Dynamic Bargaining between Hospitals and Insurers

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Broad Motivation: Dynamic Effects in Vertical Markets

- Canonical approach to vertical market bargaining is static
  - Cable TV, supply chains, labor unions, American healthcare
  - Empirical literature assumes contracts are short-lived & formed simultaneously
- Novel data: hospital-insurer contracts are multiyear & staggered
  - To understand dynamic effects, need bargaining with dynamics
- This paper: dynamics with contracts formed at different times
  - Tractability issues from naively extending the canonical approach
  - Propose **the** extension that overcomes tractability issues

Empirical Motivation: Dynamic Medicare Benchmark Effects

- $400B+ private insurer spending calculated using **benchmarks**
  - Spending has important consequences for premiums & wages
  - E.g. "insurer + patient will pay 150% of amount Medicare would pay"
  - **Benchmarks**: hospital out-of-network list prices and government-set Medicare rates
- Underappreciated: benchmark prices change over time
  - Usual static approach: Medicare benchmark dynamics are irrelevant
  - Multiyear contracts: benchmarks shape private price dynamics and **bargaining**

Empirical Question: How would private insurer spending change if Medicare benchmark rates went up faster?

How I Add Multiyear Contracts to Vertical Market Bargaining

- Vertical market: how we bargain depends on your other contracts
  - Static (simultaneous) model: spillovers through anticipated contracts
  - Dynamic (staggered) model: today's contract will affect your future contracts
- Point out Nash + staggered contracts adds many bargaining states
- Key innovation: Kalai proportional for dynamic bargaining
  - **Extends static Nash**: same predictions as Nash in many static applications
  - **Tractable dynamics**: I prove under Kalai, only a few states affect chosen contract

Preview of Results & Talk

1. Key descriptives from a decade of novel contract data
   a. Important role of benchmarks in how private payments evolve
   b. Unusual opportunity — contracts are usually trade secrets
   c. Typical: contract in place 3+ years, 5 month wait until neighbor negotiates
2. Novel method for adding dynamics to vertical market bargaining
   a. Need for forward-looking negotiators that respond to expected future conditions
   b. Prove unique benefits of applying Kalai proportional solution to dynamic bargaining
3. Estimation of empirical model and counterfactuals
   a. Find bargainers are forward-looking — reject myopia
   b. Proposed Medicare dynamics would increase 2015 private spend by $4.98B

Key Literature

- Vertical markets: single period Nash*

  Lee and Fong (2013); Grennan (2013); Gowrisankaran, Nevo, and Town (2015); Ho and Lee (2017); Crawford, Lee, Whinston, and Yurukoglu (2018); Collard-Wexler, Gowrisankaran, and Lee (2019)

- Dynamic bargaining: not vertical markets

  Binmore, Rubinstein, and Wolinsky (1986); MacLeod and Malcomson (1993); Stole and Zwiebel (1996); Levin (2003); Sorger (2006) Backus, Blake, Larsen, and Tadelis (2020); Cahuc, Postel-Vinay, and Robin (2006); Gertler and Trigari (2009); Gottfries (2022)

- Bargaining solutions: static perspective

  Nash (1950); Kalai and Smorodinsky (1975); Kalai (1977)

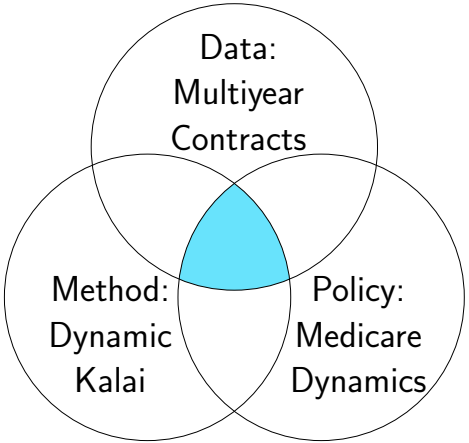
- US healthcare spending: massive mechanisms

  Reinhardt (2006); Sorensen (2003); Cooper, Craig, Gaynor, and Reenen (2019); Weber, Floyd, Kim, and White (2019); Clemens and Ippolito (2019); Chernew, Dafny, and Pany (2020); Clemens and Gottlieb (2017); Prager and Tilipman (2022); Duffy, Whaley, and White (2020)

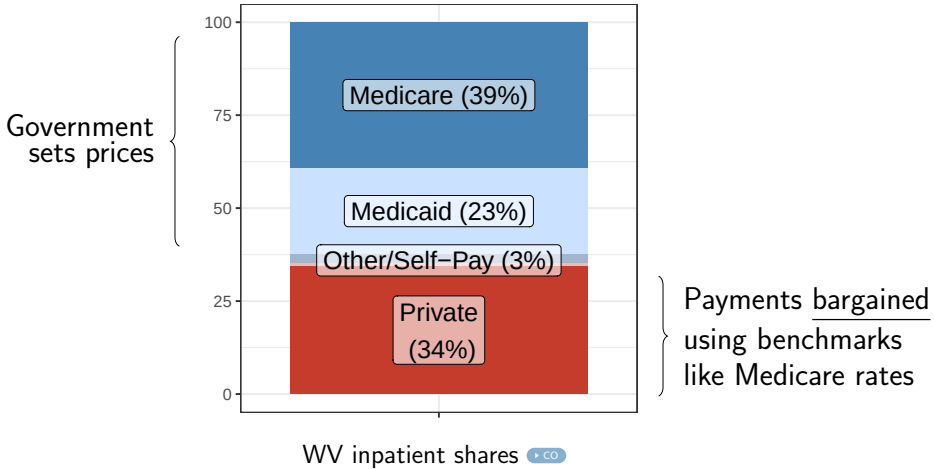
*For today, "Nash" means Nash-in-Nash (I tweak Nash bargaining, not equilibrium)

This Paper's Contributions

- Novel dataset
- Novel methodology
- Important policy



Research Focus: Benchmarks in the Private Market



There Are Two Common Benchmarks

Thousands of services $\Rightarrow$ impractical to negotiate service-by-service

1. Medicare-set rates (BCBS, national, my focus)
2. Hospital-set list prices (non-BCBS, endogenous, future work)

How do dynamics in these benchmark prices affect real payments?

Different Benchmarks Have Different Dynamic Implications

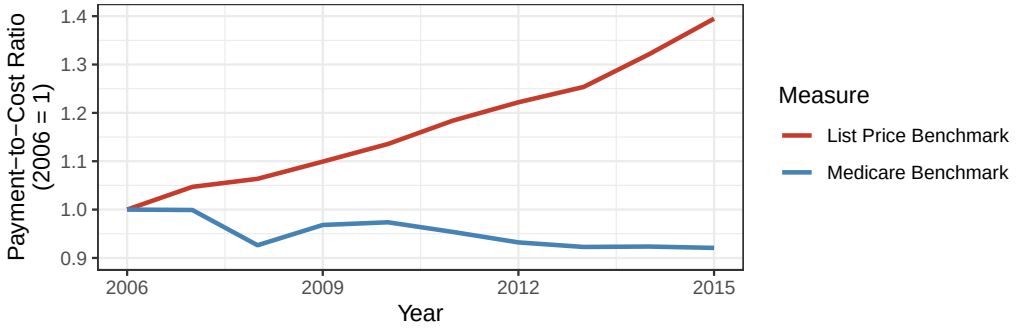


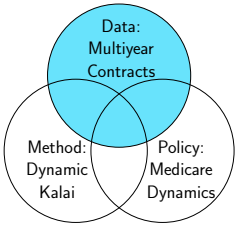
Figure: Medicare payments decreased relative to reported costs while list prices increased quickly.

▸ Payments

Novel Data to Study Contract Dynamics:

Public record contract report panel

- Proof of concept for future price data
- Scans of annual hospital reports
  - Payment rates, timing, benchmarks, ...
  - Frequency | Networks | Other Data



How to Think About Contracts:

Multiyear and formed at different times

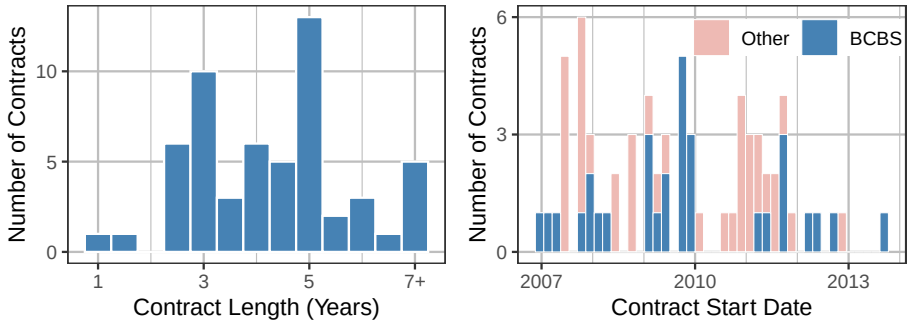


Figure: Histograms of BCBS reported lengths (left) and contract formation dates (right). ▸ Others

Need Dynamic Approach for Dynamic Effects

- Medicare dynamics affect how private prices evolve
- Canonical approach is static Nash bargaining
- Static negotiators do not care how prices evolve

Need Dynamic Approach to Capture Forward-Looking Offsets

- Forward-looking price-setters offset future changes (Taylor, 1980; Calvo, 1983)
  - Suppose BCBS & Large General negotiate a two-year contract in 2013 ▸ Illustration
  - Status quo: everything constant, benchmark multiple of $\alpha = 1.5$ to pay \$30m
  - Suppose Medicare doubles 2014 price — myopic negotiators still choose $\alpha = 1.5$
  - Forward-looking negotiators should reduce α and 2013 prices
- A classic point that introduces new empirical challenges
  - Key empirical parameter: discounting rate β
  - $\beta > 0$ introduces tractability issues for vertical market bargaining

▸

Empirical Model: Ho and Lee (2017) + Dynamics

1. Price benchmarks (Medicare prices and list prices) are updated
2. Hospitals and insurers simultaneously bargain new contracts
   - Contracts can last more than one period — forward-looking negotiators
3. Consumers choose plans and get sick $\Rightarrow$ hospital, insurer demand D^{Hosp}, D^{Ins}
4. Flow profits realized with price spillovers ▸ ▸ GFTs — some internalized

$$\pi_j^{Ins} = \underbrace{D_j^{Ins}(\cdot)(\phi_j - \eta_j)}_{\substack{\text{Premium revenue} \\ \text{net of } \eta}} - \underbrace{\sum_{h \in \mathcal{G}_j^{Ins}} D_{hj}^{Hosp}(\cdot) p_{hj}}_{\textbf{Payments to hospitals}} \quad \text{and} \quad \pi_i^{Hosp} = \underbrace{\sum_{n \in \mathcal{G}_i^{Hosp}} D_{in}^{Hosp}(\cdot)(p_{in} - c_i)}_{\substack{\textbf{Payments received} \\ -\text{cost of care}}}$$

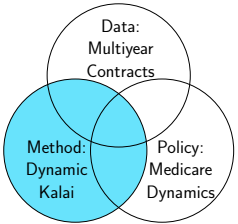
Method Preview: Dynamic Bargaining Challenge & Solution

Challenge: Dynamic Nash disagreement introduces many states

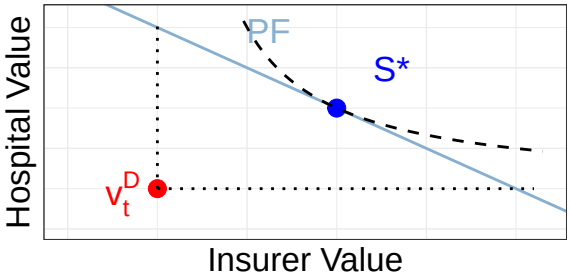
- Data & theory suggest quick return to bargaining table
- With staggered contracts, **when** you bargain changes how you bargain

Solution: Apply Kalai proportional to dynamic bargaining

- Favorable axioms, intuition, & experiments, plus often same as Nash
- Contribution: prove most states irrelevant under Kalai proportional



Method: Nash Bargaining (Static Review)



- Pareto frontier $PF = \{(V_t^{Ins}(p), V_t^{Hosp}(p))\}$
- Disagreement value $v_t^D = (v_t^{Ins,D}, v_t^{Hosp,D})$
- Gains from trade $GFT_t^i(p) = V_t^i(p) - v_t^{i,D}$
- Bargaining solution S^*, insurer weight τ_{ij}
- $p^*_{t,\text{Nash}}$: max asymmetric product of GFTs

$$\frac{GFT_t^{Ins}(p^*_{t,\text{Nash}})}{GFT_t^{Hosp}(p^*_{t,\text{Nash}})} = \frac{\tau_{ij}}{1-\tau_{ij}} \frac{-V_t^{Ins}(p^*_{t,\text{Nash}})'}{V_t^{Hosp}(p^*_{t,\text{Nash}})'}$$

Method: Dynamic Nash Introduces Many Bargaining States

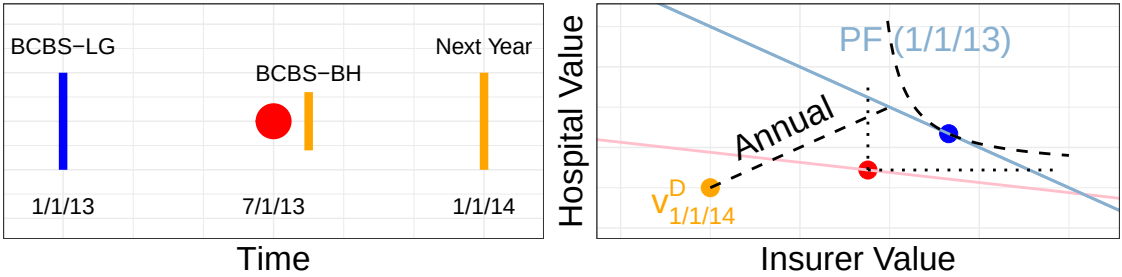


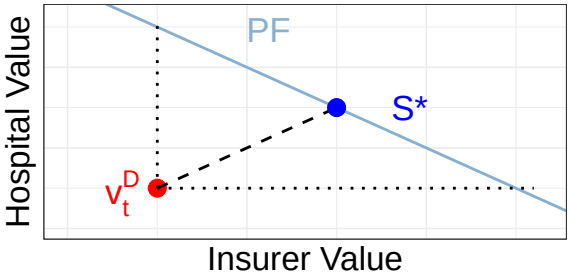
Figure: BCBS and Large General dynamic (recursive) Nash bargain on 1/1/13. BCBS-Big Hospital contract expires 7/5/13. When you bargain changes how you bargain ⇒ contract depends on period length & need many states to capture disagreement States.

To focus on forward-looking response, I go beyond Nash bargaining

Method: Kalai Proportional Solution (Static Background)

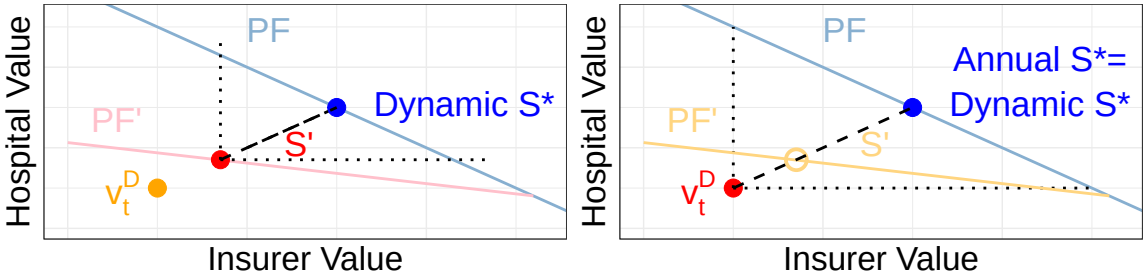
$$\frac{GFT_t^{Ins}(p^*_{\text{Kalai}})}{GFT_t^{Hosp}(p^*_{\text{Kalai}})} = \frac{\tau_{ij}}{1-\tau_{ij}}$$

$$\frac{GFT_t^{Ins}(p^*_{Nash})}{GFT_t^{Hosp}(p^*_{Nash})} = \frac{\tau_{ij}}{1-\tau_{ij}} \underbrace{\frac{-V_t^{Ins}(p^*_{Nash})'}{V_t^{Hosp}(p^*_{Nash})'}}_{=1 \text{ if TU}}$$



- Static view: "central role in the theory" (Thomson, 1994) — axioms, intuition, and data
- Same as Nash if transferable utility (estimate $\approx$ TU in my setting) ▸ Heuristic Nash?

Method: Key Innovation is a Kalai Static Utility Property



- *Step-by-step* property (Kalai, 1977), AKA *path-invariance* property (Roth, 1979)
- Kalai (1977): "One has to be careful:" on utility, not "the underlying game"
- **Innovation**: step-by-step exactly solves underlying *dynamic* game complexity

Method: Under Kalai, Most States Are Irrelevant

Theorem 1

Suppose hospital i and insurer j reach a contract in period t_0 with starting price p^*_{ijt} through Kalai proportional bargaining over expected values. Suppose certain restrictions ▸ *like rational expectations* *hold. Then they reach the same price $p^*_{ijt_0}$ under:*

1. **A "short disagreement" model in continuous time** ▸
2. **A particular bargaining model defined in discrete time** ▸

Static arguments: only Kalai proportional has this property (Kalai, 1977; Roth, 1979).

▸ Demonstration ▸ Bargaining Moment

Estimation of Empirical Model

Estimation step	Data inputs	Method outputs	Timing	Identification
1. Hospital demand	BCBS inpatient choice	Hospital network WTP (utils)	Static	Observables logit
2. Insurer demand	H demand, sales estimates, Census	Network effect on sales	Static	ACA area FEs
3. Contract bargaining	Multiple years of payments, demand	Discounting β	Dynamic	GMM (H & I IVs)
4. Benchmark	Prices over time	Observed	Implicit	Observed

Adapted and extended based on Ho (2006)

Estimates: Negotiators Are Forward-Looking

Key parameter drives forward-looking offset: discounting β

Parameter	Myopic	Forward-Looking
β	0	0.899***
	$(\cdot)$	(0.03)

*p<0.1; **p<0.05; ***p<0.01

▸ GFT Shares ▸ Table ▸ Other Parameters ▸ Other Models ▸ Nash Approximation

Counterfactual: Faster Medicare Rate Increases

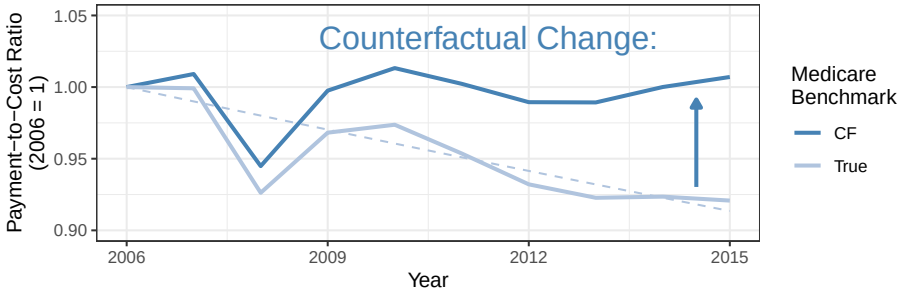
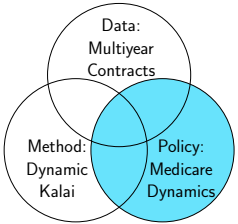


Figure: Medicare payments (light blue) decreased relative to reported costs by roughly one percentage point annually (dashed line). What if Medicare increased rates one percentage point faster each year, relative to actual rates?

Counterfactual: Summary of Core Mechanisms

- Surprise Medicare announcement at end of 2006
  - One percentage point annual price increase going forward (relative to actual)
  - Will hold expiration and benchmark choice fixed Details
- Conventional static view: no effect
- **Mechanical**: future prices increase
- **Quantify**: starting prices decrease



Counterfactual: Estimate Meaningful Medicare Effects

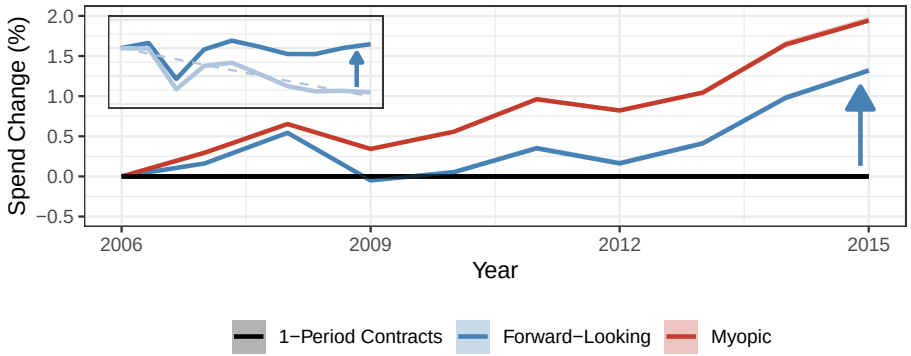
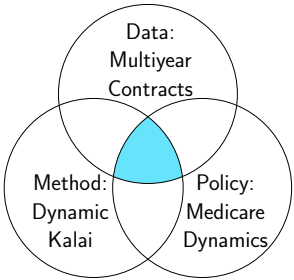


Figure: Counterfactual 2015 payments increase by an estimated 1.319%. The myopic model overestimates effects by 45%+. ▸ 45%+ Overestimate ▸ Construction (Time Series-Adjacent) ▸ Decomposition ▸ Timing ▸ By Insurer ▸ By Hospital ▸ $\beta = 0.97$ ▸ Premiums ▸ Drop CAMC ▸ List Price Caps ▸ Limitations

This Paper Finds Contract Dynamics Have Meaningful Effects

- **Data**: contracts are multiyear & staggered
- **Method**: staggered contracts in vertical markets
  - Leverage Kalai proportional to cut through complexity
- **Policy**: meaningful Medicare effects



Implications for Future Work

Framework for answering new questions like:

- How does disagreement affect subsequent demand? (Cable carriage)
- How does inflation impact multiunit labor bargaining? (UAW)
- How do provider payments affect care supplied? (Medicare IV)
- Why are list price-benchmarked contracts long-lived? (Auto-renew process)

Thank you!

Other thoughts and questions or for data: `jacobdorn.info`

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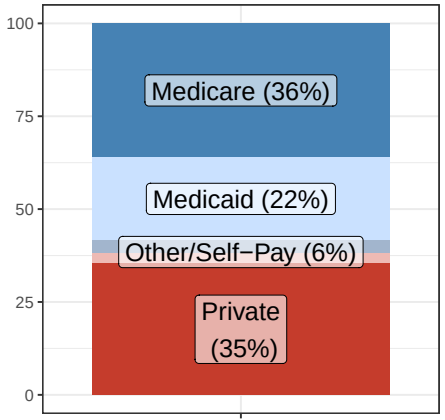
Colorado Payor Mix

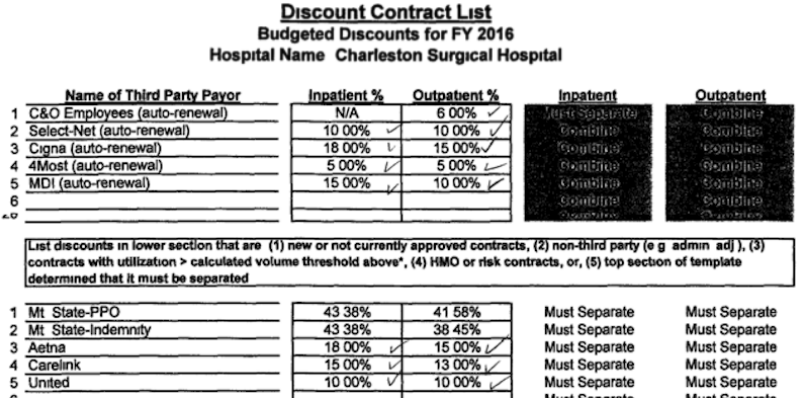
Government sets prices



Payments bargained using benchmarks like Medicare rates

2016 CO shares, From Colorado (2022)

Example West Virginia Contract Report Scan



Discount Contract List

Budgeted Discounts for FY 2016

Hospital Name Charleston Surgical Hospital

	Name of Third Party Payor	Inpatient %	Outpatient %	Inpatient	Outpatient
1	C&O Employees (auto-renewal)	N/A	6 00%	[illegible]	[illegible]
2	Select-Net (auto-renewal)	10 00%	10 00%	Combine	Combine
3	Cigna (auto-renewal)	18 00%	15 00%	Combine	Combine
4	4Most (auto-renewal)	5 00%	5 00%	Combine	Combine
5	MDI (auto-renewal)	15 00%	10 00%	Combine	Combine
6				Combine	Combine
[illegible]				[illegible]	[illegible]

List discounts in lower section that are (1) new or not currently approved contracts, (2) non-third party (e g admin adj), (3) contracts with utilization > calculated volume threshold above*, (4) HMO or risk contracts, or, (5) top section of template determined that it must be separated

1	Mt State-PPO	43 38%	41 58%	Must Separate	Must Separate
2	Mt State-Indemnity	43 38%	38 45%	Must Separate	Must Separate
3	Aetna	18 00%	15 00%	Must Separate	Must Separate
4	Carelink	15 00%	13 00%	Must Separate	Must Separate
5	United	10 00%	10 00%	Must Separate	Must Separate
[illegible]				[illegible]	[illegible]

Figure: Charleston Surgical Hospital report, fiscal year 2016. Mountain State/Highmark BCBS generally used Medicare as a benchmark (non-round numbers) while other smaller insurers generally used list prices. ▸ Was WV Unrepresentative? ◂

West Virginia Rate Regulation

- From 1993-2016, West Virginia:
  1. Capped hospital charge increases
  2. Required all hospital–insurer contracts to cover average costs
  3. Approved hospital–insurer contracts and made them public records
- Does this make West Virginia unrepresentative?
  - 1 & 2: Caps "too generous" as of Murray and Berenson (2015) and contracts easily covered costs, though may have been associated with lower list prices and more outpatient care
  - 3: disclosure unusual at time — may be more representative of where the US is going

Contract Benchmark Frequency

Insurer	Medicare	List Prices
All	46.74	53.26
Modeled	60.20	39.80
Highmark BCBS	72.27	27.73
HPUOV	56.24	43.76
Other Modeled	13.14	86.86
Nonmodeled	3.03	96.97

Table: Estimated percentage of 2011-16 projected inpatient payments classified as Medicare-benchmarked and list price-benchmarked.

Network Strength

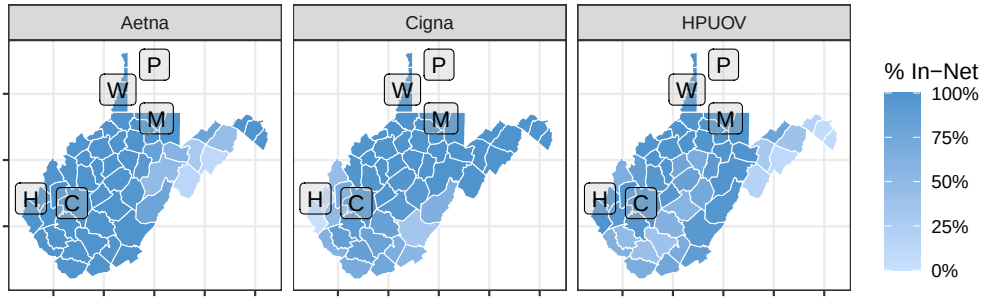


Figure: Network quality (large cities overlaid), measured as a percentage of 2016 inpatient discharges in a given insurer's 2015 network.

Key Other Data Sources

- Hospital inpatient discharges
  - Demographics, diagnosis, major insurance, ... (2016)
  - Use for hospital demand and insurer demand
- State fully insured premiums & sales
  - Annual data by insurer (2006-16)
  - Use for pre-2016 insurer demand

Non-BCBS Contract Lengths (Auto-Renew)

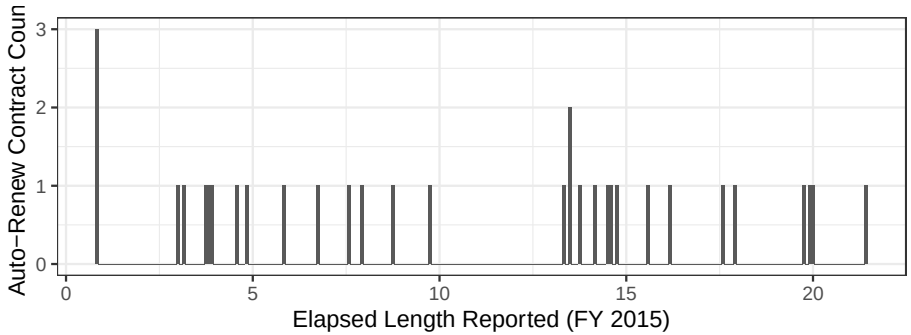


Figure: Retrospective length for non-BCBS modeled insurer auto-renew contracts (where available) as of fiscal year 2015.

Benchmark Price vs. Payment Increases

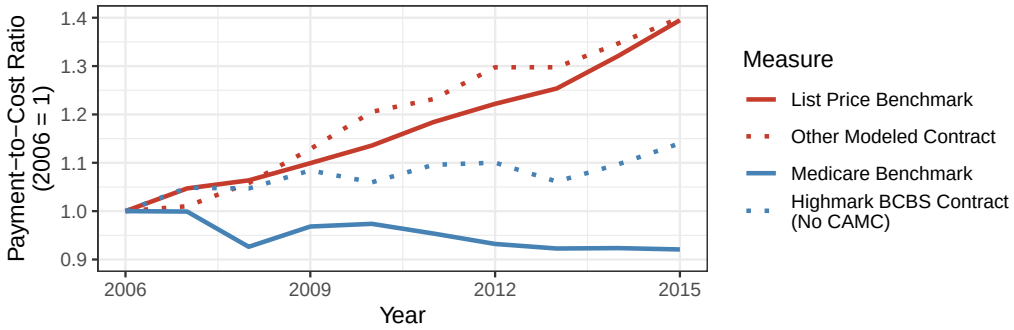


Figure: List prices went up quickly while Medicare deflated slightly relative to costs. Medium-sized insurer (list price-based) payments went up quickly while Blue Cross (Medicare-based) payments roughly tracked hospital costs. ▸ Decomposition ◂

Decomposition of BCBS-Other Insurer Divergence

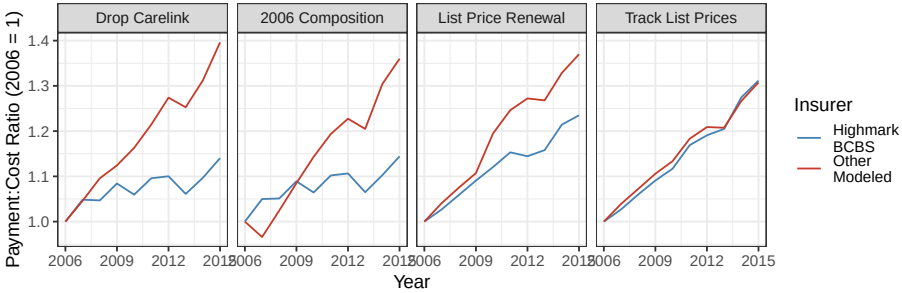


Figure: Decomposition of BCBS-other modeled insurer payment divergence by standardizing (i) insurers and (ii) insurer-hospital quantities across years, (iii) renewing prices proportionally to list prices, and (iv) renegotiating prices proportionally to list prices. The divergence between BCBS and the other insurers is largely driven by the lower renewing prices (iii) and the slower increases in starting prices (iv).

Asymmetric Nash Bargaining Weights

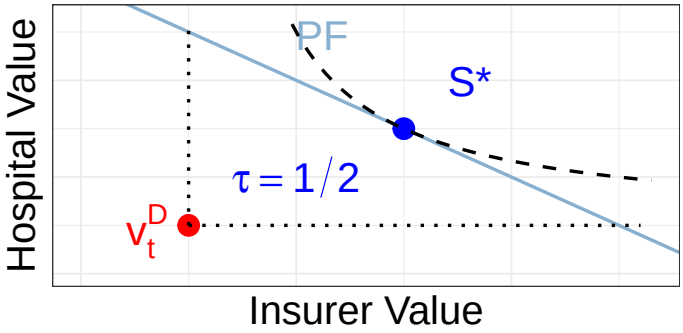


Figure: Nash bargaining solutions for various values of τ.

Bargaining State Space

- *hn* bargain in t_0 over contract terms $(B_{hnt_0}, \alpha_{hnt_0}, \ell_{hnt_0})$
  - Benchmark B_{hnt_0}, multiple $\alpha_{hnt_0} = p_{hnt_0}/p^B_{it_0}$, expiration ℓ_{hnt_0} (disagree $= (N, 0, 0)$)
  - $(B^*_{\text{Nash}}, \alpha^*_{\text{Nash}}, \ell^*_{\text{Nash}}) \in \text{argmax}_{(B,\alpha,\ell)} \left(GFT^{Ins}_{hnt_0}((B,\alpha,\ell))\right)^{\tau_{ij}} \left(GFT^{Hosp}_{hnt_0}((B,\alpha,\ell))\right)^{1-\tau_{ij}}$

- Let $\mathbb{C}_t(B, \alpha, \ell)$ be the market potential outcome (random)

$$GFT^i_{hnt_0}((B_{hnt_0}, \alpha_{hnt_0}, \ell_{hnt_0})) = V^i_{hnt_0}((B_{hnt_0}, \alpha_{hnt_0}, \ell_{hnt_0})) - V^i_{hnt_0}((N, 0, 0))$$

$$V^i_{hnt_0}((B, \alpha, \ell)) = \mathbb{E}_{t_0}\left[\sum_{t=t_0}^{\infty} \beta^{t-t_0}\left\{\pi^i_t(\mathbb{C}_t((B, \alpha, \ell)))\right\}\right]$$

  - Value of disagreement $V^i_{hnt_0}((N, 0, 0))$ includes recursive choice of *hn* contract in $t_0 + 1$
  - Bargaining state includes other lengths ℓ_{-hn,t_0}: effect of α_{hnt_0} on p_{ijt} depends on $\ell_{hnt_0}, \ell_{ijt_0}$
  - Every disagreement introduces a bargaining state

Illustration: The Model Needs Forward-Looking Negotiators

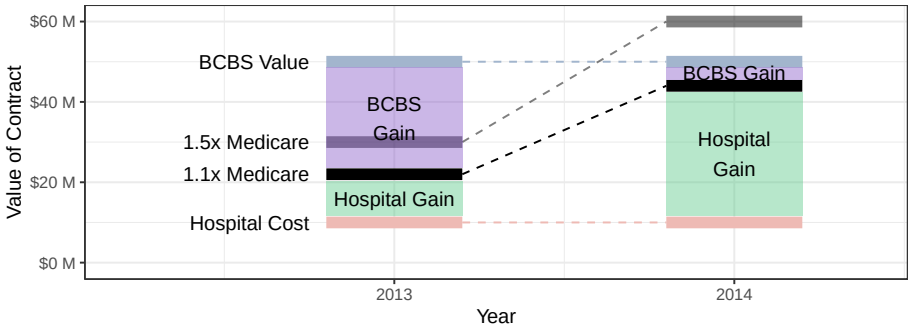


Figure: Forward-looking bargainers offset future price increases (illustration). Large General Hospital negotiates a two-year contract in 2013 with BCBS that is benchmarked to Medicare. Myopia corresponds to no offsets.

Vertical Market Contract Spillovers (Static Review)

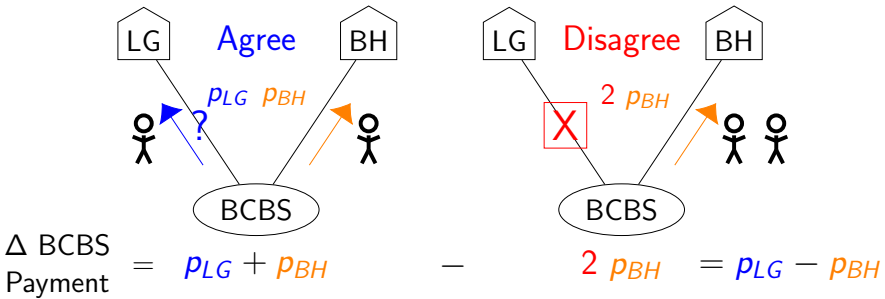
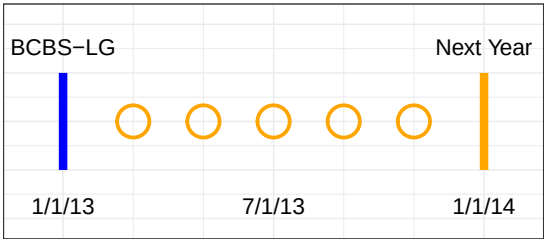
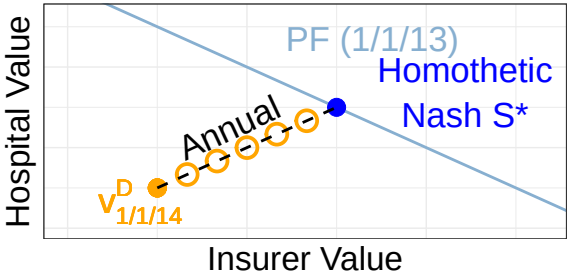


Figure: Static illustration in which BCBS gain from trading with LG with anticipated Big Hospital price p_{BH} is (stuff) $+p_{BH}$.

- Spillovers: p^*_{LG} depends on p_{BH} through disagreement cost

Dynamic Recursive Nash is Tractable Under Homotheticity





- Binmore et al. (1986)-type intuition requires homothetic PFs (Coles and Muthoo, 2003)
- Homotheticity: Pareto Frontier slope is constant in time

Suggestive Evidence Firms Would Not Exclude for a Year

- Hard to prove: six years of annual expiration data, disagreement is rare
- Suggestive evidence of within-year bargaining of fixed-length contracts
- BCBS-Charleston Surgical negotiation
  - On 9/1/2009, form a contract scheduled to end 8/31/2012
  - In November 2012 report, expiration changes to 12/31/2012
  - At some point (may be July 2013), form a contract to expire 12/31/2018
- BCBS-Reynolds Memorial negotiation
  - Form a contract scheduled to end 2/28/2011
  - In July 2011 report, expiration changes to 9/30/2011
  - By July 2012, form a contract to expire 9/30/2014

Bargaining State Space Growth (Five Years, Monthly)

- 60 (LG month) states, 864+ (LG month) $\times$ (BH month) states
- 10,368+ states if 12 contracts/year
- 9.6 million states if we want to capture largest spillovers (daily)

Would a Heuristic Nash Model be Better?

- Why use Nash? ~~Microfounded~~, ~~precedent~~, ~~tractable~~, axioms (scale invariance)
- Considered a Nash model — need heuristic fixes like aggregate time
  - To capture largest (closest) spillovers, need many (short period) states
  - Either Kalai approximates Nash or no tractable accurate Nash
- Exciting room for more new methods!
  - I identify challenges  , propose a yardstick, & document a testing ground

Nash Bargaining Empirics: Need Strong Uncertainty Stance

	$V^{Ins}_{Realized}(p)$	$V^{Hosp}_{Realized}(p)$
H	$30 - p$	0
T	$10 - p$	$2p$
$E[V(p)]$	$20 - p$	p

Table: Table of hypothetical realized value functions depending on a fair coin tossed after bargaining. (Disagreement value equals zero.)

- $\tau = 1/2 \Rightarrow p^* = 10$ for Nash and Kalai
- Naive Nash estimates $\hat{\tau} = 0$: $V^{Hosp}_{Realized}(p^*)' > 0$ implies $V^{Ins}_{Realized}(p^*) = 0$

Nash Bargaining Can Be Non-Monotonic

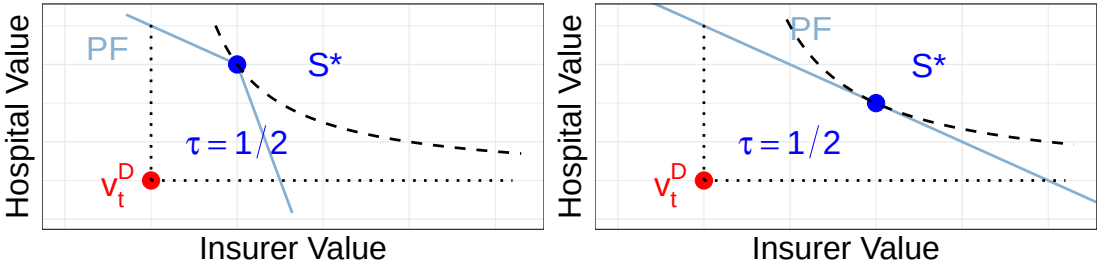
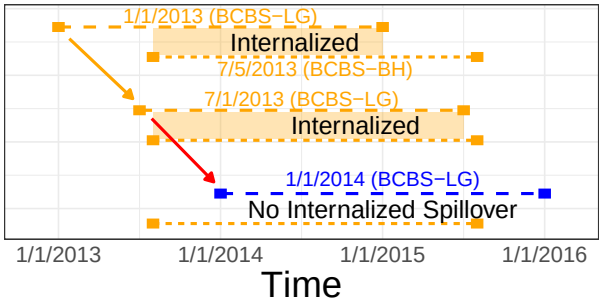


Figure: Example in which an insurer Pareto frontier expansion harms the hospital by making hospital losses more beneficial to the insurer.

Kalai Equivalence Regularity Conditions

- Risk-neutral, shared unbiased expectations, shared discount rate $\beta \in [0, 1)$
- Markov strategies
- Good-Faith Disagreement: disagreement does not change subsequent networks

Dynamic Vertical Market Slope Depends on Time (Facts 1-3)



- Suppose BCBS always forms two-year contracts with fixed prices
  - Equilibrium negotiation with Large General on Jan. 1, Big Hospital on July 5
- As July nears, BCBS-LG marginal value ratio $\frac{-V_t^{Ins}(p^*_{t,\text{Nash}})'}{V_t^{Hosp}(p^*_{t,\text{Nash}})'}$ (-slope) grows

Method: Solution Concept:

Kalai Relative to Short Disagreement

1. *Kalai bargaining*. Hospital i and insurer j always choose contracts from Kalai proportional bargaining over expected values with fixed insurer weight τ_{ij}

2. *Short disagreement*. Gains from trade recursively defined relative to i and j disagreeing now, then returning to the bargaining table as quickly as possible

3. *Continuous time*. The time in between bargaining attempts is arbitrarily small

Method: Equivalent Model Defined in Discrete Time:

Kalai Relative to Impasse

1. *Kalai bargaining*. Hospital i and insurer j always choose contracts from Kalai proportional bargaining over expected values with fixed insurer weight τ_{ij}

2. *Impasse disagreement*. i and j disagreement value: everyone will reach contracts expecting ij agreement, but i and j will ultimately fail to reach an agreement

3. *Discrete time*. No bargaining is attempted between equilibrium bargaining times

Estimation: Dynamic Bargaining Moment

Theorem 1'

Suppose hospital i and insurer j negotiate in period t_0 and other assumptions hold. Then the expected net present value payment is:

$$\mathbb{E}_{t_0}\left[\overbrace{\sum_{t=t_0}^{t^*}\beta^{t-t_0}D_{ijt}^{Hosp}p_{ijt}^*}^{\text{NPV Payment}}\right] = \mathbb{E}_{t_0}\left[\sum_{t=t_0}^{t^*}\beta^{t-t_0}\overbrace{\text{Pay}_{NiN,ijt}}^{\substack{\text{Static Nash}\\ \text{Flow Payment}}} + \overbrace{\text{Pay}_{NC}+\text{Pay}_{IRT}}^{\substack{\text{Added Multiperiod}\\ \text{Bargaining Terms}}}\right],$$

where Pay_{NC} reflects negotiation costs and Pay_{IRT} reflects the effect of spillovers on impasse profits (show zero in steady state).

- Extends myopic Nash: $\beta = 0$

Demonstration: Kalai Proportional Controls Relevant States

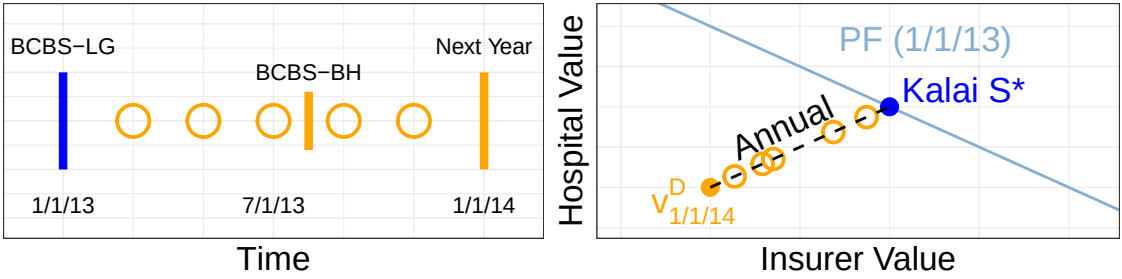


Figure: By the step-by-step property from static utility (Kalai, 1977; Roth, 1979) applied to dynamic bargaining, negotiating relative to one disagreement ⇔ negotiating relative to two disagreements.

Impasse Repricing Transfer

If A and D subscripts denote the path of prices and premiums under agreement-then-impasse and immediate impasse, the Impasse Repricing Transfer is:

$$
\begin{aligned}
Pay_{IRT} = \mathbb{E}_{t_0}\Bigg[\sum_{t=t_0+1}^{\infty}\beta^{t-t_0}(-\tau_j)\sum_{n\in\mathcal{G}_{it}^{Hosp}/j}\Bigg(&D_{int}^{Hosp}\left(\mathcal{G}_t/ij,\phi_{jt|t_0}^{A}\right)\left(p_{int|t_0}^{A}-c_i\right)\\ -\;&D_{int}^{Hosp}\left(\mathcal{G}_t/ij,\phi_{jt|t_0}^{D}\right)\left(p_{int|t_0}^{D}-c_i\right)\Bigg)\Bigg]\\
+\mathbb{E}_{t_0}\Bigg[\sum_{t=t_0+1}^{\infty}\beta^{t-t_0}(1-\tau_j)\Bigg(&D_{nt}^{Ins}(\mathcal{G}_t/ij,\phi_{t|t_0}^{A})(\phi_{jt|t_0}^{A}-\eta_j)\\ -\;&D_{nt}^{Ins}(\mathcal{G}_t/ij,\phi_{t|t_0}^{D})(\phi_{jt|t_0}^{D}-\eta_j)\Bigg)\Bigg]\\
+\mathbb{E}_{t_0}\Bigg[\sum_{t=t_0+1}^{\infty}\beta^{t-t_0}(1-\tau_j)\sum_{h\in\mathcal{G}_{jt}^{Ins}/i}\Bigg(&D_{hjt}^{Hosp}(\mathcal{G}_t/ij,\phi_{t|t_0}^{A})p_{hjt|t_0}^{A}\\ -\;&D_{hjt}^{Hosp}(\mathcal{G}_t/ij,\phi_{t|t_0}^{D})p_{hjt|t_0}^{D}\Bigg)\Bigg].
\end{aligned}
$$

Flow Gains From Trade Before Payment or Frictions

$$[\Delta_{ij}\pi_j^{Ins}] = \overbrace{[\Delta_{ij}D_j^{Ins}](\phi_j - \eta_j)}^{\text{Premium and enrollment effect}} - \overbrace{\sum_{h \in \mathcal{G}_j^{Ins}/i} [\Delta_{ij}D_{hj}^{Hosp}]p_{hj}}^{\text{Price reinforcement effect}}$$

$$[\Delta_{ij}\pi_i^{Hosp}] = \underbrace{\sum_{n \in \mathcal{G}_i^{Hosp}/j} [\Delta_{ij}D_{in}^{Hosp}](p_{in} - c_i)}_{\text{Recapture effect}} - \underbrace{D_{ij}^{Hosp}(\cdot)c_i}_{\substack{\text{Hospital} \\ \text{cost effect}}}$$

- Higher price spillover: larger insurer GFTs, smaller hospital GFTs

Adapted from Ho and Lee (2017)

Other Assumptions (High Level)

- Risk-neutral, shared unbiased expectations, shared discount rate $\beta \in [0, 1)$
- Markov strategies, good-faith disagreement (no change in networks)
- Negotiation cost paid to validate a successful bargain (for Pay_{NC})

Step 1: Hospital Demand

- Notation based on on Ho (2006) for hospital h and diagnosis ℓ:

$$u_{i,h,\ell}^{Hosp} = \delta_{h,\ell}^{Hosp} + \nu_{i,h,\ell}\rho + \varepsilon_{i,h,\ell}$$

  - $\nu_{i,h,\ell}$: diagnosis-distance interactions

- Estimate logit model with 2016 BCBS (complete network) patients Results

Step 2: Insurer Demand

$$u_{i,j,c}^{Ins} = \gamma_k WTP_{j,k,c} + \tilde{\delta}_{j,m}^{Ins} + \xi_{j,k,c} + \varepsilon_{i,j,c,m}$$

- Individual i of age group k choosing insurer j in county c in rating area m
- Control for premiums with $\tilde{\delta}_{j,m}^{Ins}$ area FEs
- Moment $E[WTP_{j,k,c}\xi_{j,k,c}] = 0$ for each age group k Details Results

Step 3: Bargaining Estimation Becomes Fairly Standard

$$\sum_{t=t_0}^{t^*} \beta^{t-t_0} D_{ijt}^{Hosp} p_{ijt}^* - \sum_{t=t_0}^{t^*} \beta^{t-t_0} \text{Pay}_{NiN,ijt} - \text{Pay}_{IRT} - \text{Pay}_{VC} = \overbrace{\text{“}\omega_{ijt_0}\text{”}}^{\mathbb{E}_{t_0}[\omega]=0}$$

- Moments $\mathbb{E}[\omega Z^{\omega}]$ and $\mathbb{E}[(\widehat{MedicalLoss} - MLReport) Z^{MLR}]$ ▸ Details
  - Z^{ω} hospital group & insurer dummies, Z^{MLR} insurer dummies, five-year finite horizon
- Approximating $\text{Pay}_{IRT} \to 0$ (ij impasse $\to$ ij disagreement via others' response)

◂

Hospital Demand Sanity Check: Consumers Dislike Travel

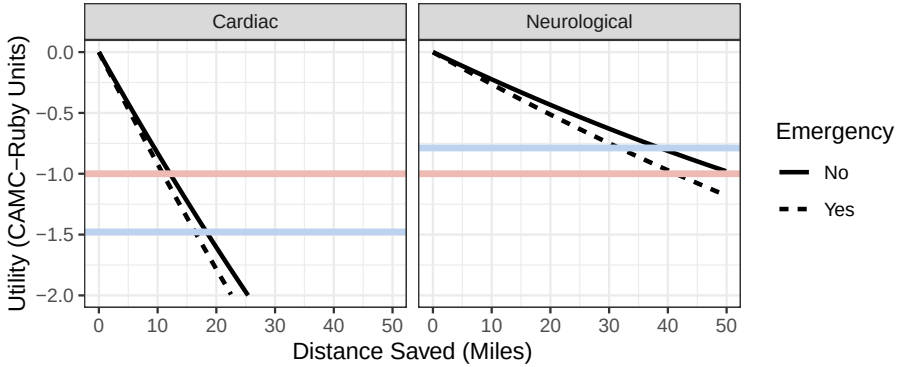


Figure: Consumer cost of travel for cardiac (left) and neurological (right) care in non-emergency (solid) and emergency (dashed) discharges, in CAMC-WVU Ruby units (red line at -1.0). Blue horizontal line is United Hospital-WVU value. ▸ Table ◂

Hospital Demand Parameter Estimates

	Dependent variable:					
	choice					
	Cancer	Cardiac	Digestive	Labor	Neurological	Other
	(1)	(2)	(3)	(4)	(5)	(6)
100 Miles	−4.909**	−8.591***	−7.607***	−29.100	−2.306***	−4.836***
	(1.949)	(1.597)	(1.821)	(72.654)	(0.138)	(0.213)
100 Miles x Emergency	−0.409	−0.899***	−1.526***	4.845	−0.398***	−0.677***
	(0.797)	(0.312)	(0.474)	(14.314)	(0.109)	(0.083)
(100 Miles) Squared	1.579**	2.830***	2.295***	6.182	0.690***	1.518***
	(0.644)	(0.550)	(0.550)	(14.056)	(0.054)	(0.068)
Observations	284	2,469	2,048	4,143	1,094	10,053
R^2	0.555	0.577	0.615	0.646	0.497	0.555
Log Likelihood	−286.987	−2,722.077	−2,324.572	−3,923.918	−1,297.677	−12,578.030
Note:						*p<0.1; **p<0.05; ***p<0.01

Table: Consumer valuation of distance by category in units of going from highest-value (WVU Ruby) to second highest-value (CAMC) hospital. Consumers do not like traveling, especially in non-labor emergencies. They do like flagship hospitals (omitted).

Insurer Demand (2016): Willingness to Pay

	WTP Coefficient				
	γ_{0-17}	γ_{18-44}	γ_{45-64}	γ_{65-74}	γ_{75+}
	26.6***	4.94***	2.76***	2.79***	2.05***
	(2.65)	(0.67)	(0.33)	(0.27)	(0.15)
Note:					*p<0.1; **p<0.05; ***p<0.01

Table: Coefficients on Willingness to Pay parameters. The smaller coefficients for older groups mainly reflect the larger probability of having a diagnosis, and resulting smaller standard deviation of WTP.

Insurer Demand Estimation Details

- Estimate 2016 BCBS, Aetna, HPUOV sales based on inpatient shares
  - Ensure at least one sale per county, at least 10% of county in outside option
- Iteratively apply outer loop-inner loop strategy to find γ_k
- Outer loop for 2016 demand: take putative United and Cigna FEs given γ_k
  - Inner loop: contraction to match non-United/Cigna sales estimates with $\tilde{\delta}_{j,m}^{Ins} + \xi$
  - Solve for outer loop to match United & Cigna sales
  - Find new γ_k from (population) weighted least squares
- Add pre-2016 insurer FE to fit state-level sales with historical population
  - Assume Carelink had same ξ as Aetna pre-2014 acquisition

Bargaining Estimation Details

- Interpolate calendar years to bargain years via day-weighted average
- τ_{ij}: hospital system (cost) size in 2006
- Optimization in terms of bargain sets $\mathcal{B}$, parameters θ, and now hospital groups i:

$$\hat{\omega}_{ijt_0}(\theta) = \sum_{t=t_0}^{t^*} \beta^{t-t_0} \left(D_{ijt}^{Hosp} p_{ijt} - \widehat{Pay}_{NiN,ijt}(\theta) \right) - \overbrace{\widehat{Pay}_{VC}(\theta)}^{(2\tau_{ij}-1) r_j^{Ins} \text{ by BCBS or not}}$$

$$\hat{\theta} = \text{argmin} \sum_j \frac{\left(\frac{1}{|\mathcal{B}_j^{Ins}|} \sum_{h,t_0 \in \mathcal{B}_j^{Ins}} \hat{\omega}_{ijt_0}(\theta) \right)^2}{\frac{\sum_{t=0}^{mean(t^*-t_0)} \beta^t}{|\mathcal{B}_j^{Ins}|} \sum_{h,t_0 \in \mathcal{B}_j^{Ins}} \sum_t \beta^{t-t_0} D_{hjt}^{Hosp} p_{hjt}} + 100,000 \left(\frac{1}{6} \sum_{2011 \le t \le 2016} \hat{MLR}_{jt} - MLR_{jt} \right)^2$$

$$+ \sum_i \frac{\left(\frac{1}{|\mathcal{B}_i^{Hosp}|} \sum_{n,t_0 \in \mathcal{B}_i^{Hosp}} \hat{\omega}_{int_0}(\theta) \right)^2}{\frac{\sum_{t=0}^{mean(t^*-t_0)} \beta^t}{|\mathcal{B}_i^{Hosp}|} \sum_{n,t_0 \in \mathcal{B}_i^{Hosp}} \sum_t \beta^{t-t_0} D_{int}^{Hosp} p_{int}}$$

Estimated Gain From Trade Shares

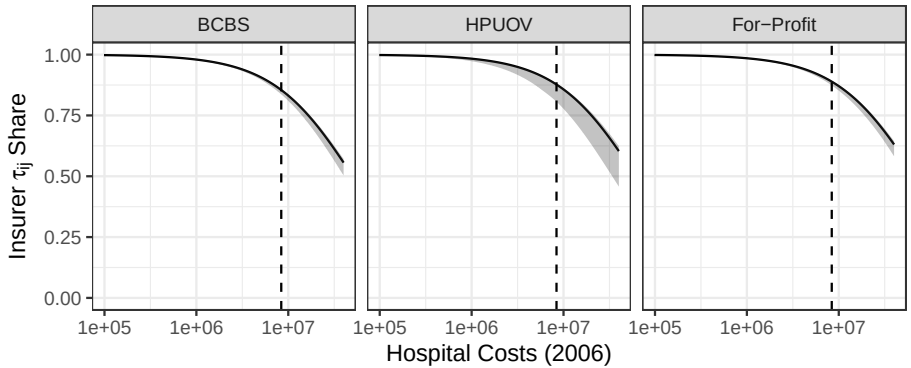


Figure: Estimated percent of gains from trade retained by the insurer under estimated dynamic model. ▸ Myopic ◂

Estimated Gain From Trade Shares (Myopic)

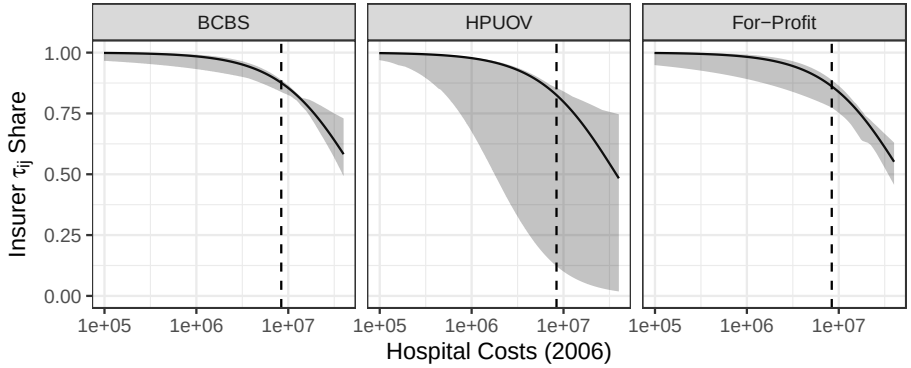


Figure: Estimated percent of gains from trade retained by the insurer under estimated myopic model.

Bargaining Parameters (Table)

	Parameter				
	β	τ_{BCBS}	τ_{HPUOV}	τ_{FP}	$-\tau^{Size}$
Only-2015	·	0.487**	-7.54	0.694***	3.354
(Nash/Kalai)	(·)	(0.191)	(17.204)	(0.175)	(22.875)
Myopic	·	0.876***	0.825***	0.861***	1.037***
(Nash/Kalai)	(·)	(0.012)	(0.232)	(0.034)	(0.199)
Forward-Looking	0.899***	0.854***	0.877***	0.889***	0.989***
($\text{Pay}_{IRT} = 0$)	(0.03)	(0.006)	(0.026)	(0.005)	(0.028)

Note: *p<0.1; **p<0.05; ***p<0.01

Other Bargaining Results

	Parameter (τ^{Size} Estimated)							
	η_{BCBS}	η_{HPUOV}	η_{Aetna}	$\eta_{UnitedHealth}$	η_{Cigna}	$\eta_{Carelink}$	r^M_{yBCBS}	r^M_{nBCBS}
Only-2015	3657***	3404***	3658***	2008***	4627***	3139***	10000***	9999***
(Nash/Kalai)	(45)	(85)	(116)	(29)	(32)	(39)	(2614)	(1441)
Myopic	4640***	4036***	3659***	3197***	4624***	3139***	10000***	10000***
(Nash/Kalai)	(14)	(650)	(37)	(374)	(26)	(463)	(1444)	(1)
Forward-Looking	4638***	3631***	3660***	3284***	4626***	3140***	9999***	9999***
($\text{Pay}_{IRT} = 0$)	(130)	(302)	(37)	(69)	(30)	(45)	(29)	(65)
Data	3600	3356	3554	1999	4635	3114		

Note: *p<0.1; **p<0.05; ***p<0.01

Bargaining Model Robustness Tests

	Parameter				
	β	τ_{BCBS}	τ_{HPUOV}	τ_{FP}	$-\tau^{Size}$
Forward-Looking (Baseline)	0.899*** (0.03)	0.854*** (0.006)	0.877*** (0.026)	0.889*** (0.005)	0.989*** (0.028)
Forward-Looking (No Hosp. Size)	0.714*** (0.025)	0.852*** (0.011)	0.86*** (0.01)	0.685*** (0.028)	. (·)
Forward-Looking (Mean $\sum\beta^t$ normalization)	0.925 (·)	0.854 (·)	0.876 (·)	0.89 (·)	0.991 (·)
Forward-Looking (Estimate Hospital Costs)	0.497 (·)	0.939 (·)	0.938 (·)	0.942 (·)	1.009 (·)
Forward-Looking (Hospital Costs * 2)	1 (·)	1 (·)	1 (·)	1 (·)	-0.276 (·)
Forward-Looking (Hospital Costs * 0.9)	0.931 (·)	0.838 (·)	0.858 (·)	0.875 (·)	0.969 (·)
Forward-Looking (Hospital Costs * 1/2)	1 (·)	0.778 (·)	0.781 (·)	0.821 (·)	0.903 (·)
Forward-Looking (Medicare Costs)	0.895 (·)	0.834 (·)	0.847 (·)	0.871 (·)	0.913 (·)
Note:					*p<0.1; **p<0.05; ***p<0.01

	Parameter				
	β	τ_{BCBS}	τ_{HPUOV}	τ_{FP}	$-\tau^{Size}$
Forward-Looking (η from MLR)	0.826 (·)	0.864 (·)	0.874 (·)	0.891 (·)	0.892 (·)
Forward-Looking (Inpat. Share GFT Weight)	0.722 (·)	0.881 (·)	0.905 (·)	0.897 (·)	0.847 (·)
Forward-Looking ($\beta = 0.99$)	0.99 (·)	0.854 (·)	0.875 (·)	0.881 (·)	1 (·)
Forward-Looking (Hospital TIOLI)	0.696 (·)	0.001 (·)	0.001 (·)	0.001 (·)	. (·)
Forward-Looking ($\tau = 0.5$)	0.817 (·)	0.5 (·)	0.5 (·)	0.5 (·)	. (·)
Forward-Looking (MCO TIOLI)	0.52 (·)	0.999 (·)	0.999 (·)	0.999 (·)	. (·)
Myopic (Baseline)	. (·)	0.876*** (0.012)	0.825*** (0.238)	0.861*** (0.034)	1.037*** (0.201)
Myopic (No Hosp. Size)	. (·)	0.863*** (0.006)	0.845*** (0.016)	0.631*** (0.028)	. (·)
Note:					*p<0.1; **p<0.05; ***p<0.01

Figure: Bargaining parameter estimates under alternative modeling assumptions. (Confidence intervals have only been implemented for some models.)

Approximation Quality is Partially Testable

$$\frac{GFT^{Ins}(p^*_{\text{Nash}})}{GFT^{Hosp}(p^*_{\text{Nash}})} = \frac{\tau_{ij}}{1-\tau_{ij}} \frac{-\frac{\partial V^{Ins}(p)}{\partial p}\Big|_{p=p^*_{\text{Nash}}}}{\frac{\partial V^{Hosp}(p)}{\partial p}\Big|_{p=p^*_{\text{Nash}}}}$$

Kalai sets to 1

- I estimate a Kalai bargaining model with GFT split $\tau_{ij}/(1-\tau_{ij})$
- Under estimated model, is marginal value ratio ≈ 1? ▸ Limitations
  - A heuristic test that Kalai proportional would approximate Nash
- All but one estimated marginal value ratio $\in (0.9, 1.1)$

Limitations on Approximation Quality Test

Under Kalai model estimates, is marginal value ratio ≈ 1?

$$\frac{GFT^{Ins}(p^*_{\text{Nash}})}{GFT^{Hosp}(p^*_{\text{Nash}})} = \overbrace{\frac{\tau_{ij}}{1-\tau_{ij}}}^{\text{Bargaining weights}} \overbrace{\frac{-\frac{\partial V^{Ins}(p)}{\partial p}\Big|_{p=p^*_{\text{Nash}}}}{\frac{\partial V^{Hosp}(p)}{\partial p}\Big|_{p=p^*_{\text{Nash}}}}}^{\text{Kalai sets to 1}}$$

- Does not test Nash model estimated spillovers or disagreement values
- If spillovers are present, does not test which model is more accurate

The Estimated Approximation Quality is Good

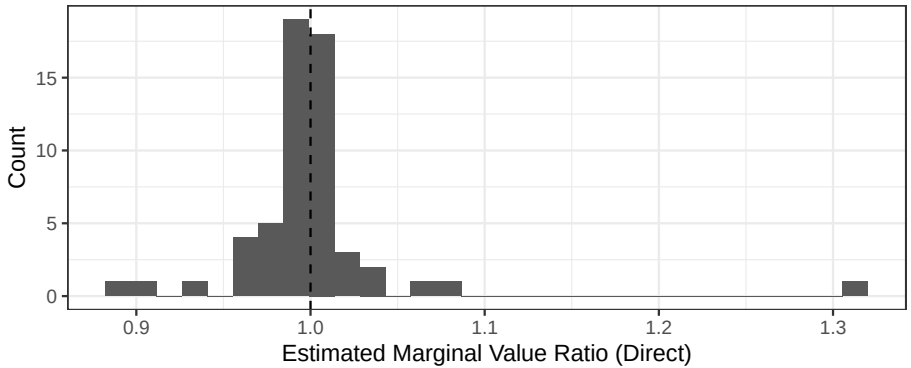


Figure: Histogram of estimated marginal value ratios under estimated Kalai proportional bargaining model without including equilibrium effects. Residuals seem uncorrelated .

Bargaining Residuals Do Not Seem Driven By Spillovers

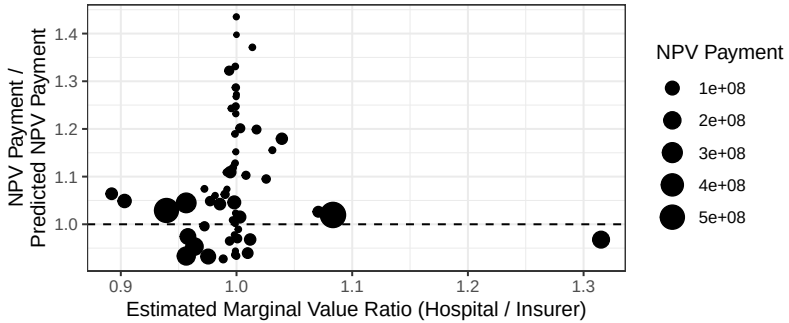


Figure: Ratio of realized to model predicted NPV payments as a function of first pass marginal value ratio (not accounting for compounding equilibrium effects) between the hospital and insurer. Results

Counterfactual Details

- Hold renegotiation timing, benchmark choice, hospital list prices fixed
- Assume all Medicare-based payments increase one ppt faster annually
  - Content: any idiosyncratic BCBS DRG weights increase proportionally to Medicare
- Hold fixed small insurer prices (conservative)
- Main analysis holds fixed premiums (conservative)
  - Estimate downstream response from calibrated Nash-Bertrand model

A Myopic Model Would Overestimate Effects Substantially

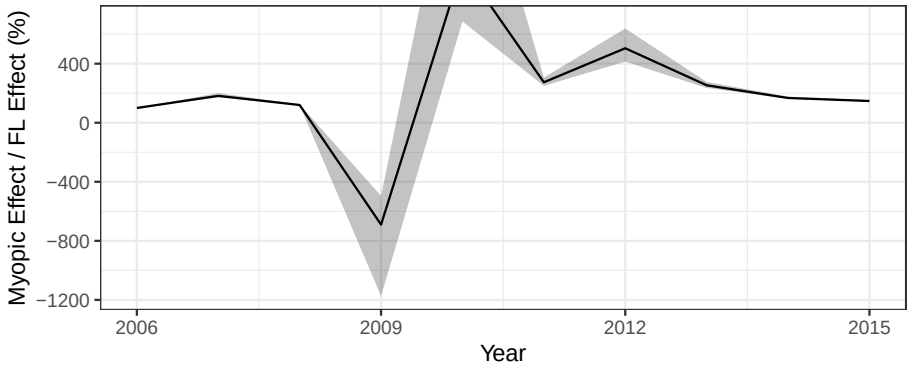


Figure: Ratio of estimated effects under myopic model to estimated effects under dynamic forward-looking model.

Counterfactual Construction (Time Series-Adjacent)

I estimate a finite horizon model with $T = 5$ periods

$$\mathbb{E}_t\left[\sum_{t=t_0}^{t^*} \beta D_{ijt}^H \frac{p_{it}^{B_{ijt}}}{p_{it_0}^{B_{ijt}}}\right] p_{ij,t_0}^R = \sum_{t=t_0}^{t^*} \mathbb{E}_{t_0}[\gamma_{ijt_0,hnt}\ p_{hnt}] + C_{ijt_0}$$

$$y_t \equiv \left(\mathbf{p}_{t-1}{}^T \quad \mathbf{p}_t{}^T \quad E_t[\mathbf{p}_{t+1}{}^T] \quad \dots \quad E_t[\mathbf{p}_{t+4}{}^T]\right)^T$$

$$\Gamma_{0,t} y_t = \Gamma_{1,t} y_{t-1} + C_t + \Psi_t \varepsilon_t.$$

- Changing benchmark inflation $\Leftrightarrow$ changing Γ_1 matrices
- Estimate $\hat{\Gamma}_0$ and realized $\hat{\Gamma}_1 \Rightarrow$ realized prices in terms of $C + \varepsilon$
  - Currently set $\Psi_n = I$, recover $\widehat{C + \varepsilon}$ to match realized prices, and change Γ_1

Counterfactual: Decomposition

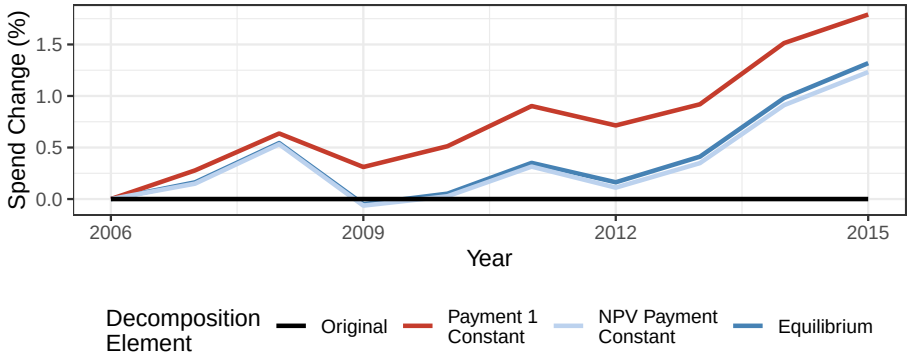


Figure: Decomposition of estimated direct effects under myopia (blue), direct effects with forward-looking firms (pink), and equilibrium effects (red).

Contracts Generally Renewed in Late Years

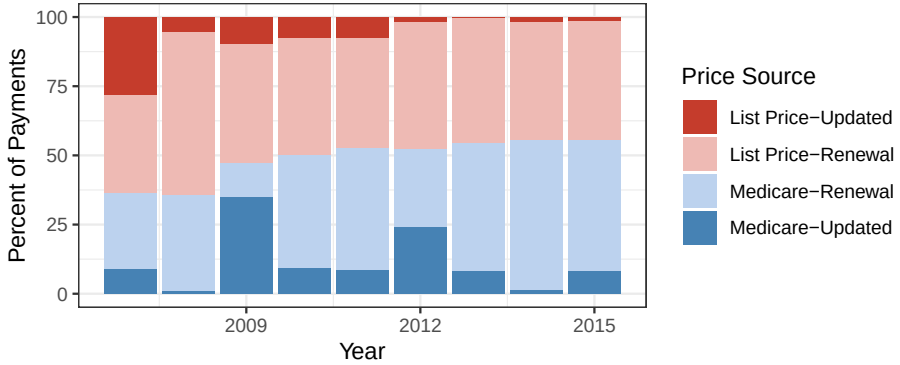


Figure: Fraction of each year's payments that reflect an inferred bargain (dark) or renewed contract (light), and which were imputed as list price-linked (teal) or other benchmark-linked (blue). Effects are large in 2015-16 because contracts generally renewed after 2013. ▸ Without imputation ◂

Contracts Generally Renewed in Late Years (No Imputation)

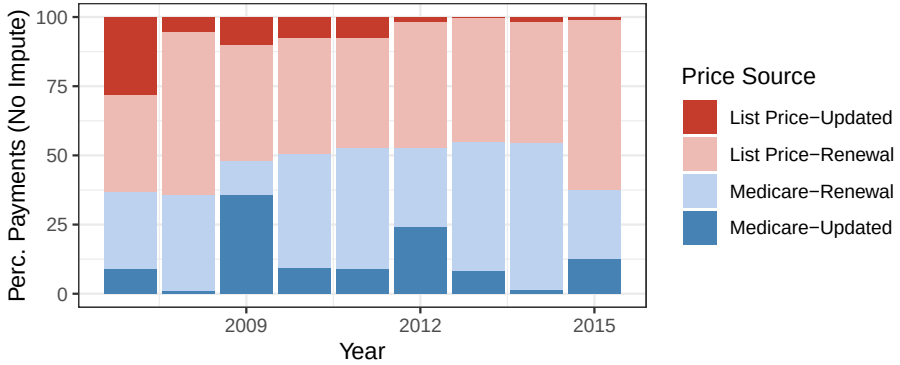


Figure: Fraction of each year's payments that reflect an inferred bargain (dark) or renewed contract (light), and which were imputed as list price-linked (teal) or other benchmark-linked (blue) without including missing reports for which I impute contracts.

Counterfactual Effects by Insurer

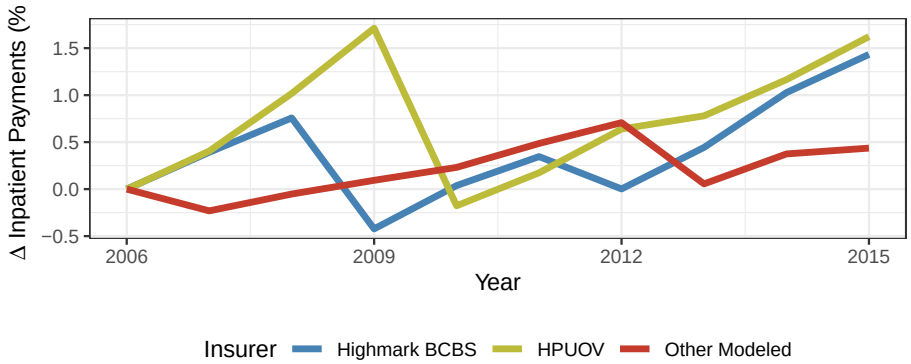


Figure: Estimated counterfactual effects on payments by insurer.

Counterfactual Effects by Hospital

Figure: Estimated counterfactual effects on 2014 revenue by hospital. Most are generally only affected by less than 3%.

Counterfactual: Less Discounting

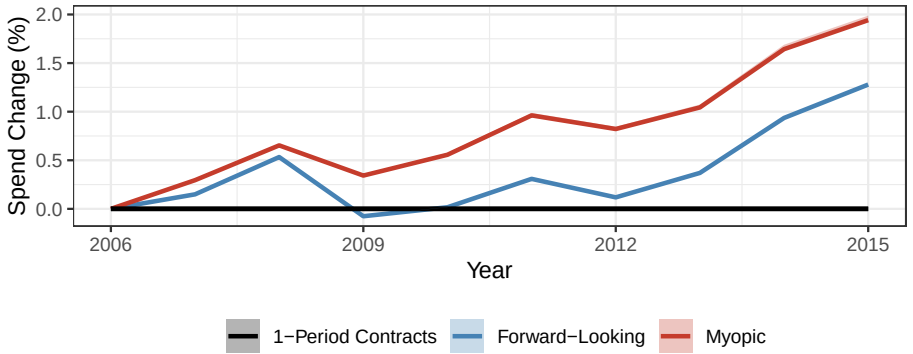


Figure: Results with discount rate β set to 0.97 rather than estimated 0.899. The forward-looking counterfactual is more forward-looking, so the estimated savings would be even smaller.

Counterfactual: Downstream Premium Effects

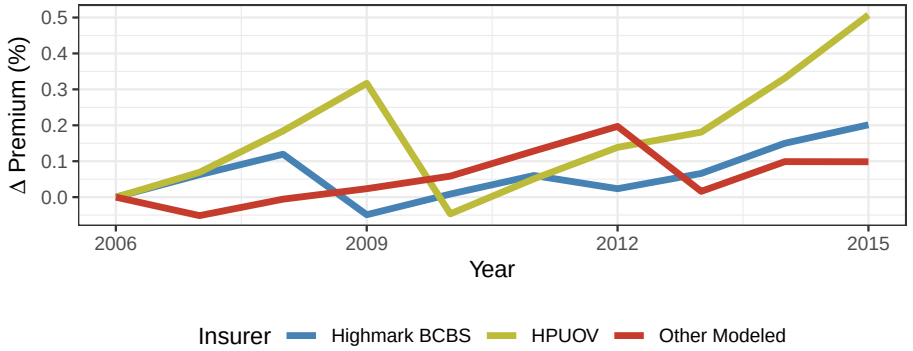


Figure: Estimated downstream effects on premiums under annual Nash-Bertrand premium competition. (Smaller percent effects because counterfactual holds outpatient constant.)

Counterfactual: Premium Change (% of Spend)

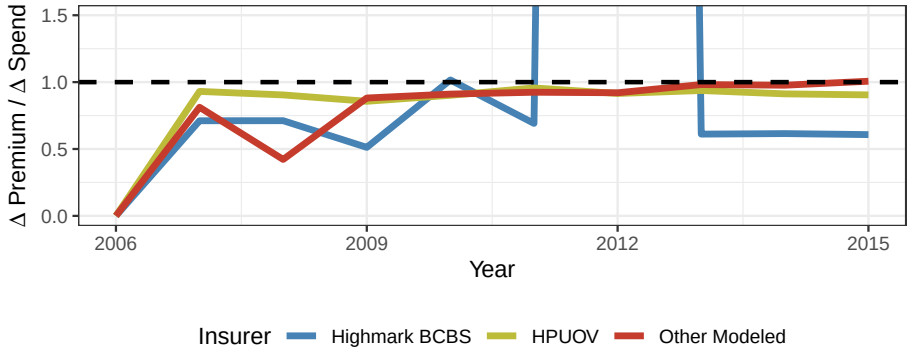


Figure: Ratio of estimated premium change to estimated marginal cost change by insurer.

Counterfactual: Drop Charleston Area Medical Center

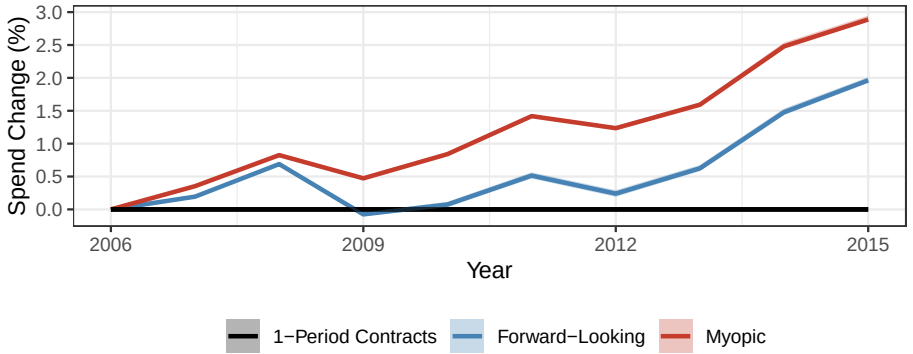


Figure: Counterfactual with Charleston Area Medical Center, a large hospital center with many low-discount high-renewal contracts, excluded.

Counterfactual: List Prices Limited

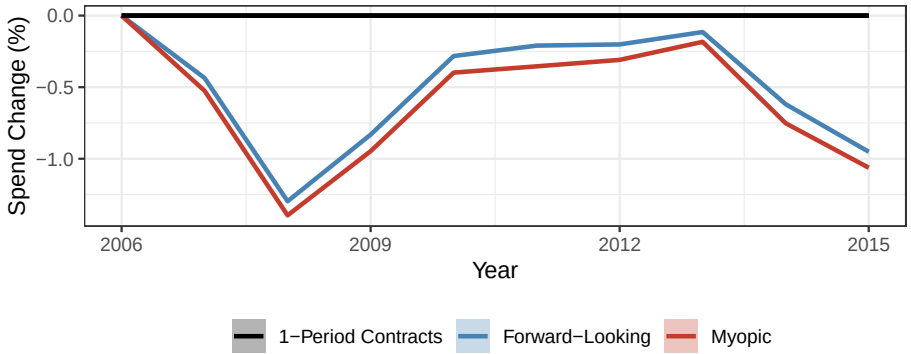


Figure: Estimated counterfactual effects on payments if list prices were capped to generally increase two ppt faster than reported costs instead of three ppt faster than reported costs. Details

Substantial Limitations (More in Paper)

- Miss outpatient, hold premiums & renegotiation constant
- Highly stylized insurer demand & premium-setting models (data limitations)
- Finite horizon, time definition, & end of panel biases
- Potential endogeneity of non-price bargaining like adjudication (minor)
- Effect of disagreement on consumer insurer inertia (future work)
- No effects from moral hazard, consumer cost-sharing, or benchmark choice
  - Cost-sharing small (Gowrisankaran et al., 2015), benchmark choice insurer-driven
  - Found suggestive evidence of some Medicare-driven supply effects (future work)
- Missing pre-2016 demand (data on way), investment (minimal with CON)
- Heterogeneous DRG weights, per diems, & other non-charge benchmarks
  - Shifted payments may include non-Medicare, per diems, or complex share of charges

Counterfactual List Price Construction

- Start: 102% of average state Medicare pay-to-cost change from previous year
- Where there is reliable state financial data, pull up to 50% of allowed increase towards hospital previous year Medicare increase (scaled by square root of previous year costs)
- Assume that hospitals attempt to set list prices at real list price
  - No added stockpiling effect beyond optimizing under the existing WV regulation