OCCUPATIONAL LICENSING AND MATERNAL HEALTH: EVIDENCE FROM EARLY MIDWIFERY LAWS

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Abstract

Exploiting variation across states and municipalities in the timing and details of midwifery laws introduced during the period 1900-1940, and using data assembled from various primary sources, we find that requiring midwives to be licensed reduced maternal mortality by 7-8 percent and may have led to modest reductions in infant mortality. These estimates represent the strongest evidence to date that licensing restrictions can improve the health of consumers and are directly relevant to ongoing policy debates on the merits of licensing midwives.

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1. INTRODUCTION

Requirements that workers hold an occupational license as a condition of employment have become increasingly common in recent decades. Indeed, the fraction of licensed workers today is nearly three times larger than the roughly 11 percent of workers in labor unions (Gittleman and Kleiner 2016). Despite the rapid growth in the prevalence of licensure requirements, there has been relatively little empirical work assessing their effects, with the bulk of studies focusing on the outcomes of licensees as opposed to the outcomes of consumers served by these workers.[1]

Whether consumers are helped or hurt by occupational licensure is theoretically ambiguous. Licensure has historically been justified on the grounds that requiring licensees to, for instance, pass an exam or receive formal training should push low-quality providers out of the market and raise the quality of those who remain, both of which should improve the health and safety of consumers (Shapiro 1986, Kleiner 2000, Gittleman and Kleiner 2016). On the other hand, theory suggests possible adverse consequences of licensure that could counteract, and possibly even override, the benefits to consumers from improved provider quality. Perhaps the most important among these is the possibility that licensure could lead to higher prices and reduced access to the service in question, causing consumers to substitute towards cheaper, inferior alternatives (Shepard 1978; Adams et al. 2003; Kleiner and Kudrle 2000; Kleiner et al. 2016). Moreover, because licensees are insulated from competitive pressure, their incentive to provide high-quality service may be diminished, and they may even engage in behavior that strictly lowers quality.[2]

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[1] A number of papers have shown, across a variety of sectors, that persons holding occupational licenses have higher earnings (Kleiner and Kudrle 2000; Timmons and Thornton 2008; Kleiner and Krueger 2010; Kleiner and Krueger 2013; Thornton and Timmons 2013; Kleiner et al. 2016; Blair and Chung 2018). See Kleiner (2015) for an excellent review of this literature. Gittleman and Kleiner (2016) contrasted the dramatic increase in licensed workers with the equally dramatic decrease in unionized workers in the United States from the mid-1950s through the late 2000s.

[2] Carrol and Gaston (1979) suggested several mechanisms through which licensing could negatively impact quality in health care, including self-substitution towards inferior products or services, reduction in the time spent with each customer (e.g., briefer office visits), and location choices more in line with provider preferences than consumer needs (e.g., doctor shortages in rural areas).

Not only is theory ambiguous about how licensure should affect consumer health and safety, but there is a lack of credible empirical work on this question, perhaps because outcomes in the modern health care system generally depend on the actions of a host of specialists, making it difficult for researchers to convincingly disentangle how health is causally affected by licensing standards that pertain to one specific type of specialist. Establishing the causal relationship between licensing the providers of a particular medical service and consumer health would seem to require a tight link between the actions of these providers and the particular health outcome being measured.

In this study, we examine how the adoption of state midwifery licensing requirements in the early 20th century affected the likelihood of dying from complications of pregnancy and childbirth among American women. In our view, this historical episode represents a unique natural experiment that can be leveraged to document the causal effect of licensing on health. Unlike today, American women in the early 20th century typically gave birth at home, where they were attended by a single health care provider, either a doctor or midwife, who had sole responsibility for the health of the mother and infant (Leavitt 1983). By drawing upon historical data, we are able to estimate the relationship between requiring that a group of health care providers (midwives) be licensed and a specific consumer health outcome (maternal mortality) over which they had a direct, immediate, and profound impact.

Another advantage of examining the early adoption of state licensing requirements for midwives is that, before their adoption, the market for midwifery services was wholly unregulated. By contrast, in the modern health care sector, where a large number of specialists are already licensed, loosening or tightening licensing requirements for a specific type of health care provider represents only an incremental change in the overall licensing regime. The effect of this incremental change might be quite different from the effect of going from an unregulated market to requiring that all providers pass an exam or receive formal training. Thus, the adoption of midwifery laws in

the early 20th century represents an opportunity to explore what happens when licensing is first imposed in a context where it had not existed previously.

Our analysis uses data from 1900-1940, a period when 22 states, and at least a dozen municipalities, adopted midwifery licensing requirements. Drawing on various primary sources, we assembled information on these requirements, including their dates of passage and key provisions, which varied dramatically across states. For instance, applicants for licenses in Mississippi were judged based on their character, cleanliness, and intelligence, but were not required to take an exam or graduate from a school of midwifery. By contrast, midwives in California, Washington, and Wisconsin were required to graduate from a recognized school of midwifery and to pass an examination administered by their State Board of Medical Examiners. Exploiting geographical and temporal variation in the adoption of requirements such as these, we are able to assess their impact on maternal mortality. In addition, we are able to explore their effects on infant mortality as well as mortality among children under the age of 2 due to diarrhea.

Our main data sources are *Mortality Statistics* and *Vital Statistics of the United States*. Both of these sources were published on an annual basis by the U.S. Census Bureau and contain mortality counts by cause at the state level. Using data for the period 1900-1940, we estimate a series of models that relate maternal mortality in a particular state and year to whether midwives were required to be licensed in order to practice. The models control flexibly for state and year effects; mortality from non-pulmonary tuberculosis and typhoid serve as proxies for milk and water quality, respectively (Clay et al. 2014). Using municipal-level mortality counts by cause for the period 1900-1917, which are also available from *Mortality Statistics*, we are able to estimate similar models that exploit the adoption of local ordinances requiring midwives to be licensed.

We find that the introduction of licensing requirements for midwives is associated with a reduction in maternal mortality of approximately 7-8 percent. This finding is robust across a variety

of specifications, including controlling for state-specific time trends. Because broad improvements in antiseptic technique or awareness could have been correlated with the adoption of midwifery laws and maternal mortality, we conduct two falsification tests. Specifically, we test whether midwifery laws were related to non-maternal mortality from sepsis (i.e., deaths caused by bacterial infection), and tetanus. The falsification test results suggest that the relationship between midwifery licensing requirements and maternal mortality is not driven by improvements in antiseptic technique or awareness. Finally, we turn our attention to infant, as opposed to maternal, mortality. Requiring a license in order to practice midwifery is associated with a modest reduction in infant mortality, which is consistent with Lazuka (2018), who found that being attended by a trained midwife reduced mortality among Swedish infants at the turn of the 20th century.

Given the levels of health, medical technology, and wealth that prevailed in the United States during the time period we study, our results are directly relevant to ongoing policy debates about the merits of licensing and training midwives in developing countries today, where maternal mortality rates are often comparable to U.S. rates at the turn of the 20th century.[3] In many developing nations, the majority of births are attended by traditional birth attendants (TBAs), who have no formal education or training.[4] Experts have claimed that replacing TBAs with licensed midwives would substantially reduce infant and maternal mortality (WHO 2005 pp. 68-72; Thompson et al. 2011; UNFPA 2011 pp. 2-7). This claim is based, in large part, on historical studies showing that Sweden had a lower maternal mortality rate than a handful of other industrialized countries (including the United States) during a period lasting roughly from when its municipalities were first required to

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[3] During the first decades of the 20th century, the number of maternal deaths per 100,000 live births in the United States was approximately 700 (Woodbury 1924; Loudon 2000a, 2000b). By comparison, the number of maternal deaths per 100,000 live births in Sub-Saharan Africa today is estimated to be between 380 and 730 (WHO 2014). Not only are maternal mortality rates in developing countries often comparable to U.S. rates at the turn of the 20th century, but the underlying causes of maternal mortality appear to be broadly similar. For more details, please see Section 2.

[4] See United Nations Population Fund Report (UNFPA 2011).

employ a trained midwife in the early 19th century until 1940 (De Brouwere et al. 1998; Adegoke and van den Broek 2009; Loudon 2000a; UNFPA 2011). However, these studies do not isolate the effect of Sweden's midwifery policies from other potentially important influences such as the introduction of antiseptic technology and changes in nutrition (Högberg et al. 1986; Tomkins 2001).[5] Moreover, the credibility of cross-country comparisons is limited by the fact that in the late 1800s (when the first midwife laws were introduced in the United States) through the early 1900s, maternal mortality was not coded in a uniform fashion across countries (Loudon 1999). Our results and methods contribute credible evidence to this important policy issue.

The remainder of the paper is organized as follows. In Section 2, we provide historical context with an emphasis on the so-called "midwife problem." At the turn of the 20th century, doctors and public health officials argued that midwives were to blame for puerperal fevers, the cause of approximately half of all maternal deaths in the United States, and proposed licensing as a solution. In Section 3, we describe our empirical approach, and in Sections 4 and 5 we report the principal maternal mortality results based on state- and municipal-level data, respectively. In Section 6, we explore the effect of midwifery laws on infant mortality and in Section 7 we examine midwifery laws and the supply of midwives. Section 8 concludes.

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[5] Swedish midwives practicing in the 19th century were required by law to receive training, but TBAs were allowed to attend births if a trained midwife was not available (Högberg 2004, p. 1315). Over the course of the 19th century, trained midwives gradually supplanted TBAs in Sweden. Sixty percent of births to Swedish mothers were attended by TBAs in 1861; by 1900 only 22 percent of births to Swedish mothers were attended by TBAs (De Brouwere et al. 1998, p. 772). Using data from Sweden for the period 1830-1894, Pettersson-Lidbom (2015) found that increases in the supply of trained midwives were associated with substantial reductions in maternal mortality; using data from rural Norwegian medical districts for the period 1887-1921, Kotsadam et al. (2017) found that a 10 percent increase in the number of trained midwives was associated with a 13 percent reduction in maternal mortality; and using data from 5 rural Swedish parishes during the period 1881-1930, Lazuka (2018) found that delivery by a trained midwife, as opposed to a TBA, was associated with a substantial reduction in the likelihood of death during the neonatal period.

2. BACKGROUND

In the mid-1800s, the field of obstetrics was in its infancy and the vast majority of births in

the United States were attended by midwives without formal training (Leavitt 1983; Drife 2002). As

obstetrical knowledge and practices advanced, middle- and upper-class women increasingly relied on

doctors to deliver their babies. By the turn of the 20th century, doctors attended roughly half of U.S.

births (Rushing 1994).[6]

This emerging preference for doctors as birth attendants can be attributed, at least in part, to

the widespread perception that they were more competent than midwives (Rooks 1997, pp. 22-23).

However, there is reason to believe the public's trust in doctors was misplaced. In the early 1900s,

doctors routinely used forceps and anesthesia (ether or chloroform) during delivery. Being trained

in the use of forceps was an important advantage if the labor was prolonged or the baby was breech,

but the overuse of forceps came with significant risks to the mother and child. The leading cause of

maternal mortality during the first decades of the 20th century was "childbed" or puerperal fever

(Loudon 2000a).[7] According to Leavitt (1983, p. 292):

> Inappropriate forceps use and the careless administration of ether and chloroform
> introduced serious lacerations and breathing disorders that otherwise might not have
> developed. Most significant, physicians carried puerperal fever, which was
> potentially disastrous, to birthing women. Because their medical practices included
> attending patients with communicable diseases, doctors were more likely than

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[6] According to Leavitt (1983, p. 295), "Most of these births took place in the woman's home." By 1933, approximately one-third of all births took place in the hospital (Leavitt 1983, p. 301).

[7] Puerperal fever, an infection of the reproductive tract during labor or its aftermath, was typically caused by Group A streptococcus bacteria (Nathan and Leveno 1994; De Costa 2002). Described as "the classic example of iatrogenic disease--that is, a disease caused by medical treatment itself" (Wertz and Wertz 1989, p. 128), puerperal fever accounted for nearly half of all deaths related to childbirth at the turn of the 20th century; only tuberculosis killed more women of childbearing age in the United States (Woodbury 1924; Loudon 2000a, 2000b). In our sample, which covers the period 1900-1940, 38 percent of maternal deaths were due to puerperal fever. By comparison, Ngonzi et al. (2016) found that puerperal sepsis accounted for 31 percent of maternal deaths in a major Ugandan hospital during the period 2011-2014. Seale et al. (2009) found that sepsis caused 10 percent of maternal deaths and 26 percent of neonatal deaths in sub-Saharan Africa, but these authors cautioned that these "are likely to be considerable underestimates because of methodological limitations" (p. 428).

midwives to bring with them on their hands and on their clothing the agents of infection.

In fact, contemporary studies provide strong evidence that mortality rates were higher among mothers attended by a doctor than among mothers attended by a trained midwife (Jacobi 1912; Mendenhall 1917; Levy 1918, 1923; Sobel 1918). Despite this evidence, doctors and public health officials argued forcefully that midwives were to blame for puerperal fevers (Cody 1913; Plecker 1915; Edgar 1916; Frizzelle 1917; Terry 1917; Stedman 1920; Howe 1921; Rude 1922), and a variety of solutions to the so-called "midwife problem" were proposed. The abolition of midwifery was prominent among these solutions (Emmons and Huntington 1912; Williams 1912; Huntington 1913; De Lee 1915; Holmes 1920), although other physicians conceded that abolition was impractical and, as an alternative, recommended the licensing and increased supervision of midwives coupled with the teaching of antiseptic technique and how to recognize pregnancy complications (Edgar 1916; Hardin 1925/1986). Nevertheless, even trained and licensed midwives were thought to be capable of attending "normal cases of confinement only" (Edgar 1916, p. 395) and were generally discouraged from intervening in the birth process.[8]

Midwives, many of whom were black or foreign-born, lacked the political and social clout to effectively counter the physician-led campaign against them (Rooks 1997, p. 24), and the demand for midwifery services continued to fall.[9] By 1935, only 11-13 percent of births in the United States were

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[8] For instance, Hardin (1925/1986, p. 147), who trained and supervised midwives in North Carolina, wrote:

> I have tried to drive home to them the things they must not do, and have particularly emphasized the fact that it is their duty and responsibility under the law to have the family call a physician when any complications occur. They have been told repeatedly that it is dangerous for them to make vaginal examinations and give douches, that it is against the law, and they will be prosecuted if they violate this law.

Dodd (1920, p 854) used similar language to describe the training of midwives in South Carolina: "The instruction consists principally of what *not* to do, and the simple rules for ordinary cleanliness."

[9] Information on the race and national origin of midwives is available from a variety of contemporary sources. Crowell (1907) surveyed 500 midwives practicing in New York City; 96 percent were foreign born and 30 percent were "unable to speak English." Koehler and Drake (1911, p. 25) estimated that, of the 485 midwives practicing in Chicago, "35 per

attended by midwives; of these, approximately 60 percent were to nonwhite mothers (Jacobson 1956; Rushing 1994). By 1940, the last year of our analysis, 9 percent of births were attended by midwives; of these, 68 percent were to nonwhite mothers (Jacobson 1956).

2.1. Early midwifery laws

The practice of midwifery was wholly unregulated in the United States until 1877, when Illinois became the first state to require licensure (Rooks 1997, pp. 17-22; Sandvick 2009). Under the Illinois Medical Practice Act, licensure was required of any person "practicing medicine, in any of its departments." Licenses were issued by the newly created State Board of Health, which was empowered to give examinations to practitioners who had not graduated from a recognized medical institution.[10] Although midwifery was nowhere mentioned in the Act, the Board of Health contended that it made "the same requirement of midwives as of physicians" (Illinois State Board of Health 1879, p. 54).

The Illinois Medical Practice Act of 1877 served as a model for other state legislatures interested in regulating the practice of medicine (Sandvick 2009). By the turn of the 20th century, most states required physicians to be licensed (Hamowy 1979), but only 8 states (CT, IL, IN, LA,

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cent are Slavic and 6 per cent are Italian." Jeidell and Fricke (1912) surveyed 119 midwives living in Anne Arundel County, Maryland. Of these, 95 were identified as "Negroes", 17 were identified as "Americans", and the remainder were identified as foreign born. Thirty-four had registered with the Board of Health and only 21 were licensed to practice midwifery. According to Williams (1915), 326 midwifery licenses were issued by the State of New York between November 16, 1914 and April 15, 1915. Eight of the licensed midwives were identified as "American", 1 was identified as "Colored", and the remaining midwives were identified as foreign born (Williams 1915). The Texas Bureau of Child Hygiene (1925) provided background information on 485 midwives practicing in 6 Texas counties. Of these, 76 percent were identified as "Colored", 18 percent were identified as "Mexican", and 6 percent were identified as either "White" or "American." Finally, according to Smith (2005, p. 62), by "the mid-1920s the state [of Washington] had licensed…at least 40 Japanese midwives out of a total of 60 midwives."

[10] One year after the Act came into effect, the State Board of Health estimated that no fewer than 1,400 "non-graduates" had been forced out of the state for practicing medicine without a license (Illinois State Board of Health 1879, p. 5).

MN, NJ, OH, and WY) required midwives to be licensed.[11] Under increasing pressure from public

health officials and members of the medical profession to address the "midwife problem" (Kobrin

1966; Rooks 1997, p. 23), 16 states passed laws requiring the licensure of midwives between 1900

and 1920 (see Figure 1 and Appendix Table 1). Cities and towns also took up the cause. During

this same period, at least 12 municipalities (including Los Angeles and New York City) adopted

ordinances requiring practicing midwives to obtain a license, certificate, or permit. North Carolina,

which did not require licensure until 1935, nonetheless required midwives to wash their hands

before touching a patient and banned women who were addicted to drugs or alcohol from the

practice of midwifery (van Blarcom 1913).

Licensing requirements varied considerably across states. For instance, applicants in

Mississippi did not have to take an exam or graduate from a school of midwifery. Instead, they were

judged based on their character, cleanliness, intelligence, and "reputation for calling a doctor in

difficult or abnormal cases" (Mississippi Board of Health 1921).[12] By contrast, California,

Washington, and Wisconsin required applicants to graduate from a recognized school of midwifery

and to pass an examination administered by their State Board of Medical Examiners. Midwives

licensed in California, Colorado, Florida, Maryland, New York, West Virginia, and Wisconsin were

prohibited from using forceps and from administering any type of anesthesia or drugs, while those

licensed in New Jersey and Washington were required to summon a physician if the mother

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[11] In 1896, midwives in the District of Columbia were required to pass an exam administered by the board of medical supervisors.

[12] Although Texas required that midwives be of "good moral character" and graduates of a "bon fide, reputable" medical school, the law did "not apply to those who do not follow obstetrics as a profession, and who do not advertise themselves as obstetricians or midwives" (Texas 1916). Likewise, women in Missouri who did not practice midwifery as a profession and did not charge for their services were not required to obtain a license (Missouri 1909). Utah required anyone practicing obstetrics to obtain a license but permitted the practice of obstetrics "in case of emergency" and in communities "where there are no licensed practitioners" (Egan 1910).

exhibited the symptoms of "abnormal labor" (Foote 1919, p. 535); midwives licensed in New York, Maryland, and West Virginia were even prohibited from performing vaginal examinations.[13]

2.2. Previous studies on licensing and health

As noted in the introduction, most empirical studies in the licensing literature have focused on the outcomes of licensees (Kleiner 2015). There are, however, a handful of studies focused on the health and safety of consumers. One of the earliest of these examined the association between licensing requirements for dentists and the dental health of U.S. Air Force enlistees. Kleiner and Kudrle (2000) found that the dental health of enlistees who grew up in states with the strictest licensing requirements was no different from that of enlistees from states with looser requirements, although there was evidence that licensing requirements increased the price of basic dental services.[14]

Law and Kim (2005) studied whether the imposition of more stringent licensing requirements for physicians contributed to the dramatic reduction in U.S. mortality during the first half of the 20th century. In an effort to answer this question, these authors regressed cause-specific mortality rates at the state level on an index of physician licensing restrictions and a few basic

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[13] For more information on the midwifery laws in these states see Appendix Table 1. Midwives licensed in Ohio were forbidden to use forceps, but the law did not mention anesthesia or drugs (Ohio 1905); midwives licensed in California were prohibited from introducing their hands into the vagina or uterus (Henning and Hyatt 1921); and midwives licensed in New Jersey were prohibited from administering any drug or medicine (New Jersey State Board of Medical Examiners 1902). Midwives practicing in New York were perhaps subject to the most stringent licensing requirements in the country. As of 1907, midwives practicing in New York City were required to attend at least 20 deliveries under the supervision of a physician (New York Department of Health 1909). In addition, applicants had to be 21 years of age, of "moral character", able to read and write, and "show evidences…of habits of cleanliness." The homes and equipment of midwives had to be available for inspection "at all times." As of 1914, the New York City Board of Health required applicants to graduate from a registered school of midwifery (New York Bureau of Child Hygiene 1915). Under a state law passed in 1913, midwives practicing outside of New York City and Rochester had to show evidence of "habits of cleanliness" and had to graduate from a recognized midwifery program or receive instruction from a physician in at least 15 deliveries (New York Department of Health 1915; Williams 1915). Because over half of its residents lived in New York City, we coded New York as requiring midwives to be licensed as of 1907.

[14] Using data on naval recruits, Carroll and Gaston (1981) estimated the cross-sectional association between licensing requirements for dentists and oral hygiene. They found little evidence that licensing requirements affected oral hygiene.

controls.[15] The association between maternal mortality and this index was negative and statistically

significant, but was only based on two years of data (1920 and 1930).[16]

Finally, many modern-day health care practitioners are subject to post-entry "scope of

practice" (SOP) restrictions, which specify what services licensees can perform (Kleiner et al. 2016;

Markowitz et al. 2017). Two recent studies have explored the effects of SOPs on health outcomes.

Markowitz et al. (2017) found no evidence that requiring certified nurse midwives to practice under

the supervision of physician affected outcomes such as birth weight, gestation duration, or whether

babies sustained an injury during birth. Kleiner et al. (2016) found that precluding nurse

practitioners (NPs) from prescribing controlled medications was unrelated to infant mortality.[17]

3. DATA AND EMPIRICAL FRAMEWORK

The U.S. Census Bureau began publication of *Mortality Statistics* in 1900. The initial issue

contained mortality counts by cause, age, and sex for 10 registration states. Mortality counts from

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[15] Law and Kim's (2005) index was equal to the sum of indicators for whether doctors were required to be licensed, the existence of a state licensing board, whether doctors were required to take an exam, whether there was a four-year medical school requirement, whether there was a two-year premedical college requirement, whether there was an internship requirement, and whether there was a science requirement. Law and Kim (2005) controlled for urbanization, per capita income, physicians per 1,000 population, state fixed effects, and year fixed effects.

[16] Because Law and Kim (2005) had only two years of maternal mortality data, they could not rule out the possibility that the negative association between maternal mortality and their index of physician licensing requirements was driven by omitted factors. In addition to maternal mortality, Law and Kim (2005) considered several other outcomes, including diabetes mortality, appendicitis mortality, infant mortality, and cancer mortality. They used 2 years of data on diabetes mortality (1920 and 1930), 3 years of data on appendicitis mortality (1910, 1920, and 1930), 4 years of data on infant mortality (1900, 1910, 1920, and 1930), and 4 years of data on cancer mortality (1900, 1910, 1920 and 1930). These authors found a negative association between appendicitis mortality and their index of physician licensing requirements and concluded that, "[b]ecause the onset of appendicitis is more or less random," this association was "least likely to be influenced by an endogeneity bias" (Law and Kim 2005, p. 749).

[17] Markowitz et al. (2017) did, however, find that requiring certified nurse midwives to practice under the supervision of a physician increased the likelihood of C-section. Kleiner et al. (2016) found that precluding NPs from prescribing controlled medications was associated with an increase in the price of well-child visits. Using a regression discontinuity design, Bowblis and Smith (2018) examined whether requiring nursing homes to hire an additional licensed social worker affected the scores they received during their annual recertification inspection. Hotz and Xiao (2011) explored the effects of state-level regulations on child care providers. They found that such regulations were associated with fewer center-based child care establishments, but they were also associated with an increase in the quality of services provided.

additional registration states became available over time, and, by 1933, mortality counts from all 48 states were available (see Appendix Table 2). For our primary analysis, we transcribed maternal mortality counts by state and year for the period 1900-1940. We also transcribed maternal mortality counts by urbanicity and by cause (puerperal fever versus other causes), infant mortality counts by race, and mortality counts for tuberculosis (pulmonary and non-pulmonary), typhoid, influenza, malaria, sepsis, tetanus, nephritis, peritonitis, ill-defined causes, and non-maternal mortality among women of childbearing age.[18]

As described above, the effect of midwifery laws on maternal mortality is, *a priori*, ambiguous. Licensing requirements could have stimulated the formation of human capital and prevented the least competent midwives from practicing (Shapiro 1986). However, by restricting supply and insulating midwives from competition, midwifery laws could have reduced the quality of services provided (Carroll and Gaston. 1979). For instance, if licensed midwives attended more births than their unlicensed counterparts (or intervened more often in an effort to hasten delivery), then their clients would have been at greater risk of puerperal fever.

To further explore how early midwifery laws affected maternal mortality, we estimate the following baseline regression:

$$(1) \qquad \ln(\textit{Maternal Mortality}_{st}) = \beta_0 + \beta_1 \textit{Midwifery License Required}_{st} + \textbf{\textit{X}}_{st}\boldsymbol{\beta_2} + v_s + w_t + \varepsilon_{st},$$

where s indexes states and t indexes years. Our independent variable of interest, *Midwifery License Required*, is equal to one if midwives in state s were required by state law to be licensed in year t.[19]

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[18] Specifically, mortality data for the period 1900-1936 come from the Census Bureau's annual publication *Mortality Statistics* (U.S. Bureau of the Census 1906-1938). For the period 1937-1940, these data were published as part of the *Vital Statistics of the United States* (U.S. Bureau of the Census 1939-1941, 1943).

[19] This variable takes on a fractional value for the year in which a licensing law took effect. For instance, if a law went into effect on July 1st, *Midwifery License Required* would take on a value of 0.5.

The coefficient β_1 is our parameter of interest. It is the combined effect of the various mechanisms by which a state's decision to require occupational licensing for midwives affected maternal mortality, including any effect operating through increased human capital among providers, changes in the price charged by (or ease of access to) providers, and any switching to cheaper, inferior providers. We measure maternal mortality as deaths due to complications from pregnancy or childbirth per 100,000 live births.[20] More specifically, maternal mortality counts included women in the "puerperal state", which lasted through pregnancy and continued for 42 days after delivery (Guyer et al. 2000). Women who died from infectious diseases during the puerperal state were included in these counts (Loudon 1999).

The controls, represented by the vector X, are listed in Table 1, along with descriptive statistics and definitions. State-level demographic controls are from the Census (estimated using linear interpolation for intercensal years) and include physicians per capita and the percentages of the population by age group, race, urbanicity, gender, and foreign-born status. Policy controls include a set of physician licensing and education-related requirements,[21] indicators for whether osteopaths and practical nurses were required to have a license, a department of child hygiene indicator, a women's suffrage indicator, and Sheppard-Towner Act spending.[22] Miller (2008) found

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[20] Information on live births comes from the U.S. Bureau of the Census (1902), U.S. Public Health Service (1918), and Linder and Grove (1947). We used linear interpolation to estimate live births for the 26 percent of state-year observations for which this information was missing. The results presented below are not sensitive to dropping these observations from the analysis.

[21] The physician-related controls include an indicator for whether states required physicians to have a diploma, an indicator for whether state medical boards were empowered to set preliminary education requirements, an indicator for whether states required physicians to pass an examination for licensure, an indicator for whether medical schools were required to use a four-year curriculum, and an indicator for whether state medical boards could exclude graduates of "inferior" schools from being certified. Information on educational requirements for physicians is from Hamowy (1979) and Baker (1984). Law and Marks (2009) explored the effects of states requiring premedical college education and four-year medical degrees on minority representation in the physician labor market.

[22] Formal training of practical nurses began in the 1890s and focused on providing home care for infants, children, the elderly, and disabled (White et al. 2010). Case reports from the early 1900s suggest that osteopathic manipulative treatments during labor and delivery helped to shorten labor times, limit perineal tearing, and reduce the use of forceps (Keurentjes 2008). Information on the licensing of practical nurses and osteopathic doctors is from Spector and Frederick (1952). Information on the establishment of departments of child hygiene and when suffrage was granted to

that allowing women to vote led to substantial increases in public health spending by municipalities and an 8 to 15 percent reduction in child mortality. The Sheppard-Towner Act, passed in 1921, funded the training of midwives and the establishment of health care clinics; public health nurses used Sheppard-Towner funds to visit new and expectant mothers (Moehling and Thomasson 2014).[23]

The terms v and w represent state and year fixed effects, respectively. The state fixed effects account for state-level determinants of maternal mortality that are constant over time; the year fixed effects account for nation-wide shocks to maternal mortality.[24]

Next, following Clay et al. (2014), we augment the baseline estimating equation by including mortality from typhoid as a proxy for water quality and mortality from non-pulmonary tuberculosis as a proxy for milk quality. Water quality was an important determinant of health at the end of the 19th century and the first decades of the 20th century (Cutler and Miller 2005; Alsan and Goldin 2019; Anderson et al. forthcoming). Local and state policies aimed at improving milk quality were introduced in response to alarmingly high rates of infant mortality (Wolf 2003), but adult mortality due to non-pulmonary (e.g., bovine) tuberculosis was not inconsequential (Olmstead and Rhode 2004a, 2004b). The augmented estimating equation is:

(2) $\ln(\text{Maternal Mortality}_{st}) = \beta_0 + \beta_1 \text{Midwifery License Required}_{st} + \mathbf{X}_{st}\boldsymbol{\beta_2} + \beta_3 \text{Typhoid}_{st}$

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women is from Moehling and Thomasson (2012). Data on Sheppard-Towner spending are from the U.S. Children's Bureau (1931).

[23] In Appendix Table 3, we use demographic data from the decennial censuses to predict whether a license was required to practice midwifery in state s 10 years later. For instance, we use demographic data from the 1910 census to predict whether a license was required in 1920, and demographic data from 1920 to predict whether a license was required in 1930. There is evidence that the percent foreign-born is positively and statistically significantly associated with the adoption of midwifery laws, but these estimates are not robust to the inclusion of state-specific linear trends.

[24] One such shock was the widespread adoption of sulfa drugs in 1937, which had the effect of dramatically reducing maternal mortality (Jayachandran et al. 2010). This period also saw a shift in childbirth from the home to the hospital. This shift, and its effect on maternal mortality, is discussed in detail below.

$$+ \beta_4 \textit{Non-Pulmonary TB}_{st} + v_s + w_t + \varepsilon_{st},$$

where *Typhoid* is equal to mortality due to typhoid per 100,000 population and *Non-Pulmonary TB* is equal to mortality due to non-pulmonary tuberculosis per 100,000 population.

Finally, we include state-specific linear time trends ($\Theta_s \cdot t$) to account for the possibility that mortality rates evolved at different rates in states that adopted licensing requirements as compared to states that did not:

$$(3) \qquad \ln(\textit{Maternal Mortality}_{st}) = \beta_0 + \beta_1 \textit{Midwifery License Required}_{st} + \boldsymbol{X_{st}\beta_2} + \beta_3 \textit{Typhoid}_{st}$$
$$+ \beta_4 \textit{Non-Pulmonary TB}_{st} + v_s + w_t + \Theta_s \cdot t + \varepsilon_{st}.$$

The actual effect of midwifery laws on maternal mortality is an empirical question, to which we now turn our attention.

4. RESULTS BASED ON STATE-LEVEL DATA, 1900-1940

Estimates of β_1 using annual data for the period 1900-1940 are presented in Table 2. The regressions are weighted by live births in state s and year t, and the standard errors are corrected for clustering at the state level (Bertrand et al. 2004). During the period under study, 22 states required midwives to be licensed. Pre- and post-treatment mortality data are available for 18 of these states. Figure 1 shows when each midwifery law was adopted and Appendix Table 1 provides descriptions of these laws as well as our sources, most of which are contemporary.[25]

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[25] In Appendix Table 2, we report the years of data available for each of the states used in the analysis. In Appendix Table 4, we report estimates obtained by regressing births per 100,000 female population on *Midwifery License Required* and the set of controls described above. Reassuringly, there is no evidence that requiring midwives to be licensed is associated with fertility. In addition to these regressions, we used census data to explore whether the characteristics of mothers (i.e., average number of children, percent black, percent literate, and percent married) were related to whether

The estimate of β_1 reported in the first column of Table 2 is from a model that only controls for state and year fixed effects. It suggests that requiring midwives to be licensed leads to a reduction in maternal mortality of 7.6 log points, or approximately 7 percent ($e^{-.076} - 1 = .073$). To put the magnitude of this estimate in perspective, we can do a back-of the-envelope estimate of the relationship between licensing and mortality among mothers who were actually attended by midwives (i.e., the effect of treatment on the treated). According to Jacobson (1956), midwives in the United States attended 40 percent of births prior to World War I. Assuming that the adoption of licensing requirements did not affect this figure (which is, of course, a strong assumption), a reduction in total maternal mortality of 7 percent would correspond to an 18 percent decrease in maternal mortality among births attended by midwives.[26]

Controlling for state-level demographic characteristics produces a slightly larger estimate of β_1: licensing is associated with a reduction in maternal mortality of 8.0 log points. After controlling for the policies listed in Table 1, typhoid mortality, and non-pulmonary tuberculosis mortality (our proxies for water and milk quality, respectively), requiring midwives to be licensed is associated with a reduction in maternal mortality of 7.5 log points. Although we do not observe every public health initiative at the state or local level that may have affected maternal mortality, and therefore cannot account for their influence, the stability of the estimates reported in Table 2 is reassuring.[27]

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midwives were required to be licensed. The results of this exercise provide little evidence that our estimates are driven by compositional changes in the type of mothers who gave birth.

[26] Note that $100 * \left[\left(\frac{40-7.3}{40}\right) - 1\right]$ = -18.25. By comparison, Högberg (2004) estimated that replacing TBAs with trained midwives reduced non-septic maternal deaths in Sweden by 46 percent. Approximately 13 percent of births in the United States were attended by midwives by 1935 (Rushing 1994). Even using this lower-bound to calculate treatment on the treated, a 7.3 percent decrease in total mortality would roughly correspond to Högberg's (2004) estimate.

[27] Miller (2008) showed that the passage of women's suffrage laws led to substantial increases in public health spending at the municipal level on charities, corrections, and hospitals. Although this spending was negatively and significantly related to infant mortality from infectious diseases, it was essentially unrelated to maternal mortality (Miller 2008, p. 1310). Other local public health initiatives undertaken during this period were mostly aimed at reducing infant, as opposed to maternal, mortality (Kotelchuck 2007, p. 108). For instance, the Chicago Health Department sent nurses into neighborhoods with the highest infant mortality rates to promote breastfeeding; in Minneapolis, public health workers helped new mothers with lactation-related problems (Wolf 2003). The Sheppard-Towner Act funded a wide

An estimate of β_1 with state-specific linear trends included as controls is reported in column (5) of Table 2. With state-specific linear trends on the right-hand side, requiring midwives to be licensed is associated with a reduction in maternal mortality of 7.7 log points. In the final column of Table 2, we test the parallel trends assumption by adding a lead to the model, equal to 1 if a midwifery law was passed in year $t + 1$, and equal to 0 otherwise. The estimated coefficient of the lead, although negative, is small and statistically insignificant.[28] In Figure 2, we show the results of replacing *Midwifery License Required* with an indicator that is equal to 1 the year in which a licensing law went into effect, 4 leads of this indicator, and 5 lags.[29] Again, there is no evidence that maternal mortality began trending prior to the adoption of midwifery licensing laws, suggesting that midwifery laws were not preceded by, for instance, other state initiatives aimed at improving maternal health.

In Table 3, we report results from several robustness checks. We begin by restricting the analysis to only those states that, by 1940, required midwives to be licensed. With this restriction in place, requiring midwives to be licensed is associated with a reduction in maternal mortality of 7.6 log points. In the second column, we report an unweighted estimate of β_1, which is slightly smaller than the estimates reported in Table 2, but nevertheless suggests that requiring midwives to be

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variety of public health initiatives at the local and state level that could have potentially affected maternal mortality. Moehling and Thomasson (2014) found that Sheppard-Towner spending was negatively related to infant mortality but did not examine its relationship to maternal mortality. During the period under study, maternity dispensaries were opened in several large cities (e.g., Boston, Los Angeles, Manhattan, and Pittsburgh). These dispensaries provided obstetrical services, typically free of charge and performed by a medical student, to poor women giving birth at home (Huntington 1912; Ziegler 1912). Controlling for the presence of a maternity dispensary had little effect on the estimates reported in Table 2.

[28] In columns (1) and (2) of Appendix Table 5, we include additional leads of *Midwifery License Required* to the model. The estimated coefficients of these leads are, with one exception, statistically indistinguishable from zero. In columns (3) and (4) of Appendix Table 5, we decompose *Midwifery License Required* into an indicator for the year in which a midwifery license was required (*Year of Law Change*) and 3 lags. One to two years after coming into effect, requiring a license is associated with reductions in maternal mortality between 5.8 and 7.2 log points. Five or more years after coming into effect, requiring a license is associated with reductions in maternal mortality between 8.7 and 12.1 log points.

[29] The omitted category is 9+ years before the passage of a midwifery licensing law.

licensed led to an almost 7 percent reduction in maternal mortality. In the third column, we deflate

maternal deaths by female population rather than live births. This alternative outcome captures

both the risk of dying during pregnancy as well as changes in fertility (World Health Organization

2014) and has been used in previous studies such as Högberg and Wall (1986) and Boerma (1987).

Using female population in the denominator, we find that requiring midwives to be licensed is

associated with a reduction in maternal mortality of 6.1 log points. Estimating the regression in

levels or modeling maternal mortality as a count process also produces effect sizes similar to those

reported in Table 2.[30]

4.1. Falsification tests

Until the 1920s, public health officials focused their efforts on reducing infant, as opposed to

maternal, mortality (Kotelchuck 2007, p. 108). However, state and local initiatives to combat

tuberculosis and other infectious diseases (such as influenza and malaria) could have been correlated

with the adoption of midwifery laws, potentially biasing our estimates.[31] Such initiatives included the

application of insecticides and other methods of pest control (Kitron and Spielman 1989; Sledge and

Mohler 2013), waste management (Centers for Disease Control and Prevention 1999), forming local

and state anti-tuberculosis associations (Knopf 1922; Hollingsworth 2014; Anderson et al. 2019),

and passing anti-spitting laws (O'Conner 2015).

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[30] Inference is similar when we use the wild cluster bootstrap method recommended by Cameron et al. (2008) and Cameron and Miller (2015). See Appendix Table 6 for these results.

[31] As noted above, during the period under study, many states used a broad definition of maternal mortality that included women who died in pregnancy, during labor, and up to 42 days after delivery due to infectious diseases such as influenza and tuberculosis (Loudon 1999). Almond (2006), in fact, used maternal mortality to measure the intensity of the 1918 influenza epidemic.

We address this potential issue by conducting three falsification tests. Specifically, we examine the association between midwifery laws and mortality due to the following causes: pulmonary tuberculosis, malaria, and influenza. The results of these falsification tests are reported in columns (1)-(6) of Table 4.[32] The estimated coefficients of the midwifery law indicator are imprecisely estimated, small, and (with one exception) positive, suggesting that the adoption of midwifery licensing requirements was not related to maternal mortality through public health initiatives aimed at combating tuberculosis and other infectious diseases.

In the remainder of Table 4, we report the results of two additional falsification tests. In columns (7)-(8), we examine the association between non-maternal sepsis mortality (i.e., non-maternal deaths caused by bacterial infection) and midwifery laws. If improvements in antiseptic technique or awareness were driving the results in Table 2, we should find evidence that requiring a license reduced non-maternal mortality due to sepsis. Instead, we find that this association is statistically insignificant and quite small.[33]

Tetanus is caused by infection with the bacterium *Clostridium tetani,* which is found in soil, dust, and feces (Hinman and Orenstein 2007). The U.S. tetanus mortality rate fell rapidly in the early 1900s as antiseptic awareness spread (Heath et al. 1964). In the first half of the 1920s, after tetanus antitoxin use had become routine (Oppenheimer 1915; Robertson 1915), 12 percent of tetanus cases could still be linked to unsterile conditions during surgery (Wainwright 1926). Again, if broad improvements in antiseptic technique or awareness were driving the results in Table 2, we

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[32] Because the mortality rate for malaria was equal to zero for a number of state-year observations, we take its quartic root, rather than the natural log. This method of dealing with zeros has been used by Thomas et al. (2006), Tarozzi et al. (2014), and Ashraf et al. (2015), among others. Marginal effects are reported in brackets. Defining the dependent variable as $\ln(1 + Malaria)$ produced an estimated coefficient of .059 (SE = .095).

[33] Because the mortality rate for sepsis was equal to zero for a number of state-year observations, we take its quartic root, rather than the natural log. Defining the dependent variable as $\ln(1 + Sepsis)$ produced an estimated coefficient of -.030 (SE = .040).

should find a negative association between tetanus mortality and licensing requirements for midwives. Instead, this association is statistically insignificant, small, and positive.[34]

4.2. Heterogeneous effects

In 8 of the 18 states for which we have pre- and post-treatment maternal mortality data, a license could be obtained by receiving basic instruction from a public health nurse or county health officer.[35] Five states required applicants to pass an examination, typically administered by the State Board of Health, and 5 required applicants to graduate from a recognized school of midwifery.[36]

In Table 5, we explore whether these types of requirements were related to maternal mortality. The estimates suggest that adopting even the least stringent licensing requirements led to a reduction in maternal mortality of 5.0 log points. We also find evidence that the relationship between midwifery laws and maternal mortality was more pronounced in states that required applicants to graduate from a recognized school of midwifery, but cannot formally reject the hypothesis that all three types of midwifery laws had comparable effects on maternal mortality.

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[34] Because the mortality rate for tetanus was equal to zero for a number of state-year observations, we take its quartic root, rather than the natural log. Defining the dependent variable as $\ln(1 + Tetanus)$ produced an estimated coefficient of .013 (SE = .026).

[35] Specifically, these states were DE, GA, KY, MS, NC, SC, VA, and WV.

[36] We observe maternal mortality in CO, MD, NM, PA, and RI before and after midwives were required to pass an exam. We observe maternal mortality in CA, FL, NY, WA, and WI before and after midwives were required to graduate from a recognized school of midwifery. We include Florida in this third category despite the fact that applicants had the option of attending 15 deliveries under the supervision of a physician in lieu of graduating from a recognized school of midwifery (Hanson 1931). Likewise, we include New York in this category despite the fact that New York City did not require applicants to graduate from a registered school of midwifery until April 1, 1914 (New York Department of Health 1915), and applicants outside of New York City and Rochester had the option of receiving instruction in at least 15 deliveries from a physician in lieu of graduating from a recognized school of midwifery (Williams 1915). In some states, applicants who had practiced midwifery for a specified number of years prior to the passage of a licensing law were exempt from its requirements. See Appendix Table 1 for more details. Fines and other punishments for practicing midwifery without a license are also provided in Appendix Table 1.

In column (2), we interact *Midwifery License Required* with an indicator for whether a state's black population share was above the median.[37] The results from this exercise suggest that the effects of licensing were greater in states with relatively large black populations. This pattern of results is, in retrospect, not surprising. The demand for midwives appears to have been much higher among blacks than among whites throughout the period under study (Dart 1921; Cornely 1942; Jacobson 1956; Robinson 1984).[38]

In columns (3) and (4) of Table 5, we distinguish between maternal mortality due to puerperal fever and maternal mortality from other causes (e.g., breech births, hemorrhaging, albuminuria, or infectious diseases such as tuberculosis). Requiring a license is associated with a reduction in maternal mortality due to puerperal fever of 8.5 log points, suggesting that the focus on antiseptic technique and non-intervention was effective.[39] It is also associated with a reduction in maternal mortality from other causes of 7.2 log points, suggesting that licensed midwives could, at a minimum, identify birth complications and ask for assistance from a physician in a timely fashion.[40]

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[37] The median black population share was calculated based on the variable *Percent Black* for 1940. Results were similar if instead we used the share of the black population in 1900. As an alternative, we also transcribed data on maternal mortality by race and separately regressed white and nonwhite maternal mortality on *Midwifery License Required* and the full set of controls. A disadvantage to this approach is that maternal mortality counts by race are (with the exception of Maryland) unavailable prior to 1910, restricting policy variation. For white mothers, licensing requirements are associated with a (statistically insignificant) 1.5 percent decrease in the maternal mortality rate. For nonwhite mothers, licensing requirements are associated with a 5.4 percent decrease in the maternal mortality rate, but this estimate was also statistically insignificant at conventional levels (p-value = .151).

[38] Even in 1940, almost half of all births to nonwhite mothers were attended by midwives (Jacobson 1956, p. 254).

[39] Midwifery laws often required applicants to demonstrate their "cleanliness" (Williams 1915; Mississippi Board of Health 1921; Hanson 1931), while midwifery instruction and textbooks emphasized antiseptic technique and discouraged the use of forceps except in the case of emergency (Jewett and Jewett 1901; Johnstone 1913; Dodd 1920; Leavitt, 1983).

[40] Midwifery exams and instruction emphasized recognizing birth complications in advance. For instance, licensed midwives in North Carolina were taught basic "danger signals" and when to call a physician or take a patient to the nearest clinic (Dodd 1920, p. 865). In New York City, students at a prominent school of midwifery were taught "what not to do, and when to seek the aid of a practising physician" (Edgar 1918, p. 249). A copy of the exam administered by the Wisconsin Medical Board of Examiners to Dora Larson, a Norwegian-born, apprentice-trained midwife, is available at: http://ebling.library.wisc.edu/historical/wi-women/exam_questions.pdf. The exam consisted of 12 questions, including, "When you examine a woman in labor, how do you determine if the position is normal?" and, "What are the symptoms of kidney trouble in a pregnant woman?" We have reproduced the questions from this exam in Appendix Table 7. It is also possible that that the imposition of licensing restrictions reduced maternal mortality through discouraging midwives from performing abortions. During the first decades of the 20th century, the prosecution of

In the remaining columns of Table 5, we focus on urban versus rural maternal mortality.[41] Specifically, urban mothers are defined as those who lived in a city or town with a population greater than 10,000.[42] Maternal mortality was substantially higher among these women than among their rural counterparts (17.7 per 100,000 population versus 11.6), but enforcement of midwifery laws was, by many accounts, much stricter in urban areas (Borst 1995, pp. 55-60; Molina 2006, p. 105). Consistent with these accounts, the results suggest that the relationship between licensing and maternal mortality was strongest in urban areas.

4.3. Licensing and hospital births

At the turn of the 20th century, maternity hospitals typically served indigent and unmarried women; 95 percent of babies were delivered at home (Ziegler 1922; Shorter 1991, p. 156; Wertz and Wertz 1989, pp. 132-133). As attitudes, physician training, and medical technology evolved, middle- and upper-class women increasingly chose to give birth in hospitals, a trend that accelerated markedly after 1920 (Wertz and Wertz 1989, p. 133).[43] By 1940, more than half of women were choosing to give birth in hospitals (Leavitt 1986).

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midwives for performing abortions was commonplace (Crilley 2014) and midwifery laws often explicitly required women to provide evidence of "good moral character" (see Appendix Table 1). Unfortunately, *Mortality Statistics* did not distinguish between maternal deaths due to abortion complications and other causes until 1930.

[41] Because data on live births by urban versus rural status do not exist, we deflate maternal mortality by 100,000 of the relevant population.

[42] Prior to 1910, *Mortality Statistics* defined "urban" as cities or towns with a population greater than 8,000. The inclusion of year fixed effects should account for any effect this change in definition might have had on maternal mortality.

[43] See Thomasson and Treber (2008) for a detailed discussion of the factors that led women to prefer giving birth in hospitals. According to Thomasson and Treber (2008, p. 82), physicians encouraged women to give birth in hospitals because there was often "physical difficulty utilizing forceps in the home birth bed, and some types of anesthesia were best administered in the hospital environment...physicians also found that centralizing childbirth in hospitals was more convenient and perhaps more lucrative." Thomasson and Treber (2008, p. 78) went on to write:

> A primary cause of maternal mortality was puerperal (related to childbirth) septicemia. Increased operative intervention in the form of version, forceps delivery and cesarean section all increased the

It is not entirely clear what effect, if any, the shift towards hospital births had on maternal

mortality. Using data for the period 1928-1940, Thomasson and Treber (2008) found a negative

relationship between maternal mortality and hospital bassinets per 100,000 population, their proxy

for hospital births.[44] This relationship, however, was much stronger during the period 1937-1940,

after the introduction of sulfa drugs. Before the introduction of sulfa drugs, the estimated

relationship between hospital births and maternal mortality, although negative, was smaller and

measured with less precision.[45]

In an effort to explore whether the estimated relationship between maternal mortality and

requiring midwives to be licensed can be explained by the shift towards hospital births, we

transcribed data on hospital bassinets for the years 1925 and 1928-1940. These data were originally

collected and published by the Council on Medical Education and Hospitals of the American

Medical Association in a series of reports entitled, *Hospital Service in the United States*.[46]

In columns (1)-(3) of Table 6, we report the results of regressing the natural log of bassinets

per 100,000 live births on *Midwifery License Required*. Across all three specifications, the estimated

relationship between bassinets and requiring a license to practice midwifery is small and statistically

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mother's likelihood of contracting such an infection, and complications from anesthesia could also
lead to maternal death.

[44] A bassinet is a basket, often with a hood over one end, which is used as a cradle. Both maternity and general hospitals
had bassinets and delivered babies.

[45] These authors reported two estimates of the relationship between maternal mortality and bassinets per 100,000
population for the period prior to the introduction of sulfa drugs. In the full sample, their estimate of this relationship
was not statistically significant. When Thomasson and Treber (2008) restricted their attention to a balanced panel of
cities with populations greater than 25,000, an additional bassinet per 100,000 population was associated with a 0.75
reduction in the maternal mortality rate (i.e., .75 fewer maternal deaths per 100,000 births). In Appendix Table 8, we
explore whether the effect of requiring midwives to be licensed changed over time. Specifically, we provide pre- and
post-1920 estimates of the effect of licensing on maternal mortality. During the period 1900-1919, requiring midwives
to be licensed is associated with a reduction in maternal mortality of 8.4 log points. After 1919, requiring midwives to be
licensed is associated with a reduction in maternal mortality of 6.1 log points.

[46] We have pre- and post-treatment data on bassinets for 5 states: GA, FL, NM, NC, and WV. Bassinet data were not
published in the 1926 or 1927 issues of *Hospital Service in the United States*.

indistinguishable from zero, suggesting that licensing requirements were not correlated with the shift towards hospital births. In the final column of Table 6, we report the results of regressing the quartic root of maternity hospitals beds per 100,000 live births, an alternative proxy for hospital births, on *Midwifery License Required*.[47] Again, there is little evidence that requiring midwives to be licensed was correlated with hospital births.

4.4. Misclassification of maternal mortality

During the period under study, maternal deaths were, with some frequency, misreported on death certificates as non-maternal sepsis, nephritis, and peritonitis (Woodbury 1924; Louden 1999). According to Loudon (1999, p. 325), misreported maternal deaths were typically due to puerperal fever "for the simple reason that a doctor (or midwife) whose patient died of puerperal fever was liable to be blamed for the death whether justified or not." Maternal deaths from puerperal fever could be hidden by reporting them as due to an infection (e.g., peritonitis or sepsis) without mentioning childbirth on the death certificate. Maternal deaths could also be hidden by attributing them to an "unspecified/unknown" cause.[48]

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[47] The data on maternity hospital beds, which also come from *Hospital Service in the United States*, are available for the years 1920, 1925, and 1928-1940. Because the data on maternity hospital beds were originally reported at the hospital-year level, we transcribed these records and aggregated them to the state-year level. We take the quartic root of the maternity hospital bed rate to account for zero values, which represent 25 percent of the state-year observations. Maternity hospital beds are highly correlated with bassinets. For instance, the simple correlation between maternal hospital beds and bassinets was 0.91 in 1925 and 0.87 in 1940. It should be noted, however, that only a small percentage of total hospital births took place in maternity hospitals. During the period 1926-1940, approximately 8 percent of bassinets were in maternity hospitals. We have pre- and post-treatment data on maternity hospital beds for 6 states: GA, FL, MS, NM, NC, and WV. Although not reported, we experimented with regressing the quartic root of maternity hospitals beds per 100,000 female population, as opposed to 100,000 live births, on *Midwifery License Required*. We also experimented with taking the natural log of one plus the maternity hospital bed rate rather than using the quartic root function. These results were similar to those reported in Table 6.

[48] Woodbury (1924, p. 742) estimated that a small proportion (0.33 percent) of all deaths categorized as due to "ill-defined/unknown" causes were actually maternal. Nephritis describes inflammation of the kidneys, but often develops after a serious infection (Dresden 2016).

In columns (1)-(3) of Table 7, we explore whether the negative relationship between requiring midwives to be licensed and maternal mortality documented in Table 2 can be attributed to the misclassification of maternal deaths. Specifically, we report estimates obtained by regressing mortality due to nephritis, peritonitis, and "ill-defined" causes on the licensing indicator and the full set of controls. In addition, we explore whether licensing restrictions were associated with deaths among women of childbearing age (i.e., ages 15-44) from all causes except maternal mortality.[49] The results provide no evidence that midwifery laws were associated with deaths from these causes: the estimated effects in Table 7 are, without exception, small in magnitude and statistically indistinguishable from zero.[50]

5. RESULTS BASED ON MUNICIPAL-LEVEL DATA, 1900-1917

We turn now to an analysis of the relationship between midwifery laws and maternal mortality at the municipal level. Again, we use annual data drawn from the U.S. Census Bureau's *Mortality Statistics*. The initial issue contained mortality counts by cause and age for over 300 registration cities. By 1917, mortality counts from over 500 cities are available, although we restrict our attention to the 539 municipalities that had a population greater than 8,000.[51]

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[49] The association (or lack thereof) between midwife licensing requirements and non-maternal sepsis deaths was reported above, in Table 4. It is, of course, unlikely that the misreporting of maternal mortality was entirely restricted to non-maternal sepsis, nephritis, peritonitis, and "ill-defined" causes. A positive association between requiring midwives to be licensed and non-maternal mortality among women ages 15-44 would provide evidence that requiring midwives to be licensed did in fact encourage misreporting.

[50] Because mortality rates for peritonitis and ill-defined causes were equal to zero for a handful of observations, we use the quartic root function, rather than taking the natural log. For mortality due to peritonitis, defining the dependent variable as $\ln(1 + Peritonitis)$ produced an estimated coefficient of -.023 (SE = .040). For mortality due to ill-defined causes, defining the dependent variable as $\ln(1 + Ill\text{-}defined)$ produced an estimated coefficient of -.015 (SE = .096). Mortality counts for women of childbearing age were not reported in the 1912-1913 issues of *Mortality Statistics*.

[51] We chose this population cutoff because, prior to 1910, *Mortality Statistics* defined "urban" as cities or towns with a population greater than 8,000. Our results are similar if we make this cutoff more restrictive (e.g., 10,000 population) or drop it entirely. On average, each municipality contributed 15.8 observations to the analysis. We chose to focus on the period 1900-1917 in order to avoid confounding the effect of midwifery laws with the 1918 influenza epidemic. It should be noted that the state-level results discussed above are robust to excluding the years 1918-1920. To our

There are several advantages to adding municipal-level results to our analysis above, which exploited state-level variation. First, 9 municipalities adopted midwifery licensing requirements before the state in which they were located did, representing an alternative source of policy variation (see Appendix Table 9). Second, the municipal-level data allow us to focus on mothers living in "urban" areas, where the results in Table 5 suggest that the effect of midwifery laws are most pronounced. Third, a number of cities began reporting maternal mortality counts before this information was available at the state level. For instance, Texas required midwives to be licensed in 1907, but state-level mortality counts are not available for Texas until 1933. However, municipal-level data are available for the city of Galveston for the period 1906-1917 and for San Antonio for the period 1900-1917. We report the states and years covered in the municipal-level data set in Appendix Table 10. Using municipal-level data allows us to exploit policy variation for Missouri, Texas, and Utah that was not captured in the state-level analysis. A serious limitation of using municipal-level data is that our models no longer include pre- and post-treatment mortality counts for 8 states (DE, GA, KY, MS, NM, RI, SC, and WV).

We estimate municipal-level regressions similar to those used in the state-level analysis. We first estimate the municipal-level analog to equation (1), and then augment that specification by adding controls for typhoid mortality, non-pulmonary tuberculosis mortality, and municipality-specific linear time trends. The estimating equation is thus

$$(4) \quad \textit{Maternal Mortality}_{mt} = \beta_0 + \beta_1 \textit{Midwifery License Required}_{mt} + \boldsymbol{X}_{mt}\boldsymbol{\beta_2} + \beta_3 \textit{Typhoid}_{mt}$$
$$+ B_4 \textit{Non-Pulmonary TB}_{mt} + v_m + w_t + \Theta_m \cdot t + \varepsilon_{mt},$$

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knowledge, this is the first study to utilize data from *Mortality Statistics* for such a large number of cities. Several studies written after ours have also used city-level data from *Mortality Statistics*, including Anderson et al. (2019), Anderson et al. (forthcoming), and Feigenbaum et al. (2019).

where *Maternal Mortality$_{mt}$* is equal to maternal deaths per 100,000 population in municipality *m* and year *t*. Our independent variable of interest, *Midwifery License Required*, is equal to 1 if midwives in municipality *m* were required by either state law or a municipal ordinance to be licensed. The variables included in $\boldsymbol{X}$ are listed in Appendix Table 11. Because maternal mortality at the municipal level can be zero, we take its quartic root, which mimics the natural log function for positive numbers.[52] Standard errors are corrected for clustering at the municipal level.[53]

The results are reported in Table 8 and provide additional evidence that requiring midwives to be licensed is associated with reductions in maternal mortality. When we do not control for municipality-specific linear time trends, estimates of β_1 are larger than those reported in Table 2: licensing is associated with decreases in maternal mortality of 19-22 percent relative to the mean (e.g., -3.01/16.2 = -.186). When municipality-specific trends are added to the model, licensing is associated with a 6.7 percent reduction in maternal mortality, an effect size that is comparable to that found in the state-level analysis.

6. INFANT MORTALITY

Our analysis has thus far focused on maternal mortality. Requiring midwives to be licensed could also have affected the health of infants, although, as with maternal mortality, the direction of the effect is ambiguous. On the one hand, the imposition of licensing requirements could have led to higher prices and caused mothers to substitute towards cheaper, inferior alternatives such as traditional birth attendants (TBAs). On the other hand, requiring licensees to receive formal training

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[52] In our sample, there are 745 observations for which *Maternal Mortality* is equal to zero. We also estimated a version of equation (4) in which the dependent variable was set equal to $\ln(1 + Maternal\ Mortality)$. These estimates are similar to those shown in Table 8 and are reported in Appendix Table 12. It should also be noted that *Maternal Mortality* for the municipal-level analysis is defined as the rate per 100,000 population, not per 100,000 live births. Data on births at the municipality level are not available.

[53] Inference was similar if the standard errors were corrected for clustering at the state level.

and pass an exam could have pushed low-quality providers out of the market. Licensed midwives were typically trained in antiseptic technique and artificial respiration, and would have been able to recognize and handle common birth complications such as breech position or a nuchal cord (Jewett and Jewett 1901; Johnstone 1913).[54] The possibility that this kind of training could have reduced the number of infants dying shortly after birth is supported by the results of Lazuka (2018). Lazuka (2018) analyzed birth outcomes in 5 rural Swedish parishes for the period 1881-1930. Most of the births in these parishes were attended by TBAs, but the supply of formally trained midwives gradually increased during this period.[55] Lazuka (2018) found that infants whose births were attended by a trained midwife (as opposed to a TBA) stood a much better chance of surviving their first 28 days. Being attended by a trained midwife was also associated with better health in adulthood and an increase in the likelihood of being a skilled worker.[56]

In Table 9, we report estimates of the relationship between midwifery laws and infant mortality. The first three columns show results based on the state-level panel for the period 1900-1940, while the last three columns show results based on the municipal-level panel for the period 1900-1917.[57] An advantage to using the state-level data is that information on infant mortality by race is available.

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[54] A nuchal cord occurs when the umbilical cord becomes wrapped around the baby's neck.

[55] Formal training lasted two years and included training in bacteriology and the use of obstetrical instruments (Lazuka 2018). During the period studied by Lazuka (2018), TBAs in Sweden were prohibited from using disinfectants and obstetrical instruments.

[56] Additional evidence on the relationship between the training of midwives and infant mortality comes from recent research conducted in Zambia, the results of which suggest that teaching TBAs about newborn care (including training in cleanliness, resuscitation, and how to diagnose birth complications) can lead to dramatic reductions in 7-day neonatal mortality due to asphyxia and infection (Carlo et al. 2010).

[57] Because live birth data are unavailable at the municipal level, we use municipal population in the denominator to calculate the infant and diarrhea morality rates in the last three columns of Table 9.

Requiring midwives to be licensed is associated with a reduction in the overall infant

mortality rate of 2.6 log points.[58] By contrast, it is associated with a 9.6 percent reduction in the

nonwhite infant mortality rate.[59] Because nonwhite mothers were much more likely to use a

midwife than their white counterparts, better training coupled with the forced retirement of less

competent midwives could have had a substantial impact on the health of black infants.[60]

Next, we turn our attention to the municipal-level data. While infant mortality counts by

race are not available for most registration cities, we have information on diarrhea mortality

counts.[61] The so-called "urban mortality penalty" at the turn of the 20th century was due, at least in

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[58] Data on stillbirths are available for 1922-1940, but we found little evidence to suggest that the licensing of midwives mattered for stillbirth rates during this period. These results are available from the authors upon request.

[59] For the nonwhite infant mortality regression, we take the quartic root of nonwhite infant mortality per 100,000 nonwhite live births. There are 36 observations for which *Nonwhite Infant Mortality* is equal to zero. Requiring midwives to be licensed is associated with 1,022 fewer nonwhite infant deaths, or a 9.6 percent reduction relative to the mean of 11,222. Defining the dependent variable as ln(1 + *Nonwhite Infant Mortality*) produced an estimated coefficient of -.099 (SE = .023).

[60] There is anecdotal evidence that the adoption of licensing restrictions substantially improved the quality of midwives serving black communities in the South. For instance, Dodd (1920, p. 863), the Director of Child Hygiene and Public Health Nursing, described the typical midwife practicing in South Carolina prior to the imposition of licensing requirements:

> In South Carolina, she is usually the grandmother or grand-aunt or old friend of the family who goes in to "help out" in the emergency of child birth. When she becomes too old and too decrepit to be of any further use of earth, she takes up midwifery. She cannot fill out a birth certificate because she cannot write her own name. She has no standards, her remuneration is negligible, and her number is legion.

After licensing was required in 1920, midwives received instruction in recognizing birth complications and "what *not* to do and the simple rules for ordinary cleanliness" (Dodd, 1920, p. 864). Midwives were also required to attend 4 deliveries under the supervision of a public health nurse. "If the midwife is found to be following instructions, and observing the laws of cleanliness, she will be given a midwife permit" (Dodd 1920, p. 864). According to South Carolina public health officials, the licensing of midwives had a dramatic effect on infant and maternal mortality among blacks:

> It is interesting to note that from 1919 to 1928, the last year for which we have figures tabulated separately for white and colored, there was a decided reduction in the colored rates [of death] for both infants and mothers although there was an increase in both rates for whites. This would seem to indicate that the instruction of midwives, who deliver most of the negro mothers, has not been without value to the State (South Carolina Board of Health (1932) cited in Bonaparte (2014, p. 172)).

[61] Deaths due to diarrhea are reported in the same category as deaths due to enteritis and are available by age group for children under the age of 2 and individuals ages 2 and over. Enteritis is inflammation of the small intestine and is generally accompanied by diarrhea.

part, to diarrheal diseases (Haines 2001). In addition to encouraging breastfeeding, which helps maintain hydration, trained midwives had an effective treatment for diarrhea at their disposal (Johnstone 1913, p. 413).[62] While we find little evidence of a relationship between licensing and overall infant mortality in the municipal data, licensing is associated with a 9.6 percent reduction in the mortality among children under the age of 2 from diarrhea relative to the mean.[63]

We view the estimates reported in Table 9 as less definitive than the maternal mortality results reported above. A wide variety of public health initiatives directed at reducing infant mortality were undertaken during the period 1900-1930 (Kotelchuck 2007). For instance, state and local educational campaigns encouraged breastfeeding (Wolf 2003); public health inspectors visited dairy farms to ensure that milk was processed under sanitary conditions and shipped in refrigerated railroad cars (Atkins 1992). If these initiatives were correlated with the adoption of midwifery laws, the results reported in Table 9 could be biased. As a falsification test, we examine the relationship between midwifery laws and mortality due to diarrhea among individuals aged 2 years or older. While midwives often made multiple visits to the mother and child during the first few weeks of the postpartum period (Baker 1913; Dart 1921, p. 29; Smith 2005, p. 130; Bartlett 2008, p. 21), mortality from diarrhea among individuals ages 2 and over should have been unaffected by licensing requirements but may have been affected by latent policy changes occurring at roughly the same time as licensure. Our results show that the relationship between requiring midwives to be licensed

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[62] Huffman and Combest (1990) reviewed literature on the role of breastfeeding in the prevention and treatment of diarrhea among infants in developing countries. Johnstone's (1913, p. 413) text for midwives describes the use of albumin water to treat severe diarrhea in children. Han et al. (2009, p. 444) found that normal saline solution and albumin were equally effective for "initial hydration therapy for dehydrated term infants...due to acute diarrhea."

[63] For the diarrhea mortality regressions, we take the quartic root of the mortality rate. There are 31 observations for which *Diarrhea Under Age 2* is equal to zero. Defining the dependent variable as ln(1 + *Diarrhea Under Age 2*) produced an estimated coefficient of -.087 (SE = .038).

and diarrhea mortality among individuals ages 2 and over is relatively small and statistically insignificant, suggesting that the mortality estimates for children under the age of 2 are unbiased.[64]

7. MIDWIFERY LAWS AND THE SUPPLY OF MIDWIVES

We conclude our analysis with an examination of the relationship between midwifery laws and the supply of midwives. From the U.S. Decennial Census data, we can obtain full counts of the number of women who reported that midwifery was their occupation in the years 1900, 1910, 1920, 1930, and 1940.[65] Aggregating the individual self-reports to the state level, we created a variable, *Total Midwives*, which measures the number of women in state s and year t whose occupation was recorded as "midwife" per 100,000 women ages 15-45. Presuming that these self-reports are accurate, and that women without formal training did not describe themselves as "midwives", this measure can be thought of as capturing the supply of trained, professional midwives as opposed to TBAs.[66] There is, in fact, evidence that women without formal training, but who attended the births of family members and neighbors, did not typically consider themselves to be midwives (Borst 1988; Bickley 1990), and Census enumerators clearly undercounted women who worked on an irregular basis or at informal jobs (Lebergott 1966, pp. 153-154; Goldin 1990; Pudup 1990).

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[64] Defining the dependent variable as ln(1 + *Diarrhea Ages 2+*) produced an estimated coefficient of -.039 (SE = .025). Because data on diarrhea mortality for individuals ages 2 and over were not consistently reported, we restricted our attention to the city-year combinations for which we have information on diarrhea mortality for children under the age of 2 and diarrhea mortality for individuals ages 2 and over. Without this restriction, requiring midwives to be licensed is associated with a reduction in diarrhea mortality among children under the age of 2 of 6.4 percent relative to the mean. This estimate is statistically significant at the 5 percent level.

[65] Specifically, we use IPUMS full counts of the Decennial Censuses, housed at the Minnesota Population Center at the University of Minnesota (https://usa.ipums.org/usa/index.shtml).

[66] It should be noted that the "midwife" occupation included public nurses in the 1940 Census. Our results were qualitatively similar when the analysis was restricted to the period 1900-1930.

During the first decades of the 20th century, untrained midwives typically attended 1 or 2 births per year (Borst 1995, pp. 54-58; Barney 2000, pp. 62-65). Licensed midwives in Southern states, by contrast, attended, on average, 4 or 5 births per year, while those in Northern and Midwestern states averaged as many as 50 births per year. These numbers suggest that, if the adoption of licensing requirements prevented TBAs from practicing, even small increases in the number of licensed, professional midwives could have easily attended the births that had been handled by TBAs.[67]

We estimate the following equation:

(5) $Total\ Midwives_{st} = \beta_0 + \beta_1 Midwifery\ License\ Required_{st} + X_{st}\beta_2 + v_s + w_t + \Theta_s \cdot t + \varepsilon_{st},$

where the independent variable of interest, *Midwifery License Required*, is defined as before.[68] Because there are states in which *Total Midwives* is equal to zero prior to the adoption of licensing requirements, we take the quartic root of the dependent variable and report marginal effects in

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[67] The number of births per year attended by licensed midwives is available from a variety of contemporary sources and can be estimated based on others. For instance, during the period 1909-1920, licensed midwives in New York City attended an average of 28.2 births per year (New York City Department of Health 1921). Nicholson (1921) surveyed health departments across the country asking how many midwives were practicing in their state and what percentage of births they attended. Based on the responses to Nicholson's survey and data on births from Linder and Grove (1947), we estimated the average caseloads of licensed midwives. For instance, in Connecticut, licensed midwives attended, on average, 20.1 births per year. In Kentucky, they attended 5.4 births per year, while in Virginia they attended 4 births per year. Although Georgia and North Carolina did not require licensure, midwives in these states were required to register. Based on the responses to Nicholson's survey, we estimate that (unlicensed) midwives in Georgia attended, on average, 3.2 births per year. In North Carolina, they attended 3.1 births per year. In 1911, licensed midwives practicing in Providence, Rhode Island attended, on average, 49.6 births per year, while midwives in Kentucky (who were unlicensed), attended, on average, 4.1 births per year (American Association for the Study and Prevention of Infant Mortality 1913).

[68] The variables included in X are percent of population less than 18 years of age, percent 18-65 years of age, percent white, percent black, percent living in an urban area, percent female, percent foreign born, the physician-related controls listed in Table 1, an osteopathy licensing indicator, a practical nursing licensing indicator, a department of child hygiene indicator, a women's suffrage indicator, and Sheppard-Towner spending.

brackets.[69] Regressions are weighted by the relevant female population ages 15-45, and standard

errors are corrected for clustering at the state level.

The results, which are reported in Table 10, suggest that the adoption of licensing

requirements may have led to a modest increase in the supply of professional midwives. Controlling

for state-specific linear trends, we find that licensing is associated with an increase of 14.4 midwives

per 100,000 women ages 15-45, relative to a mean of 78.5. This estimate, however, is not statistically

significant at conventional levels. Estimates of the effect of licensing requirements on the supply of

black and foreign-born midwives are also positive but insignificant.[70] Finally, it should be noted

that, because we have no information on TBAs, it is impossible to gauge the effect of licensing

requirements on the overall supply of midwifery services.[71]

8. CONCLUSION

Holders of occupational licenses earn between 11 and 18 percent more than their unlicensed

counterparts, presumably because it restricts the supply of labor (Kleiner and Krueger 2010; 2013).

This premium is of similar magnitude to estimates of the union-nonunion wage gap (Lewis 1986;

Blanchflower and Bryson 2003). However, occupational licensing rules are rarely portrayed by

advocates as a vehicle for increasing the earnings of licensees. Instead, rules obligating practitioners

to pass an exam, receive training, or obtain letters of reference are often justified on the grounds that

they improve safety and public health (Kleiner 2000; Gittleman and Kleiner 2016).

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[69] For instance, *Total Midwives* is zero for 3 states (ME, NH, NV) in 1910. None of these states required midwives to be licensed in order to practice.

[70] Using census data from 1870-1960, Law and Marks (2009) found that requiring midwives to be licensed was associated with an increase in the likelihood of working as a midwife. This increase was larger for nonwhite as compared to white women.

[71] We also explored whether requiring midwives to be licensed was associated with the number of women working in other occupations, such as beautician, practical nurse, and professional nurse. We found no evidence to suggest that licensing laws predicted the number of women working in these occupations.

Previous researchers have found that the incremental tightening (or loosening) of licensing requirements has little impact on the health of consumers (Carroll and Gaston 1981; Kleiner and Kudrle 2000; Kleiner et al. 2016; Markowitz et al. 2017). Using U.S. Census Bureau data from the period 1900-1940, we estimate the effects of midwifery licensing requirements on maternal mortality. An advantage of examining early licensing requirements for midwives is that, before their adoption, the market for midwifery services was wholly unregulated. At the turn of the 20th century, puerperal fever was the leading cause of maternal mortality, accounting for approximately half of all deaths related to childbirth (Woodbury 1924; Loudon 2000a, 2000b). Doctors and public health officials argued that the unsanitary practices of midwives were to blame for the high rates of puerperal fever (Cody 1913; Plecker 1915; Edgar 1916; Frizzelle 1917; Terry 1917; Stedman 1920; Howe 1921; Rude 1922), and recommended licensing as the solution (Edgar 1916; Hardin 1925/1986). In response, 22 states (and at least a dozen municipalities) passed midwifery laws, bringing educational requirements and oversight to a previously unregulated market. Under these laws, a license could often be obtained by simply receiving basic instruction from a public health nurse or county health officer. In other states, applicants were required to graduate from a recognized school of midwifery and pass an examination administered by their State Board of Medical Examiners. Exploiting geographical and temporal variation in the adoption of requirements such as these, we find that the licensing of midwives led to a reduction in maternal mortality of approximately 7-8 percent. We also find evidence, albeit more tentative, that requiring a license reduced the infant mortality rate.

These basic results, however, mask important heterogeneity. For instance, the relationship between midwifery laws and maternal mortality appears to have been more pronounced in states that required applicants to have graduated from a recognized school of midwifery. Moreover, this relationship was strongest in urban areas, a result that is consistent with anecdotal evidence that

enforcement of midwifery laws was less strict in the countryside and small towns (Borst 1995, pp. 55-60; Molina 2006, p. 105). When we distinguish between maternal mortality due to puerperal fever and maternal mortality from other causes, we find that requiring a license is associated with an over 8 percent reduction in maternal mortality due to puerperal fever, suggesting that the focus on antiseptic technique and non-intervention was effective. Requiring a license also led to a reduction in maternal mortality from other causes of roughly 7 percent, suggesting that licensed midwives could, at a minimum, identify birth complications and when to ask for assistance from a physician.

After 1920, middle- and upper-class women increasingly chose to give birth in hospitals (Leavitt 1986; Wertz and Wertz 1989, p. 133). In an effort to explore whether the estimated relationship between maternal mortality and midwifery licensing laws can be explained by this phenomenon, we transcribed data on hospital bassinets, a proxy for hospital births (Thomasson and Treber 2008). We found that the estimated relationship between bassinets per 100,000 live births and requiring a license to practice midwifery was small and statistically insignificant, suggesting that our estimates described above are not confounded by the post-1920 shift towards hospital births.

Obtaining accurate estimates of the effect of requiring midwives to be licensed is relevant for ongoing policy debates. A majority of births in many developing countries are still attended by TBAs with no formal education or training (UNFPA 2011). Experts contend that replacing TBAs with trained and licensed midwives would substantially reduce infant and maternal mortality (WHO 2005, pp. 68-72; Thompson et al. 2011; UNFPA 2011, pp. 2-7), but the evidence in support of this contention is largely anecdotal.

Economic theory offers no clear guidance as to the direction of the relationship between licensing and the quality of services received by consumers (Kleiner 2000), yet licensing requirements have become commonplace in the United States and other developed countries (Gittleman and Kleiner 2016). Our results provide strong evidence that the adoption of licensing

requirements for midwives between 1900 and 1940 reduced maternal mortality. Whether requiring

doctors, dentists, and other health professionals to be licensed also leads to better health outcomes

is an open, but crucial, question that deserves the attention of future researchers.

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Figure 1. Passage of Midwife Licensing Requirements
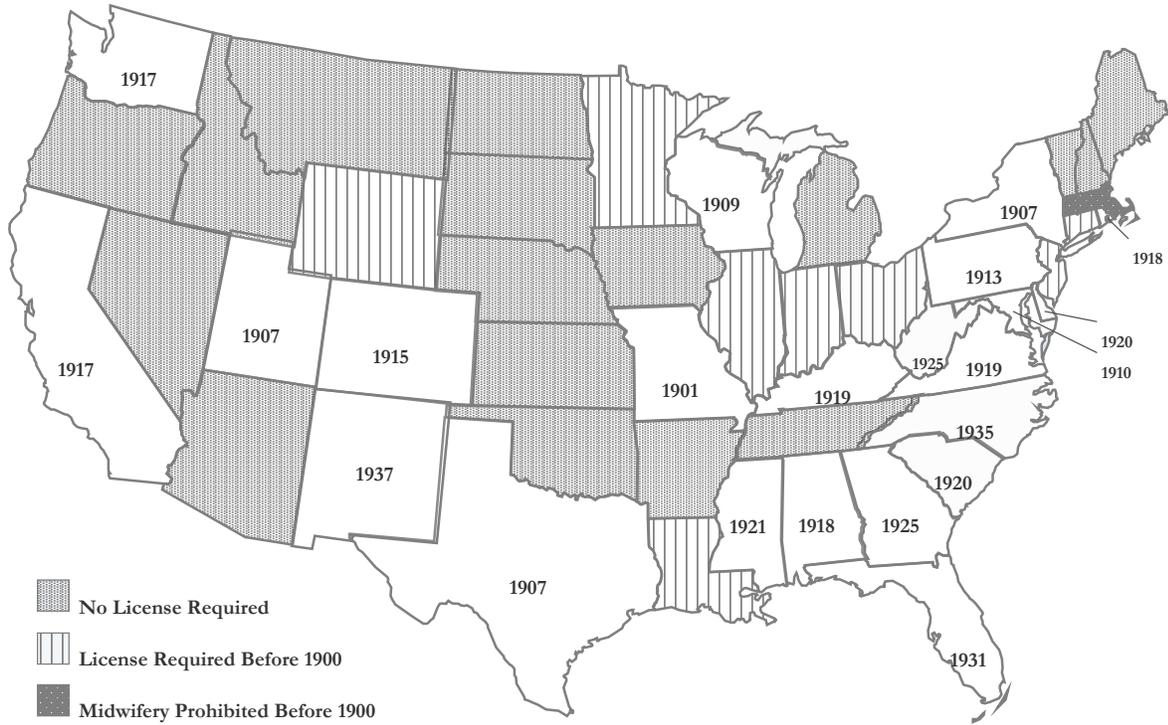
Notes: Years are for when the first midwifery law was passed. Sources are provided in Appendix Table 1. The District of Columbia required midwives to be licensed in 1896.

Figure 2. Trends in Maternal Mortality
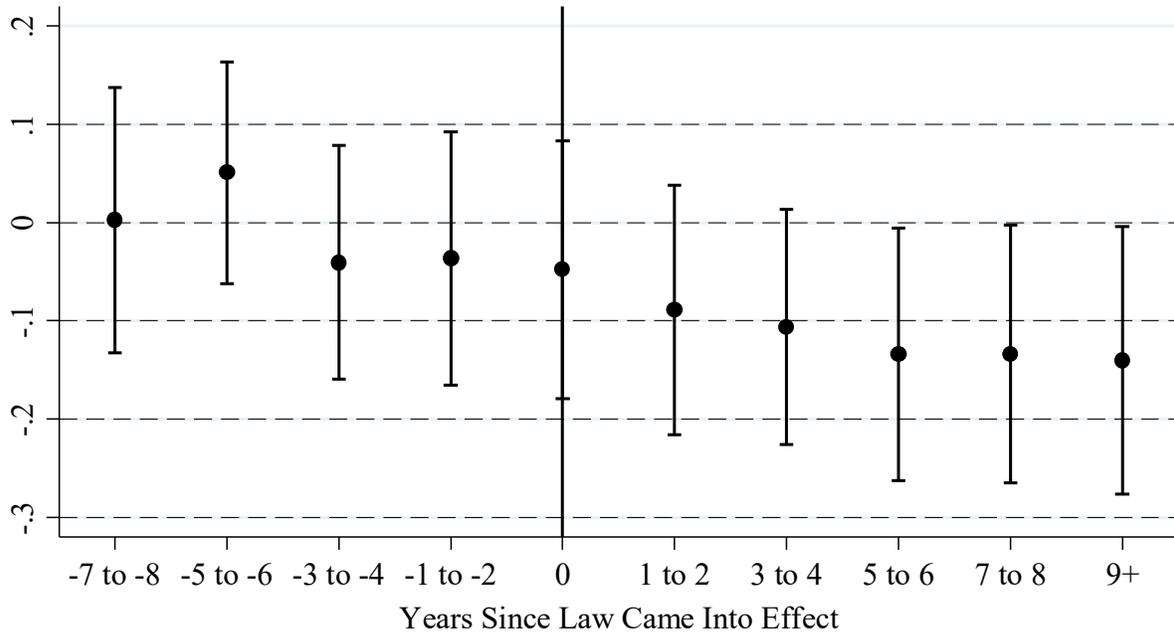
Notes: OLS coefficient estimates (and their 90% confidence intervals) are reported, where the omitted category is 9 or more years before treatment. The dependent variable is equal to the natural log of maternal deaths per 100,000 live births in state s and year t. Controls include the state characteristics listed in Table 1, state fixed effects, year fixed effects, and state-specific linear time trends. The regression is weighted by live births. Standard errors are corrected for clustering at the state level

Table 1. Descriptive Statistics for State-Level Maternal Mortality Analysis, 1900-1940

	Full sample	Midwifery License Required = 1	Midwifery License Required = 0	Description
Maternal Mortality	648.3 (232.2)	626.4 (183.1)	674.9 (278.3)	Maternal deaths per 100,000 live births
	N = 1,296	N = 711	N = 585	
Percent Pop < 18	.351 (.045)	.352 (.046)	.350 (.043)	Percent of population that was less than 18 years of age
Percent Pop 18-65	.598 (.037)	.600 (.038)	.597 (.036)	Percent of population that was 18-65 years of age
Percent White	.899 (.134)	.882 (.141)	.919 (.121)	Percent of population that was white
Percent Black	.079 (.128)	.101 (.142)	.052 (.102)	Percent of population that was black
Percent Urban	.482 (.183)	.523 (.186)	.431 (.166)	Percent of population that lived in an urban area
Percent Female	.489 (.018)	.493 (.014)	.485 (.022)	Percent of population that was female
Percent Foreign	.116 (.091)	.107 (.090)	.126 (.091)	Percent of population that was foreign born
Physicians per Capita	131.8 (45.5)	129.4 (41.3)	134.6 (49.9)	Physicians per 100,000 population
Physician Diploma	.962 (.191)	.982 (.134)	.938 (.241)	= 1 if state required physicians to have a diploma
Physician Education	.952 (.214)	.989 (.106)	.908 (.290)	= 1 if state medical boards could set preliminary education requirements
Physician Exam	.324 (.468)	.354 (.479)	.287 (.453)	= 1 if state required physicians to pass an examination to be licensed
Four-Year Medical School	.458 (.498)	.525 (.500)	.376 (.485)	= 1 if state required medical schools to use a four-year curriculum
Inferior Medical School	.962 (.191)	1.00 (.000)	.916 (.277)	= 1 if state medical boards could exclude graduates of "inferior" schools from being certified
Osteopathy License Law	.794 (.405)	.931 (.253)	.627 (.484)	= 1 if state required osteopaths to be licensed
Practical Nursing License Law	.174 (.379)	.222 (.416)	.115 (.319)	= 1 if state required practical nurses to be licensed
Dept. of Child Hygiene	.726 (.446)	.820 (.384)	.612 (.488)	= 1 if state had a division of child hygiene
Suffrage	.767 (.423)	.823 (.382)	.699 (.459)	= 1 if women were allowed to vote
ST Act	4.15 (10.2)	5.26 (12.2)	2.80 (6.84)	Sheppard-Towner spending for 1922-1929 (1930 dollars in thousands)
Typhoid	8.87 (9.30)	7.75 (8.29)	10.2 (10.2)	Typhoid mortality per 100,000 population
Non-pulmonary TB	11.1 (7.04)	10.1 (5.93)	12.4 (8.01)	Non-pulmonary tuberculosis mortality per 100,000 population

Notes: Unweighted means with standard deviations in parentheses.

Table 2. Maternal Mortality and Midwifery Laws: State-Level Analysis, 1900-1940

	(1)	(2)	(3)	(4)	(5)	(6)
Year Prior to Midwifery License Required	…	…	…	…	…	-.008
						(.018)
Midwifery License Required	-.076**	-.080***	-.075**	-.075**	-.077***	-.080***
	(.037)	(.029)	(.031)	(.031)	(.026)	(.027)
Mean	648.3	648.3	648.3	648.3	648.3	648.3
N	1,296	1,296	1,296	1,296	1,296	1,296
R^2	.865	.883	.889	.889	.911	.911
Demographic controls	no	yes	yes	yes	yes	yes
Policy controls	no	no	yes	yes	yes	yes
Typhoid and non-pulmonary TB	no	no	no	yes	yes	yes
State-specific linear trends	no	no	no	no	yes	yes

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* and *Vital Statistics of the United States*, published by the U.S. Census Bureau. Each column represents the results from a separate OLS regression. The dependent variable is equal to the natural log of maternal deaths per 100,000 live births in state *s* and year *t*. The demographic controls, which are measured at the state-year level, are described in Table 1. They include physicians per capita and the percentages of the population by age group, race, urbanicity, gender, and foreign-born status. The policy controls are described in Table 1 and include a set of physician licensing and education-related requirements, indicators for whether osteopaths and practical nurses were required to have a license, a department of child hygiene indicator, a women's suffrage indicator, and Sheppard-Towner Act spending. All models control for state fixed effects and year fixed effects. Regressions are weighted by live births. Standard errors, corrected for clustering at the state level, are in parentheses.

Table 3. Robustness of Relationship between Maternal Mortality and Midwifery Laws: State-Level Analysis, 1900-1940

	(1)	(2)	(3)	(4)	(5)
	Restrict sample to states that required licensure by 1940	Unweighted	ln(maternal deaths per 100,000 female population)	Maternal deaths per 100,000 live births	Negative binomial
Midwifery License Required	-.076**	-.068**	-.061**	-43.5***	-.078***
	(.032)	(.030)	(.028)	(16.0)	(.024)
Mean	654.8	648.3	27.9	648.3	648.3
N	842	1,296	1,296	1,296	1,296

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* and *Vital Statistics of the United States*, published by the U.S. Census Bureau. Unless otherwise noted, each column represents the results from a separate OLS regression. In column (1), the dependent variable is equal to the natural log of maternal deaths per 100,000 live births in state s and year t; and the regression is weighted by live births. In column (2), the dependent variable is equal to the natural log of maternal deaths per 100,000 live births in state s and year t; and the regression is unweighted. In column (3), the dependent variable is equal to the natural log of maternal deaths per 100,000 female population in state s and year t; and the regression is weighted by female population. In columns (4), the dependent variable is equal to maternal deaths per 100,000 live births in state s and year t; and the regression is weighted by live births. In column (5), the dependent variable is equal to maternal deaths in state s and year t; and the regression is weighted by live births. All models control for the state characteristics listed in Table 1, state fixed effects, year fixed effects, and state-specific linear time trends. Standard errors, corrected for clustering at the state level, are in parentheses.

Table 4. Falsification Outcomes and Midwifery Laws: State-Level Analysis, 1900-1940

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Pulmonary Tuberculosis		*Malaria*		*Influenza*		*Sepsis*		*Tetanus*	
Midwifery License Required	.042**	.027	.028	.038	-.020	.052	-.008	-.011	.017	.015
	(.017)	(.018)	(.032)	(.044)	(.068)	(.062)	(.016)	(.020)	(.017)	(.016)
			[.255]	[.349]			[-.047]	[-.069]	[.081]	[.072]
Mean	81.6	81.6	3.05	3.05	37.2	37.2	1.76	1.76	1.25	1.25
N	1,296	1,296	1,296	1,296	1,296	1,296	1,296	1,296	1,296	1,296
State-specific linear trends	no	yes	no	yes	no	yes	no	yes	no	yes

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* and *Vital Statistics of the United States*, published by the U.S. Census Bureau. Each column represents the results from a separate OLS regression. The dependent variable is equal to the natural log (or, in the case of malaria, sepsis, and tetanus, the quartic root) of the specified mortality count per 100,000 population in state *s* and year *t*. All models control for the state characteristics listed in Table 1, state fixed effects, and year fixed effects. Regressions are weighted by state population. Standard errors, corrected for clustering at the state level, are in parentheses and marginal effects are in brackets.

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Table 5. Heterogeneous Effects and Midwifery Laws: State-Level Analysis, 1900-1940

	(1)	(2)	(3)	(4)	(5)	(6)
	Maternal Mortality	*Maternal Mortality*	*Maternal Mortality due to Puerperal Fever*	*Maternal Mortality due to Other Causes*	*Urban Maternal Mortality*	*Rural Maternal Mortality*
Midwifery License Required	-.050**	.010	-.085**	-.072***	-.090**	-.036
	(.022)	(.036)	(.040)	(.023)	(.040)	(.026)
Midwifery License Required * Exam Sufficient	.003	…	…	…	…	…
	(.037)					
Midwifery License Required * Graduation Necessary	-.085	…	…	…	…	…
	(.058)					
Midwifery License Required * Percent Black Above Median	…	-.103**	…	…	…	…
		(.043)				
Mean	648.3	648.3	244.5	403.8	17.7	11.6
N	1,296	1,296	1,296	1,296	1,296	1,296

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* and *Vital Statistics of the United States*, published by the U.S. Census Bureau. Each column represents the results from a separate OLS regression. In columns (1)-(4), the dependent variable is equal to the natural log of the specified maternal mortality count per 100,000 live births in state *s* and year *t*. These regressions are weighted by live births. In columns (5)-(6), the dependent variable is equal to the natural log of the specified maternal mortality count per 100,000 of the relevant population in state *s* and year *t*. These regressions are weighted by the relevant population. All models control for the state characteristics listed in Table 1, state fixed effects, year fixed effects, and state-specific linear time trends. Standard errors, corrected for clustering at the state level, are in parentheses.

Table 6. Hospital Births and Midwifery Laws

	(1)	(2)	(3)	(4)
	Hospital Bassinets (1925, 1928-1940)	*Hospital Bassinets (1925, 1928-1940)*	*Hospital Bassinets (1925, 1928-1940)*	*Maternity Hospital Beds (1920, 1925, 1928-1940)*
Midwifery License Required	.041	-.016	.001	-.228
	(.028)	(.044)	(.024)	(.422)
				[-54.5]
Mean	2,454	2,454	2,454	233.8
N	672	672	672	720
Demographic and policy controls	no	yes	yes	yes
State-specific linear trends	no	no	yes	yes

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on data from *Hospital Service in the United States*, published by the Council on Medical Education and Hospitals of the American Medical Association. Each column represents the results from a separate OLS regression. In columns (1)-(3), the dependent variable is equal to the natural log of hospital bassinets per 100,000 live births in state s and year t. In column (4), the dependent variable is equal to the quartic root of maternity hospital beds per 100,000 live births in state s and year t. Demographic controls include physicians per capita and the percentages of the population by age group, race, urbanicity, gender, and foreign-born status. Policy controls include a set of physician licensing and education-related requirements, indicators for whether osteopaths and practical nurses were required to have a license, a department of child hygiene indicator, and Sheppard-Towner Act spending. All models control for state fixed effects and year fixed effects. Regressions are weighted by live births. Standard errors, corrected for clustering at the state level, are in parentheses and marginal effects are in brackets.

Table 7. Misclassification of Maternal Mortality:
State-Level Analysis, 1900-1940

	(1)	(2)	(3)	(4)
				Non-Maternal Mortality, Women Ages
	Nephritis	*Peritonitis*	*Ill-defined*	*15-44*
Midwifery License Required	-.009	-.007	-.008	-.010
	(.014)	(.019)	(.047)	(.014)
		[-.055]	[-.361]	
Mean	87.4	2.45	24.8	431.5
N	1,296	1,296	1,296	1,251

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* and *Vital Statistics of the United States*, published by the U.S. Census Bureau. Each cell represents the results from a separate OLS regression. The dependent variable is equal to the natural log (or, in the case of peritonitis and ill-defined causes, the quartic root) of the specified mortality count per 100,000 of the relevant population in state *s* and year *t*. All models control for the state characteristics listed in Table 1, state fixed effects, year fixed effects, and state-specific linear time trends. Regressions are weighted by the relevant state population. Standard errors, corrected for clustering at the state level, are in parentheses and marginal effects are in brackets.

Table 8. Maternal Mortality and Midwifery Laws: Municipal-Level Analysis, 1900-1917

	(1)	(2)	(3)	(4)
Midwifery License Required	-.093**	-.108***	-.103***	-.033*
	(.045)	(.035)	(.031)	(.015)
	[-3.01]	[-3.51]	[-3.33]	[-1.08]
Mean	16.2	16.2	16.2	16.2
N	7,412	7,412	7,412	7,412
R^2	.338	.344	.356	.450
Policy controls listed in Appendix Table 11	no	yes	yes	yes
Typhoid and non-pulmonary TB	no	no	yes	yes
Municipality-specific linear trends	no	no	no	yes

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics*, published by the U.S. Census Bureau. Each column represents the results from a separate OLS regression. The dependent variable is equal to the quartic root of maternal deaths per 100,000 population in municipality *m* and year *t*. All models control for municipality fixed effects and year fixed effects. Regressions are weighted by municipality population. Standard errors, corrected for clustering at the municipal level, are in parentheses and marginal effects are in brackets.

Table 9. Infant Mortality and Midwifery Laws

	State-level analysis, 1900-1940				Municipal-level analysis, 1900-1917		
	(1)	(2)	(3)		(4)	(5)	(6)
	Infant Mortality	*White Infant Mortality*	*Nonwhite Infant Mortality*		*Infant Mortality*	*Diarrhea Under Age 2*	*Diarrhea Ages 2+*
Midwifery License Required	-.026* (.014)	-.012 (.029)	-.248*** (.059) [-1,082]	*Midwifery License Required*	-.002 (.015)	-.075*** (.026) [-9.06]	-.021 (.014) [-.758]
Mean	7,636	6,693	11,222	Mean	296.4	94.7	18.8
N	1,296	1,114	1,114	N	7,412	3,977	3,977
R^2	.979	.975	.903	R^2	.888	.881	.629

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* and *Vital Statistics of the United States*, published by the U.S. Census Bureau. Each column represents the results from a separate OLS regression. **State-level analysis:** The dependent variable is equal to the natural log (or, in the case of nonwhite infant mortality, the quartic root) of infant deaths per 100,000 live births in state s and year t. Controls include the state characteristics listed in Table 1, state fixed effects, year fixed effects, and state-specific linear time trends. Regressions are weighted by live births. Standard errors, corrected for clustering at the state level, are in parentheses and marginal effects are in brackets. **Municipal-level analysis:** The dependent variable is equal to the natural log (or, in the case of diarrhea, the quartic root) of the specified mortality count per 100,000 population in municipality m and year t. Controls include the characteristics listed in Appendix Table 11, municipality fixed effects, year fixed effects, and municipality-specific linear time trends. Regressions are weighted by municipality population. Standard errors, corrected for clustering at the municipal level, are in parentheses and marginal effects are in brackets.

Table 10. Licensing and the Supply of Midwives: Evidence from the Decennial Census

	(1)	(2)	(3)	(4)	(5)	(6)
	Total Midwives		Black Midwives		Foreign-Born Midwives	
Midwifery License Required	.018	.136	.132	.039	.121	.076
	(.093)	(.092)	(.143)	(.198)	(.117)	(.131)
	[1.97]	[14.4]	[13.1]	[3.84]	[21.5]	[13.4]
Mean	78.5	78.5	72.3	72.3	157.1	157.1
N	240	240	240	240	240	240
R^2	.969	.986	.930	.952	.883	.929
State-specific linear trends	no	yes	no	yes	no	yes

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on the 100-percent samples of U.S. Census data from 1900-1940 aggregated to the state level. Each column represents the results from a separate OLS regression. The dependent variable is equal to the quartic root of the specified midwife count per 100,000 female population ages 15-45 from the relevant population in state s and year t. All models control for physicians per capita and the percentages of the population by age group, race, urbanicity, gender, and foreign-born status, a set of physician licensing and education-related requirements, indicators for whether osteopaths and practical nurses were required to have a license, a department of child hygiene indicator, Sheppard-Towner Act spending, state fixed effects, and year fixed effects. Regressions are weighted by the relevant female population, ages 15-45. Standard errors, corrected for clustering at the state level, are in parentheses and marginal effects are in brackets.

Appendix

For online publication

Appendix Table 1. State Midwifery Laws, 1870-1940

State	Licensing Requirement	Year of Passage	Description
Alabama	Yes	1918	Midwives were required to pass an examination and register with the Alabama State Board of Health. According to Tovino (2004, p. 72), "Although thousands of women practiced as lay midwives in Alabama, only a few completed the required training." In response to the passage of the law, the Tuskegee Institute developed a four-week course "of intensive training in midwifery" (Kennedy 1921).
Arizona	No		A 1903 law stipulated that the practice of midwifery be unrestricted (van Blarcom 1913).
Arkansas	No		A 1904 law stipulated that the practice of midwifery be unrestricted (van Blarcom 1913).
California	Yes	1917	The law came into effect on July 27, 1917. It required that midwives receive instruction in anatomy, hygiene and sanitation, obstetrics and physiology from a legally chartered school approved by the Board of Medical Examiners. Applicants also had to pass an examination in these subjects, but could receive a license without having to pass an exam (and without having to graduate from a recognized midwifery school) if they had attended at least 25 cases of labor. Persons practicing midwifery without a license were subject to a fine of not more than $600 and/or imprisonment for up to 180 days. Midwives were prohibited from using forceps and from administering any type of drug. The full text of the law is available in Henning and Hyatt (1921).
Colorado	Yes	1915	The law required that applicants be examined by the State Board of Medical Examiners. Persons practicing midwifery without a license were subject to a fine of not more than $300 or imprisonment for up to 30 days. Midwives were prohibited from using forceps and from administering any type of drug. See Colorado (1915) for the full text of the law. Also see Stone (1918).
Connecticut	Yes	1893	The law came into effect in October 1893. Applicants had to pass an exam administered by a committee appointed by the State Board of Health. Persons practicing midwifery without a license were subject to a fine of not more than $300 or imprisonment for up to 90 days. See Connecticut (1893) for the full text of the law.
Delaware	Yes	1920	License to be issued by the State Board of Health upon a signed statement from a licensed physician that the applicant is qualified. See the National Committee for the Prevention of Blindness (1920) for more details.
Florida	Yes	1931	The law required that applicants be at least 21 years of age, sponsored by two practicing physicians, be able to read "the Manual for Midwives intelligently" and show evidence "of habits of cleanliness." Applicants were required to have attended 15 deliveries under the supervision of a licensed physician or to have graduated from a school for midwives

			recognized by the State Health Officer. Midwives were prohibited from using forceps and from administering any type of drug "except where the attendance of a physician cannot be speedily secured." See Hanson (1931) for the full text of the law.
Georgia	Yes	1925	On January 28, 1925, the Georgia State Board of Health required midwives to receive basic instruction from public health nurses in order to be certified. Beginning in 1956, applicants had to be of "good character and sound mind." Under the new requirements, applicants who were not previously certified had to complete a course of instruction approved by the Georgia Department of Public Health and were required to pass an examination. Previously certified midwives were required to receive "periodic instruction made available to them each year in order to maintain eligibility for certification." See Georgia Department of Public Health (1928), Cadwallader (1957), Georgia (1957), Pennell and Stewert (1968) and Warsh (2010, pp. 108-109) for details.
Idaho	No		A 1908 law stipulated that the practice of midwifery be unrestricted (van Blarcom 1913).
Illinois	Yes	1877	The law came into effect on July 1, 1877. It created the State Board of Health, which was empowered to examine midwives (and physicians) who had not graduated from a medical institution "in good standing." Persons practicing midwifery without a license were subject to a fine of not more than $500 and/or imprisonment for up to 365 days. See Illinois State Board of Health (1884), Egan (1910) and Sandvick (2009) for more details.
Indiana	Yes	1897	The law came into effect on April 14, 1897. It required applicants to have graduated from a recognized school of midwifery or pass an examination given by the Board of Medical Registration and Examination. Applicants who had practiced midwifery for at least 10 years prior to the passage of the act were exempt from its requirements. Persons practicing midwifery without a license were subject to a fine of not less than $25 and not more than $500 (Egan 1910; van Blarcom 1913; Burns 1914, pp. 142-144; Pennell and Stewart 1968).
Iowa	No		The practice of midwifery was unregulated until 1978, when it was prohibited AG's opinion (Egan 1910; Pennell and Stewart 1968; Butter and Kay 1988).
Kansas	No		Under a 1911 law, midwives were required to register with the local registrar of vital statistics (van Blarcom 1913).
Kentucky	Yes	1919	Established in 1919, the Bureau of Child Hygiene was tasked with instructing, examining and licensing midwives "through county health officers." See Kentucky (1922) for the full text of the law.
Louisiana	Yes	1894	The law required examination by the Board of Medical Examiners, but exempted midwives who were practicing prior to its passage and exempted the "so-called midwife of the rural districts and plantation practice, who, in the sense of this act, are not considered as practicing midwifery as a profession." Persons practicing midwifery without a

			license were subject to a fine of up to $100 (Louisiana 1904; Duffy 1962, p. 409; Pennell and Stewart 1968).
Maine	No		A 1903 law stipulated that the practice of midwifery be unrestricted (van Blarcom 1913).
Maryland	Yes	1910	The law came into effect on July 1, 1910. It required examination by the State Board of Health. Applicants were also required to provide a "certificate from a legal practitioner of medicine…that he or she has attended at least 5 cases of childbirth" and had to provide certificates from three "reputable citizens" attesting that the applicant was of good moral character. Anyone who was practicing midwifery prior to 1910 was exempt from these requirements. Midwives were prohibited from using forceps and from administering any type of drug. See Maryland (1914) for the full text of the law.
Massachusetts	No		The practice of midwifery was prohibited by the Medical Practice Act of 1894 (Declercq 1994).
Michigan	No		The practice of midwifery was (and remains) unregulated (Egan 1910; Pennell and Stewart 1968; Butter and Kay 1988; Gray 2015).
Minnesota	Yes	1891	The law came into effect on April 20, 1891. It required anyone "beginning the practice of midwifery" to have graduated from a recognized school of midwifery or pass an examination administered by the Board of Medical Examiners. Practicing midwifery without a license was subject to a fine of up to $50 or imprisonment of up to 30 days. See Minnesota (1891) for the full text of the law. Also see Egan (1910).
Mississippi	Yes	1921	Beginning in 1921, the Bureau of Child Welfare provided instruction to midwives and required them to be certified. Applicants were judged based on character, cleanliness, intelligence and "reputation for calling a doctor in difficult or abnormal cases." See Mississippi Board of Health (1921) for more details.
Missouri	Yes	1901	Applicants had to pass an examination administered by the State Board of Health. Women who did not practice midwifery as a profession and did not charge for their services were not required to obtain a license. Persons practicing midwifery as a profession without a license were subject to a fine of not more than $50 or imprisonment for up to two months. See Missouri (1909) for the full text of the law. Also see Perry (1983).
Montana	No		The practice of midwifery was unregulated until 1978, when it was prohibited AG's opinion (Egan 1910; Pennell and Stewart 1968; Butter and Kay 1988).
Nebraska	No		The practice of midwifery was unregulated (Egan 1910; van Blarcom 1913; Pennell and Stewart 1968; Butter and Kay 1988).
Nevada	No		The practice of midwifery was unregulated (Egan 1910; van Blarcom 1913; Pennell and Stewart 1968; Butter and Kay 1988).
New Hampshire	No		The practice of midwifery was unregulated (Egan 1910; van Blarcom 1913; Pennell and Stewart 1968; Butter and Kay 1988).
New Jersey	Yes	1892	Under the law, applicants were required to have 6 months of training from a legally incorporated school of midwifery and pass an

			examination given by the Board of Medical Examiners. Practicing midwifery without a license was punishable by a fine of not more than $50 and/or imprisonment for up to 30 days (New Jersey State Board of Medical Examiners 1902). Midwives were prohibited from administering any type of drug and required to summon a physician if the mother exhibited the symptoms of abnormal labor. In 1910, the law was amended to require two years of training (van Blarcom 1913; Levy 1921).
New Mexico	Yes	1937	A 1901 law stipulated that the practice of midwifery be unrestricted (van Blarcom 1913). The 1937 law provided for licensure by examination and set penalties for practicing midwifery without a license (Pennell and Stewart 1968).
New York	Yes	1907	Midwives practicing in New York City were required to attend at least 20 deliveries under physician supervision (New York Department of Health 1909). In addition, applicants had to be 21 years of age, of "moral character", able to read and write and "show evidences…of habits of cleanliness." As of 1914, the New York City Board of Health required applicants to graduate from a registered school of midwifery (New York Bureau of Child Hygiene 1915). Under a state law passed in 1913, midwives practicing outside of New York City and Rochester had to show evidence of "habits of cleanliness" and had to graduate from a recognized midwifery program or receive instruction from a physician in at least 15 deliveries (New York Department of Health 1915; Williams 1915). Midwives were prohibited from using forceps and from administering any type of drug.
North Carolina	Yes	1935	The practice of midwifery was unregulated until a 1908 law required midwives to wash hands before touching a patient and banned women who were addicted to drugs or alcohol from the practice of midwifery (van Blarcom 1913). In 1917, midwives were required to register with the Board of Health (North Carolina 1920). In April of 1935, midwives were required to obtain a permit from the Board of Health, "under rules and regulations which it shall adopt with respect thereto…" Practicing midwifery without a permit was punishable by a fine of not more than $50 or imprisonment for up to 30 days. See North Carolina (1935) for the full text of the law.
North Dakota	No		The practice of midwifery was unregulated (Egan 1910; van Blarcom 1913; Pennell and Stewart 1968; Butter and Kay 1988).
Ohio	Yes	1896	Applicants were required to pass an examination administered by the State Board of Medical Registration and Examination. Practicing midwifery without a license was punishable by a fine of not less than $25 and not more than $100. Midwives were prohibited from using forceps. See Laning (1896), Ohio (1905) and Egan (1910).
Oklahoma	No		The practice of midwifery was unregulated (Egan 1910; van Blarcom 1913; Pennell and Stewart 1968; Butter and Kay 1988).
Oregon	No		The practice of midwifery was unregulated (Egan 1910; van Blarcom 1913; Pennell and Stewart 1968; Butter and Kay 1988).

Pennsylvania	Yes	1913	Beginning in 1914, applicants were required to pass an examination administered by the Bureau of Medical Education and Licensure and penalties for practicing midwifery without a license came into effect (van Blarcom 1913; Pennsylvania State Department of Health 1913, pp. 8-9; Stevens 1914, p. 404; Miller and Baker 1916, p. 1000).
Rhode Island	Yes	1918	The law came into effect on July 1, 1918. It required applicants to be examined by the State Board of Health and stipulated penalties for practicing midwifery without a license. Persons practicing midwifery without a license were subject to a fine of up to $100 and/or imprisonment for up to 6 months. See Rhode Island (1918) for the full text of the law.
South Carolina	Yes	1920	Midwives were required to receive basic instruction from public health nurses in order to obtain a permit. Beginning in the early 1940s, midwives were required to be able to read and write, "see well, have average intelligence and be in good general health." New midwives were required to attend a two-week course of instruction "at an annual State or district midwife institute" before receiving a certificate "at the discretion" of the county health officer. Certified midwives were required to attend "a two weeks institute every four years." See Dodd (1920), South Carolina (1960) and Hill (2012) for details.
South Dakota	No		The practice of midwifery was unregulated (Egan 1910; van Blarcom 1913; Pennell and Stewart 1968; Butter and Kay 1988).
Tennessee	No		The practice of midwifery was unregulated (Egan 1910; van Blarcom 1913; Pennell and Stewart 1968; Butter and Kay 1988).
Texas	Yes	1907	The Medical Practice Act required applicants to be 21 years of age, of good moral character and to have graduated from a "bon fide, reputable" medical school. Applicants were examined by the Board of Medical Examiners in obstetrics, but the law did "not apply to those who do not follow obstetrics as a profession, and who do not advertise themselves as obstetricians or midwives." Persons practicing obstetrics without a license were subject to a fine of up to $500 and/or imprisonment for up to 6 months. See Daniel (1910), Egan (1910) and Texas (1916) for more details.
Utah	Yes	1907	The law required a license to practice obstetrics, but permitted the practice of obstetrics "in case of emergency" and in communities "where there are no licensed practitioners." Applicants were required to pass an examination administered by the Board of Medical Examiners. See Egan (1910) for more details.
Vermont	No		A 1906 law stipulated that the practice of midwifery be unrestricted (van Blarcom 1913).
Virginia	Yes	1919	The law required that midwives register with the local registrar and "obey the sanitary rules of the State Board of Health." Persons convicted of practicing the profession of midwifery without a permit were subject to a fine in "a sum not less than ten dollars and not more than fifty dollars." See Virginia (1918) and Pennell and Stewart (1968).
Washington	Yes	1917	The law required that applicants receive 14 months of training from a "legally incorporated school on midwifery in good standing" and pass

			an examination administered by the Board of Medical Examiners. Any person practicing midwifery without a license "shall be deemed guilty of a misdemeanor." Midwives were required to summon a physician if the mother exhibited the symptoms of abnormal labor. For details see Washington (1919), Smith (2005, pp. 55-56) and Varney and Thompson (2016, p. 143).
West Virginia	Yes	1925	The law into effect on January 11, 1926. Applicants for licensure had to be at least 21 years of age, able to read and write, show habits of cleanliness and have good moral character. A diploma from a school of midwifery or a physician's statement verifying that the applicant had attended at least five births was required. Midwives were prohibited from using forceps and from administering any type of drug. See Bickley (1990) for more details.
Wisconsin	Yes	1909	The law came into effect in December, 1909. It required applicants to have graduated from a reputable midwifery school, pass an examination administered by the Medical Board of Examiners and furnish evidence of "good moral and professional character." To be considered reputable, a school had to offer at least 12 months of instruction and practical experience in at least 20 "cases of confinement." Midwives were prohibited from using forceps and from administering any type of drug. See Wisconsin (1909) for the full text of the law.
Wyoming	Yes	1899	Examination and licensure by the State Board of Medical Examiner (van Blarcom 1913; Pennell and Stewart 1968). The law allowed the practice of obstetrics or midwifery without a license "in cases of emergency." See Wyoming (1899) for the full text of the law.

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Appendix Table 2. States and Years Covered in State-Level Analysis, 1900-1940

State	Years Covered	State	Years Covered
Alabama	1925-1940	Nebraska	1920-1940
Arizona	1926-1940	Nevada	1929-1940
Arkansas	1927-1940	New Hampshire	1900-1940
California	1906-1940	New Jersey	1900-1940
Colorado	1906-1940	*New Mexico*	1929-1940
Connecticut	1900-1940	*New York*	1900-1940
Delaware	1919-1940	*North Carolina*	1916-1940
Florida	1919-1940	North Dakota	1924-1940
Georgia	1922-1924, 1928-1940	Ohio	1909-1940
Idaho	1922-1940	Oklahoma	1928-1940
Illinois	1918-1940	Oregon	1918-1940
Indiana	1900-1940	*Pennsylvania*	1906-1940
Iowa	1923-1940	*Rhode Island*	1900-1940
Kansas	1914-1940	*South Carolina*	1916-1940
Kentucky	1911-1940	South Dakota	1906-1909, 1930-1940
Louisiana	1918-1940	Tennessee	1917-1940
Maine	1900-1940	Texas	1933-1940
Maryland	1906-1940	Utah	1910-1940
Massachusetts	1900-1940	Vermont	1900-1940
Michigan	1900-1940	*Virginia*	1913-1940
Minnesota	1910-1940	*Washington*	1908-1940
Mississippi	1919-1940	*West Virginia*	1925-1940
Missouri	1911-1940	*Wisconsin*	1908-1940
Montana	1910-1940	Wyoming	1922-1940

Notes: States that contributed data before and after a midwifery law was passed are denoted in italics.

Appendix Table 3. Correlates of Midwifery Laws

	(1)	(2)	(3)	(4)
			Restrict sample to states that required licensure by 1940	
	Midwifery License Required	*Midwifery License Required*	*Midwifery License Required*	*Midwifery License Required*
Percent Pop < 18 in Prior Census	-.007	-.029	-.037	-.066
	(.052)	(.126)	(.117)	(.198)
Percent Pop 18-65 in Prior Census	-.022	-.027	-.067	-.040
	(.063)	(.137)	(.123)	(.202)
Percent White in Prior Census	.003	-.011	-.008	-.057**
	(.011)	(.036)	(.018)	(.022)
Percent Black in Prior Census	-.035*	.017	-.037	-.017
	(.018)	(.065)	(.022)	(.048)
Percent Urban in Prior Census	-.007	.003	-.002	-.003
	(.005)	(.010)	(.008)	(.020)
Percent Female in Prior Census	-.001	.002	.013	-.024
	(.036)	(.048)	(.059)	(.100)
Percent Foreign in Prior Census	.028**	.003	.040**	.015
	(.011)	(.034)	(.019)	(.058)
Physicians per Capita in Prior Census	.000002	.000007	.000006	.00002
	(.000004)	(.000008)	(.000009)	(.00001)
N	192	192	120	120
R²	.831	.915	.665	.832
State-specific linear trends	no	yes	no	yes

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on decennial U.S. census data from 1900, 1910, 1920, and 1930. Each column represents the results from a separate OLS regression. The dependent variable is equal to one if state *s* required midwives to be licensed in year *t* (i.e., 1910, 1920, 1930, or 1940). All models control for state fixed effects and year fixed effects. Standard errors, corrected for clustering at the state level, are in parentheses.

Appendix Table 4. Births and Midwifery Laws: State-Level Analysis, 1900-1940

	(1)	(2)	(3)
Midwifery License Required	.006	.007	.015
	(.018)	(.018)	(.012)
Mean	4,251	4,251	4,251
N	1,296	1,296	1,296
R^2	.942	.946	.969
Typhoid and non-pulmonary TB	no	yes	yes
State-specific linear trends	no	no	yes

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* and *Vital Statistics of the United States*, published by the U.S. Census Bureau. Each column represents the results from a separate OLS regression. The dependent variable is equal to the natural log of live births per 100,000 female population in state s and year t. All models control for the state demographic characteristics and policies listed in Table 1, state fixed effects, and year fixed effects. Regressions are weighted by female population. Standard errors, corrected for clustering at the state level, are in parentheses.

Appendix Table 5. Maternal Mortality and Leads and Lags of Midwifery Laws: State-Level Analysis, 1900-1940

	(1)	(2)	(3)	(4)
5 to 6 Years Prior to Midwifery License Required	.055* (.029)	.038 (.030)	…	…
3 to 4 Years Prior to Midwifery License Required	-.035 (.033)	-.052 (.036)	…	…
1 to 2 Years Prior to Midwifery License Required	-.046 (.035)	-.047 (.031)	…	…
Midwifery License Required	-.096** (.041)	-.113** (.044)	…	…
Year of Law Change	…	…	-.030 (.023)	-.030 (.020)
1 to 2 Years After Midwifery License Required	…	…	-.058** (.023)	-.072*** (.023)
3 to 4 Years After Midwifery License Required	…	…	-.072** (.034)	-.090*** (.030)
5+ Years After Midwifery License Required	…	…	-.087** (.037)	-.121*** (.043)
Mean	648.3	648.3	648.3	648.3
N	1,296	1,296	1,296	1,296
R^2	.890	.913	.889	.912
State-specific linear trends	no	yes	no	yes

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* and *Vital Statistics of the United States*, published by the U.S. Census Bureau. Each column represents the results from a separate OLS regression. The dependent variable is equal to the natural log of maternal deaths per 100,000 live births in state *s* and year *t*. All models control for the state characteristics listed in Table 1, state fixed effects, and year fixed effects. Regressions are weighted by live births. Standard errors, corrected for clustering at the state level, are in parentheses.

Appendix Table 6. Estimates from Table 2 with p-Values from Wild Bootstrap

	(1)	(2)	(3)	(4)	(5)	(6)
Year Prior to Midwifery License Required	…	…	…	…	…	-.008
						(.018)
Midwifery License Required	-.076**	-.080***	-.075**	-.075**	-.077***	-.080***
	(.037)	(.029)	(.031)	(.031)	(.026)	(.027)
p-value from clustering at state level	.044	.008	.020	.019	.005	.005
p-value from wild cluster bootstrap	.052	.007	.042	.041	.003	.003
Mean	648.3	648.3	648.3	648.3	648.3	648.3
N	1,296	1,296	1,296	1,296	1,296	1,296
R^2	.865	.883	.889	.889	.911	.911
Demographic controls	no	yes	yes	yes	yes	yes
Policy controls	no	no	yes	yes	yes	yes
Typhoid and non-pulmonary TB	no	no	no	yes	yes	yes
State-specific linear trends	no	no	no	no	yes	yes

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* and *Vital Statistics of the United States*, published by the U.S. Census Bureau. Each column represents the results from a separate OLS regression. The dependent variable is equal to the natural log of maternal deaths per 100,000 live births in state *s* and year *t*. The demographic controls, which are measured at the state-year level, are described in Table 1. They include physicians per capita and the percentages of the population by age group, race, urbanicity, gender, and foreign-born status. The policy controls are described in Table 1 and include a set of physician licensing and education-related requirements, indicators for whether osteopaths and practical nurses were required to have a license, a department of child hygiene indicator, a women's suffrage indicator, and Sheppard-Towner Act spending. All models control for state fixed effects and year fixed effects. Regressions are weighted by live births. Standard errors, corrected for clustering at the state level, are in parentheses. The p-values from the wild cluster bootstrap procedure are based on 1,000 repetitions.

Appendix Table 7. Examination in Midwifery Administered by the Wisconsin Medical Board of Examiners, 1926

1. Describe the female organs of generation.

2. Give the symptoms of pregnancy during the first three months.

3. When you examine a woman in labor, how do you determine if the position is normal?

4. What would you do for the severe case of hemorrhage during labor until a physician could be called?

5. What are the symptoms of kidney trouble in the pregnant woman?

6. Describe the preparation of the woman in the beginning of labor. Also how do you prepare yourself?

7. How do you take care of the cord and the baby's eyes? Describe after care of the mother with especial reference to the nipples and genitals.

8. How do you deliver the placenta? In case a severe hemorrhage follows delivery of the placenta, what would you do?

9. If the baby does not breathe well or cry lustily, what do you do?

10. How do you feed a baby for the first three or four days? What do you use?

11. What would lead you to suspect a parturient woman would be likely to develop convulsions?

12. What benefit may be derived from your making a report of a birth? Why is it necessary so to report?

Notes: The original copy of this exam is available at http://ebling.library.wisc.edu/historical/wi-women/exam_questions.pdf.

Appendix Table 8. The Effects of Midwifery Laws Over Time: State-Level Analysis, 1900-1940

	Maternal Mortality
*Midwifery License Required * Pre-1920*	-.084***
	(.029)
*Midwifery License Required * Post-1920*	-.061**
	(.026)
Pre-1920 Mean	688.9
Post-1920 Mean	631.7
N	1,296

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* and *Vital Statistics of the United States*, published by the U.S. Census Bureau. Results from an OLS regression are reported. The dependent variable is equal to the natural log of maternal deaths per 100,000 live births in state *s* and year *t*. Controls include the state characteristics listed in Table 1, state fixed effects, year fixed effects, and state-specific linear time trends. Regressions are weighted by live births. Standard errors, corrected for clustering at the state level, are in parentheses.

Appendix Table 9. Municipality Midwifery Ordinances, 1900-1917

City and State	Year Ordinance Adopted	Description
Alexandria, Virginia	1912	Adopted on July 23, 1912. Applicants were examined by the health officer of the city. Persons found guilty of practicing midwifery without a license were subject to a fine of "not less than $5 nor more than $100."
Jacksonville, Florida	1913	Effective April 1, 1914. Applicants had to pass an examination administered by the city board of health. The city board of health, in turn, was required to provide instruction free of charge. "No test of the literacy or the education of the applicants shall form part of the examination." Any person "to assist for a compensation of any kind a woman in normal childbirth" was subject to the ordinance. Violation of the ordinance was punishable by a fine of not more than $25 or imprisonment for up to 30 days.
Los Angeles, California	1910	Applicants were required to pass an examination administered by board of health. The board of health was also tasked with investigating the applicant and refusing permits to those with a criminal history and to those found to have committed immoral acts. Practicing midwifery without a permit was punishable by a fine of up to $500 and/or imprisonment for up to 6 months.
Marquette, Michigan	1915	Applicants had to be 21 years of age, able to read and write and pass an examination administered by the city health officer. Based on the results of the examination, her qualifications and her "experience as a midwife", the city health officer was authorized to certify the applicant. Violation of the ordinance was punishable by a fine of up to $50 or imprisonment for up to 90 days.
Memphis, Tennessee	1910	Effective August 9, 1910. Applicants were required to pass an examination administered by the superintendent of health. In addition, applications for a permit had to be signed by at least three "reputable citizens and taxpayers of the city of Memphis, who certify to the good character of the applicant." Practicing midwifery without a permit was punishable by a fine of not less than $5 but not more than $50. Anyone acting as a midwife for "hire or compensation" was subject to the ordinance.
New York, New York	1907	As of November 6, 1907, midwives were required to obtain a permit issued by the New York City Board of Health (Bell 1914). According to rules adopted by the Board of Health, applicants were required to have attended at least 20 deliveries under the supervision of a

		physician. In addition, applicants had to be 21 years of age, of "moral character", able to read and write and "show evidences…of habits of cleanliness." The homes and equipment of midwives had to be available for inspection "at all times." New rules took effect on April 1, 1914. Under the new rules, applicants were required to have graduated from a registered school of midwifery. See New York Department of Health (1909), Bell (1914), New York Bureau of Child Hygiene (1915) and New York Department of Health (1915) for more details.
Norfolk, Virginia	1912	Adopted July 16, 1912. Applicants were required to receive a permit from the city health commissioner who was empowered to "refuse such permit in any case where in his judgement it is not advisable to grant the same." Violations of the ordinance were punishable by a fine of up to $20.
Raleigh, North Carolina	1912	Adopted on July 19, 1912. Midwives were required to register in the office of the board of health and provide the name and location of the "college or school or other institution from which such person received a diploma, certificate or license." Neglecting to register was punishable with a fine of $10 per day.
Syracuse, New York	1913	Effective April 7, 1913. Midwives were examined and licensed by the Board of Examiners in Midwifery, appointed by the mayor. Applicants had to be 21 years of age. The board was empowered to exam applicants "as to their moral character and qualifications to practice midwifery." Violation of the law was punishable by a fine not less than $50 but not more than $100. According to the New York Department of Health (1915), the city of Syracuse "has not exercised any systematic supervision of the midwives licensed."

Sources for Appendix Table 9

Alexandria, VA. 1913. "Births and Deaths-- Registration of." Ordinance Adopted July 23, 1912. Source: Public Health Reports (1896-1970), 28(8): 372-375. Available at: http://www.jstor.org/stable/pdf/4569281.pdf?acceptTC=true.

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Los Angeles, CA. 1910. "Midwifery and Lying-In Houses." Ordinance adopted on July 19, 1910. Source: Municipal Ordinances, Rules, and Regulations Pertaining to Public Hygiene Adopted from January 1 1910, to June 30, 1911 by Cities in the United States Having a Population over 25,000 in 1910 (1913). Washington, DC: Government Printing Office.

Marquette, MI. 1915. "Midwifery—Practice of—License Required." Ordinance adopted on October 18, 1915. Municipal Ordinances, Rules, and Regulations Pertaining to Public Health 1915 (1917). Washington, DC: Government Printing Office.

Memphis, TN. 1910. "Midwifery—Practice of." Ordinance adopted on August 9, 1910. Source: Municipal Ordinances, Rules, and Regulations Pertaining to Public Hygiene Adopted from January 1 1910, to June 30, 1911 by Cities in the United States Having a Population over 25,000 in 1910 (1913). Washington, DC: Government Printing Office.

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Norfolk, VA. 1912. "Physicians, Surgeons, and Midwives—Registration of." Ordinance, July 19, 1912. Source: Municipal Ordinances, Rules, and Regulations Pertaining to Public Health Adopted from July 1, 1911 to December 31, 1911 by Cities of the United States Having a Population of over 10,000 in 1910 (1913). Washington, DC: Government Printing Office.

Raleigh, NC. 1912. "Board of Health—Organization, Powers, and Duties." Chapter XX, Ordinance July 19, 1912. Source: Municipal Ordinances, Rules, and Regulations Pertaining to Public Health Adopted from July 1, 1911 to December 31, 1911 by Cities of the United States Having a Population of over 10,000 in 1910 (1913). Washington, DC: Government Printing Office.

Syracuse Midwifery Act, Chapter 227. Source: Charter of the City of Syracuse Consisting of Second Class Cities Law and Special Statutes Together with General Ordinances, and Rules and Regulations of the Boards, Bureaus, Offices and Departments of the City of Syracuse (1915).

Appendix Table 10. States and Years Covered in Municipal-Level Analysis, 1900-1917

State	Number of Cities in Sample	Years Covered	State	Number of Cities in Sample	Years Covered
Alabama	3	1900-1917	Nebraska	2	1900-1917
Arizona	0	…	Nevada	0	…
Arkansas	0	…	New Hampshire	9	1900-1917
California	21	1900-1917	New Jersey	32	1900-1917
Colorado	5	1900-1917	New Mexico	0	…
Connecticut	23	1900-1917	*New York*	53	1900-1917
Delaware	1	1900-1917	*North Carolina*	7	1900-1917
Florida	4	1900-1917	North Dakota	1	1916-1917
Georgia	4	1900-1917	Ohio	39	1900-1917
Idaho	0	…	Oklahoma	0	…
Illinois	10	1900-1917	Oregon	1	1900-1917
Indiana	28	1900-1917	*Pennsylvania*	66	1900-1917
Iowa	6	1900-1905	Rhode Island	10	1900-1917
Kansas	7	1900-1917	South Carolina	4	1900-1917
Kentucky	8	1900-1917	South Dakota	1	1906-1909
Louisiana	6	1900-1917	*Tennessee*	5	1900-1915, 1917
Maine	9	1900-1917	*Texas*	7	1900-1917
Maryland	5	1900-1917	*Utah*	2	1900-1917
Massachusetts	59	1900-1917	Vermont	4	1900-1917
Michigan	27	1900-1917	*Virginia*	11	1900-1917
Minnesota	8	1900-1917	*Washington*	8	1900-1917
Mississippi	5	1915-1917	West Virginia	1	1900-1917
Missouri	10	1900-1917	*Wisconsin*	21	1900-1917
Montana	6	1900, 1910-1917	Wyoming	0	…

Notes: States with cities that contributed data before and after a midwifery law was passed are denoted in italics.

Appendix Table 11. Descriptive Statistics for Municipal-Level Maternal Mortality Analysis, 1900-1917

	Full sample	Midwifery License Required = 1	Midwifery License Required = 0	Description
Maternal Mortality	16.2 (11.4)	16.4 (11.5)	16.1 (11.4)	Maternal deaths per 100,000 population
	N = 7,412	N = 3,095	N = 4,317	
Physician Diploma	.838 (.369)	.982 (.134)	.735 (.441)	= 1 if state required physicians to have a diploma
Physician Education	.760 (.427)	.921 (.271)	.645 (.479)	= 1 if state medical boards could set preliminary education requirements
Physician Exam	.294 (.456)	.396 (.489)	.221 (.415)	= 1 if state required physicians to pass an examination to be licensed
Four-Year Medical School	.310 (.463)	.467 (.499)	.198 (.398)	= 1 if state required medical schools to use a four-year curriculum
Inferior Medical School	.766 (.424)	.999 (.036)	.598 (.490)	= 1 if state medical boards could exclude graduates of "inferior" schools from being certified
Osteopathy License Law	.547 (.498)	.813 (.390)	.356 (.479)	= 1 if state required osteopaths to be licensed
Practical Nursing License Law	.110 (.313)	.209 (.406)	.040 (.195)	= 1 if state required practical nurses to be licensed
Dept. of Child Hygiene	.084 (.277)	.139 (.346)	.044 (.205)	= 1 if state had a division of child hygiene
Suffrage	.065 (.246)	.051 (.221)	.074 (.262)	= 1 if women were allowed to vote
Typhoid	28.0 (28.6)	25.7 (25.5)	29.6 (30.6)	Typhoid mortality per 100,000 population
Non-pulmonary TB	22.4 (13.8)	22.0 (13.4)	22.7 (14.1)	Non-pulmonary tuberculosis mortality per 100,000 population

Notes: Unweighted means with standard deviations in parentheses.

Appendix Table 12. Specifying Dependent Variable as ln(1 + *Maternal Mortality*):
Municipal-Level Analysis, 1900-1917

	(1)	(2)	(3)	(4)
Midwifery License Required	-.170**	-.196***	-.186***	-.056**
	(.084)	(.065)	(.058)	(.027)
Mean	17.2	17.2	17.2	17.2
N	7,412	7,412	7,412	7,412
R^2	.358	.367	.382	.480
Policy controls listed in Appendix Table 11	no	yes	yes	yes
Typhoid and non-pulmonary TB	no	no	yes	yes
Municipality-specific linear trends	no	no	no	yes

*Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Based on annual data from *Mortality Statistics* and *Vital Statistics of the United States*, published by the U.S. Census Bureau. Each column represents the results from a separate OLS regression. The dependent variable is equal to the natural log of one plus *Maternal Mortality* in municipality *m* and year *t*. All models control for municipality fixed effects and year fixed effects. Regressions are weighted by municipality population. Standard errors, corrected for clustering at the municipal level, are in parentheses.