Appendix: For Online Publication

Table A1: Fixed Effects Models: Prices Charged by Practices that Use NCAs

	(1)		(2)		(3)	
	β	SE	β	SE	β	SE
NCA	-1.70	[4.52]	1.89	[8.24]		
Bishara Score*NCA					1.75	[11.77]
Office-Based	13.24	[10.61]	3.68	[20.16]	3.61	[20.20]
Free-Standing Practice	-7.46	[14.65]	-29.24	[25.69]	-29.33	[25.70]
University Practice	47.73	[38.09]	41.58	[57.59]	41.94	[57.06]
Large Practice (25+)	-5.14	[5.60]	-6.43	[11.05]	-6.39	[11.08]
Multi-Specialty Practice	0.74	[5.35]	4.68	[9.64]	4.90	[9.53]
Part Owner	-8.49*	[4.58]	-9.12	[7.73]	-8.95	[7.75]
Independent Contractor	6.16	[12.51]	-3.83	[15.29]	-3.63	[15.40]
Internal Medicine	10.30*	[6.14]	7.53	[11.39]	7.49	[11.39]
Pediatrics	-2.39	[4.77]	-4.88	[8.10]	-4.94	[8.03]
Secondary Specialty	26.17***	[6.37]	31.33***	[9.87]	31.26***	[9.88]
US Med. School	15.10***	[5.56]	17.59*	[9.09]	17.53*	[9.10]
Male	-2.04	[4.69]	-2.96	[7.98]	-3.04	[7.99]
Job Tenure	-0.50	[0.36]	-0.84	[0.64]	-0.84	[0.64]
Experience	0.09	[0.38]	0.42	[0.65]	0.41	[0.65]
County Effects	Yes		No		No	
Primary Care Market Effects	No		Yes		Yes	
R Sq.	0.34		0.60		0.60	
N	659		659		659	

Notes: Dependent variable is the reimbursement rate for privately-insured patient. The survey question was worded: 'On average, what is your net fee after discount for an initial office visit with a private, commercially-insured patient?' Model 1 includes county effects, and Models 2 and 3 include Primary Care Service Area (PCSA) market effects from the Dartmouth Atlas of Health Care. PCSAs market definitions are calculated based on patient travel patterns for primary care services. All models also include race indicators. Standard errors in brackets are heteroskedasticity-adjusted. * $p < 0.10$, ** $p < 0.05$, *** $p < .01$.

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).

Table A3: Bishara (2011) Summary of State Restrictiveness of Non-Compete Agreements

	California	Georgia	Illinois	Pennsylvania	Texas
Average Total Score	31	285	430	365	350
State Rank*	50	43	4	23	32
Q1	10	30	50	50	80
Q2	10	70	70	70	80
Q3	5	25	30	20	35
Q3(a)	0	50	50	50	20
Q3(b&c)	0	50	50	25	15
Q4	0	0	90	80	60
Q8	0	60	90	70	60

Note: *Out of 51, including D.C.. 1 is the most restrictive.
Source: Bishara (2011). See Table A2 for explanation of question numbers.

Table A4: Fixed Effects Models of Aggregate Physician Supply

Dependent Variable:	Log Physicians per 100,000 Population	
Bishara Score	-0.055	
	(0.036)	
Lagged Bishara Score	0.012	0.030
	(0.041)	(0.028)
Log Per Capita Income	0.149*	0.149*
	(0.030)	(0.030)
N	48,881	48,881
Adj. R Sq.	0.87	0.87

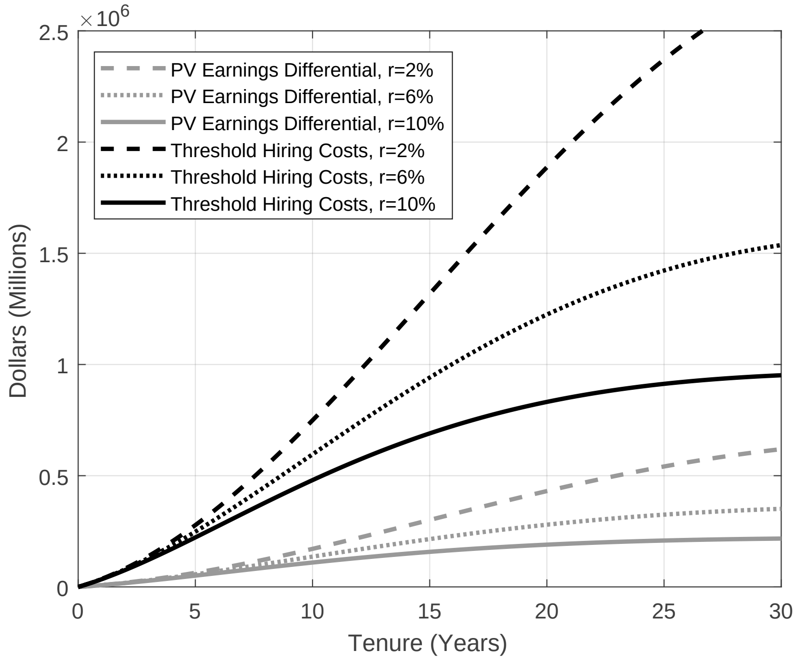
Notes: All specifications are fixed effects models and include county effects and year effects. Robust standard errors reported. Number of physicians per county measured using CMS MPIER file from 1996-2007. Bishara Scores measured in every state year from 1996-2007 using data from Hausman and Lavetti (2016). * indicates significance at the 0.05 level.

Table A5: Fixed Effects Wage Models

	(1)			(2)			(3)		
	Dep Var: Log Hourly Earnings						Dep Var: Log Annual Earnings		
	β		SE	β		SE	β		SE
NCA	0.125	**	[0.061]	1.059	***	[0.407]	−1.309	**	[0.593]
NCA*Log Exp.				−0.389	**	[0.151]	1.346	***	[0.507]
Bishara Score*NCA				−1.377	**	[0.533]			
Bishara Score*NCA*Log Exp				0.587	***	[0.198]			
NCA*Log Exp. Sq.							−0.289	***	[0.106]
Office-Based	−0.128		[0.078]	−0.139	*	[0.079]	−0.135	*	[0.078]
Free-Standing Practice	−0.151		[0.227]	−0.170		[0.230]	−0.147		[0.230]
University Practice	0.111		[0.159]	0.087		[0.157]	0.099		[0.154]
Multi-Specialty Practice	0.029		[0.063]	0.030		[0.063]	0.032		[0.062]
Small Practice (1-3)	0.012		[0.066]	0.021		[0.065]	0.018		[0.065]
Part Owner	0.086		[0.062]	0.079		[0.061]	0.095		[0.062]
Sole Owner	−0.112		[0.097]	−0.122		[0.097]	−0.131		[0.097]
Independent Contractor	−0.036		[0.156]	−0.059		[0.152]	−0.055		[0.154]
Patients per Week	0.001	**	[0.001]	0.001	*	[0.001]	0.001	**	[0.001]
Internal Medicine	0.055		[0.080]	0.045		[0.080]	0.062		[0.080]
Pediatrics	0.054		[0.071]	0.043		[0.071]	0.050		[0.071]
Secondary Specialty	0.054		[0.081]	0.040		[0.082]	0.041		[0.082]
Male	0.115	*	[0.068]	0.117	*	[0.067]	0.129	*	[0.066]
US Med. School	−0.041		[0.102]	−0.037		[0.102]	−0.036		[0.102]
Log Tenure	0.242	*	[0.140]	0.234	*	[0.139]	0.257	*	[0.140]
Log Tenure Sq.	−0.042		[0.037]	−0.038		[0.037]	−0.048		[0.037]
Log Exp.	0.210		[0.231]	0.199		[0.255]	−0.674		[0.462]
Log Exp. Sq	−0.047		[0.052]	−0.041		[0.054]	0.133		[0.097]
R Sq.	0.508			0.519			0.516		
N	894			894			894		

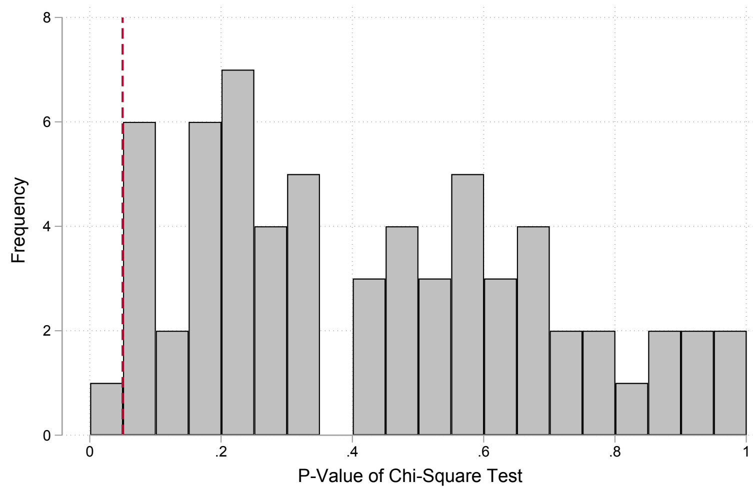
Notes: All models include Primary Care Service Area market effects, as defined by the Dartmouth Atlas of Health Care. Sample includes physicians who reported between 200 and 4000 annual hours worked and are less than 65 years old. White-Huber standard errors in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < .01$

Figure A1: Is Preventing Turnover the Primary Explanation for NCA Use?



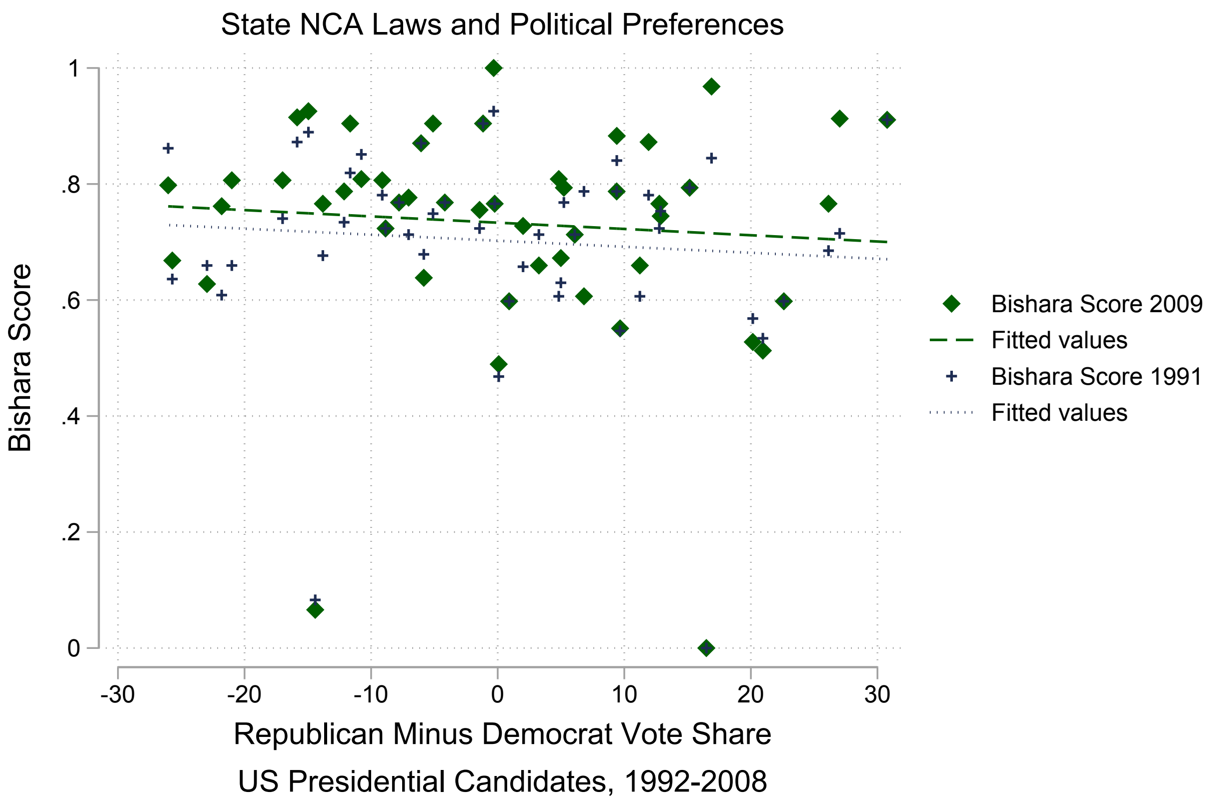
Notes: 'Present Value of Earnings Differential' calculated by integrating over the difference in the predicted wage-tenure profiles shown in Figure 1, discounted at the corresponding interest rates shown. 'Threshold Hiring Costs' are the minimum costs to the firm of recruiting one additional worker that are implied by the wage and job-spell length differences associated with NCA use, if job turnover were the only explanation why firms use NCAs. The calculations come from the 'PV of Earnings Differentials' combined with the job-spell duration effects predicted by Model 2 in Table 11.

Figure A2: Tests of Differences in Responses to Clinical Questions:
Comparison of Physicians With and Without NCAs



Notes: Graph is a histogram of the p-values of chi-square tests of the null hypothesis that physicians with NCAs gave the same responses to the corresponding vignette question as physicians without NCAs. Samples include physicians with 15 of fewer years of experience. The vertical red line corresponds to cutoff of p-values below 0.05. Vignette questions were designed by clinical consultants and pre-tested with a clinical panel.

Figure A3: State NCA Laws and Political Preferences



Notes: Data points are Bishara Scores normalized such that the highest value, Florida in 2009, equals 1. The horizontal axis measures the difference between the percentage of voters in the corresponding state that voted for the Republican Party presidential candidate minus the share that voted for the Democrat Party candidate, averaged over the five elections between 1992 and 2008. 'Fitted Values' shows the predicted equation from an OLS regression of the Bishara Score on vote shares. The slope coefficient is -0.059 with a standard error of 0.097 in 1991, and -0.061 with a standard error of 0.106 in 2009.

Table A6: NCAs and Conditional Revenue Generated
Dependent Variable: Revenue Generated per Hour

	Coef.	SE
NCA	79.75	[60.15]
Owner	30.66	[44.37]
Owner*NCA	-41.37	[66.75]
Internal Medicine	-23.82	[39.96]
Pediatrics	21.27	[34.29]
Secondary Specialty	49.27	[36.59]
Office-Based	21.60	[75.54]
Free-Standing Practice	-1.69	[101.94]
University Practice	-67.54	[125.97]
Multi-Specialty Practice	-3.72	[31.28]
Independent Contractor	-134.33	[107.60]
Potential Experience	-10.98	[7.39]
Potential Experience Sq.	0.24	[0.18]
Job Tenure	7.32	[6.63]
Job Tenure Sq.	-0.23	[0.21]
Male	-8.52	[35.63]
US Med. School	-74.50**	[35.83]
R Sq.	0.71	
N	473	

Notes: Dependent variable is revenue per hour of patient care. Revenue is calculated by multiplying the number of weekly privately-insured patient visits by the reported average prices based on responses to the question: 'On average, what is your net fee after discount for an initial office visit with a private, commercially-insured patient?', plus the number of patient-visits covered by Medicaid multiplied by a state-level index of reimbursement rates for a standard bundle of primary care services based on data from Zuckerman et al (2009), plus the number of patient-visits covered by Medicare times the reimbursement rate in the relevant geographic area for CPT code 99214. Model 1 is OLS, Model 2 is a fixed effects model with Primary Care Service Area market effects, as defined by the Dartmouth Atlas of Health Care. Sample includes physicians who reported between 200 and 4000 annual hours worked and are less than 65 years old. White-Huber standard errors in brackets. * $p < 0.10$, ** $p < 0.05$.

Table A7: Can Altruism Explain Variation in Compensation Contracts?

Dep Var:	Share of Earnings from Individual Production				
	Employed Physicians			Part-Owners	
NCA	0.185***	0.182***	0.161*	0.030	-0.075
	[0.039]	[0.047]	[0.091]	[0.047]	[0.091]
Percent Charity Main Practice		-0.222	-0.485	0.191	-1.931
		[0.170]	[0.319]	[0.809]	[1.283]
Any Charity Outside Practice		-0.003	0.209	-0.125	-0.068
		[0.060]	[0.155]	[0.096]	[0.175]
Hours of Charity Outside Practice		-0.004**	-0.008*	0.006	0.006
		[0.002]	[0.004]	[0.011]	[0.019]
Control Variables:	No	Yes	Yes	Yes	Yes
State Effects:	Yes	Yes	No	Yes	No
PCSA Effects:	No	No	Yes	No	Yes
R Sq.	0.047	0.180	0.746	0.152	0.738
N	459	375	375	325	325

Notes: Dependent variable is the share of earnings that are based directly on a physician's individual productivity. Column 1 is a univariate regression without any controls. Columns 2 through 5 also include controls for specialty, practice setting, practice size, employed spouse, US medical school graduate, experience, experience squared, gender, county median household income, and county population. Sample includes physicians who reported between 200 and 4000 annual hours worked and are less than 65 years old. White-Huber standard errors in brackets. $*p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

NCA Use Conditional on Selection into Group Practice

To show heterogeneity in the characteristics of practices that choose to impose NCAs, it may also be informative to consider the joint decision whether to join a group practice, since NCAs are only used in group practices. We model the pair of decisions using a bivariate probit model to account for sample selection. The selection equation for entering a group practice or hospital is a probit model:

$$g_i = z_i\gamma + u_i$$

where g_i equals 1 if physician i chooses a group practice and 0 if they choose a solo practice, and z_i is a vector of physician and market characteristics, and the decision to accept an NCA as:

$$N_i = x_i\beta + \varepsilon_i$$

where N_i equals 1 if physician i accepts an NCA and x_i contains observable characteristics of the group practice, the geographic market, and physician i. The reason for estimating the equations simultaneously is that u_i may be correlated with ε_i. For example, latent preferences for geographic mobility could affect both the decision to start a solo practice and the costs associated with accepting an NCA.

The selection equation is fully observed in that we have complete information for the entire sample, but the NCA equation exhibits incidental truncation since we do not know whether physicians in solo practices would have accepted NCAs if they had instead chosen to work in a group practice. The log-likelihood function is:

$$\begin{aligned}\log L &= \sum_{i=1}^{N}\{g_iN_i\ln\Phi_2(z_i\gamma, x_i\beta;\rho) + g_i(1-N_i)\ln[\Phi_1(x_i\beta) - \Phi_2(z_i\gamma, x_i\beta;\rho)]\\ &+ (1-g_i)\ln\Phi_1(-x_i\beta)\}\end{aligned}$$

where Φ_1 is the distribution of ε_i and Φ_2 is the bivariate normal distribution of (ε_i, u_i). Identification comes primarily from two exclusion restrictions. The selection equation includes a geographic index of the overhead costs associated with operating a physician practice, which is excluded from the NCA equation. This index affects the incentive to share overhead costs across a group. The NCA model includes characteristics of the group practice, which are excluded from the selection equation.

Table A8 presents estimates of the marginal effects of observed characteristics on the probability of accepting an NCA, conditional on selection into a group practice. To be clear, these estimates are intended only as stylized summary statistics that describe patterns of NCA usage, while accounting for correlation with the decision to enter a group practice. We find that physician, practice, and market characteristics are strongly predictive of NCA use. Estimates in column 1 suggest that physicians in office-based practices are about 18 percentage points more likely to have NCAs, while those in free-standing clinics and university practices are about 22 and 18 percentage points less likely, respectively. Part owners are also about 12 percentage points less likely to have NCAs. Physicians who are likely to be less mobile for observable reasons, such as having an employed spouse, are also less likely to be bound by NCAs.

In column 3 we include the Bishara Score and find that it is strongly predictive—an

Table A8: Bivariate Probit Model with Sample Selection: Determinants of NCA Usage

Dependent Variable: Non-Compete Agreement

	(1)		(2)		(3)	
	$(dy/dx\|s=1)$	SE	$(dy/dx\|s=1)$	SE	$(dy/dx\|s=1)$	SE
Bishara Score					0.322***	[0.069]
Office-Based	0.180***	[0.037]	0.185***	[0.037]	0.179***	[0.037]
Free-Standing Practice	-0.214*	[0.123]	-0.200	[0.127]	-0.213*	[0.122]
University Practice	-0.187***	[0.058]	-0.185***	[0.058]	-0.183***	[0.058]
Multi-Specialty Practice	0.038	[0.036]	0.035	[0.035]	0.040	[0.035]
Large Practice (25 Plus)	0.021	[0.042]	0.013	[0.042]	0.018	[0.042]
Part Owner	-0.122***	[0.032]	-0.164*	[0.090]	-0.122***	[0.032]
Independent Contractor	-0.208***	[0.053]	-0.198***	[0.054]	-0.208***	[0.053]
Internal Medicine	0.052	[0.040]	0.057	[0.040]	0.054	[0.040]
Pediatrics	0.056	[0.035]	0.055	[0.035]	0.060*	[0.035]
Secondary Specialty	0.059	[0.038]	0.056	[0.038]	0.064*	[0.038]
Plan to Retire	-0.218**	[0.087]	-0.203**	[0.091]	-0.223***	[0.085]
Male	0.006	[0.033]	0.007	[0.033]	0.006	[0.033]
Employed Spouse	-0.072**	[0.031]	-0.071**	[0.031]	-0.072**	[0.031]
US Med. School	0.046	[0.046]	0.049	[0.046]	0.053	[0.045]
Median HH Income	0.029	[0.178]	0.096	[0.180]	0.021	[0.171]
Poverty Rate	-0.004	[0.011]	-0.003	[0.011]	-0.005	[0.010]
Unemployment Rate	-0.052**	[0.026]	-0.049*	[0.025]	-0.056**	[0.026]
State PA	0.115	[0.091]	0.117	[0.108]		
State CA	-0.182***	[0.071]	-0.251***	[0.082]		
State TX	0.038	[0.074]	0.082	[0.091]		
State IL	0.093	[0.081]	0.070	[0.099]		
Log Potential Experience	-0.015	[0.009]	-0.016*	[0.009]	-0.014	[0.009]
Log Potential Experience Sq.	0.001*	[0.000]	0.001*	[0.000]	0.001*	[0.000]
Adult Uninsured Rate	-0.005	[0.006]	-0.006	[0.006]	-0.007*	[0.004]
% Employed in Agriculture	0.014*	[0.008]	0.014*	[0.008]	0.014*	[0.008]
% Employed in Construction	0.027	[0.016]	0.028*	[0.016]	0.029*	[0.015]
% White Collar Jobs	-0.004	[0.005]	-0.003	[0.005]	-0.004	[0.005]
State PA*Part Owner			-0.052	[0.119]		
State CA*Part Owner			0.186	[0.119]		
State TX*Part Owner			-0.065	[0.109]		
State IL*Part Owner			0.067	[0.130]		
Log Likelihood	-1596.41		-1590.71		-1604.95	
Log Likelihood under Null of No Selection Bias	-1601.49		-1594.79		-1607.53	
p-value of LR Test	0.001		0.004		0.023	
N	1677		1677		1677	

Notes: Marginal effects at means reported conditional on selection into a group practice. Selection model, not shown, includes a geographic physician practice cost index (GPCI), and its squared value. GPCI is calculated by the US GAO to estimate geographic variation in the cost of operating a private medical practice to set Medicare reimbursement rates. The group practice equations exclude GPCI, and include group practice characteristics, which are excluded from the selection equations. All models also include cubic function of county population, and physician race. Standard errors are in brackets. * $p < 0.10$, ** $p < 0.05$, *** $p < .01$.

increase in enforceability from the least restrictive state (ND) to the most restrictive state (FL) is associated with a 30 percentage point increase in the probability that a physician will have an NCA. This suggests that firms consider state laws to be important factors in calculating the expected benefits to imposing NCAs. It is still possible that some firms use unenforceable NCAs simply as threats. This may explain why about 30% of employed physicians in CA have NCAs despite their lack of enforceability in the state. Selection into NCAs also appears to be related to the decision whether to start a solo practice or join a group practice. The p-values of an LR test of no selection, shown in Table A8, range from 0.01 to 0.09 in the three models shown.

Model Appendix with Proofs

Our goals in this section are (1) to articulate an example of a theoretical model in which physician practices value NCAs because they prevent patients from being poached, (2) to use the predictions from the model to motivate the intuition behind our empirical analyses.

The model is simplified to include only necessary features for motivating our analyses, and abstracts from potentially interesting extensions such as the structure of firms or the role of physical capital. However, the model does incorporate important legal constraints discussed above in Section 2.3 by prohibiting compensation contracts that may potentially be interpreted as including an implicit or explicit purchase or sale of patient referrals. Without these features, which may be unique to medical professionals, the model could be adapted to generate different predictions in alternative settings.

6.1 Basic Model Setup

We consider a two-period model of a firm owned by a physician proprietor, indexed by a, who is endowed with P patients, which she can treat to generate revenue

$$Y = f(P)$$

where f is assumed to satisfy: $f(0) = 0$, $f'(P) > 0$, and $f''(P) < 0$. The strictly concave production function f can be interpreted as the monetary equivalent of the utility the owner would receive by treating the patients, net of any utility lost to providing the effort and time required to treat the patients.

Alternatively, the owner could hire a worker physician, indexed by w. In this case, the owner can choose to allocate ("refer") $P_w \equiv P - P_a$ patients to the worker, and the firm's per-period profit is given by:

$$\pi = f(P_a) + f(P_w) - S$$

where S is the cost of paying the worker's salary. Since f is strictly concave, it is potentially advantageous for the owner to share the patients with the worker and pay the worker's salary. However, any allocated patients P_w become loyal to the worker physician, who may then poach the patients.

The worker may exit the firm in the second period for two reasons. First, with probability $(1 - \rho)$ the worker and firm exogenously separate, where $0 < \rho < 1$. Second, if the worker can earn a higher salary in the outside competitive market she will voluntarily exit. In either case the worker takes allocated patients with her. The outside option salary for a physician without any patients is denoted $\bar{S}$, and the outside option increases to $f(P_w) > \bar{S}$ for a worker with $P_w > 0$ loyal patients.

In order to prevent the worker from poaching patients in the second period, the owner may require the worker to agree to an NCA. If a worker signs an NCA and the job is then terminated for any reason, allocated patients are returned to the owner, and the worker must exit the geographic market. At the beginning of period 1, workers have heterogeneous geographic location preferences R_w, expressed in monetary units, which are distributed uniformly $R_w \sim U[0, \bar{R}]$, and are private knowledge of the worker. Larger R_w indicate high willingness to pay for staying in the geographic market, which increases the expected cost of signing an NCA. At the end of period 1, workers receive geographic preference shocks with a Bernoulli distribution $\varepsilon \sim \{-e, e\}$, where $e = \frac{\bar{R}}{2}$ and each outcome has equal probability. Therefore the sum $(R_w + \varepsilon) \sim U[-e, \bar{R} + e]$ is a continuous uniform distribution. If $R_w + \varepsilon$

is sufficiently negative, relative to earnings potential, workers may increase their utility by moving to a new geographic market.

The timing of events occurs as follows. At time zero, firms post take it or leave it offers that have three elements: (1) non-compete agreements $\{N, C\}$, where N corresponds to a contract with an NCA, and C to a contract without, (2) first-period compensation, S_1, and (3) second-period compensation, S_2. Workers observe all posted offers and choose jobs that maximize earnings $S_1 + S_2$, net of any expected relocation costs $\mathbb{E}[R_w]$.[32] Firm owners then make patient referral choices. Production occurs, workers and firms earn payoffs, and then exogenous separation draws ρ are realized. Workers then announce whether they wish to voluntarily exit the job.

Contractual commitments to allocate P_w are forbidden, and as discussed in Section 2.3, compensation in each period must be based on fair market value and may not include an implicit purchase or sale of patient referrals. We impose this legal constraint by assuming a minimum salary $S \geq \bar{S}$ in each period, which is consistent with fair market value and prevents workers from forgoing salary to implicitly purchase referrals.[33]

We begin the model by considering fixed salary compensation only, and allowing one-sided forward commitments by the firm to guarantee S_2. We then consider an extension of the model in which future salary commitments have limited credibility—firms can guarantee not to cut earnings, but they may not credibly commit to guarateed salary increases. These assumptions about contract structures play an important role, because once a worker has signed an NCA their reservation salary decreases in the second period due to the cost of relocating.

Firms maximize the sum of expected profits over the two periods $\pi_1 + \pi_2$. Workers choose jobs that maximize two-period earnings net of expected relocation costs, $S_1 + S_2 - \mathbb{E}[R_w]$.

Hedonic wage theory (Rosen, 1974) says that the competitive market salary will be determined by the preferences of the marginal worker, who has a value of $R^\star$ that makes them indifferent to accepting an NCA. Since we are interested in studying a mixed equilibrium, in which some jobs include NCAs and others do not, we assume that $\bar{R}$ is sufficiently large that some workers would never accept an NCA at any price that firms are willing to pay. The hedonic equilibrium is therefore characterized by a single worker with preferences $R^\star$ that determines assignment to jobs: workers with $R_w < R^\star$ sort into jobs with NCAs, and workers with $R_w > R^\star$ sort into jobs without NCAs. For simplicity, we also assume that $R^\star > e$, which implies that workers who sort into jobs without NCAs will never choose to relocate (as long as their earnings do not decrease in period two.)

Earnings Path and Patient Referrals Without NCAs

If a contract does not include an NCA, the firm owner maximizes profits by solving:

$$\max_{P_a} 2f(P_a) + (1+\rho)f(P_w) - S_1 - \rho S_2$$

where $P_a = P - P_w$. The worker will accept the offer as long as $S_1 + S_2 \geq 2\bar{S}$.

Working backwards, in the second period the firm must offer the worker at least the

[32] Note that when choosing jobs, workers do not require compensation for the risk that their preferences will change in the future, leading them to voluntarily exit the job. However, firms do consider this possibility when maximizing profits.

[33] We are grateful to an anonymous referee for noting that removing this model assumption may lead to alternative model predictions.

outside option salary, $S_2 \geq f(P_w)$, to prevent the worker from voluntarily exiting. This second period constraint captures the idea that once a worker controls patients P_w they bring more value to an outside firm, increasing output above the level that could be produced by a worker without patients, $\bar{S}$. Knowing this, the firm would ideally like to offer the bundle $\{S_1, S_2\}$ at which the two-period participation constraint is binding, which implies $S_1 = 2\bar{S} - S_2 = 2\bar{S} - f(P_w)$. However, this contract requires the worker to implicitly pay the agent for the value of referrals, $f(P_w)$, which the worker then recoups in the second period. In practice this contract would be illegal because physicians are prohibited from receiving explicit or implicit compensation for referrals. This prohibition on both overt and covert markets for patient referrals is fundamentally why NCAs can create value in this setting, offering protection against losing valuable assets for which there is no market.

To model this legal constraint, we assume the agent must offer the fair market salary, without accounting for the value of referrals: $S_1 \geq \bar{S}$. Given this legal restriction, the initial participation constraint $S_1 + S_2 \geq 2\bar{S}$ cannot bind with equality. When both the retention constraint and legal constraint bind: $S_1 = \bar{S}$ and $S_2 = f(P_w)$. The firm's problem is then:

$$\max_{P_a} 2f(P_a) + f(P_w) - \bar{S}$$

The FOC is

$$\frac{\partial \pi}{\partial P_a} = 2f'(P_a) + f'(P_w)\frac{\partial P_w}{\partial P_a} = 0$$

$$\Rightarrow \quad f'(P_a^{C\star}) = \frac{f'(P_w^{C\star})}{2}$$

Earnings Path and Patient Referrals With NCAs

Contracts that include NCAs are more complicated, because the probability of separation may depend on earnings. The unconditional probability of separation is given by:

$$\mathbb{P}[sep] = (1-\rho) + \rho\mathbb{P}\left[R_w + \varepsilon < \bar{S} - S_2\right]$$

$$\mathbb{P}[sep] = (1-\rho) + \rho\left[\frac{\bar{S} - S_2 + e}{\bar{R} + 2e}\right]$$

Note that

$$\frac{\partial \mathbb{P}[sep]}{\partial S_2} = \frac{-\rho}{\bar{R} + 2e} < 0$$

The firm's profit maximization problem is:

$$\max_{P_a, S_1, S_2} (2 - \mathbb{P}[sep])\left[f(P_a^N) + f(P_w^N)\right] + \mathbb{P}[sep]f(P) - S_1 - (1 - \mathbb{P}[sep])S_2$$

When firms use NCAs there are no externalities between factors of production, patients and labor. When the firm hires a worker, the firm's referral decision is independent of wages that offered to recruit the worker. Therefore we can first solve the patient referral problem, and then solve the profit maximizing salary offers.

Patient referrals are chosen by solving:

$$\max_{P_a} (2 - \mathbb{P}[sep])\left[f(P_a^N) + f(P_w^N)\right] + \mathbb{P}[sep]f(P) - S_1 - (1 - \mathbb{P}[sep])S_2$$

The FOC is:

$$\frac{\partial \pi}{\partial P_a} = (2 - \mathbb{P}[sep]) \left[f'(P_a^N) + f'(P_w^N) \frac{\partial P_w^N}{\partial P_a^N} \right] = 0$$

$$\Rightarrow \quad f'(P_a^{N\star}) = f'(P_w^{N\star}) \quad \Rightarrow \quad P_a^{N\star} = P_w^{N\star} = \frac{P}{2}$$

This solution, along with the concavity of f, gives the first hypothesis of the model:

Hypothesis 1 *Physicians with NCAs will have more patients allocated to them by the practice owner:* $P_w^{N\star} > P_w^{C\star}$.

Notice that since NCAs allow firms to equitably distribute patients, the total output is greater even though all firms use the same inputs.

Corollary 1 *The more equitable distribution of clients made possible by NCAs increases the productive efficiency of firms.*

Given this solution to the referral problem, firms choose salary offers by maximizing

$$\max_{S_1,S_2} (2 - \mathbb{P}[sep]) 2f(P/2) + \mathbb{P}[sep] f(P) - S_1 - (1 - \mathbb{P}[sep]) S_2$$

Plugging in the formula for the probability of separation gives:

$$\max_{S_1,S_2} 4f(P/2) - \left[(1-\rho) + \rho \left[\frac{\bar{S} - S_2 + e}{\bar{R} + 2e} \right] \right] [2f(P/2) - f(P) - S_2] - S_1 - S_2$$

subject to the legal constraint on minimum salaries, and the worker's participation constraint:

$$S_1, S_2 \geq \bar{S}$$

$$S_1 + \rho S_2 + (1-\rho)(\bar{S} - R^\star) \geq \bar{S} + f(P_w^{C\star})$$

Notice that the worker's participation constraint is based on ρ, the probability they are forced to separate. Firms do not compensate workers for the risk that the worker's geographic preferences may change, leading the worker to prefer to relocate in the future. The Kuhn-Tucker conditions are:

$$\lambda_1(\bar{S} - S_1) = 0$$

$$\lambda_2(\bar{S} - S_2) = 0$$

$$\lambda_3 \left[\bar{S} + f(P_w^{C\star}) - S_1 - \rho S_2 - (1-\rho)(\bar{S} - R^\star) \right] = 0$$

$$\lambda_1, \; \lambda_2, \; \lambda_3 \geq 0$$

The FOCs with respect to S_1 and S_2, respectively, are

$$-1 + \lambda_1 + \lambda_3 = 0 \quad \Rightarrow \quad \lambda_1 + \lambda_3 = 1 \tag{9}$$

$$\frac{\rho}{\bar{R} + 2e} \left[2f(P/2) - f(P) + \bar{S} - 2S_2 + e \right] - \rho + \lambda_2 + \rho\lambda_3 = 0 \tag{10}$$

Case 1: Suppose $\lambda_2 > 0$

Complementary slackness implies $S_2 = \bar{S}$, along with the participation constraint implies

$S_1 > \bar{S}$, which implies $\lambda_1 = 0$. (9) implies $\lambda_3 = 1$. In this case, (10) implies:

$$\frac{\rho}{\bar{R}+2e}\left[2f(P/2) - f(P) - \bar{S} + e\right] + \lambda_2 = 0$$

This is a contradiction, because $2f(P/2) - f(P) - \bar{S}$ is the increase in profit that a firm earns by hiring a worker with an NCA and paying the minimum salary $\bar{S}$. This sum must be positive in order for any hiring to occur in the model. Since the sum of the first three terms is positive, the magnitude of the shock $e > 0$, and $\lambda_2 \geq 0$ by the Kuhn-Tucker conditions, (10) cannot possibly hold in this case.

Case 2: Suppose $\lambda_2 = 0$, $\lambda_1 > 0$, and $\lambda_3 = 0$
Complementary slackness implies $S_1 = \bar{S}$ and the participation constraint implies $S_2 > \bar{S}$. (10) implies

$$\frac{\rho}{\bar{R}+2e}\left[2f(P/2) - f(P) + \bar{S} - 2S_2 + e\right] = \rho$$

$$2f(P/2) - f(P) + \bar{S} + e = \bar{R} + 2e + 2S_2$$

$$S_2 = \frac{2f(P/2) - f(P) + \bar{S} - \bar{R} - e}{2}$$

The restriction $S_2 > \bar{S}$ holds if

$$\frac{2f(P/2) - f(P) + \bar{S} - \bar{R} - e}{2} > \bar{S}$$

$$2f(P/2) - f(P) > \bar{S} + \bar{R} + e$$

This condition says that the increase in per-period revenue from equally distributing patients over two workers is larger than the sum of $\bar{S}$ plus the largest possible willingness to pay to remain in the geographic market. If this condition held, then the firm would be willing to pay $R^\star$ even if $R^\star = \bar{R}$, so every firm would use NCAs. Since our primary interest in the model is a mixed equilibrium, we assume that $\bar{R}$ is large enough that some workers would never accept an NCA at any price that firms would be willing to pay. Under this assumption, the restriction required for $S_2 > \bar{S}$ to hold cannot be satisfied.

Case 3: Suppose $\lambda_2 = 0$, $\lambda_1 > 0$, and $\lambda_3 > 0$
$\lambda_1 > 0$ implies $S_1 = \bar{S}$ and the participation constraint implies $S_2 > \bar{S}$.
Complementary slackness implies S_2 solves:

$$\bar{S} + f(P_w^{C^\star}) - \bar{S} - \rho S_2 - (1-\rho)(\bar{S} - R^\star) = 0$$

$$\Rightarrow S_2 = \frac{f(P_w^{C^\star}) - (1-\rho)(\bar{S} - R^\star)}{\rho}$$

Notice that S_2 in this case is always strictly greater than $\bar{S}$ because

$$\frac{f(P_w^{C^\star}) - (1-\rho)(\bar{S} - R^\star)}{\rho} > \bar{S}$$

$$\Rightarrow f(P_w^{C^\star}) + (1-\rho)R^\star > \bar{S}$$

which always holds because $f(P_w^{C^\star}) > \bar{S}$.
(9) implies:

$$\lambda_3 = 1 - \lambda_1 > 0 \Rightarrow 0 < \lambda_3 < 1$$

(10) implies:

$$\frac{\rho}{\bar{R}+2e}\left[2f(P/2)-f(P)+\bar{S}-2S_2+e\right]-\rho+\rho\lambda_3=0$$

$$\frac{\rho}{\bar{R}+2e}\left[2f(P/2)-f(P)+\bar{S}-2S_2+e\right]=\rho(1-\lambda_3)=\rho\lambda_1$$

$$\lambda_1(\bar{R}+2e)=2f(P/2)-f(P)+\bar{S}-2S_2+e$$

$$\lambda_1=\frac{2f(P/2)-f(P)+\bar{S}-2S_2+e}{\bar{R}+2e}$$

Notice that the RHS is a probability, consistent with the restriction that $0<\lambda_1<1$.

$$\lambda_1=\mathbb{P}\left[R_w+\varepsilon<2f(P/2)-f(P)-S_2+(\bar{S}-S_2)\right]$$

This is equal to the probability that a worker would prefer to voluntarily exit in period 2 if they are offered a salary equal to the firm's entire second period profit, $2f(P/2)-f(P)-S_2$ less $\bar{S}-S_2<0$, which is the opportunity cost in lost wages of voluntarily moving. This, along with (9), implies:

$$\lambda_3=\mathbb{P}\left[R_w+\varepsilon\geq 2f(P/2)-f(P)-S_2+(\bar{S}-S_2)\right]$$

which has a similar interpretation as the probability of deterring a worker from having a preference for exiting.

The equilibrium earnings path in jobs with NCAs is therefore $\{S_1^N,S_2^N\}=\{\bar{S},\frac{f(P_w^{C\star})-(1-\rho)(\bar{S}-R^\star)}{\rho}\}$.

This result directly yields the hypothesis:

Hypothesis 2 *Physicians with NCAs have greater within-job earnings growth.*

Proof: All physicians earn $\bar{S}$ in period 1. In period 2, $S_2^C=f(P_w^{C\star})$, while

$$S_2^N=\frac{f(P_w^{C\star})-(1-\rho)(\bar{S}-R^\star)}{\rho}>f(P_w^{C\star})$$

To see why this last inequality is true, notice that $f(P_w^{C\star})=\rho S_2^N+(1-\rho)(\bar{S}-R^\star)$ is a ρ-weighted average of S_2^N and $\bar{S}-R^\star$. Since $f(P_w^{C\star})>\bar{S}-R^\star$, $f(P_w^{C\star})$ can only be a weighted average if $S_2^N>f(P_w^{C\star})$.

Intuitively, total earnings growth can be expressed as the sum of returns to experience and returns to tenure. Physicians without NCAs have the same earnings growth regardless of whether they remain at the firm, so the return to tenure conditional on experience is zero. All of the earnings growth is caused by returns to experience. In contrast, if physicians with NCAs separate in the second period they earn $\bar{S}$. Therefore there is zero earnings growth from increasing experience without also increasing tenure. All of the earnings growth occurs within-jobs, and is due to greater returns to job tenure.

Corollary 2 *The increase in within-job earnings growth associated with NCAs is due to larger returns to tenure, conditional on experience.*

Proof: Total earnings growth is the sum of returns to experience and returns to tenure. For physicians without NCAs, $S_2^C=f(P_w^{C\star})$ regardless of whether the worker remains at the firm or separates in period 2. Therefore, for workers without NCAs, earnings are equal when job tenure is zero or one, so the return to job tenure conditional on experience is zero. The return to experience is $S_2^C-S_1^C=f(P_w^{C\star})-\bar{S}>0$.

For physicians with NCAs, if a separation occurs in period 2, then earnings in the second period are $\bar{S}$. Therefore physicians without NCAs receive zero earnings growth when moving from experience-tenure pair $(0,0)$ to $(1,0)$, so the return to experience conditional on tenure is zero. For physicians that remain at the same firm, earnings growth when moving from experience-tenure pair $(0,0)$ to $(1,1)$ is $S_2^N - S_1^N > 0$. This earnings growth is the sum of the experience component, $(1,0)-(0,0)$ and the tenure component, $(0,1)-(0,0)$. The former is zero, so all of the earnings growth is due to larger returns to tenure, conditional on experience.

6.2 Contracting Frictions, Bargaining, and Earnings

A stylized fact of labor markets, however, is that forward commitments to guaranteed salary increases are rarely observed. If firms cannot credibly commit to a contract specifying a second-period salary, then NCAs create a bargaining problem. Once a worker has signed an NCA their bargaining position decreases in the second period, since the firm knows that the worker's reservation wage has declined due to the cost of relocating. Without credible forward commitments, workers may demand front-loaded compensation in order to accept a job with an NCA. All else equal, this incentive may force the earnings path to be flatter than the profit-maximizing path derived above. Flattening the earnings path increases the probability of worker separations in the second period, and reduces welfare relative to the equilibrium with credible forward commitments.

Our goal in this section to demonstrate that there exists an incentive compatible revenue-sharing contract in which the loss of ex post bargaining position due to NCAs does not cause distortions that flatten earnings paths, avoiding potential deadweight loss from excess turnover. The existence of such a contract suggests that when turnover is costly to firms, as is the case in the model presented above, then share-based contracts may be Pareto-improving relative to front-loaded or flat compensation paths.

To see this, suppose compensation structures may depend linearly on output:

$$M = S + \alpha f(P_w)$$

where α is the share of output that the worker keeps as compensation. A contract is now defined as (1) first-period compensation, M_1, (2) non-compete agreements $\{N, C\}$, and (3) forward "sticky wage" commitments by the firm to not reduce S or α in the second period. The sticky wage commitment reflects the limited credibility of guaranteed future salary increases, but allows firms to credibly commit to not decreasing either compensation parameter.[34]

To pin down the intuition behind the model equilibrium, suppose there is a small amount of stochasticity in output. We also introduce an upward-sloping output function, by assuming that output grows in the second period at the rate $\delta > 1$. Firms without NCAs have no compelling reason to use revenue-sharing contracts. Since the firm is risk-neutral, they will insure the worker against output shocks by offering the contract $\{S_C^1, \alpha_C^1\} = \{\bar{S}, 0\}$ in period 1. The worker can then re-negotiate the contract in the second period by threatening to separate, $\{S_C^2, \alpha_C^2\} = \{\delta f(P_w), 0\}$.

[34] One reason why such a contract may occur is if workers choose effort, and firms are hesitant to commit to second period salary increases due to moral hazard. Facing uncertain effort, firms may be willing to commit to forward share-based contracts even when they would not commit to forward salary levels. For example, with Cobb-Douglas production and variable capital inputs, firms will pay labor a fixed share of output that is independent of effort.

Workers with NCAs, however, cannot increase their compensation in the second period by threatening to exit, since the worker's expected outside option yields a payoff of only $\bar{S} - \mathbb{E}[R_w]$. Anticipating that their bargaining position will decline in the second period, workers must negotiate an ex ante incentive-compatible contract with fixed compensation components $\{S_N, \alpha_N\}$.

To gain intuition, suppose for simplicity that output shocks are very small, so the profit-maximizing equilibrium earnings path can be approximated by re-solving the model with log utility:

$$\max_{S_1,S_2}(2+2\delta)f(P/2) - \left[(1-\rho) + \rho\left[\frac{\bar{S} - S_2 + e}{\bar{R} + 2e}\right]\right][2\delta f(P/2) - \delta f(P) - S_2] - S_1 - S_2$$

subject to the legal constraint on minimum salaries, and the worker's participation constraint:

$$S_1, S_2 \geq \bar{S}$$

$$\rho \ln(S_1 + S_2) + (1-\rho)\ln(S_1 + \bar{S} - R^\star) \geq \ln(\bar{S} + \delta f(P_w^{C^\star}))$$

When $S_1 = \bar{S}$ and the participation constraint binds,

$$(\bar{S} + S_2)^\rho (2\bar{S} - R^\star)^{(1-\rho)} = \bar{S} + \delta f(P_w^{C^\star})$$

$$S_2 = \frac{\left(\bar{S} + \delta f(P_w^{C^\star})\right)^{1/\rho}}{(2\bar{S} - R^\star)^{\frac{(1-\rho)}{\rho}}} - \bar{S}$$

The profit maximizing earnings path is

$$\{S_1, S_2\} = \left\{\bar{S}, \frac{\left(\bar{S} + \delta f(P_w^{C^\star})\right)^{1/\rho}}{(2\bar{S} - R^\star)^{\frac{(1-\rho)}{\rho}}} - \bar{S}\right\}$$

Now, introducing revenue-sharing contracts, the equilibrium compensation contract $\{S_N, \alpha_N\}$ that matches this profit-maximizing earnings profile must satisfy:

$$S_N + \alpha_N f(P/2) = \bar{S} \tag{11}$$

$$S_N + \alpha_N \delta f(P/2) = \frac{\left(\bar{S} + \delta f(P_w^{C^\star})\right)^{1/\rho}}{(2\bar{S} - R^\star)^{\frac{(1-\rho)}{\rho}}} - \bar{S} \tag{12}$$

Equation (11) implies $\alpha_N = \frac{\bar{S} - S_N}{f(P/2)}$. Subtracting (11) from (12) gives:

$$\alpha_N(\delta - 1)f(P/2) = \frac{\left(\bar{S} + \delta f(P_w^{C^\star})\right)^{1/\rho}}{(2\bar{S} - R^\star)^{\frac{(1-\rho)}{\rho}}} - 2\bar{S} > 0$$

Notice that the RHS is strictly positive, because of the earnings constraint $S_2 > \bar{S}$ implies:

$$\frac{\left(\bar{S} + \delta f(P_w^{C^\star})\right)^{1/\rho}}{(2\bar{S} - R^\star)^{\frac{(1-\rho)}{\rho}}} > 2\bar{S}$$

The LHS is also strictly positive since $\delta > 1$. This implies $\alpha_N > 0$.

The economic intuition behind this result is straightforward. Although limited credibility constrains the set of contracts, this constraint can be overcome if the firm uses fixed revenue-sharing rates to match the profit-maximizing earnings path that would occur under perfect forward credibility. This equilibrium requires the existence of an upward-sloping function to which α can be tied; growing output, $\delta > 1$, is one natural example of such a function. When this occurs, firms can bundle NCAs with revenue-sharing contracts, which allows compensation to increase along with output, without the need to renegotiate contract terms in the second period.

Hypothesis 3 *If long-term forward compensation contracts have limited credibility, and output grows over time, then firms that use NCAs can use share-based compensation contracts in which $\alpha_N^\star > \alpha_C^\star$ to achieve the same profit-maximizing earnings path that would occur under credible forward contracts.*

In this simple model we abstract from explaining which firms choose to use NCAs, and the hedonic equilibrium is driven entirely by sorting on worker preferences. Of course, in a more realistic setting the decision by a firm to impose NCAs is unlikely to be random. For example, firms in geographic markets with fewer patients per physician (lower endowments of P per firm) may derive more benefits from protecting the marginal patient from being poached, increasing $R^\star$, and hence the fraction of employees with NCAs. Similarly, if production is augmented by a persistent productivity shifter $\tau f(P)$, more productive firms may derive greater benefits from NCAs. Finally, if firms differ in hiring costs, higher cost firms may benefit more from NCAs. Although our theoretical discussion abstracts from many of these issues, appropriate interpretation of our empirical estimates depends on the extent to which potentially unobserved factors directly affect both the decision to use NCAs as well as the outcomes of interest in our hypotheses. We return to discuss these selection issues, and the conditions under which our parameter interpretations may be affected by selection, in Section 5.

6.3 Summary of Testable Hypotheses

The goal of our empirical analyses is to test for evidence that physician practices use NCAs to prevent patients from being poaching, protecting firms' investments in client relationships, which we model as intra-firm referral choices in the stylized model above. Our primary analyses test Hypothesis 2, that NCAs increase the rate of return to job-tenure. We test this hypothesis by estimating the relationship between the use of NCAs and within-job earnings growth, and decomposing the earnings growth differential into components due to experience and job tenure.

We also make use of several other predictions from the model to provide corroborating suggestive evidence. Hypothesis 1 is that firms that use NCAs allocate more patients to employed physicians. In the survey data, we are able to observe the distribution of patients to physicians. We test for evidence of disparities in the allocation of patients between employed physicians and those that have equity ownership in the firm. If NCAs reduce referral holdups, firms that use NCAs should have more balanced distributions of patient loads across physicians. In the medical context, however, all patients are not alike. Physicians that treat privately insured patients tend to receive higher reimbursements than than those that treat Medicaid patients, for example. In addition to testing for overall disparities in the number of clients, we also examine heterogeneity in the allocation of clients by their source of insurance coverage.

Hypothesis 3 is that NCAs may be bundled with share-based compensation incentives to overcome the effects of changes in bargaining position. We use data on the fraction of earnings that come from incentive payments tied to individual production to provide stylized summary statistics on this hypothesis. We also empirically evaluate the alternative hypothesis that physician practices use NCAs solely to reduce job turnover.