Hospital Choices, Hospital Prices and Financial Incentives to Physicians

by

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Questions We Are Trying To Adress.

- Do hospital referrals respond to the price paid by the insurer to the hospital, and how do price responses differ with the incentive structure built into insurance contracts with physician groups?

- What are the trade-offs between cost, “quality”, and convenience factors implicit in the hospital choice function, and how do they relate to the incentives built into insurance contract?

Relationship to US Health Reforms.

• PPACA: ACO's are groups of providers who share responsibility for managing a large part (often all) of the health care needs of a group of Medicare patients (and private sector ACO's are forming in parallel; often same ACO).

• Cost control incentives for ACO's and California's physician groups are similar:

(i) both based on costs incurred by the group as a whole (no rules on how to pass down to particular providers), and
(ii) both either bear financial risk for hospital payments

or benefit from hospital savings relative to a benchmark (for ACO's it depends on a quality adjustment, but $\approx$ 50% of saving).

Large and important prior literatures which
(i) estimate models of hospital choice from discharge records, and
(ii) establish that HMO's generate cost savings.

One part of our analysis focuses on a part of the allocation process that is not studied elsewhere
(i) referral responses to insurer-paid hospital prices,
(ii) dependance of response to incentives in provider's insurer contracts.

Our main question. *What impact do sharred savings programs have on the cost and quality of care?*

E.g.; Conflicting views on ACOs.

- "These organizations will ... improve the quality of care and help lower costs" (Kathleen Sebelius, secretary of health and human services)

- "[ACOs] could reduce competition and harm consumers through higher prices or lower quality of care" (joint statement by Justice Department and Federal Trade Commission)

Outline

- Details of the institutional setting.

- Details of the Dataset.

- Analytic Frameworks;
  (i) Multinomial Logit Analysis
  (ii) Inequalities Analysis.

- Results on price effects.

- Results on trade-offs between cost, convenience and "quality".

The California Medical Care Market 2003

- Focus on HMOs (53% of employed pop.)

- 7 largest HMOs had 87% of HMO market: we consider all but Kaiser (about 1/3 of these; they do not report prices).

- Physician contracts: HMOs have non-exclusive contracts with large physician groups.

- Two payment mechanisms for physician groups:
(1.) Capitation; fixed payment per patient ($\approx$ 75% of hospitals payments in our data).
(2.) Fee-for-service contracts.

- Types of capitation:

  - Global capitation: payment covers both primary care and hospital stays ($\approx$ 20%).

  - Non-global ($\approx$ 80%): $\approx$ 90% include "shared risk arrangements" (group shares in cost savings at hospital made relative to pre-agreed target).

How are capitation incentives passed on from physician group to physicians?

- Medical groups (contains partners and salaried physicians): by profit sharring and promotion on pay scale contingent on management of costs (for salaried doctors).

- IPA: typically direct capitation.

Our Analysis.

We utilize hospital discharge data for California in 2003; only women in labor (largest patient group). Census of hospital discharges of private HMO enrollees.

- Patient characteristics: insurer name, hospital name, detailed diagnoses, procedures, age, gender, zip code, list price, outcome measures.

- Hospital characteristics: average discount, address, teaching status, number of beds, services, annual profits.

Data. Does not identify patients' physician groups or details of compensation schemes. Do observe each patient's insurer and percent of each insurer's payments for primary services that are capitated. Considerable dispersion in this across insurers:

- Blue Cross: 38% capitated payments.

- Pacificare: 97% capitated payments.

Notes on hospital choice.
(i) Patient chooses obstetrician (OB) based partly on hospital affiliation.
(ii) OB affiliated with 1-3 hospitals.
(iii) Interview evidence indicates physician group pass on price information to OBs.

Mechanisms for price response

- Within-physician differential treatment of patients (consistent with prior literature; e.g. Melichar,2009),

- Physicians with more capitated patients use cheaper hospitals. This could be

  - a response to incentives facing physicians, or

  - sorting of inherently cost conscious doctors to high capitation physician groups

Can not separate out causal mechanisms with our data (though the distribution of cost consciousness may be endogenous).

Overview of the Model

Physician and patient jointly make the hospital choice within a choice set determined by the insurer. $W_{i,\pi,h}$ provides observed part of the plan and severity specific ordering of hospitals that this generates.

$$W_{i,\pi,h} = \theta_{p,\pi} p_{i,\pi,h} + g_\pi(q_h(s), s_i) + \theta_{d,\pi} d(l_i, l_h)$$

- $p_{i,\pi,h}$ = the expected price at hospital h for treating patient i in plan π.
- $d(l_i, l_h)$ = distance between hospital and patient's (home) location

- s_i = measure of patient severity

- $q_h(s)$ = a hospital-specific vector of perceived qualities for different sickness levels

- $g_\pi(\cdot)$ = plan-specific non-parametric function of $q_h(s)$ and s_i which allows hospital quality rankings to differ by severity and plan.

Note:

- plan trade-off's between "quality", price and convenience can differ across severities,
- different plans can make these trade-off's differently.

Our questions in the context of the model.

- The price coefficient
  - is it negative?
  - more negative when insurer gives physicians incentives to control costs?

- Do the plans which are more averse to price send patients to lower quality or to more distant hospitals?

Previous Hospital Choice Literature. Utility as a function of distance, hospital quality, hospital-patient interactions.

- Often multinomial logit models with no price term (Gaynor and Vogt construct and use a single price for each hospital).

- The hospital quality terms and the patient-hospital quality interactions are a particular parameterization of our $g_\pi(q_h(s), s)$ terms.

Our Price Variable

- Agents do not know price when decision is made: need an expected price.

- Assume expected price per entering diagnosis/hospital is the average list price per diagnosis/hospital multiplied by a discount.

- Have data on average list price per entering diagnosis (like hotel ”rack rate”) and average discount at hospital level.

- Define price = expected list price*(1-average discount)

Major problems with price measure.

- Expectational and/or measurement error; likely more of a problem for severities with a small number of patients.

- Discounts are negotiated separately with each plan (and so are plan-specific); we come back to a correction for this below.

Start with multinomial logit analysis (follows previous literature).

- Need to limit controls for $g_\pi(q_h(s), s)$ due to sample size per (s, h). Leads to worries about
  - price endogeneity (unobserved quality, and its importance, by severity).
  - expectational and/or measurement error (small price cells).
- Get positive price coefficient.

- Mitigate both problems by focusing on least sick patients.

- Gives negative price coefficient; more negative for more highly capitated insurers. *Magnitudes questionable.* Move to inequalities.

Notes on the Data.

- Discharge Descriptive Statistics. Note the average discount is 67.5

- Adverse Outcomes. Note: Discharge not home = patients; discharged to acute care or special nurising facility, deaths, and discharge against medical advice.

- Plan characteristics (capitation, premium/month).

- Prices and Outcomes by Patient Age and Charlson Score. Charlson score (Charlson et al, 1986, *Journal of Chronic Diseases*): clinical index that assigns weights to comorbidities other than principal diagnosis where higher weight indicates higher severity. Values 0-6 observed in data.

Discharge Descriptive Stats	Mean	(Std Dev)
Number of patients	88,157	
Number of hospitals	195	
Teaching hospital	0.27	
Ave. Dist. to Feasible Hosp.	24.6	(25.6)
Dist. to Chosen Hosp.	6.7	(10.3)
List price ($)	$13,312	($13,213)
List price*(1-discount)	$4,317	($4,596)
Length of Stay	2.54	(2.39)
Outcome Measures		
Infant Readmission	9.42%	(.1%)
Mother Readmission	2.39%	(.1%)
Discharge Not Home	6.60%	(.1%)
Plan Characteristics	capit.	pm/pm
Pacificare (FP)	.97	149.9
Aetna (FP)	.91	152.4
Health Net (FP)	.80	184.9
Cigna (FP)	.75	n.a.
Blue Shield (NFP)	.57	146.3
Blue Cross (FP)	.38	186.9

Prices and Outcomes By Patient Type

	N	P(1-δ)	Percentage M-Read	Percentage I-Read	Percentage N-Home
Age					
≤ 40	71073	4259	2.4	9.4	6.5
≥ 40	2044	5420	3.5	9.6	9.9
Charlson					
0	71803	4256	2.3	9.4	6.5
≥ 0	1314	6227	5.8	12.3	10.5

- Price and outcome measures vary in the expected direction with age and Charlson score.

- Most women are under 40, and most women come in with a zero Charlson score (severity, however, also differs by diagnosis).

Multinomial Logit Analysis

$$W_{i,\pi,h} =$$

$$\theta_{p,\pi}(\delta_h lp(c_i, h)) \; + \; g_\pi(q_h(s), s_i) \; + \; \theta_d d(l_i, l_h) \; + \; \varepsilon_{i,\pi,h}$$

where

- $\epsilon_{i,\pi,h}$ is added extreme value distrubance
- δ_h = 1 - discount, and $lp(c_i, h)$ = average list price for type c_i at h (so there is no measurement error in price).
- s_i has age groups (4), principal diagnosis (21), Charlson score (6) and diagnosis generating Charlson score.

Multinomials restrict

$$g_\pi(q_h(s), s_i) = q_h + \beta z_h x(s_i)$$

where

•q_h= hospital fixed effects,

•z_h= hospital characteristics (teaching hospitals, FP hospitals, hospitals with transplant servicess, a measure of quality of labor and birth services)

•$x(s_i)$ = P(adverse outcomes $\|$ age, principal diagnosis, Charlson score)

• Restrictions needed because #h = 195, #s= 105 (omitting zeroes ≈ 16,000 f.e.; few observations per group implies expectational error).

If it is **incorrect**

$$g_\pi(q_h(s), s_i) = q_h + \beta z_h x(s_i) + e_\pi(q_h(s), s_i).$$

Cases:

• Fix $s_i = s^*$, $e_\pi(q_h(s), s^*)$ is absorbed in q_h.

• Let s_i vary. Then residual will be positively correlated with price if more severly ill woman go to higher quality hospitals and higher quality hospitals are more highly priced.

• No allowance for measurement error in price, and even at this level of aggregation some groups are small.

Logit Results: 1

	All	Least sick	Sick
Price	.010**	-0.017*	.012**
	(.002)	(.009)	.002
Distance	-.215**	-.215**	-.217**
	(.001)	(.002)	(.002)
Distance^2	.001**	.001**	0.001**
	(.000)	(.000)	(.000)
$z_h x(s_i)$	Y	Y	Y
(15 coeffts)			
Hosp. F.E.s	Y	Y	Y
(194 coeffts)			
N	88,157	43,742	44,059

Notes:

- Least sick patients are aged 20-39 with zero Charlson scores and all diagnoses "routine".
- Price is average list price by age group (4) × principal diagnosis (21) × Charlson Score (6) × diagnosis Charlson score was in where

possible. Often had to aggregate, ≈ 65 price groups per hospital.

- Hospital characteristics include teaching hospital, for profit, offer transplants, nurses per bed, quality of labor services
- Individual characteristics or probabilities of our adverse events conditional on diagnosis, age, Charlson score.

Results

- Positive coefficient consistent with omitted variable bias.

- When we control for hospital and consider a more homogenous severity group get a negative coefficient.

- When we look at the group with a lot of variance in severity the coefficient is even more positive.

Conclude: It is likely that there is an omitted variable and it is related to severity-hospital interactions.

Results: Logit Analysis 2

	% capit	Discharges	Least sick patients Estimates
Spec 1: Price x			
constant			.069**(.014)
% capit			-.127** (.016)
Spec 2: Price x			
Pac-care	0.97	7,633	-0.077** (0.01)
Aetna	0.91	3,173	-0.011 (0.016)
HN	0.80	8,182	-0.038** (0.01)
Cigna	0.75	4,001	-0.021 (0.014)
BS	0.57	7,992	0.018 (0.011)
BC	0.38	12,761	0.008 (0.011)
Distance			-0.215** (0.002)
Distance squared			0.001** (0.000)
$z_h x(s_i)$ controls			Y
Hospital F.E.s			Y
N			43,742

Conclusions.

- **Capitation.** Matters for price effect (Capitation coefficient for sick patients was $-.025(.006)$.)

- **Magnitudes.** From logits, even for least sick patients, questionnable

-*Distance.* Average impact of a 1 mile increase in distance to hospital h (all else fixed) on P_{ih} is a 13.7% reduction. Comparable to prior estimates.

-*Price.* A $1000 price increase for Pacificare enrollees (97% capitated) in hospital h a 5.2% reduction in P_{ih}. $\approx$ $2,600 per mile for Pacificare (average price $\approx \$3,400$), and higher for all others.

Inequalities Analysis

$$W_{i,\pi,h} = \theta_{p,\pi}(\delta_h lp(c_i, h)) + g_\pi(q_h(s), s_i) + \theta_{d,\pi} d(l_i, l_h)$$

- Analysis done separately by plan.

- Normalize $\theta_{d,\pi} = 1$. s_i determines severity group and c_i determines price group. Both far more detailed than logit analysis.

- s_i groups: age $\times$ principal diagnosis $\times$ Charlson score $\times$ diagnosis generating Charlson score $\times$ rank of most serious comorbidity.

- Price groups. Severity $\times$ actual comorbidity $\times$ # comorbidities.

- Groupings done at suggestion of Columbia Presbyterian obsetetricians: rank of most serious comorbidities determines hospital choice, but not the number of comorbidities (which do determine hospital costs).

- $g_\pi(q_h(s), s_i)$ freely interacts s_i groups ($\approx$ 105) with q_h (hospital F.E.). We assume it absorbs all unobserved quality variation that affects hospital choice.

Assumptions. For price start with

$$p_i^o \equiv \delta_h^o lp^o(c_i^o, h) = \delta_h lp(c_i, h) + \varepsilon_{i,\pi,h},$$

and in robustness analysis allow for within hospital variation (including plan effects), and

$$g_\pi(q_h(s), s_i^o) = g_\pi(q_h(s), s_i) + \epsilon_{s_i,\pi,h},$$

where for all ϵ

$$E[\varepsilon_{i,\cdot,h} | z_{i,\pi,h} \neq p^o(c_i, h), h] = 0.$$

Inequalities Analysis: Developing Estimator.

Use Revealed Preference: If h' was feasible for i_h

$$W_{i_h,\pi,h} \geq W_{i_h,\pi,h'}.$$

Procedure: Find all pairs of **same** π and s but **different** c patients, say i_h, $i_{h'}$ s.t.:

- $i_{\pi,h}$ visited h and had alternative h'
- $i_{\pi,h'}$ visited h' and had alternative h.

Then sum the two revealed preference inequalities, and then average over such couples.

- Equal and opposite $g_\pi(\cdot)$ terms drop out.
- Terms that are errors in price average out.

Formalities. For any x let $x(i_h, h, h') \equiv x_{i_h,h} - x_{i_h,h'}$. If $s_{i_h} = s_{i_{h'}}$, $h' \in C(i_h)$, $h \in C(i_{h'})$ then

$$0 \leq W(i_h, h, h') = \theta_p p^o(i_h, h, h')$$

$$+ [g(q_h, s^o) - g(q_{h'}, s^o)] - d(i_h, h, h') + \varepsilon(i_h, h, h')$$

and

$$0 \leq W(i_{h'}, h', h) = \theta_p p^o(i_{h'}, h', h)$$

$$+ [g(q_{h'}, s^o) - g(q_h, s^o)] - d(i_{h'}, h', h) + \varepsilon(i_{h'}, h', h).$$

So

$$0 \leq W(i_h, h, h') + W(i_{h'}, h', h) =$$

$$\theta_p(p^o(i_h, h, h') + p^o(i_{h'}, h', h)) - (d(i_h, h, h') + d(i_{h'}, h', h))$$

$$+ \varepsilon(i_h, h, h') + \varepsilon(i_{h'}, h', h).$$

For each $x(i_h, h, h')$ let

$$\overline{x}(h,h') = \frac{1}{N_{h,h'}} \sum_{i_h : h' \in C(i_h)} x(i_h, h, h').$$

The sum of the revealed preference inequalities over $\{i_h : h' \in C(i_h)\}$ and $\{i_{h'} : h \in C(i_h)\}$ is

$$\frac{-1}{N_{h,h'}N_{h',h}}\Big(\theta_p[\overline{p}^o(h,h') + \overline{p}^o(h',h)] + \overline{d}(h,h') + \overline{d}(h',h)\Big)$$

$$\rightarrow_P \quad \kappa \geq 0, \;\; \text{at} \;\; \theta_p = \theta_0.$$

Can interact this with any positive function and it should still be positive at $\theta = \theta_0$.

Moments. Interact the original inequalities with "instruments" ($E[\varepsilon|z] = 0$) of the same sign, proceeding as above, and then summing over $h' > h$. Instruments

- a constant term

- the positive and negative parts of distance differences for h and for h' (come back to a robustness test for errors in this below).

Limitation of this methodology

- Unobservables causing selection absorbed in $g_\pi(.)$; i.e. there is no idiosyncratic structural error.

- Assume price variable has no "systematic" error (i.e. it averages out for each plan). Assume the distance measure is exact. Come back to these two problems.

Current limitations analogous to those for "matching estimators", only here we have inequalities from revealed preference for each matched agent.

Benefits:

- Differencing out the $g_\pi(.)$ terms makes detailed hospital-quality/patient-severity/plan controls possible,

- Averaging over patients addresses measurement error problems in price variable (and only require mean independence, and not a distributional assumption, of the error and we do use average discounts).

Robustness: Price and Distance Measures.

• Model for differences in discounts at a given hospital between insurers. We observe d_h; the revenue weighted average of discounts at each hospital. Model $d_h =$ f(revenue share from each π interacted with hospital characteristics, market and insurer fixed effects); logistic log-odds ratio. Use discount (i) Prediction from estimates, $\widehat{d}^1_{\pi,h}$, or (ii) d_h minus the impact of other insurers is $\widehat{d}^2_{\pi,h}$.

• Error in distance due to not being at centroid of zip code. For instruments use only an indicator function for the positive and negative parts of the difference in distances being greater that 3 miles.

Price and Severity Groups.

- 106 populated severity groups; 272 populated price groups (157 hospitals with over 1000 switches).

- Columns of table: severity groups aggregated (over age, principal diagnosis,...) into max rank.

- Rows give us the average of the price group in that severity group. Prices increase with the number of comorbidities in each rank.

- Given a severity, within rank differences in the price group relative to distance differences give us the distance-price tradeoff for a given severity.

Table 5: Prices: Aggregated Price and Severity Groups.

Number diags	Max rank 1			Max rank 2		
of max rank	Pats	Price ($)	SD	Pats	Price ($)	SD
1	23029	3431 (15)	1612	13128	4968 (42)	2476
2	11757	4145 (28)	2180	4196	6019 (88)	2785
3	4077	4682 (60)	2356	1274	7428 (212)	3609
4	1179	5505 (149)	2590	380	8602 (462)	5283
5	331	6189 (254)	3123	110	10186 (1002)	6084
≥ 5	95	7663 (936)	4896	55	13365 (1596)	8880
Total	40468	3857 (15)		19143	5488 (40)	

Details.

- 73 - 283 moments per insurer.
- Divide each moment by its estimated std. error.
- Find set of $\theta_{p,\pi}$ satisfying implied system of inequalities. If none: find $\theta_{p,\pi}$ to minimize squarred metric in amount by which inequalities violated.
- Use PPHI confidence intervals (those that required computing covariance matrix repeatedly at different θ too computationally costly).

Prepatory Analysis and Results.

- Can accept that the variance of price groups within severity group does not effect our measures of adverse effects (standard χ^2 tests).

- Price variation: Moving from severity to price groupings explains an additional 12% of variance in price (from 50% to 62% of total variance).

- Inequalties always yield point estimates but accept $H_0 : m(\cdot, \theta_0) \geq 0$ (CHT, Andrews-Soares moment shifting).

- Calculate t-statistic for each of our 977 moments at $\theta = \theta_0$. 6.1% negative, $\approx$ .7% with $t \leq -2$.

Summary of t-values.

	Pac/care	Aet.	H/Net	Cigna	BS	BC
# pos.	152	75	173	93	170	254
# neg.	11	3	9	2	4	31
Ave pos.	12.7	22.5	17.1	19.5	19.1	21.5
# $t \leq -2$	0	0	2	0	0	5

- Do analysis with and without moments with $t < -2$, not much difference. Health Net sometimes varies with whether you include the extra 2 moments and so I include both but use those that drop the $t < -2$.

Baseline Price Coefficients.

	% capit.	$\widehat{\theta}_{p,\pi}$	$[CI_{LB},$	$CI_{UB}]$
	Using observed discount d_h			
Pac/care	0.97	-1.50	[-1.68,	-1.34]
Aetna	0.91	-0.92	[-0.95,	-0.86]
(Hnet	.80	-.17	[-0.27,	-0.13])
HNet	drop t $\leq$ -2	-0.78	[-0.80,	-0.44]
Cigna	0.75	-0.35	[-0.40,	-0.33]
BS	0.57	-0.06	[-0.15,	0.23]
(BC	0.38	-0.10	[-0.24,	-.01])
BC	drop t $\leq$ -2	-0.29	[-0.31,	-0.25]

Note. (Except Blue Shield; A Not For Profit.)

- All negative.
- Ordered by capitation rates.
- Confidence intervals do not overlap.

	% capit.	$\widehat{\theta}_{p,\pi}$	$[CI_{LB},$	$CI_{UB}]$
		Price using $\widehat{d}_h^1$		
Pac/care	0.97	-1.07	[-1.52,	-0.62]
Aetna	0.91	-0.68	[-0.72,	-0.62]
Hnet	0.80	-0.41	[-0.43,	0.94]
HNt +2		-0.11	[-0.23,	-0.07]
Cigna	0.75	-0.35	[-0.39,	-0.33]
BS	0.57	0.18	[-0.16,	0.79]
BC	0.38	-0.12	[-0.14,	-0.05]
BC	+t $\leq$ -2	-.03	[-0.18,	0.39]
		Price using $\widehat{d}_h^2$		
Pac/care	0.97	-1.47	[-1.64,	-1.32]
Aetna	0.91	-0.77	[-0.81,	-0.71]
HNet	0.80	-1.87	[-1.89,	-1.33]
HNet +2		-0.20	[-0.30,	-0.17]
Cigna	0.75	-0.32	[-0.36,	-0.30]
BS	0.57	0.00	[-0.28,	0.70]
BC	0.38	-0.18	[-0.21,	-0.14]
BC	+t $\leq$-2	-.09	[-0.21,-0.14]	
	Instruments:	$\{\lvert\Delta d(l_i, l_h, l_h')\rvert \geq 3\}$		
Pac/care	0.97	-1.42	[-1.66,	-0.94]
Aetna	0.91	-0.73	[-0.77,	-0.66]
HNet	0.80	-2.16	[-2.27,	-1.13]
HNet +2		-0.60	[-0.71,	-0.51]
Cigna	0.75	-0.66	[-0.71,	-0.58]
BS	0.57	set	[-0.95	0.65]
BC	0.38	-0.31	[-0.34,	-0.27]
BC	+t < -2	-0.27	[-0.31,	-0.25]

Magnitude of Results

- $\eta^{d,p}$ = percent distance reduction needed to compensate for a 1% price increase (using $\widehat{d}$):

	P-coeff=	Logits	Inequalities
	patients=	less-sick	all
HMO	% cap	$\eta^{d,p}$	$\eta^{d,p}$
Pac-care	0.97	0.33	11.10
Aetna	0.91	0.10	11.47
Health Net	0.80	0.15	06.52
Cigna	0.75	0.10	02.49
BC	0.38	-0.03	03.24

Note: Price elasticities.

- $\geq$ order of magnitude larger than logits.
- vary a great deal with capitation rates.

Plan-Specific Tradeoffs: Quality, Cost, & Distance.

Need plan-specific estimates of hospital "quality" ($\forall s$). Revealed preference implies that for each (π, s, h, h')

$$q_h^\pi(s) - q_{h'}^\pi(s) \ \geq \ g^\pi(s; h, h') \ = \theta_p^\pi \overline{p}(s; h, h') + \overline{d}(s; h, h')$$

For each couple of hospitals in the same market we have two such inequalities:

• One for those who chose h over h', and one for those who chose h' over h.

• # inequalities per market = $H_m(H_m - 1)$, where $H_m =$ # of hospitals in market.

Reliability of Ordering: Transitivity.

Note that regardless of θ_p

$$\overline{p}(h,h') \geq 0 \text{ and } \overline{d}(h,h') \geq 0, \ \Rightarrow \ q_h \succ q_{h'};$$

This defines a partial order which *is independent of our estimate*. However that partial order need not obey transitivity. I.e. we could have

$$A \succ B, \ \ B \succ C, \ \text{ but } C \succ A; \text{ or just; } A \succ B, \ \& \ B \succ A.$$

• No non-tranistive cycle's non-parametrically. Table lists number of non-transitive cycles when we use estimated price coefficients. Small number and **all** associated with differences in means which were not significantly different from zero.

Severity	Number ordered	Number cycles $\lvert t\rvert \geq 0$	Number cycles $\lvert t\rvert \geq 1.95$
Pacificare			
342	2298	0	0
343	1086	246	0
344	4	0	0
366	76	0	0
380	3078	6	0
Cigna			
342	1340	72	0
343	652	0	0
344	0	0	0
366	14	0	0
380	1416	0	0
Aetna			
342	1406	0	0
343	412	0	0
344	0	0	0
366	6	0	0
380	1920	0	0
Healthnet			
342	2162	194	0
343	1154	0	0
344	4	0	0
366	52	0	0
380	2728	6	0
Bluecross			
342	2900	202	0

Quality Bounds.

Quality estimates depend on θ_p, but our results change very little as we vary the θ_p's over their c.i.'s. Here I use point estimates of θ_p.

For a given (π, s) the quality of hospital h relative to a (market-specific) base hospital (H), is bounded by

$$\overline{q}(h) \equiv \min_{h' \neq h} E[-\widehat{q}(H, h') - \widehat{q}(h', h)] \geq q_h$$

$$\geq \max_{h' \neq h} E[\widehat{q}(h', H,) + \widehat{q}(h, h')] \equiv \underline{q}(h).$$

We stack these inequalites for each hospital, weight each by its estimated standard error, and then find the (set) estimator that minimizes the squared inequality violations (drop all comparisons with less than 5 switches)

Constraining the Quality Estimates.

• Too many $q_h^\pi(s)$ estimates (and sample sizes too small). Aggregate to five "Super-severity" groups: four determined by obstetrician (ordered by size) and a "remainder". Use five biggest markets (Bay Area, Inland Empire, LA, Orange County, San Diego); they contain almost all data with 5 or more switches.

Question. Are the insurers orderings affine transforms of one another? Or can we accept

$$q_h^\pi(s) = \alpha_{\pi,m,s} + \beta_{\pi,m,s} q_{s,h}.$$

m is for market. Note that the estimats of $\{q_h^\pi(s)\}$ are independent across plans. So if they are alike it is not because of the way we construct the estimates.

Implications of Accepting.

Preferences are linear functions of price, distance and a quality measure which is *common across insurers*. Can then compare trade-offs across insurers.

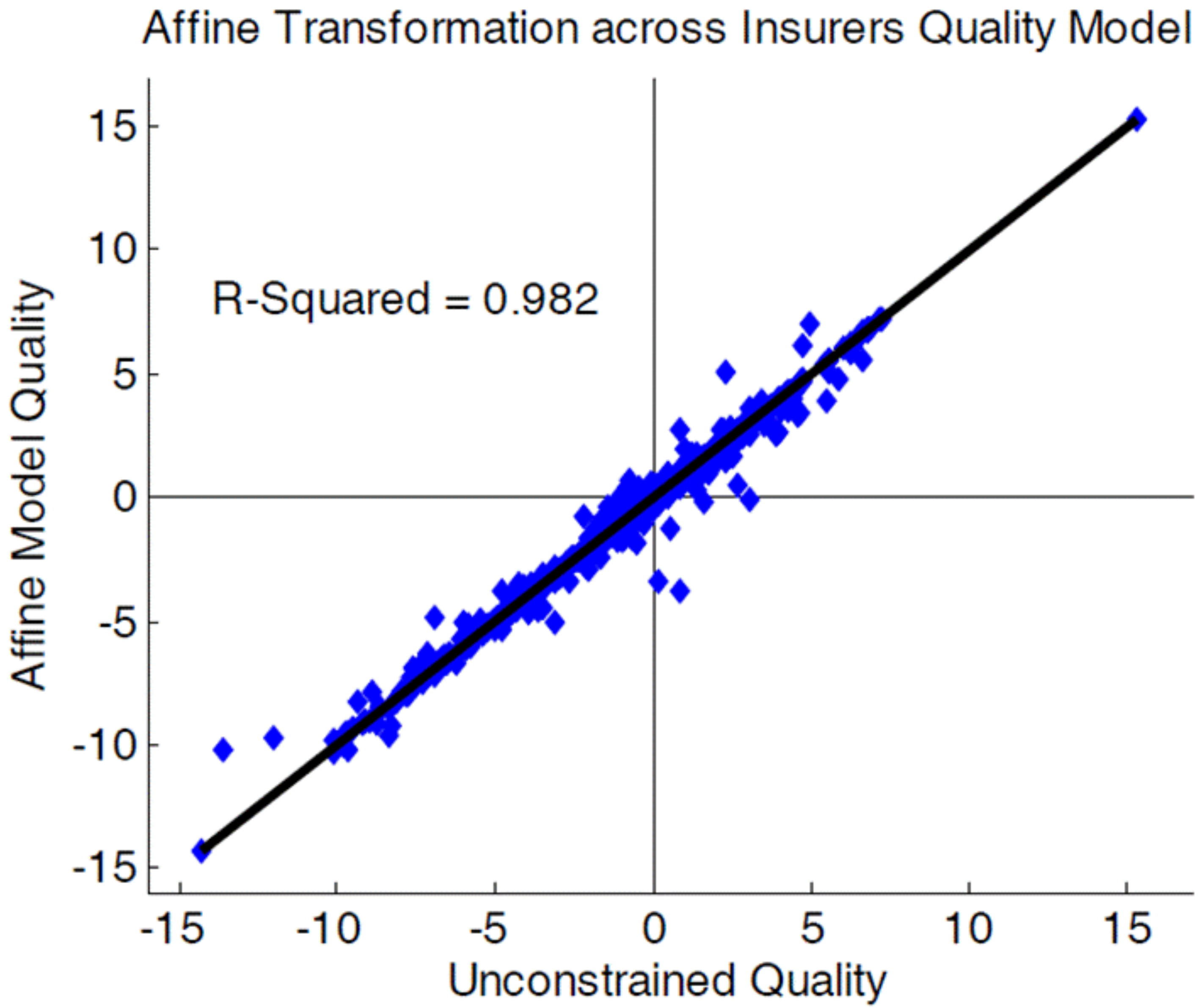
If in addition

$$\beta_{\pi,m,s} = \beta_\pi,$$

we can omit the (m, s) indices and divide $W_{i,\pi,h}$ by β_π to obtain

$$E[W_{i,\pi,h}|c_i, l_i, l_h] \propto -\Big(\frac{\theta_\pi}{\beta_\pi}\Big)p(c_i, h, \pi) - \Big(\frac{1}{\beta_\pi}\Big)d(l_i, l_h) + q_{h,s_i}.$$

This makes differences in plans' trade-offs between cost, preceived quality, and distance transparent.


Affine Transformation across Insurers Quality Model
R-Squared = 0.982
Affine Model Quality
Unconstrained Quality
15
10
5
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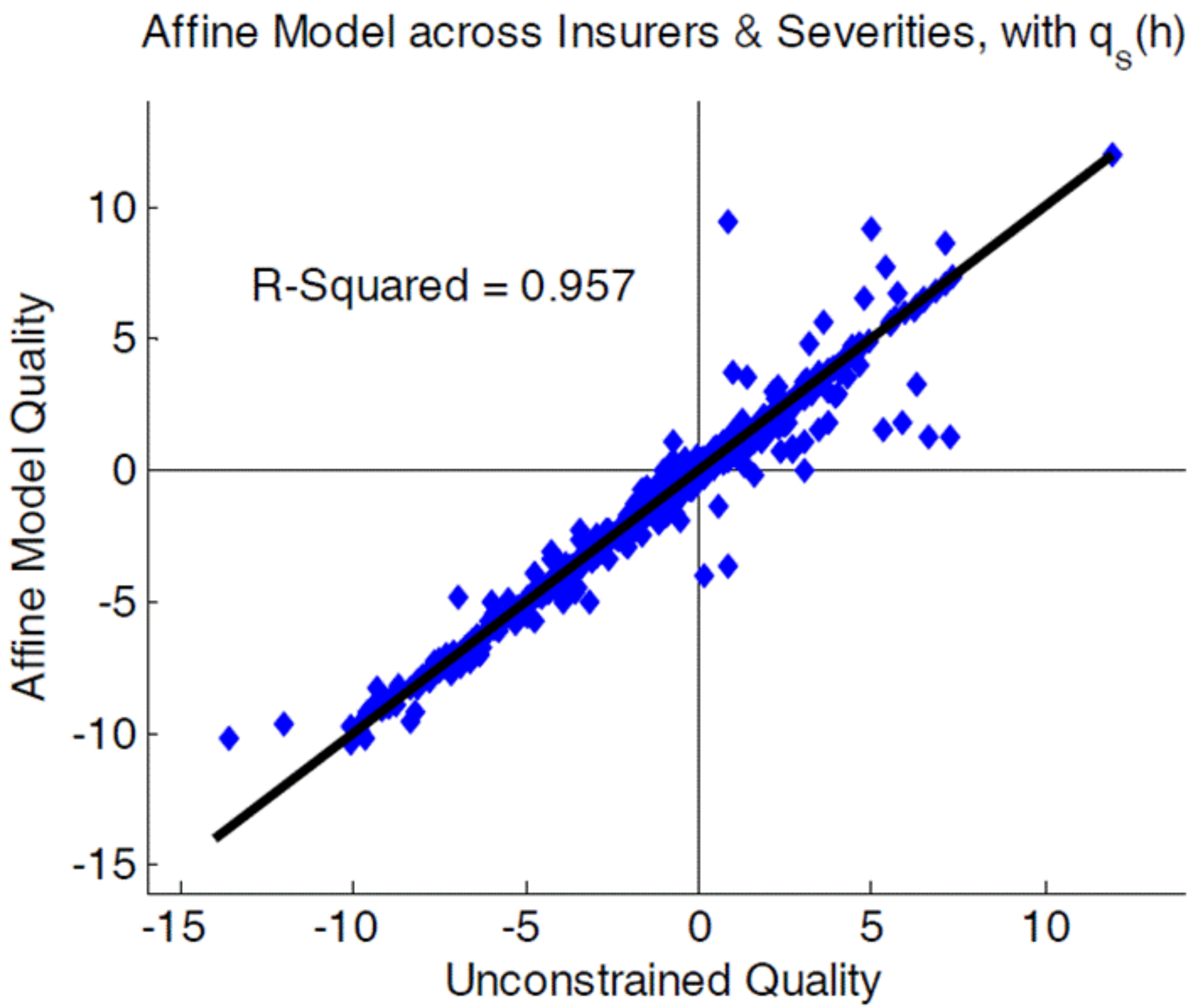
15


Affine Model across Insurers & Severities, with $q_s(h)$
R-Squared = 0.957
Affine Model Quality
Unconstrained Quality
10
5
0
-5
-10
-15
-15
-10
-5
0
5
10

Details.

- Normalize BC coeff.s = 1.

- First equality takes 1,078 estimates to 452 parameters. $R^2 = .982$ (see picture).

- Both equalities give us 380 parameters $R^2 = .957$ (see picture) Fall in R^2 is .00009 per added constraint.

- Results when we aggregate all markets are incredibly precise, but they are alot more variant when we disaggregate by market.

Trade-Off's for the Different Plans.

Insurer	P-care	Aetna	Hnet	Cigna	BC
% cap	0.97	0.91	0.80	0.75	0.38
$-\theta_\pi^p$	1.50	0.92	0.78	0.35	0.29
$-\beta_\pi$	5.13	3.12	2.63	1.20	1.00
θ_π^p/β_π	.293	.295	.297	.291	.290
$-1/\beta_\pi$	0.20	0.32	0.38	0.83	1.00
Upper and Lower Bounds on C.I. θ_p/β_π^*					
Upper	0.34	0.35	0.34	0.35	0.31
Lower	0.26	0.25	0.26	0.25	0.25.

*Calculated as lower bound (upper bound) θ_p divided by upper bound (lower bound) β_π.

• Just as the price coefficient increases montonically with capitation rate, so does the quality coefficient.
• The implication is that their ratio, which is the trade-off between price and our quality measure, is virtually identical across plans.
• More highly capitated plans send their patients further to obtain the same quality – but do not sacrifice quality.

Results consistent with (independent) outcome data.
χ^2 tests of differences of four outcomes* conditional on our five severities. Tested each couple of the five insurers for each severity and none significant.

*Mother and infant readmission within twelve months, mother and infant not discharged to home.

A Simple Counterfactual Analysis

- Findings indicate that patients in insurers using capitation incentives are referred to lower-priced hospitals. Assume the introduction of capitation would prompt low-capitation insurers to "act like" high-capitation insurer.

- Ask: under this assumption, how much would be saved if the use of capitation contracts was increased?

- Consider patients of Blue Cross (lowest-capitation insurer). Assume that increasing percent capitation to Pacificare level would change BC utility equation to that of Pacificare. Simulate BC patients' hospital referrals under Pacificare utility equation.

- Finding: 4.8% reduction in average price paid, with 6 mile average increase in distance, very little quality change. Savings in other diagnosis groups could be higher - since procedures and costs might vary more across hospitals

Potential implications for structure of ACOs

- Analysis assumes physicians free to choose hospitals within the existing networks

- Of approx 430 ACOs established by 1/13, around 50% integrated with a hospital system, the rest sponsored by physician group

- If ACOs integrated with hospital(s), with physician incentives to use own hospitals, cost reductions could be more limited.

- Could offset the benefits of integration (e.g. improved information flow, care coordination).

Conclusions.

- Hospital referrals are sensitive to price.

- The sensitivity of the hospital referrals to price depends on the extent to which the contracts the plan signs with physician groups are capitated: a 60% difference in extent of capitation triples coefficients and more than triples elasticities.

- At least in an environment where hospitals and other providers are separate, the higher capitation insurers substitute convenience for cost, but **do not** sacrifice quality for cost. They simply send their patients further to get the same quality of care.

Cost-Quality Trade-off By Market and Severity.

Insurer	P-care	Aetna	Hnet	Cigna	BC
LA S1	-0.29	-0.29	-0.29	-0.29	-0.29
LA S2	-0.28	-0.29	n/a	-0.30	-0.29
LA S3	-0.31	-0.34	-0.30	-0.32	-0.29
LA S4	-0.33	-0.39	-0.31	-0.31	-0.29
LA S5	-0.30	n/a	n/a	n/a	-0.29
Bay S1	-0.34	-0.30	-0.32	-0.32	-0.29
Bay S2	-0.37	-0.33	-0.35	-0.39	-0.29
Bay S3	-0.38	-0.34	-0.24	-0.29	-0.29
Bay S4	-0.41	-0.45	-0.83	-0.51	-0.29
Bay S5	n/a	-0.35	n/a	-0.19	-0.29
Ora S1	n/a	-0.304	-0.419	n/a	-0.290
Ora S2	n/a	-0.316	-0.387	n/a	-0.290
Ora S3	n/a	-0.350	-0.503	n/a	-0.290
Ora S4	n/a	-0.308	-0.279	n/a	-0.290
Ora S5	n/a	-0.488	n/a	n/a	-0.290
SD S1	-0.451	-0.327	-0.621	-0.453	-0.290
SD S2	-0.384	-0.284	-0.452	-0.474	-0.290
SD S3	-0.255	-0.419	-0.223	-0.246	-0.290
SD S4	-2.793	-0.453	-1.429	-5.584	-0.290
SD S5	-1.131	n/a	n/a	-2.212	-0.290
IE S1	-1.361	-0.344	-0.919	-0.793	-0.290