Specialization and Regulation: The Rise of Professionals and the Emergence of Occupational Licensing Regulation

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During the Progressive Era, advances in knowledge and specialization led to the emergence of modern-day professions. This growth in professions was accompanied by the adoption of occupational licensing regulation. In this article we explore the origins and effects of occupational licensing regulation during this period. Although most studies argue that occupational licensing regulation is adopted to restrict entry and reduce competition, the evidence from the Progressive Era suggests that regulation arose to improve markets as specialization and advances in knowledge made it increasingly difficult for consumers to judge the quality of professional services.

> *Not long ago, the Governor of a midwestern state was approached by representatives of a particular trade anxious to enlist the Governor's support in securing passage of legislation to license their trade.*
>
> *"Governor," the men said, "passage of this licensing act will ensure that only qualified people will practice this occupation; it will eliminate charlatans, incompetents or frauds; and it will thereby protect the safety and welfare of the people of this state."*
>
> *The governor, from long experience, was somewhat skeptical. "Gentlemen," he asked, "are you concerned with advancing the health, safety and welfare of the people under the police powers of the state, or are you primarily interested in creating a monopoly situation to eliminate competition and raise prices?"*
>
> *The spokesman for the occupational group smiled and said, "Governor, we're interested in a little of each."*
>
> Council of State Governments[1]

The late nineteenth and the early twentieth centuries witnessed the birth of modern-day professions. Prior to the late 1800s only medicine, law, and theology were considered "learned professions." The

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[1] Council of State Governments, *Occupational Licensing*, p. 1.

growth of modern day professions was fueled not only by a transformation of these older professions but also by a significant increase in new professional occupations such as teaching, engineering, dentistry, and accountancy to list a few. Between 1900 and 2000 the percentage of the labor force engaged in technical and professional occupations increased from 4 percent to over 20 percent.[2] This rise of professionals was also accompanied by the widespread adoption of occupational licensing regulation at the state level.

For many economists, occupational licensing regulation is primarily motivated by a profession's interest in "creating a monopoly situation to limit competition and raise prices."[3] Ever since the classic study by Milton Friedman and Simon Kuznets, economists have generally believed that the wages of physicians and other professionals are often artificially raised by regulation.[4] The dominant view today is that the regulatory licensing process has been captured by industry to erect entry restrictions for its own benefit.[5] Studies typically find that regulation is correlated negatively with entry, positively with earnings, and that the occupation being regulated is an important constituency in favor of regulation. Most scholars argue that this evidence supports some version of the capture theory.[6]

However, there is an alternative explanation. The sale and purchase of professional services are often subject to problems of asymmetric information.[7] More often than not, sellers of specialized services are better informed than buyers about the various dimensions of product qual-

[2] U.S. Department of Commerce, *Statistical Abstract*.

[3] Historically, licensing has also been a source of revenue for state governments.

[4] Friedman and Kuznets, *Income*.

[5] See Stigler, "Theory of Economic Regulation."

[6] This literature is vast. For a comprehensive overview see Olsen, "Regulation."

[7] Although there are numerous definitions of the term "professions," most definitions seem to suggest that professions sell specialized services whose quality is difficult to verify *ex ante* by the buyer. According to the Merriam-Webster Dictionary a profession is "a calling requiring specialized knowledge and often long academic training." See Merriam-Webster, *Dictionary*, p. 585. William Rothstein argues that a profession is "a manner of earning a livelihood through the application of a body of highly abstract knowledge in some set of institutions." See Rothstein, *American Physicians*, p. 8. An even more detailed definition has been offered by Paul Starr, who writes: "A profession . . . is an occupation that regulates itself through systematic, required training and collegial discipline; that has a base in technical, specialized knowledge; and that has a service rather than a profit orientation enshrined in its code of ethics." See Starr, *Social Transformation*, p. 15. In medicine, the concern about asymmetric information was explicitly incorporated into law. Judges in the United States ultimately classified medical malpractice suits as torts rather than contracts because they believed that a "meeting of minds" was not possible between a physician and a patient. Contracts between physicians and patients were not possible because the latter lacked the necessary knowledge to bargain equally. However, physicians could be sued under torts defined broadly as "private civil wrongs that violate certain duties or responsibilities." See DeVille, *Medical Malpractice*, pp. 156–86.

ity. When informational asymmetries are significant, then the classic "lemons" problem may arise as lower quality goods drive out higher quality goods from the market. Thus, professionals may choose to self-regulate, or professionals and consumers may seek government regulation to "eliminate charlatans, incompetents or frauds" and "protect the safety and welfare" of consumers.[8] In this instance, regulation may increase the earnings of professionals and be sought by the profession itself, not because it limits competition at the expense of efficiency, but because it improves the quality of services that consumers expect to receive. Hence, much of the evidence presented in favor of the capture hypothesis is observationally equivalent with the asymmetric information hypothesis.[9] Although the two hypotheses do offer different predictions with respect to the relationship between licensing and professional quality, the absence of reliable data on the quality of professional services makes it extremely difficult to cleanly distinguish between these two hypotheses.[10]

We explore in this article the causes and consequences of state government occupational licensing regulation in the United States during the Progressive Era.[11] This period witnessed not only a sharp increase in professionals in numerous occupations, but also a surge in state licensing legislation for professions and trades. By the mid-twentieth century, there were more than 1,200 state occupational licensing statutes, aver-

[8] See Akerlof, "Market for Lemons"; Arrow, "Uncertainty"; Leland, "Quacks and Lemons"; and Weingast, "Physicians."

[9] There also seems to be some ambiguity in the use of the word "capture." Some scholars use the term "capture" to refer to the process of enacting legislation. In this usage, capture arises when producer groups influence government officials into drafting and passing new regulation. Both efficiency-improving and efficiency-retarding regulation may thus be the product of capture. In this article, we use the term to refer to outcomes. The "capture" thesis refers to regulations that are passed to acquire monopoly rents at the expense of efficiency whereas the "public interest" or "asymmetric information" thesis refers to regulations that are enacted to improve markets. This approach makes a clear distinction between regulation that benefits certain producers and reduces welfare and regulation that benefits certain producers but also improves efficiency.

[10] Whereas the asymmetric information hypothesis argues that licensing should increase quality, the capture hypothesis argues that quality should remain unchanged, or may even deteriorate as competition is reduced. A handful of scholars have examined the relationship between licensing and proxies for professional quality using contemporary data. See, for instance, Carroll and Gaston, "Occupational Restrictions"; Feldman and Begun, "Welfare Cost"; Haas-Wilson, "Effect of Commercial Practice Restrictions"; and more recently, Angrist and Guryan, "Does Teacher Testing."

[11] The Progressive Era was accompanied by a rise in government regulation more generally and this article contributes to this larger literature. Fishback, "Operations of 'Unfettered' Labor Markets," surveys the rise of government regulation in the nonprofessional labor market. The market failures (monopsony and labor immobility) that may have led to regulation of nonprofessional labor markets differ from the market failure (asymmetric information) that was most relevant in professional labor markets.

aging 25 per state, for at least 75 occupations ranging from physicians to embalmers. Typically, licensing boards were created to control entry into an occupation and to enforce standards of practice among licensed practitioners. However, the form and content of licensing legislation differed greatly across occupations, states and time. In many occupations, the qualifications for licensure were raised and tightened over the years.[12]

We examine the factors that led to the adoption of licensing regulation and the effect of licensing on entry for eleven different occupations between 1880 and 1930.[13] Using a hazard model, we find that while the size of the occupational group was a major factor influencing the adoption of regulation for most occupations, for architects, attorneys, physicians, and veterinarians, urbanization was also a significant factor. However, when we estimate the impact of licensing legislation on entry, we find that licensing did not restrict entry into most occupations. Licensing regulations appear to have restricted entry into only four professions: architects, dentists, physicians, and veterinarians. Except for these four occupations, licensing requirements were either too weak or licensing boards too ineffective to limit entry into most occupations in our sample.

At least for the Progressive Era, evidence we present seems to be more consistent with the asymmetric information hypothesis. The fact that licensing regulations were more likely to be adopted in states with significant urban populations is consistent with this perspective. In this period, as growth in scientific knowledge was accompanied by specialization and urbanization, individuals became less knowledgeable about the goods and services they purchased in the marketplace. Although firms were able to use advertising and brand-names and other devices to signal their commitment not to cheat, these devices worked imperfectly.[14] Additionally, because scientific advances were more likely to occur in cities, informational asymmetries may have been more acute

[12] See Council of State Governments. *Occupational Licensing*, pp. 20–27.

[13] Occupations in our sample include architects, attorneys, barbers, beauticians, dentists, engineers, nurses, physicians, plumbers, teachers, and veterinarians.

[14] Kim, "Markets and Multiunit Firms," argues that multiunit firms arose in part as a market solution to the growing informational problems in the product market. As consumers became less knowledgeable about the quality of products they consumed, conditions were ripe for the lemons problem. Because multiunit firms were able to economize on advertising costs and because the costs of reneging were so much greater for multiunit rather than single-unit firms, multiunit firms were better able to solve the asymmetric information problem than single-unit firms. However, as noted by Law, "Origins of State Pure Food Regulation," private solutions were not sufficient to completely solve the asymmetric information problem in certain markets because increases in the complexity of many products (for instance, foods) made it difficult for consumers to determine whether they had been cheated.

for professional services in those areas.[15] This difference might explain why doctors, dentists, and veterinarians were more successful in restricting entry into their professions as this was a time when there were significant advances in these fields.

Indeed, licensing regulations seem to have been stricter for those occupations where informational asymmetries were most troubling to consumers. Consumers are more likely to be concerned with informational asymmetries when they purchase services directly from professionals and when the consequences of poor purchases are great. Consumers are less likely to be concerned with regulating professions such as engineers and nurses because they are mostly hired by firms rather than consumers.[16] They are also less likely to be concerned with regulating professions such as barbers and beauticians because the costs of a bad haircut are relatively low.[17] We do not believe that it is merely a coincidence that the standards of practice and qualifications for entry are most strictly regulated for physicians, dentists, and veterinarians, whose services are purchased directly by consumers and where the costs of receiving poor services could be high and sometimes even catastrophic.

To delve more deeply into whether Progressive Era licensing regulation was introduced to reduce information asymmetries or to limit competition, we analyze the medical profession in greater detail. We collect detailed information on specific licensing regulations to examine what types of regulations were most effective in regulating entry. Because licensing regulations were rarely static, especially for physicians, it is important to determine what types of regulations had the most significant impact on entry. Indeed, we investigate not only how the evolution of licensing standards affected entry, but also whether licensing affected the earnings of physicians and the quality of physicians' services. In particular, we examine whether medical licensing lowered mortality rates and the incidence of medical malpractice suits or whether it merely restricted entry into the medical profession and raised physician incomes.

We find that those licensing regulations that had the most negative impact on entry were also those that were most likely to increase physician quality. A close analysis of the effects of specific state medical licensing requirements on the number of physicians per capita shows that

[15] Sokoloff, "Inventive Activity"; and Lamoreaux and Sokoloff, "Inventive Activity."

[16] For example, the *American Machinist* wrote that a code of ethics was unnecessary for engineers as compared to doctors and lawyers because few engineers were independent consultants: "The employer [of the engineer] is the final judge of the manner in which his money shall be spent. He is usually more or less of an engineer himself, and frequently a competent one." Quoted in Calvert, *Mechanical Engineer*, p. 267.

[17] Although it is true that barbers have historically also played a public health role, at least with respect to haircuts, the costs of receiving poor service are low.

the licensing regulations that most sharply reduced entry were those that increased the length of the medical degree and increased the length of premedical college education.[18] Although stricter licensing did not increase gross or net physician incomes, it was associated with higher incomes relative to that of dentists. We also find that licensing regulation reduced mortality rates from illnesses where the quality of physicians is likely to have made a difference during this period. Although states with stricter licensing regulations did not have lower overall mortality rates or lower mortality rates due to cancer and diabetes, they did have significantly lower rates of maternal and appendicitis mortality.

Not all of the consequences of licensing were in the general interests of practicing physicians. If physicians were unified in their desire for licensing regulation, they were also unified in their opposition to the growth of medical malpractice suits during this period. Surprisingly, we find that licensing increased rather than reduced the incidence of state appellate malpractice suits. It appears that medical licensing regulations, by better defining the standards of local practice, made it easier for consumers to successfully sue physicians for poor outcomes.[19] Because licensing regulations were unlikely to eliminate all unqualified physicians, malpractice suits may have raised the costs of operation for less skilled physicians. However, because even qualified physicians were threatened by the potential for frivolous lawsuits, physicians did not find it in their collective interest to defend the rights of consumers to sue physicians.

Although it is extremely difficult to rule out the importance of the industry-capture explanation for professional regulation, we urge scholars to pay greater attention to motivations based on asymmetric information. The desire to eliminate charlatans and quacks from a given profession is more than mere rhetoric for both the practitioner and the consumer. However, we are fully aware that if professionals are granted powers to limit entry into their own professions, then the potential for misusing the state for private gain is always present. Indeed, the funda-

[18] Friedman and Kuznets, *Income*, pp. 8–30, report that acceptance rates at medical schools between 1926 and 1941 were near 60 percent and the passing rate for licensing was around 96 percent. For dental schools in 1941, the acceptance rate was over 83 percent whereas the licensing passing rate was a little over 80 percent. However, it would be erroneous to believe that medical schools rather than licensing regulation were responsible for restricting entry into medicine. It is more likely that medical schools, as compared to dental schools, internalized licensing restrictions into their admissions decisions and did not accept unqualified applicants in order to preserve their reputations. Most scholars believe that stricter licensing regulation was the binding constraint on the number of physicians admitted to the profession. See, for instance, Starr, *Social Transformation*, pp. 118–21.

[19] See De Ville, *Medical Malpractice*, for a general discussion of the rise of malpractice suits in the United States over the nineteenth century.

mental dilemma of licensing regulation is that it can improve efficiency, or limit competition, or do "a little of each."

THE GROWTH OF PROFESSIONS AND THE EMERGENCE OF LICENSING

Scientific knowledge expanded tremendously during the nineteenth and twentieth centuries. The scope and depth of human understanding about the physical, social, and biological world underwent a massive expansion during these centuries. Not only did the total stock of knowledge grow, but scientific knowledge became increasingly specialized. Over time, this new scientific knowledge found applications in occupations such as medicine, dentistry, architecture, and engineering.[20]

The consequences of this explosion of specialized knowledge were twofold. First, it became increasingly difficult to be a successful generalist. Within particular fields, specialists emerged who possessed a deeper knowledge of a more specific subject area. Second, the benefits of longer periods of formal education increased as many occupations became increasingly technical. Universities, colleges, and other institutions of higher learning emerged to educate individuals who wanted to acquire the knowledge and skills to work in occupations where the growth of relevant knowledge was greatest.

Advances in knowledge made it increasingly difficult for consumers to judge the quality of professional services. In fields such as medicine and dentistry, for instance, technical advances made it harder for consumers to know if they were getting the right treatment.[21] Additionally, the heterogeneity of professional quality increased as more technically trained experts competed with long standing practitioners. Although membership in key professional societies may have served as a partial signal of quality, the signaling value associated with membership was not very high because professional societies and associations were proliferating in nearly every occupation.[22] Consumers thus faced more uncertainty about professional quality.

These changes in the market for professional services were accompanied by a sudden surge in state government occupational

[20] See Price, *Little Science*; Flexner, *Medical Education*; Ludmerer, *Learning to Heal*; and Society for the Promotion of Engineering Education, *Report*.

[21] In medicine, for instance, the development of tools such as the microscope, ophthalmoscope, and laryngoscope made it possible for physicians to "see things" that ordinary consumers could not. Without the ability to independently verify and understand what physicians were doing, it was harder for patients to evaluate the quality of the diagnosis.

[22] See Rothstein, *America Physicians*.

TABLE 1: THE TIMING OF LICENSING REGULATIONS: NUMBER OF STATES ENACTING LICENSING REGULATION BY 10-YEAR INTERVAL FOR SELECTED OCCUPATIONS, 1870–1950

Profession	Pre 1870	1871–1880	1881–1890	1891–1900	1901–1910	1911–1920	1921–1930	1931–1940	1941–1950	Timing Unknown	Total
Accountants				3	18	25	1	1			48
Architects				1	6	11	12	10	6		46
Attorneys	10	1	1	4	5	2	5	4		16	48
Barbers				2	11	1	12	15	1	4	46
Beauticians						1	20	21	3		45
Chiropractors				1		17	21	4	1		44
Dentists	2	4	21	10	5	4	1	1			48
Electricians					1	2			2	4	9
Engineers					1	10	14	15	8		48
Insurance Brokers	1			1	3	8	1	3		5	22
Midwives				4	2	5	1	1		1	14
Practical Nurses					5	2	1	1	15	8	32
Registered Nurses					23	20	4	1			48
Optometrists					15	21	5	1		6	48
Osteopaths				8	19	8	3		1	8	47
Pharmacists		7	24	10	4	1		2			48
Physical therapists						1	1		2	5	9
Physicians	5	15	22	6							48
Plumbers				2	2		3	6	3		16
Psychologists									3		3
Real Estate Brokers						6	23	6	5		40
Surveyors					2	4	3	3	1	20	33
Teachers	10	1	2	2	2	4	1			26	48
Veterinarians			2	7	15	11	3			10	48

Source: See the text.

licensing regulation.[23] As shown in Table 1, whereas state governments began to regulate some occupations as early as the 1870s, most occupational licensing laws were adopted in the first two decades of the 1900s. Some occupations were regulated earlier than others. Physicians and dentists were among the earliest occupations to be regulated as licensing laws regulating these professions were first adopted in the 1870s. By the early 1900s, most states had enacted some kind of medical or dental licensing regulation. In contrast, the earliest laws regulating accountants, architects, and nurses were generally not enacted until the 1890s and early 1900s. For these occupations, it was not until the 1910s and 1920s that the majority of states had enacted licensing legislation.

WHY DID LICENSING ARISE? AN EMPIRICAL ANALYSIS

Why did occupational licensing arise in turn-of-the-century America? Several studies have examined the effects of licensing on entry and on the incomes of certain professionals (such as physicians, dentists, and nurses) using more contemporary data but to our knowledge no scholarship has analyzed the factors that led to the adoption of initial licensing legislation in the late nineteenth and early twentieth centuries, or the effects of these early licensing laws on entry into a wide variety of occupations. Hence, in this section, we exploit cross-state variation in the timing of licensing legislation for 11 different occupations in order to investigate the factors that influenced the adoption of initial licensing legislation and the impact of licensing on the number of workers per capita in a given occupation.[24]

[23] Occupational licensing in America did not begin in the late 1800s. During the colonial period and into the early nineteenth century, state governments regulated the practice of law and medicine in various ways. Nevertheless, occupational licensing on a wide scale did not begin until the late nineteenth century. In the latter half of the 1800s and continuing through the first half of the 1900s, state governments throughout America enacted legislation that regulated a wide variety of occupations. This second wave of licensing regulation differed from colonial licensing laws in several ways. First, it applied to a wider variety of occupations than medicine and law; the licensing statutes enacted in the late 1800s and early 1900s included occupations ranging from barbers and beauticians to architects, engineers, and dentists. Second, the requirements that were established by these regulations were generally stricter than those that were in place during the colonial era. Although colonial era licensing laws generally did not preclude unlicensed individuals from practicing law or medicine, in the late nineteenth and early twentieth centuries, a license was usually a prerequisite to practice a given occupation. Third, the enforcement of these more recent regulations was more vigilant than in the colonial era. Indeed, enforcement of these laws was generally placed in the hands of independent or state licensing boards, whose members were largely drawn from the occupational group being licensed. See Council of State Governments, *Occupational Licensing*, pp. 13–19.

[24] We would also have liked to examine the effect of early licensing laws on the incomes of these 11 occupations. Unfortunately, prior to the 1940s the Census of Population did not include

The primary source for our data on licensing is the Council of State Governments study, which reports information on when each state adopted licensing legislation for several different occupations.[25] We matched this with data taken from the decennial population censuses on the number of workers in each occupation. Because the occupational definitions in the population censuses do not always overlap neatly with the occupations that were licensed by state governments, we limited our sample to 11 occupations (architects, attorneys, barbers, beauticians, dentists, engineers, nurses, physicians, plumbers, teachers, and veterinarians). This limitation is unfortunate because, as noted earlier, by the 1950s state governments regulated over 75 different occupations. Nevertheless, we believe that these 11 occupations provide us with enough cross-occupational variation to tell a reasonably comprehensive story about the causes and consequences of early licensing laws. We also restricted our attention to the 1880 to 1930 population censuses because the occupational classifications over these years were most consistent, and because after 1930, most occupations were already licensed by state governments.[26]

Event History Analysis of the Adoption of Licensing Laws

To determine what factors motivated state governments to enact licensing regulation, we conduct an event history analysis. In particular, we estimate hazard regressions of the adoption of licensing legislation. Hazard models are appropriate for this purpose because they allow us to exploit the longitudinal structure of our data set. Within the class of hazard models, we use the logistic discrete time hazard model. This is a sensible choice because the adoption of licensing legislation was a single, nonrepeated event and because our observations are separated by ten-year intervals along the temporal dimension.[27]

The basic regression equation we estimate takes the following form

$$log[Pr_t/(1 - Pr_t)] = \lambda + \theta(U_{it}) + \pi(L_{it}/P_{it}) + \rho(L_{it}/P_{it})^2 + \varepsilon_{it}$$

Pr_t is the probability that occupational licensing legislation for a given occupation is adopted by year t; L_{it}/P_{it} is the per capita number of indi-

information on wages or incomes. In our case-study section, we use the earliest available data on professional incomes to test whether stricter medical licensing laws increased physician incomes in the late 1920s and early 1930s.

[25] See Council of State Governments, *Occupational Licensing*. For physicians, we use information contained in Baker, "Physician Licensure Laws," on the state medical licensing statutes.

[26] See Edwards, *Comparative Occupation Statistics*.

[27] See Allison, *Event History Analysis*.

viduals working in a given occupation in state i in year t; U_{it} is the urbanization rate in state i in year t; and ε_{it} is an error term. The per capita population of individuals working in a given occupation is included to proxy for producer interests. We also include the square of the per capita population of workers in a given occupation to allow for nonlinearity in the effect of occupational group size. Although increases in the per capita size of the occupational group may lower the time until licensing is adopted (i.e., increase the licensure hazard), the effect of group size may eventually become negative because free riding or coordination problems among members of the group reduces its political effectiveness.

The urbanization rate is included because it controls for other factors that may have contributed to the rise of licensing.[28] Professionals in urban areas may have been more likely to press for regulation to reduce competition because urban consumers can more easily switch to practitioners in the next neighborhood. On the other hand, because scientific advances and innovations in professional techniques were more likely to occur in urban areas, information asymmetries may have been more acute for professionals working in cities. This in turn would generate a greater demand for regulation to help consumers distinguish high from low quality professionals.[29]

We estimated this equation separately for each of the 11 occupations, and pooled across all 11 occupations. In the pooled regression, the effects of occupational size per capita and its square are constrained to be the same across occupations but each occupation has its own fixed effect. The occupational fixed effect indicates whether a given occupation is more likely to be regulated sooner or later relative to the average time of adoption across all occupations, other things held constant.

Table 2 presents the coefficient estimates when the regression equation was estimated separately for each of the 11 occupations. For architects, attorneys, physicians, and veterinarians, urbanization had a

[28] The urbanization rate is defined as the population in incorporated places with 2,500 or more divided by state population.

[29] Government officials were also aware that specialization and urbanization contributed to problems of asymmetric information. For instance, the Council of State Governments, *Occupational Licensing*, p. 3, made the following argument in favor of licensing regulation: "First, in modern urban society, where great multitudes of people live under increasingly crowded conditions, government agencies become responsible for ensuring adequate knowledge and competence among those ministering to the public health and well-being. This can only be accomplished by defining the conditions of admission and retention into the occupations. Second, the intense specialization in all fields that is characteristics of complex society often means that the public may fail to distinguish between competent and incompetent, honorable and dishonorable practitioners. State occupational licensing agencies therefore perform vital functions in protecting the people from fraud and dishonesty."

TABLE 2: DISCRETE TIME HAZARD MODEL ESTIMATES OF THE FACTORS INFLUENCING THE ADOPTION OF LICENSING REGULATION

	Architect	Architect	Attorney	Attorney	Barber	Barber	Beautician	Beautician	Dentist	Dentist	Engineer
Constant	–3.01***	–3.00***	–1.55*	–2.17*	–8.31***	–9.01***	–6.20***	–6.26***	2.93***	–3.44***	–3.67***
	(0.39)	(0.40)	(0.82)	(1.20)	(1.81)	(2.24)	(1.07)	(1.14)	–0.63	(0.66)	(0.47)
Urbanization	1.74*	1.69*	2.53**	2.31**	–0.84	0.17	–2.57	–1.65	0.98	1.34	–0.48
	(1.00)	(1.00)	(1.05)	(1.01)	(0.96)	(1.49)	(1.72)	(1.97)	(1.01)	(1.08)	(0.89)
Workers per thousand	2.20	2.61	–0.88	–0.96	6.17***	4.60*	13.32***	8.25**	7.10***	5.33*	1.51***
	(5.16)	(5.11)	(1.10)	(1.16)	(0.96)	(2.71)	(2.61)	(3.95)	(2.52)	(3.18)	(0.93)
(Workers per thousand)^2	1.34	0.94	0.24	0.29	–1.25**	–1.11	–5.43***	–3.37	–3.62**	–3.15*	–0.16*
	(9.56)	(9.83)	(0.30)	(0.29)	(0.58)	(0.74)	(1.83)	(2.13)	(1.54)	(1.88)	(0.09)
Time varying hazard	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Log–likelihood	–93.13	–93.04	–38.56	–35.41	–76.39	–56.73	–37.48	–35.63	–86.93	–73.53	–75.13
N	284	284	83	83	286	286	329	329	162	162	312

	Engineer	Nurse	Nurse	Physician	Physician	Plumber	Plumber	Teacher	Teacher	Vet	Vet
Constant	–5.32***	–4.39***	–4.91***	–6.11**	3.49***	–6.23***	–6.92***	–6.85**	–5.95**	–3.67***	–3.08***
	(1.25)	(0.48)	(0.20)	(2.54)	(0.78)	(1.16)	(1.07)	(3.07)	(2.95)	(0.56)	(0.64)
Urbanization	–2.49	1.28	1.47	1.53*	1.49*	–1.63	0.22	0.48	–0.08	3.32***	3.69***
	(1.77)	(0.95)	(1.18)	(0.83)	(0.85)	(1.46)	(1.66)	(2.10)	(2.25)	(1.10)	(1.30)
Workers per thousand	0.33	4.43***	3.73***	6.12**	1.41**	3.38**	2.31	1.34	1.06	11.94	20.68**
	(0.93)	(0.56)	(0.73)	(3.09)	(0.55)	(1.36)	(1.86)	(0.95)	(1.10)	(8.32)	(10.50)
(Workers per thousand)^2	–0.07	–1.25***	–0.99**	–1.87**	–0.07**	–0.67	–0.53	–0.06	–0.05	–1.51	–36.39
	(0.15)	(0.24)	(0.31)	(0.91)	(0.03)	(0.44)	(0.50)	(0.09)	(0.09)	(2.76)	(30.39)
Time varying hazard	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Log–likelihood	–50.59	–89.09	–64.73	–89.44	–77.07	–23.11	–21.22	–23.35	–21.33	–83.03	–67.89
N	312	268	268	162	162	308	308	57	57	197	197

* = significant at the 10-percent level. ** = significant at the 5-percent level. *** = significant at the 1-percent level.

Notes: The coefficient estimates show the change in the log-odds of adopting licensing legislation for a given occupation resulting from a one-unit change in the variable. Heteroskedasticity-robust standard errors are reported in parenthesis.

positive and statistically significant effect on the licensure hazard, indicating that more urban states were more likely to enact licensing legislation for these occupations sooner. For the other occupations, the coefficient on urbanization is not statistically significant. The per capita number of workers in an occupation had a positive and statistically significant effect on the licensure hazard for barbers, beauticians, dentists, engineers, nurses, physicians, plumbers, and veterinarians. Hence, for these occupations, greater producer representation increased the probability that licensing would be adopted sooner.

Table 3 presents the coefficient estimates from the pooled regression. The coefficients on workers per capita, workers per capita squared and urbanization all have the predicted signs and are statistically significant. Additionally the occupational fixed effects indicate that there were occupational-specific differences in the timing of licensing. Barbers are the omitted category and hence the fixed effects should be interpreted as the occupational-specific effect on the timing of licensure relative to barbers. The coefficients indicate that occupations such as architects, attorneys, dentists, nurses, physicians, and veterinarians were regulated earlier than barbers whereas plumbers and teachers were regulated later.

The regression results suggest that for most occupations, producer interests were an important factor influencing the timing of licensure, and that for certain professions, urbanization also affected the timing of licensure. Because producer groups were generally the main proponents of licensing, the statistical significance of producer interests in most of the hazard regressions is not altogether surprising: producer interests probably stood to gain most from licensing, either because they perceived it would function as an entry barrier or because of its potential to reduce informational asymmetries and help make a market for their services. That urbanization also had a positive and significant effect on the licensure hazard for some professions (architects, attorneys, physicians, and veterinarians) is also potentially consistent with both hypotheses.[30] Urban professionals in these fields may have been more likely to lobby for regulation because competition was greater in urban areas, or because the asymmetric information problem was more severe in urban settings. The fact that urbanization is significant for these professions but

[30] One potential problem with the urbanization variable is that it might be correlated with political activity among professionals. If the per capita number of workers is correlated with urbanization, then collinearity between urbanization and the per capita number of workers may explain why urbanization is not significant in some of the regressions. To check for this, we reestimated the regression equations for those occupations where urbanization was not significant excluding the number of workers per capita and its square and we still found that urbanization was not significant. Hence, the failure of urbanization to be significant in these regressions is unlikely to be a consequence of collinearity among the independent variables.

TABLE 3
POOLED HAZARD MODEL ESTIMATES OF THE FACTORS INFLUENCING THE TIMING OF LICENSING REGULATION, 1880–1930

	Dependent Variable: Licensing Statute Enacted (Yes = 1)
Constant	–4.67***
	(0.31)
Urbanization	1.52***
	(0.28)
Workers per thousand	1.32***
	(0.14)
(Workers per thousand)^2	–0.08***
	(0.02)
Occupation fixed effects (omitted category: Barbers)	
Architects	1.86***
	(0.34)
Attorneys	1.01***
	(0.39)
Beauticians	0.10
	(0.36)
Dentists	2.92***
	(0.32)
Engineers	0.11
	(0.32)
Nurses	1.51***
	(0.30)
Physicians	1.31***
	(0.29)
Plumbers	–2.08***
	(0.55)
Teachers	–1.52***
	(0.52)
Veterinarians	2.76***
	(0.33)
Log–likelihood	–785.49
N	2,462

* = significant at the 10–percent level.
** = significant at the 5–percent level.
*** = significant at the 1–percent level.
Notes: The coefficient estimates show the change in the log-odds of adopting licensing legislation for a given occupation resulting from a one-unit change in the variable. Heteroskedasticity-robust standard errors are in parentheses.

not others may be more supportive of the asymmetric information hypothesis than the capture hypothesis, however, because occupations such as medicine and veterinary science were those where scientific advance was most likely to make the asymmetric information problem more severe. Finally, the pooled event history analysis suggests that licensing laws were adopted earlier for those professions such as dentists, physicians and veterinarians whose markets were more likely to suffer from problems of asymmetric information.

Effect of Licensure on Entry

In this section we conduct an empirical investigation of the effect of early state occupational licensing laws on entry into these eleven occupations. The basic fixed effect regression equation we estimate is as follows

$$L_{it}/P_{it} = \mu + S_i + Y_t + \alpha R_{it} + X_{it}\beta + \varepsilon_{it} \quad (1)$$

P_{it} denotes the population of state i in year t; L_{it} denotes the number of workers in a particular occupation in state i in year t; S_i denotes a fixed-effect for state i; Y_t denotes a fixed-effect for year t; R_{it} denotes a binary variable that is equal to one in all years t in which occupational licensing is in place in state i and zero otherwise; and X_{it} denotes a vector of time-varying control variables for state i in year t. The two time-varying state-level control variables we include are the urbanization rate; and real income per capita.[31] We include these variables because both were likely to influence the per capita number of workers in each occupation. The variable of interest in this regression, α, is the coefficient on the regulation dummy variable. If $\alpha < 0$ then regulation reduced the number of individuals employed in a particular occupation. If, on the other hand, $\alpha \geq 0$, then regulation either had no impact on entry or increased the entry of individuals into a particular occupation.

We also examine the effect of occupational licensing on entry by estimating a "dynamic" version of equation 1 which takes the following form

$$(\%\Delta L_{it}) = \gamma + S_i + Y_t + \delta(\%\Delta P_{it}) + \alpha R_{it} + \nu_{it} \quad (2)$$

In regression equation 2, the dependent variable is $\%\Delta L_{it}$, which is the growth rate between adjacent census years (approximated by the first difference in the natural logarithm) in the number of individuals working in a given occupation. As before, α is the coefficient of interest. If $\alpha < 0$, then occupational licensing regulation reduced the growth rate of the number of persons in a given occupation (i.e., reduced the rate of entry). On the other hand, if $\alpha \geq 0$, then occupational licensing had no impact or increased the growth rate of the number of persons working in a given occupation (i.e., did not affect or increased entry).

[31] Data on real income per capita at the state level are taken from Kuznets and Brady, *Population Redistribution*. Values for 1890 and 1910 were imputed.

Our analysis from the previous section suggests that there is potentially an endogeneity problem with respect to R_{it}, the regulation binary variable, and our dependent variables. The hazard regressions indicated that an increase in the per capita number of workers in a given occupation increased the likelihood that occupational licensing regulation would be enacted. As a result, a positive correlation exists between the regulation binary variable and the error term in equations 1 and 2, which implies that ordinary least squares estimates of the coefficient on the regulation binary variable will be biased.[32] To address this problem, we instrument for occupational licensing regulation. The particular variable we use to instrument for regulation of a given occupation is an index variable that equals the number of *other* occupations licensed by a given state in a given year.[33] This is an excellent instrument because it is likely to be correlated with the probability that licensing regulation of a given occupation is enacted but not with the per capita number of workers in that given occupation.[34] Using this variable as an instrument for occupational licensing regulation for each occupation, we also estimate equations 1 and 2 by two-stage least squares.

Table 4 presents ordinary least squares (OLS) and two stage least squares (2SLS) regression estimates of the effects of licensing regulation on the number of workers per 1,000 persons for each occupation. In none of the regressions is the coefficient on the regulation binary variable negative and significant; early licensing laws do not appear to have reduced the per capita number of workers in any of these occupations, regardless of whether we estimate these regressions by OLS or by 2SLS. For beauticians the coefficient on the regulation dummy is positive and significant in both the 2SLS and OLS regressions suggesting that regulation increased entry into this occupation. In the 2SLS regressions, we find that the coefficient on the regulation variable is negative but not

[32] To some degree the fixed effect framework should deal with the problem of correlation between the regulation indicator variable and the error term. If the state fixed effects are capturing unmeasured correlations between the regulation variable and the error, then the coefficient on the regulation binary variable should be "less positive" when fixed effects are included. We estimated both equations 1 and 2 with and without fixed effects and found that for most occupations, the coefficient on the regulation dummy variable was significantly smaller with state fixed effects than without them. Hence, we believe that the fixed effect framework goes some way in dealing with this problem.

[33] Because we have information on the licensing of eleven occupations, our index variable takes on values from zero to ten.

[34] For instance, to instrument for whether physicians were regulated in 1910 in Alabama we construct an index variable that is equal to the total number of *other* occupations (excluding physicians) licensed by Alabama in 1910. This index variable should be correlated with the probability that physicians were licensed in Alabama in 1910, but not with the per capita number of physicians or the growth rate of physicians in Alabama.

TABLE 4
EFFECTS OF OCCUPATIONAL LICENSING REGULATION ON THE NUMBER OF WORKERS PER 1,000 PERSONS FOR ELEVEN DIFFERENT OCCUPATIONS, 1880–1930

	Architects	Attorneys	Barbers	Beauticians	Dentists	Engineers	Nurses	Physicians	Plumbers	Teachers	Vets
					A: Ordinary Least Squares Estimates						
Constant	–0.09***	1.72***	0.31	–0.11	0.13***	–27.41***	–0.86***	21.05***	–36.35***	8.83***	–2.78***
	(0.03)	(0.24)	(0.21)	(0.11)	(0.05)	(14.73)	(0.29)	(8.03)	(6.25)	(1.12)	(0.94)
Urbanization	0.23***	–1.48**	3.32***	0.20	0.05	1.00	4.19***	0.49	2.02***	–3.72	0.14
	(0.08)	(0.67)	(0.44)	(0.16)	(0.12)	(1.00)	(0.72)	(0.96)	(0.51)	(2.36)	(0.86)
Per capita income	0.00006**	0.0002	0.004**	0.0001	0.0005	0.0004	0.0001	–0.0002	0.0001	–0.003***	–0.00009**
	(0.00002)	(0.0002)	(0.002)	(0.00007)	(0.0003)	(0.0004)	(0.0002)	(0.0002)	(0.0002)	(0.0007)	(0.00004)
Regulation	0.0009	0.06	–0.06	0.16**	–0.002	0.10	0.14	–0.30	0.13	0.79***	0.02**
	(0.01)	(0.10)	(0.06)	(0.07)	(0.05)	(0.14)	(0.12)	(0.44)	(0.13)	(0.30)	(0.008)
Adjusted–R^2	0.77	0.64	0.84	0.84	0.68	0.72	0.46	0.31	0.84	0.92	0.69
N	275	163	271	283	283	283	284	283	271	132	236
					B: Two Stage Least Squares Estimates						
Constant	–0.09***	1.71***	0.50**	–0.13	–14.5**	0.74	–69.73**	21.79**	–37.67***	8.86***	0.10***
	(0.03)	(0.24)	(0.24)	(0.12)	(5.52)	(0.60)	(33.03)	10.36)	(6.23)	(1.56)	(0.04)
Urbanization	0.26*	–1.97***	2.89***	–0.02	0.19	1.12	1.53**	0.46	2.03***	–2.21	0.06
	(0.15)	(0.58)	(0.53)	(0.26)	(0.18)	(1.38)	(0.64)	(1.36)	(0.51)	(6.83)	(0.10)
Per capita income	0.00005	0.00008	0.0004**	0.0002**	–0.00006	0.0006*	–0.0004*	–0.0002	0.0002	–0.004***	–0.00005
	(0.00004)	(0.0002)	(0.0001)	(0.00001)	(0.00008)	(0.0003)	(0.0002)	(0.0003)	(0.0002)	(0.001)	(0.00004)
Regulation	–0.02	0.49	0.20	0.78**	–0.16	1.27	–0.37	–0.25	–0.49	–0.73	0.06
	(0.07)	(0.33)	(0.16)	(0.25)	(0.15)	(0.90)	(0.84)	(1.29)	(0.83)	(6.66)	(0.18)
Adjusted–R^2	0.76	0.60	0.82	0.67	0.62	0.59	0.57	0.30	0.83	0.88	0.73
N	275	163	271	283	283	283	284	284	271	132	236

* = significant at the 10-percent level. ** = significant at the 5-percent level. *** = significant at the 1-percent level.

Notes: State fixed effects were included. Heteroskedasticity-robust standard errors are in parentheses.

significant for architects, dentists, nurses, physicians, plumbers, and teachers, and positive but not significant for attorneys, barbers, engineers, and veterinarians. The first stage regression results give us confidence that our instrument for licensing performs well; the coefficient on the licensing instrument is positive and significant in nearly all of the first-stage regressions. Finally, the control variables in each of the regression equations generally have plausible signs. For many occupations, urbanization and real per capita income are positively correlated with the number of workers per 1,000.

However, because the enactment of licensing regulation is more likely to have an impact on the rate of entry over time, the dynamic version of the entry restriction regression model is likely to be more informative. Table 5 reports the OLS and 2SLS regression estimates of equation 2 for each occupation. Although the OLS estimates suggest that regulation only had a negative and significant effect on the growth rate in the number of architects and veterinarians, the 2SLS estimates suggest that regulation also had a negative and significant effect on the growth rate of physicians and dentists. For beauticians, the coefficient on the regulation variable is positive and significant, but for the remaining occupations, the coefficient on the regulation variable is insignificant. Hence, whereas regulation may have functioned as an entry barrier for architects, dentists, physicians, and veterinarians, it did not function in this way for the rest of the occupations in our sample. As before, the coefficient on the licensing instrument is positive and significant in most of the first-stage regressions.

The regression results therefore suggest that the occupational licensing laws enacted in turn-of-the-century America were negatively correlated with entry for a handful of occupations. For most occupations, licensing did not reduce entry, perhaps because the standards set by most early licensing statutes were not very strict, or because enforcement of early licensing laws was weak. However, it is interesting to note that licensing had a negative effect on entry on physicians, dentists, and veterinarians—professions whose services tended to be purchased directly by consumers, for which the costs associated with low quality service were potentially greatest, and where advances in technique gave rise to greater heterogeneity in professional quality—and that licensing did not have a negative effect on entry for engineers and teachers, whose services were generally purchased by firms, or barbers and beauticians, for which the costs of obtaining low quality service were not substantial.[35]

[35] From this perspective, architects are an outlier, as their services tend to be purchased by firms, rather than individuals and we do find that licensing reduced entry into architecture.

TABLE 5
EFFECTS OF OCCUPATIONAL LICENSING REGULATION ON THE GROWTH RATE OF WORKERS IN ELEVEN DIFFERENT OCCUPATIONS, 1880–1930

	Architects	Attorneys	Barbers	Beauticians	Dentists	Engineers	Nurses	Physicians	Plumbers	Teachers	Vets
					A: Ordinary Least Squares Estimates						
Constant	–0.47*	–0.30*	–0.34	–13.29	0.35***	–0.17	0.50*	0.06	–0.15	0.60***	–0.04
	(0.29)	(0.19)	(0.30)	(8.91)	(0.13)	(0.17)	(0.25)	(0.14)	(0.26)	(0.14)	(0.30)
Population growth	2.02***	1.27***	1.11***	1.33***	0.99***	1.43***	0.66*	0.97***	1.80***	1.07***	1.00***
	(0.33)	(0.15)	(0.18)	(0.42)	(0.10)	(0.25)	(0.39)	(0.09)	(0.24)	(0.14)	(0.22)
Regulation	–0.26***	0.05	–0.04	0.64***	–0.14	–0.08	0.01	–0.18	–0.009	0.02	–0.16*
	(0.08)	(0.13)	(0.12)	(0.18)	(0.09)	(0.10)	(0.10)	(0.13)	(0.12)	(0.04)	(0.09)
Adjusted–R^2	0.39	0.28	0.16	0.06	0.37	0.05	0.18	0.40	0.64	0.08	0.54
N	262	162	270	254	274	274	210	282	265	132	224
					B: Two Stage Least Squares Estimates						
Constant	–0.45	–0.16	–0.16	1.20***	0.47***	–0.10	0.73	0.54***	13.35	0.40**	0.13
	(0.29)	(0.28)	(0.23)	(0.44)	(0.15)	(0.19)	(0.64)	(0.25)	(8.75)	(0.15)	(0.28)
Population growth	1.95***	1.20***	1.22***	0.94**	0.91***	1.36***	0.57	0.85***	1.87***	1.24***	1.20***
	(0.33)	(0.19)	(0.20)	(0.37)	(0.12)	(0.27)	(0.51)	(0.14)	(0.29)	(0.15)	(0.22)
Regulation	–0.40***	–0.10	–0.16	0.49**	–0.41***	–0.27	–0.86	–0.63***	–0.87	–0.23	–0.68***
	(0.14)	(0.27)	(0.30)	(0.24)	(0.12)	(0.25)	(1.73)	(0.23)	(1.29)	(0.80)	(0.12)
Adjusted–R^2	0.38	0.27	0.11	0.23	0.33	0.04	0.17	0.24	0.42	0.07	0.30
N	262	262	270	254	274	274	210	282	282	132	224

* = significant at the 10-percent level. ** = significant at the 5-percent level. *** = significant at the 1-percent level.

Notes: State fixed effects were included. Heteroskedasticity-robust standard errors are in parentheses.

CASE STUDY OF THE MEDICAL PROFESSION

We focus on the medical profession for several reasons. First, licensing regulations were not static for physicians and it is important to determine which types of regulations were most effective for limiting entry. Second, the availability of data on physician incomes allows us to investigate whether state licensing led to higher incomes. Third, data on health outcomes (i.e., disease-specific mortality rates) can be used to provide a sharper test of whether licensing increased physician quality. Fourth, it is interesting to examine whether medical licensing regulation affected the incidence of medical malpractice suits. Finally, because the medical profession was (and continues to be) more strictly regulated than other professions, it is important to determine whether medical licensing improved quality of physician services or merely restricted entry and reduced competition.

Our data on the nature of medical licensing legislation from 1870 to 1930 is taken from Baker and from the American Medical Association's (AMA) Council on Medical Education.[36] For each state we know: the year in which the initial licensing law was enacted; the year a state licensing board was introduced; the year in which a state licensing exam was required for new medical license applicants; the year in which a two-year premedical college requirement was introduced; the year in which the length of the medical degree was required to be at least four years long; the year in which an internship requirement was imposed; and the year in which a basic science requirement was introduced. By incorporating information on these seven licensing requirements in a regression framework, we hope to control more fully for changes in the nature of medical licensing legislation over time.

Our basic empirical strategy is simple. As before, we match our information on licensing with data on the outcomes that are of interest to us (per capita number of physicians, physicians' incomes, disease specific-mortality rates, and the incidence of malpractice suits) and we exploit cross-state variation in licensing to estimate the effect of medical licensing laws on these outcomes. Because our outcome measures are not always available for every state or for the full sample period (1880-1930), sample sizes do vary across regressions. Nevertheless, we believe that the data are rich enough to furnish a nuanced picture of the effects of medical licensing laws.

[36] See Baker, "Physician Licensure Laws"; and Council on Medical Education, "Medical Education in the United States."

Effects of Medical Licensing Laws on Entry

Table 6 presents OLS regression estimates of the effects of particular medical licensing requirements on the number of physicians per 1,000 persons from 1880 to 1930. OLS estimates of the effect of licensing on entry are likely to be biased against finding a negative effect, because states with more practitioners per capita were also more likely to enact regulation. Hence, our regression estimates of the effect of specific licensing requirements on reducing entry into medicine will understate the true effect. In the first column we control for licensing by including a binary variable for each of the seven medical licensing requirements. In the second column we construct two separate indices to measure early licensing and later licensing requirements separately. Early licensing requirements were the initial licensing law and the introduction of a state board. These requirements were generally introduced prior to 1900. To index for these early requirements we summed the binary variables that indicate whether a state had an initial law and whether the state had a licensing board. Later licensing requirements were those introduced after 1900 (licensing exam, four year medical school requirement, two year premedical college requirement, internship requirement, and the science requirement). The index for these later requirements is a sum of the binary variables that indicate whether the state had introduced these requirements by a given year. Finally, in column 3, we construct a composite licensing index to measure the overall strictness of a state's medical licensing laws. This index is simply the sum of each of the individual binary variables. Because there are seven requirements, this index takes on values between 0 and 7. As before, we also control for the real per capita income in each state and the urbanization rate in each state to account for other factors that might have influenced the number of physicians per capita.

When we control for each licensing requirement separately (column 1), we find that the introduction of a two-year premedical college requirement and the four-year medical school requirement had a negative and statistically significant impact on the number of physicians per 1,000 persons. Thus, the licensing requirements that restricted entry were those that were most likely to improve physician quality. When we index separately for early and later medical licensing requirements, (column 2) we find that earlier requirements had a positive and significant effect on the number of physicians per 1,000, whereas later requirements had a negative and significant impact. Hence, it seems that those licensing requirements that were introduced in the post-1900 period

TABLE 6:
EFFECTS OF MEDICAL LICENSING REQUIREMENTS ON THE NUMBER OF PHYSICIANS PER 1,000 PERSONS, 1880–1930

	(1)	(2)	(3)
Constant	1.60	1.56***	1.85***
	(0.17)	(0.16)	(0.15)
Urbanization	0.003	–0.01	–0.03
	(0.06)	(0.07)	(0.10)
Income per capita	–0.0002*	–0.0001***	–0.0003***
	(0.0001)	(0.00001)	(0.0001)
1. Initial law	0.01		
	(0.07)		
2. State board	0.05		
	(0.05)		
3. Licensing exam	0.02		
	(0.05)		
4. College requirement	–0.28***		
	(0.04)		
5. Four year requirement	–0.09**		
	(0.04)		
6. Internship requirement	0.005		
	(0.06)		
7. Science requirement	–0.13		
	(0.11)		
Early requirements (1 and 2)		0.08*	
		(0.04)	
Later requirements (3, 4, 5, 6, 7)		–0.12***	
		(0.02)	
Composite licensing index			–0.04***
			(0.01)
Adjusted–R^2	0.70	0.68	0.64
N	282	282	282

* = significant at the 10-percent level.
** = significant at the 5-percent level.
*** = significant at the 1-percent level.
Notes: State fixed effects were included. Heteroskedasticity-robust standard errors are reported in parentheses.

were those that were most negatively correlated with entry.[37] Finally, when we use the composite licensing index to measure overall licensing strictness (column 3), we find that stricter medical licensing reduced the number of physicians per 1,000. Because of the direction of endogeneity bias, the true effect of licensing on reducing entry into medicine is likely to have been even stronger. Thus, the evidence presented in this set of regressions suggests that medical licensing requirements, particu-

[37] Superficially, this would appear to be inconsistent with our analysis in the previous section, which found that initial state licensing regulation reduced entry into medicine. We believe that this is a consequence of the fact that the stricter licensing standards were correlated over time with initial legislation.

larly those introduced in the early decades of the twentieth century, significantly reduced entry into medicine.

Effects of Medical Licensing Laws on Physician Incomes

Perhaps the most highly cited evidence supporting the industry capture explanation for professional licensing comes from the classic study by Milton Friedman and Simon Kuznets.[38] Using survey data on the incomes of physicians and dentists from 1929 to 1932, Friedman and Kuznets found that, at a national level, average physician incomes were higher than average dentist incomes. Even after adjusting for the fact that it took longer to become a physician, physicians appeared to earn a premium relative to dentists. Based on this evidence, Friedman and Kuznets attributed this premium to medical licensing regulations that were enacted in response to lobbying by the AMA. In this section, we use the same data on professional incomes to examine whether licensing regulations increased average physician earnings. However, unlike Friedman and Kuznets, we examine whether cross-state variation in physician incomes as well as the ratio of physician to dentist incomes can be explained by variation in the strictness of medical licensing regulation across states.

The data on physician and dental incomes are taken from a U.S. Senate Report.[39] For each state, we know the total earnings of physicians and the number of physicians surveyed. Hence, we divide the total earnings of physicians in each state by the number of physicians surveyed to obtain a measure of average physician earnings. As an alternative measure of physician incomes, we follow Friedman and Kuznets and examine the ratio of average physician earnings to average dentist earnings.[40] We then matched these data with our information on state-level medical licensing legislation from 1929 to estimate the impact of stricter medical licensing regulation on physician earnings.[41] Because, by 1929, cross state variation in medical licensing regulation was limited to variation in: whether the state had a basic science requirement; whether the state had an internship requirement; and whether the state

[38] Friedman and Kuznets, *Income*.

[39] U.S. Senate, "National Income."

[40] An examination of the effects of licensing on the ratio of physician to dentist incomes is potentially problematic if dental licensing varied significantly across states. The available evidence suggests that dental licensing requirements were fairly similar across states at this time. See Fraundorf, "Organized Dentistry."

[41] We restricted our attention to 1929 because licensing requirements did not change significantly during these few years. Qualitatively similar results were obtained when we examined 1930, 1931, and 1932 individually.

TABLE 7
EFFECTS OF MEDICAL LICENSING REGULATION ON PHYSICIAN INCOMES IN 1929

	Dependent Variable: Log(Average Gross Income) (1)	Dependent Variable: Log(Average Net Income) (2)	Dependent Variable: Ratio of Gross Physician to Gross Dentist Income (3)	Dependent Variable: Ratio of Net Physician to Net Dentist Income (4)
Constant	8.56***	8.13***	0.88***	1.11***
	(0.17)	(0.17)	(0.20)	(0.21)
Income per capita	0.0001	–0.0001	0.42	–0.0005
	(0.0004)	(0.0004)	(0.53)	(0.90)
Urbanization	0.90*	0.78*	–0.0001	0.74
	(0.46)	(0.44)	(0.0005)	(0.68)
Licensing index	0.09	0.03	0.15*	0.06
	(0.07)	(0.07)	(0.08)	(0.09)
Adjusted–R^2	0.17	0.12	0.10	0.08
N	48	48	48	48

* = significant at the 10-percent level
** = significant at the 5-percent level
*** = significant at the 1-percent level
Notes: Heteroskedasticity-robust standard errors are in parentheses.

had a premedical college requirement of two years, we restricted our attention to these dimensions of licensing. Because the overall level of income in the state, as well as the extent to which the state was urban may have influenced physician incomes, we also include the urbanization rate and the level of personal income per capita.[42]

Table 7 displays OLS regression estimates of the impact of medical licensing regulation on the natural logarithm of average physician incomes and the ratio of physician to dentist incomes.[43] We report regression results using the licensing index variable to measure licensing strictness. Qualitatively similar results were obtained when we controlled separately for the various medical licensing requirements. The regression coefficients indicate that stricter medical licensing requirements did not have a significant impact on average gross or average net physician earnings but they did have a positive and significant impact on the ratio of physician to dentist gross incomes. Hence, our results are

[42] Urbanization and real per capita personal income are somewhat collinear. Qualitatively similar coefficient estimates were obtained when we control for only urbanization but not real per capita income (and vice versa).

[43] OLS estimates are likely to underestimate the true effect of licensing on doctors' incomes because doctors from states where physician earnings were low likely faced the strongest incentive to lobby for regulation in order to restrict entry and raise their incomes. Accordingly, these estimates should be interpreted as a lower bound of the actual effect. Qualitatively similar results were obtained when we used the licensing instrument developed in the empirical analysis section to instrument for the strictness of medical licensing. This suggests that the OLS bias is small.

consistent with Friedman and Kuznets's claim about the effect of medical licensing on the ratio of physician to dentist incomes.

Effects of Medical Licensing on State-Level Mortality Rates

In this section we analyze the correlation between licensing and quality by investigating the relationship between physician licensing and mortality.[44] In the early 1900s the Census Bureau began to collect cause-specific mortality data at the level of individual states and cities.[45] By matching this information with our data on state medical licensing regulations, we can estimate the impact of licensing on state mortality rates. Because most of our independent variables are only available at ten-year intervals, we collected state-level mortality statistics for 1900, 1910, 1920, and 1930.

Because estimates of impact of medical licensing regulation on mortality rates may be subject to an endogeneity problem, we take the following empirical strategy.[46] First, we include state fixed effects in our analysis in order to sweep out any state-specific factors (for instance, state-specific investments in public health) that may have influenced mortality rates in a given state. Second, we include real per capita income and urbanization as control variables. Urbanization controls for the fact that the disease environment was different in urban areas than in rural areas. Real per capita income is included to proxy for nutritional quality; presumably, average nutrition was better in states with higher real incomes. Third, we examine the impact of licensing not only on overall mortality rates, but also on a few cause-specific mortality rates. Although public health investments or nutrition may have heavily influ-

[44] A large and growing body of scholarship has been devoted to analyzing the determinants of mortality in America during the twentieth century. In general, little attention has been paid to the role that medical licensing and improvements in physician quality may have played in reducing mortality rates. See Fogel, "Economic Growth"; Costa and Steckel, "Long Term Trends"; Cutler and Meara, "Changes"; and Cutler and Miller "Role of Public Health Improvements."

[45] See U.S. Bureau of the Census, *Mortality Statistics*.

[46] One might imagine that states that were more likely to enact stricter medical licensing requirements were also those states that were more "health conscious." "Health conscious" states may have differed from other states not only in terms of their willingness to adopt stricter medical licensing regulations, but also in terms of their level of public health or nutrition. Presumably, the residents of "health conscious" states enjoyed above-average nutrition and were also more willing to invest in public health infrastructure. Hence, mortality may therefore tend to be lower in "health conscious" states, not because stricter licensing improved physician quality, but rather, because investments in public health and better nutrition altered the disease environment in these states or the ability of individuals in these states to fight disease. Without controlling for these other factors, OLS will be biased toward showing that licensing improved health outcomes.

enced the probability of dying from certain diseases (for instance, cholera or influenza), the likelihood of dying from other causes (for instance, appendicitis) may be completely unrelated to nutrition or public health.[47]

We collected data on six different mortality rates: the overall mortality rate, cancer mortality rate, diabetes mortality rate, infant mortality rate, maternal mortality rate, and appendicitis mortality rate. To measure the strictness of medical licensing in each state, we used our composite medical licensing index. Table 8 presents OLS regression estimates of the determinants of these six mortality rates. In each regression we control for the urbanization rate in each state, real income per capita, the strictness of medical licensing regulation, state fixed effects, year fixed effects, and the number of physicians per 1,000 persons.[48]

The coefficient estimates of the effects of licensing on mortality suggest that licensing, by increasing the quality of physicians, lowered mortality rates due to those illnesses where physician quality is likely to have mattered during this period. Although stricter medical licensing did not have a significant impact on overall mortality rates, cancer mortality rates, diabetes mortality rates, or infant mortality rates, it appears to have significantly reduced rates of maternal mortality and appendicitis mortality.[49] Stricter licensing should have little effect on overall mortality rates because many causes of death were beyond the control of physicians during this period. In particular, licensing should have no effect at all on cancer mortality because the state of medical science at this time was such that physicians were powerless to affect cancer mortality. Accordingly, the coefficient on the licensing variable is insignificantly different from zero in the cancer mortality rate regression. Increases in physician quality did not significantly lower mortality rates due to diabetes in spite of the fact that the invention of insulin in 1922 provided physicians with a means for treating this illness. However, stricter licensing does seem to have reduced maternal mortality rates

[47] Even after controlling for these factors, OLS estimates may still be biased, but in the opposite direction. One might argue that states with worse health outcomes were more likely to enact licensing if they believed that licensing would improve health outcomes. In this case, OLS will be biased toward showing that licensing did not improve health outcome. Any finding that licensing improved health outcomes would therefore be robust.

[48] We include the number of physicians per 1,000 persons to control for variation in physician access. Year fixed effects were included to control for overall improvements in the treatment of certain diseases that may have been unrelated to licensing. Using a time trend as opposed to year fixed effect to control for overall improvements in medical treatment does not materially affect our results.

[49] Qualitatively similar results were obtained when we used the lagged value of the composite licensing index to control for physician quality and when we instrumented for medical licensing using the occupational licensing instrument developed in the empirical analysis section.

TABLE 8
EFFECTS OF MEDICAL LICENSING REQUIREMENTS ON STATE-LEVEL MORTALITY RATES DUE TO DIFFERENT CAUSES, 1900–1930

	(1) Overall Mortality Rate	(2) Cancer Mortality Rate	(3) Diabetes Mortality Rate[a]	(4) Infant Mortality Rate[b]	(5) Maternal Mortality Rate[c]	(6) Appendicitis Mortality Rate[d]
Urbanization	–58.15	–1.28	–0.59	4.32	0.10	0.79
	(151.78)	(4.69)	(1.42)	(10.03)	(0.18)	(2.45)
Income per capita	–1.60	0.001	0.004*	–0.03	0.0004	0.01**
	(1.34)	(0.008)	(0.002)	(0.02)	(0.001)	(0.004)
Physicians per 1,000 persons	303.30	–11.70	–1.18	–41.68	–0.52	–10.66**
	(353.87)	(9.26)	(2.45)	(30.28)	(2.18)	(4.65)
Composite licensing index	363.69	0.84	–0.41	1.43	–1.05***	–1.84**
	(353.86)	(1.47)	(0.42)	(3.51)	(0.34)	(0.89)
Adjusted–R^2	0.38	0.92	0.87	0.86	0.89	0.64
N	111	108	80	65	69	100

* = significant at the 10-percent level.
** = significant at the 5-percent level.
*** = significant at the 1-percent level.
Notes: Mortality rate per 100,000 persons from 1900 to 1930 (unless otherwise specified). State fixed effects and year fixed effects were included in each regression.
[a] Because insulin treatment was only developed in 1922, we restricted our sample to diabetes mortality rates in 1920 and 1930 for this regression.
[b] The infant mortality rate is expressed as the number of deaths of children less than one year old per 1,000 children one year of age or less. Estimates of the number of children one year of age or less were not available for every state in the registration area; hence, the sample size is smaller for this regression.
[c] The maternal mortality rate is expressed as the number of deaths due to childbirth per 1,000 live births. These data were only available for selected states in 1920 and 1930; hence the sample size is smaller for this regression
[d] Data on deaths due to appendicitis were only available for 1910, 1920, and 1930; hence, the sample size is smaller for this regression.

because well trained physicians during this period may have been better able to deal with complications arising from childbirth.[50] Finally, states with stricter licensing had lower appendicitis mortality rates. This period witnessed dramatic improvements in basic surgery due to advances in antiseptics. Because the onset of appendicitis is more or less random, this estimate is least likely to be influenced by an endogeneity bias.

The coefficients on the remaining control variables are worth discussing briefly. Although the urbanization variable is generally not significant, it appears that the lack of significance of urbanization is due to the inclusion of state fixed effects. When we omit the fixed effects in the regressions, the urbanization coefficient generally becomes significant

[50] Collins and Thomasson, "Declining Contribution," examine whether the racial gap in infant mortality rates from 1920 to 1970 at the state level can be explained by differences in income, urbanization, women's education, and physicians per capita.

with the correct sign and the signs and significance levels of the other variables remain unchanged. The absence of a significant correlation between cancer and real income also seems reasonable. The positive and significant correlation between real per capita income and diabetes and appendicitis mortality is somewhat puzzling, but the size of these coefficients is small.

The coefficient on physicians per 1,000 persons, which proxies for physician access, is positive but not significant in the overall mortality rate regression; negative but not significant in the cancer, diabetes, infant, and maternal mortality rate regressions; and negative and significant in the appendicitis mortality rate regressions. Although access to a physician may not have been important for overall mortality or cancer mortality (because physicians were powerless to treat most illnesses, especially cancer, at this time), it may have been important for appendicitis mortality as surgery requires access to a physician. Finally, access to physicians may not have been critical for infant or maternal mortality rates because of the availability of midwives as a substitute, although it is worth noting that physician quality (as proxied by the composite licensing index) did matter for maternal mortality.

Effects of Medical Licensing Regulation on State-Level Appellate Court Malpractice Suits

In this section, we examine the relationship between state medical licensing requirements and the incidence of medical malpractice suits. In principle, if licensing requirements increased physician quality, then one might expect to observe a reduction in the number of malpractice suits in response to medical licensing legislation. However, the frequency of medical malpractice suits seems to have increased dramatically over the Progressive Era. According to Kenneth De Ville, the growth in malpractice suits during this period was caused by competition among physicians of different sects as well as dramatic advances in medical technology.[51]

Our data on malpractice cases are taken from Hubert Smith, who reports the number of appeals court cases on medical malpractice over each decade and in each state from 1790 to 1940.[52] We restrict our attention to the data from 1880 to 1930 because these overlap with our data on medical licensing regulations. Ideally we would have liked to use data on the total number of malpractice cases rather

[51] DeVille, *Medical Malpractice*.
[52] Smith, "Legal Responsibility."

than merely the number of cases reaching state appeals courts. However, to the extent that the number of malpractice cases reaching state appeals courts is positively correlated with the total number of malpractice cases in a given state, the data reported in Smith should serve as a reasonable proxy for the incidence of malpractice suits in each state.

Because we expect that the number of malpractice cases should be greater in more populous states, we normalize Smith's data by state population (in millions) to obtain our dependent variable. Because Smith reports the number of appellate court malpractice cases filed over a decade, our dependent variable is the cumulative number of appellate court cases in a given state over the decade per million persons in a given state at the beginning of the decade. As control variables, we include state fixed effects, the number of physicians per 1,000 persons, the urbanization rate, real per capita income, and medical licensing variables. Our time varying control variables (physicians per 1,000, urbanization, real per capita income, and medical licensing) are matched with the dependent variable so they control for conditions as they existed at the beginning of the decade. We also include a time trend to sweep out factors that may have contributed to an overall rise in litigation during this period.

Fixed effect OLS regression estimates of the determinants of medical malpractice are displayed in Table 9. In column 1, we use separate binary variables to control for each of our seven medical licensing requirements. Surprisingly, the data indicate that the four year medical degree requirement significantly increased the incidence of medical malpractice suits. In columns 2, 3, and 4 we group the medical licensing requirements in different ways and continue to find a positive and significant relationship between medical licensing and the frequency of medical malpractice suits.[53] Thus, despite the fact that licensing is likely

[53] In order to determine whether the lack of significance of some of these medical licensing requirements was due to collinearity among these binary variables, we grouped together the requirements in various ways. In column 2 we control for the presence the four-year medical degree requirement, but we group the initial licensing law and state board together, and the exam, college, internship, and science requirements together. In this regression, the four-year medical school requirement continues to be significant but the other requirements are not. In column 3 we group licensing requirements into two categories: early requirements (initial law and the presence of a state board) and later requirements (the remaining five requirements). We find that later requirements had a positive and significant effect on the incidence of malpractice suits, but early requirements did not. Finally, in column 4, we combine all of these medical licensing requirements into a composite licensing index to measure the overall strictness of licensing regulations and find that increases in the index increased the incidence of malpractice suits. In each regression the Durbin-Watson statistic is close to two, which indicates that serial correlation in the residuals is unlikely to be problematic.

TABLE 9
EFFECTS OF MEDICAL LICENSING REQUIREMENTS ON THE NUMBER OF STATE–LEVEL APPEALS COURT MALPRACTICE CASES PER 1 MILLION PERSONS FOR EACH DECADE, 1880–1930

	(1)	(2)	(3)	(4)
Constant	0.62 (3.34)	0.25 (3.45)	0.15 (3.42)	–0.22 (3.49)
Urbanization	–0.49 (0.92)	–0.61 (0.94)	–0.44 (0.92)	–0.39 (0.92)
Physicians per 1,000 persons	0.22 (0.90)	0.28 (0.86)	0.30 (0.87)	0.004 (0.84)
Income per capita	–0.001 (0.002)	–0.0004 (0.002)	–0.0004 (0.002)	–0.0002 (0.002)
Time trend	0.97*** (0.32)	0.80** (0.35)	0.79** (0.35)	0.79** (0.34)
1. Initial law	0.24 (0.84)			
2. State board	0.09 (0.70)			
3. Licensing exam	0.23 (0.69)			
4. College requirement	–0.11 (0.82)			
5. Four year requirement	1.35* (0.79)	1.29* (0.74)		
6. Internship requirement	1.29 (1.71)			
7. Basic science requirement	2.18 (2.29)			
Early requirements (1 and 2)		0.13 (0.48)	0.12 (0.47)	
Exam, college internship, and science (3, 4, 6, 7)		0.56 (0.57)		
Later requirements (3, 4, 5, 6, 7)			0.76* (0.43)	
Composite licensing index				0.50* (0.29)
Adjusted–R^2	0.40	0.40	0.40	0.40
D–W statistic	1.97	1.96	1.97	1.96
N	282	282	282	282

* = significance at the 10-percent level.
** = significance at the 5-percent level.
*** = significance at the 1-percent level.
Notes: State fixed effects and a time trend were included. Heteroskedasticity-robust standard errors are displayed in parentheses.

to have raised overall physician quality, licensing led to an increase rather than a decrease in medical malpractice suits.[54]

We believe that there is a plausible explanation why licensing may have increased the incidence of medical malpractice suits. Throughout the Progressive Era, as well as for most of the modern period, the courts ruled on medical malpractice suits based on standards of care available in a given locality.[55] When licensing requirements did not exist, the standards of local practice were difficult to define because anyone could legally call himself a physician. Licensing regulations, by better defining the standards of local practice, may have made it easier for patients to successfully sue physicians. In this vein, it is noteworthy that Smith finds that most medical malpractice suits were filed against ordinary physicians rather than quacks.[56] Although medical licensing may have eliminated "charlatans" and "quacks," it probably did not eliminate all incompetent doctors. Licensing legislation may therefore have increased the incidence of medical malpractice suits because it made it less costly for consumers to sue negligent and unqualified doctors for poor outcomes.

CONCLUSION

The Progressive Era marked the transformation of the United States from a traditional to a modern society. During this period, with advances in science and knowledge based on ever increasing specialization, modern professionals emerged in numerous occupations. In addition, the spatial organization of everyday life changed radically as peopled moved away from rural villages and small towns to large urban areas where market exchanges became more impersonal and anonymous. The expansion of knowledge, specialization, and urbanization were accompanied by a more expansive role of government in the

[54] The positive correlation we observe between licensing and the incidence of medical malpractice suits may be biased if stricter licensing laws were adopted in response to increases in the frequency of medical malpractice suits. To test for this source of endogeneity, we estimated a regression of the composite licensing index in a given state in year $t + 10$ on the number of malpractice cases per million over the decade between t and $t + 10$ and the other control variables discussed earlier. In this regression, the coefficient on the number of malpractice cases per decade per million persons was negative but not significantly different from zero, which suggests that stricter licensing requirements were not enacted in response to malpractice cases. Qualitatively similar results were obtained when other measures of licensing were used in place of the composite licensing index as the dependent variable. Hence, we believe we can rule out this source of endogeneity bias.

[55] DeVille, *Medical Malpractice*.

[56] Smith, "Legal Responsibility."

economy. In this article, we examine why state governments began to regulate the professional labor market at this time.

The evidence presented suggests that the emergence of professional licensing regulation during the Progressive Era was motivated by a desire to improve the market for professional services. During this period, advances in knowledge and increased specialization gave rise to asymmetric information problems in the market for professional services, especially in urban areas. But, because private mechanisms alone could not eliminate all unqualified practitioners from the market, it was necessary for state governments to enact regulations that set standards of qualification to practice these occupations. Our analysis finds that licensing legislations were adopted earlier and were more likely to restrict entry into professions where informational asymmetries were most likely to be problematic. In addition, a detailed study of the effects of medical licensing shows that the specific licensing regulations that restricted entry most effectively were those that were likely to increase physician quality. Accordingly, we also find that stricter licensing also lowered mortality rates from diseases where physician quality may have mattered.

When the Council of State Governments met in 1951 to request a survey of the professional and occupational licensing practices of states, it was aware that state licensing powers could be used not only as an instrument to "protect the safety and welfare" of consumers, but also as a device to create "monopoly conditions." However, when the survey was reported in 1952, the council reached no definitive conclusions regarding which of these forces was more important. Although we believe that the evidence from the Progressive Era is more consistent with a public interest explanation for licensing regulation than one based on industry capture, we, like the skeptical Midwestern governor quoted in our introduction, cannot dismiss the fact that licensing regulations also "lay the foundation for creating monopolies that inhibit market competition." We hope that future scholars will take up the task to determine if and when licensing regulations became a tool to advance the narrow interests of professionals at the expense of the general public.

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