Physician Practice Organization and Negotiated Prices: Evidence from State Law Changes

Naomi Hausman and Kurt Lavetti

Online Appendix

Table A1: NCA Law Change Frequencies by Census Division

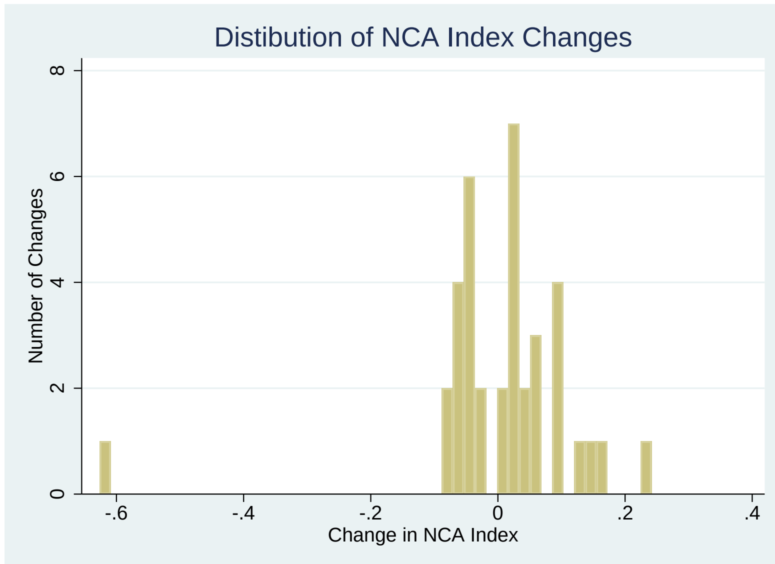
	East North Central	East South Central	Middle Atlantic	Mountain	New England	Pacific	South Atlantic	West North Central	West South Central	Total
					Positive Changes					
Statutory Index	0	1	0	0	0	0	0	1	0	2
Protectible Interest Index	0	1	1	2	1	1	1	2	2	11
Burden of Proof Index	1	1	1	2	1	0	1	0	0	7
Consideration Index Inception	0	0	0	0	0	0	0	1	0	1
Consideration Index Post-Inception	1	0	0	0	1	0	0	0	2	4
Blue Pencil Index	0	0	0	0	0	0	0	1	0	1
Employer Termination Index	0	0	2	0	0	0	0	0	0	2
					Negative Changes					
Statutory Index	1	1	0	2	0	0	1	0	2	7
Protectible Interest Index	1	1	0	0	0	1	0	0	0	3
Burden of Proof Index	0	1	1	0	0	0	1	1	0	4
Consideration Index Inception	0	1	1	0	0	0	0	0	0	2
Consideration Index Post-Inception	0	1	0	0	0	1	2	0	0	4
Blue Pencil Index	0	1	0	0	1	0	1	1	0	4
Employer Termination Index	0	0	0	0	0	0	0	0	0	0
Total All Dimensions	4	9	6	6	4	3	7	7	6	52

Table A2: Bishara (2011) Rating of the Restrictiveness of Non-Compete Agreements

Question #	Question	Criteria	Question Weight
Q1	Is there a state statute that governs the enforceability of covenants not to compete?	10 = Yes, favors strong enforcement 5 = Yes or no, in either case neutral on enforcement 0 = Yes, statute that disfavors enforcement	10
Q2	What is an employer's protectable interest and how is that defined?	10 = Broadly defined protectable interest 5 = Balanced approach to protectable interest 0 = Strictly defined, limiting the protectable interest of the employer	10
Q3	What must the plaintiff be able to show to prove the existence of an enforceable covenant not to compete?	10 = Weak burden of proof on plaintiff (employer) 5 = Balanced burden of proof on plaintiff 0 = Strong burden of proof on plaintiff	5
Q3a	Does the signing of a covenant not to compete at the inception of the employment relationship provide sufficient consideration to support the covenant?	10 = Yes, start of employment always sufficient to support any CNC 5 = Sometimes sufficient to support CNC 0 = Never sufficient as consideration to support CNC	5
Q3b	Will a change in the terms and conditions of employment provide sufficient consideration to support a covenant not to compete entered into after the employment relationship has begun?	10 = Continued employment always sufficient to support any CNC 5 = Only change in terms sufficient to support CNC 0 = Neither continued employment nor change in terms sufficient to support CNC	5
Q3c	Will continued employment provide sufficient consideration to support a covenant not to compete entered into after the employment relationship has begun?	10 = Continued employment always sufficient to support any CNC 5 = Only change in terms sufficient to support CNC 0 = Neither continued employment nor change in terms sufficient to support CNC	5
Q4	If the restrictions in the covenant not to compete are unenforceable because they are overbroad, are the courts permitted to modify the covenant to make the restrictions more narrow and to make the covenant enforceable? If so, under what circumstances will the courts allow reduction and what form of reduction will the courts permit?	10 = Judicial modification allowed, broad circumstances and restrictions to maximum enforcement allowed 5 = Blue pencil allowed, balanced circumstances and restrictions to middle ground of allowed enforcement 0 = Blue pencil or modification not allowed	10
Q8	If the employer terminates the employment relationship, is the covenant enforceable?	10 = Enforceable if employer terminates 5 = Enforceable in some circumstances 0 = Not enforceable if employer terminates	10

Source: Bishara (2011). Notes: The questions in the table correspond to the NCA law components used in the IV estimates throughout the paper. In the paper and tables, we refer to Q1 as the 'Statutory Index', to Q2 as the 'Protectible Interest Index', to Q3 as the 'Burden of Proof Index', to Q3a as 'Consideration Index Inception', to Q3b and Q3c together as 'Consideration Index Post-Inception', to Q4 as 'Blue Pencil Index', and to Q8 as 'Employer Termination Index'. In the raw data, the laws are scaled in each state-year from 0 to 10, as indicated by this table. In the estimations, each component is rescaled to range from 0 to 1, where 0 is the least restrictive observation in the data and 1 is the most.

Figure A1: Distribution of NCA Index Changes



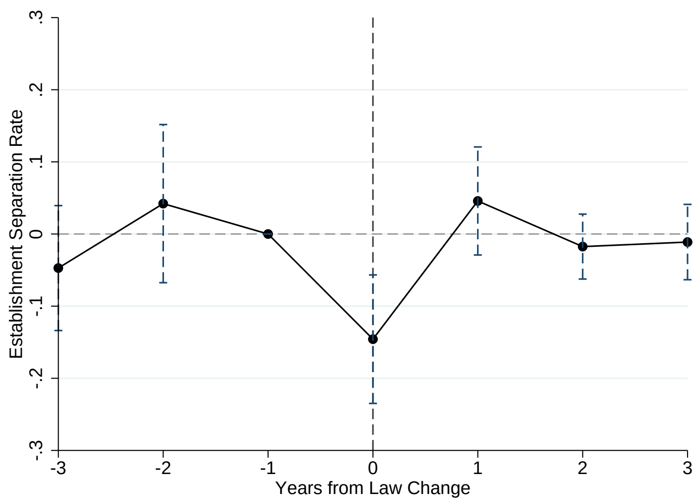
Notes: Data points underlying the histogram are state-year observations of year-to-year changes in the NCA Index, which is a weighted sum of the 7 NCA law dimensions. The Index is scaled to range from 0 to 1, where 0 is the least restrictive state-year in the sample and 1 is the most restrictive. Changes in the Index can thus range from -1 to 1.

Table A3: NCA Law Components: Descriptive Statistics

	Mean	SD	N (State-Years)
Statutory Index	0.55	0.24	612
Protectible Interest Index	0.59	0.24	604
Burden of Proof Index	0.56	0.27	599
Consideration Index Inception	0.85	0.29	562
Consideration Index Post-Inception	0.70	0.33	524
Blue Pencil Index	0.53	0.34	538
Employer Termination Index	0.62	0.29	407

Notes: Statistics in the table represent data from 1995-2007 for each state-year in which a legal precedent exists. The minimum of each component is 0 and the maximum of each component is normalized to 1.

Figure A2: Event Study: Physician-Establishment Separation Rates
Before and After Decrease in Enforceability



Notes: Sample includes treatment states with only one law change within the event window, and control states in the same Census division as the treatment state that had no law changes during the corresponding event window. Estimates are from fixed effects regressions including county effects, census division by year effects, and specialty effects. Specialties included in sample are primary care and non-surgical specialists. Dashed lines represent 95% confidence intervals based on standard errors clustered by state. Year 0 is the calendar year during which the law change occurred, and the dependent variable is normalized to zero in year -1.

Table A4: Fixed Effects Models of Establishment Births and Deaths

Dependent Variable:	Births		Deaths	
	Univar.	Multivar.	Univar.	Multivar.
	(1)	(2)	(3)	(4)
Statutory Index$_{t-1}$	–1.277*	–0.608*	–1.347*	–0.733*
	(0.091)	(0.092)	(0.121)	(0.124)
Protectible Interest Index$_{t-1}$	0.582*	1.258*	0.609*	1.205*
	(0.066)	(0.158)	(0.089)	(0.177)
Burden of Proof Index$_{t-1}$	–0.633*	–3.689*	–0.531*	–3.657*
	(0.117)	(0.270)	(0.136)	(0.329)
Consideration Index Inception$_{t-1}$	0.023	3.392*	–0.354*	2.039*
	(0.088)	(0.299)	(0.090)	(0.265)
Consideration Index Post-Inception$_{t-1}$	–0.293*	–0.848*	–0.081*	–0.459*
	(0.050)	(0.093)	(0.038)	(0.074)
Blue Pencil Index$_{t-1}$	0.234*	0.286*	–0.197*	–0.306*
	(0.041)	(0.060)	(0.048)	(0.065)
Employer Termination Index$_{t-1}$	–4.020*	–4.677*	–4.424*	–4.529*
	(0.513)	(0.630)	(0.682)	(0.780)
Number of Physicians in county		0.070*		0.123*
		(0.012)		(0.019)
N		599,975		599,975
R-Sq		0.43		0.34

Notes: Columns 1 and 3 report estimates from separate univariate regressions, and columns 2 and 4 report estimates from mutivariate regressions of the number of establishment births and deaths (MPIER) on the 7 NCA law indices, controlling for the aggregate supply of physicians, and including fixed effects for county by medical specialty, and census division by year. Huber-White standard errors reported in parentheses. * indicates significance at the 0.05 level.

Table A5: Lasso IV: Effect of Establishment-Based Market Concentration on Prices

	Dependent Variable: $\ln(Price)_t$
$\text{HHI}_{(t-1)}$	–0.027*
	(0.012)

First Stage: Effect of NCA Laws on Establishment-Based Market Concentration

	Dependent Variable: HHI_{t-1}
Consideration Index Post-Inception$_{t-1}$	–3.14*
	(0.52)
Burden of Proof Index$_{t-1}$	–3.35*
	(0.09)
Employer Termination Index$_{t-1}$	–4.49*
	(0.15)
N	3,226,374
R-Sq	0.60
CD F-Stat	329.9
KP F-Stat	510.6

Notes: All specifications include fixed effects for county, census division by year, procedure code (CPT), physician specialty, and facility type. All independent variables are scaled to range between 0 and 1, where 1 is the strongest observed measure of the variable in any state and year in the data. HHI is calculated from establishment sizes in MPIER data, provided by CMS. HHI is scaled to range from 0 to 100, so that a 1 unit change in HHI corresponds to a 100 point change in the typical 10,000 point scale. All standard errors are clustered by state. * indicates significance at the 0.05 level.

Table A6: IV First Stage Estimates: Effect of NCA Laws on Sales-Based HHI

Dependent Variable:	Estab. HHI_{t-1} (1)	Firm HHI_{t-1} (2)
Statutory $Index_{t-1}$	–0.25	–3.09
	(2.16)	(2.31)
Protectible Interest $Index_{t-1}$	14.11*	7.23
	(4.45)	(4.10)
Consideration Index $Inception_{t-1}$	17.26*	22.56*
	(6.20)	(10.57)
Consideration Index $Post\text{-}Inception_{t-1}$	–2.19*	2.79*
	(0.41)	(1.45)
Burden of Proof $Index_{t-1}$	–16.15*	–19.49*
	(6.08)	(9.22)
Blue Pencil $Index_{t-1}$	–0.75	0.53
	(3.27)	(4.61)
Employer Termination $Index_{t-1}$	–24.06*	–10.28*
	(4.53)	(4.44)
Insurer HHI_{t-1}	0.00	–0.04
	(0.01)	(0.02)
MPIER Data Used	Yes	Yes
Census Data Used	Yes	Yes
N	6,330,000	
R-Sq	0.83	
CD F-Statistic	270.27	
KP F-Statistic	52.2	

Notes: All specifications include fixed effects for county, census division by year, procedure code (CPT), physician specialty, and facility type. Legal indices are scaled to range between 0 and 1, where 1 is the strongest observed measure of the variable in any state and year in the data. Firm HHIs are based on sales from the Census LBD and SSEL, and establishment HHIs are based on employment levels from MPIER. HHIs are scaled to range from 0 to 100, so that a 1 unit change in HHI corresponds to a 100 point change in the typical 10,000 point scale. All standard errors are clustered by state. Cragg-Donald F-statistic and Kleinbergen-Paap F-statistic reported. * indicates significance at the 0.05 level.

Table A7: Sensitivity to IV Estimator

	Dependent Variable: $\ln(Price)_t$		
Estimator:	2SLS	LIML	2SGMM
HHI_{t-1}	–0.019*	–0.028*	–0.020*
	(0.006)	(0.008)	(0.0004)
N	3,226,374	3,226,374	3,226,374
1st Stage CD F-Stat	232.4	232.4	232.4
1st Stage KP F-Stat	1090.5	1090.5	1090.5

Notes: All specifications include fixed effects for county, census division by year, procedure code (CPT), physician specialty, and facility type. HHI is calculated from establishment sizes in MPIER data, provided by CMS. HHI is scaled to range from 0 to 100, so that a 1 unit change in HHI corresponds to a 100 point change in the typical 10,000 point scale. All standard errors are clustered by state. * indicates significance at the 0.05 level.

Table A8: IV Second Stage Estimates: MPIER HHIs, Markets defined by county only

	Dependent Variable: ln($Price$)	
	IV	OLS
$\text{HHI}_{(t-1)}$	–0.018*	–0.000
	(0.004)	(0.000)
N	3,226,374	3,226,374
1st Stage CD F-Stat	200.5	
1st Stage KP F-Stat	2535.0	

Notes:All specifications include fixed effects for county, census division by year, procedure code (CPT), and facility type. Markets are defined by county only, and are not differentiated by physician specialty. HHI is calculated from establishment sizes in MPIER data, provided by CMS. HHI is scaled to range from 0 to 100, so that a 1 unit change in HHI corresponds to a 100 point change in the typical 10,000 point scale. All standard errors are clustered by state. * indicates significance at the 0.05 level.

Table A9: Fixed Effects Models of Insurer Concentration (10,000 Scale)

Dependent Variable: Insurer HHI (LBD)		
	Lags 1 and 2	Lag 1
	(1)	(2)
Statutory Index$_{t-1}$	–8.63	28.44
	(30.73)	(14.81)
Protectible Interest Index$_{t-1}$	1.65	–6.00
	(17.31)	(12.56)
Burden of Proof Index$_{t-1}$	30.87	74.99
	(62.21)	(72.22)
Consideration Index Inception$_{t-1}$	9.97	2.56
	(5.90)	(3.01)
Consideration Index Post-Inception$_{t-1}$	–38.24	-82.91
	(63.16)	(71.09)
Blue Pencil Index$_{t-1}$	21.24	-18.68
	(22.92)	(16.20)
Employer Termination Index$_{t-1}$	–13.12	–4.86
	(17.13)	(13.10)
Statutory Index$_{t-2}$	37.33	
	(24.03)	
Protectible Interest Index$_{t-2}$	1.44	
	(15.64)	
Burden of Proof Index$_{t-2}$	46.75	
	(31.59)	
Consideration Index Inception$_{t-2}$	–10.11	
	(7.30)	
Consideration Index Post-Inception$_{t-2}$	–50.81	
	(27.77)	
Blue Pencil Index$_{t-2}$	–56.72	
	(39.52)	
Employer Termination Index$_{t-2}$	6.50	
	(16.10)	
N	6,509,000	6,509,000
R-Sq	0.903	0.898

Notes: Column 1 reports estimates from a regression of Insurer HHI, calculated at the state level from LBD data, on first- and second-lagged NCA laws, while Column 2 reports estimates from the analogous regression with only first-lagged laws. All specifications include fixed effects for county and census division by year. All standard errors are clustered by state. * indicates significance at the 0.05 level.

Robustness to Treatment of Multi-Specialty Practices: Defining markets by specialty involves assumptions about how to treat physicians in multi-specialty practices. For example, when defining a market for orthopedists, how should one treat practices that contain orthopedists as well as radiologists? One approach is to ignore radiologists altogether and only consider the market shares of orthopedists in the geographic market. However, an insurer concerned about the negative consequences of failing to reach an agreement with such a practice may care about the consequences of losing both the orthopedists and the radiologists. Our main specifications calculate HHIs using all physicians in any practice containing at least one physician in a given specialty. In Appendix Table A10, we consider four different possible sets of assumptions about the treatment of multispecialty practices in measuring concentration. The estimates are similar under each alternative assumption tested, though in some cases alternative assumptions increase the coefficient estimates and decrease precision.

Table A10: IV Second Stage Estimates for Alternative MPIER HHI Measures

	Dependent Variable: ln(*Price*)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$HHI_{(t-1)}$	–0.019*	–0.018*	–0.018*	–0.017*	–0.027	–0.027	–0.023	–0.023
	(0.008)	(0.004)	(0.008)	(0.007)	(0.020)	(0.019)	(0.015)	(0.015)
N	3,226,374	2,981,693	2,894,173	2,894,173	2,981,693	2,981,693	2,894,173	2,894,173
CD F-Stat	210.2	600.4	400.5	467.5	100.4	112.7	172.2	172.2
KP F-Stat	382.0	739.0	1295.5	1236.3	344.3	353.3	982.3	982.3

Notes: All specifications include fixed effects for county, census division by year, procedure code (CPT), physician specialty, and facility type. HHI is calculated from establishment sizes in MPIER data, provided by CMS. In column (1) the HHI is measured including all physicians in any group that has at least one member in a given specialty, and assumes physicians with missing addresses are solo establishments. The HHI in column (1) is the one used throughout the paper. The HHI in column (2) is similar to that in column (1), but assumes all physicians in a given market with missing addresses are in the same establishment. In column (3) the HHI is measured including all physicians in any group that has at least one member in a given specialty, drops observations with missing addresses if the same physician has another known address in the same zip code, and assumes all remaining missing addresses are solo establishments. The HHI in column (4) is similar to that in column (3), but assumes all remaining missing addresses in a given market are a single establishment. In column (5) the HHI is measured including only physicians in the given specialty within the market, and assumes physicians with missing addresses are solo establishments. The HHI in column (6) is similar to that in column (5), but assumes all physicians in a given market with missing addresses are in the same establishment. In column (7) the HHI is measured including only physicians in the given specialty within the market, drops observations with missing addresses if the same physician has another known address in the same zip code, and assumes all remaining missing addresses are solo establishments. The HHI in column (8) is similar to that in column (7), but assumes all remaining missing addresses in a given market are a single establishment. All HHIs are scaled to range from 0 to 100, so that a 1 unit change in HHI corresponds to a 100 point change in the typical 10,000 point scale. In each specification, the instruments include all first-lagged (corresponding to the specification in Panel 3 of Table 5). All standard errors clustered by state. * indicates significance at the 0.05 level.

Table A11: First Stage IV Signs by Subsample

	Dependent Variable: ln($Price$)								
	All Counties (1)	Metro Counties (2)	Non-Metro Counties (3)	Primary Care (4)	Non-Surg. Specialists (5)	Positive Law Changes (6)	Negative Law Changes (7)	High HHI (8)	Low HHI (9)
Statutory Index$_{t-1}$				-			-		
Protectible Interest Index$_{t-1}$	+	+			+			+	+
Burden of Proof Index$_{t-1}$	+	+		+	+	+		+	+
Consideration Index Inception$_{t-1}$	-	-	-	-	-			-	
Consideration Index Post-Inception$_{t-1}$	-	-		-	-	-		-	-
Blue Pencil Index$_{t-1}$	+	+		+	-			+	-
Employer Termination Index$_{t-1}$	-	-		-	-	-		-	-

Notes: All estimates are based on the main specification, including fixed effects for county, census division by year, procedure code (CPT), physician specialty, and facility type. '+' and '-' indicate that the coefficient is positive (negative) and statistically significant at the 0.05 level, based on standard errors clustered by state. 'Positive (Negative) Law Changes' includes all observations in states that ever have an increase (decrease) in NCA enforceability Missing indicates non-identified or insignificant coefficients. 'High (Low) HHI' refers to observations with HHI levels above (below) the median level.

Table A12: IV Estimates Excluding Blue Pencil Index

	Dependent Variable: $\ln(Price)_t$
HHI_{t-1}	–0.019*
	(0.006)
N	3,226,374
1st Stage CD F-Stat	266.8
1st Stage KP F-Stat	627.1

Notes: All specifications include fixed effects for county, census division by year, procedure code (CPT), physician specialty, and facility type. Instruments do not include Blue Pencil Index, which is the only index with a positive coefficient in the univariate just-identified first-stage model, as shown in Table 6. HHI is calculated from establishment sizes in MPIER data, provided by CMS. HHI is scaled to range from 0 to 100, so that a 1 unit change in HHI corresponds to a 100 point change in the typical 10,000 point scale. All standard errors are clustered by state. * indicates significance at the 0.05 level.

Table A13: Interactions between Physician and Insurer Concentration

	Dependent Variable: $\ln(Price)_t$					
	(1)	(2)	(3)	(4)	(5)	(6)
		All Counties			Metro Counties	
$Phys\ HHI_{t-1}$	–0.026*	–0.023*	–0.019*	–0.036*	–0.035*	–0.030*
	(0.007)	(0.007)	(0.007)	(0.005)	(0.004)	(0.012)
$Phys\ HHI_{t-1} \times I(Ins\ HHI > 25thPctl)$	0.015			0.015		
	(0.024)			(0.025)		
$Phys\ HHI_{t-1} \times I(Ins\ HHI > 50thPctl)$		0.009			0.010	
		(0.024)			(0.024)	
$Phys\ HHI_{t-1} \times I(Ins\ HHI > 75thPctl)$			0.003			0.007
			(0.023)			(0.026)
N	3,226,374	3,226,374	3,226,374	2,196,206	2,196,206	2,196,206
1st Stage CD F-Stat	114.3	152.2	70.9	80.1	117.7	43.4
1st Stage KP F-Stat	391.0	269.6	51.6	53.7	19.3	4.9

Notes: All specifications include fixed effects for county, census division by year, procedure code (CPT), physician specialty, and facility type. Physician HHIs are calculated from establishment sizes in MPIER data, insurer HHIs are state-level measures in 2007 from the AMA. HHI is scaled to range from 0 to 100, so that a 1 unit change in HHI corresponds to a 100 point change on the typical 10,000 point scale. '25th Pctl' refers to the 25th percentile of the distribution of insurer concentration. All standard errors are clustered by state. * indicates significance at the 0.05 level.

Table A14: Economies of Scale

	Dependent Variable: $\ln(Price)_t$			
	(1)	(2)	(3)	(4)
	All Counties		High Phys. Supply	Low Phys. Supply
Establishment Size	–0.0601*	–0.0906	–0.0963*	–0.0246
	(0.0271)	(0.0662)	(0.0440)	(0.0368)
Establishment Size Sq.		0.0009	0.0006	-0.0004
		(0.0017)	(0.0007)	(0.0007)
N	3,309,697	3,309,697	626,868	2,682,829
1st Stage CD F-Stat	185.2	1.5	1.8	14.1
1st Stage KP F-Stat	3319.0	70.8	754.2	365.3

Notes: All specifications include fixed effects for county, census division by year, procedure code (CPT), physician specialty, and facility type. Establishment sizes are means by county, specialty, year, and facility type. 'Low (High) Phys. Supply' denotes counties with below (above) the mean number of physicians. All standard errors are clustered by state. * indicates significance at the 0.05 level.

Table A15: Effect of Concentration on Prices, by Medical Specialty and Urban Status

	Dependent Variable: $\ln(Price)_t$		
	All Counties (1)	Metro Counties (2)	Non-Metro Counties (3)
	All Physicians		
HHI_{t-1}	–0.019*	–0.031*	–0.005*
	(0.006)	(0.011)	(0.002)
N	3,226,374	2,196,206	1,030,168
1st Stage CD F-Stat	232.4	144.3	182.8
	Primary Care Physicians		
HHI_{t-1}	–0.011*	–0.022*	–0.001
	(0.004)	(0.005)	(0.004)
N	485,962	312,817	173,145
1st Stage CD F-Stat	96.8	55.35	79.3
	Non-Surgical Specialists		
HHI_{t-1}	–0.010	–0.020*	0.001
	(0.005)	(0.006)	(0.002)
N	317,657	243,310	74,347
1st Stage CD F-Stat	99.6	56.3	43.5
	Surgical Specialists		
HHI_{t-1}	–0.002	–0.008	0.004
	(0.016)	(0.015)	(0.014)
N	262,029	183,485	78,544
1st Stage CD F-Stat	36.9	45.8	5.3

Notes: All specifications include fixed effects for county, census division by year, procedure code (CPT), physician specialty, and facility type. HHI is calculated from establishment sizes in MPIER data, provided by CMS. HHI is scaled to range from 0 to 100, so that a 1 unit change in HHI corresponds to a 100 point change in the typical 10,000 point scale. All estimates represent the second stage coefficient on HHI in 2SLS models corresponding to that in Table 5 Panel 3, here for all counties, metro counties, and non-metro counties. The first column of the first panel reproduces the second stage results for all physicians in Table 5, Panel 3. The 'Primary Care Physicians' sample includes primary care MDs (excluding DOs), Internal Medicine, Family Practice, Geriatric Medicine, and Pediatric specialists. The 'Non-Surgical Specialist' sample includes specialists in Proctology, Urology, Dermatology, Cardiovascular Dis/Cardiology, Neurology, Gastroenterology, and Hematology. The 'Surgical Specialist' sample includes specialists in General Surgery, Neurological Surgery, Orthopaedic Surgery, Thoracic Surgery, Anesthesiology, and Radiology. All standard errors are clustered by state. * indicates significance at the 0.05 level.

Robustness to Balanced Panel Restriction: The sample size of the MarketScan price data increases over time. To test whether the imbalance in our panel caused by sample growth affects our baseline results, we re-estimate the model using only the subset of county-specialty pairs for which we have price data in all years of our panel. The IV estimates, shown in Appendix Table A16, are similar in the balanced panel.

Table A16: IV Estimates on Balanced Panel

	Dependent Variable: ln($Price$)
$\text{HHI}_{(t-1)}$	–0.018*
	(0.005)
N	2,418,133
1st Stage CD F-Stat	435.0
1st Stage KP F-Stat	1237.7

Notes: All specifications are the same as in Table 5 panel 3, except the sample includes only observations corresponding to a county-specialty pair that is observed in all 12 years of the panel. All standard errors clustered by state. * indicates significance at the .05 level.

Robustness to Fuzzy Matching Algorithm and Measurement Error:

The association of addresses to practices requires an assumption about the tolerance in the fuzzy matching algorithm. The algorithm allows characters in the addresses to be slightly different, allowing for typographic errors and abbreviations, while forcing numerical elements of the addresses to be exactly identical (that is, street numbers and office numbers must match exactly.) We use the normalized Levenshtein distance as a metric for the distance between all combinations of character subsets of addresses in the same zip code. Appendix Table A17 presents estimates from the main specification by re-calculating HHIs under alternative fuzzy matching thresholds that allow for stricter or more flexible matching of addresses. Smaller distance thresholds result in smaller average establishment sizes by forcing addresses to almost exactly match, while the opposite is true for larger thresholds. The results have very little sensitivity to this tolerance parameter, ranging from –0.019 to –0.020 in all nine specifications.

Table A17: Sensitivity of MPIER Second Stage IV Estimates to Fuzzy Matching Algorithm Parameter

Normalized Levenshtein Distance Threshold	IV Estimate	First Stage KP F-Stat.
0.01	–0.020* (0.006)	213.9
0.05	–0.019* (0.006)	244.6
0.10	–0.019* (0.006)	239.4
0.15	–0.019* (0.006)	229.8
0.20	–0.019* (0.006)	232.4
0.25	–0.020* (0.006)	221.3
0.30	–0.019* (0.005)	233.9
0.35	–0.019* (0.006)	240.2
0.40	–0.019* (0.005)	241.6

Notes: All specifications include fixed effects for county, census division by year, procedure code (CPT), physician specialty, and facility type. IVs are the full set of first and second lags of law components. The normalized Levenshtein Distance equals the minimum number of character insertions, deletions, or substitutions necessary to make two strings equal, divided by the length of the shorter string. The threshold value is the value of the normalized Levenshtein distance below which the character elements of two addresses in the MPIER are assumed to be equivalent. A larger threshold value results in over-estimating the size of establishments, while too low a value in the presence of typographical errors may lead to an underestimate of establishment sizes. The main estimates in the paper are based on a threshold value of 0.20. HHI is calculated from establishment sizes in MPIER data, provided by CMS. HHI is scaled to range from 0 to 100, so that a 1 unit change in HHI corresponds to a 100 point change in the typical 10,000 point scale. All standard errors are clustered by state. * indicates significance at the 0.05 level.

Table A18: Fixed Effects Models of Aggregate Physician Supply

Dependent Variable:	Log Physicians per 100,000 Population	
NCA Index$_t$	-0.027	
	(0.041)	
NCA Index$_{t-1}$	–0.022	–0.043
	(0.045)	(0.030)
Log Per Capita Income	0.156*	0.156*
	(0.030)	(0.030)
N	48,807	48,807
Adj. R Sq.	0.87	0.87

Notes: All specifications are fixed effects models and include county effects and census division by year effects. * indicates significance at the 0.05 level.

Table A19: IV Estimates with Alternative Lag Assumptions

	Dependent Variable: ln($Price$)		
	First Lags	Second Lags	First and Second Lags
	(1)	(2)	(3)
HHI$_{t-1}$	–0.019*	–0.017*	–0.017*
	(0.006)	(0.006)	(0.005)
N	3,226,374	3,226,374	3,226,374

Notes: All specifications are fixed effects models and include county effects, year effects, census division by year effects, procedure code (CPT) effects, physician specialty effects, and facility type effects. HHI is scaled to range from 0 to 100, so that a 1 unit change in HHI corresponds to a 100 point change in the typical 10,000 point scale. All standard errors clustered by state. * Significant at the .05 level.

Table A20: Correlation of Law Changes with State Political and Economic Outcomes

Dependent Variable:	Log Payroll per Worker (1)	Unemployment Rate (2)	Population (3)	Republican Vote Share (4)
Statutory Index$_{t-1}$	–0.010	1.148*	–2183.276*	0.050
	(0.022)	(0.559)	(1073.492)	(0.033)
Protectible Interest Index$_{t-1}$	0.060	–0.636	724.974	–0.037
	(0.078)	(0.785)	(584.068)	(0.044)
Burden of Proof Index$_{t-1}$	0.051	0.762	–139.085	–0.034
	(0.040)	(0.859)	(520.628)	(0.061)
Consideration Index Inception$_{t-1}$	–0.056	0.328	678.706	–0.012
	(0.057)	(1.151)	(970.078)	(0.098)
Consideration Index Post-Inception$_{t-1}$	–0.038	–0.345	–367.454	0.035
	(0.023)	(0.599)	(252.488)	(0.035)
Blue Pencil Index$_{t-1}$	0.009	–0.702	–1485.250*	0.024
	(0.034)	(0.528)	(735.155)	(0.039)
Employer Termination Index$_{t-1}$	–0.119	–0.612	–567.853	–0.057
	(0.061)	(0.778)	(481.806)	(0.065)
N	969	969	969	510
N Clusters	51	51	51	51

Notes: An observation in these regressions is a state-year, and regressions are estimated by OLS with state and year fixed effects. All independent variables are scaled to range from 0 to 1, where 1 is the strongest observed measure of the variable in any state and year in the data. Standard errors are clustered by state. Data are from the Bureau of Labor Statistics (cols. 1 and 2), the Census Bureau (col. 3), and the Federal Election Commission (col. 4: presidential and congressional elections – every two years). Population is measured in thousands. Unemployment rate is measured in percentage points. * indicates significance at the 0.05 level.

Table A21: Correlation of Law Changes with Political and Economic Views in the GSS

Dependent Variable:	Respondent Thinks The Government Should Do Less:		Respondent Thinks We are Spending too Much On:			Respondent Considers Himself:	
	In General (1)	To Help Pay for Medical Care (2)	Urban Issues (3)	Welfare (4)	Nation's Health (5)	A Republican (6)	Satisfied With His Finacial Situation (7)
Statutory Index$_{t-1}$	0.316	0.031	–0.166	–0.102	–0.121	–0.009	–0.297
	(0.177)	(0.120)	(0.257)	(0.322)	(0.155)	(0.169)	(0.216)
Protectible Interest Index$_{t-1}$	–0.026	0.074	–0.427	–0.513	0.021	–0.331	–0.074
	(0.376)	(0.196)	(0.372)	(0.462)	(0.210)	(0.365)	(0.363)
Burden of Proof Index$_{t-1}$	–0.103	–0.031	–0.685	0.394	0.215	–0.141	–0.454
	(0.383)	(0.360)	(0.515)	(0.745)	(0.343)	(0.502)	(0.317)
Consideration Index Inception$_{t-1}$	0.029	–0.092	0.819	–0.164	–0.453	0.463	0.527
	(0.438)	(0.340)	(0.558)	(0.758)	(0.347)	(0.502)	(0.422)
Consideration Index Post-Inception$_{t-1}$	0.144	–0.131	–0.034	0.151	0.546*	–0.062	0.001
	(0.123)	(0.086)	(0.407)	(0.244)	(0.208)	(0.271)	(0.237)
Blue Pencil Index$_{t-1}$	–0.297	0.365	–0.026	–0.121	0.268	–0.297	0.228
	(0.339)	(0.240)	(0.468)	(0.474)	(0.317)	(0.405)	(0.535)
Employer Termination Index$_{t-1}$	0.817	0.738	–0.974	–0.197	0.237	–0.325	0.631
	(0.532)	(0.568)	(0.484)	(0.791)	(0.590)	(0.538)	(1.006)
N	1,026	1,026	1,026	1,026	1,026	1,026	1,026
N Clusters	28	28	28	28	28	28	28

Notes: Regressions are linear probability models in which an observation is a survey respondent in a given year and a positive outcome represents the respondent's agreement with the statement presented in each column. All regressions include state, year, occupation, and industry fixed effects, as well as controls for age, education, marital status, and employment status. All independent variables are scaled to range from 0 to 1, where 1 is the strongest observed measure of the variable in any state and year in the data. Standard errors are clustered by state. Data on political and economic views are taken from the Generalized Social Survey for the years 1993-2010, where data exist (approximately every other year and in only 28 states). * indicates significance at the 0.05 level.

Table A22: NCA Laws and Managed Care Penetration Rates

Dependent Variable: HMO Penetration Rate, 2004	First Lagged Laws (1)	First Lead Laws (2)
Statutory Index	0.188	0.350
	(1.020)	(1.010)
Protectible Interest Index	1.112	1.299
	(1.009)	(1.161)
Burden of Proof Index	–1.050	–1.307
	(0.935)	(1.040)
Consideration Index Inception	0.267	0.219
	(1.066)	(1.042)
Consideration Index Post-Inception	–0.411	–0.287
	(0.635)	(0.604)
Blue Pencil Index	0.445	0.319
	(0.435)	(0.429)
Employer Termination Index	–0.883	–0.942
	(1.191)	(1.252)
N	328	329
R-Sq	0.07	0.07

Notes: Column 1 reports estimates from a regression of HMO penetration rates in 2004 (the only year in our sample period for which data is publicly available by state) on first-lagged NCA laws. Column 2 reports estimates from the same regression but with laws included as a one-period lead. Standard errors are clustered at the state level. * indicates significance at the 0.05 level.

A Appendix Notes to Conceptual Framework: NCA Laws and Practice Organization

These notes elaborate on the mechanics of the conceptual framework presented in Section 3.

Case 1: NCA practice attempts to merge with no-NCA practice.

First, note that if the merger attempt is successful, the location of the indifferent consumer will change.

$$dx/2 = d(\frac{1}{4} - x)$$

$$x = \frac{1}{4(1.5)} = 1/6$$

That is, the indifferent point between the NCA practice and the no-NCA practice (that is not involved in the merger) moves from 1/8 away from the NCA firm to 1/6 away. Therefore the NCA practice gains 1/16 of the total demand along the circle.

If the no-NCA firm has a spinoff, the NCA firm has the same demand as it did before the merger. If the NCA firm has a spinoff, demand is reduced. The expected change in the flow of profits for the NCA practice:

$$\Delta\pi_N = [(1-\epsilon)(1-\epsilon(1-\theta))]\left[\frac{5pD}{16} - \frac{pD}{4} - w_1\left(\frac{5t}{16\overline{K}^{\beta}}\right)^{1/\alpha_1} + w_1\left(\frac{t}{4\overline{K}^{\beta}}\right)^{1/\alpha_1}\right]$$

$$+\epsilon^2(1-\epsilon)\theta) * 0 + [\epsilon(1-\theta)]\left[\frac{pD}{8} - \frac{pD}{4} - w_1\left(\frac{t}{8\overline{K}^{\beta}}\right)^{1/\alpha_1} + w_1\left(\frac{t}{4\overline{K}^{\beta}}\right)^{1/\alpha_1}\right]$$

$$\Delta\pi_N = \frac{pD}{16}\left[1 - 4\epsilon + 3\epsilon\theta + \epsilon^2 - \epsilon^2\theta\right] + [(1-\epsilon)(1-\epsilon(1-\theta))]\, w_1\left(\frac{t}{16\overline{K}^{\beta}}\right)^{1/\alpha_1}\left[4^{1/\alpha_1} - 5^{1/\alpha_1}\right]$$

$$+ [\epsilon(1-\theta)]\, w_1\left(\frac{t}{16\overline{K}^{\beta}}\right)^{1/\alpha_1}\left[4^{1/\alpha_1} - 2^{1/\alpha_1}\right]$$

$$\Delta\pi_N = \frac{pD}{16}\left[1 - 4\epsilon + 3\epsilon\theta + \epsilon^2 - \epsilon^2\theta\right]$$

$$+w_1\left(\frac{t}{16\overline{K}^{\beta}}\right)^{1/\alpha_1}\left[4^{1/\alpha_1}\left(1 - \epsilon + \epsilon^2 - \epsilon^2\theta\right) - 5^{1/\alpha_1}\left(1 - 2\epsilon + \epsilon\theta + \epsilon^2 - \epsilon^2\theta\right) - 2^{1/\alpha_1}\left(\epsilon - \epsilon\theta\right)\right]$$

The expected change in the flow of profits for the no-NCA practice:

$$\Delta\pi_C = [(1-\epsilon)(1-\epsilon(1-\theta))]\left[\frac{5pD}{16} - \frac{pD}{4} - w_0\left(\frac{5t}{16\overline{K}^{\beta}}\right)^{1/\alpha_0} + w_0\left(\frac{t}{4\overline{K}^{\beta}}\right)^{1/\alpha_0}\right]$$

$$+(1-\epsilon)\epsilon(1-\theta)*0+\epsilon\left[\frac{pD}{8}-\frac{pD}{4}-w_0\left(\frac{t}{8\overline{K}^{\beta}}\right)^{1/\alpha_0}+w_0\left(\frac{t}{4\overline{K}^{\beta}}\right)^{1/\alpha_0}\right]$$

$$\frac{\partial\Delta\pi_C}{\partial\theta}>0$$

Case 2: The two practices with NCAs merge
The problem is symmetric, so we just need to solve one practice's change in profits.

If the merger is successful, the indifferent consumer will again be located $x = 1/6$ away from the NCA practice, this time on each side of the NCA practice. The total gain in market share for each of the NCA practices is 1/8 of the total demand along the circle.

The expected change in the flow of profits is:

$$\Delta\pi_N=\left[(1-\epsilon+\epsilon\theta)^2\right]\left[\frac{3pD}{8}-\frac{pD}{4}-w_1\left(\frac{3t}{8\overline{K}^{\beta}}\right)^{1/\alpha_1}+w_1\left(\frac{t}{4\overline{K}^{\beta}}\right)^{1/\alpha_1}\right]$$

$$+(1-\epsilon+\epsilon\theta)(\epsilon(1-\theta))*0+[\epsilon(1-\theta)]\left[\frac{pD}{8}-\frac{pD}{4}-w_1\left(\frac{t}{8\overline{K}^{\beta}}\right)^{1/\alpha_1}+w_1\left(\frac{t}{4\overline{K}^{\beta}}\right)^{1/\alpha_1}\right]$$

The expected increase in profits from the merger is larger, so the additional profits from the merger are more likely to exceed M. Again, $\frac{\partial\Delta\pi_N}{\partial\theta}>0$, so there is a range of values for M and times t for which an increase in θ will cause practices to merge. The merger can still happen even if only one practice uses NCAs, but it is more likely to occur between practices that both use NCAs.

B Bargaining Model

We model bargaining between physician groups and insurers following the setup of Ho and Lee (2016). The purpose of the model is to derive a relationship between negotiated prices and firm sizes under a set of plausible assumptions, and clarify how our empirical estimates can provide bounds on the underlying theoretical parameters. The market consists of a set of physician groups j and insurers i. Enrollees in insurance plan i can only visit a physician that is in the insurer's network, where the network is denoted by $\mathcal{G}_i \subseteq \{0,1\}^{i\times j}$. Similarly, $\mathcal{G}_j$ is the set of insurers with whom physician group j has contracted to be included in the network.

In each period of the model the following events take place. First, insurers and physician groups conduct simultaneous bilateral bargains over capitated prices p_{ij}, which are private knowledge of the negotiating parties.[24] Simultaneously with bargaining, insurers set profit-maximizing uniform premiums ϕ_i. Next, consumers form willingnesses to pay for insurance plans based on premiums and physician access in the network, measured by the amount of time a patient has to wait to get an appointment, $w_i(\phi_i, \mathcal{G})$, which depends on plan enrollment (and therefore plan premiums) and the size of the provider network. Finally, consumers probabilistically get sick and derive utility from being treated by a physician, and disutility from waiting for an appointment.

There are several simplifying assumptions about consumer choices. First, consumers are assumed to be incapable of discerning physician quality; they view physicians as homogeneous and value networks insofar as they differ in access. This assumption is made due to data limitations. In the hospital setting it is possible to obtain data on input choices for each hospital in a given market, which can allow researchers to estimate cost functions directly and model latent quality differences through fixed hospital effects (see Ho and Lee, 2016.) In physician markets there are no known similar data on the input choices of every physician office in a market, so the same estimation approach cannot be used. Second, we assume that insurers set uniform copayments. As a result, consumers are not directly affected by negotiated prices between physicians and insurers, although prices may have indirect effects on consumers through premiums or wait times. We abstract from specialties, but in the empirical estimates we consider each physician specialty to be a distinct market. The remaining model assumptions are similar to those made in models of hospital bargaining, such as Ho and Lee (2016) and Gowrisankaran et al. (2013).

The profit function of insurer i is:

$$\pi_i(\mathbf{p}, \mathcal{G}) = D_i(w_i, \phi)\phi_i - \sum_{r\in\mathcal{G}_i} D_{ir}(w_i, \phi)p_{ir}$$

where D_i represents the number of enrollees in insurance plan i, which depends on wait times $w_i(\phi_i, \mathcal{G})$ in network i, and D_{ij} is the number of enrollees in plan i who visit physician

[24] In reality many contracts are capitated, but for other contracts a capitated payment is conceptually similar to an average price for an expected bundle of services.

group j.[25] The profits of physician group j are similarly:

$$\pi_j(\mathbf{p}, \mathcal{G}) = \sum_{s \in \mathcal{G}_j} D_{sj}(w_i, \phi)(p_{sj} - c_j)$$

which equals the sum of enrollees D_{sj} over all insurers in the network of physician group j times the negotiated price p_{sj} minus c_j, the average per-patient cost for physician group j.

Prices are negotiated through simultaneous bilateral Nash bargains, where p_{ij} solves:

$$p_{ij} = \arg\max_{p_{ij}} \left[\pi_i(\mathbf{p}, \mathcal{G}) - \pi_i(\mathbf{p}_{-ij}, \mathcal{G} \backslash ij)\right]^{\tau_i} \times \left[\pi_j(\mathbf{p}, \mathcal{G}) - \pi_j(\mathbf{p}_{-ij}, \mathcal{G} \backslash ij)\right]^{\tau_j} \quad \forall\ ij \in \mathcal{G}$$

where $\pi_i(\mathbf{p}_{-ij}, \mathcal{G} \backslash ij)$ represents the disagreement profits of insurer i if they fail to reach an agreement over network inclusion with physician group j, and similarly $\pi_j(\mathbf{p}_{-ij}, \mathcal{G} \backslash ij)$ are the disagreement profits of physician group j. τ_i and τ_j are the bargaining power parameters of the insurer and physician group.

The first order condition of the bargaining problem simplifies to:

$$\begin{aligned}
\underbrace{p^{\star}_{ij} D_{ij}}_{\text{Physician Group Revenue}} &= \tau_j \left[\underbrace{\phi_i \left(D_i - D_{i-j}\right)}_{\Delta\text{Insurer Revenue}} - \underbrace{\left(\sum_{h \in \mathcal{G}_i \backslash ij} p^{\star}_{ih} \left(D_{ih} - D_{ih-j}\right) \right)}_{\Delta\text{Insurer } i \text{ Payments to Other Physicians}} \right] \\
&+ \tau_i \left[\underbrace{c_j D_{ij}}_{\text{Average Cost}} - \underbrace{\left(\sum_{n \in \mathcal{G}_j \backslash ij} \left(p^{\star}_{nj} - c_j\right) \left(D_{nj} - D_{nj-i}\right) \right)}_{\Delta\text{Physician Group } j \text{ Profits from Other Insurers}} \right] + \varepsilon_{ij} \quad (5)
\end{aligned}$$

where D_{i-j} is the number of enrollees in plan i if there is disagreement between i and j. The second term equals the additional payments that the insurer will have to make to other physician groups if group j is not included in the network, which is negative. $D_{ih} - D_{ih-j}$ is the effect of disagreement between insurer i and group j on the number of consumers in plan i who visit another group h, where $h \neq j$. The third term is the average cost to group j of treating an enrollee. The fourth term is the effect of disagreement between plan i and group j on the profits of group j from other insurers, which is negative. And ε_{ij} represents *iid* cost shocks.

Conditional on getting sick, consumer k derives utility from visiting a physician j in network i, which we assume takes the form:

$$u_{kij} = \eta_k + \frac{1}{w_{ij}}$$

[25] More precisely ϕ_i can be thought of as the premium for plan i net of any per-capita non-medical costs of running the plan.

where in equilibrium wait times will be equal within any network, so that $w_{ij} = w_i$. The average wait time for an enrollee who gets sick in network i is:

$$w_i = \beta \frac{\sum_{r\in\mathcal{G}_{i\times j}} \gamma N_i}{\sum_{r\in\mathcal{G}_{i\times j}} |P_j|}$$

where N_i is the number of enrollees in insurance plan i, γ is the probability of getting sick, $|P_j|$ is the size of physician group j, and $\mathcal{G}_{i\times j}$ denotes the connected subset of $\mathcal{G}$ that contains all insurers and physician groups that have any nodes in common with the networks $\mathcal{G}_i$ or $\mathcal{G}_j$. For an insurer i with an exclusive network of physicians that do not participate in other networks, this subset is simply $\mathcal{G}_i$.

As in Capps, Dranove, and Satterthwaite (2003) we consider willingness to pay (WTP) as a measure of the surplus that consumer k would lose if a given physician group were to leave the network. A consumer's change in utility caused by physician group j exiting the network is:

$$\Delta\text{WTP}_{kij} = u_{kij} \mid_{j\in\mathcal{G}_i} - u_{kij} \mid_{j\notin\mathcal{G}_i}$$

Each consumer's ex ante WTP is then $\gamma\Delta u_{kij}$. We express the WTP by the insurer for participation of group j in the network, which affects the premium charged by insurer i, as a constant proportion ξ of the average consumer surplus:

$$\Delta\text{WTP}_{ij} = \frac{\sum_k \Delta\text{WTP}_{kij}}{N_i}\xi = \frac{|P_j|}{\beta\gamma\sum_{r\in\mathcal{G}_{i\times j}} N_i}\xi$$

As a result $\frac{\partial\text{WTP}_{ij}}{\partial|P_j|} > 0$ since premiums reflect consumers' WTP. Also $\frac{\partial p^\star_{ih}\left(D_{ih}-D_{ih-j}\right)}{\partial|P_j|} < 0$, so the second term of Equation 5 gets increasingly negative as practice size increases, since the number of consumers who visit other physician groups increases when a larger group exits the network. The fourth term is also increasing with group size. If a plan fails to agree with a larger group, equalization of wait times implies the group will attract more consumers from other plans. Therefore the sum of the first, second, and fourth terms in Equation 5 cause prices to increase with group size. However, the cost function potentially opposes this effect. Without making assumptions, it is plausible that there are economies of scale, and that average costs (the third term) are declining in group size. In this case the sign of the aggregate effect of group size on negotiated prices is ambiguous.

To construct an empirical analogue of the FOC, suppose in disagreement the potential consumers of group j are distributed proportionally among the other physicians in the network. Then:

$$\begin{aligned} p^\star_{ij} &= a + |P_j|\,\tau_j\xi + \sum_{h\in\mathcal{G}_i\setminus ij} \tau_j p^\star_{ih}\frac{D_{ih}}{D_{ij}}\left(1+\frac{|P_h|}{|\mathcal{G}_i|-|P_j|}\right) + \tau_i c_j(|P_j|) \\ &+ \sum_{n\in\mathcal{G}_j\setminus ij} \tau_i\left(p^\star_{nj}-c_j\right)\frac{D_{nj}}{D_{ij}}\left(\frac{|P_j|}{|\mathcal{G}_i|-|P_j|}-\frac{|P_j|}{|\mathcal{G}_i|}\right) + \epsilon_{ij} \qquad (6) \end{aligned}$$

This gives the equilibrium negotiated price, plugging the WTP values from the utility function into Equation 5. The negotiated price depends on the bargaining power parameters, physician group sizes, and the number of physicians in insurer i's network, $|\mathcal{G}_i|$, conditional on agreement with group j. Given the theoretical ambiguous effect of $|P_j|$ on $p^\star_{ij}$, it is an empirical exercise to determine this relationship.

B.1 Empirical Implementation

In our empirical setting we cannot estimate Equation 6 directly because we do not observe the bargaining parameters or practice-level demand. Instead we consider the combined impact of physician practice sizes on negotiated prices through two aggregated components: the value of including practice j in the network of insurer i, and the cost function of practice j:

$$p_{ij}^{\star} \equiv a + \beta_1 \times \text{Network Value}_j(|P_j|) + \tau_i \times \text{Average Cost}_j(|P_j|) + \epsilon_{ij} \tag{7}$$

where Network $\text{Value}_j(|P_j|)$ is defined by the sum of the first, second, third, and fifth terms in Equation 6, and β_1 captures the average effect of practice size on prices through network value. Average $\text{Cost}_j(|P_j|)$ is the fourth term, which has coefficient τ_i according to Equation 6.

There are several further adjustments to the model that must be made given our empirical setting and data. First, since we do not observe costs, what we can actually identify is an aggregate coefficient that combines β_1 and τ_i. Second, Equation 7 represents a specific market, where markets may be defined by a combination of geography, physician specialty, and time. In our analyses we use data from many markets, while controlling for latent market-specific variation. Finally, we do not observe the negotiated price for each practice; we only know the average price across all practices in a market.

The empirical analogue of the structural model we consider is thus:

$$\overline{p_{mpct}^{\star}} = \alpha + \beta_2 ES_{mct} + \beta_3 FS_{mct} + \eta_m + \pi_p + \gamma_c + \nu_{d(c)t} + \varepsilon_{mpct} \tag{8}$$

where ES_{mct} measures establishment sizes in specialty market m, county c, and year t; FS_{mct} measures firm sizes; and β_2 and β_3 represent effects of changes in each of the practice size measures on average negotiated prices. This specification allows the derivative of costs with respect to firm size to differentially affect prices depending on whether firm growth occurs within or across establishments. The equation includes controls for latent heterogeneity across services through medical specialty effects, η_m, and procedure code effects, π_p; across space through geographic effects, γ_c, for which we consider a variety of potential market definitions; and over time through census-division-by-year effects, $\nu_{d(c)t}$, which nest year effects while allowing prices to change arbitrarily over time across census divisions.

Given the limitations of the empirical model relative to the structural analogue, it is worth questioning whether the parameters are nevertheless useful for understanding the extent to which larger practice sizes may lead to higher prices by increasing the network value of the practice. In general they may not be very informative, since both β_2 and β_3 identify combinations of the effects of changes in average costs and network value, without separately identifying either parameter of interest. However, the estimates turn out to be informative in our setting because we find an important sign difference: $\beta_2 < 0$ while $\beta_3 > 0$. This combination of results implies lower bounds on both the network value parameter β_1 and the cost function parameter τ_i.

To understand why this result is informative, consider a hypothetical merger between two nearby physician practices that remain physically distinct after the merger but minimize costs jointly and negotiate with insurers jointly. The network value of the combined firm cannot decline, because otherwise the firm would prefer to negotiate separately by establishment, an option still within the choice set. Similarly, average costs cannot increase, since minimizing costs separately by establishment is still within the choice set. After the merger, there is no change in ES since the establishments remain distinct, but FS increases. If the merger were to increase negotiated prices, $\beta_3 > 0$, this would imply that the true effect of the merger on network value is at least as large as β_3, since τ_i is non-positive in this case.

Conversely, suppose the same two nearby firms merge and physically consolidate into a single establishment. In this case the change in FS is the same as in the case above, but ES now also increases. In our theoretical model, the network value of the post-merger firm depends on the total number of doctors (not on physical consolidation) and is thus the same as in the case above. A finding of $\beta_3 > 0$, then, suggests the effect of the merger on prices due to network value will also be positive in this case. However, a cost-reducing physical consolidation could put downward pressure on negotiated prices. If this merger were to generate a decrease in prices the implication would be that the average cost effect of τ_i dominates any change in network value, implying that β_2 is a lower bound estimate of τ_i.

In our empirical analyses we estimate an aggregated version of this model using establishment sizes from the MPIER data and firm sizes calculated by linking multi-establishment practices together using IRS tax IDs. Our finding that $\widehat{\beta_2} < 0$ and $\widehat{\beta_3} > 0$ suggests insurers extract the efficiency gains from larger establishments in the form of lower prices, but multi-establishment consolidation yields efficiency gains that are smaller than the effects on network value, causing negotiated prices to increase. This model aims to facilitate the interpretation of these empirical parameters as lower bound estimates of τ_i and β_1, the parameters of interest.