypertension with complications and	18	0.01	3
101. Coronary atherosclerosis and other	1	0	3
102. Nonspecific chest pain	21	0.01	2
103. Pulmonary heart disease	7	0	3
104. Other and ill-defined heart diseas	12	0.01	3
105. Conduction disorders	28	0.01	3
106. Cardiac dysrhythmias	193	0.09	3
107. Cardiac arrest and ventricular fib	2	0	3
108. Congestive heart failure; nonhyper	1	0	3
114. Peripheral and visceral atheroscle	3	0	3
117. Other circulatory disease	187	0.09	2
118. Phlebitis; thrombophlebitis and th	74	0.04	2
119. Varicose veins of lower extremity	4	0	1
120. Hemorrhoids	186	0.09	1
121. ther diseases of veins and lymphat	18	0.01	2
122. Pneumonia (except that caused by t	66	0.03	2
123. Influenza	21	0.01	1
125. Acute bronchitis	13	0.01	1
126. Other upper respiratory infections	190	0.09	1
129. Aspiration pneumonitis; food/vomit	6	0	2
130. Pleurisy; pneumothorax; pulmonary	42	0.02	3
131. Respiratory failure; insufficiency	12	0.01	3
133. Other lower respiratory disease	79	0.04	2
134. Other upper respiratory disease	19	0.01	2
135. Intestinal infection	37	0.02	1
136. Disorders of teeth and jaw	5	0	1
138. Esophageal disorders	101	0.05	2
139. Gastroduodenal ulcer (except hemor	1	0	2
140. Gastritis and duodenitis	24	0.01	1
141. Other disorders of stomach and duo	13	0.01	1
142. Appendicitis and other appendiceal	67	0.03	2
143. Abdominal hernia	94	0.04	1

Diagnosis	# patients	% patients	Rank (1-3)
144. Regional enteritis and ulcerative	55	0.03	2
145. Intestinal obstruction without her	41	0.02	2
146. Diverticulosis and diverticulitis	2	0	2
147. Anal and rectal conditions	16	0.01	1
148. Peritonitis and intestinal abscess	8	0	3
149. Biliary tract disease	401	0.19	2
151. Other liver diseases	84	0.04	2
152. Pancreatic disorders (not diabetes	41	0.02	2
153. Gastrointestinal hemorrhage	12	0.01	3
154. Noninfectious gastroenteritis	61	0.03	1
155. Other gastrointestinal disorders	390	0.18	2
156. Nephritis; nephrosis; renal sclero	11	0.01	2
157. Acute and unspecified renal failur	8	0	3
158. Chronic renal failure	2	0	3
159. Urinary tract infections	838	0.4	1
160. Calculus of urinary tract	216	0.1	1
161. Other diseases of kidney and urete	191	0.09	2
162. Other diseases of bladder and uret	15	0.01	2
163. Genitourinary symptoms and ill-def	97	0.05	1
167. Nonmalignant breast conditions	14	0.01	1
168. Inflammatory diseases of female pe	837	0.4	1
169. Endometriosis	94	0.04	1
170. Prolapse of female genital organs	3	0	1
171. Menstrual disorders	5	0	1
172. Ovarian cyst	297	0.14	1
173. Menopausal disorders	3	0	1
174. Female infertility	6	0	1
175. Other female genital disorders	448	0.21	1
176. Contraceptive and procreative mana	5,442	2.58	1
177. Spontaneous abortion	20	0.01	1
178. Induced abortion	9	0	1
179. Postabortion complications	98	0.05	2
180. Ectopic pregnancy	11	0.01	2
181. Other complications of pregnancy	16,871	7.99	2
182. Hemorrhage during pregnancy; abrup	755	0.36	3
183. Hypertension complicating pregnanc	2,388	1.13	2
184. Early or threatened labor	3,223	1.53	2
185. Prolonged pregnancy	5,103	2.42	1
186. Diabetes or abnormal glucose toler	3,501	1.66	2
187. Malposition; malpresentation	3,375	1.6	1
188. Fetopelvic disproportion; obstruct	3,061	1.45	2
189. Previous C-section	2,592	1.23	1
190. Fetal distress and abnormal forces	2,586	1.22	1
191. Polyhydramnios and other problems	5,086	2.41	2
192. Umbilical cord complication	10,393	4.92	1
193. OB-related trauma to perineum and	3,157	1.49	1
194. Forceps delivery	273	0.13	1
195. Other complications of birth; puer	26,576	12.58	1
196. Normal pregnancy and/or delivery	83,408	39.48	1
197. Skin and subcutaneous tissue infec	66	0.03	1
198. Other inflammatory condition of sk	92	0.04	1
200. Other skin disorders	182	0.09	1

Diagnosis	# patients	% patients	Rank (1-3)
201. Infective arthritis and osteomyeli	2	0	2
202. Rheumatoid arthritis and related d	5	0	2
203. Osteoarthritis	2	0	1
204. Other non-traumatic joint disorder	23	0.01	1
205. Spondylosis; intervertebral disc d	212	0.1	1
206. Osteoporosis	3	0	2
208. Acquired foot deformities	3	0	1
209. Other acquired deformities	6	0	1
210. Systemic lupus erythematosus and c	7	0	2
211. Other connective tissue disease	93	0.04	2
212. Other bone disease and musculoskel	35	0.02	2
213. Cardiac and circulatory congenital	42	0.02	2
214. Digestive congenital anomalies	2	0	2
215. Genitourinary congenital anomalies	240	0.11	2
216. Nervous system congenital anomalie	5	0	2
217. Other congenital anomalies	47	0.02	2
218. Liveborn	1	0	1
219. Short gestation; low birth weight;	2	0	2
224. Other perinatal conditions	6	0	2
225. Joint disorders and dislocations;	5	0	2
226. Fracture of neck of femur (hip)	2	0	2
228. Skull and face fractures	3	0	2
229. Fracture of upper limb	9	0	2
230. Fracture of lower limb	8	0	2
231. Other fractures	15	0.01	2
232. Sprains and strains	21	0.01	1
233. Intracranial injury	6	0	3
234. Crushing injury or internal injury	6	0	3
235. Open wounds of head; neck; and tru	5	0	2
236. Open wounds of extremities	3	0	2
237. Complication of device; implant or	21	0.01	2
238. Complications of surgical procedur	138	0.07	2
239. Superficial injury; contusion	55	0.03	1
240. Burns	2	0	2
242. Poisoning by other medications and	5	0	2
244. Other injuries and conditions due	45	0.02	2
245. Syncope	27	0.01	2
246. Fever of unknown origin	58	0.03	2
247. Lymphadenitis	5	0	2
249. Shock	3	0	3
250. Nausea and vomiting	32	0.02	1
251. Abdominal pain	185	0.09	1
252. Malaise and fatigue	15	0.01	1
253. Allergic reactions	194	0.09	2
255. Administrative/social admission	13	0.01	1
256. Medical examination/evaluation	1	0	1
257. Other aftercare	37	0.02	1
259. Residual codes; unclassified	1,537	0.73	1
650. Adjustment disorders	11	0.01	1
651. Anxiety disorders	129	0.06	1
652. Attention-deficit, conduct, and di	3	0	1
654. Developmental disorders	2	0	1

Diagnosis	# patients	% patients	Rank (1-3)
655. Disorders usually diagnosed in inf	1	0	1
657. Mood disorders	397	0.19	2
658. Personality disorders	5	0	2
659. Schizophrenia and other psychotic	8	0	2
660. Alcohol-related disorders	13	0.01	2
661. Substance-related disorders	164	0.08	2
663. Screening and history of mental he	410	0.19	1
670. Miscellaneous disorders	684	0.32	2

Appendix 5a: Mother's Outcome Variation Across Aggregated Price and Severity Groups

No. diags	Max rank 1			Max rank 2			Max rank 3		
of max rank	Pats	readm	not home	Pats	readm	not home	Pats	readm	not home
1	26721	1.97%	1.23%	14863	2.46%	1.90%	1310	3.89%	1.68%
		(0.08%)	(0.07%)		(0.13%)	(0.11%)		(0.53%)	(0.36%)
2	14187	2.11%	1.43%	4708	3.40%	2.15%	52	7.69%	1.92%
		(0.12%)	(0.10%)		(0.26%)	(0.21%)		(3.73%)	(1.92%)
3	5086	2.38%	1.75%	1431	3.84%	2.66%	5	0.00%	40.0%
		(0.21%)	(0.18%)		(0.51%)	(0.43%)		(0.00%)	(24.5%)
4	1496	1.80%	2.47%	414	3.86%	3.62%	1	0.00%	0.00%
		(0.34%)	(0.40%)		(0.95%)	(0.92%)		-	-
5	407	1.72%	1.72%	119	5.04%	3.36%	1	100%	100%
		(0.65%)	(0.65%)		(2.01%)	(1.66%)		-	-
≥ 5	124	3.23%	1.61%	47	8.51%	0.00%	0	-	-
		(1.59%)	(1.14%)		(4.11%)	(0.00%)			

Notes: Data taken from OSHPD Birth Cohort 2003 (see notes to Table 3 for details). Comparison of maternal outcomes for patients who have a Charlson score of 0 across comorbidity ranks. Standard errors in parentheses (calculated assuming that 0/1 variables are binomially distributed). "Pats" shows the number of patients in each "max rank" group and each "number diags of max rank" group. Here "Max rank j" means the maximum rank of a comorbidity for this patient, as defined by obstetrical experts at Columbia Presbyterian Hospital, is j. "Number diags of max rank" groups patients according to the number of co-morbidities in their discharge record with the relevant max rank. Patients in different rows of a particular column of the table will have different price groups. "Readm" is the percent of patients readmitted to hospital within 12 months of birth episode; "Not home" is percent of patients discharged somewhere other than home (including transfer to acute care setting, transfer to skilled nursing facility, discharge against medical advice and death).

Appendix 5b: Infant Outcome Variation Across Aggregated Price and Severity Groups

No. diags	Max rank 1			Max rank 2			Max rank 3		
of max rank	Pats	readm	not home	Pats	readm	not home	Pats	readm	not home
1	26721	8.44%	4.49%	14863	10.19%	8.05%	1310	12.98%	13.44%
		(0.17%)	(0.13%)		(0.25%)	(0.22%)		(0.93%)	(0.94%)
2	14187	9.16%	5.17%	4708	11.21%	10.94%	52	15.38%	19.23%
		(0.24%)	(0.19%)		(0.46%)	(0.45%)		(5.05%)	(5.52%)
3	5086	8.61%	6.90%	1431	12.86%	13.14%	5	0.00%	40.00%
		(0.39%)	(0.36%)		(0.89%)	(0.89%)		(0.00%)	(24.49%)
4	1496	9.22%	7.62%	414	12.32%	13.04%	1	0.00%	100%
		(0.75%)	(0.69%)		(1.62%)	(1.66%)		-	-
5	407	7.37%	11.06%	119	15.97%	21.01%	1	100%	100%
		(1.30%)	(1.56%)		(3.37%)	(3.75%)		-	-
≥ 5	124	7.26%	8.87%	47	29.79%	29.79%	0	-	-
		(2.34%)	(2.57%)		(6.74%)	(6.74%)			

Notes: Data taken from OSHPD Birth Cohort 2003 (see notes to Table 3 for details). Comparison of infant outcomes for patients who have a Charlson score of 0 across comorbidity ranks. Standard errors in parentheses (calculated assuming that 0/1 variables are binomially distributed). "Pats" shows the number of patients in each "max rank" group and each "number diags of max rank" group. Here "Max rank j" means the maximum rank of a comorbidity for this patient, as defined by obstetrical experts at Columbia Presbyterian Hospital, is j. "Number diags of max rank" groups patients according to the number of co-morbidities in their discharge record with the relevant max rank. Patients in different rows of a particular column of the table will have different price groups. "Readm" is the percent of patients readmitted to hospital within 12 months of birth episode; "Not home" is percent of patients discharged somewhere other than home (including transfer to acute care setting, transfer to skilled nursing facility, discharge against medical advice and death).

Appendix 6: Average Individual Variation in Quality and Expected Price

	Bay Area	San Diego	Los Angeles	Orange Cty	Inland Empire	*All Markets*
Standard Deviation in Quality ($000)						
Severity 1	1.637	0.716	1.136	1.011	3.259	*1.337*
Severity 2	2.237	0.313	1.202	1.122	3.064	*1.467*
Severity 3	2.454	0.943	1.500	1.299	3.851	*1.779*
Severity 4	1.994	0.434	1.482	1.650	4.431	*1.718*
Severity 5	2.674	0.254	2.145	1.135	3.432	*1.823*
Standard Deviation in Expected Price ($000)						
Severity 1	1.867	0.679	1.278	1.158	1.509	*1.311*
Severity 2	2.917	0.958	1.652	1.651	1.927	*1.857*
Severity 3	3.070	1.243	1.865	2.329	2.099	*2.182*
Severity 4	3.101	1.272	2.199	2.513	2.410	*2.396*
Severity 5	4.000	1.189	2.649	2.346	2.749	*2.678*

Notes: Statistics are cross-patient averages of standard deviations across hospitals in the choice set. Expected price and quality are both measured in $000; quality is defined as $\alpha_\pi q_{h,s}/\theta_{p,\pi}$. Data are recorded for the five largest markets (those for which quality estimates were generated) and for the five "super-severities". The super-severities are: Group 1 are patients who have a rank 1 (routine) principal diagnosis, rank 1 comorbidities and are young; Group 2 are patients who have rank 2 principal diagnosis, rank 1 comorbidities and young; Group 3 are patients who have rank 1 principal diagnosis, maximum rank 2 comorbidities and young; Group 4 are patients with rank 2 principal diagnosis, maximum rank 2 comorbidities and young; and Group 5 has all other patients.