Generalized Insurer Bargaining

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Setting

- Bargaining between large health care providers and insurers (especially the US model)
- Hospitals bargaining over price per patient per day
- Pharmaceuticals bargaining over price per dosage
- Patients pay through insurance premium
- Related setting – purchasing department

Objective

- Identify implications of NiN in insurance markets
  - Theoretical – potential for market breakdown
  - Empirical – potential for underestimating hospitals' costs and/or bargaining power
  - Policy – inefficient mergers may be welfare enhancing under NiN
- Propose an alternative – Repeated Sequential Nash
  - "Nicer" theoretic features
  - Consistent with practitioner "extensive form game"
- Propose estimation procedure that generalizes the NiN and RSN models
  - A minor modification to Gowrisankaran et. al. 2015 model
  - One additional parameter

Prevalent Insurer-Market Features

- Hospital price is not (major) part of the patient choice
- Demand for A increases if B drops out of the network
- Patients may choose insurance that will not have their ex-post preferred hospital
- Insurer may be consumer surplus maximizing

Observation

- Current applied theory analysis of price per-unit NiN bargaining (Horn-Wolinsky 1988) assumes the opposite on all four insurer-market features
- Consumers pay the full price when buying
- Demand for A fixed at equilibrium level
- Consumers choose downstream product (insurer) based on upstream product
- Downstream is profit maximizing

Workhorse Model

1. Estimate/model patient demand model from each hospital to determine
    1. Patient's option value from access to each hospital
    2. Insurer's expected benefit/loss from adding/removing a hospital to/from the network
    3. Hospital's expected benefit from joining an insurer's network
    4. (usually out of scope) Competition model between insurers
2. Use the Nash-in-Nash bargaining model to estimate Hospital costs and bargaining parameters given observed prices
3. Counterfactual analysis holding bargaining parameters fixed

This Paper and the Workhorse Model

1. Replace NiN in the second part with Repeated Sequential Nash bargaining model
    - Change estimation of costs and bargaining power
    - Change counterfactual for expected prices, profits and welfare
2. Propose an estimation procedure that allows for both models
    - Estimation complication unaffected
    - Estimation provides direct test of NiN vs. RSN

Literature

- Plenty of applied theory (much in marketing) on general setting
  - Not much theory for the specific structure
  - Theoretical foundation for empirical work is Horn-Wolinsky, RJE 1988
  - Collard-Wexler, Gowrisankaran and Lee (2015) - Extensive form derivation of NiN for insurance markets with lump-sum payments
- Healthcare structural IO
  - Gaynor and Town, Handbook of Health Economics 2011
  - Gaynor, Ho and Town 2014 (NBER)
  - Gowrisankaran, Nevo and Town (GNT), AER 2015
- Related bargaining structural IO
  - Crawford and Yurukoglu (AER 2012), Lee et. al. (2013)

Example Setup

- One insurer, two hospitals ($h \in \{A, B\}$)
- Cost of serving a patient is zero
- Hospitals' bargaining power $\beta \in (0, 1)$
- Negotiation over p^h: hospital h price per patient-day
- Patients type $\theta \in \{a, b\}$, value hospital h: v_θ^h

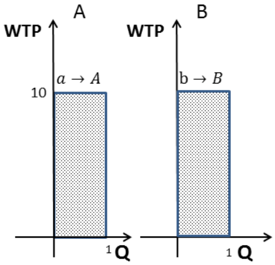
$$v_a^A = v_b^B = 10 \quad ; \quad v_b^A = v_a^B = 5$$

- If both hospitals are in the network, unit demand per type
- If a hospital leaves the network, α of the patients that prefer it stay in the network

Illustration

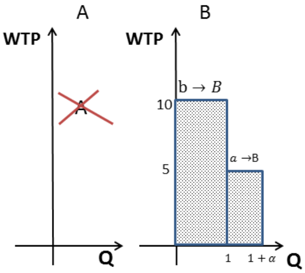
GNT estimate patients' utility decreases by about \$167 per extra minute travel

Total Surplus



$$TotalSurplus^{A+B} = 20$$

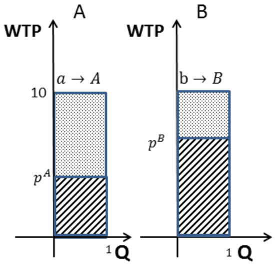
$$AverageSurplus^{A+B} = 10$$



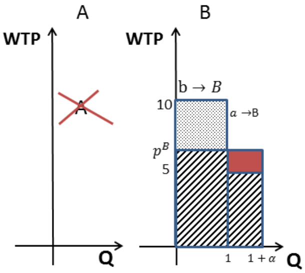
$$TotalSurplus^{B} = 10 + 5\alpha$$

$$AverageSurplus^{B} = \frac{10 + 5\alpha}{1 + \alpha} < 10$$

Consumer Surplus

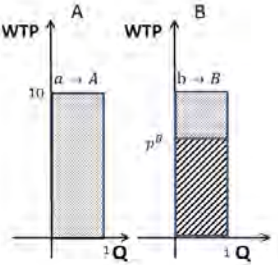


$$V^{A+B} = 20 - p^A - p^B$$

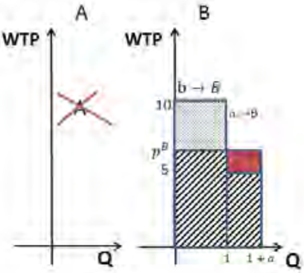


$$V^B = 10 - p^B + \alpha(5 - p^B)$$

Nash Bargaining With Hospital A



$$V^{A+B}(p^A = 0) = 20 - p^B$$



$$V^B = 10 - p^B + \alpha(5 - p^B)$$

$$p^A(p^B) = \beta \cdot [V^{A+B}(p^A = 0) - V^B]$$
$$= \beta \cdot [10 \cdot (1 - \alpha) + (p^B + 5) \cdot \alpha]$$

The Catch – The α Patients

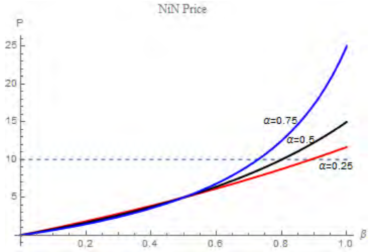
$$p^A = \beta \cdot \left[(1-\alpha) \cdot 10 + \underbrace{\alpha \left(p^B + 5 \right)} \right]$$

- Patients that prefer A but would stay with the insurer
- Adding A to the network creates $v_a^A + \left(p^B - v_a^B\right) > v_a^A$ per patient going to A
- A's per-patient value is inflated if p^B is higher than the value of B to A's patients
- A “takes advantage” of the insurer's pre-commitment to serve A's patients.

Nash in Nash Bargaining

Equilibrium of the bargaining game is such that

$$p^A(p^B) = p^A$$
$$p^B(p^A) = p^B$$



Nash in Nash Market Breakdown

- Multiple hospitals, multiple insurers
- Main qualification: insurers maximize (fraction of) patient surplus, not short term revenue

Theorem

In the general model with NiN bargaining there is a $\overline{\beta} < 1$ such that for any $\beta > \overline{\beta}$, the surplus generated by each insurer is negative.

- Regularity assumptions
  - At least two hospitals
  - Hospitals are substitutes
  - Value of a hospital is highest to those that would choose it as first option
  - IIA

One-Shot Sequential Bargaining

Sequential Bargaining Structure

- Negotiate with A first and then with B
- Each negotiation is Nash Bargaining
- Backward induction from $p^B(p^A)$ to p^A

- A "knows" that if the negotiations break, the insurer will set the right price for B
- Immediate implication: each negotiation must increase surplus

Do insurers negotiate sequentially?

- Equivalent question: can the insurer commit not to reopen to a failed negotiation?
- Blue Cross CEO: "We can and want to only do sequential negotiations"
  - Limited negotiating resources
  - Reduce hospital leverage and negotiation failures
- Ultimately empirical question
  - Proposed estimation generalization should answer

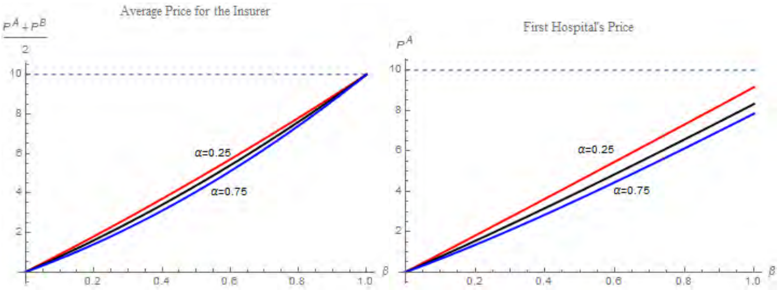
Sequential Bargaining Prices

- Suppose A goes first
- If A in the network, B's price determined like in previous version, can be higher than value
- If A isn't in the network, B's price is *lower*

$$\tilde{p}^B = \beta \frac{\alpha \cdot 5 + 10}{1 + \alpha}$$

- A's negotiated price is lower: accounts for the effect on B's price

Sequential Nash Prices



One-Shot Sequential Bargaining Results

Proposition

- No market breakdown
- Order matters only to the hospitals
- First of two is always worse
- First of symmetric is always worse

- Next step – order doesn't matter in a repeated game

Repeated Interaction

- Insurer sets the price for each hospital
- If a hospital disagrees:
  - Revert to the sequential game
  - The disagreeing hospital is first
- Equilibrium prices – maximize insurer profit while preventing deviation (IC)

$$p_j = (1-\delta) \cdot p_j^{Deviate}(p_{-j}) + \delta p_j^{First}$$

- Prices are unique (under technical assumptions)

Market Efficiency with Patient Hospitals

Proposition

In the *repeated* sequential model, if hospitals are sufficiently patient, the insurer's per-period surplus is strictly positive for any $\beta \leq 1$.

- If hospitals are sufficiently patient, prices converge to first-hospital price, strictly lower than value
- No market breakdown

Market Efficiency with Impatient Hospitals

- If hospitals are sufficiently impatient, everyone deviates
- Each hospital's price is a NiN
- Insurer would choose an order and avoid the repeated threat
- No market breakdown

Generalized Bargaining

- When estimating, we **observe** prices, want to infer β, costs.
- RSN model:

$$p_j = \delta p_j^{First} + (1 - \delta)\, p_j^{Deviate}$$

Estimation Insight

Conditional on the other prices, $p_j^{Deviate} = p_j^{Nash-in-Nash}$

Estimation for j hospitals

- First stage – estimate demand parameters as usual
- Workhorse model (GNT notation)
  - Set Ω, Δ, $j \times j$ matrices of demand parameters and β
  - Costs and price vectors must satisfy

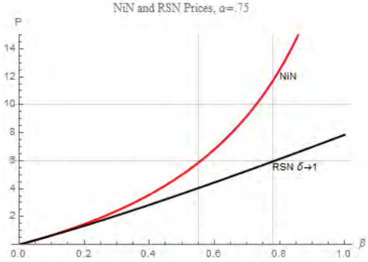
$$p = c - (\Omega + \Delta)^{-1} q$$

- Generalized model

$$p = \delta\theta + c \cdot ((1 - \delta\beta)I + \delta\Psi) - (1 - \delta)(\Omega + \Delta)^{-1} q$$

- One additional variable to estimate: δ
- When $\delta = 0$, the two models are identical
- θ (vector) and Ψ (matrix) from demand estimates plus bargaining parameters

Comparing Models



- Observe $p \approx 6$
- Suppose the true model is RSN with $\delta \to 1$ (so $\beta \approx 0.8$)
- Estimating with $\delta = 0$ (Nash-in-Nash) increases hospital margins for every β
- Results in lower estimates of β (hospital bargaining power) and/or hospital costs

GNT Table 5

Table 5—Bargaining Parameter Estimates

	Specification 1		Specification 2	
Parameter	Estimate	SE	Estimate	SE
MCO welfare weight (τ)	2.79	(2.87)	6.69	(5.53)
MCO 1 bargaining weight	0.5	—	0.52	(0.09)
MCOs 2 & 3 bargaining weight $1-\beta$	0.5	—	1.00**	(7.77×10^{-10})
MCO 4 bargaining weight	0.5	—	0.76**	(0.09)
Hospital cost parameters				
Prince William Hospital	8,635**	(3,009)	5,971**	(1,236)
Inova Alexandria	10,412*	(4,415)	6,487**	(1,905)
Inova Fairfax	10,786**	(3,765)	6,133**	(1,211)
Inova Fair Oaks	11,192**	(3,239)	6,970**	(2,352)
Inova Loudoun	12,014**	(3,188)	8,167**	(1,145)
Inova Mount Vernon	10,294*	(5,170)	4,658	(3,412)
Fauquier Hospital	14,553**	(3,390)	9,041**	(1,905)
No. VA Community Hosp.	10,086**	(2,413)	5,754**	(2,162)
Potomac Hospital	11,459**	(2,703)	7,653**	(902)
Reston Hospital Center	8,249**	(3,064)	5,756**	(1,607)
Virginia Hospital Center	7,993**	(2,139)	5,303**	(1,226)
Patients from MCO 2	−9,043**	(2,831)	—	—
Patients from MCO 3	−8,910**	(3,128)	—	—
Patients from MCO 4	−4,476	(2,707)	—	—
Year 2004	1,130	(1,303)	1,414	(1,410)
Year 2005	1,808	(1,481)	1,737	(1,264)
Year 2006	1,908	(1,259)	2,459*	(1,077)

Cost adjustment

Notes: Significance tests for bargaining parameters test the null of whether the parameter is different than 0.5. We report bootstrapped standard errors with data resampled at the payor/year/system level. Patients from MCO 1 and Year 2003 are both excluded indicators.

**Significant at the 1 percent level.

*Significant at the 5 percent level.

Average pre-adjustment cost is $\approx$ 10,500

Policy Implications

- When β is high, NiN predicts mergers decrease prices and increase total welfare by construction
  - Formal condition: merging hospital's price is higher than its value as an alternative to the merging partner
  - Same intuition as Cournot Complements
  - If NiN is the correct model for these markets, mergers can be good for consumers, bad for hospitals
  - If NiN is *not* the correct model for these markets, mergers can seem better to regulators than they are
- Under-estimating hospital bargaining power will tend to favor mergers
- Effect of under-estimating pre-merger costs?

Conclusion: Bargaining in Insurer Markets

- NiN incorporates specific assumptions
- NiN assumptions imply very high profits for upstream providers with strong bargaining power
- NiN potential for market breakdown
- Models based on sequential Nash bargaining
  - Have different assumptions
  - Limit upstream profits
  - Avoid market breakdown
- Estimation can be generalized to accommodate both
- Data can test the models

θ and Ψ

$$
\begin{aligned}
p &= \delta p_j^{First} + (1-\delta)\, p_j^{Deviate} \\
&= \delta\theta + c\cdot((1-\delta\beta)I + \delta\Psi) - (1-\delta)(\Omega+\Delta)^{-1} q
\end{aligned}
$$

$$p_j^{Deviate} = c - (\Omega+\Delta)^{-1} q$$

$$
\begin{aligned}
p_j^{First} &= \beta\tau \frac{q_j v_j + \sum_{k\in J, k\neq j}\left[\beta q_{k,j} v_{k,j} - (1-\beta) q_{j,k} v_{j,k}\right]}{q_j + \beta\sum_{k\in J,k\neq j} q_{k,j}} \\
&+ \beta \frac{\sum_{k\in J,k\neq j}(1-\beta) q_{j,k} c_k}{q_j + \beta\sum_{k\in J,k\neq j} q_{k,j}} \\
&+ (1-\beta) c_j
\end{aligned}
$$

θ and Ψ

$$
\begin{aligned}
p &= \delta p_j^{First} + (1-\delta)\, p_j^{Deviate} \\
&= \delta\theta + c \cdot ((1-\delta\beta) I + \delta\Psi) - (1-\delta)\,(\Omega+\Delta)^{-1}\, q
\end{aligned}
$$

$$
p_j^{Deviate} = c - (\Omega+\Delta)^{-1}\, q
$$

$$
\begin{aligned}
p_j^{First} = \beta\tau & \frac{q_j v_j + \sum_{k\in J, k\neq j}\left[\beta q_{k,j} v_{k,j} - (1-\beta) q_{j,k} v_{j,k}\right]}{q_j + \beta \sum_{k\in J, k\neq j} q_{k,j}} \\
& + \beta \frac{\sum_{k\in J, k\neq j} (1-\beta) q_{j,k} c_k}{q_j + \beta \sum_{k\in J, k\neq j} q_{k,j}} \\
& + (1-\beta) c_j
\end{aligned}
$$

Handbook, p. 530

$$H_{\text{agree}} = (p_{jh} - c_j)q_{jh}(J_h)$$

$$H_{\text{disagree}} = r_j$$

$$M_{\text{agree}} = F_h(J_h) - p_{jh}q_{jh}(J_h) - \sum\nolimits_{l \neq j} p_{lh}\boxed{q_{lh}(J_h)} - cm_{jh}$$

$$M_{\text{disagree}} = F_h(J_{h-j}) - \sum\nolimits_{l \neq j} p_{lh}\boxed{q_{lh}(J_{h-j})}$$

Under Nash bargaining each bilateral price maximizes the Nash product of hospital net profits and the net insurer surplus from agreement, taking the other prices as given, solving

$$\max_p [H_{\text{agree}} - H_{\text{disagree}}]^{\beta}[M_{\text{agree}} - M_{\text{disagree}}]^{1-\beta}$$

Handbook p. 530 continued

where $\beta \in [0,1]$ is the relative bargaining ability or non-modeled bargaining power of the hospital relative to the insurer. Differentiating and solving for p_{jh} yields:[30]

$$p_{jh} = (1-\beta)\left(c_j - \frac{r_j}{q_{jh}}\right) + \frac{\beta}{q_{jh}}\left(F_h(J_h) - F_h(J_{h-j}) - cm_{jh}\right) + \beta \boxed{\sum_{l \neq j} p_{lh} d_{jlh}} \qquad (9.7)$$

where we refine d as a share so $d_{jk} = (q_{kh}^{J-j} - q_{kh})/q_{jh}$ and q_{kh}^{J-j} is the number of patients that flow to hospital k if the network is J_{h-j}. That is, d_{jk} is the diversion share from hospital j to hospital k when hospital j is no longer available.