Competitive Occupational Licensure:

Doctors Versus Chiropractors

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Abstract

This paper provides the first analysis of competitive occupational licensure, where substitute professions maintain separate licensing boards that set entry requirements strategically. I develop and structurally estimate a model where professional organizations choose licensing stringency to maximize industry profits while accounting for competitive responses, as workers with heterogeneous abilities select occupations based on expected returns and consumers observe only average quality within each profession. Testing this theory using historical competition between medical doctors (MDs) and chiropractors (DCs) from 1907-1960, I exploit digitized American Medical Association records and state-by-year variation in chiropractic board adoption. Medical boards responded strategically by increasing college requirements by 10 percentage points, mandating internships (10+ percentage points), and reducing pass rates by 5 percentage points. These regulatory changes generated substantial economic effects: doctors home values rose by 26% while their numbers declined by 17-40 practitioners per 100,000 population, and chiropractors saw 44% higher home values with increased market presence of 2-12 practitioners per 100,000. Structural estimation reveals that observed equilibria closely approximate profit-maximizing sequential competition rather than welfare-maximizing behavior.

Acknowledgements

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Any remaining errors are my own.

1 Introduction

The study of occupational licensure goes back to Adam Smith, but existing analyses tend to assume occupational licensing has only one board per broad occupation (Leland, 1979; Shapiro, 1986; Plemmons and Timmons, 2023; Shaked and Sutton, 1981; Blair and Chung, 2021; Kleiner and Soltas, 2023; Persico, 2015). There are many examples of sets of near-substitute professions that have separate licensing boards, such as architects and structural engineers, social workers and psychologists, optometrists and ophthalmologists, among others. As occupational licensing becomes more common (Carollo et al., 2022), there will likely be an increase in such occurrences. Using theory, structural estimates, and reduced-form empirical analysis, I show that we should account for competition between occupational licensing boards.

To support my general framework, I study the competition between doctors (MDs) and chiropractors (DCs) in the early 20th century. While some may not view chiropractors and doctors as close substitutes in the current context, it is much easier to argue that these professions were substitutes in the past. Both professions aimed to address all health issues during this period, and both campaigned against each other. At a minimum, these

professions believed consumers might see them as substitutes.

To estimate the response from medical boards to chiropractic boards, I digitize records from the American Medical Association to measure the stringency of licensure. From 1907 to 1960, the American Medical Association released licensure statistics reports that include the years when state medical boards adopted more restrictive policies, such as requiring two years of medical school or requiring a doctor to complete an internship year. Additionally, I can identify the board passage rate of graduates from each medical school in each state for each year. This allows me to control for selection into medical schools, isolating shifts in the difficulty of board restrictions.

State medical boards increased barriers to entry around the same time as a chiropractic board was established. Using a stacked event study design (Cengiz et al., 2019), I examine how state medical boards adjusted entry requirements following chiropractic licensing. State medical boards are increasingly likely to require an internship year after medical school, with effects gradually rising to 10-15 percentage points. Conditional on medical school quality, candidates seeking licensure failed more frequently, with passage rates declining by approximately 5 percentage points in treated states. The consistent pattern of increased stringency across multiple regulatory instruments provides evidence of systematic response to chiropractic entry.

My findings suggest that the shift in medical board policy affected the selection and profitability of doctors. Using complete count census data (Ruggles et al., 2024), I show that following chiropractic board adoption, doctors experience a 26% increase in home values and a 4.4 percentage point increase in home ownership probability. Educational attainment among doctors increases by 0.2 years, while doctor prevalence declines by 17 practitioners per 100,000 population using fixed effects estimation and by 40 practitioners per 100,000 using instrumental variables estimation.

The establishment of a chiropractic board also impacted the selection and profitability of chiropractors. Chiropractors experience a 44% increase in home values and an 18.6 percentage point increase in home ownership probability. Educational attainment among

chiropractors increases substantially by 0.6 years. Chiropractor prevalence increases by two practitioners per 100,000 using fixed effects estimation and by 12 per 100,000 using instrumental variables estimation.

To validate these findings, I examine similar non-health professions (Electrical Engineers, Civil Engineers, Librarians, Mechanical Engineers, and Government Officials) as a placebo group. These professions show markedly different responses: following chiropractic board adoption, they experience smaller increases in home values and home ownership, with no significant change in educational attainment and no evidence of supply effects.

I estimate the impact on chiropractic prevalence using a natural extension of the jackknife instrumental variable estimation strategy (Angrist et al., 1999) that should be usable in other contexts. I use the characteristics of other counties in a state as an instrument for the policy adopted within a specific county. To avoid spatial correlation violating the exclusion restriction, I control for the characteristics of the counties that surround my county of interest. This strategy produces large F statistics (ranging from 338 to 699, well above conventional thresholds) and passes an over-identification test (Sargan test p-values of ≈ 1).

To understand the mechanisms driving these empirical patterns, I develop and estimate a structural model of competitive occupational licensing. The model features sequential competition between professional organizations that set licensing requirements to maximize incumbent profits, workers who differ in ability and choose professions based on expected returns, and consumers who observe only average quality within each profession. Licensing stringency acts as a barrier to entry and influences both labor quality and quantity. Consumers observe only average quality within each profession, creating a potential asymmetric information problem, as in Akerlof (1970), and allowing for an upward-sloping demand curve as in Wilson (1979). Workers, who differ in ability as in Larsen et al. (2022), decide whether to enter a profession based on expected profit, entry costs, and personal preferences; both worker and consumer decisions are represented using a multinomial logit structure, which ensures non-zero, continuous supply and demand. Professional organizations choose licensing requirements strategically to maximize total profession-wide profit, taking

into account competitive responses. The equilibrium entry costs chosen by the professional organizations regulate market access and shape the average quality of services provided.

I structurally estimate the model's parameters using a five-stage procedure that combines ability estimation from census earnings data, Berry et al. (1995)-style demand estimation (BLP) with simulated skill heterogeneity, and empirical Bayes shrinkage to stabilize regulatory effect estimates. The estimated parameters reveal that workers show modest responsiveness to profitability and regulatory barriers, while consumers exhibit strong price sensitivity but weak quality sensitivity. Both professions face substantial baseline entry costs, with chiropractors facing larger barriers that reflect doctors' prestige advantage. The stringency parameters—approximately 2,600 for chiropractors and 3,200 for doctors after empirical Bayes shrinkage—indicate that regulatory barriers impose stricter quality requirements for doctors than chiropractors, consistent with differences in medical training intensity.

Using the estimated parameters, I simulate the model to compare equilibrium outcomes across alternative regulatory regimes. The simulations show that the estimated equilibrium closely approximates profit-maximizing outcomes under sequential competition (Stackelberg equilibrium), producing 50 doctors and 4 chiropractors per 100,000 population with doctor profits of $36,425 and chiropractor profits of $2,906. These estimates substantially underpredict actual practitioner densities of 105 doctors and 10 chiropractors per 100,000, likely because the static model estimates equilibrium under current stringency levels while observed stocks reflect accumulated entry under historically more permissive regimes. The simulations reveal that allowing boards to compete can be welfare-increasing compared to having only one board under certain conditions. The competing professions may adopt a separating equilibrium that better ameliorates the asymmetric information problem by allowing consumers to choose between tiered options, though this depends critically on baseline profession preferences. When professions have asymmetric baseline attractiveness, welfare rankings across regulatory regimes can shift substantially. Additional simulation results exploring these dynamics are presented in the appendix.

This paper is the first to model and show evidence that licensed professions strategically compete by changing how strict their licensing requirements are. **?** examines battles between dentists and hygienists. They show how one licensed occupation can use regulations to affect another related occupation. Anderson et al. (2020) examines how midwifery licensing laws affected maternal health outcomes in a context where midwives and physicians competed. Dodini (2023) shows how labor regulations in one occupation spill over to affect other occupations. Multiple papers examine what happens when scope of practice limits competition between professions (Perry, 2009; Kleiner et al., 2016; Cai and Kleiner, 2020). Persico (2015) models how different groups within a profession vote on licensing policy. However, he focuses on one board within a profession. I show something different. When substitute professions have separate licensing boards, they strategically adjust how strict their entry requirements are. They do this in response to competitive threats. I develop a model where professional organizations choose entry requirements to maximize profits in a profession.

The empirical context demonstrates the potential importance of competitive occupational licensure. The Flexner Report was a 1910 comprehensive evaluation of medical schools that was followed by widespread closures of low-quality institutions. Scholars traditionally view this report as an exogenous reform driven by scientific advancement and public interest. Recent work has demonstrated that changes associated with the Flexner Report led to substantial effects on mortality and other health outcomes (Andrews, 2021; Clay et al., 2025), though these reforms also contributed to rural physician shortages (Moehling et al., 2020). The reforms occurred during a period when stricter physician licensing laws and improved medical education were contributing to broader mortality improvements (Haines, 2001).

However, my findings suggest these reforms may have been endogenous strategic responses to competitive threats from alternative practitioners like chiropractors. The timing of medical board policy changes around chiropractic licensing adoption indicates that established medical professionals used quality standardization as a competitive weapon rather than purely pursuing public welfare.

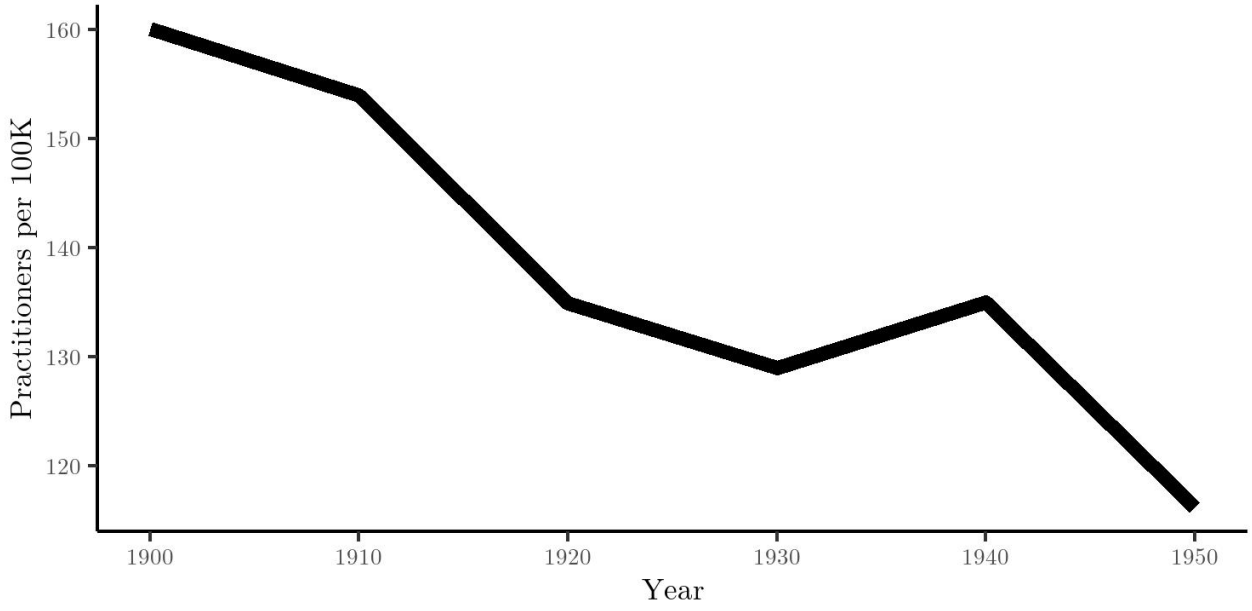
My evidence reframes the Flexner reforms not as exogenous shocks to medical markets, but as outcomes of the competitive dynamics between medical professions that my model predicts. Understanding these reforms as strategic responses rather than exogenous improvements has important implications for evaluating their welfare effects and understanding the political economy of professional regulation.

2 Context

2.1 The Medical Profession in the Early 20th Century

The medical profession in the early 20th century was undergoing a significant transformation, but remained underdeveloped by modern standards. Although germ theory was increasingly accepted by the late 19th century, medical training in the United States lagged behind global standards. The profession faced substantial changes following the landmark 1910 report by Abraham Flexner, which was followed by sharply rising education standards. Medical boards began requiring more extensive education and hands-on training through internships. This transformation was dramatic: the number of MD-granting institutions dropped from 160 in 1904 to 85 in 1920, and just 66 by 1935.

Figure 1: National Prevalence of Doctors Over Time



Data from IPUMS.

Despite these improvements, major medical breakthroughs such as the discovery of penicillin (1928), the structure of DNA (1953), and the introduction of the polio vaccine (1955) were still decades away. Nationally, the prevalence of doctors actually declined during the first half of the 20th century, with this long decline plateauing briefly but largely continuing throughout the period (Figure 1).

The high status of the medical profession is reflected in various socioeconomic indicators. Doctors consistently rank among the most prestigious occupations in American society, leading in educational attainment and maintaining substantial economic advantages over other healthcare professions. This elevated status would become a key factor in the medical establishment's resistance to alternative practitioners like chiropractors.

Table 1: Socioeconomic Status Indicators for Doctors and Chiropractors

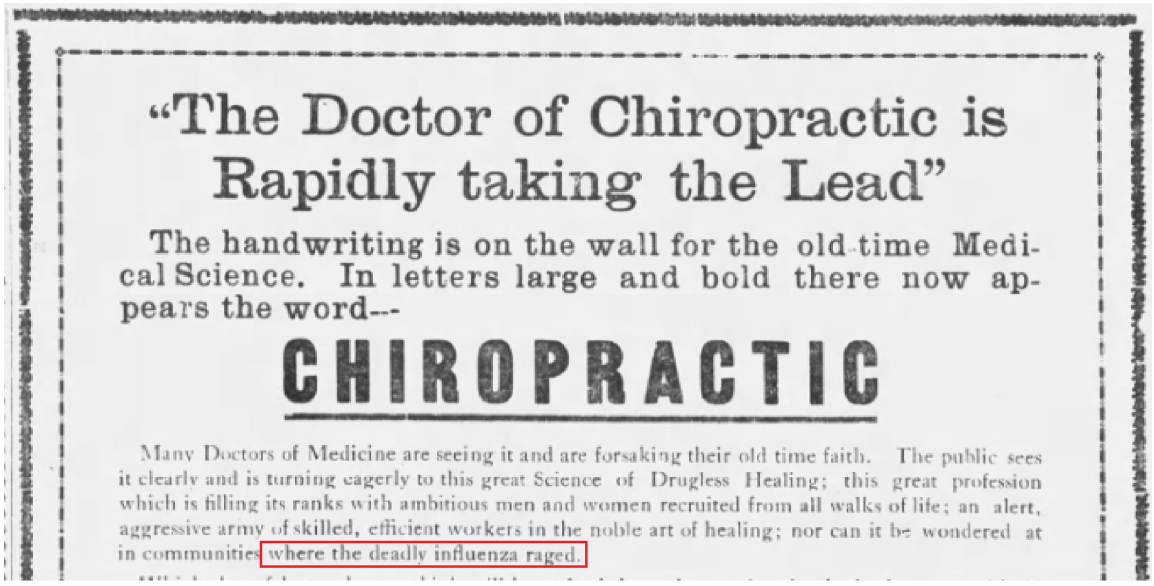
Occupation	Educational Attainment		Home Value		Home Ownership	
	Years	Rank	Value ($)	Rank	Rate	Rank
Doctors	16.39	1/223	8,378	4/223	0.554	15/223
Chiropractors	13.63	21/223	4,728	54/223	0.509	35/223

Note: Data from IPUMS. Ranks are relative to other occupational codes. All data is from the 1940 complete count census.

2.2 The Chiropractic Profession and Its Development

Chiropractic emerged as a distinct profession in 1895, initially taking root in the Midwest before spreading across the United States. Chiropractors claimed the superiority of their philosophy and practice, asserting that their manual adjustments could address a wide range of ailments, including influenza (see Figure 2). Some chiropractic methods, particularly spinal manipulative therapy, do show evidence of benefit for lower back pain even by modern standards (Paige et al., 2017).

Figure 2: Chiropractors Claimed to Be Able to Heal a Broad Range of Ailments



"The Doctor of Chiropractic is Rapidly taking the Lead"

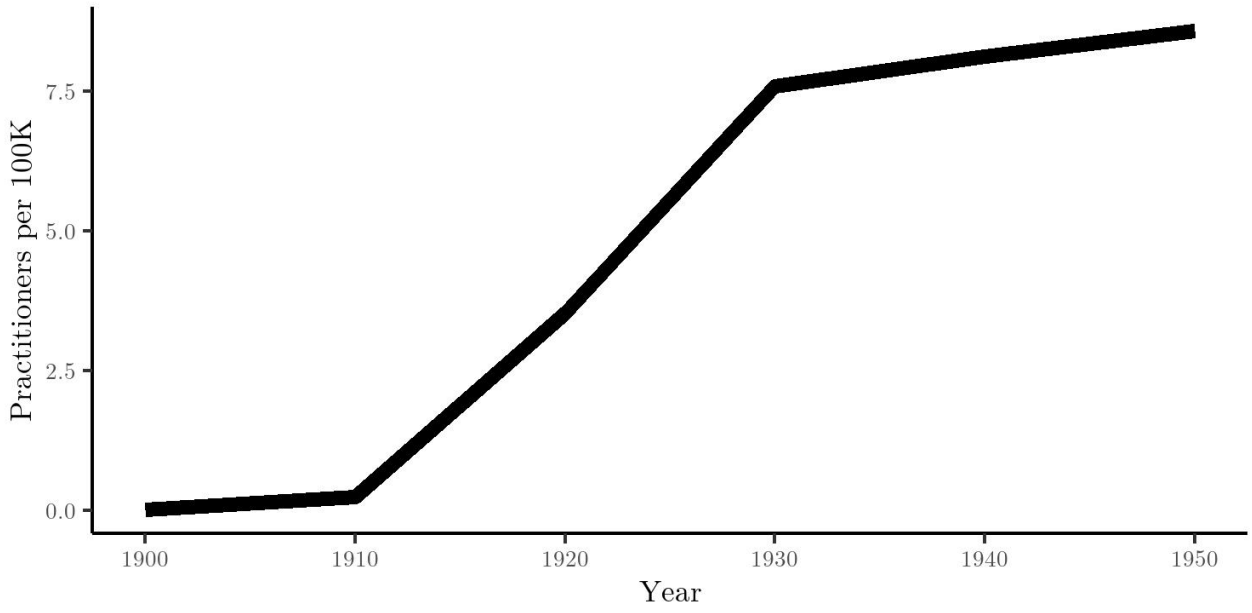
The handwriting is on the wall for the old-time Medical Science. In letters large and bold there now appears the word---

CHIROPRACTIC

Many Doctors of Medicine are seeing it and are forsaking their old time faith. The public sees it clearly and is turning eagerly to this great Science of Drugless Healing; this great profession which is filling its ranks with ambitious men and women recruited from all walks of life; an alert, aggressive army of skilled, efficient workers in the noble art of healing; nor can it be wondered at in communities where the deadly influenza raged.

Printed July 8, 1921 in The Lahoma Sun on page 6. Accessed via Newspapers.com

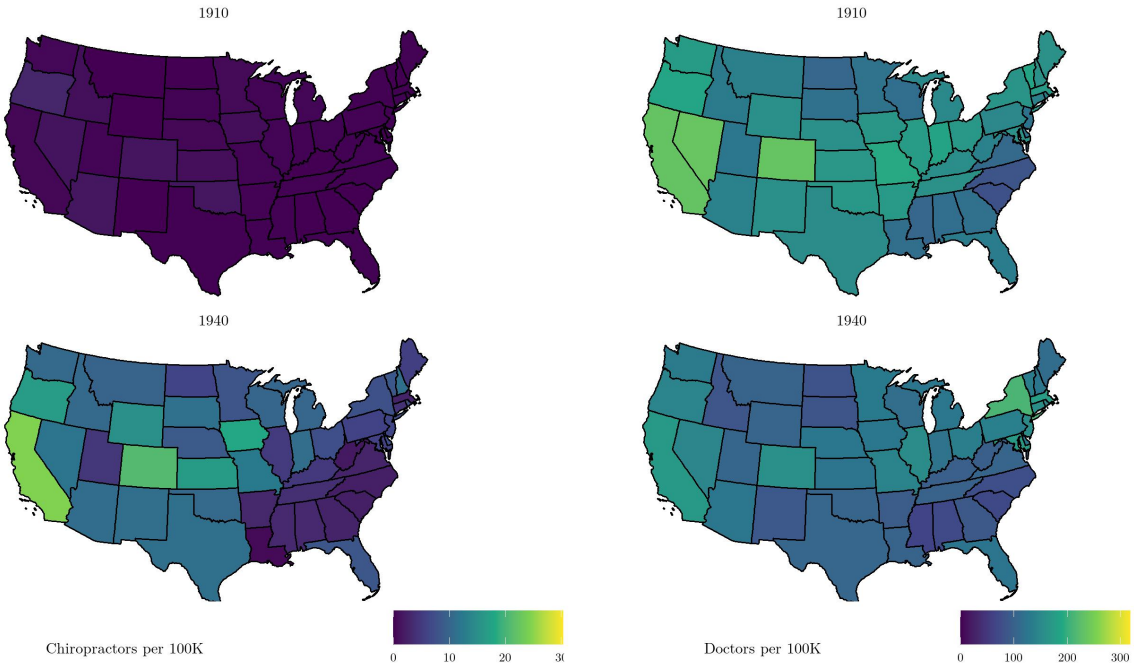
Figure 3: National Chiropractic Prevalence Over Time



Data from IPUMS.

The profession expanded rapidly until around 1930, when it entered a prolonged plateau before resuming growth in the 1970s (Figure 3). Today, there are approximately 29 chiropractors per 100,000 people, according to the Federation of Chiropractic Licensing Boards. Geographically, while chiropractic eventually became well-represented on the West Coast, it struggled to gain widespread acceptance in the Northeast and South (Figure 4).

Figure 4: Prevalence by State



Data from IPUMS. Scales are the same within a profession, but different across professions.

The professional status differences between chiropractors and doctors in the early 20th century are evident in their educational backgrounds and economic outcomes. Chiropractors consistently ranked below doctors across key socioeconomic indicators, but still bore similarities to other skilled professions. Analysis of Mahalanobis distances (Table 2) in average home-ownership, home values, and educational attainment reveals that chiropractors, share similar characteristics with other healthcare professionals and educators, while doctors share characteristics with elite professional occupations.[1]

[1]The Mahalanobis distance is a multivariate statistical measure that accounts for correlations between variables and differences in their variances when calculating the distance between two groups or observations. Unlike Euclidean distance, which treats all variables as independent and equally scaled, the Mahalanobis distance standardizes for the covariance structure of the data. It is calculated as:

$$D^2(\mathbf{x}, \mathbf{y}) = (\mathbf{x} - \mathbf{y})^T \mathbf{S}^{-1} (\mathbf{x} - \mathbf{y})$$

where $\mathbf{x}$ and $\mathbf{y}$ are vectors of observations for two groups, and $\mathbf{S}^{-1}$ is the inverse of the pooled covariance matrix. This metric is particularly useful for comparing occupational groups across multiple socioeconomic dimensions simultaneously, as it reveals which groups are similar after controlling for the natural correlation structure

Table 2: Mahalanobis Distance Rankings by Occupation Category

Average Distance			Chiropractor Distance			Doctor Distance		
Rank	**Occupation**	**Distance**	**Rank**	**Occupation**	**Distance**	**Rank**	**Occupation**	**Distance**
1	Osteopaths	2.343	1	Librarians	0.220	1	Lawyers and judges	0.518
2	Optometrists	2.373	2	Pharmacists	0.295	2	Engineers, mechanical	1.903
3	Dentists	2.428	3	Officials	1.121	3	Engineers, electrical	2.150
4	Engineers, electrical	2.449	4	Osteopaths	1.226	4	Dentists	2.476
5	Engineers, civil	2.786	5	Teachers	1.356	5	Engineers, chemical	2.616
6	Chemists	3.350	6	Bookkeepers	1.407	6	Optometrists	3.185
7	Librarians	3.420	7	Chemists	1.419	7	Engineers, industrial	3.393
8	Pharmacists	3.632	8	Draftsmen	1.422	8	Osteopaths	3.459
9	Engineers, mechanical	3.685	9	Optometrists	1.560	9	Engineers, civil	3.920
10	Officials	3.791	10	Apprentice electricians	1.649	10	Architects	4.026

Note: Data from IPUMS. Distance is the Mahalanobis distance between the average values for the indicated profession and the profession of interest across home value, home ownership and years of education. All data is from the 1940 complete count census.

2.3 The Evolution of Occupational Licensing

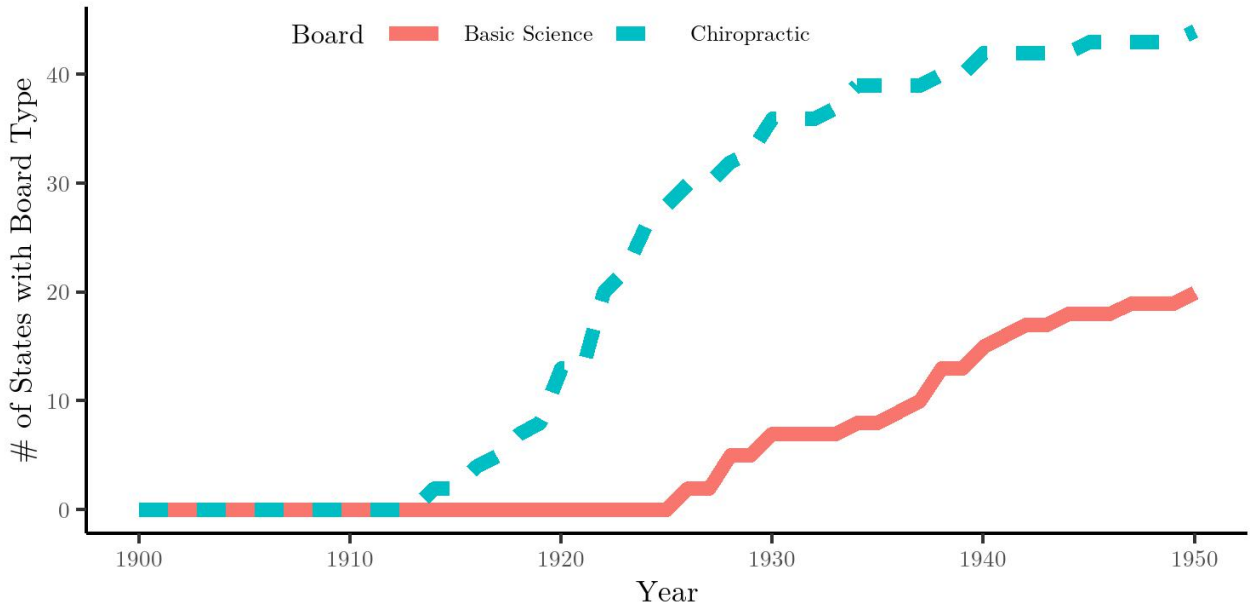
By the end of the 19th century, medical licensing statutes had been enacted across nearly every U.S. state, with the main exceptions being Kansas (which established an examining board in 1901), Oklahoma (1903), and Alaska (1913). These laws often targeted alternative practitioners and gave the medical establishment significant regulatory power.

Early chiropractors were routinely prosecuted for practicing medicine without a license. D.D. Palmer, the founder of chiropractic, spent 23 days in jail in 1906 for such a charge. Ironically, these prosecutions may have helped the profession grow, as chiropractors often portrayed themselves as persecuted visionaries, using the legal system to build political support and public sympathy.

Kansas became the first state to establish a chiropractic licensing board in 1913. By 1929, 36 states had followed suit, and all 50 states had chiropractic licensing boards by 1973 (Figure 5).

among variables like home ownership, home values, and educational attainment. Smaller Mahalanobis distances indicate greater similarity between groups in the multidimensional space defined by these characteristics.

Figure 5: Number of States with a Board Over Time



Chiropractic licensure data are from Keating et al., (2004). Medical board requirements are collected from annual licensure statistics reported in the Journal of the American Medical Association. Medical Boards are omitted due to a lack of variation.

Concurrent with the development of chiropractic licensing boards was another important regulatory innovation: the basic science board. Beginning in 1925 with Connecticut and Wisconsin, these boards required candidates for both chiropractic and medical licensure to pass an additional exam in "basic scientific subjects". These boards typically consisted of doctors, so the subjects more closely mirrored those taught in medical school. By 1959, a total of 24 states had implemented such boards, essentially giving doctors substantial influence over entry into the chiropractic profession.

The introduction of basic science boards is an important confounding factor in analyzing the impact of an independent licensing board. Chiropractors performed poorly on these basic science exams. In 1932, out of 23 chiropractors tested across seven states, only five passed, compared to 590 out of 657 MDs. By 1952, 195 chiropractors sat for basic science board exams across 21 states, but only 68 passed. In contrast, 2,870 out of 3,263 medical professionals passed that same year. These exams have been frequently cited as a key reason

for the stalled growth of the chiropractic profession between 1930 and 1970 (Keating et al., 2004).

2.4 The Relationship Between Medical Doctors and Chiropractors

In the early 20th century, competition between chiropractors and doctors was both direct and intense. Chiropractors were legally restricted from administering many of the treatments that doctors could offer. However, consumers may not have fully understood these limitations. Patients typically lacked both the information to choose the most effective provider and the ability to evaluate whether a treatment worked, since the counterfactual outcome was unobservable. Furthermore, the difference in treatment outcomes between doctors and chiropractors was likely narrower in the early 20th century than it is today, given the underdeveloped state of medical practice at the time.

Chiropractors briefly gained limited recognition from mainstream institutions. For example, chiropractic students were granted observing privileges at Cook County Hospital in Chicago. These privileges were later revoked after the students repeatedly disrupted surgeries by shouting, "Have you tried chiropractic?" to patients in the operating room (Keating et al., 2004).

Doctors, in turn, viewed chiropractors with deep skepticism and often outright hostility. At a meeting of the American Medical Association (AMA), Doyl Taylor declared, "Since the birth of chiropractic in 1895, the AMA has considered chiropractic an unscientific cult whose practitioners are not qualified to diagnose and treat human illness." He went on to say that chiropractic had not produced "a single shred of scientific proof" for its foundational hypothesis, that spinal subluxations cause human disease and can be cured through spinal adjustment (Johnson and Green, 2021).

As early as 1914, an article in the Journal of the American Medical Association declared chiropractic to be "the sheerest kind of quackery," practiced by individuals with little formal education and no understanding of basic science (10., 1914). Beyond disparaging chiropractic

publicly, the AMA took active steps to suppress its growth. The association barred its members from teaching at chiropractic colleges or attending chiropractic conferences. It also created a dedicated Committee on Quackery that lobbied against chiropractic practice. This committee even partnered with the syndicated advice column Ask Ann Landers to spread negative messages about chiropractors (Johnson and Green, 2021).

These efforts ultimately ran afoul of antitrust law. In the case Wilk v. American Medical Association, the courts ruled that the AMA had violated antitrust statutes by organizing a boycott against chiropractors and prohibiting its members from referring patients to them. Notably, the key evidence in the trial came from infiltrators associated with the Church of Scientology, which had also been targeted by the Committee on Quackery. These individuals leaked internal AMA documents to the Washington Post under the pseudonym "Sore Throat."

3 Do Medical Boards React to Chiropractic Boards?

I show that medical licensing boards tightened entry requirements after their state established chiropractic licensing boards. This analysis exploits variation in the timing of chiropractic board adoption across states and over time, using newly digitized data on medical licensing requirements from 1907-1960.

Medical Licensure Statistics for 1960

Fifty-Ninth Annual Presentation of Licensure Statistics by the Council on Medical Education and Hospitals of the American Medical Association

The data in the following annual report on Medical Licensure Statistics have been compiled by the staff under the supervision of Mrs. Anne Tipner, Assistant to the Secretary of the Council on Medical Education and Hospitals

WALTER S. WIGGINS, M.D., *Secretary*
Council on Medical Education and Hospitals

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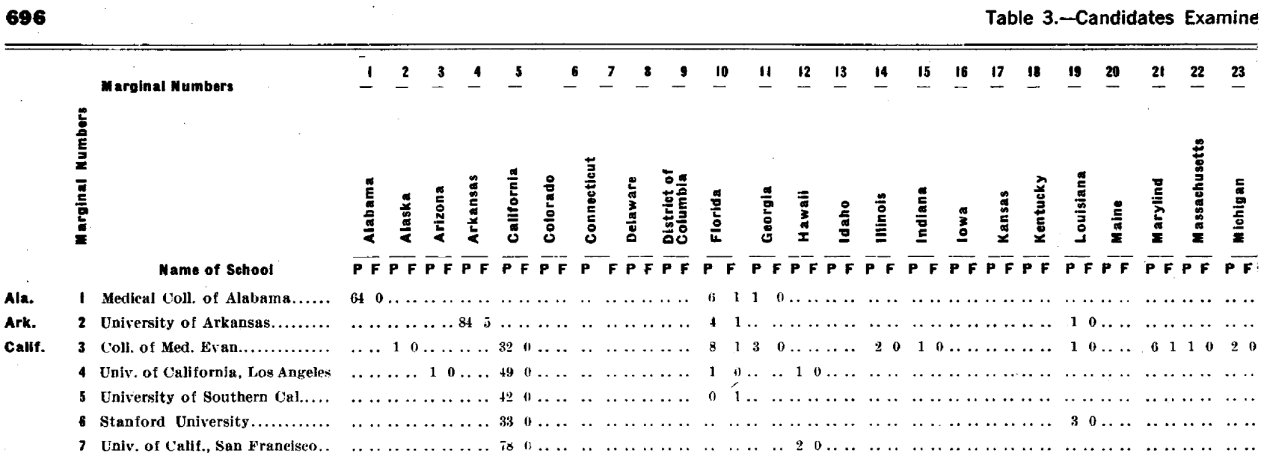
AMA published these reports from 1907-1960 documenting medical licensing requirements across states.

The identification strategy leverages the staggered adoption of chiropractic licensing boards across states as a shock to the competitive environment faced by medical boards. The key insight is that if medical boards view chiropractors as substitute providers, they should respond to legitimization of the chiropractic profession through state licensing by raising barriers to medical practice.

State Examining Board of	One Year of College Work		Two Years of College Work		A Hospital Internship	
	Affects Students Matriculating	Affects All Graduates	Affects Students Matriculating	Affects All Graduates	Affects Students Matriculating	Affects All Applicants
Alabama	.....	....	1915-16	1919	.....	....
Alaska	1914-15	1918	1918-19	1922	1912-13	1917
Arizona	1914-15	1918	1918-19	1922	.....	....
Arkansas	1915-16	1919	1918-19	1922	.....	....
California	1920-21	1924	.....	....	.....	....
Colorado	1908-09	1912	1910-11	1914	.....	....
Connecticut	1915-16	1919	.....	....	.....	....
Delaware*	.....	....	.....	....	1919-20	1924
Dist. of Columbia	.....	....	1925-26	1929	1924-25	1929
Florida	1914-15	1918	1918-19	1922	.....	....
Georgia	.....	....	1918-19	1922	.....	....
Idaho	.....	....	1915-16	1919	.....	....
Illinois	1915-16	1919	1919-20	1923	1918-19	1923

AMA reports documented when state medical boards adopted specific policies including education requirements and internship mandates, providing the data foundation for tracking policy changes over time.

The empirical analysis focuses on three key dimensions of medical licensing stringency: passage rates on medical board examinations, requirements for two years of pre-medical college education, and mandatory internship requirements.



696 Table 3.—Candidates Examine

	Marginal Numbers	Name of School	1 Alabama P	F	2 Alaska P	F	3 Arizona P	F	4 Arkansas P	F	5 California P	F	6 Colorado P	F	7 Connecticut P	F	8 Delaware P	F	9 District of Columbia P	F	10 Florida P	F	11 Georgia P	F	12 Hawaii P	F	13 Idaho P	F	14 Illinois P	F	15 Indiana P	F	16 Iowa P	F	17 Kansas P	F	18 Kentucky P	F	19 Louisiana P	F	20 Maine P	F	21 Marylind P	F	22 Massachusetts P	F	23 Michigan P	F
Ala.	1	Medical Coll. of Alabama.....	64	0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	6	1	1	0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ark.	2	University of Arkansas.....	..	..	..	..	..	..	84	5	..	..	..	..	..	..	..	..	..	..	4	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	0	..	..	..	..	..	..
Calif.	3	Coll. of Med. Evan.....	..	..	1	0	..	..	..	..	32	0	..	..	..	..	..	..	..	..	8	1	3	0	..	..	..	..	2	0	1	0	..	..	..	..	..	..	..	..	1	0	..	..	6	1	1	0	2	0
	4	Univ. of California, Los Angeles	..	..	..	..	1	0	..	..	49	0	..	..	..	..	..	..	..	..	1	0	..	..	1	0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	5	University of Southern Cal.....	..	..	..	..	..	..	..	..	42	0	..	..	..	..	..	..	..	..	0	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	6	Stanford University.....	..	..	..	..	..	..	..	..	33	0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	0	..	..	..	..	..	..	..	..
	7	Univ. of Calif., San Francisco..	..	..	..	..	..	..	..	..	78	0	..	..	..	..	..	..	..	..	..	..	..	..	2	0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Example data showing number of applicants from a medical school who passed or failed state medical board examinations in a given year, illustrating the granular nature of the data used to calculate passage rates by state, school, and year.

I implement a stacked event study design following Cengiz et al. (2019), which addresses potential bias from heterogeneous treatment effects across states and time periods. Each event d represents a subset of observations where states either adopted a chiropractic board in a given year or did not adopt a chiropractic board until the end of the subpanel. This design ensures identification comes only from comparisons between just-treated and never-treated states within each event window. The estimating equation is:

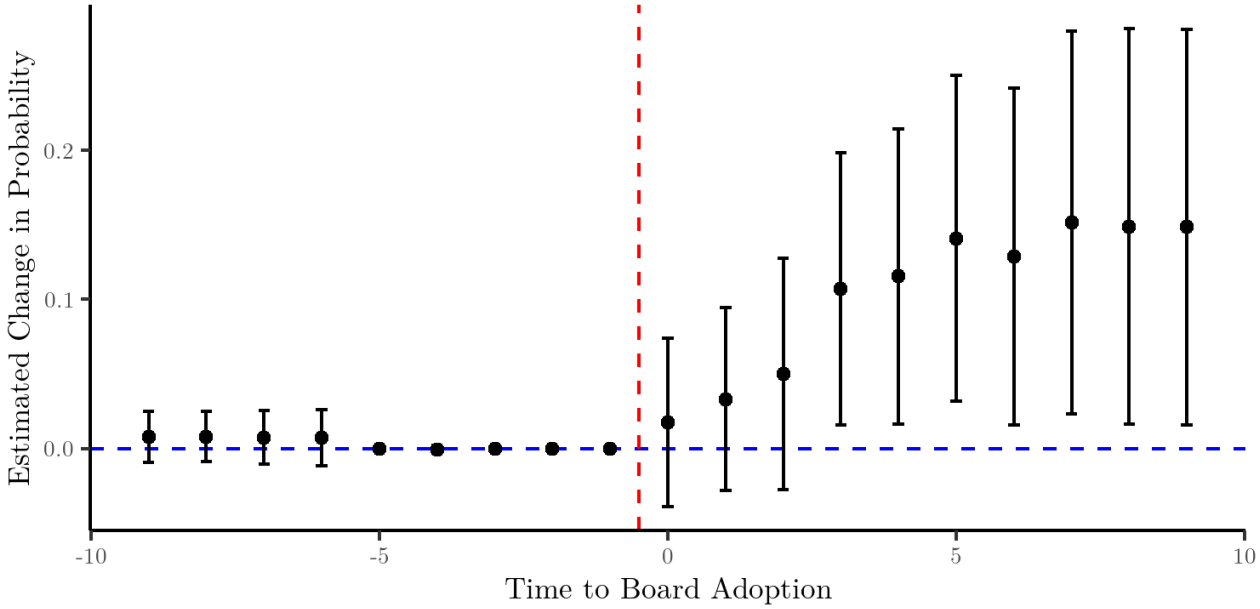
$$Y_{scyd} = \alpha \text{NewBoard}_{syd} + \beta X_{syd} + \gamma_{scd} + \phi_{cyd} + \varepsilon_{csyd} \tag{1}$$

where Y_{scyd} represents the outcome of interest (passage rate, education requirement, or internship requirement) for state s, school c, and year y relative to treatment timing (event) d. The treatment indicator NewBoard_{syd} captures the adoption of chiropractic boards or basic science boards, allowing me to separately identify the effect of direct competitive pressure versus general regulatory changes. State-level controls X_{syd} include alternative medical practice restrictions and other licensing board adoptions to isolate the chiropractic-specific effect.

The specification for the passage rate of individual students includes event-school-state

fixed effects γ_{scd} and event-school-year fixed effects ϕ_{cyd}, which control for time-invariant unobservables at the state-college level and common temporal shocks within each college, respectively. For the state-level regressions the fixed effects are simply at the event-year (yd) and state-event (sd) level. This two-way fixed effects structure ensures identification by comparing within-state variation across newly treated and not-yet-treated states.

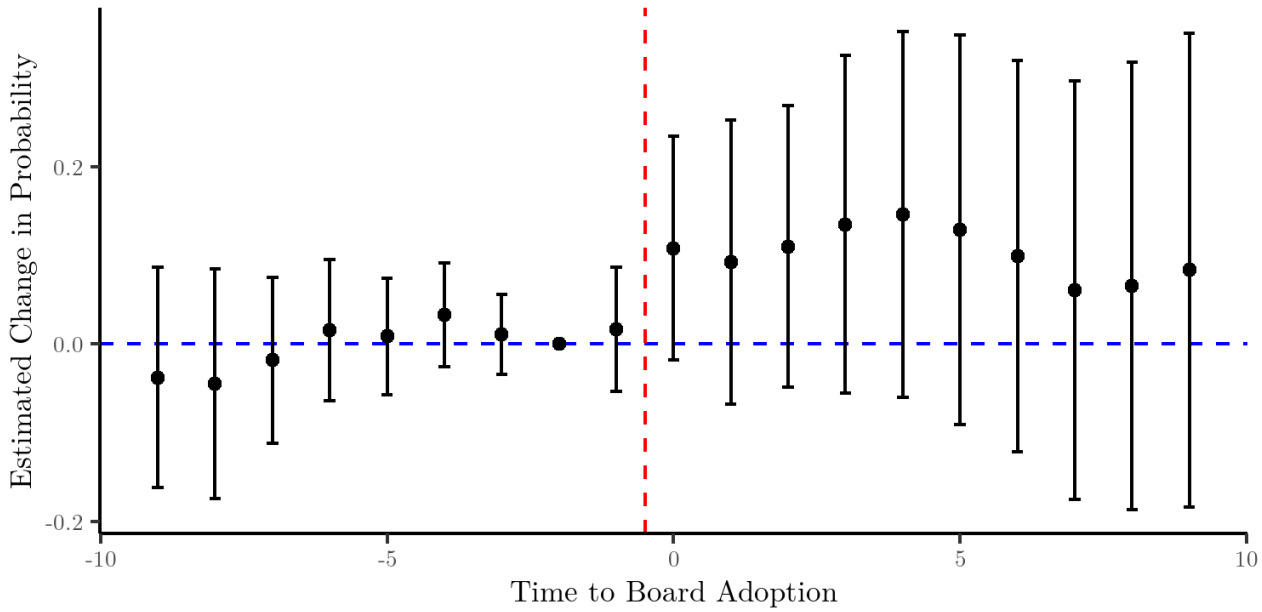
Figure 6: Requiring an Internship by Time to Chiropractic Board



Event study plot using stacked event study methodology. Outcome variable is the probability of a state requiring doctors to complete an internship year following medical school. Plot shows coefficients relative to two years prior to chiropractic board adoption (time -2), with 95% confidence intervals. The specification includes state-event and event-year fixed effects. Small confidence intervals in the pre-period are a result of limited movement in covariates. For combined effect see Appendix A.

The event study results reveal a pattern consistent with strategic response by medical boards. Figure 6 demonstrates that medical boards increased internship requirements in response to chiropractic legitimization. This effect builds more gradually over time, growing to just over 10 percentage points in treated states relative to control states. This pattern suggests that internship requirements may have required coordination or additional legislative processes to implement.

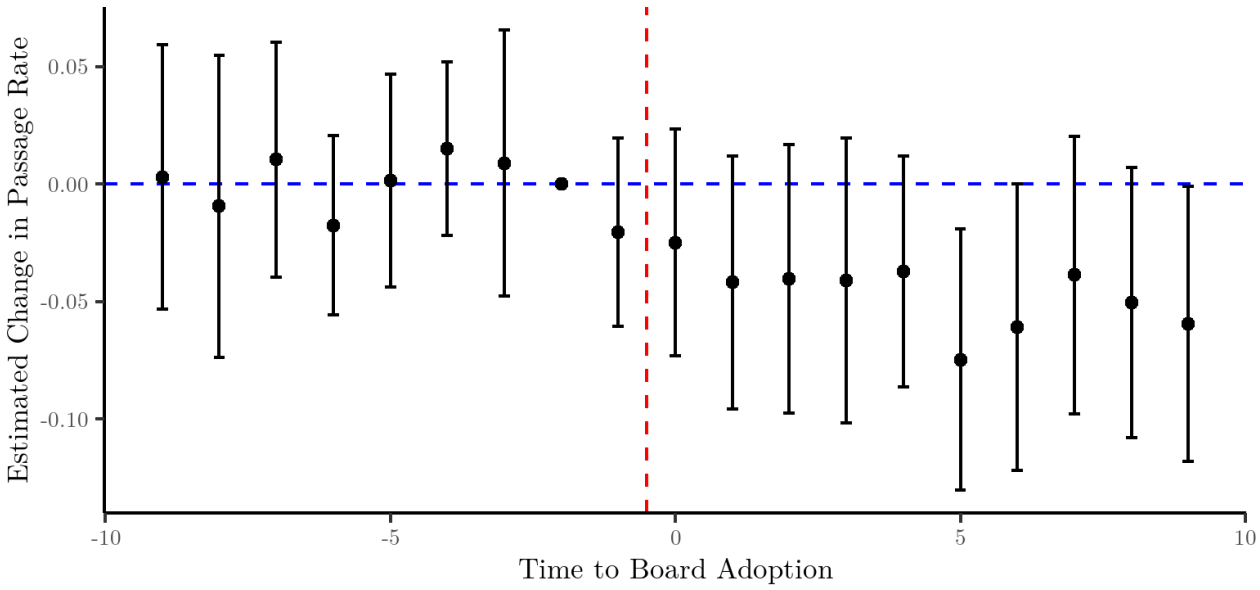
Figure 7: Requiring Two Years of College by Time to Chiropractic Board



Event study plot using stacked event study methodology. Outcome variable is the probability of requiring two years of college prior to medical school. Plot shows coefficients relative to two years prior to chiropractic board adoption (time -2), with 95% confidence intervals. Identification comes from within-state variation in timing of chiropractic board establishment. For combined effect see Appendix A.

Similarly, Figure 7 shows that medical boards increased the probability of requiring two years of pre-medical college education following chiropractic board establishment. While individual post-adoption coefficients do not reach conventional significance levels, the pattern suggests an immediate effect of approximately 10 percentage points that persists in subsequent years. The consistent elevation of point estimates across all post-adoption periods, combined with the absence of any comparable pre-trend, provides suggestive evidence of a regulatory response, though the limited statistical power warrants caution in drawing definitive conclusions about the precise timing and magnitude of the effect.

Figure 8: Medical Board Passage Rate by Time to Chiropractic Board



Event study plot using stacked event study methodology. Outcome variable is the passage rate of state medical boards conditional on medical school quality. Plot shows coefficients relative to two years prior to chiropractic board adoption (time -2), with 95% confidence intervals. Methodology controls for medical school quality to isolate changes in board examination difficulty. For combined effect see Appendix A.

The results for examination passage rates, shown in Figure 8, provide additional evidence of strategic tightening. Medical boards appear to have made their examinations more difficult following chiropractic board adoption, with passage rates declining by approximately 5 percentage points in treated states. Notably, this decline may begin the year prior to chiropractic board establishment, potentially demonstrating anticipatory behavior by medical boards who could foresee the competitive threat and adjust examination difficulty more quickly than formal regulatory requirements.

Collectively, these findings provide strong empirical support for strategic interaction between professional licensing boards. The consistency of results across multiple dimensions of licensing stringency suggests that medical boards systematically responded to competitive threats by raising barriers to entry into their own profession. This behavior is consistent with the theoretical prediction that medical professional organizations will use regulatory tools to

maintain market power when faced with substitute providers.

4 How Does This Affect Doctors?

The evidence shows that medical boards tightened entry requirements in response to chiropractic licensing. I now examine how these regulatory changes affected the medical profession economically. If medical boards acted to protect incumbent interests, tightening requirements may have improved physician welfare. I focus on three key measures: profitability measured by home values from 1930-1940 census data, educational attainment from 1940-1950 census records, and physician prevalence from 1900-1950 census data. These outcomes capture the net effect of both medical board responses and chiropractic licensing introduction on physician welfare, though separating the two effects is difficult since they occurred together.

4.1 Methodology and Empirical Strategy

The primary analytical approach employs a difference-in-differences framework to isolate the causal effects of chiropractic board adoption. The baseline specification takes the form:

$$Y_{icy} = \alpha ChiroBoard_{cy} + \delta BasicScience_{cy} + \beta Age_{icy} + \gamma_c + \phi_y + \varepsilon_{icy} \tag{2}$$

In this model, Y_{icy} represents the outcome variables of interest, including the logarithm of home values and home ownership rates for individual i in county c during year y. The key treatment variables $ChiroBoard_{cy}$ and $BasicScience_{cy}$ capture the adoption of either chiropractic boards or basic science boards in county c during year y. Age_{icy} controls for general differences by age, while the specification incorporates county fixed effects γ_c and year fixed effects ϕ_y to control for time-invariant county characteristics and common temporal shocks.

4.2 Control Group: Similar Non-Health Professions

To provide context and test whether licensing effects are specific to health professions, I examine outcomes for similar non-health professions as a control group. I selected five professions—Electrical Engineers, Civil Engineers, Librarians, Mechanical Engineers, and Government Officials—to minimize the Mahalanobis distance between their average log home values, educational attainment, and home ownership rates relative to both chiropractors and doctors. This control group analysis helps validate that the observed effects are specific to health professions rather than reflecting broader economic trends affecting all skilled professions.

4.3 Impact on Doctor Economic Outcomes

The empirical results reveal striking patterns in how licensing reforms impact the economic well-being of medical professionals compared to the control group. When examining home ownership patterns among doctors, the adoption of chiropractic boards generates a positive effect on home values, with a coefficient of 0.228 (approximately a 26% increase in home values) for doctors following the establishment of chiropractic licensing boards. This is unlikely to be driven by selection given that, home ownership itself increases by about four percentage points.

In contrast, the results for similar non-health professions present a markedly different picture. Chiropractic board adoption shows much smaller effects on these placebo professions' home values, with a coefficient of 0.060. The probability of home ownership for similar non-health professions also increases by a smaller magnitude of 0.021. Fully interacted regressions demonstrate that, in most cases, the effects on doctors differ significantly from those on placebo professions, as shown by the interaction terms.

Table 3: Difference-in-Differences on Doctor Home Ownership versus Similar Non-Health Professions

	Doctor		Placebo Professions		Doctor & Placebo	
Event Type	log(Home Value)	Pr(Own Home)	log(Home Value)	Pr(Own Home)	log(Home Value)	Pr(Own Home)
Adopt Chiropractic Board	0.228***	0.044***	0.060*	0.021†	0.060*	0.021†
	(0.031)	(0.013)	(0.026)	(0.012)	(0.026)	(0.012)
Adopt Basic Science Board	−0.137***	0.003	−0.053†	0.037**	−0.053†	0.037**
	(0.034)	(0.014)	(0.029)	(0.012)	(0.029)	(0.012)
Adopt Chiropractic Board × Doctor					0.168***	0.024
					(0.041)	(0.017)
Adopt Basic Science Board × Doctor					−0.084†	−0.034†
					(0.046)	(0.019)
Observations	80,436	151,030	141,808	301,782	222,244	301,782

Note: † $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Difference-in-differences estimation with county and year fixed effects. Pair cluster bootstrap standard errors clustered by state in parentheses. Sample includes doctors from 1930-1940 Census and similar non-health professions (Electrical Engineers, Civil Engineers, Librarians, Mechanical Engineers, and Government Officials).

The adoption of basic science boards shows a negative effect on doctor home values, with a coefficient of -0.137 (a 12.8% decrease). The probability of home ownership shows virtually no change. For similar non-health professions, basic science board adoption shows a smaller negative effect on home values (-0.053) and a positive effect on home ownership probability (0.037).

4.4 Educational Quality Analysis

The analysis extends beyond economic outcomes to examine how licensing reforms affect the quality of medical professionals, as proxied by educational attainment. Using a selection-on-observables approach, the specification becomes:

$$Y_{icy} = \alpha ChiroBoard_{cy} + \delta BasicScience_{cy} + \beta X_{icy} + \phi_y + \varepsilon_{icy} \tag{3}$$

Here, the outcome Y_{icy} represents years of educational attainment, while the control variables X_{icy} include individual age and the average educational attainment of non-health professionals in the county to account for local educational trends.

The results show that chiropractic board adoption is associated with increased

educational attainment among doctors. The most robust specification, which includes both age fixed effects and controls for local educational trends, yields a coefficient of ≈ 0.2 years of additional education.

The parallel analysis of similar non-health profession educational attainment provides additional validation for the identification strategy. Chiropractic board adoption produces negligible effects on placebo profession education in the most comprehensive specification, which includes age fixed effects and controls for local educational trends. Fully interacted regressions show that the estimated effect on doctors differs significantly from the effect on placebo professions.

Table 4: Board Adoption on Doctor Educational Attainment versus Similar Non-Health Professions

	Doctor Attainment			**Placebo Attainment**			**Doctor & Placebo**
	(1)	(2)	(3)	(1)	(2)	(3)	(4)
Adopted Chiropractic Board	0.138	0.186*	0.175†	0.040	0.038	−0.031	−0.031
	(0.091)	(0.089)	(0.093)	(0.119)	(0.120)	(0.096)	(0.096)
Adopted Basic Science Board	−0.042	−0.040	−0.059	−0.042	−0.022	−0.071	−0.071
	(0.108)	(0.096)	(0.086)	(0.154)	(0.159)	(0.106)	(0.106)
Average Educational Attainment			0.120**			0.486***	0.486***
			(0.035)			(0.053)	(0.053)
Adopted Chiropractic Board × Doctor							0.206*
							(0.089)
Adopted Basic Science Board × Doctor							0.012
							(0.122)
Average Educational Attainment × Doctor							−0.366***
							(0.046)
Observations	200,442	200,442	200,442	516,829	516,829	516,829	717,271
Age FEs		✓	✓		✓	✓	✓

Note: † $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Selection-on-observables approach with year fixed effects and individual controls. Standard errors clustered by state in parentheses. Sample includes doctors and similar non-health professions from 1940-1950 Census.

Basic science board adoption shows consistently negative but statistically insignificant effects on doctor educational attainment across all specifications, with coefficients ranging from -0.040 to -0.059. For similar non-health professions, the effects are also generally negative and insignificant.

4.5 Supply Effects and Market Dynamics

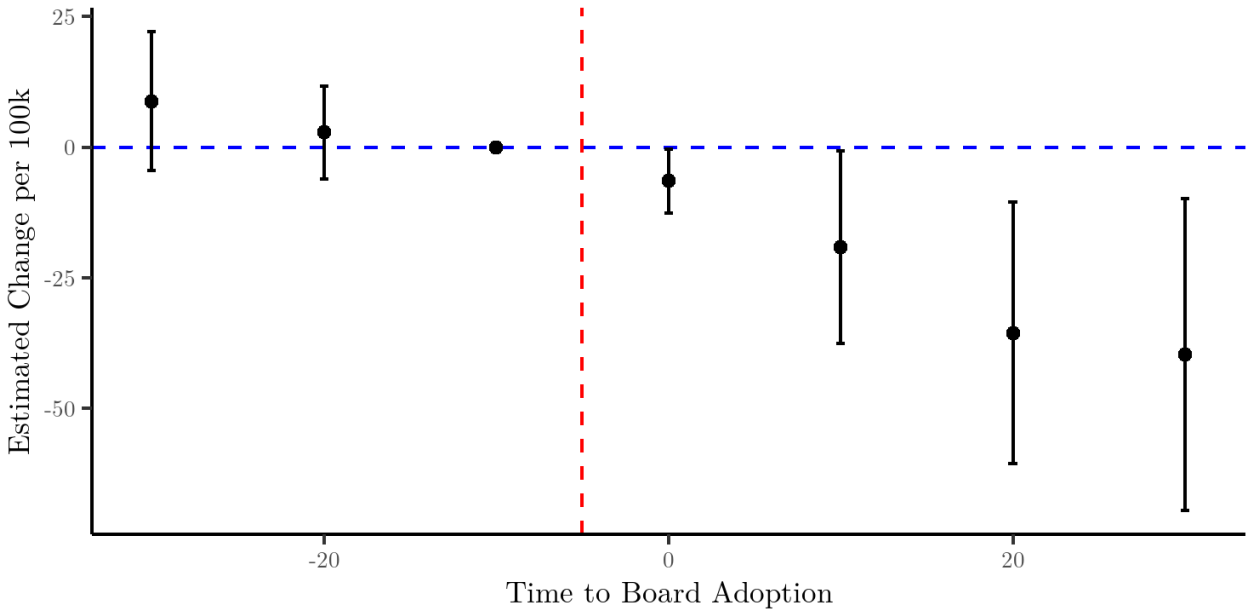
To examine how licensing affects the supply of medical professionals, I employ the same stacked event study approach I used in the earlier analysis of medical board responses to chiropractic licensing. I follow the methodology of Cengiz et al. (2019). This specification addresses potential concerns about treatment effect heterogeneity and timing of adoption:

$$Y_{cyd} = \alpha NewBoard_{cyd} + \beta X_{cyd} + \gamma_{cd} + \phi_{yd} + \varepsilon_{cyd} \tag{4}$$

Each event d represents a subset of observations where states either adopted a chiropractic board in a given year or did not adopt a chiropractic board until the end of the subpanel. The outcome variable Y_{cyd} measures the number of practitioners per 100,000 population in county c, year y, for event d. The treatment variable $NewBoard_{cyd}$ indicates the adoption of licensing boards. Controls X_{cyd} include the adoption of alternative board types and urban-rural classification. The specification incorporates event-county fixed effects γ_{cd} and event-year fixed effects ϕ_{yd}. These provide more flexible control for confounding factors.

Following the adoption of chiropractic licensing boards, the prevalence of doctors in treated states exhibits a decline (Figure 9). While no individual pre-adoption coefficient reaches conventional significance levels, the point estimates suggest some evidence of a pretrend, warranting caution in interpreting the full magnitude of the post-adoption decline as purely causal. The observed decline is similar in magnitude to the national drop in doctor prevalence commonly attributed to the Flexner Report (Figure 1). While the evidence suggests chiropractic licensing boards contributed to reduced physician prevalence, the presence of potential pre-existing trends implies the policy's causal effect may be smaller than the raw post-adoption decline indicates. These findings provide suggestive evidence of a meaningful relationship, though the precise magnitude remains uncertain.

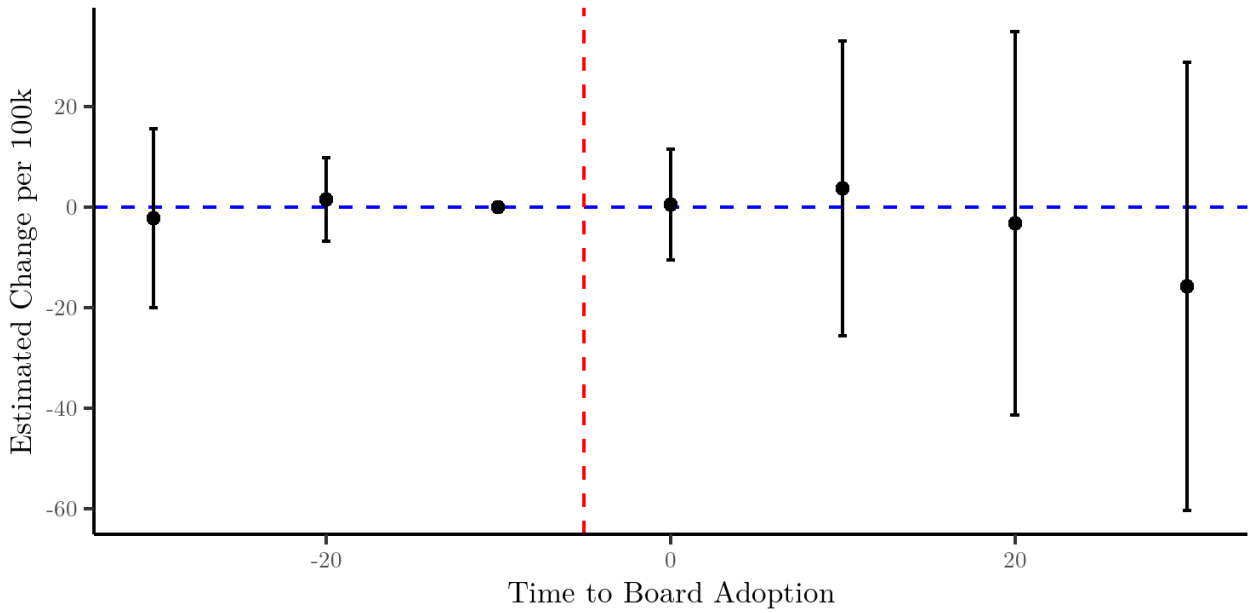
Figure 9: Event Study on Prevalence of Doctors at Adoption of Chiropractic Board



This figure shows the dynamic effects of chiropractic board adoption on the number of doctors per 100,000 population using a stacked event study methodology comparing treated states to untreated states. The x-axis represents years relative to chiropractic board adoption, and the y-axis shows the estimated treatment effects with 95% confidence intervals.

In contrast, the analysis of similar non-health profession supply using the same stacked difference-in-differences approach reveals patterns distinct from those observed for doctors. As Figure 10 shows, the event study analysis provides no evidence of a shift in the prevalence of similar non-health professions following chiropractic board introduction. The coefficients remain close to zero across all periods, both before and after board adoption, with confidence intervals that consistently include zero.

Figure 10: Event Study on Prevalence of Similar Non-Health Professions at Adoption of Chiropractic Board



This figure shows the dynamic effects of chiropractic board adoption on the number of similar non-health professionals per 100,000 population using a stacked event study methodology comparing treated states to untreated states. The x-axis represents years relative to chiropractic board adoption, and the y-axis shows the estimated treatment effects with 95% confidence intervals. Similar non-health professions include Electrical Engineers, Civil Engineers, Librarians, Mechanical Engineers, and Government Officials.

This stark contrast between the supply effects on doctors versus similar non-health professions provides additional validation that the observed patterns reflect profession-specific responses to healthcare regulation rather than broader economic trends affecting all skilled professions.

5 How Does This Affect Chiropractors?

Having established the spillover effects of chiropractic licensing on the medical profession, I now examine how these regulatory changes directly impact chiropractors themselves. This analysis examines the primary intended beneficiaries of licensing reform and provides insight into how professional regulation shapes market outcomes for the regulated profession.

5.1 Economic Impact on Chiropractors

The economic effects of licensing on chiropractors show patterns that differ from those observed for doctors and are even more distinct from the control group of similar non-health professions. Using the same difference-in-differences framework applied to doctors, the adoption of chiropractic boards generates a positive effect on chiropractor home values, with a coefficient of 0.364 (approximately a 44% increase in home values). The effect on home ownership probability is also positive, with an increase of about 19 percentage points.

These effects are substantially larger than those observed for similar non-health professions, which show coefficients of 0.060 for home values and 0.021 for home ownership probability following chiropractic board adoption.

Table 5: Difference-in-Differences on Chiropractor Home Ownership versus Similar Non-Health Professions

	Chiropractor		**Placebo Professions**		**Chiro & Placebo**	
Event Type	log(Home Value)	Pr(Own Home)	log(Home Value)	Pr(Own Home)	log(Home Value)	Pr(Own Home)
Adopt Chiropractic Board	0.364*	0.186*	0.060*	0.021†	0.060*	0.021†
	(0.172)	(0.078)	(0.026)	(0.012)	(0.026)	(0.012)
Adopt Basic Science Board	−0.277	−0.096	−0.053†	0.037**	−0.053†	0.037**
	(0.184)	(0.083)	(0.029)	(0.012)	(0.029)	(0.012
Adopt Chiropractic Board × Chiropractor					0.304†	0.165*
					(0.173)	(0.079)
Adopt Basic Science Board × Chiropractor					−0.224	−0.133
					(0.185)	(0.084)
Observations	3,152	6,855	141,808	301,782	144,960	308,637

Note: † $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Difference-in-differences estimation with county and year fixed effects. Pair cluster bootstrap standard errors clustered by state in parentheses. Sample includes chiropractors from 1930-1940 Census and similar non-health professions.

5.2 Educational Quality Effects

The adoption of chiropractic licensing boards substantially increases educational attainment among chiropractors. Using the most comprehensive specification, which includes age fixed effects and controls for local educational trends, the policy change is associated with 0.6 additional years of education.

This effect is consistent across specifications, with coefficients ranging from 0.520 to 0.565,

all statistically significant at the 1% or 0.1% level. This contrasts sharply with the effects on similar non-health professions, where chiropractic board adoption produces negative effects on education in the most comprehensive specification, with a statistically insignificant coefficient of -0.031.

Table 6: Board Adoption on Chiropractor Educational Attainment versus Similar Non-Health Professions

	Chiropractor Attainment			**Placebo Attainment**			**Chiro & Placebo**
	(1)	(2)	(3)	(1)	(2)	(3)	(4)
Adopted Chiropractic Board	0.520**	0.540***	0.565***	0.040	0.038	−0.031	−0.031
	(0.158)	(0.152)	(0.161)	(0.119)	(0.120)	(0.096)	(0.096)
Adopted Basic Science Board	−0.082	−0.067	−0.074	−0.042	−0.022	−0.071	−0.071
	(0.133)	(0.122)	(0.127)	(0.154)	(0.159)	(0.106)	(0.106)
Average Educational Attainment			−0.054			0.486***	0.486***
			(0.061)			(0.053)	(0.053)
Adopted Chiropractic Board × Chiropractor							0.596***
							(0.136)
Adopted Basic Science Board × Chiropractor							−0.004
							(0.129)
Average Educational Attainment × Chiropractor							−0.540***
							(0.074)
Observations	12,641	12,641	12,641	516,829	516,829	516,829	529,470
Age FEs		✓	✓		✓	✓	✓

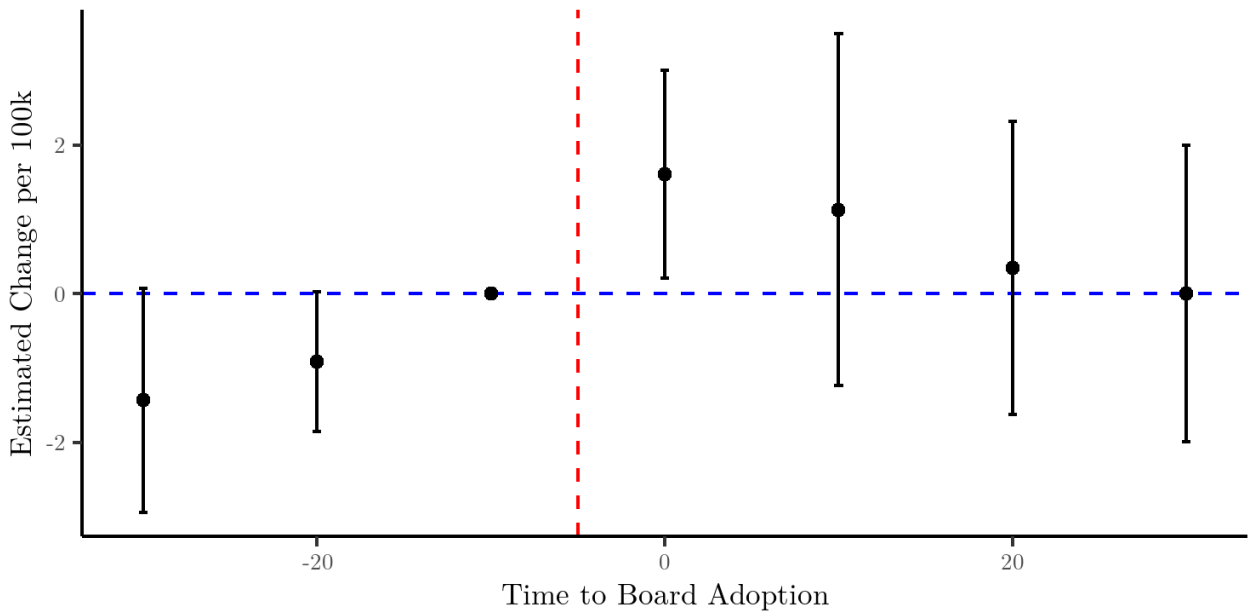
Note: † $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Selection-on-observables approach with year fixed effects and individual controls. Standard errors clustered by state in parentheses. Sample includes chiropractors and similar non-health professions from 1940-1950 Census.

The fully interacted regression shows that the effect on chiropractors is significantly larger and different from that on placebo professions, with an interaction coefficient of 0.596.

5.3 Supply Dynamics and Market Entry

A simple stacked event study (Figure 11) on the prevalence of chiropractors suggests that the prevalence of chiropractors increased after the adoption of a chiropractic board. The periods before adoption, however, show a concerning upward trajectory, complicating causal interpretation.

Figure 11: Event Study on Prevalence of Chiropractors at Adoption of Chiropractic Board



This figure presents the event study analysis of chiropractic board adoption effects on chiropractor prevalence per 100,000 population. The analysis uses a two-way fixed effects specification with event-time relative to board adoption on the x-axis and estimated coefficients with confidence intervals on the y-axis.

5.4 Methodological Challenges and Solutions

The analysis of chiropractor supply effects confronts two primary identification challenges that threaten the validity of standard difference-in-differences approaches. First, higher prevalence of chiropractors may increase their political lobbying power, leading to endogenous adoption of licensing boards Law and Kim (2005). This reverse causality problem means that jurisdictions with more chiropractors may be more likely to adopt licensing, confounding the ability to identify the causal effect of licensing on prevalence.

Second, the prevalence of chiropractors exhibits strong persistence over time, meaning that a higher current prevalence leads to a higher future prevalence, as workers often remain in the profession they previously chose. This creates a serial correlation problem that can bias estimates of treatment effects.

To address these challenges, I implement an instrumental variables approach combined with dynamic panel methods. The strategy involves two key innovations: first, instrumenting for the existence of a licensing board using the prevalence of health professions in non-bordering counties within the state, combined with the lagged urbanicity of the state. Second, including a lagged dependent variable and higher-order polynomial controls for prior profession prevalence to address persistence issues.

5.5 Instrumental Variables Strategy

The first stage of the instrumental variables approach takes the form:

$$NewBoard_{pcyd} = \sum^{P} \gamma_{cdpi} \left(Y_{dp,-10,-c}\right) * 1[T] + \upsilon X_{pcyd} + \varepsilon_{pcyd} \tag{5}$$

where $NewBoard_{pcyd}$ is a binary indicator for chiropractic board adoption in profession p, county c, year y, event d. This specification instruments for board adoption using $Y_{dp,-10,-c}$, the prevalence of various health professions in non-bordering counties within the same state ten years prior to adoption, interacted with time period indicators $1[T]$. The coefficients γ_{cdpi} capture the relationship between distant professional prevalence and local licensing decisions, while X_{pcyd} represents control variables with coefficients υ. The identifying assumption is that state-level political and regulatory environments influence licensing decisions, while the specific prevalence in non-bordering counties remains uncorrelated with local economic shocks directly affecting chiropractor outcomes in the focal county.

The second stage incorporates the predicted board adoption variable with flexible persistence controls:

$$Y_{cydp} = \alpha \hat{NewBoard}_{pcyd} + \beta X_{pcyd} + \sum^{P} \sum_{i=1}^{3} \delta_{cdpi} f(Y^{i}_{cdp,y-1}) + \phi_{pyd} + \varepsilon_{pcyd} \tag{6}$$

where Y_{cydp} is the outcome variable, α is the coefficient of interest on predicted board adoption $\hat{NewBoard}_{pcyd}$, and β represents coefficients on control variables X_{pcyd}. The

specification includes $f(Y^i_{cdp,y-1})$, a cubic polynomial (i=1,2,3) in lagged prevalence of each of the professions with coefficients δ_{cdpi} to flexibly control for persistence effects, and ϕ_{pyd} representing event-specific year fixed effects to absorb common temporal shocks.

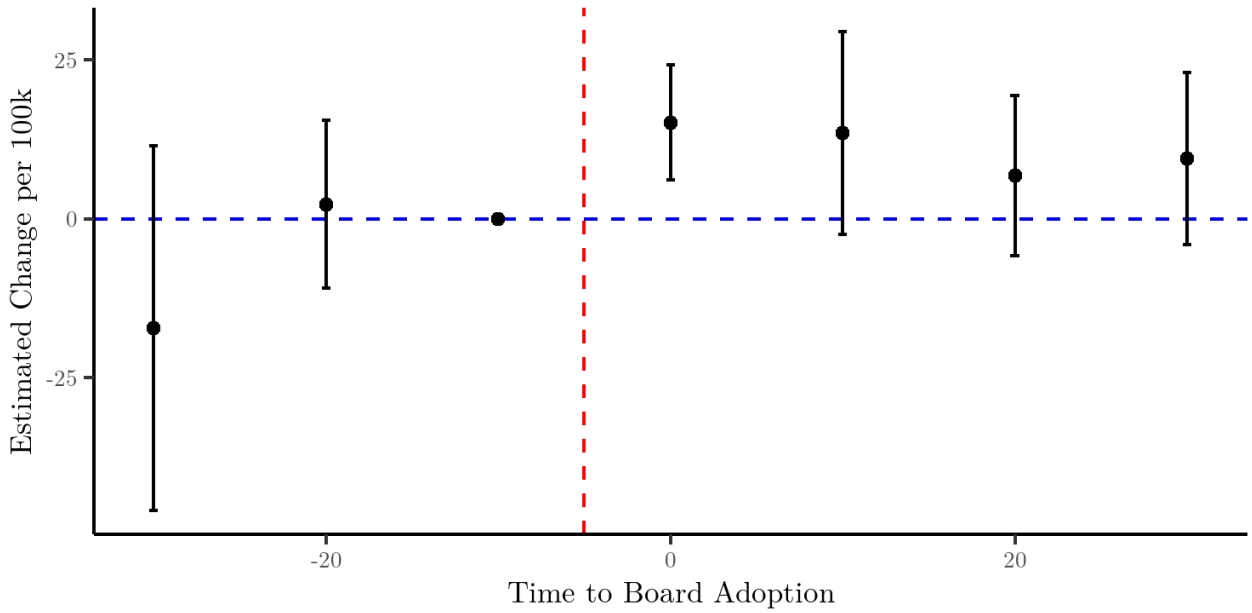
The key insight underlying this identification strategy is that policy decisions are determined by characteristics of the entire state, which can be isolated from local economic shocks that might directly affect professional outcomes. The prevalence of health professions in distant parts of the state reflects broader political economy factors that influence regulatory decisions without being directly correlated with local market conditions.

The primary threat to the exclusion restriction is spatial correlation in economic conditions across counties within a state. However, the extensive controls for neighboring county characteristics and flexible time trends should address this concern. Additionally, using non-bordering counties helps minimize direct spillover effects while preserving the relevance of state-level political determinants.

5.6 Instrumental Variables Results

This instrumental variables approach continues to show an increase in chiropractor prevalence, but with a less concerning pre-trend. Figure 12 requires a different interpretation than prior event studies due to the lagged dependent variable specification, but yields similar conclusions. Following chiropractic board adoption, the growth in chiropractor prevalence increases by approximately 11 practitioners per 100,000 people, compared to relatively flat growth rates before adoption. To contextualize this magnitude, an 11-practitioner increase in prevalence exceeds the total national increase observed over the study period (Figure 3). However, the concurrent growth in basic science board prevalence would partially offset this increase.

Figure 12: Event Study on Growth of Chiropractors at Adoption of Chiropractic Board



Notes: This figure shows event study coefficients from the instrumental variables specification described in equation (2). The dependent variable is the growth in chiropractor prevalence (practitioners per 100,000 population). The specification includes cubic polynomials in lagged profession prevalence and event-specific year fixed effects. Confidence intervals are shown at the 95% level. The interpretation differs from standard event studies due to the lagged dependent variable specification, but demonstrates relatively flat pre-trends followed by sustained growth in chiropractor prevalence after board adoption.

The results comparing fixed effects and instrumental variables approaches across different professions show distinct patterns. For chiropractors, the instrumental variables estimate of chiropractic board adoption shows a coefficient of 11.733 chiropractors per 100,000 population, compared to the fixed effects estimate of 1.825. For similar non-health professions, the coefficients are much smaller and generally insignificant, providing additional validation for the health profession-specific effects.

Table 7: Estimated Effects of Board Adoption on Prevalence

	Chiropractors/100K		Doctors/100K		Similar Non-Health Professions/100K	
Event Type	Chiropractic Board	Basic Science Board	Chiropractic Board	Basic Science Board	Chiropractic Board	Basic Science Board
Fixed Effects Regressions						
Adopted Board	1.825†	0.258	−17.177*	12.642†	−0.132	−1.086
	(0.931)	(0.973)	(8.243)	(6.543)	(0.706)	(1.183)
Observations	141,695	141,190	141,695	141,190	141,695	141,190
IV Lagged DV Regressions						
Adopted Board	11.733*	−23.009†	−39.605†	32.509	3.279	−6.132
	(4.559)	(13.263)	(21.829)	(23.829)	(3.115)	(9.789)
Observations	111,152	116,428	111,152	116,428	111,152	116,428
Instrument Strength and Validity Tests						
Cragg-Donald F statistic						
Treated	381.806	338.886	381.806	338.886	430.026	341.598
Chiropractic Board		699.318		699.318		634.419
Basic Science Board	455.011		455.011		488.752	
Sargan test p-value	1.000	1.000	1.000	1.000	1.000	1.000

Note: † $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Fixed effects models use stacked event study methodology comparing treated states to untreated states with event-county and event-year fixed effects. IV models instrument for licensing using non-bordering county health profession prevalence, with lagged dependent variables and cubic polynomial controls. Standard errors clustered by state in parentheses. Similar non-health professions include Electrical Engineers, Civil Engineers, Librarians, Mechanical Engineers, and Government Officials.

The instrumental variables results also show effects on other professions. The adoption of chiropractic boards shows a coefficient of -39.605 per 100,000 population for doctor prevalence (with large standard errors). For similar non-health professions, the chiropractic board coefficient is not significant, providing further evidence that the licensing effects are specific to health professions. The Cragg-Donald F-statistics range from 338 to 699, well above conventional thresholds for instrument relevance. The Sargan test p-values of ≈ 1 indicate that the null hypothesis of instrument exogeneity cannot be rejected.

The stark contrast in results between health professions (doctors and chiropractors) and similar non-health professions across all outcome measures—economic outcomes, educational attainment, and supply effects—provides strong validation that the observed patterns reflect profession-specific responses to healthcare regulation rather than broader economic trends affecting all skilled professions.

6 Theoretical Model

It can be difficult to build an intuition about what to expect in competitive occupational licensure, so I develop a model to help understand the dynamics at play.

The model of competitive occupational licensing is a sequential game with three key features: (1) licensing serves as a barrier to entry, (2) it may benefit consumers, and (3) professional organizations have well-defined objectives. For simplicity, I refer to an *exterior game* where professional organizations set licensing requirements, followed by an *interior market* where workers and consumers make utility-maximizing choices among professions. I use this model to perform equilibrium analysis and structural estimation.

6.1 Timing

The game proceeds in five stages:

1. **Stage 1**: Professional organization 1 (doctors) sets entry cost s_1.

2. **Stage 2**: Professional organization 2 (chiropractors) observes s_1 and sets entry cost s_2.

3. **Stage 3**: A Walrasian auctioneer sets prices (P_1, P_2) to clear markets.

4. **Stage 4**: Workers observe (s_1, s_2) and prices (P_1, P_2) and choose professions and hours (h_1, h_2).

5. **Stage 5**: Consumers observe prices (P_1, P_2) and choose services.

Stages 3-5 constitute the *interior economy*. I solve the game by backward induction, first characterizing the interior market equilibrium for any given (s_1, s_2), then solving for the optimal licensing choices.

6.2 Interior Economy (Stages 3-5)

Consider a production economy with two types of agents and a single service market that clears via a Walrasian auctioneer. Within the market, there are two professional services indexed by $p \in \{1, 2\}$ and an outside option.

Agents

- **Consumers**: A continuum of consumers indexed by $c \in [0, m]$, where m is the market size. Each consumer has a unit demand for a professional service or the option to abstain. Heterogeneous tastes are modeled via profession-specific utility shocks.

- **Workers**: A continuum of workers indexed by $i \in [0, l]$, where l is the labor force size. Each worker is endowed with labor and heterogeneous preferences over professions. Workers vary in ability q_i and face profession-specific utility shocks. Each worker who enters the profession p optimally chooses hours h_p to maximize profit.

Optimal Hours Choice Each practitioner in profession p chooses hours to maximize profit:

$$\max_{h_p} \pi_p = P_p h_p - \gamma h_p^2 \tag{7}$$

The first-order condition yields optimal hours:

$$h_p^* = \frac{P_p}{2\gamma} \tag{8}$$

and maximized profit:

$$\pi_p^* = \frac{P_p^2}{4\gamma} \tag{9}$$

Worker Payoffs A worker i with ability q_i derives utility from entering profession p as:

$$V_{pi} = a\pi_p^* - b\frac{s_p}{q_i} - cq_i + \mu_p + \varepsilon_{pi} \tag{10}$$

where π_p^* is the equilibrium profit, s_p is the entry cost, μ_p is the common profession-specific taste, and $\varepsilon_{pi} \sim$ Extreme Value is the idiosyncratic shock. This matches the intuition that workers want to earn a profit, while the cost imposed by the board is decreasing in ability, but the worker's outside option is also increasing in ability. μ_p reflects non-compensatory or regulatory features that may make a profession more or less appealing to workers. The utility from choosing the outside option is normalized to 0.

The choice probability is:

$$\mathbb{P}(\text{choose } p|q_i) = \frac{e^{\overline{V}_p(q_i)}}{1 + e^{\overline{V}_1(q_i)} + e^{\overline{V}_2(q_i)}} \tag{11}$$

with $\overline{V}_p(q_i) = a\pi_p - b\frac{s_p}{q_i} - cq_i + \mu_p$.

From this setup, labor quantity supplied and labor quality are determined by the equilibrium prices.

Labor Supply The number of workers (n) entering profession p is:

$$n_p = l\int_0^\infty \frac{e^{\overline{V}_p(q_i)} f(q_i)}{1 + e^{\overline{V}_1(q_i)} + e^{\overline{V}_2(q_i)}} dq_i \tag{12}$$

where $f(q_i)$ is the log-normal density.

Quality Formation Average quality in profession p:

$$\overline{q}_p = \frac{l}{n_p} \int_0^\infty \frac{e^{\overline{V}_p(q_i)} f(q_i) q_i}{1 + e^{\overline{V}_1(q_i)} + e^{\overline{V}_2(q_i)}} dq_i \tag{13}$$

When entry costs are higher, the average ability of workers generally increases, but if profit stays the same, fewer workers enter the profession. This creates a tradeoff between having more workers and having more capable workers in the profession.

Consumer Preferences Consumer c receives utility from profession p:

$$U_{pc} = \alpha \overline{q}_p - \beta P_p + \psi_p + \epsilon_{pc} \tag{14}$$

where $\overline{q}_p$ is average quality, P_p the price, ψ_p is the average non-varying taste for a profession, and $\epsilon_{pc} \sim$ Extreme Value are idiosyncratic differences between consumer's tastes. This follows the logic that consumers want high-quality service, but dislike paying a high price. The utility from choosing the outside option is normalized to 0.

Choice probabilities follow:

$$\mathbb{P}(\text{choose } p) = \frac{e^{\overline{U}_p}}{1 + e^{\overline{U}_1} + e^{\overline{U}_2}} \tag{15}$$

with $\overline{U}_p = \alpha \overline{q}_p - \beta P_p + \psi_p$.

Service Market Clearing Market clearing occurs when:

$$n_p h_p^* = m \frac{e^{\overline{U}_p}}{1 + e^{\overline{U}_1} + e^{\overline{U}_2}} \tag{16}$$

Substituting optimal hours:

$$n_p \frac{P_p}{2\gamma} = m \frac{e^{\overline{U}_p}}{1 + e^{\overline{U}_1} + e^{\overline{U}_2}} \tag{17}$$

with the left side as aggregate supply (number of workers times optimal hours worked per

worker) and the right side as aggregate demand.

Interior Market Equilibrium A *Walrasian equilibrium* is a collection of prices (P_1, P_2), quantities (n_1, n_2), hours (h_1^*, h_2^*), and qualities $(\overline{q}_1, \overline{q}_2)$ such that:

1. Practitioners optimize hours given prices: $h_p^* = \frac{P_p}{2\gamma}$.
2. Workers optimize profession choice given prices and optimal profit.
3. Consumers optimize utility given prices.
4. The service market clears for both professions.
5. Qualities $\overline{q}_p$ are consistent with the selection mechanism implied by worker choice.

Result:

Proposition 1 (Interior Market Equilibrium)**.** *Under the baseline model assumptions, there exists a Walrasian equilibrium for any given entry costs* (s_1, s_2)*.*

For the formal existence proof, see Appendix B. [2]

6.3 Exterior Game (Stages 1-2)

Agents Each profession p has a representative organization that sets s_p to maximize total profession-wide profit. Profession 1 (the doctors) moves first in Stage 1; Profession 2 (the chiropractors) responds in Stage 2.

Payoffs It is unclear how to model the objective function of organizations that set licensing stringency. This parallels the classic Ross-Dunlop discussion regarding labor union decision-making (Kaufman, 2002). In my primary model, I adopt an "economic model" framework, assuming that licensing organizations seek to maximize total earnings within the

[2] *With specific parameter values,* uniqueness can be verified by checking for a contraction mapping.

profession. However, I will also examine alternative decision-making models to provide a more comprehensive analysis.

Organization p maximizes:

$$\text{Payoff}_p = n_p \pi_p \tag{18}$$

This reflects the idea that professional organizations derive revenue from serving practitioners.[3] I assume that the actual cost to practitioners associated with functioning of the professional organization is sufficiently small such that it does not impact the choice of profession for workers.[4]

Exterior Game Equilibrium I focus on subgame-perfect equilibria. A subgame-perfect equilibrium is a pair (s_1^*, s_2^*) such that neither organization wishes to change its entry cost, given the other's choice and the sequential nature of the game.

7 Structural Estimation and Simulation

This model is intentionally flexible so that it can be calibrated and tailored to multiple contexts, but not all characteristics are generalizable. In this section, I estimate the parameters for my empirical context, but it is important to note that different contexts may call for different policy prescriptions.

To illustrate the model's key mechanisms and comparative statics, I conduct numerical simulations under various parameter configurations. The simulations demonstrate how licensing stringency affects quality sorting, entry quantities, prices, and strategic interactions between competing professional boards. Under symmetric baseline preferences, the model predicts that boards engage in cream-skimming behavior through strategic manipulation of licensing standards, with important implications for welfare across different regulatory

[3] A common suggestion is that a licensing board may be maximizing average profit, but in a one-generation model, this leads to unrealistic degenerate outcomes with infinitesimally small, high-quality professions.

[4] Alternatively, it could be considered part of the coefficient a.

regimes. When professions have asymmetric baseline attractiveness, the magnitude of strategic responses and welfare rankings vary substantially. Full simulation results and detailed analysis are presented in Appendix D.

I estimate the model's parameters using a five-stage procedure. I use records from the 1940 and 1950 complete count censuses. Subscripts denote workers (i), consumers (c), State Economic Areas indexed by year (m), states indexed by year (s), and professions (p).

Stage 1: Market-Level Ability Estimation. Using data on earnings of workers employed outside the regulated professions, I estimate the parameters of a log-normal distribution for latent skill at the SEA-year level. To account for top and bottom coding, I fit a *winsorized* log-normal distribution using maximum likelihood estimation (MLE), recovering μ_m and σ_m^2 governing the distribution of

$$\log q_i^{\text{prior}} \sim \mathcal{N}(\mu_m, \sigma_m^2).$$

This distribution forms the prior for profession-specific skill draws used in subsequent stages.

Stage 2: Labor Market Parameter Estimation. Each worker i draws a profession-specific latent ability q_{pi} from the market-level prior. I estimate parameters governing occupational choice and labor supply by modeling the utility of entering profession p in SEA-year m as

$$V_{pi,m} = \mu_p + a\pi_{p,m} + \frac{s_{p,s}}{q_{pi}} + cq_{pi} + \nu_{pi},$$

where $\pi_{p,m}$ denotes expected profit conditional on skill, $s_{p,s}$ is licensing stringency in state-year s, and ν_{pi} is an error term. The function b_p/q_{pi} allows the effect of regulation to vary inversely with ability, capturing that stringency disproportionately affects lower-skilled workers. Parameters (μ_p, a, b_p) are estimated using BLP methods, with demographic draws from the ability distribution serving as observed heterogeneity.

Stage 3: Empirical Bayes Shrinkage on Stringency Parameters. To improve the stability of regulatory effect estimates, I apply empirical Bayes shrinkage to the stringency parameters $\{s_p\}$ using bootstrap standard errors. For each profession, I calculate:

$$\tilde{s}_{sp} = \mu_s^{\text{prior}} + \frac{\sigma^2_{\text{signal}}}{\sigma^2_{\text{signal}} + \text{SE}^2_{sp}}(\widehat{s}_{sp} - \mu_s^{\text{prior}}),$$

where μ_s^{prior} is the cross-state mean of stringency effects, σ^2_{signal} is the variance of true stringency effects net of sampling error, and SE_s^2 is the bootstrap standard error for state p. The shrinkage is applied separately to chiropractor and physician stringency parameters within each profession. These shrunken parameters $\{\tilde{s}_s\}$ are then used in the subsequent ability imputation step.

Stage 4: Ability Imputation. Using the estimated labor market parameters (including the shrunken stringency parameters $\{\tilde{s}_s\}$) and observed occupational choices, I invert the model to impute posterior ability levels $\widehat{q}_{pi}$ for each worker in each profession and SEA-year. These quality estimates are calculated by combining the structural parameters with observed market shares and the empirically shrunken regulatory stringency measures, ensuring that the imputed abilities reflect stabilized estimates of regulatory effects.

Stage 5: Consumer Demand Estimation. Consumer c's utility from choosing profession p in market m is

$$U_{c,p,m} = \overline{U}_{p,m} + \varepsilon_{c,p,m},$$

where the mean utility is

$$\overline{U}_{p,m} = \alpha \widehat{q}_{p,m} + \beta P_{p,m} + \psi_p + \xi_{p,m}.$$

Here, $\widehat{q}_{p,m}$ is the imputed quality measure in profession p and SEA-year m (calculated using shrunken stringency parameters), $P_{p,m}$ is the effective price, and ψ_p is a profession-specific

fixed effect. The idiosyncratic shocks $\varepsilon_{c,p,m}$ are Type I extreme value distributed. The model is estimated using two-stage least squares with market shares relative to an outside option as the dependent variable, instrumenting for potentially endogenous quality and price using labor force size, competitor stringency, and demographic characteristics.

8 Results: Structural Estimation

8.1 Parameter Estimates

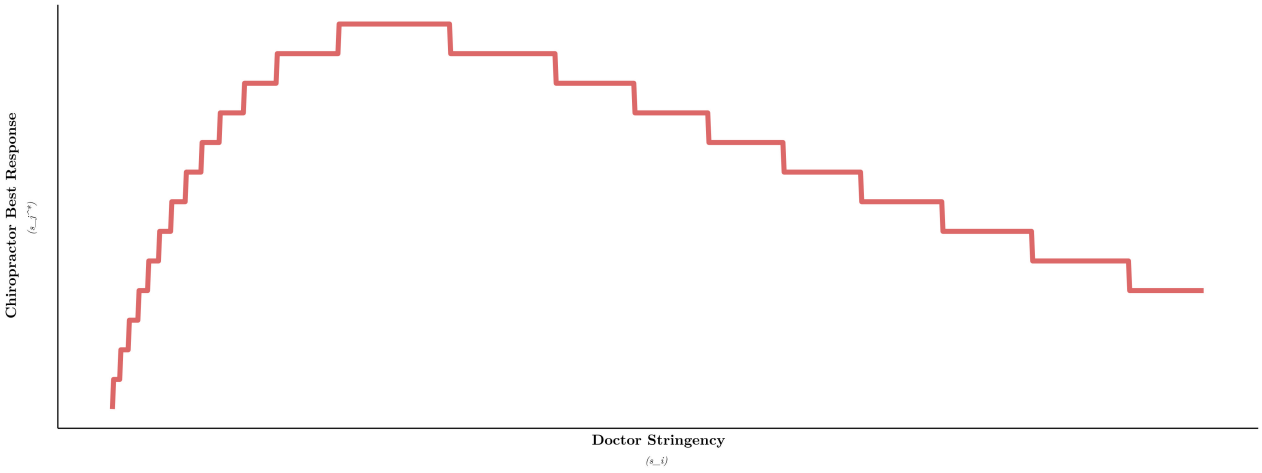
Table C.1 presents the structural parameter estimates, which broadly align with theoretical expectations. Workers show weak responsiveness to increased profitability ($a = 0.00002$) and modest deterrence from lucrative outside options ($c = -0.00476$), consistent with substantial frictions in entering and exiting these professions. Both professions exhibit substantial negative baseline parameters—doctors at $\mu_{\text{doc}} = -3.12$ and chiropractors at $\mu_{\text{chiro}} = -5.99$ (difference of -2.87). These parameters capture a combination of non-skill-varying entry costs and average tastes for working in each profession. The more negative value for chiropractors suggests either higher fixed entry barriers, lower average occupational preferences, or both—consistent with doctors' prestige advantage and the relative nascence of chiropractic as a profession during this period. The stringency parameters—2,599 for chiropractors and 3,232 for doctors after empirical Bayes shrinkage—enter utility as $s_{p,s}/q_{pi}$, indicating that regulatory barriers impose stricter quality requirements for doctors than chiropractors, as expected given differences in medical training.

Consumer demand parameters similarly conform to expectations. Consumers exhibit weak quality sensitivity ($\alpha = 0.00329$) but substantial price sensitivity ($\beta = -2.80$), generating downward-sloping demand curves. Profession-specific demand shifters reveal that consumers strongly disfavor unskilled doctors ($\psi_{\text{doc}} = -5.17$) but still prefer doctors over chiropractors ($\psi_{\text{chiro}} - \psi_{\text{doc}} = -1.51$) conditional on quality and price, plausibly reflecting greater confidence in the scientific foundations of conventional medicine.

8.2 Strategic Interactions Between Regulatory Boards

Figure 13 reveals the chiropractor board's strategic response to physician board stringency within the empirically relevant range. The best response function exhibits a striking non-monotonic pattern: chiropractors prefer *higher* stringency when doctors set low stringency, but prefer *lower* stringency when doctors set high stringency. This inverted relationship suggests chiropractor boards use licensing requirements strategically to differentiate their profession when physicians are accessible, but relax standards to maintain market share when physicians become scarce. [5]

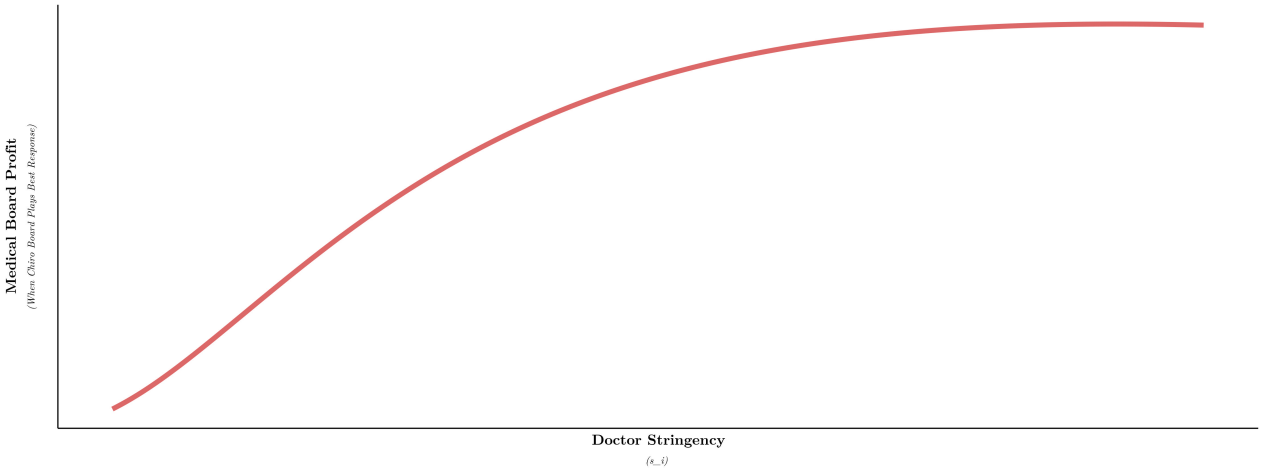
Figure 13: Chiropractor Strategic Response to Doctor Stringency
Best Response Function in Observed Stringency Range



Chiropractor board's optimal stringency choice as a function of physician board stringency, zoomed to empirically relevant range. The non-monotonic best response shows chiropractors prefer higher stringency when doctors set low stringency, and lower stringency when doctors set high stringency. The apparent step-wise nature is due to the discrete stringency levels used in the simulation. In a truly continuous setting, this would be a smooth function.

[5] This reflects a common strategy that arises across parameter values where boards seek to "cream-skim" each other (for more, see Appendix E).

Figure 14: Medical Board Prefers a High Stringency in Sequential Game
Medical Board Profits Under Chiropractor Best Response



This plots the medical board payoff for each stringency level, assuming the chiropractic board plays its best response. Estimated parameters from Table C.1.

8.3 Equilibrium Comparisons Across Governance Regimes

Using estimated parameters, I simulate five alternative regulatory regimes to assess how institutional design affects market outcomes. Table 8 presents equilibrium outcomes, while Figures 13, and 14,15 illustrate strategic interactions and welfare implications.

Stackelberg Equilibrium. When boards sequentially maximize incumbent profits with doctors moving first, restrictive outcomes emerge: 47.20 doctors and 4.70 chiropractors per 100,000. Doctor profits reach $36,437 while chiropractor profits reach $2,920. Figure 14 shows that doctors set a high stringency to avoid direct competition, forcing chiropractors into a less restrictive best response.

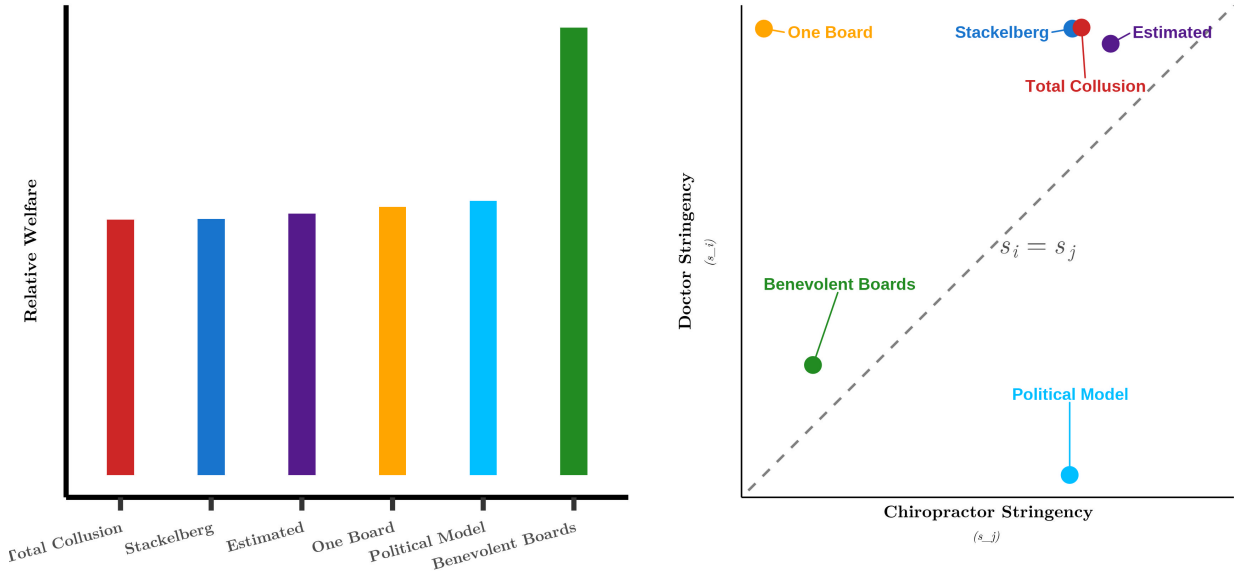
Political Model. When boards maximize producer surplus—internalizing entry costs and outside options—rather than pure profits, outcomes change dramatically. Doctor density surges to 998.22 per 100,000 while chiropractor density remains at 4.61. Doctor profits collapse to $1,469 as boards reduce barriers to enhance potential entrants' welfare.

Benevolent Boards. Under total welfare maximization, both professions expand moderately: 264.83 doctors and 26.83 chiropractors per 100,000. Figure 15 shows this regime achieves highest total welfare by balancing quality concerns against access. Doctor profits fall to $18,357 and chiropractor profits to $1,424 as boards sacrifice incumbent rents for social welfare.

Total Collusion. Joint profit maximization across professions yields outcomes nearly identical to Stackelberg: 47.02 doctors and 4.51 chiropractors per 100,000, with profits of $36,438 and $2,919 respectively. Figure 14 shows explicit coordination achieves similar outcomes to sequential play when the first mover possesses sufficient market power.

Single Board. When the medical board sets stringency for both professions to maximize doctor profits, striking asymmetry emerges: doctor density remains at 47.14 while chiropractor density surges to 58.62 per 100,000. Doctors maintain high barriers while flooding the market with chiropractors through zero stringency, preserving doctor rents ($36,405) while destroying chiropractor rents ($486).

Figure 15: Welfare and Policy Outcomes Across Regulatory Regimes
Total Welfare Comparison and Equilibrium Stringency Levels



Left panel shows total welfare (consumer surplus plus producer profits) across five governance regimes plus the estimated equilibrium. Right panel displays equilibrium stringency levels for doctors and chiropractors under each regime. Benevolent boards achieve highest total welfare, while Stackelberg and collusion regimes maximize incumbent profits. Single board regime eliminates chiropractor regulatory autonomy. Estimated parameters from Table C.1.

Table 8: Equilibrium Comparison Across Governance Regimes

Equilibrium	Doctor Per 100K	Chiro Per 100K	Doctor Outside Salary	Chiropractor Outside Salary	π_{Doc}	π_{Chiro}
Stackelberg	47.20	4.70	2,975.51	2,470.14	36,436.59	2,919.66
Political Model	998.22	4.61	818.64	2,475.34	1,469.08	2,897.61
Benevolent Boards	264.83	26.83	1,588.12	1,226.30	18,356.73	1,424.37
Total Collusion	47.02	4.51	2,979.25	2,505.59	36,437.97	2,919.08
One Board	47.14	58.62	2,976.51	813.76	36,405.37	486.18
Estimated	49.91	3.96	2,922.80	2,616.12	36,425.42	2,905.78
Actual	104.65	10.03			4,965.46	3,954.86

Note: Doctor Per 100K and Chiropractor Per 100K represent practitioners per 100,000 population. Outside salaries and profits (π) are in dollars. Estimated values from data.

8.4 Comparative Welfare Analysis

Figure 15 reveals substantial welfare variation across governance structures. Benevolent boards achieve highest welfare, followed by the political model. Profit-maximizing regimes

(Stackelberg and collusion) produce lowest welfare, while single-board governance generates intermediate outcomes due to asymmetric treatment.

The stark contrast between Stackelberg and political equilibria—both featuring sequential play with doctor first-movers—demonstrates how objective functions shape outcomes. Profit maximization produces stringent barriers preserving incumbent rents; producer surplus maximization dramatically reduces barriers by internalizing entry costs. The near-equivalence of Stackelberg and collusion shows sequential profit maximization with doctor leadership effectively achieves cartel outcomes without explicit coordination.

8.5 Implications for Regulatory Capture

The model's estimated equilibrium produces practitioner densities of 49.91 doctors and 3.96 chiropractors per 100,000, with profits of $36,425 for doctors and $2,906 for chiropractors. These estimates closely match profit-maximizing equilibria—particularly the Stackelberg and total collusion regimes—rather than political or benevolent scenarios. However, the model substantially underestimates actual practitioner densities: observed data show 104.65 doctors and 10.03 chiropractors per 100,000, with actual profits of $4,965 for doctors and $3,955 for chiropractors.

This discrepancy likely reflects the model's static treatment of regulatory stringency combined with limited statistical power in the data. The empirical Bayes shrinkage procedure pools stringency variation toward a single level for each profession, effectively estimating a representative equilibrium based on recent or average regulatory intensity. However, the observed stock of practitioners includes workers who entered under varying historical regimes—many during earlier periods when licensing requirements were likely less stringent. The model thus estimates equilibrium practitioner density under current stringency levels, while actual data reflect the accumulated stock of entrants across decades of regulatory evolution. This temporal aggregation naturally leads the static model to underpredict current practitioner stocks and overpredict current profits, as the market

contains "legacy" practitioners who entered under more permissive rules than the estimated equilibrium suggests.

Despite this quantitative misalignment, the qualitative pattern remains instructive. The historical relationship between these professions makes explicit collusion (total collusion regime) implausible. The medical profession has long viewed chiropractic skeptically, with organized medicine actively opposing chiropractor licensure throughout the early twentieth century and the American Medical Association maintaining formal policies against professional association with chiropractors until the 1980s.[6]

The more credible interpretation is that observed regulatory behavior reflects independent profit maximization by separate boards, approximating a Stackelberg-type equilibrium where physician boards set restrictive licensing standards that chiropractor boards accommodate through strategic responses. While the model underestimates market liberalization, the estimated parameters still suggest boards prioritize incumbent interests over broader social welfare. If boards instead maximized producer surplus, physician density would exceed 900 per 100,000 in the model—nearly ten times actual levels and twenty times estimated levels. The fact that actual outcomes fall between profit-maximizing and welfare-maximizing predictions suggests regulatory capture exists but faces meaningful constraints from political, legal, or competitive forces not fully captured in the model.

9 Conclusion

This paper establishes that occupational licensing boards respond strategically to competitive threats from substitute professions. Using newly digitized data on medical licensing requirements from 1907-1960, I demonstrate that medical boards tightened entry requirements following the establishment of chiropractic licensing boards in their states. Medical boards increased college requirements by approximately 10 percentage points,

[6]This adversarial history makes coordinated profit maximization across professions highly unlikely, despite the similar equilibrium outcomes.

mandated internships at rates of 10-15 percentage points, and reduced passage rates by approximately 5 percentage points. While some individual coefficients do not reach conventional significance levels, the consistent pattern of increased stringency across multiple regulatory margins provides strong evidence of strategic response to competitive entry. These regulatory responses generated substantial economic consequences: doctors experienced 26% increases in home values and gained 0.2 years of educational attainment, while their prevalence declined by 17-40 per 100,000 population. Chiropractors saw even larger gains, with 44% increases in home values, 0.6 additional years of education, and increased market presence of 2-12 per 100,000 population.

The instrumental variables strategy, which exploits variation in non-bordering county characteristics within states, addresses endogeneity concerns arising from persistence in professional prevalence and potential reverse causality in board adoption. The strategy produces strong first-stage results (F-statistics of 338-699) and passes overidentification tests. The absence of comparable effects for similar non-health professions validates that the observed patterns reflect profession-specific responses to healthcare regulation rather than broader economic trends affecting all skilled professions.

To understand the mechanisms driving these empirical patterns, I develop a structural model of competitive occupational licensing where professional organizations set licensing requirements strategically to maximize incumbent profits. The model features workers who differ in ability and choose professions based on expected returns, and consumers who observe only average quality within each profession, creating an asymmetric information problem. I estimate the model's parameters using a five-stage procedure that combines ability estimation from census earnings data, BLP-style demand estimation, and empirical Bayes shrinkage to stabilize regulatory effect estimates.

The estimated parameters reveal key features of the regulatory environment. Workers show modest responsiveness to profitability ($a = 0.00002$) and regulatory barriers, while consumers exhibit strong price sensitivity ($\beta = -2.80$) but weak quality sensitivity ($\alpha = 0.00329$). Both professions face substantial baseline entry costs, with chiropractors

facing larger barriers ($\mu_{\text{chiro}} - \mu_{\text{doc}} = -2.87$) that reflect doctors' prestige advantage. The stringency parameters—approximately 2,600 for chiropractors and 3,200 for doctors after empirical Bayes shrinkage—indicate that regulatory barriers impose stricter quality requirements for doctors, consistent with differences in medical training intensity.

Using the estimated parameters, I simulate equilibrium outcomes across alternative regulatory regimes. The estimated equilibrium closely approximates profit-maximizing outcomes under sequential competition (Stackelberg equilibrium), producing practitioner densities and profits that align more closely with strategic behavior than with welfare maximization or political models that internalize entry costs. While the static model underestimates actual practitioner stocks—likely because observed densities reflect accumulated entry under historically varying stringency levels—the qualitative patterns reveal important strategic dynamics.

The simulations demonstrate that chiropractor boards follow a non-monotonic best response function: they prefer higher stringency when doctors set low stringency (to engage in "cream-skimming" of high-ability workers), but prefer lower stringency when doctors set high stringency (to maintain market share). This strategic interaction reflects three countervailing effects: a direct entry cost effect that excludes low-ability workers, a quality effect that raises average ability and attracts consumers, and a cross-profession spillover effect where quality improvements in one profession reduce demand for the other. The joint preference distribution of workers concentrates near the origin, making workers with weak preferences between professions highly responsive to relative quality changes and amplifying the returns to cream-skimming strategies.

Welfare analysis across regulatory regimes reveals that benevolent boards maximizing total welfare achieve the highest social surplus, followed by political models that internalize entry costs. Profit-maximizing regimes (Stackelberg and collusion) produce substantially lower welfare, while single-board governance generates intermediate outcomes due to asymmetric treatment of professions. Critically, these welfare rankings depend on baseline profession preferences: when professions have asymmetric baseline attractiveness, competition

between boards can produce higher welfare than collusion under certain conditions.

These findings have important implications for regulatory policy and economic history. First, analyses of occupational licensing that ignore competitive dynamics between professions may substantially mischaracterize welfare effects. The traditional view of licensing as a simple quality-quantity tradeoff within a single profession misses the strategic interactions that shape market structure across competing professions. Second, the strategic use of licensing to limit competition suggests that professional organizations may not act as benevolent regulators maximizing social welfare. The estimated parameters indicate boards prioritize incumbent interests, though actual outcomes fall between pure profit-maximization and welfare-maximization, suggesting regulatory capture exists but faces meaningful constraints from political, legal, or competitive forces.

Third, the welfare improvements from board competition relative to monopolistic regulation under certain preference configurations indicate that policy interventions preventing explicit collusion between professional boards may yield social benefits. However, the welfare effects are highly sensitive to baseline profession characteristics, making optimal regulatory structure context-dependent.

The increase in chiropractor prevalence following licensing board adoption warrants careful interpretation. In standard models of occupational licensing with asymmetric information, licensing can increase practitioner prevalence by solving adverse selection problems—certification signals quality to consumers, raising willingness to pay and attracting entry. However, my framework identifies an additional strategic channel: medical boards' competitive response to chiropractic licensing tightened doctor entry requirements, reallocating workers toward the chiropractic profession. The observed increase in chiropractor prevalence thus reflects both the traditional information-correction mechanism and strategic substitution induced by doctors' regulatory response. Distinguishing these channels matters for welfare analysis—while solving asymmetric information problems generates unambiguous social benefits, strategic reallocation driven by rent-seeking behavior may reduce overall welfare even as it increases practitioner counts. The structural model's simulations, which

show chiropractors prefer lower stringency when doctors tighten requirements, suggest this strategic substitution channel plays a meaningful role in the observed patterns.

Fourth, the historical evidence reframes the Flexner reforms—traditionally viewed as exogenous improvements in medical quality driven by scientific progress—as potentially endogenous strategic responses to competitive threats from alternative practitioners.

The empirical context also demonstrates the value of the instrumental variables approach developed in this paper. The strategy of using non-bordering county characteristics within states as instruments for local policy adoption, while controlling for surrounding county characteristics to address spatial correlation, should apply to other contexts where policy endogeneity and outcome persistence create identification challenges. The strong first-stage results and successful overidentification tests suggest this approach can credibly address reverse causality concerns in settings where state-level political economy determines regulatory choices but local economic shocks affect outcomes.

Future research should extend this framework to contemporary licensing contexts where multiple professions compete. Particularly relevant examples include nurse practitioners and doctors, where scope-of-practice laws continue to evolve; mental health counselors and psychologists, where licensing requirements vary substantially across states; and physician assistants and doctors, where substitutability has increased with technological change. Additionally, the model could be extended to incorporate dynamics explicitly, allowing for analysis of how licensing stringency evolves over time as professions mature and competitive threats emerge or dissipate.

The structural estimation approach also opens avenues for counterfactual policy analysis. With credibly estimated parameters, researchers could quantify the welfare effects of alternative regulatory reforms, such as consolidating multiple boards under unified governance, implementing federal minimum standards, or restricting the scope of practice to reduce substitutability between professions. Such analysis would be particularly valuable for understanding the welfare consequences of recent deregulation efforts in various states and occupations.

Finally, the finding that professional organizations engage in strategic quality competition through licensing standards suggests broader implications for understanding organizational behavior in other contexts where quality is partially observable and entry can be restricted. Similar dynamics may operate in educational accreditation, where competing accrediting bodies set standards for schools and programs; professional certifications, where industry associations compete to establish credibility; and platform governance, where competing platforms set quality thresholds for participants. Understanding the competitive dynamics of standard-setting organizations remains an important area for future research.

As occupational licensing continues to expand across industries and professions, understanding these competitive dynamics becomes increasingly critical for effective regulatory design. This paper demonstrates that competition between licensing boards generates complex strategic interactions with ambiguous welfare effects that depend critically on underlying profession characteristics and institutional details. Policymakers evaluating licensing reforms must account for these competitive dynamics to avoid unintended consequences and design regulatory structures that balance quality assurance against access and competition concerns.

References

(1914). Current Comment. *Journal of the American Medical Association*, LXII(15):1176–1178.

Akerlof, G. A. (1970). The market for "lemons": Quality uncertainty and the market mechanism. *The Quarterly Journal of Economics*, 84(3):488–500.

Anderson, D. M., Brown, R., Charles, K. K., and Rees, D. I. (2020). Occupational licensing and maternal health: Evidence from early midwifery laws. *Journal of Political Economy*, 128(11):4337–4383.

Andrews, B. P. (2021). Reporting versus reputation: Physician quality and the flexner report of 1910. Technical report, Working Paper. Version: 11 December.

Angrist, J. D., Imbens, G. W., and Krueger, A. B. (1999). Jackknife instrumental variables estimation. *Journal of Applied Econometrics*, 14(1):57–67.

Berry, S., Levinsohn, J., and Pakes, A. (1995). Automobile prices in market equilibrium. *Econometrica*, 63(4):841–890.

Blair, P. Q. and Chung, B. W. (2021). A model of occupational licensing and statistical discrimination. In *AEA papers and proceedings*, volume 111, pages 201–205. American Economic Association 2014 Broadway, Suite 305, Nashville, TN 37203.

Cai, J. and Kleiner, M. M. (2020). The labor market consequences of regulating similar occupations: the licensing of occupational and physical therapists. *Journal of Labor Research*, 41:352–381.

Carollo, N. A., Hicks, J. F., Karch, A., and Kleiner, M. M. (2022). The origins and evolution of occupational licensing in the united states. *Work Pap.*

Cengiz, D., Dube, A., Lindner, A., and Zipperer, B. (2019). The effect of minimum wages on low-wage jobs. *The Quarterly Journal of Economics*, 134(3):1405–1454.

Clay, K., Miller, G., Portnykh, M., and Schmick, E. J. (2025). Medical school closures, market adjustment, and mortality in the flexner report era. Technical report, National Bureau of Economic Research.

Dodini, S. (2023). The spillover effects of labor regulations on the structure of earnings and employment: Evidence from occupational licensing. *Journal of Public Economics*, 225:104947.

Haines, M. R. (2001). The urban mortality transition in the united states, 1800-1940. In *Annales de démographie historique*, volume 101, pages 33–64. Belin.

Johnson, C. D. and Green, B. N. (2021). Looking back at the lawsuit that transformed the chiropractic profession part 4: Committee on quackery. *Journal of Chiropractic Education*, 35(S1):55–73.

Kaufman, B. E. (2002). Models of union wage determination: What have we learned since dunlop and ross? *Industrial Relations: A Journal of Economy and Society*, 41(1):110–158.

Keating, J. C., Cleveland, C. S., and Menke, M. (2004). *Chiropractic History: A Primer*. Association for the History of Chiropractic Davenport, IA.

Kleiner, M. M., Marier, A., Park, K. W., and Wing, C. (2016). Relaxing occupational licensing requirements: Analyzing wages and prices for a medical service. *The Journal of Law and Economics*, 59(2):261–291.

Kleiner, M. M. and Soltas, E. J. (2023). A welfare analysis of occupational licensing in us states. *Review of Economic Studies*, 90(5):2481–2516.

Larsen, B. J., Ju, Z., Kapor, A., and Yu, C. (2022). The effects of occupational licensing stringency on the market for public school teachers. Technical report, Technical report.

Law, M. T. and Kim, S. (2005). Specialization and regulation: The rise of professionals and the emergence of occupational licensing regulation. *The Journal of Economic History*, 65(3):723–756.

Leland, H. E. (1979). Quacks, lemons, and licensing: A theory of minimum quality standards. *Journal of Political Economy*, 87(6):1328–1346.

Moehling, C. M., Niemesh, G. T., Thomasson, M. A., and Treber, J. (2020). Medical education reforms and the origins of the rural physician shortage. *Cliometrica*, 14(2):181–225.

Paige, N. M., Miake-Lye, I. M., Booth, M. S., Beroes, J. M., Mardian, A. S., Dougherty, P., Branson, R., Tang, B., Morton, S. C., and Shekelle, P. G. (2017). Association of Spinal

Manipulative Therapy With Clinical Benefit and Harm for Acute Low Back Pain: Systematic Review and Meta-analysis. *JAMA*, 317(14):1451–1460.

Perry, J. J. (2009). The rise and impact of nurse practitioners and physician assistants on their own and cross-occupation incomes. *Contemporary Economic Policy*, 27(4):491–511.

Persico, N. (2015). The political economy of occupational licensing associations. *The Journal of Law, Economics, & Organization*, 31(2):213–241.

Plemmons, A. and Timmons, E. (2023). Occupational licensing: A barrier to opportunity and prosperity. *The Center for Growth and Opportunity*.

Ruggles, S., Nelson, M. A., Sobek, M., Fitch, C. A., Goeken, R., Hacker, J. D., Roberts, E., and Warren, J. R. (2024). Ipums ancestry full count data: Version 4.0 [dataset]. minneapolis, mn: Ipums.

Shaked, A. and Sutton, J. (1981). Heterogeneous consumers and product differentiation in a market for professional services. *European Economic Review*, 15(2):159–177.

Shapiro, C. (1986). Investment, moral hazard, and occupational licensing. *The Review of Economic Studies*, 53(5):843–862.

Wilson, C. A. (1979). Equilibrium and adverse selection. *The American Economic Review*, 69(2):313–317.

A Board Response Difference in Difference

Table A.1: Effect of Chiropractic Licensing on Medical Board Requirements

Treatment	Pass Rate	Two-Year Requirement	Internship Requirement
Chiropractic License	-0.044* (0.018)	0.106 (0.111)	0.097* (0.044)

Note:
Standard errors in parentheses, clustered at state level. † p<0.10, * p<0.05, ** p<0.01, *** p<0.001. All specifications include event-year and event-state fixed effects.

B Equilibrium Existence

This appendix provides a formal proof that a Walrasian equilibrium exists in the interior economy for any given entry costs (s_1, s_2).

B.1 Setup and Definitions

For fixed entry costs (s_1, s_2), define the excess demand functions:

$$Z_p(P_1, P_2) = D_p(P_1, P_2) - S_p(P_1, P_2), \qquad i \in \{1, 2\}, \tag{19}$$

where

$$D_p(P_1, P_2) = m \cdot \frac{e^{\overline{U}_p}}{1 + e^{\overline{U}_1} + e^{\overline{U}_2}}, \tag{20}$$

$$S_p(P_1, P_2) = n_p(P_1, P_2) \cdot \frac{P_p}{2\gamma}, \tag{21}$$

with $\overline{U}_p = \alpha \overline{q}_p - \beta P_p + \psi_p$ and $n_p(P_1, P_2)$ given in the main text.

Standing Assumptions. Throughout the proof we assume:

1. $\beta > 0$ and $\gamma > 0$.

2. The worker ability distribution is log-normal with finite mean and variance; in particular, it admits a density $f(a)$ on $(0, \infty)$ with $\int_0^\infty f(a)\, da = 1$.

3. For each ability level a, the multinomial logit choice probabilities $\pi_p(a; P_1, P_2)$ are continuous in (P_1, P_2) and satisfy $0 \leq \pi_p \leq 1$.

4. Total worker mass l is finite.

These assumptions guarantee bounded demand and well-defined supply.

B.2 Price Domain

Define the compact price domain $S \subset \mathbb{R}^2_+$ as:

$$S = [P_{\min}, P_{\max}]^2. \tag{22}$$

Here $P_{\min} > 0$ is chosen such that $Z_p(P_{\min}, P_r) > 0$ for all $P_r \in [P_{\min}, P_{\max}]$ and $p, r \in \{1, 2\}$, while $P_{\max}$ is chosen such that $Z_p(P_{\max}, P_r) < 0$ for all $P_r \in [P_{\min}, P_{\max}]$.

Existence of such bounds follows from standard comparative statics: as $P_p \to 0^+$, demand from (20) remains strictly positive while supply from (21) tends to zero, so $Z_p \to +\infty$; as $P_p \to +\infty$, demand vanishes (since $\beta > 0$) while supply is positive, so $Z_p \to -\infty$.

B.3 Excess Demand Correspondence

For small $\alpha > 0$, define the correspondence $\Phi : S \rightrightarrows S$ by

$$\Phi(P_1, P_2) = \text{Proj}_S \left[(P_1, P_2) + \alpha\big(Z_1(P_1, P_2), Z_2(P_1, P_2)\big) \right], \tag{23}$$

where Proj_S denotes the orthogonal projection onto the convex set S. By construction this projection is unique, so Φ is in fact single-valued.

B.4 Verification of Kakutani Conditions

Lemma 1 (Domain Properties)**.** *The set S is non-empty, compact, and convex.*

Proof. S in (22) is a closed, bounded rectangle in $\mathbb{R}^2$, hence compact. It is convex as the Cartesian product of convex intervals. Non-emptiness follows since $P_{\min} < P_{\max}$. □

Lemma 2 (Continuity of Excess Demand)**.** *The functions $Z_p(P_1, P_2)$ defined in (19) are continuous on S.*

Proof. Demand D_p in (20) is a composition of continuous functions. Supply depends on $n_p(P_1, P_2) = \int \pi_p(a; P_1, P_2) f(a)\, da$. The integrand is continuous in (P_1, P_2) and dominated by $f(a)$, which is integrable. By the Dominated Convergence Theorem, n_p is continuous. Therefore S_p in (21) and hence Z_p are continuous. □

Lemma 3 (Convex Values)**.** *For each $(P_1, P_2) \in S$, the set $\Phi(P_1, P_2)$ defined in (23) is non-empty and convex.*

Proof. Since projection is unique, $\Phi(P_1, P_2)$ is a singleton. Singletons are trivially non-empty and convex. □

Lemma 4 (Closed Graph)**.** *The correspondence Φ defined in (23) has a closed graph.*

Proof. Φ is single-valued and continuous, being the composition of continuous maps (addition and projection). A continuous function has a closed graph. □

B.5 Existence Result

Theorem 1 (Interior Market Equilibrium Existence)**.** *For any given entry costs (s_1, s_2), there exists a Walrasian equilibrium in the interior economy.*

Proof. By Lemmas 1–4, the correspondence $\Phi : S \rightrightarrows S$ satisfies the conditions of Kakutani's Fixed Point Theorem. Hence there exists $(P_1^*, P_2^*) \in S$ such that

$$(P_1^*, P_2^*) \in \Phi(P_1^*, P_2^*). \tag{24}$$

By (23) and (24),

$$(P_1^*, P_2^*) = \mathrm{Proj}_S\Big[(P_1^*, P_2^*) + \alpha\big(Z_1(P_1^*, P_2^*), Z_2(P_1^*, P_2^*)\big)\Big]. \tag{25}$$

If $(Z_1, Z_2) \neq (0, 0)$ at (P_1^*, P_2^*), then the update $(P_1^*, P_2^*) + \alpha(Z_1, Z_2)$ points strictly into the interior of S, so the projection would differ from (P_1^*, P_2^*), contradicting (24). Therefore we must have

$$(Z_1(P_1^*, P_2^*), Z_2(P_1^*, P_2^*)) = (0, 0).$$

Both markets clear, establishing equilibrium existence.

Equilibrium worker allocations (n_1^*, n_2^*) and average qualities $(\overline{q}_1^*, \overline{q}_2^*)$ then follow from the definitions in the main text. □

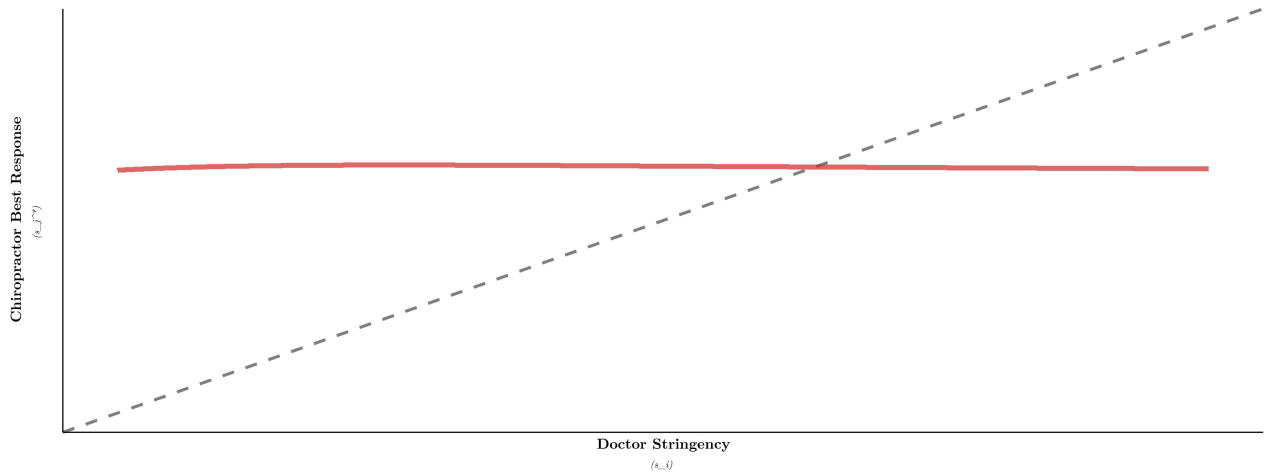
C Estimated Parameters

Table C.1: BLP Estimation Results: Parameters, Stringency, and IV Regression

Parameter	Estimate
Labor Market Parameters	
a	0.00002
	(0.00002)
c	-0.00476
	(0.01467)
μ_{doc}	-3.11607**
	(0.95124)
$\mu_{chiro} - \mu_{doc}$	-2.87273**
	(0.82506)
Mean Stringency Parameters	
Mean(s_{chiro})	-2598.95408
Mean(s_{doc})	-3231.93368
Consumer Market Parameters	
α	0.00329*
	(0.00158)
β	-2.79888*
	(1.21601)
ψ_{doc}	-5.17173†
	(2.66912)
$\psi_{chiro} - \psi_{doc}$	-1.50682*
	(0.74886)

Note: Bootstrap standard errors (in parentheses) for BLP parameters based on 500 successful iterations out of 500 bootstrap samples. Mean stringency calculated from shrunken estimates using empirical Bayes. IV regression uses clustered standard errors at statefip level (N=810). Significance levels: *** p<0.0001, ** p<0.01, * p<0.05, † p<0.10.

Figure C.1: Chiropractor Strategic Response to Doctor Stringency
Best Response Function in Full Stringency Range



Chiropractor board's optimal stringency choice as a function of physician board stringency, scaled for comparison to the medical board stringency.

D Model Simulations

Closed-form solutions to the model are analytically intractable due to the nonlinearity of the equilibrium conditions and the presence of multidimensional heterogeneity. To study the model's implications, I simulate equilibria under a range of parameter values. The goal is not to estimate structural primitives, but rather to generate comparative statics that clarify the theoretical mechanisms at play.

I calibrate the model to a stylized setting where two professions compete in a horizontally differentiated service market. The parameter values are chosen primarily to normalize the model and ensure that all relevant economic behavior can be clearly visualized in the simulation plots. I assume the practitioner hourly cost parameter $\gamma = 0.5$. I set price sensitivity (α) to 5.5. I set quality sensitivity (β) to 2.75, and practitioner productivity parameters to $a = 0.25$ and $b = 2.5$, with $c = 0.25$. Entry costs are fixed at $\psi_1 = \psi_2 = -30$, and nonpecuniary earnings shocks are set to $\mu_1 = \mu_2 = -30$. Practitioner ability is drawn from a log-normal distribution, $q_i \sim \text{LogNormal}(2.5, 0.3)$.

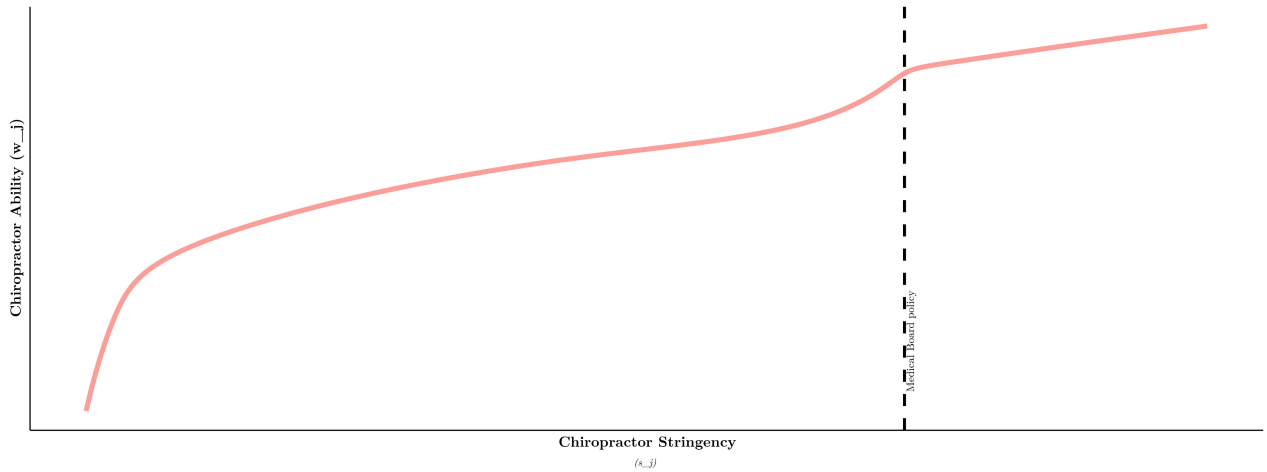
These parameter choices keep values close to unity wherever possible while ensuring that the full range of strategic interactions and equilibrium outcomes are observable in the simulations. The qualitative patterns and theoretical insights remain robust across different parameter specifications, so the particular numerical values do not materially affect the key takeaways from the analysis.

Each figure below shows how equilibrium outcomes change as one profession's licensing stringency increases, holding the other profession's stringency constant. The vertical line in each figure indicates the stringency level chosen by the doctor profession. The key insight is that licensing policy affects not only the size of the profession, but also its quality composition, price, entry dynamics, and spillover effects on competing professions.

Quality Sorting and Entry. Figure D.1 shows how average chiropractic quality evolves as licensing requirements become more stringent. Higher stringency increases the cost of entry, thereby screening out lower-ability applicants. As a result, average quality rises. This is a standard selection effect: when entry becomes more difficult, only individuals with high enough expected returns will self-select into the profession. These are usually those with higher ability.

Figure D.1: Quality Rises with Stringency; Acceleration As Surpassing Rival Board

Chiropractic Quality by Chiropractic Stringency

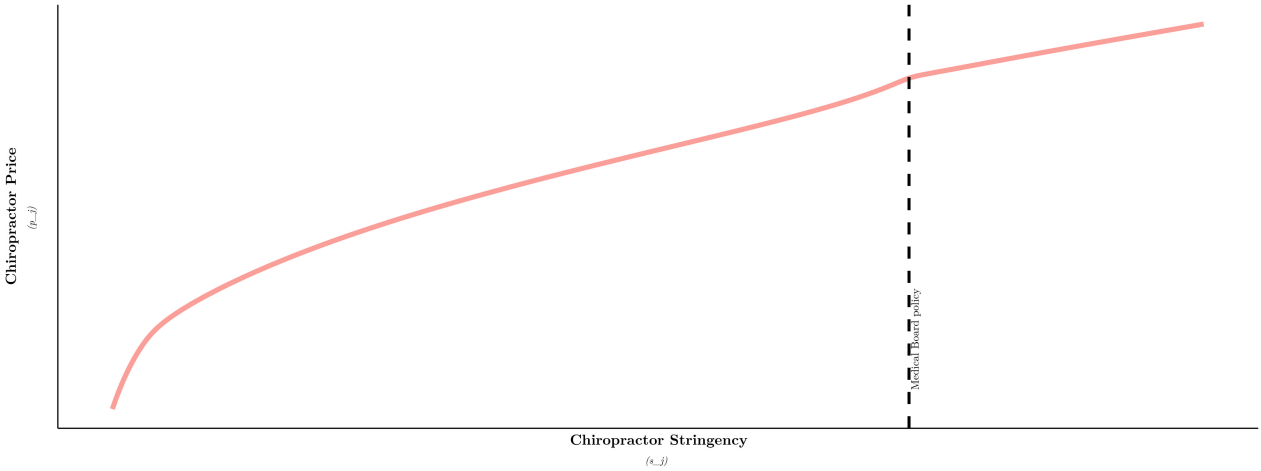


Medical board sets policy optimally under Stackelberg competition (vertical line). Parameters: $\alpha = 5.5, \beta = 2.75$, $a = 0.25$, $b = 2.5$, $c = 0.25$, $\psi_p = \psi_r = -30$, $\mu_p = \mu_r = -30$, $\gamma = 0.5$, $q_i \sim \text{LogNormal}(2.5, 0.3)$.

This quality improvement is not linear. As stringency increases beyond a certain point, the marginal increase in quality diminishes. At extreme levels, the cost of entry becomes so prohibitive that very few individuals enter, limiting further gains in average quality.

Price Effects. Because consumers value provider quality, increases in average ability translate into higher equilibrium prices. Figure D.2 confirms that price increases with licensing stringency, consistent with a demand-side response to quality improvement. This effect is also amplified by the reduction in supply that accompanies more stringent entry standards.

Figure D.2: Prices Rise with Stringency; Muted Response Near Rival's Policy
Equilibrium Price by Stringency of Own Board

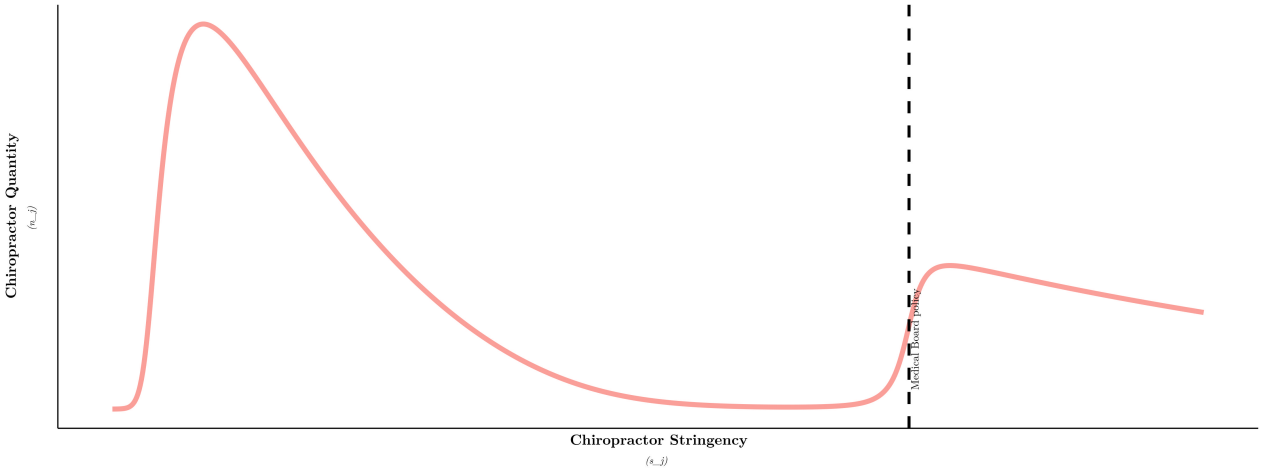


Medical board sets policy optimally under Stackelberg competition (vertical line). Parameters: $\alpha = 5.5, \beta = 2.75$, $a = 0.25$, $b = 2.5$, $c = 0.25$, $\psi_p = \psi_r = -30$, $\mu_p = \mu_r = -30$, $\gamma = 0.5$, $q_i \sim \text{LogNormal}(2.5, 0.3)$.

The nonlinearity in the price curve arises from two reinforcing effects. First, there is upward pressure from rising provider quality. Second, there is a contraction in the quantity supplied.

Quantity of Chiropractors Figure D.3 illustrates the entry quantity response. Initially, entry falls as low-ability providers are excluded. At intermediate levels of stringency, entry stabilizes or even increases slightly, as higher quality supports higher prices and makes the profession attractive to high-ability individuals. Quantity declines as the competitive nature of the model comes into play, as workers generally prefer the higher ability profession if there is a reasonable choice. As stringency increases, lower-ability workers are driven out, but higher-ability workers still prefer the doctor profession until the chiropractic profession has higher standards. Once the rank of relative stringency flips, higher quality workers surge into the chiropractic profession. At very high stringency, however, entry declines again as only a small share of the ability distribution meets the entry threshold.

Figure D.3: Entry Rises via Quality Premiums and Cream-Skimming
Chiropractic Quantity by Chiropractic Stringency



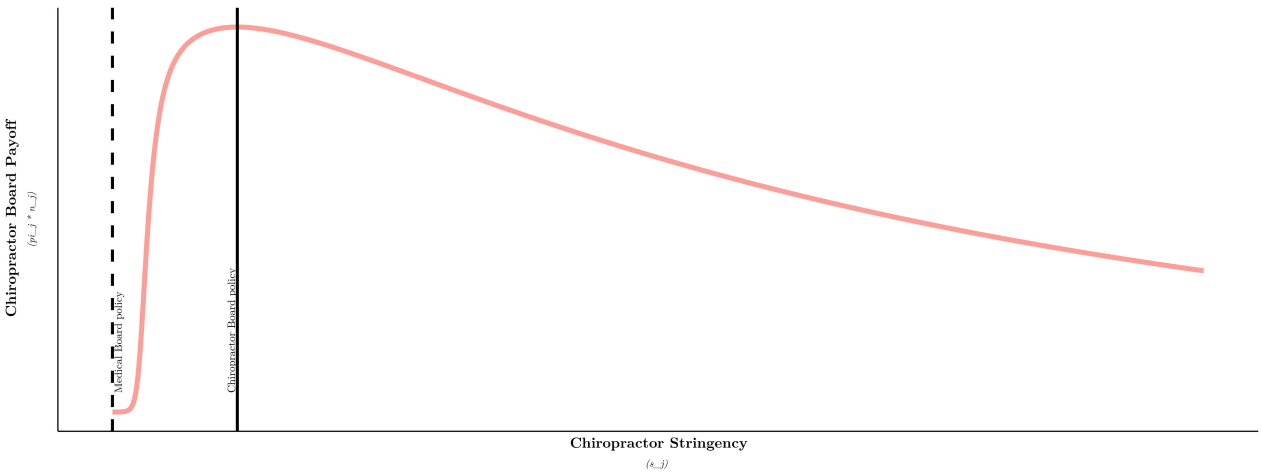
Medical board sets policy optimally under Stackelberg competition (vertical line). Parameters: $\alpha = 5.5, \beta = 2.75$, $a = 0.25$, $b = 2.5$, $c = 0.25$, $\psi_p = \psi_r = -30$, $\mu_p = \mu_r = -30$, $\gamma = 0.5$, $q_i \sim \text{LogNormal}(2.5, 0.3)$.

The result is a lopsided M-shaped pattern. This highlights a trade-off: while stringent licensing can improve provider quality, it may also create shortages or drive consumers toward substitute professions. Notably, the shape and magnitude of this pattern depend critically on the stringency level set by the competing profession's board, as indicated by the vertical line marking the medical board's policy choice.

Chiropractic Profits Figures D.4, D.5, and D.6 plot the total profits earned by the chiropractic board as stringency increases under different competitive scenarios. The pattern is non-monotonic and highly dependent on the medical board's policy stance. When facing a minimally restrictive medical board policy (Figure D.4), the chiropractic board can largely ignore the other profession and set policy based primarily on its own profit considerations. However, when the medical board acts as if they are the only board (Figure D.5), the chiropractic board's optimal response is to be slightly more restrictive. In effect, they engage in cream-skimming. This attracts high-quality practitioners away from the doctor profession. Conversely, if the medical board sets a much more restrictive policy, then the chiropractic

board prefers to set a much lower stringency level because the medical board's policy is too restrictive to make cream-skimming worthwhile.

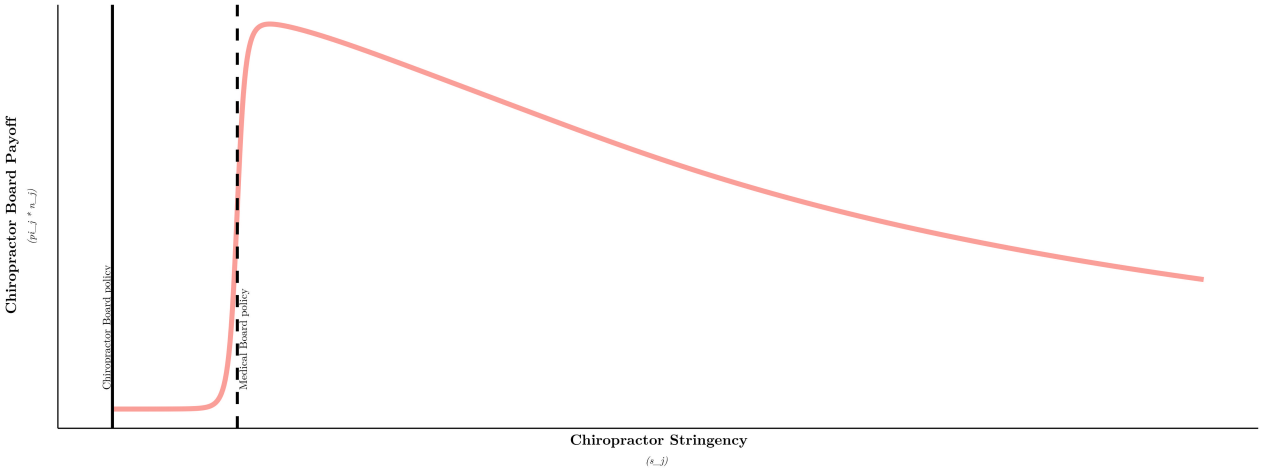
Figure D.4: Moderate Stringency Optimal Without Competitive Pressure
Total Chiropractic Profit by Chiropractic Stringency



Chiropractic board maximizes profit (solid vertical line); medical board restricted from optimal strategy (dashed vertical line). Solid vertical line shows chiropractic board's optimal policy. Parameters: $\alpha = 5.5, \beta = 2.75$, $a = 0.25$, $b = 2.5$, $c = 0.25$, $\psi_p = \psi_r = -30$, $\mu_p = \mu_r = -30$, $\gamma = 0.5$, $q_i \sim \text{LogNormal}(2.5, 0.3)$.

Figure D.5: Cream-Skimming Strategy Maximizes Profits Against Moderate Rival

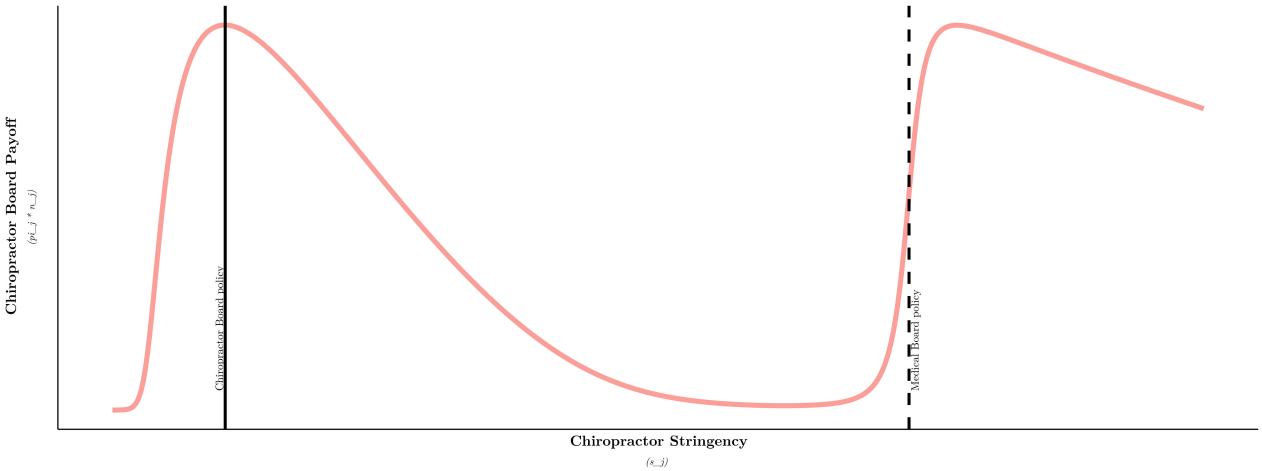
Total Chiropractic Profit by Chiropractic Stringency With Competition



Medical board maximizes profit (dashed vertical line); chiropractic board restricted to suboptimally low stringency (solid vertical line). Solid vertical line shows chiropractic board's restricted policy. Parameters: $\alpha = 5.5, \beta = 2.75$, $a = 0.25$, $b = 2.5$, $c = 0.25$, $\psi_p = \psi_r = -30$, $\mu_p = \mu_r = -30$, $\gamma = 0.5$, $q_i \sim \text{LogNormal}(2.5, 0.3)$.

Figure D.6: High Stringency Deters Rival Cream-Skimming Through Entry Costs

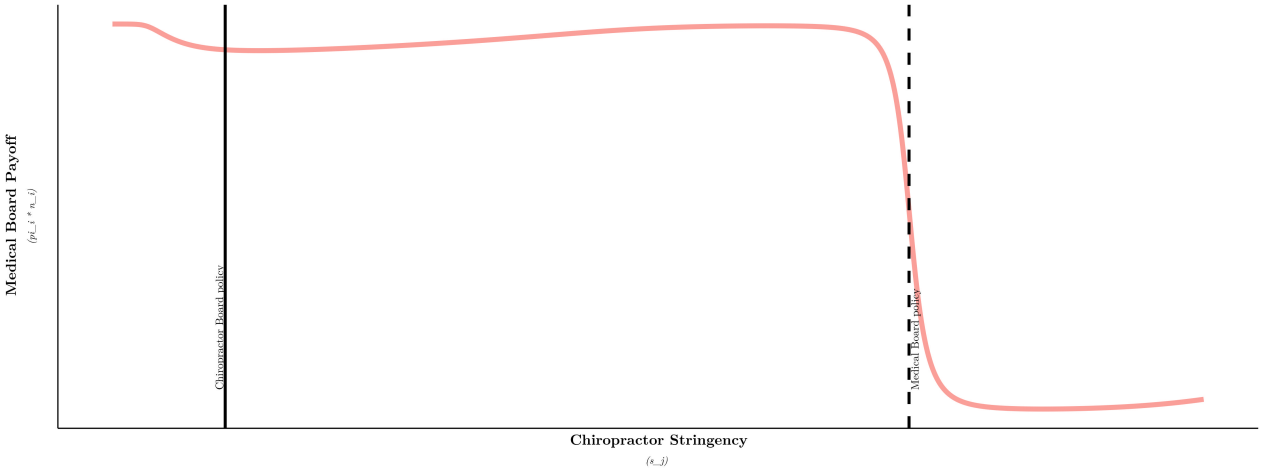
Total Chiropractic Profit by Chiropractic Stringency In Stackelberg Equilibrium



Both boards set policies optimally under Stackelberg competition. Dashed vertical line is medical board's optimal policy; solid vertical line is chiropractic board's optimal policy. Parameters: $\alpha = 5.5, \beta = 2.75$, $a = 0.25$, $b = 2.5$, $c = 0.25$, $\psi_p = \psi_r = -30$, $\mu_p = \mu_r = -30$, $\gamma = 0.5$, $q_i \sim \text{LogNormal}(2.5, 0.3)$.

Strategic Interaction and Spillovers Figure D.7 shows doctor profession profits as a function of the chiropractic's stringency level. When the chiropractic profession is unregulated, the doctors face little competitive pressure and prefer relatively low stringency. If the chiropractic board increases its entry standards above the medical board standards, the medical board suffers from cream-skimming as high-ability doctors shift to the rival. This incentivizes the medical board to raise its own stringency in order to avoid being cream-skimmed.

Figure D.7: Cream-Skimming Costly; Higher-Status Board Prefers Keeping Lead
Total Medical Board Profit by Chiropractic Stringency



Both boards set policies optimally under Stackelberg competition. Dashed vertical line is medical board's optimal policy; solid vertical line is chiropractic board's optimal policy. Parameters: $\alpha = 5.5, \beta = 2.75$, $a = 0.25$, $b = 2.5$, $c = 0.25$, $\psi_p = \psi_r = -30$, $\mu_p = \mu_r = -30$, $\gamma = 0.5$, $q_i \sim \text{LogNormal}(2.5, 0.3)$.

D.1 Asymmetric Profession Preferences

The baseline simulations assumed symmetric preferences across professions, setting entry costs and nonpecuniary benefits equal for both doctors and chiropractors ($\psi_p = \psi_r = -30$, $\mu_p = \mu_r = -30$). However, in practice, professions often differ in their baseline attractiveness due to factors such as prestige, working conditions, professional identity, or social status. To explore how such asymmetries affect strategic licensing behavior and welfare outcomes, I

simulate four scenarios where one profession has systematically higher baseline utility:

1. Chiropractors more attractive on both dimensions:

   $\psi_p = -30, \psi_r = -25, \mu_p = -30, \mu_r = -25$

2. Chiropractors more attractive on for workers, docctors more attractive for consumers:

   $\psi_p = -30, \psi_r = -25, \mu_p = -25, \mu_r = -30$

3. Doctors more attractive for workers, chiropractors more attractive for consumers:

   $\psi_p = -25, \psi_r = -30, \mu_p = -30, \mu_r = -25$

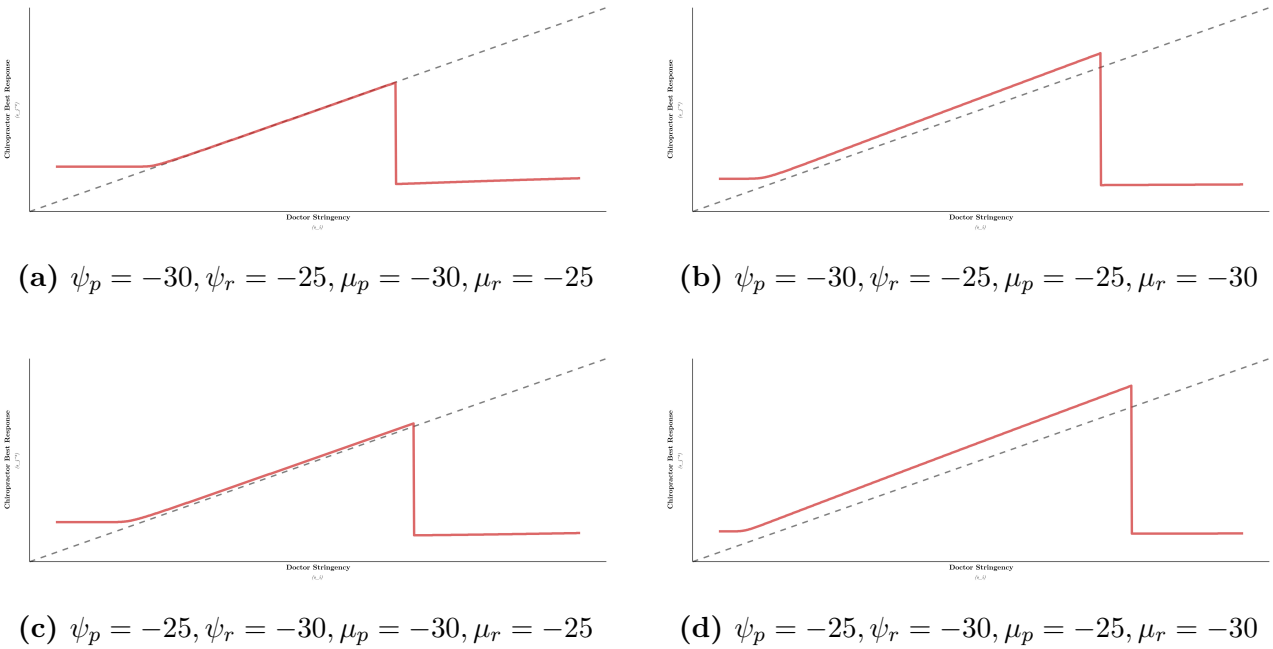
4. Doctors are more attractive on both dimensions:

   $\psi_p = -25, \psi_r = -30, \mu_p = -25, \mu_r = -30$

Figure D.8 presents the chiropractic board's profit as a function of its own stringency choice under Stackelberg competition for each scenario. The qualitative pattern remains consistent across all cases: the chiropractic board's optimal response involves setting stringency higher than the medical board's level to engage in cream-skimming of high-ability practitioners. However, the magnitude of this strategic response varies substantially with baseline preferences.

When chiropractors are inherently more attractive to consumers (Scenarios 1 and 3), the chiropractic board does not need to set stringency significantly higher than the medical board in order to cream-skim, but chiropractors are also willing to deviate from cream-skimming at a lower threshold. The optimal stringency gap is largest when doctors dominate on both dimensions (Scenario 4). When doctors are preferred the chiropractic board needs to have a larger stringency premium in order to cream skim and the medical board needs to set a much higher standard in order for the chiropractic board to accept the less stringent position. The differences in preference in the labor market appears to have similar, but smaller affects than differences in the consumer market.

Figure D.8: Baseline Preferences Determine Optimal Stringency Gap
Total Chiropractic Profit by Chiropractic Stringency Under Asymmetric Preferences



(a) $\psi_p = -30, \psi_r = -25, \mu_p = -30, \mu_r = -25$

(b) $\psi_p = -30, \psi_r = -25, \mu_p = -25, \mu_r = -30$

(c) $\psi_p = -25, \psi_r = -30, \mu_p = -30, \mu_r = -25$

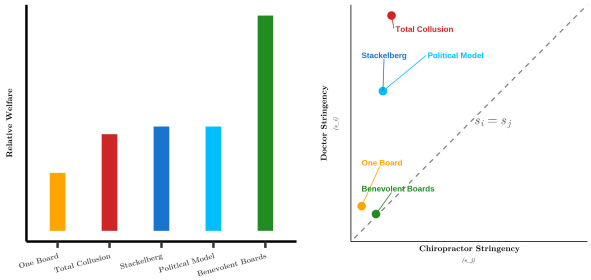
(d) $\psi_p = -25, \psi_r = -30, \mu_p = -25, \mu_r = -30$

Each panel shows chiropractic board profit maximization under Stackelberg competition with different baseline preference parameters. Dashed vertical line indicates medical board's optimal policy; solid vertical line indicates chiropractic board's optimal response. Other parameters: $\alpha = 5.5, \beta = 2.75$, $a = 0.25$, $b = 2.5$, $c = 0.25$, $\gamma = 0.5$, $q_i \sim \text{LogNormal}(2.5, 0.3)$.

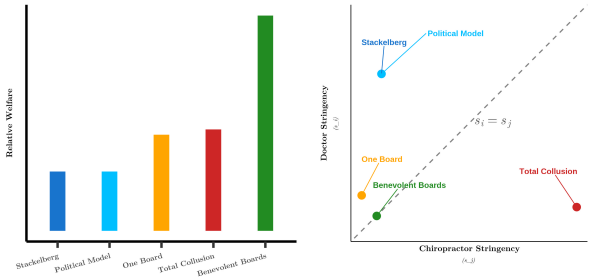
The welfare implications of these asymmetries are shown in Figure D.9. Importantly, the ranking of regulatory regimes by total welfare varies across scenarios. In the symmetric baseline, collusion outperforms having a single board, which in turn dominates competition between boards. However, when professions have asymmetric baseline attractiveness, this ordering can shift.

The key insight is that baseline preferences affect not only the equilibrium stringency levels but also the relative welfare performance of different regulatory structures. When the second mover (who has an advantage (see Appendix E)) produces relatively more utility at baseline, competition produces higher total welfare than collusion. When the second mover produces less utility, competition is particularly harmful to welfare. In all cases, boards appear to set standards too high relative to when they are acting in societies interest.

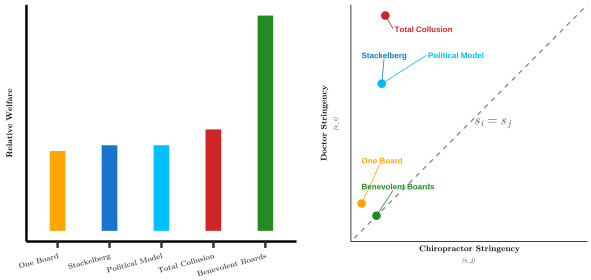
Figure D.9: Welfare Rankings Vary with Baseline Profession Preferences
Total Welfare and Policy Combinations Under Asymmetric Preferences



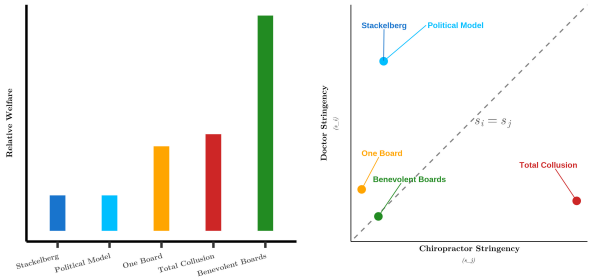
(a) $\psi_p = -30, \psi_r = -25, \mu_p = -30, \mu_r = -25$



(b) $\psi_p = -30, \psi_r = -25, \mu_p = -25, \mu_r = -30$



(c) $\psi_p = -25, \psi_r = -30, \mu_p = -30, \mu_r = -25$



(d) $\psi_p = -25, \psi_r = -30, \mu_p = -25, \mu_r = -30$

Each panel shows total welfare (left) and policy combinations (right) across regulatory scenarios for different baseline preference parameters. Other parameters: $\alpha = 5.5, \beta = 2.75$, $a = 0.25$, $b = 2.5$, $c = 0.25$, $\gamma = 0.5$, $q_i \sim \text{LogNormal}(2.5, 0.3)$.

These results demonstrate that optimal regulatory structure is context-dependent. The welfare consequences of allowing competing licensing boards to set policy independently depend critically on the underlying symmetry or asymmetry in profession characteristics. Policymakers should account for baseline differences in profession attractiveness when designing regulatory oversight, as these differences fundamentally alter the strategic incentives facing licensing boards and the resulting welfare outcomes.

E Appendix: The Strategic Logic of Cream Skimming Through Licensing Stringency

This appendix provides graphical intuition for why the second-moving board finds cream skimming—selectively attracting higher-ability workers from the rival profession—an attractive strategic response to the first mover's stringency choice.

E.1 The Basic Entry Decision

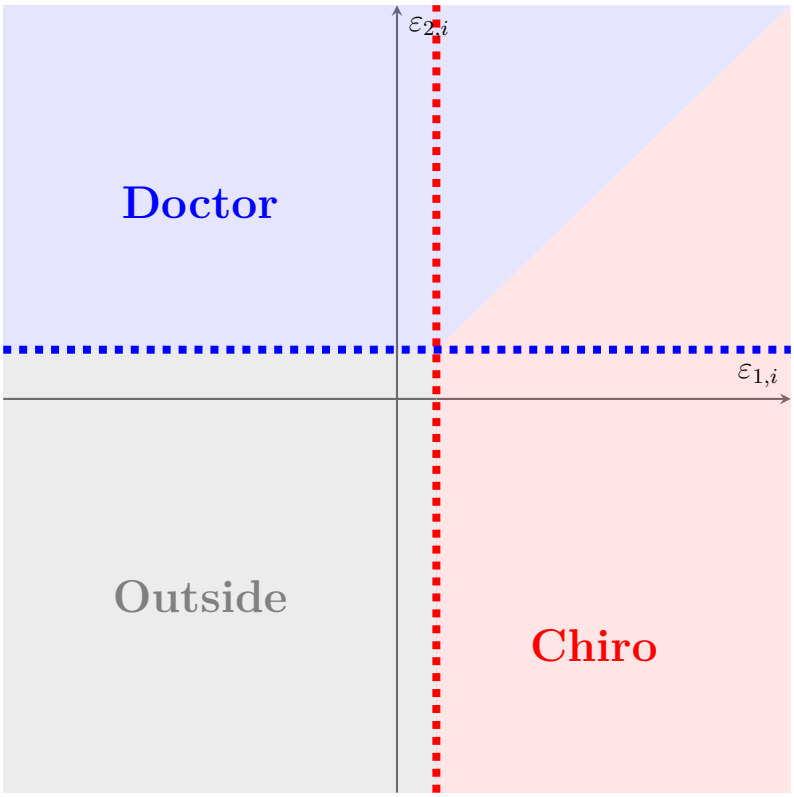
Workers choose between two professions or an outside option based on utility comparisons. For each profession p with parameters (μ_p, q_i, π_p, s_p), there exists an indifference threshold:

$$\overline{\varepsilon}_p = cq_i + b\frac{s_p}{q_i} - \mu_p - a\pi_p \tag{26}$$

where workers with preference shock $\varepsilon_{pi} > \overline{\varepsilon}_p$ prefer profession p over the outside option. Figure E.1 maps the joint distribution of preference shocks $(\varepsilon_1, \varepsilon_2)$ to occupational choice. The dashed lines represent these entry thresholds—workers above the blue line prefer doctors over outside options, those to the right of the red line prefer chiropractors over outside options.

Figure E.1: Entry Thresholds Partition Worker Preference Space

Entry Thresholds Conditional on Ability



Workers with preference shocks above and to the right of both thresholds choose their preferred profession. The joint distribution of $(\varepsilon_1, \varepsilon_2)$ is bivariate normal, making the region near the origin most densely populated.

E.2 The Three Effects of Increased Stringency

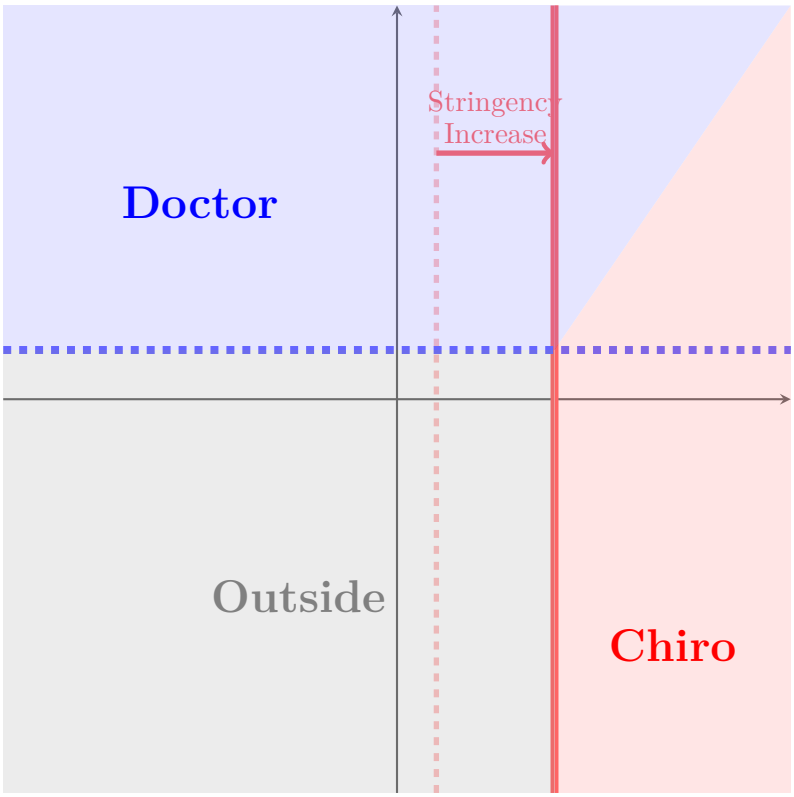
When a board increases licensing stringency, three distinct effects shape equilibrium outcomes:

Direct Entry Cost Effect. Higher stringency s_p mechanically increases entry costs, particularly for low-ability workers who face costs of s_p/q_i. This shifts the profession's entry threshold rightward (for chiropractors) or upward (for doctors), directly reducing the number of potential entrants. Figure E.2 shows this mechanical barrier-to-entry effect: the original chiropractic threshold (light dashed red line) shifts right to the new threshold (solid red line)

as stringency increases.

Figure E.2: Direct Effect: Higher Stringency Increases Entry Costs

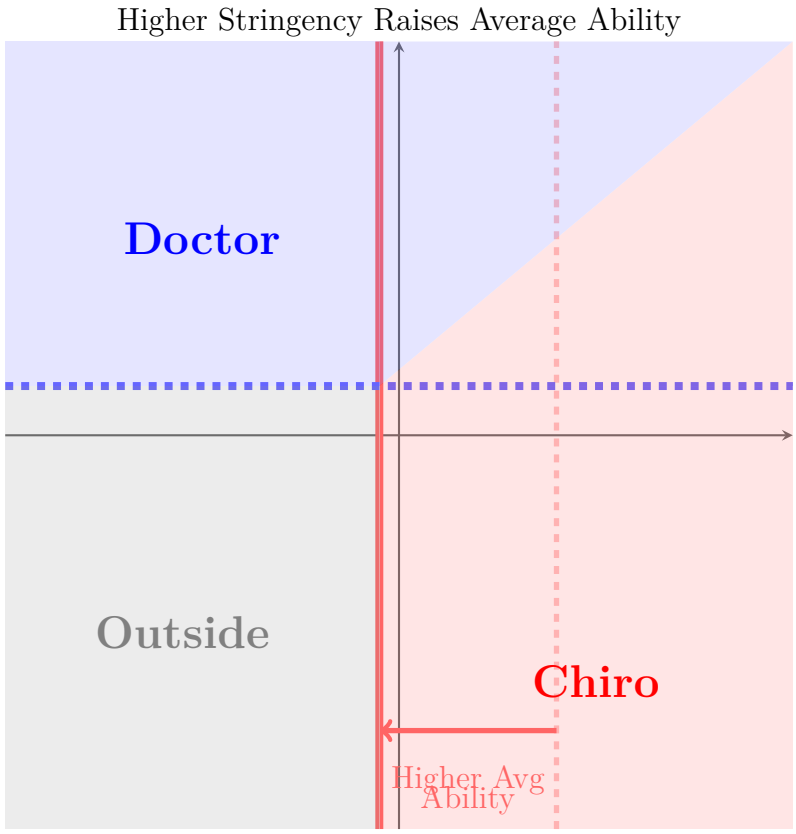
Higher Stringency Directly Makes Entry Less Attractive



The rightward shift in the chiropractic entry threshold excludes marginal workers, particularly those with low ability who face disproportionately high costs from stringency requirements.

Quality Effect. Excluding low-ability workers raises average practitioner quality, increasing consumer demand and prices. This profitability boost makes entry more attractive, partially offsetting the direct cost effect by shifting the entry threshold back toward its original position. Figure E.3 illustrates this countervailing force: the threshold that moved right due to costs now shifts back left (from light dashed to solid red line) as higher average quality increases profits.

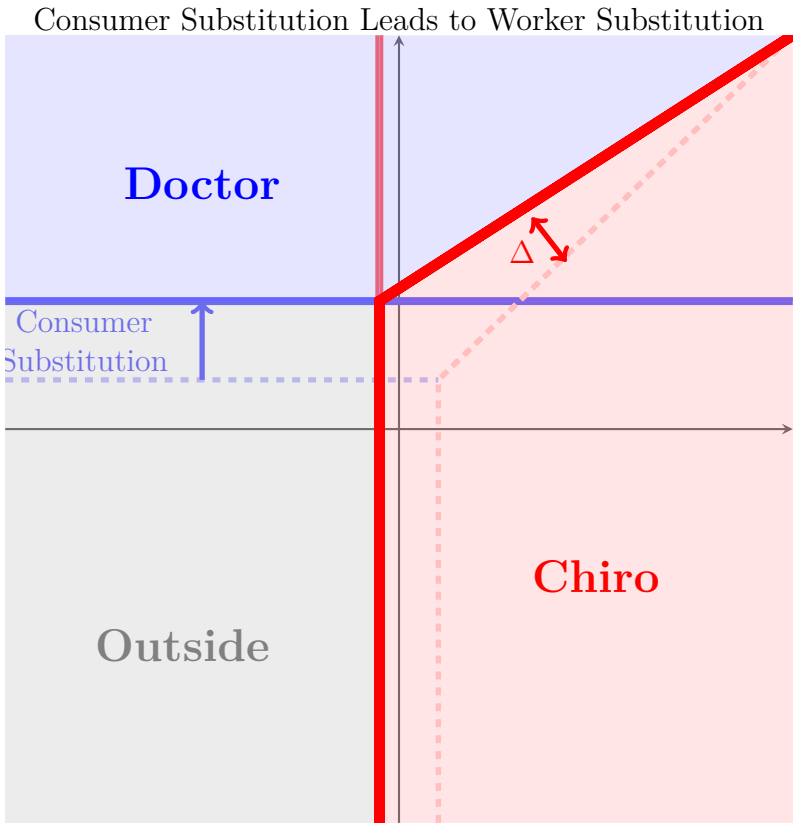
Figure E.3: Quality Effect: Excluding Low-Ability Workers Raises Profits



Higher average quality attracts more consumers, raising prices and profits. This makes entry more attractive, shifting the threshold back leftward and partially offsetting the direct cost effect.

Cross-Profession Spillover Effect. Higher quality in one profession makes it a closer substitute for the other, reducing demand for the rival profession. This cross-market substitution effect is the key to cream skimming. Figure E.4 shows that when chiropractors raise quality through stringency, medical demand falls, reducing doctor profitability. The medical entry threshold shifts upward (from light dashed to solid blue line), causing some workers who previously chose medicine to switch to chiropractic. Critically, this transferred region (marked with Δ) lies near the origin of the joint preference distribution where worker density is highest.

Figure E.4: Spillover Effect: Quality Competition Redistributes Workers



Consumer substitution toward higher-quality chiropractors reduces medical demand, shifting the doctor entry threshold upward. The region Δ represents workers who switch from medicine to chiropractic—precisely those near the origin with weak preferences between professions.

E.3 Why Cream Skimming Is Strategically Attractive

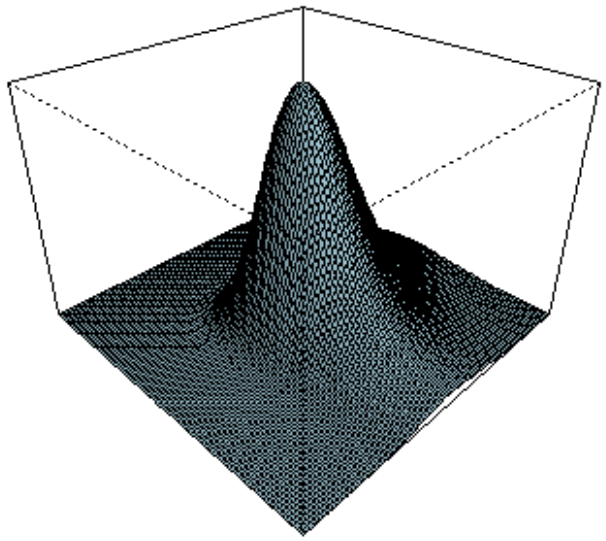
The spillover effect makes cream skimming particularly valuable for three reasons:

First, substitution preserves scarcity rents. When both professions expand simultaneously, overall practitioner density increases, reducing scarcity rents for all incumbents. In contrast, stealing workers from the rival profession through quality competition reallocates practitioners without increasing total supply, preserving or even enhancing rents.

Second, the joint preference distribution is not uniform. Figure E.5 shows that the independent bivariate extreme value distribution of preference shocks is most dense near

the origin. Workers with $(\varepsilon_1, \varepsilon_2)$ close to $(0, 0)$ have weak preferences between professions, making them highly sensitive to relative quality changes. By raising stringency strategically, a board can target this dense region where small quality advantages flip many workers' occupational choices.

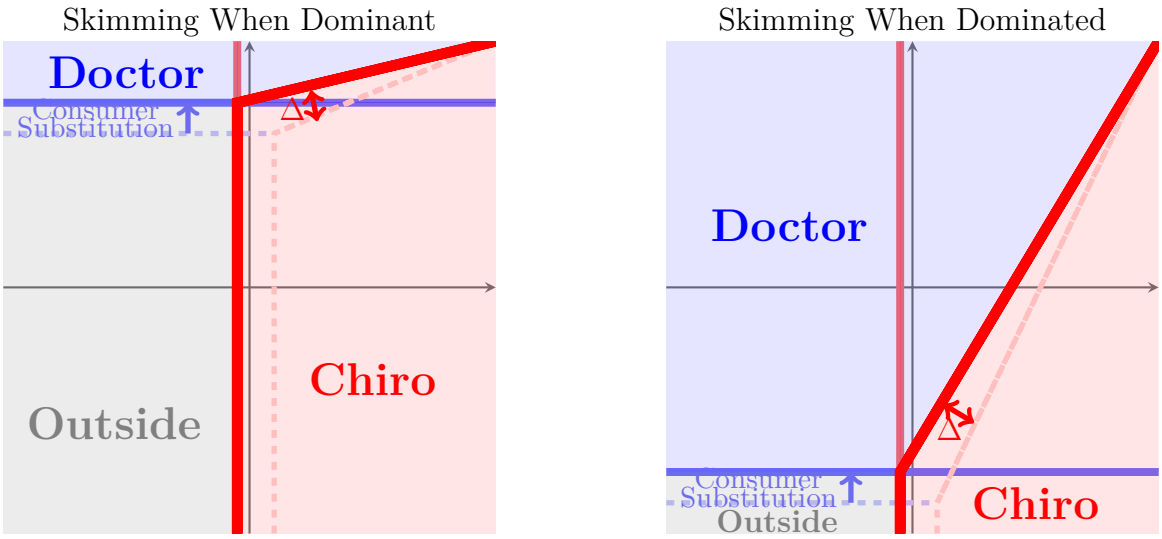
Figure E.5: Joint Preference Distribution Concentrates Near Origin



The independent bivariate extreme value distribution of preference shocks $(\varepsilon_1, \varepsilon_2)$ peaks at the origin, making workers near the entry thresholds especially responsive to quality competition. This concentration amplifies the returns to cream skimming.

Third, similar stringency levels maximize stealing potential. Figure E.6 illustrates how the effectiveness of cream skimming depends on relative attractiveness. When the chiropractic board is dominated (left panel), the medical threshold lies far above the chiropractic threshold. Raising chiropractic stringency shifts the medical threshold upward through consumer substitution, but the transferred region Δ is small because few workers have preferences in the relevant range. The same is true when being a chiropractor is significantly more attractive than being a doctor.

Figure E.6: Cream Skimming Effectiveness Depends on Relative Stringency



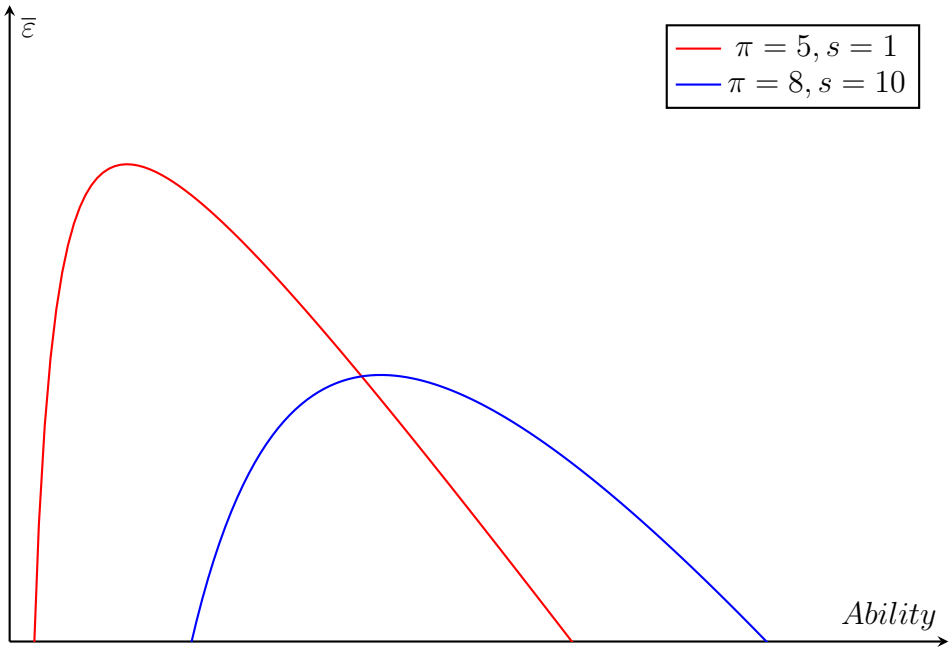
When the baseline preference for being a chiropractor is much higher than the baseline preference for being a doctor (left), or in the opposite scenario, the transferred region Δ is not in the densest part of the preference distribution, making stealing workers through stringency manipulation substantially less effective.

E.4 Ability Targeting Through Stringency

The final insight concerns how stringency allows boards to target specific ability levels. Because entry costs scale inversely with ability (s_p/q_i), stringency disproportionately excludes low-ability workers. Figure E.7 plots indifference thresholds $\bar{\varepsilon}$ as functions of ability for different (π, s) combinations. Higher stringency rotates the indifference curve, making the profession more attractive to high-ability workers (who face lower costs) relative to low-ability workers.

Figure E.7: Stringency Enables Ability-Selective Entry

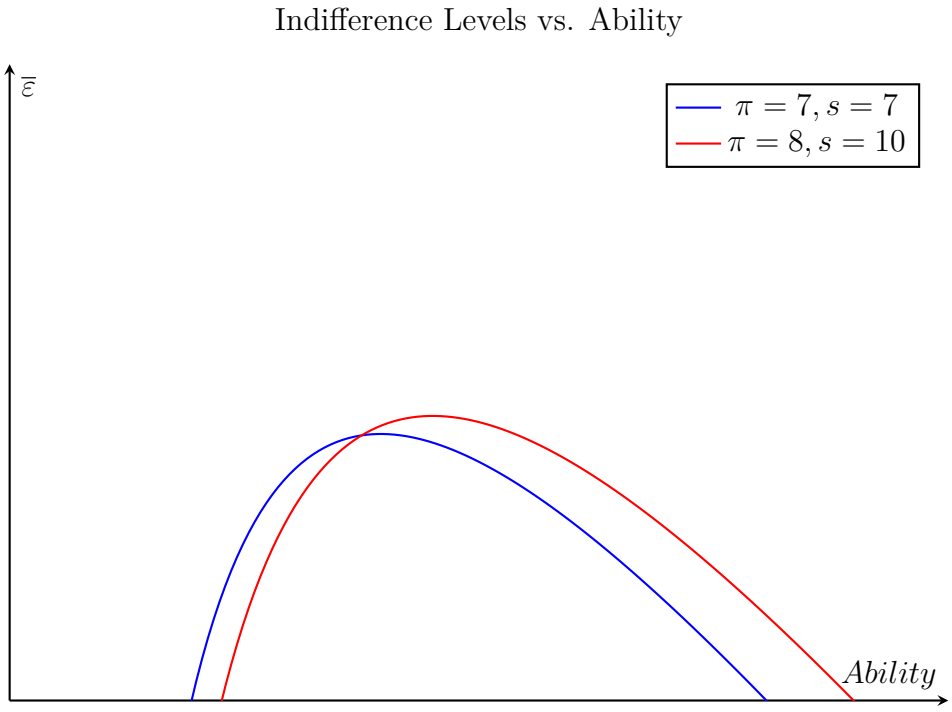
Indifference Levels vs. Ability



The indifference threshold $\bar{\varepsilon} = cq_i + bs_p/q_i - \mu_p - a\pi_p$ shows that higher stringency (blue) raises profits but imposes ability-dependent costs. High-ability workers face relatively lower entry barriers under stringent regulation, while low-ability workers are disproportionately excluded.

When two professions have similar stringency levels, their indifference curves lie close together across the ability distribution. This makes workers of many ability levels nearly indifferent between professions, creating a broad "contestable" population responsive to small quality differences. Figure E.8 illustrates this strategic advantage: with similar stringency (compare the blue and red curves), both professions target similar ability ranges, maximizing the population density in the overlap region where cream skimming is most effective.

Figure E.8: Similar Stringency Maximizes Contestable Worker Population



When professions have similar stringency (red vs. blue), their indifference curves track each other closely across the ability distribution. This creates a large population of workers who are nearly indifferent between professions, making them highly responsive to quality competition.

E.5 Strategic Implications

These mechanisms explain the non-monotonic best response function in Figure 13. When the first-moving board (doctors) sets low stringency, the second-moving board (chiropractors) prefers higher stringency to approach parity, creating a large contestable population near the origin, where cream-skimming is most effective. When the medical boards set high stringency, the chiropractic boards prefer lower stringency because the payoff to cream-skimming is no longer sufficient to be preferable to dominating the larger, lower-quality demographic. These mechanisms explain the non-monotonic best response function in Figure 13. Specifically, When the first-moving board (doctors) sets low stringency, the second-moving board (chiropractors) prefers higher stringency to approach parity, creating a large contestable population near the origin, where cream-skimming is most

effective. When the medical boards set high stringency, the chiropractic boards prefer lower stringency because the payoff to cream-skimming is no longer sufficient to be preferable to dominating the larger, lower-quality demographic .

The cream-skimming mechanism thus creates strategic complementarities in stringency at moderate levels (both boards want similar restrictions to maximize stealing opportunities) but strategic substitutes at extreme levels (very high first-mover stringency makes the second mover prefer relaxation to preserve entry). This generates the inverted-U shape in the best response function and explains why observed regulatory stringency levels cluster at intermediate values where cream-skimming incentives are strongest.