Medical Education Reforms and the Origins of the Rural Physician Shortage*

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Abstract

In the first two decades of the twentieth century, medical schools increased standards for admission and added basic science to their curricula. During this time period, the probability a new medical school graduate located in a rural area declined by 40 percent. Using novel data from the American Medical Directories, we find that physicians trained in more rigorous programs with higher admission standards were less likely to set up practice in rural areas. While all physicians were being drawn to metropolitan areas during this period, the pull was stronger for graduates of the higher quality schools. We also find some evidence that physicians trained in the more scientifically and clinically based programs were more strongly attracted to places with more hospitals. These findings suggest that the medical education reforms of the early twentieth century contributed to the urban-rural disparity in access to physician care.

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Despite an increased production of the total number of physicians, a persistent geographic maldistribution of physicians has characterized the past 70 to 80 years...The opportunity for medical education in this century is to recapture the diversity and relevance of distributed training, even as patient care, education, and research are further improved. Distributed medical education that is uniquely adapted and responsive to the needs of rural underserved communities has the potential to reclaim medicine's social contract with the public. (American Academy of Family Physicians, 2013).

1 Introduction

An estimated 20 percent of the U.S. population lives in rural areas, yet only 11.4 percent of physicians practice in these regions, a fact that concerns policymakers who worry the that the "persistent geographic maldistribution of physicians" limits the ability of rural people to access health care (Burrows *et al.* , 2012; Rosenblatt & Hart, 2000; Rosenblatt, 2010). These concerns are not new; as early as the 1920s, public health officials sounded alarms about the dwindling number of practitioners in rural areas (van Bibber, 1929). In this paper, we argue that the decline of the rural doctor has its origins in the changes that occurred in medical education in the late nineteenth and early twentieth centuries. American medical schools adopted more rigorous admission standards, extended periods of instruction, and added basic science and clinical studies to their curricula in an effort to catch up to the standards of European medical schools. These changes, initially implemented by a subset of schools, were accelerated by the 1910 publication of Abraham Flexner's scathing report on the state of medical education in North American (Flexner, 1910) and subsequent changes in physician licensing by the states.

While these changes improved the quality of medical education and encouraged uniformity among medical schools, they may have done so at the expense of making medical school less accessible to potential physicians from rural areas (Page & Branchuk, 2010; Dhalla *et al.* , 2002; Kwong *et al.* , 2002, 2005). The reforms increased the costs of going to medical school (both direct dollar costs and lost wages from years spent in school), thus influencing the types and numbers of students willing and able to enter the medical profession, as well as the locations and types of positions they were willing to accept after graduation. Raising the bar for admission to medical school was thought to prevent the "poor boy" and the "country boy" from entering the profession. Because such individuals were believed to be more willing than those from an urban background to set up practice in rural areas, their shrinking numbers in medical school likely meant a decrease in the flow of new physicians to the countryside (Mayers & Harrison, 1924, 138).

In addition, the reforms to medical education may have changed the physicians' preferences over practice location characteristics. The more scientifically and clinically based training may have encouraged new physicians to seek out places with better access to cutting edge medical technology, larger communities of health professionals, and modern hospitals (Commission on Medical Education, 1932, 113).

Although the origins of the urban-rural disparity in physician access have long been linked to the transformation of American medical education of the early twentieth century, this conjecture has never been subject to careful empirical examination. The evidence supporting the link has been the timing alone; the decline in the country doctor coincided with the changes in medical education. However, in one of the earliest studies of the geographical distribution of physicians, Mayers & Harrison (1924) argued that the reforms of medical education could have been no "more than a secondary influence in leading recent graduates to avoid rural locations." They claimed that even physicians who had "received their medical education under a regime far removed from that of today" were moving away from rural areas during this period, and concluded that the primary factors leading doctors to more urban areas were "the increasingly superior financial, social, and professional advantages of the larger places" (Mayers & Harrison, 1924, 149).

We examine the connections between medical training and practice location choice using a rich new dataset on physicians constructed from the American Medical Directories of 1909 to 1921 and reports of the American Medical Association's Committee on Medical Education. We exploit differences across schools in the timing of curricular changes, using as a summary statistic of these changes the year in which a school adopted requirements of a year or more of college coursework for admission. We find that physicians' location decisions varied systematically with the quality of their medical training. Graduates of schools with pre-medical school education requirements were more likely than other graduates to locate in metropolitan areas and in areas with greater professional amenities, such as more hospital beds per capita.

Because of data limitations, we are unable to identify why physicians trained in more modern schools were more likely to locate in urban areas. It could be because the only applicants who could meet the higher standards were already predisposed to settle in an urban location, or because some feature of training persuaded physicians to move to urban regions. In other words, reforms might have changed who selects into becoming a physician, or changes in curriculum had a treatment effect on location decisions. As such, the majority of our results should be interpreted as including both the selection and treatment effects of the reforms. Nevertheless, modern research also suggests that physicians born in rural areas may be more likely to return to rural areas (Rosenblatt & Hart, 2000). Thus, we also use a cross-section of data from North Carolina where we match physicians to their birthplaces to determine the relative impact of medical training compared to birthplace. As with the full sample results, being trained in a more rigorous school reduced the likelihood of setting up practice in a rural area. However, this effect was half the magnitude, and opposite in sign, to that of being born in a rural area. Physicians born in rural areas were about 45 percentage points more likely, than those born in urban areas to be practicing in a rural area, even after controlling for their medical school characteristics. This result indicates that the medical education reforms of the early twentieth century contributed to the early development of the urban-rural gap in access to physicians by reducing the number of “country boy” and ”poor boy” medical school graduates.

Our study makes a number of important contributions. First, it adds to the growing body of work documenting educational differences in migration patterns. More highly educated workers are, on average, more mobile and attracted to different types of places than workers with less education. These differences are linked to self-selection into education and to differences in information sets or preferences over location-specific amenities (Wozniak, 2010; Gottlieb & Joseph, 2006). What makes the arguments about physician location choices in the early twentieth century distinct is that the educational differences of interest are not differences in levels, but rather in curricula studied. All medical students received an M.D. and intended to practice as physicians upon graduation, but in the early twentieth century, medical students were subjected to very different courses of study based on school and cohort. Whether by changing the selection into medical school or changing the preferences for place characteristics, the transformation of medical education led to a shift in the geographical distribution of medical practice.

Our findings also provide insights into the changing mortality patterns of the period. At the turn of the twentieth century, urban areas had much higher mortality rates than rural areas. This urban disadvantage, however, diminished over the first half of the century. The early decline was due to improvements in public infrastructure that led to cleaner water and reduced exposure to sewage, but Haines (2001) has attributed the later declines to more rigorous medical training and stricter licensing of physicians and other health care providers (p. 45). Our results provide support for Haines’ conjecture by demonstrating that the urban advantage in medical care was not due to just the higher numbers of physicians per capita in urban areas but also to the better training of physicians who established practices in urban areas. In an era when medical technology changed rapidly, the urban preference of more rigorously trained physicians may have set the stage for later gaps in access between rural and urban areas that persist today.[1]

2 The Transformation of American Medical Education

Although the 1910 publication of Abraham Flexner's "Medical Education in the United States and Canada" is often credited with ushering in a new era of standards in medical education, the changes that led to improved standards in medical education were initiated by the schools themselves beginning in the 1870s. During the 1800s, numerous medical schools opened to supplement the apprenticeship system that produced physicians during the colonial period. Medical schools were inexpensive to operate and profitable for faculty.[2] As the number of medical schools increased, they competed heavily for students, and competition among medical schools led to shorter terms and more lax requirements for graduation (Rothstein, 1972, 97). Would-be physicians faced virtually no entrance standards, not even literacy (Ludmerer, 1985, 12-13). By the time Charles Eliot took over as President of Harvard in 1869, Harvard Medical School admitted any fee-paying student. Only 20 percent of the students held undergraduate degrees, and one faculty member suggested that over half the students could not write. Medical educators recognized this as a fundamental barrier to improving the quality of medical education. Said one, "It ought not to be necessary to teach elementary chemistry or elementary biology in the medical school any more than it ought to be necessary to teach elementary English in the law school" (Ludmerer, 1985, 114-115). Term lengths were short: Harvard's curriculum consisted of two, four-month terms of lectures. Students did not engage in laboratory or clinical

[1]Future research should examine how the rural-urban gap in physician quality affected health outcomes. The difficulty in obtaining adequate data at the county-level for the period before 1915, however, makes this a challenging research agenda. Studies conducted using state-level data do demonstrate a relationship between better trained physicians and improved health outcomes. Law & Kim (2005) examine how changes in state-level physician licensure affect mortality using data from 1900, 1910, 1920, 1930 and 1940. They find an association between licensure and mortality for a small number of measured health outcomes, suggesting that physician quality may have improved health outcomes over time, even though existing physicians were grandfathered as licensure standards became more rigorous. Lichtenberg (2011) finds that in the 1990s, life expectancy increased more rapidly in states with higher fractions of physicians trained in top-ranked medical schools.

[2]In the early 1800s, local medical societies lobbied state legislatures to enact licensing laws and give local medical societies the power to license physicians. While many states enacted licensing laws, they were "...unwilling to enact laws that would have seriously deterred unlicensed practitioners" Rothstein (1972, 76). Moreover, these laws were generally unenforceable. As a result, physicians could easily found medical schools and augment their income with student fees.

work, and needed to pass only five of nine five-minute oral quizzes to pass their studies (Ludmerer, 1985, 49-50). The quality of physicians was low enough that during the Civil War, the United States "...imposed compulsory examinations for a physician to be admitted to the army or navy's medical service," an exam that only 25 percent passed (Ludmerer, 1985, 15-16).

Physicians who wanted a rigorous medical education could not rely on U.S. medical schools, but those with resources could train in Europe, where the focus had moved beyond apprenticeship to clinical and experimental research.[3] France, with its reliance on acute clinical observation in hospitals had been the European leader of medical training until the mid-nineteenth century, when scientists in Germany embraced experimental methods. Major discoveries were made in cell theory, pathology, and physiology. The use of experimental methods in the laboratory "...allowed an epistemological shift of revolutionary proportions. It became clear to knowledgeable physicians that experimental methods could be applied to the study of disease and therapeutics as well as to the study of the healthy state. Scientific information ...began to represent the core of what a modern doctor needed to know" (Ludmerer, 1985, 30-31). Around 15,000 American physicians studied in Germany (or at German-speaking universities in Austria and Switzerland) between 1870 and 1914, with the peak of the migration occurring in the 1870s and 1880s (Bonner, 1963, 23). Many returned and went on to become leading physicians, and to join the faculties at schools such as Harvard, Cornell, Michigan and others. Notably, these foreign trained doctors were the strongest advocates for more rigorous entrance requirements and curricula, transforming medical education in the U.S. into the European model (Ludmerer, 1985, 33). In this way, "European medical science provided and European medical schools imparted to Americans the knowledge and procedures which led to reform of American medical education"(Field, 1970, 504).

The first movers started instituting reforms in the late nineteenth century. By the 1870s, Harvard had implemented a series of reforms at the medical school, which included changes in both administration and

[3]Professional standardization occurred earlier in Europe than in the United States. In France, medical education was centralized under the national government. Medical degrees were only awarded by a Faculté de Médecine, and students were required to complete a clinically based medical curriculum, pass a series of examinations, and write a thesis. Would-be physicians in Germany first had to pass a rigorous exam to get into medical school, follow a prescribed plan of study that was uniform across the country, pass several exams and complete a year-long hospital internship before being permitted to practice. In England, the Medical Act of 1858 created the General Medical Council, a central body dealing with medical education and licensure. The law and its later amendments sought to ensure uniform training, curriculum and exams for students enrolled in licensing corporations (which focused on training by apprenticeship) and universities. A second act that further strengthened the first was enacted in 1886. For greater discussion see *Commission on medical education (1932)*.

curriculum. The university took over the finances of the medical school, and no longer allowed professors to divide fees among themselves. The program was extended to three years, with nine-month terms, and the curriculum emphasized science, laboratory work, and clinical instruction. By 1880, the University of Pennsylvania followed Harvard's lead, as did the University of Michigan. Johns Hopkins opened in 1893 with the strictest requirements of all: requiring students to have a bachelor's degree for admission (including evidence of coursework in Latin, French, German, physics, biology, and chemistry), to receive rigorous training in the sciences and laboratory work, and to have two years of clinical instruction (Ludmerer, 1985, 50-51).[4]

As major scientific advances occurred – such as the germ theory of disease in the late nineteenth century – more schools began to emulate these early pioneers in increasing term lengths, use of laboratories, and pre-medical requirements. Although an early attempt to organize schools with 3-year courses failed in 1876, the Association of American Medical Colleges (AAMC) re-formed in 1889, and by 1891, 71 of 115 regular (as opposed to homeopathic, Thomsonian, or eclectic) colleges were members (Rothstein, 1972, 288). The AMA established its Council on Medical Education (CME) in 1904, and in 1905, the AMA recommended that all entering medical school students have a high school education, and that medical education be completed over five years (with four years of "pure" medical work and at least one year of study devoted to preliminary work in biology, chemistry, and physics (American Medical Association, 1906).

The Council on Medical Education conducted a survey of the nation's medical schools in 1906. Given that its members were mainly academic physicians, the Council used the rigorous university model as the yardstick against which it compared all schools. Not surprisingly, the Council drew largely the same conclusions as Abraham Flexner ultimately would in 1910: that most medical schools did not come close to meeting these standards (Ludmerer, 1985, 170). Beginning in 1907, the AMA published ratings of medical schools. Schools rated "A" were acceptable, schools rated "B" were in need of improvement, but redeemable, and schools rated "C" were in need of complete reorganization. In response, more schools began imposing more rigorous prerequisites; by 1908, 57 schools required applicants to have completed at least one year of

[4] As described in the 1905 report from the AMA Council on Medical Education, an applicant to Johns Hopkins was required to have either "(a) completed the chemical-biologic course which leads to the A.B degree in the university" or "(b) graduated at an approved college or scientific school and can furnish evidence of an acquaintance with Latin and a fair reading of French and German, and a knowledge of physics, chemistry and biology, such as may be obtained from a year's course, including laboratory instruction." (p. 556).

college before starting medical school. Nevertheless, since the AMA could not be openly critical of medical schools, it invited Abraham Flexner of the Carnegie Foundation for the Advancement of Teaching to perform a similar study. In his report, Flexner evaluated medical schools based on entrance requirements, the number of students enrolled, the number and characteristics of teaching staff, the financial resources of the school, and the laboratory and clinical facilities available to students. He suggested that the vast majority of medical schools were of very low quality and that there was gross oversupply in the number of physicians.

While reforms in medical education were well underway when Flexner published his report in 1910, the report drew public attention to the issue and may have accelerated the speed at which some schools closed and others improved their standards. Despite the changes happening in medical education prior to the publication of Flexner's report, some medical schools were slow to upgrade their standards, if at all, partially because state licensing laws remained weak. By 1904, only 4 out of 162 schools then in operation even required two years of college work to be admitted; most required a high school diploma or less (United States Department of the Interior, 1921, 72). Most state licensing boards were ineffective; as late as 1906, 13 states granted medical licenses even to people who had never graduated from medical school (Ludmerer, 1985, 235). The licensing requirements "...served only as a minimal restraint to the worst excesses of the low-grade schools" (Rothstein, 1972, 291). Many schools had improved standards of their own accord, but Flexner recognized that "...legal enactments on the subject of medical education and practice will be required before the medical schools either give up or relate themselves soundly to the educational resources of their respective states." (Flexner, 1910, 49). Medical educators had pushed for more restrictive licensing laws for years, thus supporting the economic theory that licensing laws benefit existing firms by limiting competition, but it was not until after the publication of Flexner's report in 1910 that many states began to implement higher standards (Ludmerer, 1985, 237). Figure 1 shows that while only a handful of states required pre-medical college study for licensure in 1910, the vast majority required it by 1920. In addition, state licensing boards decided whether to recognize a school's diploma based on its AMA rating, which incorporated the rigorous criteria suggested by Flexner. As early as 1914, 31 states denied recognition to graduates of medical schools with a "C" rating (Ludmerer, 1985, 241). States also began to require physicians to have graduated from a school with college coursework admissions requirements.

Schools responded quickly to these changes. An increasing number of schools raised their admission requirements. Low quality and independent schools were driven out of the market and the total number of medical schools in the U.S. fell from over 150 in 1900 to around 80 by 1923 (Mayers & Harrison, 1924, 16). As the overall number of medical schools declined in the first decades of the twentieth century, an increasing number of schools adopted more rigorous requirements, as shown in Panel A of Figure 2. By 1915, 50 out of 95 medical schools required at least one year of college; 40 required two or more years.[5] As the number of medical schools fell, so too did the number of medical school graduates, as shown in Panel B. At the turn of the century, over 5,000 physicians graduated from medical school each year. This number declined sharply during the 1910s, and rebounded somewhat only after 1920. Over these same years, population grew by 39 percent. Together, these trends caused a decline in the number of physicians per capita from 17 to 14 per 10,000 residents at the national level. In their analysis of the rise of occupational licensing in the Progressive Era, Law & Kim (2005) affirm that state laws requiring more pre-medical education were associated with a decline in the number of physicians.[6]

3 How Changes in Physician Training Impact Location Decisions

As entrance requirements increased and medical education became more rigorous, the cost of becoming a physician increased. Would-be medical students had to bear the tuition – and time – costs of doing undergraduate college coursework prior to applying for admission, and the more rigorous medical schools also tended to charge higher tuition and fees. Figure 3 shows medical school fees by whether a school adopted a pre-medical college requirement. Schools with more extensive admissions requirements charged more in fees than schools without such requirements. Physicians trained in these more expensive programs may have been more drawn to practice in cities after graduation than in rural areas by the prospect of greater

[5]Medical educators recognized that raising admission standards may hurt them financially since their applicant pools would be smaller, but competition between them for prestige led them to do so anyway. In describing the University of Pennsylvania's decision to raise entrance requirements, for example, Ludmerer (1985) states that the university recognized it would face a decrease in revenue from student fees, but that it was the right decision, and the school "...could no longer consider 'the financial or commercial side of any question in reference to medical education.'" Ludmerer (1985) notes similar decisions at other schools (p. 85).

[6]It is important to note, however, that this relationship may not be due to the constraints of the legislative restrictions but rather to the changes in the admissions standards of medical schools that predated, and perhaps, led to the new laws. As the narrative above describes, many medical schools adopted more rigorous curricula and standards before state laws required them to do so. Law and Kim found that two types of state laws had negative effects on the numbers of physicians, pre-medical school educational requirements and four-year medical school course requirements. Baker (1984) notes that most medical schools adopted four-year programs before state laws were enacted that required physicians to attend such programs. He goes on to argue that, "Four-year legislation enacted after 1900 may have been aimed at the stragglers, or may simply have been redundant confirmation of existing practice" (p. 191).

demand for their services and higher earnings. In their 1924 study of the geographic distribution of doctors, Mayers & Harrison (1924) note that the growth of roads and the rise of specialty practice increased incomes for physicians in urban areas at the expense of rural practitioners:

> The larger financial possibilities of the successful town practitioner have of course always been a feature in favor of town location; but the possibilities of the successful town specialist rise much higher still, creating in reality a wholly new level of medical earnings, and holding out to the rural practitioner a lure to the town far more powerful than formerly existed (Mayers & Harrison, 1924, 27).

Another report published by the Commission on Medical Education (CME) in 1932 summarized several studies that suggested "... that the greater opportunity in the cities for financial rewards and better opportunities for practice are the oustanding (sic) causes of the tendency of physicians to locate in the cities" (Commission on Medical Education, 1932, 113). The Commission's report also indicated that changes in medical training pulled students to urban areas because the changes "...accentuate the dependence of the doctor upon hospitals, laboratory technicians, nurses, consultants, and specialists, and ...have a very distinct effect upon the attitude of students toward practice, to some extent handicapping them in assuming the responsibility of individual practices in the smaller communities" (Commission on Medical Education, 1932, 114).[7]

The increase in costs, both direct and indirect, may have also made it more difficult for individuals from rural areas to attend medical school. Research from the current period indicates that rural-born medical students are more likely to locate in rural areas to set up practice (Rosenblatt & Hart, 2000). In the early twentieth century, the rhetoric was that the "country boy" could no longer aspire to become a doctor because of the higher admissions standards and the increased time and tuition costs of attending medical school. These "country boys" were believed to be the most likely to become country doctors (Mayers & Harrison, 1924, 138). If medical school graduates were less likely to be rural-born as schools improved, this would shift the distribution of graduates away from rural areas.

To test whether doctors trained in more rigorous (and expensive) programs preferred urban areas to their less rigorously trained counterparts, we construct a new data set on physicians, including info on their

[7] The same observer suggested that the reliance of medical education on hospitals and new laboratory techniques overemphasized rare and unusual diseases, with the result that students may have been ill-prepared to "...deal with the more usual types of illness which are so prominent in everyday practice"(Commission on Medical Education, 1932, 114).

medical training and where they chose to practice. Our empirical analysis is based on a simple theoretical framework for a physician's location choice decision based on comparing the relative rewards across potential localities.[8] We also provide narrative evidence from the period to support our choice of variables.

In our model, a physician locates a practice by choosing the location $i \in I$ with the highest expected utility.

$$\arg\max_{i \in I} U(\omega_i) = \arg\max_{i \in I} \left\{ \sum_t \delta^t \left[\frac{E\left(w(s)_{it}\right)}{p_{it}} - c(s)_{it} \right] \right\} \tag{1}$$

where ω is consumption, t is year, s indexes skill group (graduate of medical school with or without pre-medical college requirements), w is the nominal wage, p is the price level, and δ is a discount factor. Consumption amenities and costs tied to a particular location are captured in c, which is allowed to differ by skill group. Preferences over rural or urban living, or other location-specific attributes, such as proximity to family, are included here. Positive productive amenities increase the nominal wage. Examples include the presence of hospitals and laboratories, the size of the market, extent of road system, and any agglomeration effects of being located near other highly trained professionals or a medical school. Nominal wages are determined in a spatial equilibrium of the type developed by Roback (1982), Rosen (1979), and Moretti (2011). There is somewhat of a debate in the literature on whether wages in a local market are determined by supply and demand or if physicians are discriminating monopolists (Kessel, 1958; Arrow, 1963; Andersen & Anderson, 1967; Newhouse, 1970; Sloan & Feldman, 1978; McCarthy, 1985).[9] In a sense, the type of competition at the local market level is irrelevant for our application; we are interested in spatial equilibrium outcomes where the marginal physician's utility is equilibrated *across* local markets.

A physician chooses to locate in i^* if the expected benefits exceed those of all other locations. The probability of choosing location i^* increases in the real wage, and decreases in consumption disamenities, and can be written as:

$$Pr(choose\ i^*) = Pr\left[\sum_t \delta^t \frac{E\left(w(s)_{i^*t}\right)}{p_{i^*t}} - c(s)_{i^*t} > \sum_t \delta^t \frac{E\left(w(s)_{it}\right)}{p_{it}} - c(s)_{it} \right] \qquad \forall i, i \neq i^* \tag{2}$$

[8]Our discussion closely follows the simple model presented for migration choices in Wozniak (2010), but is adjusted to capture the initial location choices of newly minted graduates of medical school.

[9]See Gaynor (1994) for survey of the literature on the competitive nature of physician services.

The formulation of the problem is now a standard discrete choice problem considered in McFadden (1974), and for which the conditional logit model is appropriate to study the factors that increase the likelihood of a physician to choose a particular location in which to start a practice. In some analyses, we further simplify the model to the binary discrete choice between a rural and urban location, effectively re-framing the choice as a comparison between the expected utility of the top-ranked urban location and the top-ranked rural location.[10]

Our primary measure of medical school quality is an indicator for the presence of a two-year pre-medical college education requirement. This variable captures both the increase in admission standards and introduction of rigorous scientific curriculum, as well as the increased opportunity costs of attending medical school. In this paper, we do not attempt, nor do the data allow us, to separately estimate the impact of these components on physicians' location decisions. Instead, we treat pre-medical college requirements as a sufficient statistic for the various quality measures available, and their associated opportunity costs. In support of this view, the AMA and AAMC used pre-medical college requirements as the primary tool to increase the academic quality of applicants, while simultaneously reducing the supply of newly minted physicians. State licensing reform also focused on the requirements for pre-med college education, which Law & Kim (2005) have shown had an important negative impact on the supply of physicians during the period.[11]

[10]The model can easily be extended to include future migration by newly minted doctors, or to include the migration decisions of established physicians. For simplicity, we do not directly investigate migration decisions to focus on the first-order issues. However, the results from the analysis of equilibrium outcomes includes any migratory behavior undertaken or planned for by physicians.

[11]Other potential measures of medical school quality suffer from a number of limitations, and are all highly correlated with the adoption of pre-med college requirements. The AMA introduced its rating system for medical schools in 1907, and thus this system is not applicable to physicians in our sample who graduated prior to that date. Additionally, while there is significant variation in ratings in the early years, by 1918 an A-rating had become synonymous with requiring pre-medical college education. In fact, at no time in our dataset (1905-1920) did a B or C rated school *ever* require college education for admission. In any event, the inclusion of AMA ratings in regressions do not substantively change the coefficient on pre-medical education, nor provide much additional explanatory power. The indicator variable for attending a medical school that closed by 1923 appears to be supplying the same information contained in the AMA ratings; the two variables are highly correlated. We report results from these regressions in Appendix Table A3. We choose not to use the Flexner report descriptions as a measure of quality because the report only provides his general impression of the worthiness of each medical school's program, not a set of systematic ratings. Moreover, the Flexner report consists of a snapshot taken in 1909, which does not capture important changes in quality over time, nor does it provide information for graduates prior to 1909.

4 Data

Data to examine the relationship between the changes in medical education and the geographic distribution of physicians come from the 1909, 1914, 1918, and 1921 American Medical Directories (AMDs).[12] The AMDs provide information (by location) on all practicing physicians, the medical schools they attended, their graduation dates, and for the later years, their specialties, if any. We supplement the AMD data with data on medical school characteristics from the Flexner report and AMA publications. The medical school specific information is crucial for examining how education reforms affected physician's location choices. As discussed above, the reform movement began with a handful of schools and then spread in fits and starts to other schools. The timing of the adoption of higher admission standards varied greatly across schools. This variation was present even within states, as many schools adopted higher standards before state licensing laws required them to do so. Schools not only implemented pre-medical college requirements; they also lengthened terms and upgraded curricula. We focus on the implementation of pre-medical college requirements because over the period we examine, most schools had already imposed four-year terms and modified curricula.[13] In our probit models, the inclusion of fees interacted with the state of practice does not substantively change the magnitude of the coefficient on pre-medical college requirements, but does increase the uncertainty of the estimates. See Appendix Table A8 for results. Our lists of physicians were manually digitized and represent a novel data set for understanding the economic history of the physician labor market in the early 20th-century United States.

The amount of information contained in the AMDs is vast: 135,000 physicians listed in 1909, with similar numbers in each of the other three years we include.[14] Given the constraints in digitizing the entirety of the AMD, we limit our sample to four states: California, Mississippi, New York, and North Carolina. We focus on these states for geographic and socioeconomic reasons. California and New York both contained

[12]The AMA published the first AMD in 1906 with the subtitle, "A Register of the Legally Qualified Physicians of the United States and Canada." The AMA compiled this first listing by consulting the records of state licensing boards, medical colleges, and medical societies. The foreword notes that the goal was to include only "legally qualified" physicians.

[13]Results are robust to including term length in our model and the model fit does not appreciably change. We choose not to include a measure of fees because it appears that medical school fees mainly capture cost-of-living differences across the states. Moreover, we believe that the fees variable mechanically picks up the secular increase in both the probability of facing pre-med college requirements and the probability of urban practice. As evidence of this, the implied effect of nominal fees on physicians' location decisions is too large in economic terms. For example, average nominal fees increased by 30 percent from 1905 to 1920, but nominal GDP per capita increased by 2.5 times and real GDP per capita increased by 13 percent (Sutch, 2006). The real value of fees declined over much of the period because of war-related inflation.

[14]Appendix Figure A1 provides an example of one page of the AMD.

major metropolitan areas, as well as sizable rural population, and are located in very different regions. California is also of interest because of the high level of in-migration during this period and the dramatic growth of Los Angeles and other metropolitan areas. We also entered Mississippi and North Carolina to look at states with predominantly rural populations and large populations of African Americans.

The AMD data allow us to consider how the geographic distribution of physicians varied by the choice of medical school and timing of graduation. The overall U.S. population became more urban during the first decades of the 20th century.[15] Nevertheless, the rate at which physicians and surgeons moved to urban areas exceeded that of the general population. Between 1900 and 1920, the share of doctors living in cities with a population greater than 100,000 increased by 9.2 percentage points, compared to an increase of 7.2 percentage points for the population as a whole. Similarly, the fraction of physicians living in areas with a population under 10,000 declined by 13.5 percentage points, compared to a decline of 10.4 percentage points for the overall population. There is also evidence that not all physicians and surgeons were equally like to move to urban areas. Table 1 presents the distribution by location for our four-state sample of AMD listings, for all physicians, established physicians who have been in practice for over five years, and recent medical school graduates (five or fewer years since graduation). Since our sample includes New York and California, two populous states with several large cities, it has a much higher fraction in metropolitan areas than found in census data for the nation as a whole. Nonetheless, the AMD data show the same overall pattern of movement of physicians from rural areas into areas with population greater than 10,000. The comparison of panels B and C, however, reveals that this movement was much more pronounced for newly minted physicians. In 1909, about one-third of recent graduates had set up practice in cities with fewer than 10,000 people, compared to only 16.4 percent by 1921. There is also evidence that graduates of schools with more rigorous requirements differentially selected into large urban areas. Panels A and B of Table 2 show the distribution of new graduates by whether their school required at least one year of college prior to admission to medical school to those with no college prerequisite. Graduates of schools without college requirements were three times more likely to locate in smaller areas with less than 10,000 population in 1909 than graduates of schools with more rigorous requirements. Although the gap narrowed over time, the

[15]Estimates are calculated using the 1 percent IPUMS samples (Ruggles *et al.* , 2015). Incorporated cities and towns with below 10,000 population are grouped with "unincorporated areas", which are places that were outside municipal jurisdictions. "Unincorporated" areas tended to be sparsely populated, and the Census Bureau classified them as rural in their population counts.

likelihood that graduates of schools without college prerequisites settled in rural areas was nearly two times greater in 1924 than that of physicians graduating from schools that required at least one year of college before admittance.

5 Empirical Analysis

5.1 Probit Model of Rural Location Choice

We first estimate probit models of rural location choice to test the hypothesis that graduates of schools with more rigorous admission and curricular requirements were less likely to locate in rural areas than graduates of lower-quality schools. In these models, we consider how individual physician characteristics and the characteristics of his medical school are correlated with the likelihood that he located in an area with less than 10,000 population.[16] In this model, physician i chooses a location in time t, based on the characteristics of the medical school attended, j, in the year he graduated, g, and his own characteristics. We include as explanatory variables indicators for whether the school had adopted a requirement of one or more years of college as a prerequisite, and whether the physician attended a medical school located in a rural non-metropolitan county.[17] To gauge whether the effects of medical school characteristics were changing over time, we estimate models separately by the year of publication of the AMD list of physicians.

We separate the sample by years since graduation, and first estimate the model for physicians in practice for more than 5 years (established physicians), and then for those in practice for 5 or less years (new graduates). Many "established" physicians attended medical school in the pre-Flexner era and their medical education may have significantly differed from that of later graduates. Splitting the sample into "established" and "new" physicians helps capture these differences. Moreover, this grouping allows for the migration of established physicians into or away from rural areas. The new doctors sample focuses on the initial practice

[16]Results reported throughout the paper are robust to using a population measure of 2,500. Results are also robust when running our models using a county-based classification scheme based on the concept of metropolitan areas (a county with a large city as its economic center). We use the IPUMS definition of metropolitan counties, and divide rural (non-metropolitan counties) into those adjacent to metropolitan areas or not adjacent to metropolitan areas).

[17]Modern research suggests that physicians trained in rural areas may be more likely to return to rural areas (Rosenblatt & Hart, 2000). During the early twentieth century, medical education was not urbanizing as fast as physicians. Many of the large state-funded medical schools were located outside of major metropolitan areas, and most of the closures between 1900 and 1920 were of schools in large cities (Mayers & Harrison, 1924, 143). In our four state sample, the fraction of new physicians who attended rural medical schools increases slightly between 1909 and 1921.

location decision immediately after graduation from medical school. For the model including only established physicians practicing over five years, we include the number of years a physician had been in practice - defined as the number of years since he graduated from medical school - and its square.

A number of medical schools closed during the period under study, so we include an indicator equal to one if the physician's *alma mater* closed before 1923, which can be interpreted as a further measure of medical school quality. In addition, North Carolina enacted a law in 1918, and Mississippi in 1919, that required physicians to attend schools with pre-medical college requirements; we include a variable to indicate if a physician faced one of these laws during the year of their graduation. We also include state fixed effects to capture the persistent differences across states in the sizes of their rural population. Table 3 provides summary statistics for our sample broken down by new physicians and established physicians.

Table 4 presents estimated marginal effects from probit models on the sample of established physicians (Panel A), and then separately for new doctors (those who had graduated from medical school within the past 5 years – Panel B).[18] After controlling for years in practice, we see strong differences in location choices by medical school characteristics. Among new physicians, graduates of schools that required one or more years of college before admission were more likely (20.6 percentage points in 1909 and 2.9 percentage points in 1921) than graduates of other schools to locate in metropolitan areas with over 10,000 population. The magnitude of the correlation decreases over time, likely because of the changing selection of schools into the group requiring pre-med college education. Only 2.6 percent of the new doctors in our sample graduated from these schools in 1909 (97 percent of the graduates were from Harvard or Johns Hopkins). By 1921, 61 percent of new doctors graduated from from school with pre-med education requirements. We see the same patterns for established physicians, with even larger negative correlations than observed for new physicians. Again, this is likely because of the change in composition. Physicians who attended medical schools with pre-med college requirements prior to 1910 were even *more* positively selected in terms of school quality than physicians from medical schools that adopted the requirements in later years. The early adopters were the most prestigious medical schools.

A particularly striking finding is that even after controlling for medical school quality based on requirements for admission, new graduates of medical schools located in rural counties were roughly 3 to 8

[18]The results are robust when using a linear probability model, appendix table A1, and using a 2,500 population cutoff as a definition of rural, rather than 10,000 in population, appendix table A2.

percentage points more likely to set up practice in rural areas than their colleagues who had attended medical school in, or close to, a metropolitan area. For established physicians, the relationship is even stronger: physicians who attended a rural medical school were 7 to 11 percentage points more likely to locate in rural areas than their counterparts trained in non-rural schools. A straightforward interpretation of this result is that physicians preferred to set up practice near where they went to medical school (a hypothesis we will test directly in the conditional logit models we present later in the paper). An alternative, albeit more speculative, interpretation is that this effect captures the "country boy" story. If attending a rural medical school is a proxy for being from a rural area, then the greater probability of graduates of these schools of setting up practice in rural areas can be interpreted as supporting the idea that country doctors were mostly country boys returning home to serve their communities.

5.2 Location characteristics and physician location decisions

An important element of most explanations connecting the movement of physicians to more urban areas as the medical education reforms of the 1910s progressed is that the more science and technology based curricula - and their higher costs – made doctors trained in such programs more likely to be attracted to places with larger patient bases and more professional amenities such as hospitals and laboratories. To determine which place characteristics attracted or repelled physicians, we estimate conditional logit models (McFadden, 1974). In these models, we include factors expected to have particular influence on physicians such as the numbers of hospital beds and established doctors per capita. In order to test the hypothesis that location choices differed by type of medical training, we examine whether graduates of different quality medical schools responded differently to location characteristics.

McFadden's conditional logit model assumes each individual faces a set of J unordered alternatives and chooses the alternative that provides him with the highest level of utility (McFadden, 1974). We assume that the choice set faced by a recent medical school graduate is the set of counties in the state in which he takes the medical board examinations. In essence, this amounts to assuming a sequential decision-making process in which a physician first chooses the state in which to locate and then at the next step, chooses the county within that state. This assumption is necessitated by the nature of the data. In reality, most new medical school graduates first decided which town or city in which to locate and that dictated the state in which to take the licensing exam. However, given the structure of the data, estimating models with extended choice sets of cities or counties in multiple states is intractable. Moreover, once a physician was licensed in a particular state, the costs of interstate moves increased greatly. The county-based classification scheme we use is based on the concept of metropolitan areas, where a metropolitan area is a county, or set of counties, with a large city as its economic center. We divide non-metropolitan counties into rural counties that are adjacent to metropolitan areas (since the rapid diffusion of automobiles and the expansion of road networks expanded the influence of metropolitan areas on their neighboring areas), and rural counties not adjacent to metropolitan areas.[19]

In the choice model, we include county characteristics that potentially influenced physicians' location choices: the number of hospital beds and the number of established physicians (having graduated from medical school more than five years earlier) per 10,000 persons in the population, and the natural log of the number of miles from the physician's medical school to the county seat. These variables capture productive amenities. Physicians may have found it useful to locate near other physicians, and nearly all physicians practiced independently but needed hospitals to admit patients. Ideally, we could directly include measures of physician income to capture spatial differences in the economic return of choosing a particular location. Unfortunately, systematic income data for physicians does not exist for our sample period. We choose to use proxies instead, such as market size and the presence of productive amenities.

Given the findings above, we are also interested in how physicians' location choices were influenced by the characteristics of their medical schools. In the conditional logit framework, the characteristics of the individual decision-maker are incorporated through interactions with the characteristics of the elements of the choice sets. In other words, an individual trait like the type of medical school one attended is allowed to affect the degree to which that individual is drawn to, or repelled by, certain county characteristics. We use the measure of medical school quality used above, an indicator equal to one if the school adopted an admissions requirement of at least one year of college work, similar to the methodology used by Wozniak (2010), Gottlieb & Joseph (2006), and Polsky *et al.* (2002).

We estimate conditional logit models separately by year and state, a choice driven by the practical

[19] The IPUMS defines a metropolitan area to be a county or group of contiguous counties that contained at least one city of 50,000 or more residents. For a county to be included in a metropolitan area, it had either to contain the central city or be metropolitan in character, meaning that it contained a large non-agricultural workforce. This classification scheme is similar to that used in modern studies of the geographic distribution of medical professionals.

concern that county characteristics vary dramatically across these two dimensions. Moreover, estimating separate models allows us to consider how new physician's location decisions varied over time and across states. Because, we are interested in the decisions to choose metropolitan versus rural counties, we limit the sample to New York and California, since North Carolina and Mississippi contained no metropolitan areas during the sample period. By choosing to set up practice in those states, physicians effectively limited their choice set to rural counties. The sample is also limited to graduates trained in American medical schools to allow estimation of the importance of distance from medical school for location choices.

Table 5 presents the estimated odds ratios from the conditional logit models for all doctors in New York and California in 1909 and 1921. Odds ratios indicate how one-unit changes in the county characteristics affect the odds a physician chooses to locate in a particular county. An odds ratio greater than one indicates that an increase in that characteristic increases the probability a physician chooses a county whereas an odds ratio less than one indicates that an increase in that characteristic decreases the probability.

Not surprisingly, physicians were drawn to counties in metropolitan areas and, to a lesser extent, counties adjacent to metropolitan areas. By 1921, the odds a new doctor settled in a metropolitan county rather than a remote rural county was almost 8 to 1 in California and nearly 2 to 1 in New York. In both states, physicians had a preference of being closer to where they went to medical school: the odds of locating in a county were decreasing as the distance from that county to a physician's medical school increased. This result supports the finding of Chen *et al.* (2013) that the location of graduate medical education programs affects the practice locations of physicians.

In both states, physicians were attracted to areas with greater numbers of established physicians, with the exception of New York in 1921. The number of established doctors can be interpreted as picking up any number of unobservable factors that draw physicians but are not included in our model (e.g. productive amenities such as public laboratories, or consumption amenities not captured by the metro/rural county categories). We find conflicting evidence for the number of hospitals beds per 1,000 population. In New York in 1909, both established and new physicians were attracted to counties with more beds – 1.37 and 1.48 respectively – and this attraction grew by 1921 to 1.77 and 2.65. In contrast, physicians in California were only slightly more likely to locate in counties with more hospital beds in 1909 – 1.04 for established and 1.09 for new doctors –, and if anything this *decreases* by 1921 to 0.88 and 0.96, respectively.

Of particular interest, though, is whether the effects of location characteristics on location choices differed by type of medical school training, which we measure by interacting the location characteristics with an indicator variable equal to one if the medical school attended required one or more years of college work. As previously noted, we cannot distinguish between whether this effect is one of self-selection into the more rigorous programs or the effect of the program in shaping location preferences. Our intent here is simply to estimate the relationship between medical training and later location choice. To interpret the impact of an interaction term, the odds ratio of the interaction term is multiplied with the main effect. For instance, the effect of being a metropolitan county on recent graduates of medical schools requiring at least one year of college is 13.77*6.23 = 85.8 for California in 1909. Thus, new physicians trained under the more rigorous standards were more likely than other new physicians to set up practice in metropolitan counties in 1909 in California, and in both 1909 and 1921 in New York. However in California, the attraction to metropolitan areas for new physicians did not differ by medical school type by 1921. Additionally, in New York this gap decreases between 1909 and 1921. These results suggest the growing convergence in the location choices of recent medical school graduates, partially due to the dramatic increase in the proportion of our sample who had graduated from medical schools that required pre-medical college education: from 2.6 percent in 1909 to 61 percent in 1921.

The geographic distribution of older physicians also reflected strong differences in location choices by medical school characteristics. Graduates of schools with higher admissions standards were generally drawn to places with larger medical communities and were much more likely than their colleagues from less rigorous schools to set up practice in metropolitan areas. Interestingly, in New York, the stronger attraction of graduates of medical schools with more strict requirements for admission to metropolitan areas did not decrease between 1909 and 1921. This likely reflects the very strong pull in this state of New York City and its surrounding areas. Established physicians in both states in 1921 who attended more rigorous schools were more likely to set up practice farther from their medical schools than physicians who attended schools of lower quality, either because the applicants to more rigorous schools were more likely to move to urban areas than the applicants to programs with lower standards, or because the rigorous programs affected location decisions.[20]

[20] In 1909, the estimated odds ratio on the interaction between the number of doctors and medical school requirements is not statistically significant in CA, likely because very few schools had established those requirements in CA by 1909. A handful of

5.3 Decomposition of Changes in Physician Location Choice

In this section, we turn to trying to explain the causes of the changes in physician location choice during this transformative time for medical education in the United States. We present results from a decomposition of the change in the likelihood of rural practice for new doctors between 1909 and later years into the share due to changes in the characteristics of physicians and the share due to changes in the coefficients. The decomposition follows Fairlie (2005) and Fairlie (2017), an extension of the Oaxaca-Blinder decomposition to non-linear models.[21] The average difference in rural location between two years t_1 and t_2 can be expressed as:

$$\bar{Y}^{t_2} - \bar{Y}^{t_1} = \left[\sum_{i=1}^{N^{t_2}} \frac{F(X_i^{t_2} \hat{\beta}^{t_2})}{N^{t_2}} - \sum_{i=1}^{N^{t_1}} \frac{F(X_i^{t_1} \hat{\beta}^{t_2})}{N^{t_1}} \right] + \left[\sum_{i=1}^{N^{t_1}} \frac{F(X_i^{t_1} \hat{\beta}^{t_2})}{N^{t_1}} - \sum_{i=1}^{N^{t_1}} \frac{F(X_i^{t_1} \hat{\beta}^{t_1})}{N^{t_1}} \right]. \quad (3)$$

$\bar{Y}^t$ is the proportion of doctors choosing a rural practice location in our sample in year t. $\hat{\beta}^t$ is the vector of coefficients from a probit regression of an indicator for rural location on the vector of physician characteristics in year t, X_i^t, including an intercept. Finally, N^t is the total number of physicians in our sample in year t. The first term on the right hand side of equation 3 isolates the difference between year t_1 and t_2 in the proportion of physicians choosing to practice in a rural location that is due to changes in characteristics, holding the coefficients constant at those estimated for year t_2, and is referred to as the "explained" portion. In our context, it is an estimate of how large the change would have been if the 1921 physicians were assigned the characteristics of the 1909 physicians, but the behaviors given those characteristics were "benchmarked" at the 1921 levels. We can just as easily apply the 1909 characteristics to the 1921 physicians, holding the 1909 coefficients constant. We report both estimates. The first term can be further decomposed into the individual contribution of each covariate. Fairlie (2017) presents a procedure to solve the path dependency problem in non-linear decompositions because of the arbitrarily selected ordering of variables, by randomly ordering the variables in each of many replications; we run 5,000 replications for each decomposition.

Table 6 presents decompositions of the change over time in the proportion of new doctors choosing to

students who graduated from Johns Hopkins and chose to settle in California dominate the 1909 results – as witnessed by the implausibly large estimated odds ratio on the interaction between ln(miles to medical school) and pre-medical college requirement in CA in 1909.

[21] We include the linear Oaxaca-Blinder decomposition results in Appendix Table A4; the results show that all the explanatory power is loaded onto the pre-med requirements, which explains 100% of the change over time in the likelihood of rural practice location.

settle in rural practice locations. Relative to a 1909 base-level of 33 percent, there was a decline of 1.08 percentage points to 1914, 5.79 percentage points to 1918, and 12.97 percentage points to 1921. Fixing the coefficients at the 1909 estimates, changes in physician characteristics are responsible for the majority of the observed change in doctors choosing rural locations: 61 percent in 1914, 91 percent in 1918, and 87 percent in 1921.

The bottom half of Table 6 lists the explanatory power of each individual physician characteristic. Graduation from a medical school with pre-med requirements is the most important, accounting for over 100 percent of the full "explained" portion. New graduates from these schools in 1909 were much less likely to locate in rural areas. The coefficient on pre-medical college requirements is negative in all years, but largest in magnitude in 1909. The set of early schools with requirements was highly selected in 1909; 97 percent of these graduates were from Harvard or John Hopkins. Moreover, the proportion of the sample that attended medical schools with pre-med requirements increased dramatically over our period: from 2.6 percent in 1909 to 61 percent in 1921. Given these two facts - a large negative 1909 coefficient and a rapid increase in schools with pre-med requirements - it is no surprise that this single variable provides so much explanatory power.

The only other variable that provides some explanatory power is attendance at an out-of-state medical school, but its contribution in the decomposition is dependent on the choice of base year. In 1909, physicians trained out-of-state were more likely to practice in rural areas, all else equal (See coefficient (0.119) from table 4). By 1914, attending medical school out-of-state is no longer associated with rural practice. Relative to 1909, the number of physicians trained out of state in our sample increases by about 7 percentage points in all years, after partialling-out all other variables. Combined with the strong positive association of out-of-state training with rural practice in the 1909 sample, these changes in proportion of out-of-state trained physicians imply an *increase* in rural practice relative to 1909 (i.e. the economically and statistically significant negative contribution "Attended out-of-state med school" in the first three columns of Table 6). However, when later years are used as the base, the contribution is dramatically attenuated, because out-of-state training is not associated with rural practice in these years.

Using the coefficients from the final year as the reference group attenuates the explanatory power of observable characteristics. As medical schools choosing to require pre-medical college education became less positively selected over time, the large negative correlation between college requirements and rural practice moved towards zero. Interpreting the final column of Table 6, the proportion of physicians practicing in rural areas in 1921 would have been 4.01 percentage points lower than in 1909 based on differences in their observable characteristics. This is a much smaller proportion of the observed change than that calculated using the 1909 coefficients, but it is still sizable at 31 percent.

We interpret these results as suggesting that changing characteristics of physicians, especially characteristics of the medical school curriculum, cost, and admission requirements, account for an important part of the total decline in the number of rural physicians over the early 20th-century. Although sensitive to the choice of reference group, the results behave in a way that is consistent with the positive selection into early adoption of the reforms with lower-ranked schools eventually following the leaders. The question remains as to why the behaviors of physicians with specific characteristics changed so dramatically over an 11-year period. Two factors likely play an important role. First, the publication of Flexner's review and subsequent passage of state legislation requiring pre-medical college requirements caused close to half of all medical schools to close their doors. The schools that went on to close or to be subsumed into other schools by 1924 accounted for almost a third of the total medical school enrollments in 1910. Closures were almost entirely of smaller faculty-owned lower-ranked lower-cost schools. The AMA's desire had been achieved; the so-called "diploma mills" were shuttered, and the supply of physicians contracted. In a sense, the lower half of the physician "skill" distribution was removed. With the current data available it is difficult to account for this change in the composition of physicians in our decomposition, and part of it is loaded onto the "unexplained" portion when using 1921 as the base year. What we do we capture is the second factor, the change in pre-med college requirements for the remaining schools that did not close. As the lower-ranked schools added pre-med college requirements, this category included more physicians that were inherently more likely to practice in an urban area.

6 The Importance of Physician Birthplace

Our results show that better educated physicians differentially moved to urban areas compared to physicians who went to schools with lower standards, which suggests one reason why a rural shortage of physicians occurred over time as medical education requirements increased. Another reason underlying the current shortage of rural physicians may be that, as contemporaries of Flexner noted, these reforms made it more difficult for people from rural areas to get into medical school. While we cannot test this directly with our data, we determine whether it was indeed true that rural-born physicians were more likely to set up practice in rural areas by linking our AMD data on physician practice locations to data on physicians' birthplaces. Linking the AMD data to the contemporaneous population censuses would not be useful because the census only reports the state of birth, not town. Therefore, we take advantage of the digitized draft cards for World War I available on Ancestry.com, which do report town of birth. Draft registration for WWI took place in three waves. The first wave took place on June 5, 1917 and included men born between June 6, 1886 and June 5, 1896; the second wave took place on June 5, 1918, and included men born between June 6, 1896 and June 5, 1897; and the final wave took place on September 12, 1918 and included men born between September 11, 1872 and September 2, 1900. The registration cards for the first two waves included a question on the place of birth that specifically asked for town as well as state and nation. Since we are interested in learning more about physicians who set up practice in rural areas, we chose to focus on physicians practicing in North Carolina, a state with a predominantly rural population in the early twentieth century.[22] We started with all North Carolina physicians listed in the 1918 AMD who were born between 1886 and 1897, the group required to register in the first two waves of the draft. This gave us a population of 422 physicians. We were able to find the draft cards for 360 of these doctors, a match rate of 85 percent. However, for seven of these, the draft card was from the third wave of registration and did not contain detailed birthplace information. To increase our sample size, we searched Ancestry.com for any records (e.g, other military records, death records) for the doctors for whom we were not able to get information on birthplace in the draft cards, including those matched but having blank and illegible entries for town of birth. In the end, we were able to find the town or county of birth for all but 56 physicians out of the 422 in the original sample, but restrict our analysis to the 302 physicians for whom we have the town or county of birth and who were born in North Carolina.[23]

Table 7 provides summary statistics of this sample broken down by rural v. urban birthplace. Because North Carolina is such a rural state with few large cities, we follow the U.S. Census guidelines of 1910, by

[22]Pilot searches of physicians practicing in Los Angeles had very low match rates.

[23]For 27 physicians, we were unable to find any records in Ancestry.com. For 29, we were able to find the draft card but the information on town of birth was missing or illegible.

classifying a birthplace as rural if it has fewer than 2,500 inhabitants.[24] As shown in Table 7, 73.8 percent of physicians born in rural areas chose to practice in rural areas, while only 24.2 percent of physicians born in non-rural locations chose to practice in rural areas. In fact, almost a third of those born in rural areas (73 out of 240) were practicing in the town in which they were born. Those with non-rural birthplaces were also more likely to have attended a “better” medical school — one that required at least one year of college work and one that survived past 1923. However, these “quality” measures did not translate into a higher pass rate on state boards, calculated at the school level. Finally, differences are reported by race. Draft cards report the race of the physician, whereas the AMD lists do not. The vast majority of black physicians in North Carolina were born in urban areas, potentially leading to a significant urban-rural gap in physician access for black patients in Jim Crow era when racial segregation in services was legal and access to medical care may have differed for blacks and whites.

Table 8 presents marginal effects from a probit model of rural practice choice of North Carolina physicians, controlling for rural nativity, medical school location and quality, and whether the physician was black. All else equal, a physician born in a rural area was roughly 45 percentage points more likely to settle in a rural area than one who was not, regardless of the quality of the medical school attended. The entire sample of North Carolina doctors practiced in rural areas 63.6 percent of the time. Clearly, being from a rural area made it much more likely a physician would set up practice in a rural area, and this single factor made a significant contribution to overall rural access to physicians. However, there is still evidence that medical school characteristics mattered. Even after controlling for graduation year fixed effects, having attended a medical school with one or two years of college required for admission reduces the likelihood of practicing in a rural area by around 22 percentage points. This effect is present even for physicians born in rural areas. In the final column, the indicator for pre-med college requirements is interacted with an indicator for rural birth. We find no evidence suggestive of heterogeneous effects of college requirements based on physician nativity.

Next, we conduct a non-linear Oaxaca-Blinder decomposition on the large difference in the likelihood of rural practice between the urban-born and rural-born North Carolina physicians. Results are reported in

[24]To be consistent with the earlier models, we also estimate the North Carolina model using a definition of rural as less than 10,000 inhabitants. As shown in appendix table A7, this only strengthens our findings. Additionally, are results are quantitatively and qualitatively similar when using a linear probability model instead of a probit. Results are reported in appendix table A6.

Table 9. Rows (1) and (2) show that 73.75 percent of rural-born physicians chose to practice in rural locations compared to only 24.19 percent of urban-born physicians. This large difference in the likelihood of rural practice location between the two groups is not explained by differences in observable characteristics of the physicians or the medical schools from which they graduated. Holding the coefficients constant at those of the urban-born sample, rural-born physicians would have been 15.6 percentage points less likely to practice in rural areas if they had the same observable characteristics as the urban-born physicians, which explains only 31.5 percent of the total difference. Repeating the same exercise, but using their own coefficient estimates, rural-born physicians would have been 9.16 percentage points less likely to practice in rural areas, explaining only 18.4 percent of the total difference. "Unexplained" factors account for the vast majority of the difference in rural practice, which may be interpreted as reflecting differences in preferences, information, attitudes, or omitted variables. Had a public health authority wanted to *increase* rural access to physicians in the 1920s – or at least prevent the decline of the country doctor – the policy prescription from our results would suggest reducing the barriers faced by rural-born applicants to medical school. In reality, the American Medical Association and Association for American Medical Colleges, in conjunction with the state-based physician licensure boards, worked to increase admission requirements that would heighten the barriers for "country boys" to become doctors.

Although the results are from a single year and do not allow us to examine the impact of changing medical education over time, they suggest that the early 20th-century medical education reforms did in fact reduce the supply of physicians in rural areas through two separate effects. First, physicians trained in "modern" medical schools tended to locate in urban areas. Second, rural-born doctors provided the majority of rural-practicing physicians, and the medical reforms reduced the supply of physicians by limiting the opportunities of the "country boys" to attend medical school. However, they did so by reducing the supply of poorly trained physicians. We note, however, that we have no evidence that "poorly" trained meant worse outcomes for the patients.

7 Conclusions

During the first decades of the 20th century, the overall population of the United States became more urbanized, and physicians and surgeons moved to urban areas at greater rates than the population as a whole.

Using novel data from the American Medical Directories, we examine whether the location choices of physicians graduating in the early twentieth century were related to the massive changes in medical education that occurred during the period. We find that physicians' location decisions did vary systematically with their vintage and the quality of their medical school training. Recent medical school graduates, particularly those from the higher quality medical programs, were more strongly drawn to urban areas than were other physicians. While our data do not allow us to determine whether these results are driven by self-selection of students or the impact of more rigorous programs on students, we do find evidence supporting the "country boy" story: that those doctors most likely to return to rural areas were born in rural areas. Using conditional logit models, we confirm that graduates of better schools were disproportionately more likely to be drawn to metropolitan areas, with some evidence they were also drawn towards areas with more hospital beds per capita. Taken together, these results suggest that the modern-day "shortage" of physicians in rural areas may have had its antecedents in changes occurring in medical education over 100 years ago. They also indicate that policies that attract students from rural areas to medical school, and policies that increase the ability of rural physicians to connect with other physicians and professional amenities, may help to lure more physicians to less populated areas.

Moreover, the results indicate that a skills gap between rural and urban physicians may have developed over time. While Flexner believed that the graduates of more rigorous programs would be just as ready to settle in rural areas as graduates of schools with lower standards, we find this was not the case. More recently trained physicians and those trained in more science- and lab-based curricula were increasingly drawn to urban areas. Many of the physicians who remained in the countryside and small towns had been trained in the nineteenth century or at schools with less rigorous courses of study. These doctors may have been less able or willing to adopt the new medical technologies that were being developed during this period. Hence, rural populations potentially benefited less than urban populations from the dramatic advances in medical technology of the mid-twentieth century.

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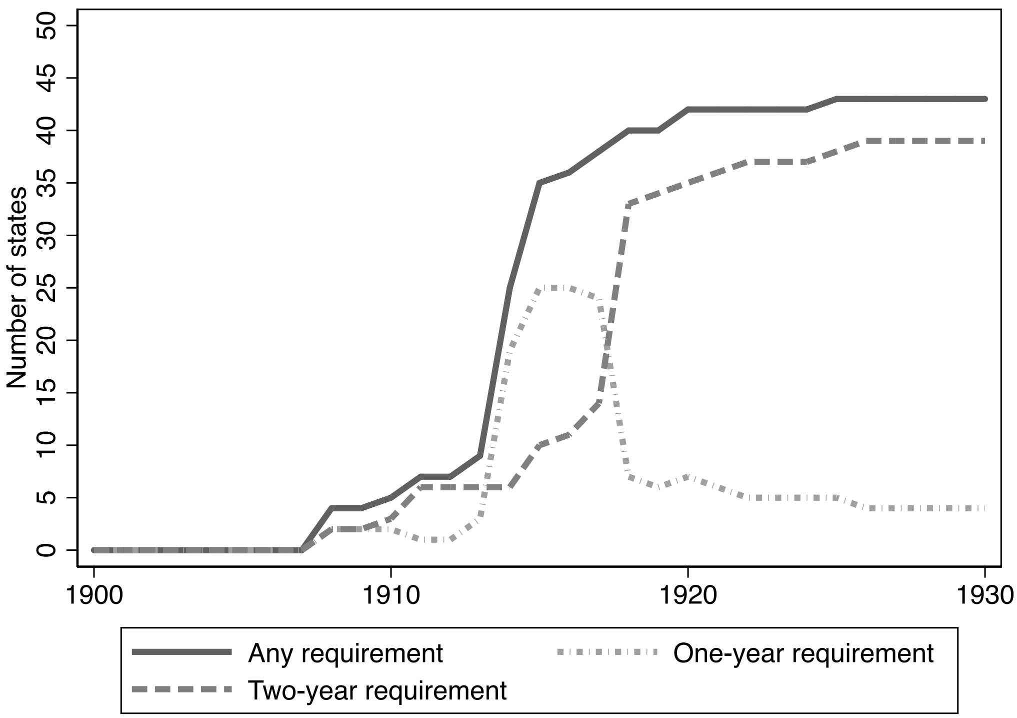
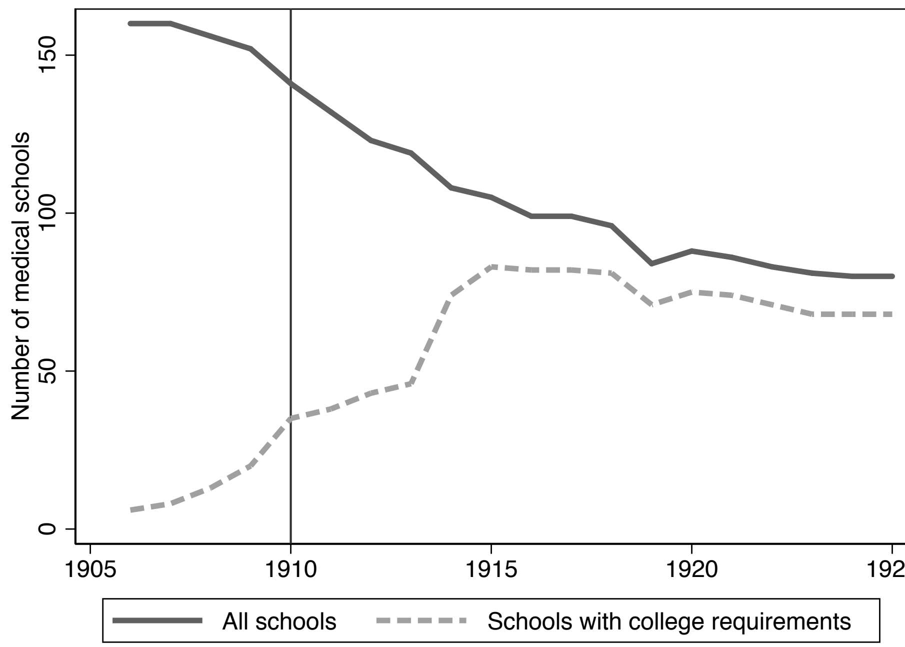
Conflict of Interest: The Authors declare that they have no conflict of interest.

Figure 1: States with Pre-Medical College Requirements for Physician Licensure

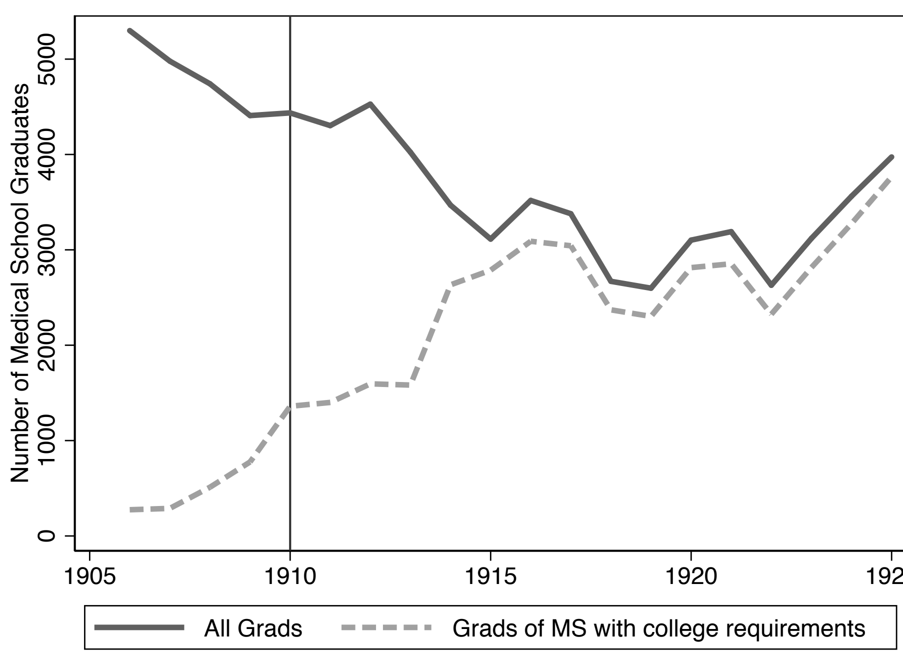


Source: "Medical Education in the United States," *Journal of American Medical Association*, Aug. 27, 1932: p. 746.

Figure 2: Number of Medical Schools and Graduates by College Requirements



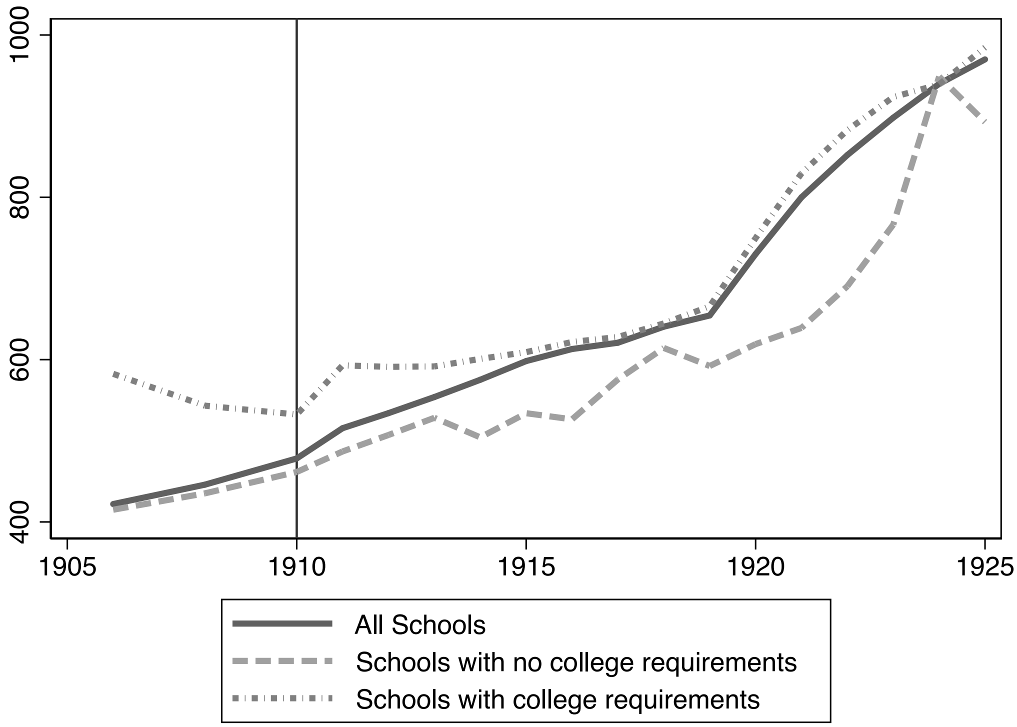
(a) Medical Schools by College Requirements



(b) Graduates by College Requirements

Source: Pre-medical college requirements are from American Medical Association Council on Medical Education (1919, 1923). Medical schools and graduates from American Medical Association Council on Medical Education (1905-1910, 1911-1914, 1915-1920).

Figure 3: Average Total Fees for 4-year Course by Pre-Medical Requirements



Notes: Figures are in current dollars.

Source: Pre-medical college requirements are from American Medical Association Council on Medical Education (1919, 1923). Fees are from American Medical Association Council on Medical Education (1905-1910, 1911-1914, 1915-1920).

Table 1: Distribution of Physicians American Medical Directory Samples by Location, All Doctors and Recent Medical School Graduates

	Panel A: All Doctors			
	1909	1914	1918	1921
10,000 and above	65.8%	67.5	68.4	73.1
Below 10,000 and unincorporated	34.2%	32.5	31.6	26.9
Number of observations	21,499	23,852	25,338	26,415
	Panel B: Established Doctors			
	1909	1914	1918	1921
10,000 and above	65.6%	66.9	67	71.3
Below 10,000 and unincorporated	34.4%	33.1	33	28.7
Number of observations	18,044	20,471	21,820	22,704
	Panel C: Recent Medical School Graduates			
	1909	1914	1918	1921
10,000 and above	66.6%	70.7	76.9	83.6
Below 10,000 and unincorporated	33.4%	29.3	23.1	16.4
Number of observations	3,455	3,381	3,518	3,711

Notes: The sample is limited to doctors in California, Mississippi, New York, and North Carolina. Recent medical school graduates defined as those who graduated within 5 years of the *American Medical Directory* publication date. "Unincorporated" refers to geographic areas that were not part of municipalities. These areas were generally sparsely populated and the Census Bureau classified them as rural.

Sources: Physician practice location, city size, and medical school graduation date are from various years of *American Medical Directory*.

Table 2: Distribution of Recent Medical School Graduates by Location, By Pre-med College Requirements

	Panel A: Graduates of Schools with College Requirements			
	1909	1914	1918	1921
10,000 and above	87.8%	84.6	84.9	87.2
Below 10,000 and unincorporated	12.2%	15.4	15.1	12.8
Number of observations	90	272	1,145	2,276
	Panel B: Graduates of Schools without College Requirements			
	1909	1914	1918	1921
10,000 and above	66.0%	69.5	73.1	77.8
Below 10,000 and unincorporated	34.0%	30.5	26.9	22.2
Number of observations	3,365	3,109	2,373	1,435

Notes: The sample is limited to doctors in California, Mississippi, New York, and North Carolina graduating from medical school within five years of the *AMD* publication date. Pre-medical college requirements includes either a one- or two-year requirement. "Unincorporated" refers to geographic areas that were not part of municipalities. These areas were generally sparsely populated and the Census Bureau classified them as rural.
Sources: Physician graduation dates, practice locations, and city size are from various years of *American Medical Directory*. Pre-medical college requirements are from American Medical Association Council on Medical Education (1919, 1923).

Table 3: Summary Statistics of AMD Physician Sample

	Panel A: Established Doctors				
	1909	1914	1918	1921	Total
Pre-med college reqs	0.002	0.007	0.015	0.027	0.014
	(0.049)	(0.086)	(0.123)	(0.162)	(0.116)
Years in practice	20.7	21.5	22.4	22.8	21.9
	(11.2)	(11.3)	(11.5)	(11.6)	(11.4)
Years in practice, sq	552.4	588.9	634.9	655.2	611.3
	(612.3)	(607.4)	(626.3)	(642.1)	(624.3)
Attended rural med school	0.079	0.080	0.081	0.082	0.081
	(0.270)	(0.271)	(0.273)	(0.275)	(0.273)
Medical school closed by 1923	0.386	0.363	0.346	0.337	0.357
	(0.487)	(0.481)	(0.476)	(0.473)	(0.479)
Attended med school out of state	0.441	0.451	0.461	0.468	0.456
	(0.497)	(0.498)	(0.499)	(0.499)	(0.498)
Observations	17,805	20,401	21,708	22,515	82,429
	Panel B: New Doctors				
	1909	1914	1918	1921	Total
Pre-med college reqs	0.026	0.081	0.326	0.614	0.270
	(0.160)	(0.273)	(0.469)	(0.487)	(0.444)
Attended rural med school	0.083	0.088	0.090	0.106	0.092
	(0.275)	(0.283)	(0.286)	(0.307)	(0.289)
Medical school closed by 1923	0.270	0.243	0.183	0.154	0.211
	(0.444)	(0.429)	(0.387)	(0.361)	(0.408)
State requires pre-med college in grad year	0	0	0.009	0.019	0.007
	(0)	(0)	(0.092)	(0.136)	(0.084)
Attended med school out of state	0.331	0.389	0.332	0.327	0.344
	(0.471)	(0.488)	(0.471)	(0.469)	(0.475)
Observations	3,436	3,357	3,515	3,709	14,017

Notes: Mean values with standard deviations in parentheses. The sample is limited to doctors in California, Mississippi, New York, and North Carolina. A new doctor graduated from medical school within five years of the *AMD* publication date, whereas established doctors graduated more than 5 years from the publication date. We do not report the summary statistics for state licensure requirements of pre-medical college education, because none of the doctors faced this requirement. New doctors settling in North Carolina in and after 1918, and Mississippi in 1919 were required to have at least one year of college education. Neither New York nor California required college education for licensure until after 1920. Pre-med college requirements is an indicator equal to one if physician graduated from a medical school with either a one- or two-year college requirement for attendance. Rural medical school is defined as being located in a county that is not a metropolitan county as defined by IPUMS. See text for more detail about metro and rural county designations.
Sources: Physician's year and school are from various years of *American Medical Directory*. Pre-medical college requirements are from American Medical Association Council on Medical Education (1919, 1923).

Table 4: Determinants of Rural Practice Location Choice: Probit Marginal Effects

	Panel A: Established Doctors			
	1909	1914	1918	1921
Pre-med college reqs	-0.136**	-0.171***	-0.135***	-0.066***
	(0.069)	(0.036)	(0.026)	(0.020)
Attended rural med school	0.109***	0.111***	0.101***	0.072***
	(0.016)	(0.015)	(0.014)	(0.013)
MS closed by 1923	0.035***	0.048***	0.038***	0.052***
	(0.008)	(0.008)	(0.008)	(0.007)
Attended med school out of state	0.026***	0.021**	0.009	0.016**
	(0.009)	(0.009)	(0.008)	(0.008)
Years in practice	0.006***	0.002*	0.001	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Years in practice, sq^{-4}	-0.217	0.363*	0.565***	0.407**
	(0.207)	(0.217)	(0.213)	(0.186)
Observations	17,805	20,401	21,708	22,515
Pseudo R2	0.156	0.174	0.164	0.162
Mean Dep. Var.	0.343	0.331	0.330	0.286
	Panel B: New Doctors			
	1909	1914	1918	1921
Pre-med college reqs	-0.206***	-0.054*	-0.073***	-0.029**
	(0.038)	(0.033)	(0.016)	(0.014)
Attended rural med school	0.083**	0.029	0.071**	0.037*
	(0.039)	(0.035)	(0.029)	(0.021)
MS closed by 1923	0.043*	0.054**	-0.040**	-0.000
	(0.024)	(0.023)	(0.019)	(0.018)
Attended med school out of state	0.119***	0.028	-0.023	0.004
	(0.023)	(0.020)	(0.018)	(0.015)
Years in practice	0.004	0.042***	0.030***	0.015***
	(0.006)	(0.006)	(0.005)	(0.004)
State requires pre-med college in grad year			0.214**	0.021
			(0.108)	(0.040)
Observations	3,436	3,357	3,515	3,709
Pseudo R2	0.271	0.325	0.253	0.226
Mean Dep. Var.	0.333	0.289	0.230	0.164

Notes: ***, **, and * represent statistical significance at the 1, 5, and 10% levels, respectively. Each column in a panel reports marginal effects from a separate probit model of rural practice location. Rural is defined as a city with less than 10,000 population or an unincorporated area. “Unincorporated” refers to geographic areas that were not part of municipalities. These areas were generally sparsely populated and the Census Bureau classified them as rural. All regressions include state fixed effects. Heteroskedasticity robust standard errors are reported in parentheses. The sample is limited to doctors in California, Mississippi, New York, and North Carolina. A new doctor is defined as graduating from medical school within five years of the *AMD* publication date, whereas established doctors graduated more than 5 years prior to the publication date. The regressions for established doctors do not include an indicator for whether a law was on the books requiring pre-med college education for licensure in the state and graduation year of the doctor. No established doctor faced such a requirement. New doctors settling in North Carolina in and after 1918, and Mississippi in 1919 were required to have at least one year of college education. Neither New York nor California required college education for licensure until after 1920.
Sources: Physician graduation dates, practice locations, and city size are from various years of *American Medical Directory*. Pre-medical college requirements and school closure information are from American Medical Association Council on Medical Education (1919, 1923).

Table 5: Odds Ratios from Conditional Logit Models of Physicians Choices of Counties

	California				New York			
	1909		1921		1909		1921	
	Est.	New	Est.	New	Est.	New	Est.	New
Metropolitan area	11.55***	6.23***	11.76***	7.72***	2.55***	2.77***	1.86***	1.78**
	(55.4)	(11.6)	(53.4)	(8.9)	(21.8)	(8.5)	(12.9)	(2.6)
Rural-adj. to metro	2.74***	2.17***	2.53***	3.07***	1.04	1.12	1.32***	1.41
	(17.6)	(4.5)	(18.1)	(4.8)	(1.0)	(0.9)	(5.9)	(1.5)
Ln(miles to med school attended)	0.71***	0.58***	0.59***	0.50***	0.37***	0.31***	0.41***	0.37***
	(-19.3)	(-12.6)	(-37.8)	(-15.1)	(-126.3)	(-56.6)	(-111.5)	(-29.9)
Hospital beds per 1,000	1.04***	1.09***	0.88***	0.96	1.37***	1.48***	1.77***	2.65***
	(6.3)	(4.7)	(-21.0)	(-1.4)	(29.7)	(15.5)	(51.2)	(17.3)
Est. doctors per 1,000	3.03***	2.58***	5.95***	3.72***	3.42***	2.50***	1.08	0.57*
	(25.3)	(7.0)	(47.8)	(7.4)	(24.7)	(7.0)	(1.1)	(-1.9)
Pre-medical college requirement								
*Metro	3.30	13.77*	2.81***	1.27	1.42	4.92**	2.92***	1.99**
	(1.0)	(1.9)	(3.7)	(0.8)	(0.5)	(2.0)	(2.9)	(2.1)
*Rural-adj. to metro	7.53	18.81*	1.81*	0.73	0.00	1.31	1.54	1.73
	(1.2)	(1.8)	(1.9)	(-1.0)	(-0.0)	(0.3)	(1.1)	(1.6)
*Ln(miles to med school)	$1.09x10^8$	0.00	1.29***	1.05	0.11**	0.31**	1.21***	1.00
	(1.0)	(-0.7)	(3.4)	(0.7)	(-2.3)	(-2.1)	(2.8)	(-0.1)
*Hospital beds	1.44**	0.91	1.02	1.03	1.27	1.41**	1.40***	1.10
	(2.1)	(-0.5)	(0.6)	(0.8)	(1.0)	(2.3)	(4.0)	(1.2)
*Est. doctors	5.65	6.29	1.13	1.45	0.85	1.61	1.31	1.05
	(1.3)	(1.6)	(0.6)	(1.6)	(-0.2)	(0.7)	(0.6)	(0.1)
Number of doctors	3,453	457	5,503	684	10,920	2,163	12,685	2,540

Notes: ***, **, and * represent statistical significance at the 1, 5, and 10% levels, respectively. Each column presents estimated odds ratios and t-stats in parentheses from a conditional logit model where each physician in a state chooses a practice location from among all counties in that state. All choice characteristics are measured at the county level. See main text for more detail about metro and rural county designations. A new doctor is defined as graduating from medical school within five years of the *AMD* publication date, whereas established doctors graduated more than 5 years prior to the publication date. Pre-medical college requirement is an indicator equal to one if the physician attended a medical school with an attendance requirement of one or two years of college work. Distance to medical school is measured from the county seat.
Sources: Physician location information, graduation year, and number of hospital beds are from various years of the *American Medical Directory*. Pre-medical college requirements are from American Medical Association Council on Medical Education (1919, 1923).

Table 6: Non-linear Oaxaca-Blinder Decomposition of Changes in Probability of Rural Location of New Doctors

	1909 Base			Final Year as Base		
	1914	1918	1921	1914	1918	1921
Difference in percent rural from 1909	.0108*	.0579***	.1297***	.0108*	.0579***	.1297***
Contribution of differences in characteristics (explained)	.0066	.0528***	.1133***	.0037	.0216***	.0401***
Contribution of differences in coefficients (unexplained)	.0042	.0052***	.0163***	.0071	.0363***	.0896***
Detailed decomposition of explained portion by individual characteristics						
Pre-med college reqs	.0108***	.0506***	.1097***	.0021***	.0292***	.0398***
	(.0024)	(.013)	(.0292)	(.0021)	(.0061)	(.0141)
MS closed by 1923	.0036**	.0104**	.0159**	.0059***	-.0070	-.0091
	(.0015)	(.0042)	(.0063)	(.0016)	(.0061)	(.0116)
Attended rural med school	.0001	.0002	.0003	-.0001	-.0009	-.0012
	(.0005)	(.0011)	(.0011)	(.0006)	(.0012)	(.0011)
Attended foreign med school	.0001	-.0002	-.0001	0.00001	-.0004	0.00007
	(.0003)	(.0004)	(.0004)	(.0002)	(.0004)	(.0003)
Attended out-of-state med school	-.0109***	-.0116***	-.0170***	-.0039***	-0.00004	.0016
	(.0024)	(.0027)	(.0037)	(.0017)	(.0023)	(.0035)
Years in practice	0.00004	-.0015	-.0030	.0007	-.0017	.0013
	(.0014)	(.0024)	(.0049)	(.0033)	(.0044)	(.0062)
Years in practice, sq	.0004	.0005	.0005	-.0011	.0013	.0063
	(.0015)	(.0021)	(.003)	(.0031)	(.0045)	(.0069)

Notes: ***, **, and * represent statistical significance at the 1, 5, and 10% levels, respectively. Oaxaca-Blinder decomposition of the change from 1909 to various years in the likelihood of rural location of new doctors using the method proposed in Fairlie (2017) with 5000 replications. The sample includes all doctors in CA, NY, MS, and NC that graduated medical school within the past five years. The dependent variable is an indicator for rural practice location and is measured as residing in an incorporated town of 10,000 or less population or an unincorporated area. "Unincorporated" refers to geographic areas that were not part of municipalities. These areas were generally sparsely populated and the Census Bureau classified them as rural. Each state is given a constant weight over time to isolate changes in characteristics away from changes in proportion of the sample across states. The first three columns use coefficients from 1909 as the base, whereas the last three columns use the coefficients from the final year as the base (e.g. 1914 coefficients for the 1914 column, etc...).
Sources: Physician location information, graduation year, are from various years of the *American Medical Directory*. Pre-medical college requirements are from American Medical Association Council on Medical Education (1919, 1923).

Table 7: Characteristics of Recent Medical School Graduates by Birthplace, North Carolina, 1918

	Born in urban area in North Carolina		Born in rural area in North Carolina	
	No. obs.	Percent	No. obs.	Percent
Practice in rural area	62	24.19	240	73.75
Black	62	24.19	240	1.67
Medical school characteristics:				
Attended rural med school	62	25.81	240	36.25
Pre-med college reqs	62	27.42	240	13.75
MS closed by 1923	62	27.42	240	36.67

Notes: Mean values with standard deviations in parentheses. Sample consists of male physicians born between 1886 and 1896 found in the AMD listings for North Carolina in 1918 and linked to World War I draft registration cards. Rural birthplace is defined as in a town of less than 2,500 population or an unincorporated area in the 1910 census (U.S. Bureau of the Census, 1913). "Unincorporated" refers to geographic areas that were not part of municipalities. These areas were generally sparsely populated and the Census Bureau classified them as rural.

Sources: Physician birthplace and race are from World War I draft registration cards provided by Ancestry.com (2005). Physician graduation dates, practice locations, and city size are from various years of *American Medical Directory*. Pre-medical college requirement and school closure information are from American Medical Association Council on Medical Education (1919, 1923).

Table 8: Marginal Effects from Probit Model of Practice in Rural Area, North Carolina 1918

	(1)	(2)	(3)	(4)
Rural birthplace	0.457***	0.445***	0.450***	0.430***
	(0.069)	(0.072)	(0.072)	(0.084)
Pre-med college reqs	-0.082	-0.209*	-0.216*	-0.279
	(0.085)	(0.112)	(0.112)	(0.171)
Rural birth * Pre-med col reqs				0.088
				(0.171)
Attended rural med school	-0.028	-0.063	-0.019	-0.017
	(0.065)	(0.068)	(0.086)	(0.086)
Black	-0.215	-0.235	-0.224	-0.238
	(0.145)	(0.150)	(0.151)	(0.153)
MS closed by 1923			-0.072	-0.072
			(0.088)	(0.088)
Grad year fixed effects	No	Yes	Yes	Yes
Observations	302	302	302	302
Pseudo R2	0.138	0.163	0.164	0.165
Mean Dep. Var.	0.636			

Notes: ***, **, and * represent statistical significance at the 1, 5, and 10% levels, respectively. Sample consists of male physicians born between 1886 and 1896 found in the AMD listings for North Carolina in 1918 and linked to World War I draft registration cards. Rural birthplace is defined as in a town of less than 2,500 population or an unincorporated area in the 1910 census (U.S. Bureau of the Census, 1913). Rural practice location is defined as a city with less than 2,500 population in the *American Medical Directory*. Pre-medical college requirements is an indicator variable for whether the medical school attended by the physician required either one or two years of college for attendance. Rural medical schools are located in non-metro counties. Heteroskedasticity robust standard errors are reported in parentheses.

Sources: Physician birthplace and race are from World War I draft registration cards provided by Ancestry.com (2005). Physician graduation dates, practice locations, and city size are from various years of *American Medical Directory*. Pre-medical college requirements, school closure information, and board pass rates are from American Medical Association Council on Medical Education (1919, 1923).

Table 9: Oaxaca-Blinder Decomposition of Difference in Rural Practice Location by Birthplace, North Carolina, 1918

	Urban birthplace as base	Rural birthplace as base
P(Rural practice | urban birth)	.2419	.2419
P(Rural practice | rural birth)	.7375	.7375
Difference in percent rural	-.4956***	-.4956***
Contribution of differences in characteristics (explained)	-.1563*	-.0916
Contribution of differences in coefficients (unexplained)	-.3392***	-.4040***

Notes: ***, **, and * represent statistical significance at the 1, 5, and 10% levels, respectively. We use the nonlinear decomposition procedure developed in Fairlie (2005) to decompose the differences in rural practice location between physicians born in rural areas and physicians born in urban areas. Estimates are from 5,000 replications (Fairlie, 2017). Rural birthplace is defined as in a town of less than 2,500 population or an unincorporated area in the 1910 census (U.S. Bureau of the Census, 1913). Rural practice location is defined as a city with less than 2,500 population in the *American Medical Directory*. The decomposition follows the specification in column (3) of Table 8: controls include an indicator for pre-med college requirements, an indicator for attending a rural medical school, an indicator for whether the physician is black, an indicator for whether the medical school closed by 1923, and series of graduation year indicators. See notes for Table 8 for sources.

8 Appendix

Figure A1: Example page from 1906 *American Medical Directory*

PHYSICIANS OF ALABAMA

ALABAMA.

Abbeville, 889, Henry.
Blackledge. John R.—Ala.2.'89: (l 1891).
HENDRICK. LOWNDES—Ala.2.'90: (l 1890).
NICHOLS. LUCIUS S.—Ala.2.'97: (l 1897).
STEAGALL. ALBERT S.—Ala.2.'88: (l 1888).
Steagall. Wm. C.—S.C.1.'60: (l 1881).
Abercrombie, 22, Bibb (R.F.D., Centerville).
Moseley. David O.—Mo.2.'72: (l 1878).
Activity, 61, Monroe.
Mason. David A.—Md.9.'04: (l 1902).
Adamsville, 600. Jefferson.
MARTIN. WM. G (b 1859)⊕—Tenn.8.'93: (l 1895): 8-10. 2-4.
Adger, 225, Jefferson.
DUNLAP. PERRY G. (b 1858)⊕—Tenn.5.'81: (l 1881).
Aiken. 20, Crenshaw.
Pryor. Wm. D.—Tenn.6.'57: (l 1881).
Akron, 88, Hale.
GEWIN. WM. C.—La.1.'78: (l 1878).
Alabama City, 2,600, Etowah.
ACTON. WM. H. (b 1861)⊕—Ala.2.'88:(l 1888)
BURNS. ROBT. A. (b 1867)⊕—Tenn.5.'01: (l †).
HAWKINS. J. P.—Tenn.9.'94: (l 1894).
Alabama Port, 300, Mobile.
Davis. Henry V.—M. R. C. S.. Eng..'59: (l †).
Alamuchee, 30, Sumter.
Jones. Jos. F.—Ga.11.'01: (l 1901).
Albertville, 1,500, Marshall.
DAVIS. SAML. J.—Ga.5.'82: (l 1882).
ELROD. SAML. M.—Tenn.5.'94: (l 1894).
ELROD. WM. A.—Tenn.11.'01: (l 1901).
HALL. WM. P.—Ga.5.'86: (l 1886).
Holliday. A. L.—* (l †).
Holliday. Walter H.—Tenn.11.'01: (l 1902).
HUDSON. FRANK N.—Tenn.5.* (l 1876).
IRWIN. WM. F.—Ky.2.'87: (l 1887).
PARRIS. DANL.—Tenn.9.'00: (l 1901).
SHIPP. MONTGOMERY G. — Tenn.5.'01: (l 1901).
Aldrich, 400, Shelby.
BELL. WALTER H. (b 1864)⊕—Ga.5.'88: (l 1888): 8-9. 1-2.
Alexander City, 1,061, Tallapoosa.
CHAPMAN. JAS. A. — Ala.2.'05: (l 1905): R.F.D. No. 2.
COLEY. ANDREW JACKSON (b 1858)⊕—Pa.2.'80: (l 1882): Coley Bldg.: 7-9:30. 4-6.
Dean. Neal B.—La.1.'05: (l 1905).
GOGGANS. JAS. ADRIAN⊕—N.Y.5.'77: (l 1882).
HARLAN. AARON L. (b 1861)⊕—Ala.2.'86: (l 1886): Jackson St.
RADFORD. GEO. C.⊕—* (l 1887): R.F.D. No. 2.
REAGAN. ONSLOW—* (l 1882).
STREET. THOS. H. (b 1876)—Pa.2.'00:(l 1900).
Alexandria, 63, Calhoun.
DOUTHIT. ANDREW J.—* (l 1881).
Aliceville, 50, Pickens.
Jones. B. C.—* (l †).
Moody. Jones (b 1846)—Ky.2.'71: (l 1878).
Snoddy. Ephraim A.—Ala.2.'97: (l 1897).
Allentown, 210, Wilcox.
Lee. John F.—Tenn.1.'80: (l 1883).
Alpine, 121, Talladega.
PRESCOTT. WILLIAM EARNEST—Ala.4.'00: (l 1900).
SMITH. THOS. C.—Ala.4.'03: (l 1903).
Alston, 65, Barbour.
Weed. Walter A. (b 1883)—Md.8.'05: (l 1905).
Altoona, 1,000, Etowah.
ELLISON. JOHN H.—Tenn.5.'88: (l 1899).
Oliver. Hilary F.—Pa.1.'59: (l 1881).
Andalusia, 551, Covington.
ADAMS. EDW. L.—Ala.2.'97: (l 1897).
BATTLE. HENRY E.—Tenn.6.'96: (l 1897).
BEAN. WALTON L.—Ky.4.'97: (l 1897).
BROUGHTON, LOUIS EDW. (b 1869)⊕—La.1. '93: (l 1893): 76 E. Three Notch St.: office. Henderson Block: 10-12. 3-5.
COLEMAN. AURELIUS D.—Ala.2.'80: (l 1880)
GRESHAM. GEO. L.—La.1.'05: (l 1905).
HARRIS. A. F.—Pa.2.'60: (l 1880): R.F.D. No. 2.
PENNINGTON. JAS. C.—Tenn.6.'94: (l 1894).
RAY. THOS. QUINCY—Ga.10.'94: (l 1894).

Anniston, 23,090, Calhoun.
ANDERSON. EDMOND C. (b 1853)⊕—Ky. 1.'77: (l 1885): 1109 Wilmer St.: office. 1107 Wilmer St.: 7-9. 11-12. 5-7.
Bowcock. Robt. L.—Va.1.'86: (l 1888).
BROTHERS. THOS. J.—Md.3.'03: (l 1902): 1010 Noble St.
Bullard. Francis A.—* (l 1881).
EDMONDSON. JAS. A. (b 1873)—Ga.5.'98: (l 1898).
GORDON. FREDK. E. (b 1861)⊕—Ala.2.'82: (l 1882): Tyler Hill St.: office. 1023 Noble St.: 10-11. 4-5.
GREENE. ALLEN A. (b 1870)⊕—Tenn.5.'91: (l 1891): 16 E. 12th St.: office. 18 E. 12th St.: 9-12. 3-5.
HUGER. RICHARD P.—S.C.1.'71: (l 1881).
KELLY. JOHN BAKER—Pa.2.'59: (l 1884).
McCURRY. SAML. J.—Ga.5.'80: (l 1881).
MARTIN. HENRY M.—Va.1.'99: (l 1900).
MATTHEWS. GEO. A. (b 1842)—Mich.1.'66: (l 1890): 2012 Gurnee Ave.
MOON. EWARD K. (b 1867)—Tenn.9.592: (l 1892): 1510 Noble St.: office. Scarborough Drug Co.. 1107 Noble St.
MOORE. J. C.⊕—Tenn.1.'00: (l 1900).
STEELE. ABNER N.⊕—Ala. 2.'90: (l 1890).
TAYLOR. JAS. R.—Ga.5.'98: (l 1898).
Thomas. Chas. E. (col.)—N.Y.8.'90: (l 1890).
VANN. PAUL D.—Ala.2.'96: (l 1896).
WALKER. JAS. F.—Ky.2.'92: (l 1892).
WARREN. WM. JAS.—Ga.5.'89: (l 1889).
WHITE. WM. Y.⊕—Tenn.5.'87: (l 1887).
WHITESIDE. JOHN M. (b 1862)—Tenn.5.'84: (l 1884): Queeland Ave. and 7th St.: office. Scarbrough Drug Co..
WIKLE. JESSIE LANE—Ga.1.'71: (l 1881).
Ansley, 95, Pike.
BROACH. FRANCIS M. (b 1855)—Ga.10.'90: (l 1890).
Dennis. Irey W. (b 1853)—Ky.4.'76: (l 1878).
Arab, 125, Marshall.
Hinds. Montgomery L.—Tenn.5,'91: (l 1892).
Hinds. Wm.—Ala.* (l †).
Ariton, 250, Dale.
NORRIS. ROY HART—Ala.2.'97: (l 1897).
Arkadelphia, 203, Cullman.
Parker. D. J.—Tenn.*'99: (l †).
Arley, 600, Winston.
DENNIS. DAVID R.⊕—* (l 1902).
Arlington, 96, Wilcox.
KIMBROUGH. FRANKLIN F.. Jr.—La.1.'90: (l 1890).
Asa, —, Franklin.
GRAVES. A.—* (l 1902).
Ashford, 286, Houston.
DOUGHTY. JAS. M. (b 1879)—Tenn.9.'04: (l 1904): Ashford St.: office. Broadway.
FILLINGIM. WM. H.—Tenn.6.'96: (l 1903).
Pate. Walter E.—Ga.2.'93: (l 1893).
Ashland, 442, Clay.
HEARN. JAS. L.—Ga.5.'01: (l 1901).
JORDAN. JOS. WILEY (b 1860)—Ga.5.'91: (l 1887): Box 24.
NORTHEN. THOS.—Ga.5.'78: (l 1887).
OWENS. ARTHUR H.—Ala.2.'05: (l 1905).
OWENS. SEABORN W.—* (l 1887): R.F.D.
WOOD. JAS. WM.—Ga.10.97: (l 1897).
Ashville, 362, St. Clair.
BASS. JOHN B. (b 1845)⊕—Md.3.'70: (l 1878).
BEASON. WM. A.—Md.3.'93: (l 1893).
Garlington. Henry S.—Ala.2.'87; (l 1887).
Aspel, 26, Jackson.
Gattis. Henry F.—* (l 1882).
Athens, 1,010, Limestone.
CRUTCHER. JOHN SIMS (b 1865)⊕—Tenn.5. '89: (l 1889): Jefferson St.: office. Market.
DARBY. HENRY A. — Ala.4.'01: (l 1901): R.F.D. No. 3.
HAGAN. WM. J. (b 1862)⊕—Pa.2.'84:(l 1884).
HOFFMAN. JOHN R.—Pa.5.'58: (l 1878).
JONES. THOS. CRITTENDEN (b 1843)—Ky.2. '76: (l 1888).
Moore. Elisha D.—Tenn.1.'68: (l 1878).
PETTUS. JOS. ALBERT—Tenn.1.'67: (l 1877).
SOWELL. W. O.—* (l 1878): R.F.D. No. 3.
WALLACE. NICHOLAS B.—Mo.7.'99: (l 1901).
Westmoreland. Theophilus (b 1834)—Tenn.5, '79: (l 1879).
WILLIAMS. GEO. ALLEN — Tenn.1.'80: (l 1881).
YORK. SEABRON EDW.—Ky.2.'76: (l 1884).

Atmore. 287, Escambia.
PEAVY. JULIUS F.⊕—Ala.2.'88: (l 1888).
WEBB. ALFRED P.—Ala.2.'96: (l 1897).
Attalla, 2,000. Etowah.
McCONNELL. ROBERT F. (b 1854)—Ga.5.'81: (l 1881): 4th St.: office. 3d Ave.: 8-11. 2-6.
STEPHENS. MILES P. (b 1868)—Tenn.9.'94: (l 1894): 4th St.
STEWART. JOHN POPE (b 1864)—Ala.2.'85: (l 1885).
WILSON. GEORGE W. (b 1855) — Ala.2.'95: (l 1895).
WOOD. JAS. H.(b 1857)—Tenn.5.'82: (l 1882): 5th St.: office. 4th St. and 5th Ave.: 11-12.1-3.
Auburn, 1,447, Lee.
BEDELL. ROBT. B.—S.C.1.'54: (l 1881).
DRAKE. JOHN H.. Sr.⊕—Ga.5.'67: (l 1881).
HOWE. ROBT. D.—Tenn.6.'90: (l 1891).
REYNOLDS. PETIT—Ala.2.'97: (l 1897).
STEADHAM. OLIVER M.—Tenn.9.'94:(l 1887).
YARBROUGH. CECIL S.—Tenn.6.'01:(l 1901).
Aurora, 62, Etowah.
Slaughter. Chas. J.—Ga.5.'81: (l 1881).
Austinville, 11, Morgan (R.F.D., New Decatur).
SHERRILL. HOMER—* (l 1894).
Autaugaville, 400, Autauga.
GIBSON. WM. BEATTY (b 1860)—N.Y.10.'80; (l 1892).
Avondale, 3,060, Jefferson.
Ball. John C.—Ga.5.'59: (l 1887).
CAFFEY. SAML. R.—Mo.1.'81: (l 1881).
FINCH. JOHN H.—Md.3.'86: (l 1886).
MARTIN. HENRY L.—Tenn.5.'81: (l 1881).
MILES. WM. GRAVLEE—Ala.4.'99: (l 1900).
MORRIS. EMORY A.—Tenn.1.'02: (l 1902).
Baileyton, 63, Cullman.
Keller. Louis M.—* (l 1888): R.F.D.
Winn. Jas. Thos.—Tenn.5.'89: (l 1889).
Winn. Joseph J.—Tenn.6.'93: (l 1889).
Banks, 198, Pike.
CROSSLEY. WM. A.—S.C.1.'54: (l 1878).
McEACHERN. CONOLY P.⊕ — Ala.2.'96: (l 1896).
Bankston, 110, Fayette.
SMITH. JOHN G.—Ala.2.'89: (l 1889).
Barfield, 63, Clay.
BARFIELD. JESSIE M.—Ga.11.'01: (l 1901).
Barlow Bend, 167, Clarke.
COBB. WM. FLOYD—Tenn.5.'95: (l 1895).
Barrytown, 30, Choctaw.
TAYLOR. E. E.—Tenn.6.'04: (l 1904).
Basham, 32, Morgan.
HAYS. CHAS.—Tenn.9.'03: (l 1903).
Bashi, 28, Clarke.
Davis. Louis J.—Ala.2.'96: (l 1896).
Batesville, 137, Barbour.
Borders. Jas. C.—Ga.2.'93: (l 1885).
Battelle, 1,500, DeKalb.
VANN. SIDNEY J. (b 1875)—Ga.1.'00:(l 1900).
Battles Wharf, 200, Baldwin (Battles P.O.).
Scott. Harvey E.—Tenn.5.'80: (l 1880).
Baxter, 64, Lamar (R.F.D., Bedford).
SIZEMORE. W. CLARENCE — Tenn.1.'04: (l 1904).
Bay Minette, 220, Baldwin.
HALL. JOSEPH—Ala.2.'01: (l 1901).
LAMBERT. GEO. L.—Ala.2.'95: (l 1895).
McLEOD. JOHN C.(b 1880)—Ala.4.'00:(l 1900): 10-12. 3-4.
Bayou Labatre, 60, Mobile.
Edwards. William—Ala.2.'80: (l 1880).
Macey. Robt. C.—Ala.2.'87: (l 1887).
Persons. Jas. T.—Ala.2.'90: (l 1890).
Shaw. Robt. E.—Ala.2.'98: (l 1899).
Bear Creek, 100, Marion.
Phillips. Wendell V. (b 1876) — Ala.2.'02; (l 1902).
SHERMAN. JOHN R.—Ga.5.'96: (l 1896).
Belgreen, 600, Franklin.
UNDERWOOD. NIMROD E. (b 1869)—Tenn.9. '00: (l 1902).
Belk, 10, Fayette.
HARTOW. J. B.—Tenn.8.* (l †).
Bellamy, 18, Sumter.
HALE. ROBT. E. (b 1874)⊕—Tenn.9.'04: (l 1905).
KNIGHTON. T. A.—Ala.2.'90: (l 1890).
Belle Ellen, 125, Bibb.
THOMAS. M. C.⊕—La.1.'99: (l 1899).

Capitals signify membership in County and State Societies: ⊕ member American Medical Association: H. homeopath: E. eclectic: P-M. physio-medic: * information regarding graduation not obtained: (Y. of P.) in practice before passage of present law. or licensed by virtue of a certain number of years of practice: figures in parentheses refer to dates of birth and state license: (l †) licensed but date not given. For key to colleges see inside front cover page.

Table A1: Determinants of Rural ($< 10,000$) Practice Location Choice: Linear Probability Model

	Panel A: Established Doctors			
	1909	1914	1918	1920
Pre-med college reqs	-0.107	-0.132***	-0.110***	-0.055***
	(0.065)	(0.034)	(0.024)	(0.017)
Attended rural med school	0.102***	0.098***	0.090***	0.066***
	(0.012)	(0.011)	(0.011)	(0.010)
MS closed by 1923	0.030***	0.040***	0.032***	0.046***
	(0.007)	(0.006)	(0.006)	(0.006)
Attended med school out of state	0.025***	0.020***	0.010	0.014**
	(0.008)	(0.007)	(0.007)	(0.006)
Years in practice	0.005***	0.001	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Years in practice, sq^{-4}	-0.090	0.399**	0.584***	0.521***
	(0.181)	(0.179)	(0.175)	(0.158)
Observations	17,805	20,401	21,708	22,515
R-squared	0.201	0.223	0.212	0.207
Mean Dep. Var.	0.343	0.331	0.330	0.286
	Panel B: New Doctors			
	1909	1914	1918	1920
Pre-med college reqs	-0.190***	-0.045*	-0.054***	-0.029**
	(0.043)	(0.024)	(0.014)	(0.013)
Attended rural med school	0.070***	0.020	0.061***	0.043**
	(0.027)	(0.023)	(0.022)	(0.018)
MS closed by 1923	0.031*	0.041**	-0.024	0.005
	(0.018)	(0.017)	(0.017)	(0.016)
Attended med school out of state	0.098***	0.020	-0.020	-0.001
	(0.018)	(0.014)	(0.015)	(0.013)
Years in practice	0.003	0.028***	0.022***	0.011***
	(0.005)	(0.004)	(0.004)	(0.004)
State requires pre-med college in grad year			0.140**	-0.002
			(0.070)	(0.042)
Observations	3,436	3,357	3,515	3,709
R-squared	0.342	0.399	0.309	0.256
Mean Dep. Var.	0.333	0.289	0.230	0.164

Notes: ***, **, and * represent statistical significance at the 1, 5, and 10% levels, respectively. Each column in a panel reports coefficient estimates from a separate linear probability model of rural practice location. Rural is defined as a city with less than 10,000 population or an unincorporated area. All regressions include state fixed effects. Heteroskedasticity robust standard errors are reported in parentheses. The sample is limited to doctors in California, Mississippi, New York, and North Carolina. A new doctor is defined as graduating from medical school within five years of the *AMD* publication date, whereas established doctors graduated more than 5 years prior to the publication date. The regressions for established doctors do not include an indicator for whether a law was on the books requiring pre-med college education for licensure in the state and graduation year of the doctor. No established doctor faced such a requirement. New doctors settling in North Carolina in and after 1918, and Mississippi in 1919 were required to have at least one year of college education. Neither New York nor California required college education for licensure until after 1920.
Sources: Physician graduation dates, practice locations, and city size are from various years of *American Medical Directory*. Pre-medical college requirements and school closure information are from American Medical Association Council on Medical Education (1919, 1923).

Table A2: Determinants of Rural ($< 2,500$) Practice Location Choice: Probit Marginal Effects

	Panel A: Established Doctors			
	1909	1914	1918	1920
Pre-med college reqs	-0.076	-0.155***	-0.099***	-0.050***
	(0.061)	(0.025)	(0.022)	(0.017)
Attended rural med school	0.089***	0.090***	0.083***	0.069***
	(0.014)	(0.013)	(0.012)	(0.011)
MS closed by 1923	0.040***	0.045***	0.036***	0.046***
	(0.007)	(0.007)	(0.007)	(0.006)
Attended med school out of state	0.015*	0.022***	0.015**	0.014**
	(0.008)	(0.008)	(0.007)	(0.006)
Years in practice	0.003***	-0.000	-0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Years in practice, sq^{-4}	-0.027	0.394**	0.468***	0.287**
	(0.178)	(0.180)	(0.181)	(0.145)
Observations	17,805	20,401	21,708	22,515
Pseudo R2	0.137	0.140	0.144	0.154
Mean Dep. Var.	0.253	0.241	0.247	0.197
	Panel B: New Doctors			
	1909	1914	1918	1920
Pre-med college reqs	-0.176***	-0.040	-0.070***	-0.040***
	(0.032)	(0.028)	(0.014)	(0.011)
Attended rural med school	0.065*	0.032	0.071***	0.045***
	(0.034)	(0.028)	(0.026)	(0.017)
MS closed by 1923	0.057***	0.085***	-0.034**	-0.002
	(0.021)	(0.019)	(0.016)	(0.013)
Attended med school out of state	0.109***	0.034*	-0.016	-0.002
	(0.021)	(0.017)	(0.016)	(0.012)
Years in practice	-0.001	0.019***	0.018***	0.007**
	(0.006)	(0.005)	(0.005)	(0.003)
State requires pre-med college in grad year			0.237**	0.010
			(0.100)	(0.027)
Observations	3,436	3,357	3,515	3,709
Pseudo R2	0.260	0.313	0.226	0.210
Mean Dep. Var.	0.278	0.227	0.183	0.108

Notes: ***, **, and * represent statistical significance at the 1, 5, and 10% levels, respectively. Each column in a panel reports marginal effects from a separate probit model of rural practice location. Rural is defined as a city with less than 2,500 population or an unincorporated area. All regressions include state fixed effects. Heteroskedasticity robust standard errors are reported in parentheses. The sample is limited to doctors in California, Mississippi, New York, and North Carolina. A new doctor is defined as graduating from medical school within five years of the *AMD* publication date, whereas established doctors graduated more than 5 years prior to the publication date. The regressions for established doctors do not include an indicator for whether a law was on the books requiring pre-med college education for licensure in the state and graduation year of the doctor. No established doctor faced such a requirement. New doctors settling in North Carolina in and after 1918, and Mississippi in 1919 were required to have at least one year of college education. Neither New York nor California required college education for licensure until after 1920.
Sources: Physician graduation dates, practice locations, and city size are from various years of *American Medical Directory*. Pre-medical college requirements and school closure information are from American Medical Association Council on Medical Education (1919, 1923).

Table A3: Rural Practice Location Choice of New Doctors: Probit Marginal Effects (Including AMA Ratings As Controls)

	Panel A: Includes controls for AMA rating			
	1909	1914	1918	1921
Pre-med college reqs	-0.204***	-0.051	-0.083***	-0.035**
	(0.039)	(0.033)	(0.017)	(0.016)
Attended rural med school	0.141***	0.058	0.060**	0.038*
	(0.040)	(0.038)	(0.029)	(0.021)
MS closed by 1923	0.090***	0.108***	-0.023	0.008
	(0.029)	(0.027)	(0.022)	(0.020)
Attended med school out of state	0.118***	0.013	-0.022	0.001
	(0.024)	(0.021)	(0.018)	(0.016)
Attended foreign med school	-0.091	0.018	-0.075	-0.009
	(0.059)	(0.057)	(0.059)	(0.048)
Years in practice	0.002	0.039***	0.029***	0.015***
	(0.006)	(0.006)	(0.005)	(0.004)
State requires pre-med college in grad year			0.219**	0.023
			(0.108)	(0.040)
B rated school	-0.022	-0.055**	-0.054**	-0.016
	(0.038)	(0.025)	(0.021)	(0.019)
C rated school	-0.214***	-0.128***	0.012	-0.026
	(0.031)	(0.029)	(0.040)	(0.030)
Observations	3,436	3,357	3,515	3,709
Pseudo R2	0.278	0.328	0.255	0.226
Mean Dep. Var.	0.333	0.289	0.230	0.164

Notes: ***, **, and * represent statistical significance at the 1, 5, and 10% levels, respectively. Each column in a panel reports marginal effects from a separate probit model of rural practice location. Rural is defined as a city with less than 10,000 population or an unincorporated area. "Unincorporated" refers to geographic areas that were not part of municipalities. These areas were generally sparsely populated and the Census Bureau classified them as rural. All regressions include state fixed effects. Heteroskedasticity robust standard errors are reported in parentheses. The sample is limited to doctors in California, Mississippi, New York, and North Carolina. A new doctor is defined as graduating from medical school within five years of the *AMD* publication date, whereas established doctors graduated more than 5 years prior to the publication date. The regressions for established doctors do not include an indicator for whether a law was on the books requiring pre-med college education for licensure in the state and graduation year of the doctor. No established doctor faced such a requirement. New doctors settling in North Carolina in and after 1918, and Mississippi in 1919 were required to have at least one year of college education. Neither New York nor California required college education for licensure until after 1920.
Sources: Physician graduation dates, practice locations, and city size are from various years of *American Medical Directory*. Pre-medical college requirements and school closure information are from American Medical Association Council on Medical Education (1919, 1923).

Table A4: Linear Oaxaca-Blinder Decomposition of Changes in Probability of Rural Location of New Doctors

	1909 Base			Final Year as Base		
	1914	1918	1920	1914	1918	1920
Difference in percent rural from 1909	0.0108	0.0579	0.1297	0.0108	0.0579	0.1297
Contribution of differences in characteristics (explained)	0.0061	0.0465	0.1132	0.0055	0.0251	0.0538
Contribution of differences in coefficients (unexplained)	0.0047	0.0114	0.0165	0.0053	0.0329	0.0758
Pre-med college reqs	0.0143***	0.0593***	0.1215***	0.0061***	0.0254***	0.0520***
MS closed by 1923	0.0001	0.0004	0.0006	-0.0012	-0.0038	-0.0056
Attended rural med school	0.0003	-0.0001	-0.0014	0.0004	-0.0002	-0.0019
Attended foreign med school	0.0001	-0.0005	-0.0003	-0.00003	0.00001	0.00008
Attended out-of-state med school	-0.0092***	-0.0117***	-0.0162***	0.0014	0.0018	0.0024
Years in practice	0.0004	-0.0009	-0.0031	-0.0008	0.0022	0.0072
Years in practice, sq	0.0001	0.0001	0.0001	-0.0004	-0.0003	-0.0004

Notes: ***, **, and * represent statistical significance at the 1, 5, and 10% levels, respectively. Linear Oaxaca-Blinder decomposition of the change from 1909 to various years in the likelihood of rural location of new doctors. The sample includes all doctors in CA, NY, MS, and NC that graduated medical school within the past five years. The dependent variable is an indicator for rural practice location and is measured as residing in an incorporated town of 10,000 or less population or an unincorporated area. Each state is given a constant weight over time to isolate changes in characteristics away from changes in proportion of the sample across states. The first three columns use coefficients from 1909 as the base, whereas the last three columns use the coefficients from the final year as the base (e.g. 1914 coefficients for the 1914 column, etc...).
Sources: Physician location information, graduation year, are from various years of the *American Medical Directory*. Pre-medical college requirements are from American Medical Association Council on Medical Education (1919, 1923).

Table A5: Characteristics of Recent Medical School Graduates by Birthplace (rural defined as pop < 10,000), North Carolina, 1918

	Born in urban area in North Carolina		Born in rural area in North Carolina	
	No. obs.	Percent	No. obs.	Percent
Practice in rural area (pop < 10k)	28	17.86	274	87.23
Black	28	25.00	274	4.38
Medical school characteristics:				
Attended rural med school	28	35.71	274	33.94
Pre-med college reqs	28	32.14	274	14.96
MS closed by 1923	28	28.57	274	35.40

Notes: Sample consists of male physicians born between 1886 and 1896 found in the AMD listings for North Carolina in 1918 and linked to World War I draft registration cards. Rural birthplace is defined as in a town of less than 10,000 population or an unincorporated area in the 1910 census (U.S. Bureau of the Census, 1913).

Sources: Physician birthplace and race are from World War I draft registration cards provided by Ancestry.com (2005). Physician graduation dates, practice locations, and city size are from various years of *American Medical Directory*. Pre-medical college requirements, school closure information, and board pass rates are from American Medical Association Council on Medical Education (1919, 1923). Flexner ratings based on authors' judgment of the overall impression of each program recorded in Flexner (1910).

Table A6: Results from Linear Probability Model of Practice in Rural Area, North Carolina 1918

	(1)	(2)	(3)	(4)
Rural birthplace	0.451***	0.430***	0.435***	0.419***
	(0.070)	(0.075)	(0.075)	(0.088)
Pre-med college reqs	-0.071	-0.169*	-0.174*	-0.213*
	(0.071)	(0.089)	(0.090)	(0.122)
Rural birth * Pre-med col reqs				0.062
				(0.157)
Attended rural med school	-0.024	-0.052	-0.016	-0.015
	(0.055)	(0.058)	(0.067)	(0.067)
Black	-0.167	-0.179	-0.168	-0.178
	(0.105)	(0.117)	(0.119)	(0.121)
MS closed by 1923			-0.061	-0.061
			(0.069)	(0.069)
Grad year fixed effects	No	Yes	Yes	Yes
Observations	302	302	302	302
R-squared	0.182	0.208	0.210	0.210
Mean Dep. Var.	0.636			

Notes: ***, **, and * represent statistical significance at the 1, 5, and 10% levels, respectively. Sample consists of male physicians born between 1886 and 1896 found in the AMD listings for North Carolina in 1918 and linked to World War I draft registration cards. Rural birthplace is defined as in a town of less than 2,500 population or an unincorporated area in the 1910 census (U.S. Bureau of the Census, 1913). Rural practice location is defined as a city with less than 2,500 population in the *American Medical Directory*. Pre-medical college requirements is an indicator variable for whether the medical school attended by the physician required either one or two years of college for attendance. Rural medical schools are located in non-metro counties. Heteroskedasticity robust standard errors are reported in parentheses.

Sources: Physician birthplace and race are from World War I draft registration cards provided by Ancestry.com (2005). Physician graduation dates, practice locations, and city size are from various years of *American Medical Directory*. Pre-medical college requirements and school closure information are from American Medical Association Council on Medical Education (1919, 1923).

Table A7: Marginal Effects from Probit Model of Practice in Rural Area (defined as pop $< 10{,}000$), North Carolina 1918

	(1)	(2)	(3)	(4)
Rural birthplace	0.354***	0.349***	0.348***	0.333***
	(0.073)	(0.075)	(0.076)	(0.088)
Pre-med college reqs	-0.131*	-0.195**	-0.194**	-0.227
	(0.074)	(0.098)	(0.098)	(0.141)
Rural birth * Pre-med col reqs				0.037
				(0.103)
Attended rural med school	-0.024	-0.033	-0.038	-0.037
	(0.052)	(0.052)	(0.069)	(0.069)
Black	-0.059	-0.067	-0.069	-0.077
	(0.098)	(0.104)	(0.106)	(0.111)
MS closed by 1923			0.008	0.009
			(0.069)	(0.069)
Grad year fixed effects	No	Yes	Yes	Yes
Observations	302	302	302	302
Pseudo R2	0.152	0.182	0.182	0.183
Mean Dep. Var.	0.636			

Notes: ***, **, and * represent statistical significance at the 1, 5, and 10% levels, respectively. Sample consists of male physicians born between 1886 and 1896 found in the AMD listings for North Carolina in 1918 and linked to World War I draft registration cards. Rural birthplace is defined as in a town of less than 10,000 population or an unincorporated area in the 1910 census (U.S. Bureau of the Census, 1913). Rural practice location is defined as a city with less than 10,000 population in the *American Medical Directory*. Pre-medical college requirements is an indicator variable for whether the medical school attended by the physician required either one or two years of college for attendance. Rural medical schools are located in non-metro counties. Heteroskedasticity robust standard errors are reported in parentheses.
Sources: Physician birthplace and race are from World War I draft registration cards provided by Ancestry.com (2005). Physician graduation dates, practice locations, and city size are from various years of *American Medical Directory*. Pre-medical college requirements, school closure information, and board pass rates are from American Medical Association Council on Medical Education (1919, 1923).

Table A8: Determinants of Rural Practice Location Choice for New Doctors: Probit Marginal Effects

	Include Current Dollar Fees				*Include Constant Dollar Fees*			
	1909	1914	1918	1921	1909	1914	1918	1921
Pre-med college reqs	-0.406*	-0.120	-0.032	-0.063	-0.411**	-0.121	-0.080	-0.079
	(0.208)	(0.124)	(0.071)	(0.069)	(0.207)	(0.123)	(0.070)	(0.069)
Attended rural med school	-0.063	-0.292**	-0.094	0.106	-0.058	-0.299**	-0.059	0.055
	(0.113)	(0.122)	(0.103)	(0.096)	(0.113)	(0.122)	(0.104)	(0.098)
MS closed by 1923	-0.126	-0.095	-0.224***	-0.032	-0.127	-0.099	-0.271***	-0.037
	(0.077)	(0.077)	(0.083)	(0.089)	(0.077)	(0.077)	(0.083)	(0.088)
Attended med school out of state	0.112	-0.080	-0.254***	-0.121	0.119	-0.079	-0.230***	-0.017
	(0.074)	(0.072)	(0.076)	(0.082)	(0.073)	(0.072)	(0.076)	(0.080)
Foreign Med-school	-1.416***	-1.278***	-1.672***	-0.740***	-1.407***	-1.282***	-1.618***	-0.405
	(0.226)	(0.236)	(0.313)	(0.281)	(0.226)	(0.236)	(0.328)	(0.270)
Years in practice	0.029	0.115***	0.090***	0.060***	0.048***	0.133***	0.187***	0.114***
	(0.018)	(0.020)	(0.020)	(0.020)	(0.018)	(0.019)	(0.020)	(0.025)
Fees (Omitted = NY)	-0.214***	-0.215***	-0.232***	-0.118***	-0.215***	-0.236***	-0.268***	-0.084**
	(0.021)	(0.027)	(0.025)	(0.024)	(0.022)	(0.029)	(0.031)	(0.035)
(MS)*Fees	0.039	0.001	-0.135	0.031	0.025	-0.000	-0.132	-0.098
	(0.075)	(0.076)	(0.086)	(0.061)	(0.078)	(0.086)	(0.094)	(0.098)
(NC)*Fees	0.128**	0.037	0.161***	0.132***	0.126**	0.025	0.150**	0.017
	(0.061)	(0.064)	(0.050)	(0.039)	(0.062)	(0.071)	(0.060)	(0.061)
(CA)*Fees	0.114**	0.148***	0.085*	0.199***	0.108**	0.162***	0.120**	0.052
	(0.049)	(0.047)	(0.045)	(0.040)	(0.050)	(0.051)	(0.055)	(0.049)
State requires pre-med college in grad year			0.423	0.055			0.562**	0.066
			(0.288)	(0.172)			(0.284)	(0.175)
Observations	3,436	3,357	3,515	3,709	3,436	3,357	3,515	3,709
Pseudo R2	0.299	0.346	0.282	0.236	0.298	0.346	0.280	0.229

Notes: ***, **, and * represent statistical significance at the 1, 5, and 10% levels, respectively. Each column in a panel reports marginal effects from a separate probit model of rural practice location. Rural is defined as a city with less than 10,000 population or an unincorporated area. "Unincorporated" refers to geographic areas that were not part of municipalities. These areas were generally sparsely populated and the Census Bureau classified them as rural. All regressions include state fixed effects. Heteroskedasticity robust standard errors are reported in parentheses. The sample is limited to doctors in California, Mississippi, New York, and North Carolina. A new doctor is defined as graduating from medical school within five years of the *AMD* publication date. New doctors settling in North Carolina in and after 1918, and Mississippi in 1919 were required to have at least one year of college education. Neither New York nor California required college education for licensure until after 1920. Fees for graduates of medical schools that did not report tuition in the *JAMA* because of closure or merging are imputed using the most recent year in which fees were reported. Typically, this means two or three years prior to the year of closure.
Sources: Physician graduation dates, practice locations, and city size are from various years of *American Medical Directory*. Pre-medical college requirements, school closure, fees are from American Medical Association Council on Medical Education (1919, 1923). Price deflator is from Sutch (2006).