Voluntary Regulation: Evidence from Medicare Bundled Payments

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Motivation

- Many government regulations / programs based on voluntary enrollment
  - Hourly pricing in electricity markets (Ito et al., in preparation)
  - Payments for ecosystem services (Jack and Jayachandran, 2019)
  - Applicant choice by charter schools (instead of lottery)

- Number of explanations
  - Political economy (too politically costly to make policy mandatory)
  - Nudges / ideological aversion to forcing mandatory compliance
  - Selection on gains

- Natural concern is unfavorable selection
  - Those with the lowest social benefit most likely to select in

This Paper

- Payment reform in Medicare
  - Providers traditional paid via FFS payment system (cost based)
  - Rapid growth of alternative payment models (ACOs, BPCI)
  - Debate about whether programs should be mandatory or voluntary

- Bundled payment program for hip and knee replacement
  - Pays hospitals fixed amount for entire episode of care
  - Initially designed as mandatory, 5-year, MSA-level randomized trial
  - In year 3, modified in to be voluntary for half of treated MSAs

- How does voluntary program compare to mandatory program?
- What are the effects of alternative voluntary payment systems?

Outline

- Background on bundled payments
- Model-free evidence
- Model
- Specification and results
- Counterfactuals

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Bundled Payments

- Fixed (often risk adjusted) payment for an episode of care
  - Typically inpatient stay + post-acute care over following 30-90 days
- Potential effects
  - Improve coordination of care, reduce unnecessary utilization
  - Skimp on care or cherry-picking of patients
- Prior literature is observational (i.e., voluntary enrollment) and small N
  - Coronary bypass (Cromwell et al. 1997), prenatal care (Carroll et al. 2017), cancer (Newcomer et al. 2014), hip and knee replacement (Doran et al. 2015, Dummit et al. 2016, Froemke et al. 2015, Navathe et al. 2017)
- Typically finds large savings

Comprehensive Care for Joint Replacement (CJR)

- We analyze Comprehensive Care for Joint Replacement (CJR)
  - Medicare bundled payment program for hip and knee replacement (lower extremity joint replacement, LEJR)
  - Large category with 486 thousand procedures, roughly $10.7 billion in spending

- Hospital responsible for Medicare spending over entire episode
  - Episode begins with hospital stay and ends 90 days after discharge
  - Some carveouts for obviously unrelated events (e.g., cancer)

- Initially designed as a mandatory, 5-year, MSA-level randomized trial

Implementation

- Let y indicate average per episode payments under FFS
- Under bundled payments, hospital receive y as under the status quo
- At end of year, receive incremental payment

$$t(y) = \tau - y$$

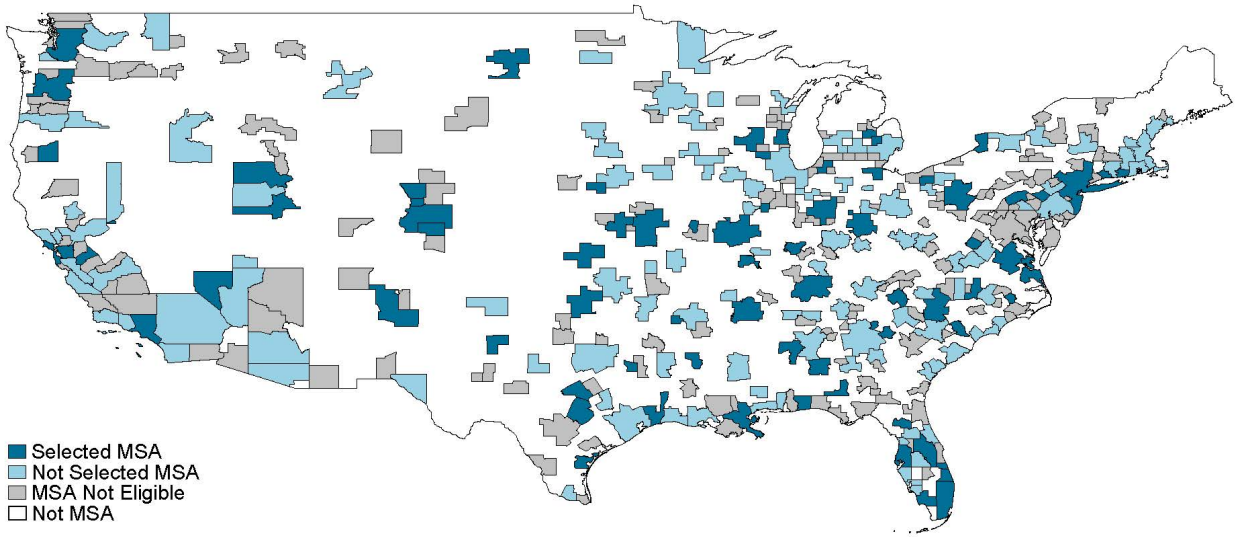
where τ is target price based on historical regional and hospital spending

Currently unmodeled

- Stop loss / stop gain for $t(y)$ that increases over time (sometimes binding)
- Minimum quality standards to be eligible for bonuses (rarely binding)

Experimental Design

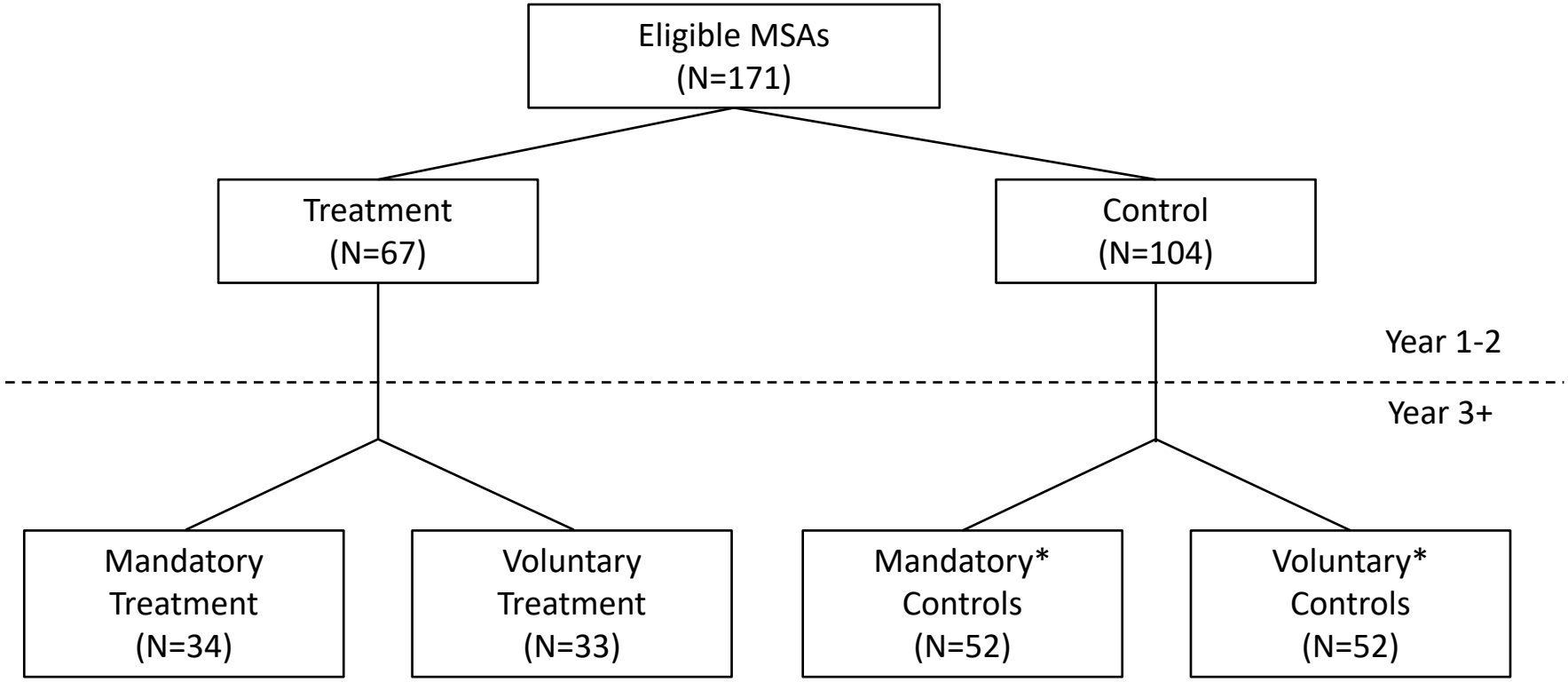
- Initially designed as mandatory, 5-year, MSA-level randomized trial
  - Year 1 is Apr 1 to Dec 31, 2016. Years 2-5 are based on calendar years
- Random assignment within 8 strata based on historical spending quartile and above / below median population
  - Non-MSAs and MSAs with low volume were excluded
- After exclusions, 67 MSAs assigned to treatment and 104 MSAs to control



Voluntary vs. Mandatory

- While in Congress, Tom Price was as vocal critic of mandatory APMs
- When appointed HHS Secretary in Trump Administration, he and his successor delayed and ultimately cancelled two bundled payment models (Episode Payment Model and Cardiac Rehabilitation)
- CJR partially escaped
  - Starting in year 3, program made voluntary for 33 MSAs with lowest historical spending
  - Within voluntary MSAs, 73 hospitals selected in while 206 selected out
- We were initially frustrated because of reduced time horizon for RCT
- Later realized that change provides a unique opportunity to study merits of voluntary vs. mandatory programs

Experimental Design



*Control group MSAs are assigned to mandatory vs. voluntary by authors using historical spending

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Summary Statistics

Summary Statistics for Control MSAs in Years 1-2

	Control MSAs	
	Mean	SD
Discharge Destination		
Institutional Post Acute Care	32.7%	11.0%
Home Health Agency	33.5%	19.1%
Home (w/o Home Health Agency)	31.9%	22.9%
Other	1.9%	2.9%
Number of Days in Index Admission	2.7	0.4
Number of Days in Institutional PAC (Unconditional)	8.1	2.5
Medicare Episode Spending in Institutional PAC, $	3,865	1,303
Total Medicare Episode Spending, $	22,846	3,622

Average Treatment Effects

Prior work

- Finkelstein et al. (2018) examine average effects during first year
- Barnett et al. (2019) examine first two years

Regression specification

- 100% Medicare claims data for first 2 years aggregated to MSA level
- Following Finkelstein et al. (2018), estimate the regression

$$y_{j,16-17} = \beta_0 + \beta_1 1(BP) + \beta_2 y_{j,2014} + \beta_3 y_{j,2013} + \beta_{4,s(j)} + \epsilon_j$$

Average outcome in years 1-2

Average Treatment effect

Lagged outcomes to improve power

Strata FE

Use and Spending

Average Treatment Effects in Years 1-2: Use and Spending

	Control Mean	Average Treatment Effect	95% CI Lower Bound	95% CI Upper Bound	P-value
Discharge Destination					
Institutional Post Acute Care	32.7%	-3.0%	-4.8%	-1.3%	0.001
Home Health Agency	33.5%	0.6%	-2.5%	3.8%	0.689
Home (w/o Home Health Agency)	31.9%	3.3%	-0.2%	6.8%	0.068
Other	1.9%	-0.3%	-0.8%	0.1%	0.097
Number of Days in Index Admission	2.7	0.0	-0.1	0.0	0.275
Number of Days in Institutional PAC	8.1	-0.5	-1.0	0.0	0.065
Medicare Episode Spending in Institutional PAC	3,865	-369	-606	-132	0.003
Total Medicare Episode Spending	22,846	-635	-1029	-240	0.002

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Non-Targeted Quality Measures

Average Treatment Effects in Years 1-2: Non-Targeted Quality Measures

	Control Mean	Average Treatment Effect	95% CI Lower Bound	95% CI Upper Bound	P-value
Complication Rate	1.5%	0.0%	-0.2%	0.1%	0.828
ER Visit During Episode	19.9%	0.3%	-0.3%	0.9%	0.368
90-day All Cause Readmission Rate	10.3%	-0.2%	-0.7%	0.2%	0.375

Note: Complication rate is the share of CJR-eligible patients who have at least 1 of the 8 underlying complications that contribute to the total hip arthroplasty/total knee arthroplasty 90-day complication measure used in the targeted quality score; unlike the input into the targeted quality score, the complication measure here is not risk-standardized and is measured for admissions during the study period rather than as a 3-year moving average. The sample for this measure includes patients who were readmitted for LEJR and those who died within the episode, both of which would otherwise be excluded from the CJR sample based on patient eligibility criteria.

Admissions and Patient Composition

Average Treatment Effects in Years 1-2: Admissions and Patient Composition

	Control Mean	Average Treatment Effect	95% CI Lower Bound	95% CI Upper Bound	P-value
LEJR Admissions (per 1,000 enrollees)	19.72	-0.46	-1.05	0.13	0.127
CJR-eligible LEJR Admissions (per 1,000 enrollees)	13.19	-0.04	-0.68	0.59	0.899
Elixhauser Comorbidity Score	2.35	-0.01	-0.07	0.04	0.650

Note: The Elixhauser Comorbidity Index is a comorbidity measure based on *International Classification of Diseases, Ninth Revision, Clinical Modification* or *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* diagnosis codes. Binary indicators were created for a list of 31 comorbidities; the index was created by summing these 31 indicators. An index of 0 means no comorbidities were present for the episode and a higher index means more comorbidities. The range of this measure is 0 to 31.

Selection on Slopes vs. Levels

- Difference between mandatory and voluntary program is selection
- Hospitals have incentive to select on both slopes and levels
  - Selection on slopes: Enroll if easy to cut costs below bundled payment
  - Selection on levels: Enroll if baseline costs below bunded payment
- Social planner wants selection on slopes but not on levels
  - Selection on slopes generates efficiencies
  - Selection on levels is a transfer
- => Effects of voluntary system depend on joint distribution of incentives and response to incentives on slopes and levels margins

Evidence on Selection

Selection on slopes

- Examine how selection decision varies with treatment effect in years 1-2
- Construct a hospital specific "treatment effect"

$$\Delta y_h = \bar{y}_{h,16-17} - \bar{y}_{h,13-14}$$

- Examine Δy_h for select in vs. select out vs. voluntary controls

Selection on levels

- Do not observe levels for treatment group
- Examine how selection decision varies by pre-BP levels ($\bar{y}_{h,13-14}$)

Selection on Slopes

Treatment Effects (Δy_h) for Select In vs. Select Out

		Mean	# of hospitals
Discharged to Institutional PAC	Select In	-0.139	73
	Select Out	-0.077	206
	Voluntary Control	-0.083	318
Medicare Episode Spending in Institutional PAC	Select In	-1,629	73
	Select Out	-1,023	206
	Voluntary Control	-806	318
Total Medicare Episode Spending	Select In	-1,988	73
	Select Out	-1,225	206
	Voluntary Control	-1,116	318

Evidence on Selection

Selection on slopes

- Examine how selection decision varies with treatment effect in years 1-2
- Construct a hospital specific "treatment effect"

$$\Delta y_h = \bar{y}_{h,16-17} - \bar{y}_{h,13-14}$$

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Selection on levels

- Do not observe levels for treatment group in years 1-2
- Examine how selection decision varies by pre-BP levels ($\bar{y}_{h,13-14}$)

Selection on Levels

Pre-BP Means ($\bar{y}_{h,13-14}$) for Select In vs. Select Out

		Mean	# of hospitals
Discharged to Institutional PAC	Select In	0.426	75
	Select Out	0.445	226
	Voluntary Control	0.437	350
Medicare Episode Spending in Institutional PAC	Select In	4,939	75
	Select Out	6,040	226
	Voluntary Control	5,411	350
Total Medicare Episode Spending	Select In	24,407	75
	Select Out	27,309	226
	Voluntary Control	26,184	350

- Robust to controlling for region, which soaks up most of the variation in target prices

Selection on Hospital Characteristics

	Select In	Select Out	P-value for difference
Share For-Profit	0.22	0.19	0.58
Share Teaching	0.06	0.11	0.17
Share with 500 or More Beds	0.14	0.11	0.54
Share with 500 or More CJR Episodes	0.24	0.14	0.06
Share with Excellent Quality	0.49	0.24	0.00
Share in South Census Region	0.13	0.15	0.63

Selection on Hospital Characteristics

	Select In	Select Out	P-value for difference
Share For-Profit	0.22	0.19	0.58
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Share with 500 or More CJR Episodes	0.24	0.14	0.06
Share with Excellent Quality	0.49	0.24	0.00
Share in South Census Region	0.13	0.15	0.63

Summary of Evidence

- Hospitals with larger treatment effects (reductions in spending) more likely to select into BP => Selection on slopes
- Hospitals with smaller pre-BP levels more likely to select into BP => Selection on levels
- Postpone discussion of correlation between slopes and levels to later

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Medicare Claims

- Framework loosely based on Laffont and Tirole (1993)
- Average annual FFS claims are

$$y = \underbrace{\lambda_{ACH} + \lambda_{PAC}}_{\lambda} - e$$

- λ_{ACH} is baseline ACH claims which are assumed to be fixed (DRG-based)
- λ_{PAC} are baseline PAC claims
- Hospitals can reduce λ_{PAC} claims by e at convex cost $\psi(e)$
- Zhu et al. (2018) survey of hospitals identifies two approaches
  - Reduce SNF discharges via risk-stratification, home care supports
  - Form networks of preferred SNFs to influence quality and costs

Hospital Objective

- Bundled payment (ignoring stop gain / loss) defined by transfer

$$\mathrm{t(y)} = \tau - y = \tau - [\lambda - e]$$

- Hospitals choose effort to maximize

$$\max_{e} \ (\lambda_{ACH} - c_{ACH}) + \ (\tau - [\lambda - e]) - \psi(e)$$

Fixed inpatient profits

Incremental payment $t(y)$

Cost of effort

where c_{ACH} is non-effort inpatient costs

Hospital Effort

- Hospital objective

$$\max_{e} \ (\lambda_{ACH} - c_{ACH}) + \ (\tau - [\lambda - e]) - \psi(e)$$

- If we assume cost of effort is quadratic of the form

$$\psi(e) = \frac{1}{2\omega} e^2$$

- Optimal effort is $e_1 = \omega$
- FFS claims are $y_1 = \lambda - \omega$
- Profits are $\pi_1 = (\lambda_{ACH} - c_{ACH}) + \left(\tau - \lambda + \frac{\omega}{2}\right)$

Note: We are implicitly assuming that cost of effort is “variable” rather than “fixed”. We have explored a fix cost specification and get similar results

Hospital Effort

- Control hospitals face no incentive to exert effort

- Optimal effort is $e_0 = 0$
- FFS claims are $y_0 = \lambda$
- Profits are $\pi_0 = \lambda_{ACH} - c_{ACH}$

Potential outcomes notation

- We can write FFS claims in potential outcomes framework

$$y = [1 - 1(PB)]\, y_0 + 1(BP)\, y_1$$

which is equivalent to

$$y = \lambda - 1(BP)\, \omega$$

- Hospitals are described by $\{\lambda, \omega\}$ pair

Voluntary Enrollment

- Hospitals select into BP if and only if

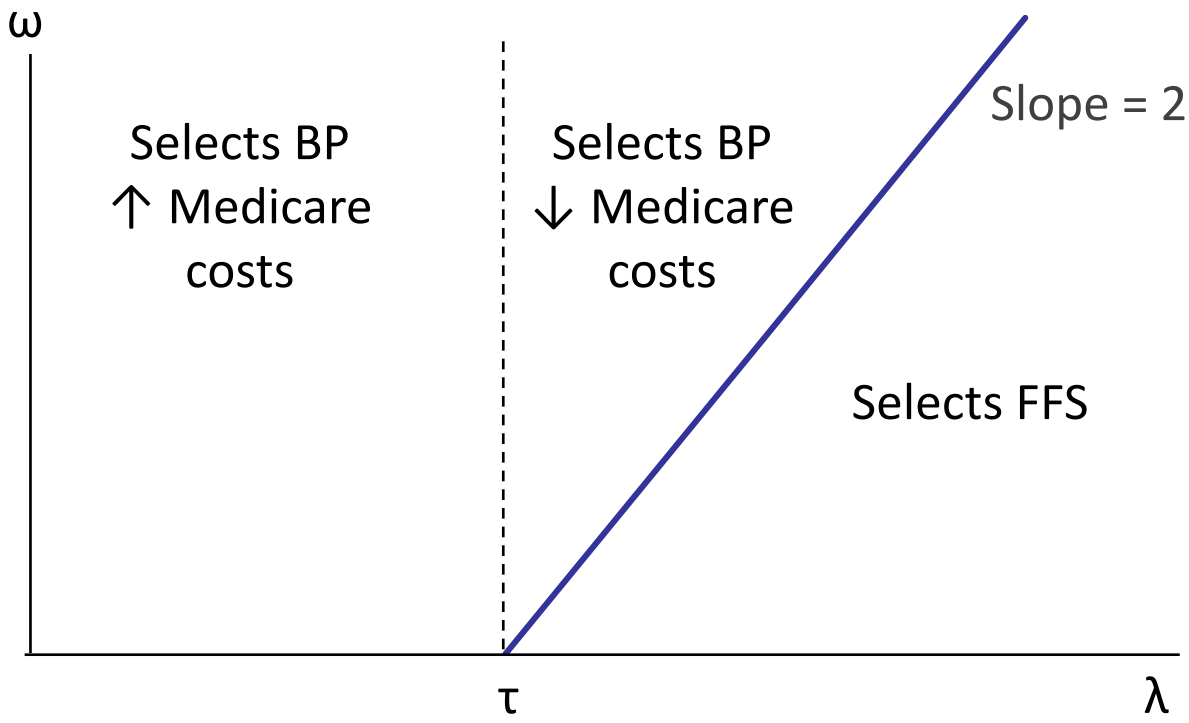
$$\pi_1 > \pi_0$$

$$\frac{\omega}{2} + [\tau - \lambda] > 0$$

Slope Level

- Selection into BP generates Medicare savings if and only if

$$\tau - \lambda < 0$$



Social Planner's Problem

- Social planner wishes to maximize

$$\max_{\tau} E[-(1+\Lambda)\text{ Medicare Costs} + \text{Hospital Profits}]$$

where $\Lambda > 0$ is the social cost of funds

First Best, Holding Hospital Profits Fixed

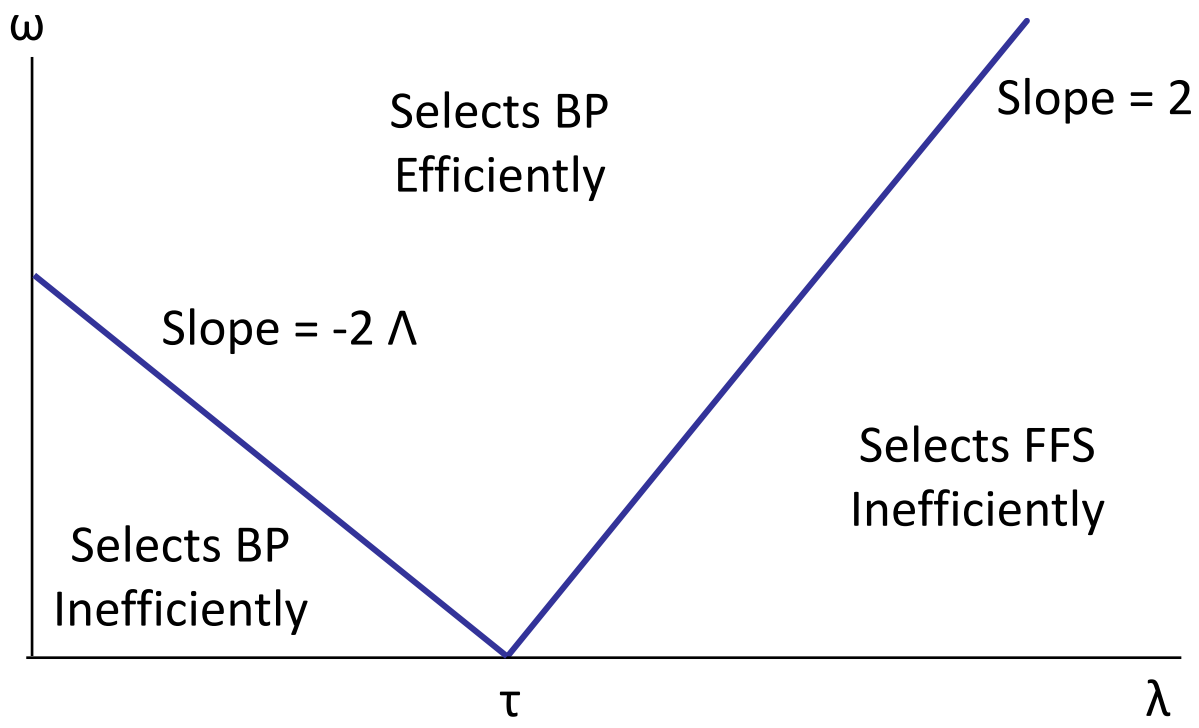
- If type were observable, social planner could set hospital-specific transfers

$$t(y|\lambda,\omega) = \begin{cases} \dfrac{\omega}{2} & \text{if } y = \lambda - \omega \\ -\infty & \text{otherwise} \end{cases}$$

- Since planner does not know type, can only set a transfer $t(y)$ as function of realized claims

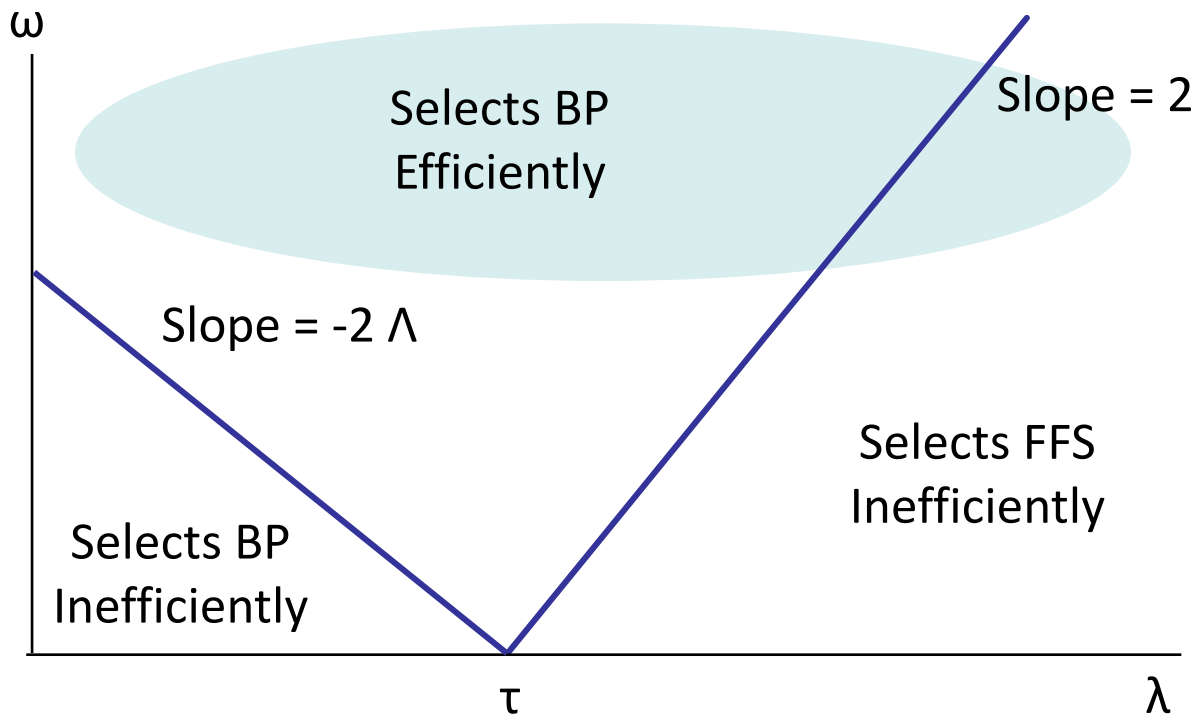
Social Planner's Problem

- Larger slopes ($\omega \gg 0$) will result in more hospitals selecting BP efficiently
- Accurate target prices ($\tau \approx \lambda$) will result in less inefficiency
- Smaller slopes ($\omega \approx 0$) and lots of heterogeneity in ($\lambda - \tau$) will lead to lots of inefficiency



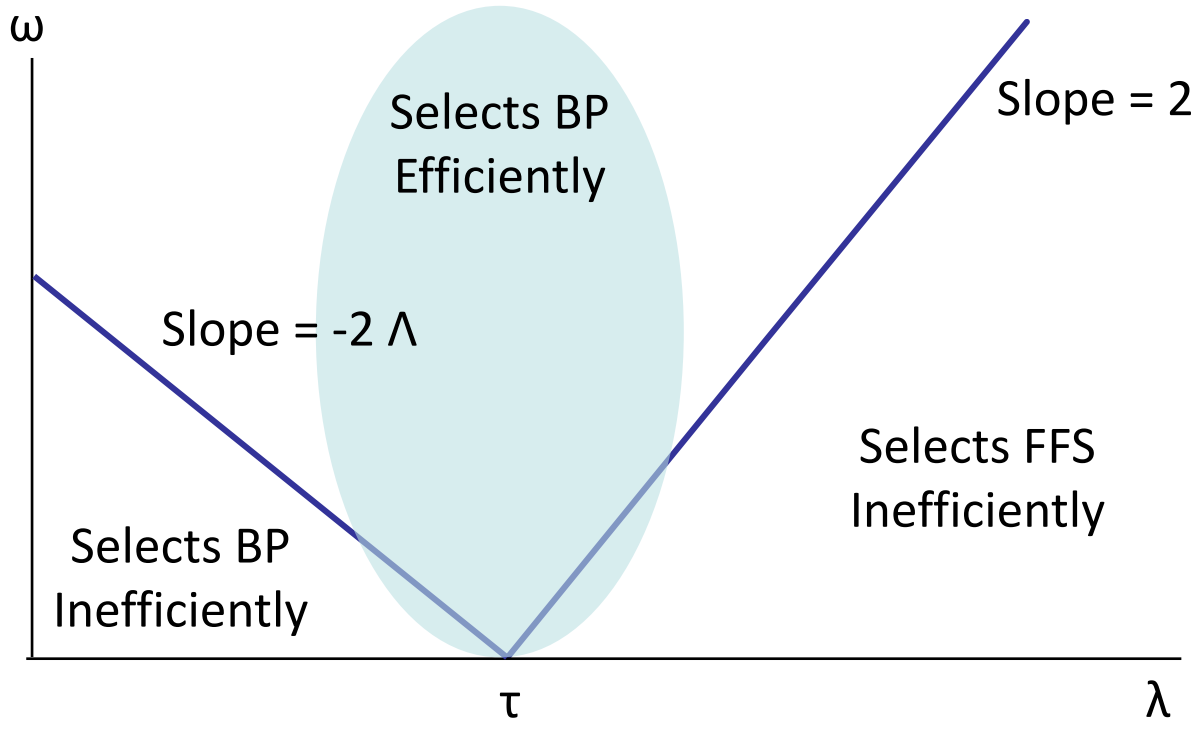
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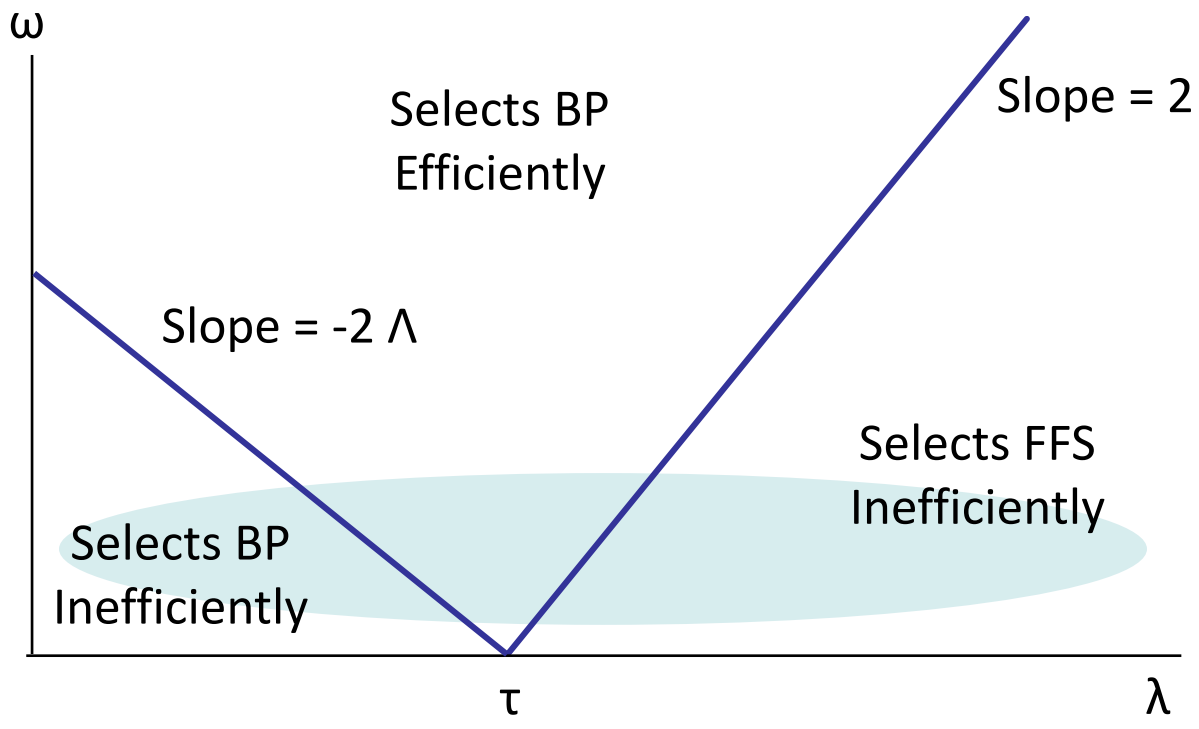
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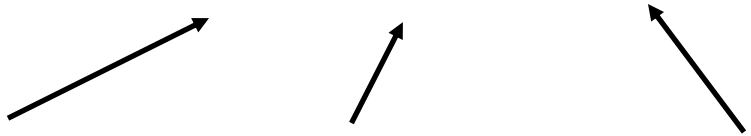
Econometric Model

- Medicare costs in years 1-2 are given by

$$y_h = \lambda_h - 1\left(BP_{h,1-2} = 1\right)\omega_h$$

- Year 3 selection decision is given by

$$1\left(BP_{h,3} = 1\right) \Leftrightarrow \frac{\omega_h}{2} + [\tau_h - \lambda_h] + \eta > 0$$



Selection on slopes

Selection on levels

Status quo bias, hassle costs, etc.

- Show counterfactuals where η is and is not welfare relevant

Note: η may be also be picking up failure to account for stop-loss / stop-gain

Correlation Between Slopes and Levels

- Do hospitals with lower levels of spending have smaller treatments effects (no fat to cut) or larger treatments effects (better at everything)

- Problem: Don't observe levels and slopes for same hospitals

- Solution:
  1. Use λ_{pre} (which we observe for every hospital) as an proxy for λ (which we only observe for control group)
  2. Assume that λ_{pre} only affects ω via λ

- Intuition is identical to instrumental variables
  - Using full data, estimate how ω varies with λ_{pre} (reduced form)
  - Using control, estimate how λ varies with λ_{pre} (first stage)
  - Ratio of reduced form to first stage tells us how ω varies with λ

Distributional Assumptions

- Assume $\{\lambda, \omega, \lambda_{pre}\}$ are jointly log normal

$$\begin{pmatrix} \lambda \\ \omega \\ \lambda_{pre} \end{pmatrix} = \ln N \left(\begin{pmatrix} \mu_\lambda \\ \mu_\omega \\ \mu_{pre} \end{pmatrix}, \begin{pmatrix} \sigma_\lambda^2 & \rho_{\lambda,\omega}\sigma_\lambda\sigma_\omega & \rho_{\lambda,pre}\sigma_\lambda\sigma_{pre} \\ \rho_{\lambda,\omega}\sigma_\lambda\sigma_\omega & \sigma_\omega^2 & \rho_{\omega,pre}\sigma_\omega\sigma_{pre} \\ \rho_{\lambda,pre}\sigma_\lambda\sigma_{pre} & \rho_{\omega,pre}\sigma_\omega\sigma_{pre} & \sigma_{pre}^2 \end{pmatrix} \right)$$

- Exclusion restriction is that λ_{pre} is conditionally uncorrelated with ω

$$Cov(\omega, \lambda_{pre} | \lambda) = 0$$

- This implies

$$\rho_{\lambda,\omega} = \frac{\rho_{\omega,pre}}{\rho_{\lambda,pre}}$$

Two-Step Maximum Likelihood

First Step

- Estimate θ_1 that govern relationship between λ_{pre} and λ
- Since λ_{pre} and λ observed for the control group, directly estimate θ_1 using control group hospitals

Second Step

- Estimate θ_2 that govern relationship between λ and ω and the year 3 selection decision, conditional on λ_{pre}, $\widehat{\theta_1}$, and treatment assignment

$$\ln L = \sum_{h=1}^{H} 1\left(BP_{h,1-2} = 0\right) \ln g_0\left(y_h | \widehat{\theta_1}, \theta_2, \lambda_{pre,h}, BP_{h,1-2} = 0\right)$$

$$+1\left(BP_{h,1-2} = 1\right) \ln g_1\left(y_h, 1(BP_{h,3} = 0) | \widehat{\theta_1}, \theta_2, \lambda_{pre,h}, BP_{h,1-2} = 1\right)$$

$$+1\left(BP_{h,1-2} = 1\right) \ln g_1\left(y_h, 1(BP_{h,3} = 1) | \widehat{\theta_1}, \theta_2, \lambda_{pre,h}, BP_{h,1-2} = 1\right)$$

Estimation Details

- Because assignment was only random conditional on strata, we allow μ_{pre} and μ_{λ} to vary by strata (i.e., include strata fixed effects)
- Weight hospitals by the number of episodes to increase precision
- Since $\mathrm{y} = \lambda - \omega$ does not have known closed form (difference of log normals), estimate probability mass function $g_1(\cdot \mid \cdot)$ by simulation

Parameter Estimates

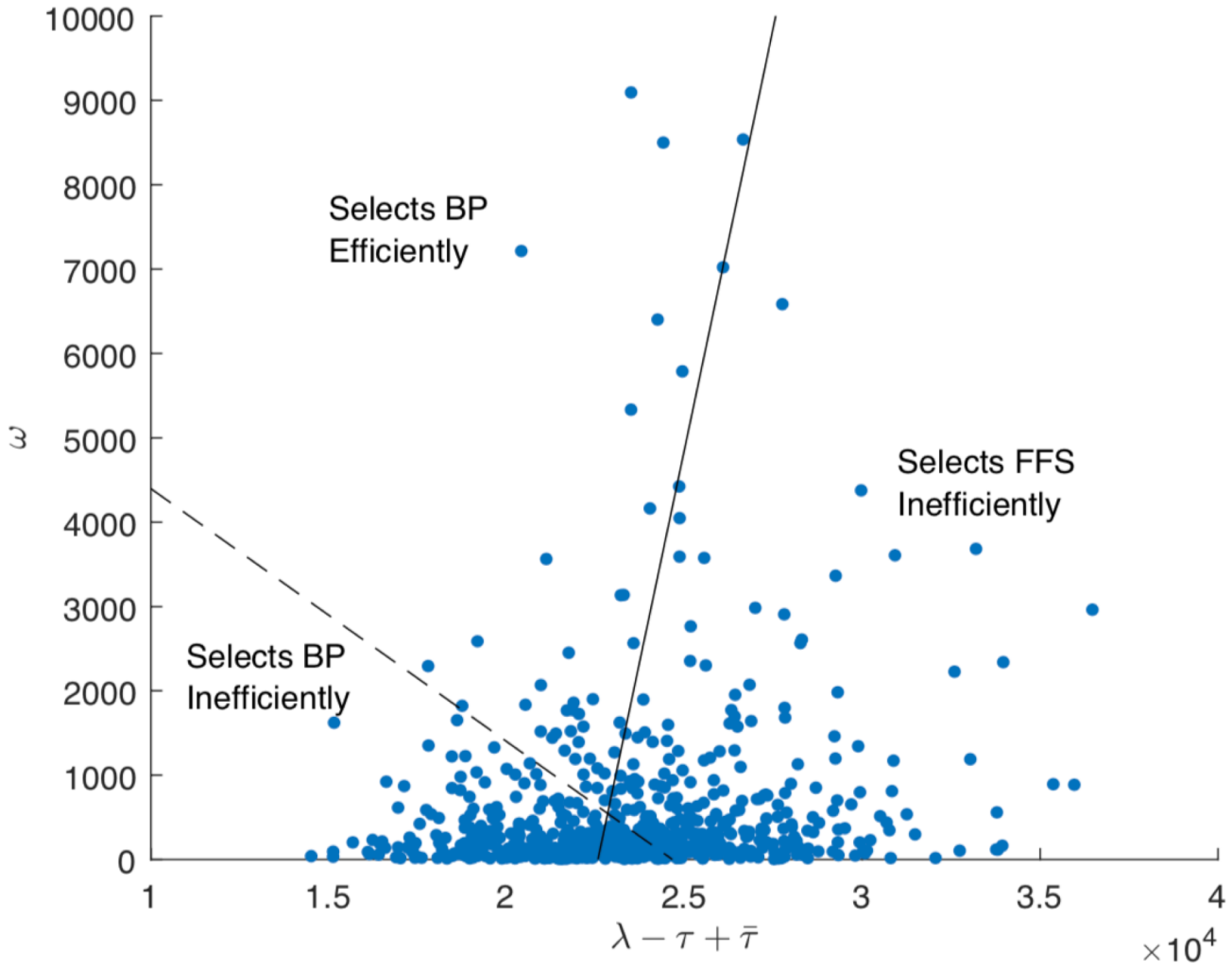
Parameter Estimates

Parameters	Estimates
$\mu_{\lambda,1}$	10.01
$\mu_{\lambda,2}$	9.99
$\mu_{\lambda,3}$	10.02
$\mu_{\lambda,4}$	10.05
$\mu_{\lambda,5}$	10.09
$\mu_{\lambda,6}$	10.07
$\mu_{\lambda,7}$	10.06
$\mu_{\lambda,8}$	10.11
σ_{λ}	0.18
σ_{pre}	0.17
$\rho_{\lambda,pre}$	0.88
μ_{ω}	5.36
σ_{ω}	1.51
$\rho_{\lambda,\omega}$	0.21
η	-2090.9

Implied Mean and SD

Variables	$\mathbb{E}(x)$	sd(x)
λ_1	22,659	3,996
λ_2	22,108	3,899
λ_3	22,910	4,040
λ_4	23,396	4,126
λ_5	24,399	4,303
λ_6	23,964	4,226
λ_7	23,797	4,197
λ_8	24,858	4,330
ω	667	1,972

Joint Distribution of $\{\lambda, \omega\}$



- Non welfare-relevant η

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Counterfactuals

- Mandatory vs. voluntary (holding fixed $\rho_{\tau,\lambda}$)
- Improved targeting (vary $\rho_{\tau,\lambda}$)
- Screening contracts [not yet complete]

Assumptions

- Social cost of funds: $\Lambda = 15\%$

Mandatory vs. Voluntary

Mandatory vs. Voluntary with Observed τ

				Non-welfare relevant η		Welfare relevant η	
	Selection	Medicare Costs	Relative Social Costs	Relative Hospital Profits	Relative Social Surplus	Relative Hospital Profits	Relative Social Surplus
Status Quo	0%	23,566	0	0	0	0	0
Mandatory	100%	24,737	1,346	1,530	184	-561	-1,907
Voluntary	56%	25,555	2,287	2,228	-58	1,057	-1,230

Mandatory vs. Voluntary

Mandatory vs. Voluntary with Observed τ

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Voluntary	56%	25,555	2,287	2,228	-58	1,057	-1,230

- Ex post, observed target prices resulted in $\mathrm{E}[\tau] > \mathrm{E}[\lambda]$

Mandatory vs. Voluntary

- Natural to reduce τ so $\mathrm{E}[\tau] = \mathrm{E}[\lambda]$, holding fixed $\mathrm{sd}[\tau]$ and $\rho_{\tau,\lambda}$

Mandatory vs. Voluntary with $\mathbf{E}[\tau] = E[\lambda]$

				Non-welfare relevant η		Welfare relevant η	
	Selection	Medicare Costs	Relative Social Costs	Relative Hospital Profits	Relative Social Surplus	Relative Hospital Profits	Relative Social Surplus
Status Quo	0%	23,566	0	0	0	0	0
Mandatory	100%	23,526	-47	319	366	-1,772	-1,725
Voluntary	44%	24,806	1,425	1,443	18	524	-902

Mandatory vs. Voluntary

- Natural to reduce τ so $\mathrm{E}[\tau] = \mathrm{E}[\lambda]$, holding fixed $\mathrm{sd}[\tau]$ and $\rho_{\tau,\lambda}$

Mandatory vs. Voluntary with $\mathbf{E}[\tau] = E[\lambda]$

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	Selection	Medicare Costs	Relative Social Costs	Relative Hospital Profits	Relative Social Surplus	Relative Hospital Profits	Relative Social Surplus
Status Quo	0%	23,566	0	0	0	0	0
Mandatory	100%	23,526	-47	319	366	-1,772	-1,725
Voluntary	44%	24,806	1,425	1,443	18	524	-902

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Improved Targeting (Vary $\rho_{\tau,\lambda}$)

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Voluntary with ρ = 0	45%	25,310	2,006	1,935	-71	1,003	-1,003
Voluntary with ρ = 0.17	44%	25,196	1,874	1,822	-53	893	-981
Voluntary with ρ = 0.35	44%	25,067	1,726	1,698	-28	775	-950
Voluntary with ρ = 0.52	44%	24,925	1,562	1,564	2	645	-917
Voluntary with ρ = 0.70	44%	24,777	1,392	1,413	22	500	-892
Voluntary with ρ = 0.80	43%	24,678	1,278	1,314	36	407	-871
Voluntary with ρ = 0.87	43%	24,604	1,193	1,236	43	338	-855
Voluntary with ρ = 1	22%	23,791	258	442	184	-25	-283

- Observed $\rho_{\tau,\lambda} = 0.66$

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Conclusion

- Many government regulations / programs based on voluntary enrollment
- Welfare effects depend on whether there is selection on slopes or levels
- Study bundled payment program for hip and knee replacement
- Document selection on both slopes and levels
- Structural model indicates modest surplus losses from voluntary relative to mandatory when η not welfare relevant
  - Reversed when η is welfare relevant
- Better calibrated target prices could raise surplus
- Will be interesting to examine effects of more complex contract design

Backup Slides

Implementation

- Let y indicate average per episode FFS payments
- Under bundled payments, hospital receive y as under the status quo
- At end of year, receive <u>incremental</u> payment $t(y)$

$$t(y) = \begin{cases} \underline{p} < 0 & \text{if} \quad \tau - y < \underline{p} \\ \tau - y & \text{if} \quad \tau - y \in \left[\underline{p}, \overline{p}\right] \\ \overline{p} > 0 & \text{if} \quad \tau - y < \overline{p} \end{cases}$$

where τ is target price based on historical regional and hospital spending

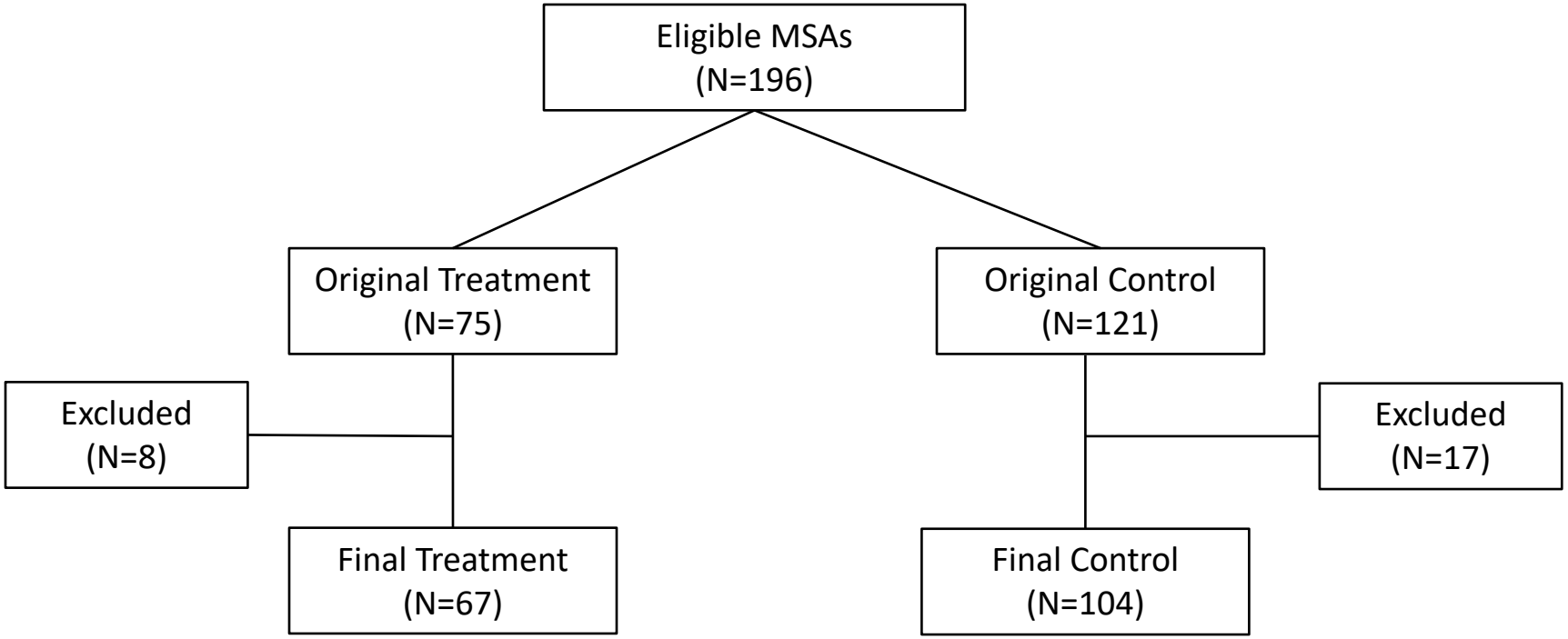
- Stop loss and stop gain increases over time

Performance Year	1	2	3	4	5
Stop loss	-	-5%	-10%	-20%	-20%
Stop gain	+5%	+5%	+10%	+20%	+20%

- Hospitals need to meet min quality standards to be eligible for bonuses

Experimental Design

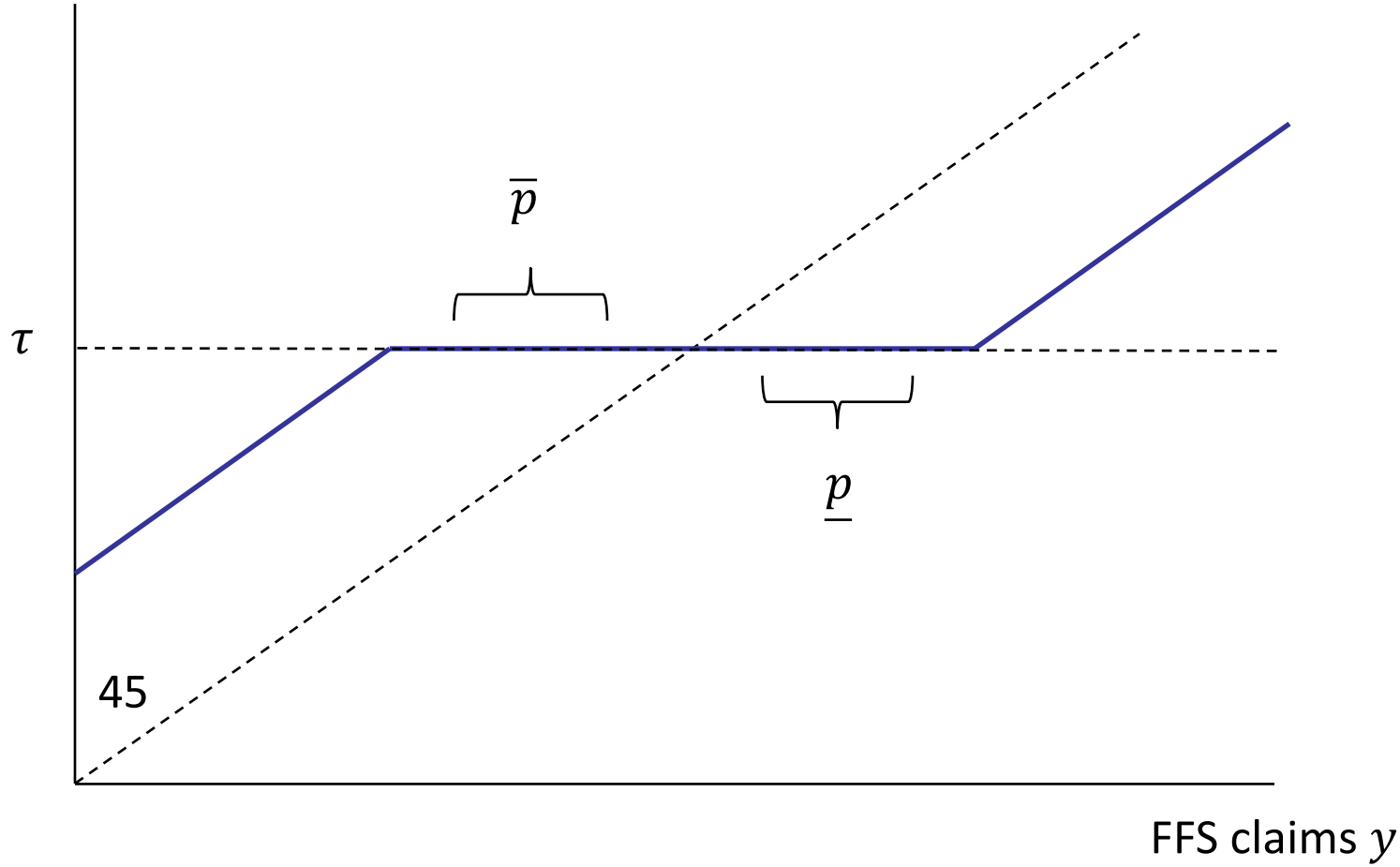
- After initial assignment, public comments point out initial assignment did not account for October 2015 enrollment in another program (BPCI)
  - In November 2015, 8 MSAs were excluded from treatment group
  - CMS later identified the 17 MSAs to exclude from control group



Net Payments

Net reimbursement

$y + t(y)$



Correlation Between Levels and Slopes

- Do hospitals with lower levels of spending have smaller treatments effects (no fat to cut) or larger treatments effects (better at everything)

- Don't observe levels and slopes for same hospitals so take "IV like" approach where we proxy for levels with pre-BP levels

- First stage of levels on pre-BP levels among control MSAs

$$y_{h,16-17} = \alpha_0 + \alpha_1 y_{h,13-14} + \alpha_{2,s(h)} + \nu_h$$

- Reduced form with treatment effect interacted with pre-BP levels

$$y_{h,16-17} = \gamma_0 + \gamma_1 1(BP) + \gamma_2\, 1(BP)_j \times y_{h,13-14} + \gamma_{3,s(h)} + \gamma_{4,s(h)} \times y_{h,13-14} + \epsilon_h$$

Average effect

Heterogeneity wrt to lagged outcome

Correlation Between Levels and Slopes

First Stage

	α1	SE	p-value	N
Share discharged to institutional PAC	0.685	0.024	<0.001	805
Medicare spending institutional PAC	0.703	0.034	<0.001	805
Total Medicare spending	0.853	0.038	<0.001	805

Reduced Form

		γ1			γ2			
	Control Mean	Est.	SE	p-value	Est.	SE	p-value	N
Share discharged to institutional PAC	0.412	-0.031	0.015	0.039	0.018	0.036	0.627	1,514
Medicare spending institutional PAC	5,507	-266	194	0.172	-0.004	0.039	0.922	1,514
Total Medicare spending	26,519	-3,095	1113	0.006	0.111	0.049	0.025	1,514

Correlation Between Levels and Slopes

Implied IV

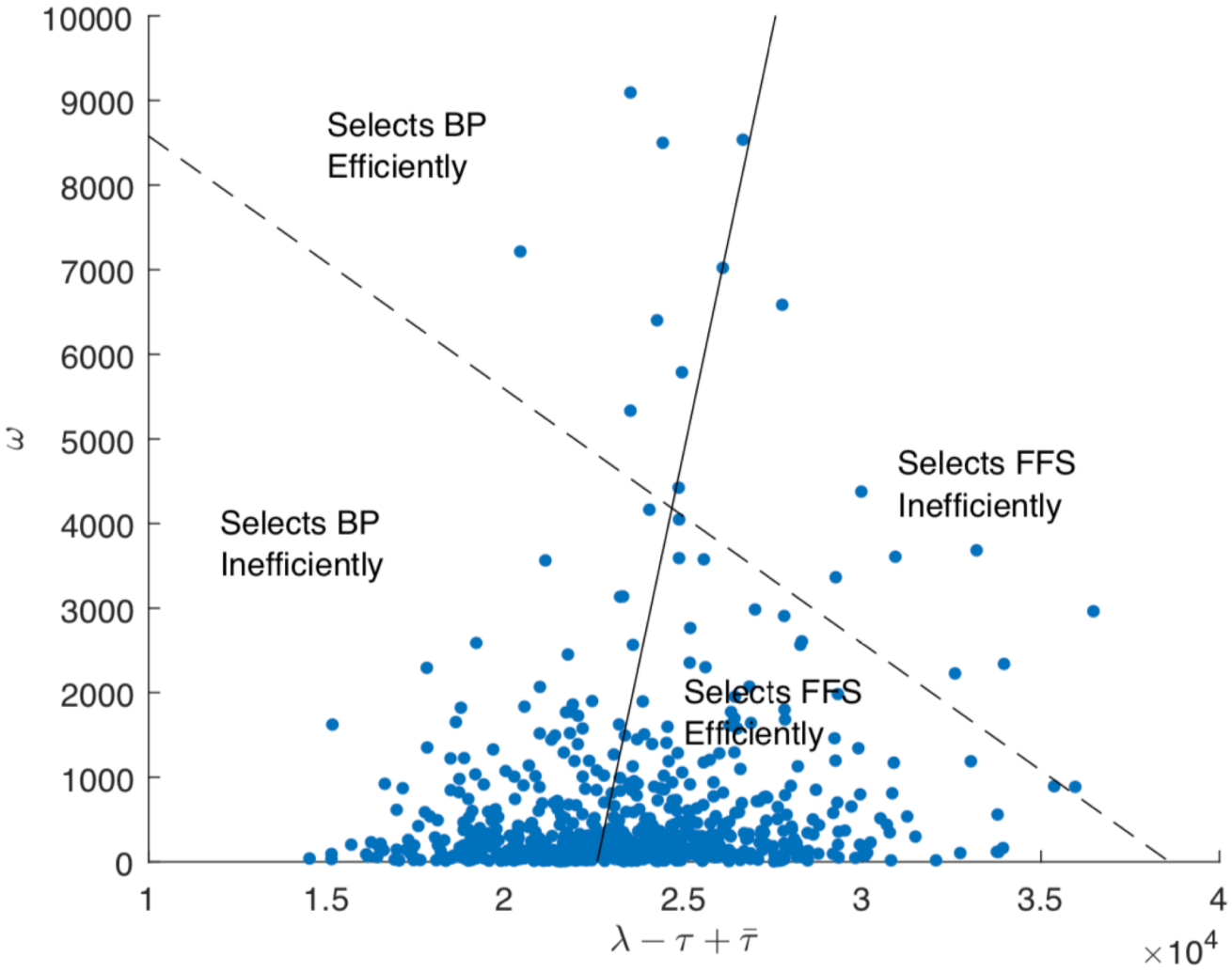
	γ_1	$\beta_2 = \gamma_2/\alpha_1$	SD of Control	β_2 X SD of Control
Share discharged to institutional PAC	-0.031	0.026	0.110	0.003
Medicare spending institutional PAC	-266	-0.006	1,303	-7
Total Medicare spending	-3,095	0.130	3,622	471

Correlation Between Levels and Slopes

Implied IV

	γ_1	$\beta_2 = \gamma_2/\alpha_1$	SD of Control	β_2 X SD of Control
Share discharged to institutional PAC	-0.031	0.026	0.110	0.003
Medicare spending institutional PAC	-266	-0.006	1,303	-7
Total Medicare spending	-3,095	0.130	3,622	471

Joint Distribution of $\{\lambda, \omega\}$



- Welfare-relevant η

Improved Targeting (Vary $\rho_{\tau,\lambda}$)

Vary $\rho_{\tau,\lambda}$ with Observed $\mathbf{E}[\tau]$

				Non-welfare relevant η		Welfare relevant η	
	Selection	Medicare Costs	Relative Social Costs	Relative Hospital Profits	Relative Social Surplus	Relative Hospital Profits	Relative Social Surplus
Status Quo	0%	23,566	0	0	0	0	0
Voluntary with ρ = 0	55%	25,977	2,772	2,643	-129	1,487	-1,286
Voluntary with ρ = 0.17	56%	25,876	2,656	2,544	-112	1,382	-1,274
Voluntary with ρ = 0.35	57%	25,777	2,543	2,449	-94	1,262	-1,280
Voluntary with ρ = 0.52	56%	25,651	2,398	2,328	-69	1,157	-1,241
Voluntary with ρ = 0.70	56%	25,534	2,262	2,208	-55	1,033	-1,229
Voluntary with ρ = 0.80	58%	25,464	2,182	2,142	-40	940	-1,242
Voluntary with ρ = 0.87	59%	25,421	2,133	2,098	-35	874	-1,258
Voluntary with ρ = 1	54%	24,858	1,485	1,564	79	445	-1,041

- Observed $\rho_{\tau,\lambda} = 0.66$

Target Price

- CMS reports τ_h for treatment group hospitals
- Eventually, impute τ_h for control hospitals (using Federal Register description) and directly estimate $\rho_{\tau,\lambda}$ using control group hospitals

For now

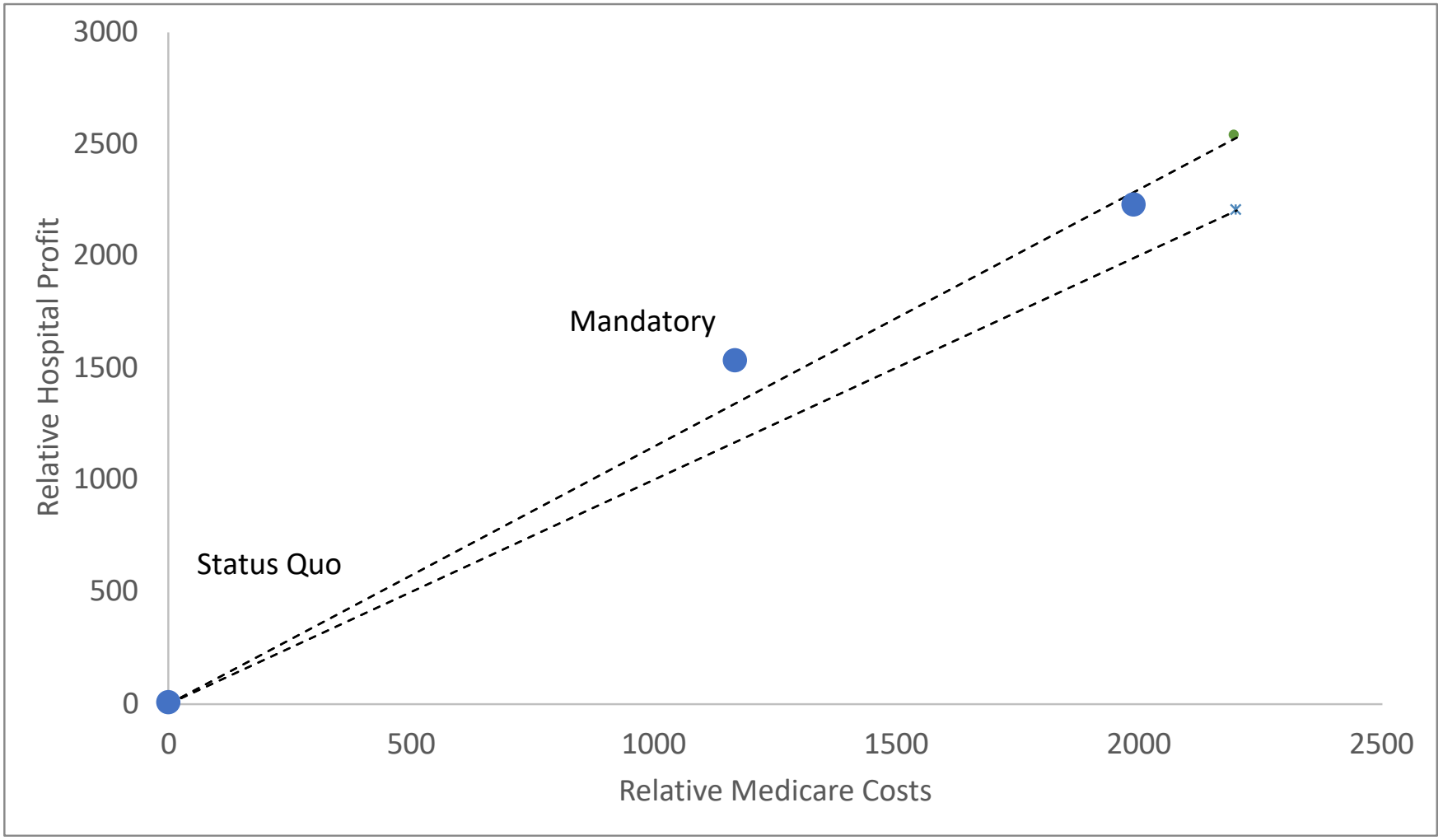
- Directly estimate $\rho_{\tau,pre}$ using treatment group hospitals
- Assume τ only correlated with λ via λ_{pre}
- Assumption implies

$$\rho_{\tau,\lambda} = \rho_{\tau,pre} \times \rho_{\lambda,pre}$$

- We estimate

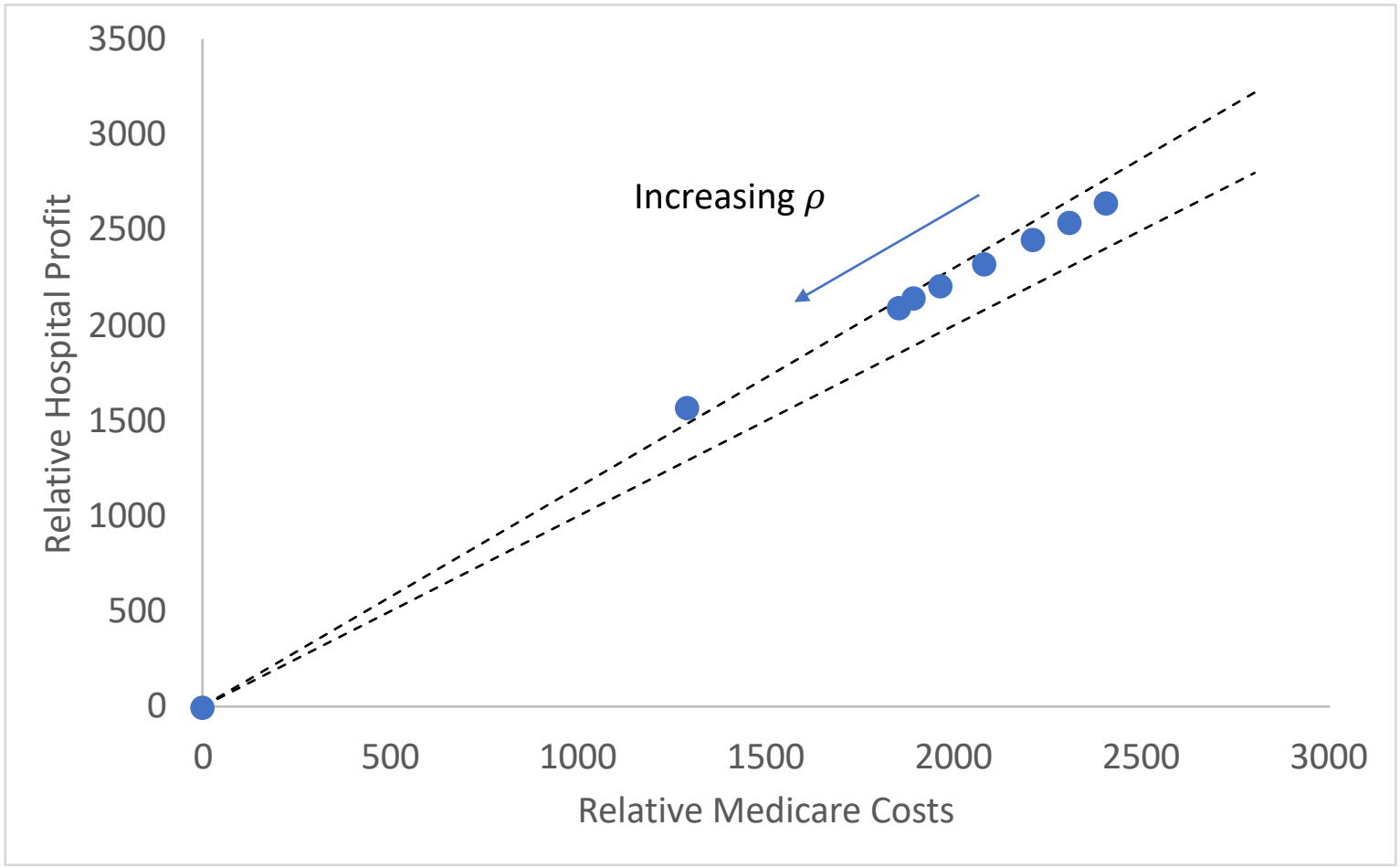
$$\rho_{\tau,\lambda} = 0.76 \times 0.87 = 0.66$$

Mandatory vs. Voluntary



- Non-welfare relevant η
- Dashed lines have slopes of 1 and $1 + \Lambda$

Alternative Target Prices (Vary $\rho_{\tau,\lambda}$)



- Non-welfare relevant β
- Dashed lines have slopes of 1 and $1 + \Lambda$