The Impact of Midwifery-Promoting Public Policies on Medical Interventions and Health Outcomes

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Abstract

This paper measures the impact of midwifery-promoting public policy on maternity care in the United States, using national Vital Statistics data on births spanning 1989-1999. State laws mandating insurance coverage of midwifery services are associated with an 11- to 17-percentage rise in midwife-attended births. The laws did not increase rates of unassisted vaginal deliveries or lead to consistent effects on maternal mortality or APGAR scores. They did, however, lead to a statistically significant drop in neonatal deaths of about 18/100,000 births. Divergence between OLS and natural experiment estimates suggests that women are selecting into provider groups based on unobserved preferences and health.

Keywords: Childbirth; Advanced practice nursing; Supplier-induced demand

JEL classification: H51, I12, I18

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1. Introduction

The vast majority of infants in the United States are born in hospitals, with a physician managing labor and delivery care. In 1999, over 99% of birth certificates listed hospital as the location of birth and 92% listed a physician as the attendant at birth. At the same time, a growing number of women are giving birth under the care of certified nurse-midwives, mainly in hospitals and clinics.[1] Midwives differ from physicians in their training, scope of practice, financial incentives and, possibly, general approaches to childbirth care. Although the practice is still relatively small, it is a subject of heated controversy. The potential benefits to midwifery care are: reduced medical interventions, improved health outcomes, improved birth experience quality, and reduced medical costs. The potential cost is worse health outcomes in complicated or difficult deliveries.

While a traditional source of midwifery support is the "natural childbirth" movement,[2] other organizations have expressed support as well. The American Public Health Association (2001) and the consumer advocacy group Public Citizen (1994, 1995a, 1995b) have come out in favor of expanding midwifery, and the National Organization for Women (NOW) includes access to the "midwifery model of care" as a key component of reproductive choice.[3] The case for midwifery has been argued in medical, nursing and midwifery journals, in public testimony and government reports, and in the popular news and magazine press.

Among industrialized nations, the United States exhibits a combination of relatively low midwifery rates, high cesarean section rates, and high neonatal death rates (Walker, Turnbull and Wilkinson 2002). Midwifery advocates cite medical studies reporting lower intervention rates and

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[1] 93% of midwife-attended births in 1999 took place in a hospital; the remainder occurred at a birth center, clinic or private home.

[2] Also referred to as the alternative birth movement, and associated with progressive social movements of the 1960s and 1970s, its members aimed to "de-medicalize" pregnancy and childbirth (Devries 1996).

[3] The 1999 NOW resolutions are online at http://www.now.org/nnt/fall-99/resolutions.html.

better health outcomes for midwife clients, ascribe a causal link to these facts, and argue that increasing midwifery can be good for women, good for infants, and good for society. They explain that midwives provide a more personalized form of care, valuing the active role of a mother in her birth experience, and are able to achieve better health outcomes with fewer technological interventions.[4] While the appropriate level of birth intervention is itself a contested issue, reducing intervention rates, particularly the use of cesarean sections, has been a stated goal of agencies such as the World Health Organization and the Centers for Disease Control and Prevention. Estimates on rates of medically unnecessary cesareans run as high as 50% of all surgical deliveries (Sakala 1993). Separately, the evidence on birth experience quality suggests that midwife clients express greater satisfaction with their care (Turnbull et al. 1996).

Another benefit to midwifery can be a more efficient allocation of healthcare resources, shifting the input mix away from physician labor towards relatively less costly labor from midwives. Knedle-Murray et al. (1993) summarize evidence from studies that find lower maternity costs for midwifery versus physician care, and birth center versus hospital birth. Krumlauf et al. (1988) report lower costs for midwives relative to physicians, even in a hospital where the providers share the same fee schedule, and Bell and Mills (1989) describe how a California HMO reduced operating costs by introducing shared care with midwives at some of their locations. How effective is certified nurse-midwifery as a substitute for medicine in maternity support of low-risk mothers? If care is sufficiently similar between physicians and midwives, there can be social gains from increased substitution towards midwives – fewer dollars to produce the same health outcomes. The answer is important for the case of childbirth, which accounts for nearly four million hospital admissions annually in the United States, and more generally, for the use of physician extenders including physician assistants, nurse anesthesiologists, nurse practitioners, and nurse-midwives. An expansion of the role of physician extenders may be a vital source of cost reduction in the face of rising healthcare costs (Fuchs 1998). In fact, non-physician provider

[4] See, for example, the Citizens for Midwifery brochure at http://www.cfmidwifery.org/mmoc/.

groups have experienced such significant growth in recent years that some physicians expressed concern about "over-supply" (Cooper, Laud and Dietrich 1998).

Physicians have historically presented the strongest opposition to midwifery, publishing critiques in medical journals, and lobbying state and federal legislatures against its expansion (Litoff 1986, DeVries 1996). The primary case is leveled against lay midwives and planned home births, but the arguments are also applied to certified nurse-midwives managing deliveries in hospitals. Midwives are less skilled than physicians at handling complications and emergency situations that can arise during childbirth and the referral process may introduce harmful delays before necessary interventions. Risks to patients stem from misdiagnosis, inappropriate treatment, and delayed treatment. Research favoring midwifery outcomes can be challenged on the grounds of selection bias, where midwives tend to treat healthier women with uncomplicated births.

The policy debate is centered on the question of which provider group is safer for mothers and infants, and on the appropriate social tradeoff between safety, birth experience quality, and costs. This paper addresses two open questions. For a given set of births: Do certified nurse-midwives achieve lower intervention rates than physicians? Do they achieve similar health outcomes? We must confront the fact that women typically select a midwife, or are assigned to one by their HMO, taking into account their health characteristics and preferences. Even after conditioning on a host of observable factors, the selection bias will likely remain. This study addresses the challenge of patient choice by exploiting a natural experiment of changes in state insurance regulations protecting midwives. These rules may lead to an exogenous increase in midwifery, and allow a cleaner measure of its impact.

The first set of findings describes the impact of reimbursement laws on the practice of midwifery. Any Willing Provider laws prohibit health insurers from discriminating against medical provider classes or individual providers by excluding them from their networks. These broad rules offer protection to midwives and physicians and are actually found to reduce midwifery. Targeted rules, specific to midwives or advanced practice nurses, lead to an 11- to 17-percentage increase in midwifery market share. The second set of findings concerns cesarean section rates, use of forceps, vacuum extraction, and neonatal health outcomes. OLS reproduces naïve estimation in finding lower intervention rates for midwives. The effect of midwifery on birth interventions diminishes with the inclusion of state fixed effects and disappears under the natural experiment framework. Neonatal mortality, however, drops in response to midwifery-promoting policy. These results can contribute to a foundation of informed public policy on midwifery.

2. Description of Provider Types

In this paper, physicians are compared to certified nurse-midwives. The physician category includes medical doctors (MD) and doctors of osteopathy (DO), obstetricians and family practitioners. The midwives category contains only certified nurse-midwives, who are responsible for the great bulk of midwife-attended births,[5] and represent the only growing segment of the market. Certified nurse-midwives (CNM) have background in nursing and advanced training in midwifery. Students gain practical birth experience and pass a national exam prior to certification. According to the 1999 ACNM membership survey (Kovner and Burkhardt 2001), CNMs are primarily employed by hospitals (30%), physician practice groups (26%), educational institutions (8%), HMOs (6%), government (5%) and midwifery practice groups (4%). Other midwives, known variously as lay, direct-entry, professional, community, licensed, granny and traditional midwives, tend to have less formal training and possess a more heterogeneous skill set. DeVries (1996) argues that CNMs are constrained by their nursing background and hospital work environment to be more dependent on the medical model of care than other midwives. This section will discuss known differences between physicians and nurse-midwives that could lead to outcome differences. The three major areas are: skills and training, financial incentives, and philosophy of childbirth.

[5] In over 93% of midwife-attended births in 1999, the attendant was a certified nurse midwife.

In the area of skills, physicians and midwives have partially overlapping sets of capabilities. Only physicians can legally perform surgery, such as cesarean delivery, and states often limit the ability of midwives to prescribe medications or perform assisted vaginal deliveries. Midwives have background in nursing and may be more knowledgeable about, and open to, alternative and traditional low-tech methods for labor support. These activities can improve the labor experience and may serve as effective substitutes for more invasive interventions. Since midwives tend to spend more time in direct contact with laboring women, they may notice difficulties sooner than physicians or labor and delivery nurses. Further, midwives have less discretion and independence than doctors, and may be more likely to seek specialist referral or consultation than family practice physicians.

CNMs and doctors may also face different financial incentives from their opportunity costs of time, compensation schemes, and vulnerability to liability risks. Economists use the term supplier-induced demand to describe the incentive problem arising from situations of asymmetric information in which the same expert individual diagnoses need and provides treatment. Medical services and car repair are prototypical examples. In obstetrics, the danger is from providers recommending and performing birth interventions that are not in the best interests of the patient.[6] Since midwives face weaker incentives to promote interventions, particularly surgery, physician-induced demand in maternity care should appear as a wedge in intervention rates between the two provider types.

The third major difference is philosophy of birth, the provider's general attitude towards childbirth and approach to the maternity care. Midwifery promotional materials often contrast the "midwifery model of care" to the "medical model." In the former, birth is perceived as a natural process, and emphasis is placed on supporting the mother as an active participant in shaping her desired birth experience. By comparison, it is claimed, the medical approach highlights the risks

[6] Best-selling feminist author Naomi Wolf noted this phenomenon in her depiction of the high-tech birth experience of her first child in *Misconceptions: Truth, Lies and the Unexpected on the Journey to Motherhood*.

of childbirth, viewing the event as inherently medical, even pathological, requiring hospital admission and technological intervention.[7] Providers of either type can adopt the midwifery model, but midwives are universally trained in it.

Taken together, these factors can potentially produce lower intervention rates, lower costs, better health outcomes, and better patient satisfaction from an expansion of midwifery. Alternatively, there may be a cost-quality tradeoff where midwives lower training leads to worse outcomes. Whether that is in fact the case, however, remains an empirical question. This paper assesses the impact of enacted policies, and its results predict the likely effects of similar policies in other states.

3. Previous Literature

Previous studies into the economics of childbirth have considered physician incentives. Gruber and Owings (1996) found evidence of supplier-induced demand in the relationship between declining fertility and cesarean rates at the county level, and Gruber, Kim and Mayzlin (1999) demonstrates a systematic positive association between Medicaid fee differentials (paid for cesarean versus vaginal deliveries) and rates of cesarean sections. Other studies have related patient insurance coverage to birth interventions and outcomes (Stafford 1987, Stafford 1990, Currie and Gruber 2001). This body of evidence suggests that physicians respond to financial incentives in determining appropriate care. The results of this paper will provide an additional test, from a new angle.

The current literature comparing midwives and physicians, published primarily in medical and nursing journals, can be classified into three categories. As shown in Table 1, the types are: (1) observational, (2) non-random clinical, and (3) randomized clinical. Each row summarizes the results of a given paper, with the columns indicating the outcome measures. At the most

[7] See the Citizens for Midwifery brochure at http://www.cfmidwifery.org/mmoc/ for a description.

basic level, the studies are each comparing average outcomes between midwife and physician patients. Since researchers understand that patients are not distributed randomly across provider types, they face a fundamental challenge in finding an appropriate control group.

In practice, researchers use three methods to generate useful comparisons. The regression framework characterizes the first approach, controlling for observable differences in women that would predict outcomes differences. In theory, if enough factors are included as covariates, the distribution of women across provider groups can be exogenous conditional on covariates, and consistent estimates can be produced. The second approach is related, but works instead on a sub-sample of women. For example, repeat cesarean sections, and high-risk pregnancies are more likely to be in the physician group. If those births are excluded from analysis, the two groups are more similar from the outset. As in the regression approach, the quality of the measure depends directly on the ability of the researcher to identify and sample on relevant factors. Observational studies and non-random clinical studies rely entirely on these two techniques.

Among the studies of those types, midwifery is found to reduce interventions and improve infant health. MacDorman and Singh (1998) run regressions with controls for health and demographic characteristics of the mother obtained from birth certificates, and only include vaginal births at term in their sample. They use linked birth-death records and find that midwife clients experience reduced rates of low birth-weight infants and neonatal death. Findings from the non-random clinical group are: lower use of forceps, lower rates of episiotomy and perineal laceration, less continuous fetal monitoring, and lower use of epidurals for pain management. As for health outcomes, no effect was found on birth-weight or five-minute Apgar scores.[8]

The third method, a direct enactment of the scientific method, is random assignment of women to provider groups. Chambliss et al. (1992) randomly assign low-risk women between midwifery and physician care at the time of hospital admission. Hueston and Rudy (1993)

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[8] APGAR scores are routinely evaluated at one minute and five minutes after birth. The score ranges from zero to ten, with up to two points for each: Activity (muscle tone), Pulse, Grimace (reflex irritability), Appearance (skin color), and Respiration.

achieves pseudo-random assignment by taking data from a rural clinic where patients are assigned to a provider (family practitioner or certified nurse-midwife) based on a system of rotating call. Harvey et al. (1996) reports the outcome of a midwifery trial program in Alberta where pregnant women volunteered for midwifery care. About half were assigned to the midwifery group and the rest found care from other local providers. Finally, Turnbull et al. (1996) uses random assignment within a U.K. hospital to compare midwife-managed care to jointly-managed care. Note that, in contrast to the other studies, Chambliss et al. (1992) find a positive association between midwifery and cesarean rates, statistically significant at P=0.082 level. The findings are not fully consistent, even within the randomized group. Another example of conflicting results, not listed in the table, is the case of prenatal amniotomy; Hueston and Rudy (1993) found a positive 6% effect of midwifery, while Harvey et al. (1996) found a negative 13% effect.

Random assignment of women across provider types sets the standard for producing clean estimates of the impact of midwifery. However, clinical studies using randomization tend to suffer from small sample size, which limits the outcomes that can be explored. Turnbull et al. (1996) studies the largest population with 635 women in the midwifery group and 643 in shared-care. The smallest is Chambliss et al. (1992) with 222 women in midwifery care and 246 in physician care. This paper improves on the non-random studies by including a wider set of covariates, regional fixed effects to control for unobserved, time-invariant factors, and year fixed effects for national trends, as well as by taking a serious approach to the selection bias. Evidence is produced, which complements the randomized trials, through use of extensive national data and the natural experiment strategy. As in the observational study by MacDorman and Singh (1998), we are able to consider mortality rates as an outcome. Another potential benefit to this approach is the identification of the effect over a population of interest to policy-makers. Outcomes resulting from actual policy changes should be good predictors for other similar policies. The randomized trials measure the effect of midwifery over quite different populations of women – Alberta study volunteers, low-income rural Kentucky women, and patients at a Washington state tertiary care hospital – which could produce different estimates in the face of heterogeneous treatment effects.

An additional contribution of the paper is the "first stage" analysis of how regulation, insurance reimbursement rules in particular, affects midwifery market share. Declercq et al. (1998) find that state regulatory support of midwifery is positively correlated with midwifery prevalence. Their measure of state support is a weighted scale of regulatory climate and reimbursement rules, combining factors such as: midwife membership on the regulatory board, prescriptive authority, hospital admission privileges, third-party reimbursement coverage, and insurance coverage of freestanding birth centers. Adams et al. (2003) retains components of the midwifery practice environment as separate regressors, including insurance reimbursement rules, prescriptive authority, physician supervision, and the legal status of lay midwifery. They group Any Willing Provider laws together with the more focused midwifery reimbursement laws and find a positive relationship between reimbursement laws and midwifery. Their analysis relies solely on cross-sectional variation between states for identification and they are unable to control for unobserved differences in state health or tastes with fixed effects. This paper measures the impact of each type of reimbursement law, controlling for a host of observable and unobservable differences across states and year effects to remove national trends. While midwifery reimbursement laws are found to increase midwifery share, Any Willing Provider laws are not.

4. Maternity Care and Selection Bias

In setting up the framework for the empirical analysis, it is useful to begin with the basic regression equation:

$$Y_{it} = \beta_0 + \beta_X X_{it} + \beta_{MW} MW_{it} + \varepsilon_{it}$$

in which Y_{it} represents an outcome of interest, either an intervention rate or a health measure. X_{it} contains controls – observed factors that predict Y_{it} – and MW_{it} indicates midwifery. The indexing is by region *i* and time period *t*. In order for ordinary least squares (OLS) regressions to yield unbiased estimates, the error term ε_{it} must be uncorrelated with the regressors. This section will describe typical events in childbirth and indicate sources of bias, stemming from non-random assignment of women to providers by underlying health or tastes for care.

The generic birth timing is as follows. First, a woman chooses her medical provider to maximize expected utility, considering her overall health and pregnancy risks, her preferences for technological birth interventions, medical provider characteristics, and effective prices of care given her insurance status. During the course of pregnancy and birth, each woman receives a random health outcome. This can be an unanticipated complication, such as breech presentation, or pregnancy-related hypertension. After observing the shock, the provider may respond by transferring the case to specialist care, and recommending the use of birth-assisting interventions. We can think of each provider as having a personal mapping from pregnancy state to preferred interventions. After interventions, another random shock occurs, and the maternal and infant health outcomes are revealed.

The selection bias can enter at several stages, mainly through factors that are known to women and medical care providers but not to the researcher. First there is the constraint: the set of provider choices that the woman faces is determined by her insurance coverage, location of residence, wealth, and health characteristics. Most birth clinics and hospitals will only accept low risk patients for midwifery care. The selection criteria can include factors from the woman's medical history that are not recorded on the birth certificate, leading to a sorting of healthier women to midwives, even after controlling for observables. There can also be correlations between geographic availability of midwifery and regional characteristics. If these features are static over the period of analysis, however, regional fixed effects should absorb the bias.

Choice, or unobserved preferences, forms the next source of bias. Again at the first stage, the pregnant woman considers her health and preferences in choosing a provider. Our expectation is that women who are healthier, and who desire a more natural birth experience, are more likely to opt for midwifery care, and conversely, a woman expecting a cesarean delivery will choose obstetric care.

Finally, bias can arise from the systematic and unrecorded transfer of care to physicians for complicated pregnancies and births. Patients who experience negative shocks during the course of pregnancy and childbirth are more likely to request or require a transfer to physician care. Even if providers were identical, this sorting leads to more interventions and worse outcomes in the physician group. Clinical studies can make use of intention to treat criterion to associate women with their initial provider type. This option is not available in birth certificate data, which includes information about a single “attendant at birth.”

Together, constraints, choice, and transfers comprise the crux of the problem. As a result, midwifery is likely to be correlated with the error term. While the sorting can take either direction, if it is in fact healthier women, with stronger tastes for natural childbirth, who are more likely to hire midwives, then OLS estimates will be biased in favor of finding a negative impact of midwifery on intervention and mortality rates.

5. State Reimbursement Laws as a Natural Experiment

This research uses state reimbursement laws as a natural experiment to measure the effect of midwifery. Adoption of state third-party reimbursement laws covering nurse-midwifery services is seen as an exogenous change that boosts midwifery market share. The laws mandate that insurers who provide coverage for services in the nurse-midwifery scope of practice reimburse nurse-midwives for provision of care. They can be general, in the form of Any Willing Provider rules, or tailored to nurse-midwives or advanced-practice nurses. Both types of laws prohibit discrimination against a class of providers. Any Willing Provider laws also prohibit discrimination within classes against particular providers. They require managed care plans to include any qualified provider willing to accept the terms of their plan. Table 2 lists states that have implemented these rules along with the year that each law came into effect. These dates were obtained from an American College of Nurse-Midwives (ACNM) fact-sheet, and verified using the ACNM Handbook of State Laws and Legislation and State Law Universe from Lexis-Nexis. During the time period of this study, eighteen states adopted laws to provide insurance coverage for nurse-midwives.

The laws affect midwifery at the first stage of the childbirth story – provider selection. As described, a woman chooses her provider type in order to maximize expected utility from the birth. The relevant prices are the effective prices that the woman faces, given her insurance coverage, and not the underlying costs of labor. Women who are uninsured, whose insurance does not include maternity care, or whose health insurance already covers certified nurse-midwifery services, will experience no change in their effective prices resulting from the law.

One concern is the potential endogeneity of the law. What leads to the adoption of legislation promoting midwifery? If it is lobbying efforts from organized midwives and other nursing proponents, unrelated to state-specific trends in the population health or preferences, the law can be used to provide a clean measure of midwifery. However, if the laws emerge in response to increased preferences for natural birth, or general health improvements, there is no natural experiment. This issue cannot be tested directly, but evidence supporting the exogeneity of the laws is presented in Section 8.

The variation in state laws is exploited for estimation in two ways: directly, using differences-in-differences (DID) to compare states that switch to other states over time, and as an instrument for midwifery prevalence in instrumental variables (IV) estimation. In the DID framework, the regression equation takes the form:

$$Y_{it} = \beta_0 + \beta_X X_{it} + \beta_{LAW}\text{ReimbursementLaw}_{it} + \varepsilon_{it}$$

where the regressor of interest is now the reimbursement law, a dummy variable set to one in states, after adoption. As in the ordinary least squares (OLS) model, state or county fixed effects are included, as well as year fixed effect. The IV regressions share the regressor of interest with

OLS: midwifery. While IV and DID both exploit the natural experiment for identification, their results have different interpretations. The coefficient on reimbursement law is the reduced form measure of the effect of the laws, while the IV coefficient on midwifery predicts the impact of an exogenous increase in midwifery share on outcomes. The natural experiment approaches both measure the average treatment effect of midwifery over the population of women influenced by the law. They can diverge from OLS for two reasons: selection bias and heterogeneity in treatment effects. The natural experiment achieves identification through women who would choose a physician in a state without a law and a midwife in the same state with one. These women are probably healthy and low-risk, price sensitive, and they do not have very strong preferences for one provider group over the other. The local average treatment effect on this sub-population may not be the same as the average treatment effect on the entire population. However, this sub-population is an interesting one to consider for policy purposes as they represent a marginal population, responsive to policy state.

6. Empirical Framework

Although Vital Statistics data is available at the individual birth level, leading to a potential 44 million observations, the analysis in this paper is primarily based on pooled units of observation – either the state or county level. Aggregation creates a more manageable dataset, and corresponds to the level of observation in the linked data sources. Identification of the midwifery effect using natural experiment approaches is itself only based on state-year level variation, so we are not sacrificing precision in estimating the main effects. In the basic regression equation, the regional index i is now for county or state. The X_{it} and MW_{it} controls are means of the individual values. For example, instead of an indicator variable for cesarean section outcomes, the dependant variable will be a proportion, the fraction of births in region i at time t delivered by cesarean.

A variety of outcome measures are explored: cesarean section rates, rates of instrumental vaginal delivery, Apgar scores (means, and fractions below different cutoffs), and mortality rates for neonates and mothers. The controls X_{it} include (1) birth characteristics: location, plurality, gestational age, sex of child, father's race; (2) maternal characteristics: previous births, previous cesarean section, marital status, race, age, education, (3) financial factors: insurance coverage (uninsured, managed care, Medicaid, Medicare, military), female labor force participation,[9] income; and (4) pregnancy risk factors: anemia, cardiac disease, lung disease, diabetes, genital herpes, hydramnios/oligohydramnios, hemoglobinopathy, hypertension, eclampsia, incompetent cervix, previous infant 4000+ grams, previous infant pre-term, renal disease, Rh sensitization, uterine bleeding, and other recorded medical risks.[10] Because of the panel feature of the data, arbitrary non-linear time trends are captured with year fixed effects, and regional differences are controlled with county or state fixed effects, depending on the regression.

In aggregating the individual level data up to state or county level, means are used for most variables. In cases where non-linear or even non-monotonic effects were expected, such as plurality, birth order, maternal education, gestational age, and maternal age, fractions above and below thresholds are used.[11] In regressions using county level data, standard errors are clustered at the state-year level, allowing for arbitrary correlations within clusters, and only assuming error independence across them. The regressions are weighted by number of births, producing more efficient estimates. Results were not significantly different without weighting.

Some studies of cesarean rates and birth outcomes have included labor complications as part of the analysis, either looking for differences in providers' diagnosis actions, and response to

[9] Female labor force participation was used as a proxy for tastes. Results were not sensitive to its removal.
[10] Smoking and alcohol consumption during pregnancy, which also appear in birth certificate data, were not included in the base specifications since they were factors that may have been outcomes of prenatal care provided, and the expansion of midwifery. When they were included for robustness, they were not statistically significant and had little effect on the midwifery coefficients.
[11] The variables used were means of: multiple births (twins or higher), first live birth, mother is a high school graduate, mother is a college graduate, short gestation (<36 weeks), long gestation (>42 weeks), mother is a teenager, and mother is over 40.

similar conditions, or as an additional control for the health risks associated with the birth. Other researchers (Dubay et al. 1999, MacDorman and Singh 1998) included some labor progress variables in models predicting use of cesarean section and infant health outcomes. For comparability, additional regressions were run using the same framework as above, and including the following indicators of labor progress: abruptio placenta (premature separation of a normally implanted placenta from the uterus), breech or malpresentation, dysfunctional labor, cephalopelvic disproportion, cord prolapse, excessive bleeding, fetal distress, precipitous labor (< 3 hours), and prolonged labor (>20 hours).

Several functional forms were considered for the intervention rate and health outcome equations, and results are presented using the log-odds transformation on the dependant variable, corresponding to a grouped logistic model. This specification is preferred since it produces predicted values limited to the interval from zero to one. For robustness, the regressions were also run using a linear model and logarithmic transformation, producing substantially similar results.[12]

7. Data Description

Maternal and pregnancy characteristics were obtained from the 1989-1999 Natality Detail Files, distributed by the U.S. Department of Health and Human Services National Center for Health Statistics. The files constitute a record of all live births in the United States during the period. Each record lists the state and county of occurrence, but small counties are grouped together, identifying 517 county groups, from the 3,066 U.S. counties. Data were averaged up to state-year and county-year levels and linked with several supplemental sources. Health insurance coverage was constructed from two sources. The 1989-1999 March Current Population Surveys (CPS) provided regional data (22 regions in the United States) on Medicaid, Medicare, and military health-

[12] When comparing marginal effects of midwifery on interventions and outcomes (β_{LINEAR}, $\beta_{LOG} \cdot \overline{Y}$, $\beta_{LOGODD} \cdot \overline{Y} \cdot \left(1 - \overline{Y}\right)$), the signs were the same across specification, and the magnitudes were within 10%.

care coverage rates for women aged 16-55, and the National Center for Health Statistics publication *Health, United States, 2001* provided HMO enrollment rates and uninsured rates for states.[13] Female labor force participation rates were also obtained from the March CPS files,[14] and per-capita personal income was added using Bureau of Economic Analysis data.

Mortality rates were from the CDC Wonder database. Neonatal mortality (deaths 0-27 days after birth) was used rather than infant mortality (death in the first year), since the latter is more likely to be influenced by external factors occurring after birth. Neonatal mortality rates were obtained at the state-year level and the county-year level. State level data is preferred since the rates are not available for smaller counties. While neonatal death is not common, maternal death from childbirth is extremely rare in the United States (averaging 8 deaths per 100,000 live births). These rates could only reasonably be collected at the state-year level, and were calculated by dividing the number of maternal deaths by the number of newborns.

Summary statistics for the major variables are detailed in Table 3. Over the sample period, midwives attended about 5.3% of births, going from 3.3% in 1989 to 7.3% in 1999, a 120% increase. At the same time, the cesarean rate went from 22.9% to 22.0%. In 1999, the states with the highest and lowest cesarean rates were Mississippi (27.0%), Louisiana (26.9%), New Jersey (26.1%), Utah (16.0%), Alaska (14.7%) and Hawaii (13.8%), while midwifery achieved greatest and least market penetration in New Mexico (27.0%), New Hampshire (16.8%), Georgia (16.3%), Mississippi (1.6%), Arkansas (1.5%) and Missouri (1.1%). Table 3 also presents variable means for states based on their adoption of midwifery reimbursement laws. The first column (Early) shows states that passed such laws prior to the sample period. Next are states that adopt between 1989 and 1999, "Sample" adopters. Finally, states that do not adopt by 1999 are the "Non" group.

[13] Values were simulated using linear interpolation for missing years: 1989, 1991 for uninsured, and 1989, 1991-1993 for HMO enrollment.
[14] Interpolated for the missing year 1994. While interpolation of these variables enables us to retain most of the sample for analysis, the regressions were also conducted on the reduced sample without interpolation, and the parameters of interest were substantially similar.

While the groups are similar in many respects, states with midwifery reimbursement rules have higher midwifery shares and rates of HMO enrollment than other states.

8. Reimbursement Laws and Midwifery

The first set of results relate to the effect of reimbursement laws on the proportion of births attended by midwives, and are summarized in Table 4. Here we determine that midwifery reimbursement laws fit our model and are positively related to midwifery, while Any Willing Provider laws are not. Together, these relationships indicate that there are women who go to midwives who would prefer to go to a physician, if prices were equal, as well as women who would prefer midwives who are being treated by doctors.

Midwife reimbursement laws are associated with a 0.5 percentage point (birth level), 0.6 percentage point (county level) and 0.9 percentage point (state level) increase in births attended by midwives, which represents an 11- to 17-percentage increase in midwifery. Some other predictors of midwifery are shown in the table. As expected, several pregnancy factors show a negative association, such as hypertension, uterine bleeding, hospital birth and previous cesarean. The positive association of anemia and genital herpes (only significant at the county level) with midwifery indicates a sorting to midwifery of women facing higher risks along some observed dimensions.

The most surprising result is that Any Willing Provider laws do not increase midwifery market share. Instead, they lead to a decline in use. This relates to the crucial difference between the two types of laws. While midwife reimbursement laws always make midwives weakly more attractive, Any Willing Provider laws can go either way. On the one hand, if the managed care organization did not cover midwives, the law can add some midwives to the network (reducing the effective price of midwives for enrolled women). On the other hand, if more physicians become available in the covered network, the midwives in the group can become relatively less attractive. In that case, where midwives are more attractive than physicians in the original network, but less attracted in the expanded network, women will switch from midwifery to physician care in response to the laws. The sign of the any willing provider law coefficient indicates that the latter mechanism was more important than the former. The impact of any willing provider laws thus includes a combination of the effect of switching from midwives to physicians, as well as switching provider within the physician group. The law is not useful for isolating and measuring the impact of midwifery. For the rest of the analysis, any willing provider law indicators are included as controls, but only midwife reimbursement laws are used for evidence concerning midwifery.

Table 5 contains evidence supporting the exogeneity of the midwife reimbursement laws. Regressions were run on the equations:

$$\mathrm{MW}_{it} = \beta_{MWLB}(\text{Before MWL})_{it} + \beta_{MWLA}(\text{After MWL})_{it} + \beta_X \mathrm{X}_{it} + \varepsilon_{it}$$

$$\text{C-sect}_{it} = \beta_{MWLB}(\text{Before MWL})_{it} + \beta_{MWLA}(\text{After MWL})_{it} + \beta_X \mathrm{X}_{it} + \varepsilon_{it}$$

where X_{it} contains the full set of controls as well as fixed regional and year effects. The Before and After variables are indicators of being in a state, which adopts at some point, in the years preceding and following adoption of the reimbursement law. They are set to zero for states that do not adopt, and for adopting states in the year of adoption. The coefficients measure the additional impact of being in such a state, beyond the national time trend, state fixed effect, and other controls. Identification is based on variation in adoption and years of adoption. Unlike the After coefficients on midwifery, the Before coefficients are not statistically significant for either dependant variables at either unit of observation. This shows that adopting states displayed similar time trends compared with other states in the years prior to adoption. It is evidence against a pre-existing differential trend in tastes causing a systematic increase in the use of midwives or decrease in cesarean sections and leading up to the reimbursement laws. Figure 1 contains a graphical depiction of the timing of effects, broken down into groups of years before and after. The B7+ category only includes four states, and may not be reliably estimated. None of the other before coefficients are individually statistically different from zero, and a joint F-test on all of the before coefficient fails to reject zero.[15] The figure shows a jump in midwifery immediately following the law, indicating a significant positive impact on market share.

9. Impact of Midwifery on Interventions and Outcomes

Having established that midwife reimbursement laws are a useful source of variation for predicting midwifery, we turn to estimating their impact and the impact of midwifery on birth interventions and outcomes. Results concerning major birth interventions are summarized in Table 6. The OLS methodology measures a large impact of midwives in reducing use of cesarean sections, vacuum extraction and forceps. As a rule, these effects are diminished in magnitude by the inclusion of county-level fixed effects. The coefficient estimate on unassisted vaginal deliveries (without forceps or vacuum assistance) is 0.57. This implies that a doubling of midwifery market share (a 5.3% increase) will lead to a 2.3 percentage point increase in the rate of unassisted vaginal deliveries, a 7.5% drop in interventions. Adding labor progress complications further attenuates the estimates, producing a coefficient on unassisted vaginal deliveries of 0.54.

As for the differences-in-differences results, no statistically significant effects were measured for rates of unassisted vaginal deliveries. All of the point estimates of interest reversed in sign, and a positive effect on cesarean rates was found, significant at the 95% level. This change indicates that OLS overestimated the role of midwives in reducing interventions. The likely cause is selection bias, either through maternal preferences or unobserved health. A Durbin-Wu-Hausman augmented regression test was conducted for the exogeneity of midwifery.[16] In predicting unassisted vaginal deliveries, the coefficient on the midwifery residual is 7.01, and exogeneity is rejected at the 95% level. The DID method produced a positive and significant coefficient for midwifery laws on cesarean rates. While this surprising result corresponds

[15] $F(4,491)=1.26$, with a P-value of 0.29.

[16] In the first stage, MW_{it} is regressed on the set of controls X_{it} and $MWRLaw_{it}$. The residuals are constructed and the augmented regression is run on $Y_{it} = MW_{it}\beta_{MW} + MW\_residual_{it}\beta_{RES} + X_{it}\beta_X + \varepsilon_{it}$. Testing the significance of β_{RES} is an exogeneity test on MW_{it}.

with the Chambliss et al. (1992) finding, we should note that the IV coefficient, though also positive, was not statistically significant. In terms of policy considerations, we should focus on the DID and IV results. In particular, policies aimed at reducing cesarean rates though an expansion of midwife-attended births, are not likely to succeed. In fact, they may have the opposite effect.

A different story emerges for the case of health outcomes. No consistent results were found using Apgar scores, birthweight or maternal mortality as the dependant variable. In the sample, neonatal mortality is significantly more common than maternal death from childbirth, and exhibits a greater deal of variation. Table 7 shows results for neonatal mortality.[17] Since neonatal death is still rare (average of 525 for every 100,000 live births), state level data are more reliable than county level. The main results are presented at the state level (columns one through four, and six). For robustness, county-level regressions were run using data from large counties (with over 8,000 births per year during the sample period), reported in column 5. County level regressions produced estimates with the same sign and order of magnitude as state level regressions, although none of the results were statistically significant at the county level.

Turning to the state-level results, the first regression had no control variables, and shows a strong negative relationship between midwifery and neonatal mortality. Once the baseline set of controls are added, without state fixed effects, the sign flips for midwifery. This change means that midwives are seeing women with *less* risky pregnancies, as predicted by the full set of *observable* controls variables. When regional fixed effects are included, and then labor progress controls, the sign on the coefficient returns to negative. This shows that midwifery is more prevalent in states with higher neonatal death rates, conditional on other observed predictors. Contrary to our prediction that midwife clients would be healthier, the sign change indicates that midwives see women with *more* risky pregnancies, based on *unobserved* factors. This is further supported with the DID results, where midwifery is shown to reduce neonatal death rates, an effect which

[17] Analysis was also conducted using death rates within the first week of life, yielding results quantitatively and qualitatively similar to those using neonatal mortality.

grows when labor progress is included (Column 4). The coefficient estimate is negative 0.036. The implied marginal effect at the mean of the dependent variable indicates that midwifery reimbursement laws reduce neonatal mortality by about 18 deaths per 100,000 births. The average drop in neonatal mortality from 1989 to 1999 among states that adopted midwifery reimbursement laws was 154 deaths per 100,000 births; the laws can apparently account for 11.7% of the total decline. Here again, the augmented regression test rejects exogeneity of midwifery at the 95% level. The direction of the bias is to increasing the measured effect of midwifery on neonatal mortality.

After controlling for selection, the estimated effect of midwifery in reducing neonatal deaths is quite large, possibly unreasonably so. The instrumental variables and differences-in-differences coefficients are remarkably consistent, [18] and imply an effect of midwifery an order of magnitude larger than the OLS estimates. Consider again the impact of doubling midwifery, a 5.3% increase. The predicted reduction in neonatal deaths is 105 per 100,000 births, which greatly exceeds 28 per 100,000 births, or 5.3% of the total neonatal death rate, the drop that we would expect if the births that switched as a result of the laws went from the average mortality rate under physician care to zero mortality under midwifery. The standard errors are quite large, however, and the 90% confidence interval is a reduction of between 11 and 190 deaths per 100,000 births. While the upper end of the interval is outside of any reasonable value for the treatment effect, it is possible that midwife reimbursement laws have a larger effect on use of midwives for prenatal care or joint-care than on midwife-attended births. It is also possible that the insurance laws improve the general allocation of women to providers, inducing some healthier women to hire midwives, leaving openings with physicians for higher-risk lower-income women. While estimation fails to provide precise point estimates, it does provide strong support for the

[18] β_{MW} is roughly two orders of magnitude larger than β_{MWL}, corresponding closely with the state-level estimates that the reimbursement laws increase midwifery by 0.9%. The estimates in Table 3.6 share this feature; ratios of β_{MWL}/β_{MW} for medical interventions are close to 0.006, the county-level estimated impact of the reimbursement laws.

more limited inference: a marginal expansion of midwifery did not lead to worse health outcomes for women or for infants.

There is a concern that, in the presence of errors which are serially correlated within states, DID will yield downward-biased standard error estimates (Bertrand, Duflo and Mullainathan 2002). Column 6 addresses the issue with robust standard error estimates clustered by state. The midwife reimbursement law effect remains significant at the 95% level. As a further robustness check, to account for potentially heterogeneous time trends in the dependant variables, the year fixed effects were interacted with dummy variables for geographic region (using 9 regions) and, in an alternative specification, for population size quintile. Although the interaction terms were themselves statistically significant, their inclusion left the instrumental variables estimates for the impact of midwifery on birth interventions and neonatal mortality qualitatively and substantively unchanged.[19]

10. Conclusion

The results of this paper constitute direct evidence concerning the impact of recently enacted midwifery-promoting insurance rules. They also provide indirect evidence regarding the potential impact of an expansion of midwifery, and on the nature of patient selection in maternity care. First, state level midwife reimbursement laws were identified as boosters of midwifery, while Any Willing Provider rules were not. While midwifery was associated with lower intervention rates in direct OLS estimation, it was not the case for the natural experiment approach, suggesting that midwifery clients are healthier or have different tastes for interventions than physician clients. Neonatal mortality decreased following the passage of midwife reimbursement laws. In this case, comparison with OLS indicated that midwife clients were less healthy, conditional

[19] For example, the IV β_{MW} on neonatal mortality at the state-year level of observation was -2.93 with year*size interactions and -3.75 with year*region interactions. The β_{MW} estimates produced with the additional parameters were not statistically different from the baseline estimates or from zero.

on the observable factors. Provider selection based on health factors is complex, and multi-dimensional, sometimes favoring midwives and sometimes physicians. The selection by tastes seems to systematically favor midwives serving women who want less intervention or a more "natural" birth experience.[20]

An apparent puzzle is how midwives are able to achieve lower mortality rates if they are providing the same care. One answer is that the care is not the same. This study only considered rates of major birth interventions, and did not factor in alternative or traditional labor support, emotional support, interaction time with the provider, or other features of care that might differ across provider groups. Further, the data only cover the birth itself, but certified nurse-midwifery practice also includes prenatal, post-partum and neonatal care, areas where midwives may provide unique care.[21] Reimbursement laws that increase midwifery presence in birth attendance would most likely increase midwifery in these areas as well, potentially in greater proportion than the increase in recorded share of births attended by midwives. Another possibility is that midwives provide the same average intervention rates, but their use of interventions is more tailored to medical need, and less sensitive to financial considerations. It is important to keep in mind that the margin of substitution is not entirely between midwives and physicians; some of the substitution can be between midwives and registered nurses.

The overall picture of midwifery that emerges is one of a skilled provider group, capable of producing outcomes that compare favorably with those of physicians, which is also not substantially different in its use of major childbirth assisting technologies. This suggests potential welfare gains from an expansion of midwifery in the current United States health care system, and that targeted legislation is more effective than general Any Willing Provider rules for increasing midwifery.

[20] These "tastes" may be the result of religious, political, or ideological factors.

[21] According to CDC mortality data, for the period 1978-1998, the most commonly reported causes of death for infants in the United States under 28 days of age were: conditions originating in the perinatal period (ICD-9 codes 760-779; 68.6% of deaths), congenital anomalies (ICD-9 codes 740-759; 23.7% of deaths), and ill-defined and unknown causes (ICD-9 codes 797-799; 2.0% of deaths).

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Table 1: Previous Findings on the Impact of Midwifery on Birth Interventions and Neonatal Outcomes

	Induction/ Stimulation	Fetal Monitoring	Pain Medication	Cesarean Delivery	Assisted Delivery	Episiotomy	Neonatal Health
Study Type 1: Observational							
MacDorman & Singh							- neonatal death - low birthweight
Study Type 2: Non-Random Clinical							
Davis et al.	-22%		-42% epidural -4% narcotic	-4%	-12%		0 Apgar<7
Oakley et al.	0	-34% constant -17% internal	-25% epidural -11% analgesia	-6%	-7% forceps 0 vacuum	-27% episiotomy -3% abrasion -16% laceration	
Rosenblatt et al.	-14%	-11% constant	-12% epidural	-5%	-6% forceps 0 vacuum	-27% episiotomy	0 Apgar<7 0 birthweight
Study Type 3: Random and Pseudo-Random Clinical							
Chambliss et al.	-25%		-12% analgesia	+2%	-5% forceps -2% vacuum	-25% episiotomy -6.8% laceration	0 Apgar<7
Hueston & Rudy	0		0 epidural 0 analgesia	0	0	-3% episiotomy -1% laceration	0 Apgar<6 0 transfer to Neonatal ICU
Harvey et al.	0		0 epidural	-11%		-17% episiotomy 0 laceration	0 Apgar<7 0 birthweight -2% transfer to Neonatal ICU
Turnbull et al.	-10% induction		0	0	0	-6% episiotomy 0 laceration	0

Cells contain percentage point differences in rates of induction/stimulation, fetal monitoring, pain medication, cesarean delivery, assisted vaginal delivery, episiotomy, mortality, transfer to NICU, and means of Apgar score and birthweight, measured as midwife – physician.

Table 2: State Reimbursement Laws Covering Nurse-Midwives

Midwife Reimbursement Laws	
Washington	1973
Utah	1979
Maryland	1979
Mississippi	1979
New Mexico	1979
Oregon	1979
South Dakota	1980
Alaska	1981
Pennsylvania	1981
Florida	1982
New Jersey	1982
Minnesota	1983
New York	1983
West Virginia	1983
Connecticut	1984
Massachusetts	1985
Nevada	1985
New Hampshire	1985
Ohio	1985
Colorado	1987
Arizona	1991
California	1991
Rhode Island	1991
Delaware	1992
Montana	1993
North Carolina	1993
Tennessee	1994
North Dakota	1995
Iowa	1996
Virginia	1997
Hawaii	1999
Maine	1999

Any Willing Provider Laws	
Louisiana	1984
Wyoming	1991
Utah	1993
Idaho	1994
Kentucky	1994
Washington	1995
Texas	1997

Source: American College of Nurse-Midwives (ACNM) Fact Sheet "Third Party Reimbursement for CNMs: State Laws."

Table 3: Descriptive Statistics

Variable	All States		By Reimbursement Law		
	Mean	S.D.	Early	Sample	Non
Midwife-attended births	0.053	0.035	0.065	0.060	0.031
Birth location hospital	0.989	0.007	0.989	0.992	0.989
Age of mother	26.7	0.945	27.2	26.8	26.0
Mother married	0.691	0.054	0.691	0.681	0.698
Mother white	0.791	0.097	0.797	0.794	0.782
Mother's years of education	12.6	0.539	12.9	12.2	12.5
First birth	0.320	0.023	0.308	0.332	0.325
Multiple births	0.026	0.004	0.028	0.025	0.026
Gestation (weeks)	39.0	0.178	39.0	39.0	38.9
Weight gain (pounds)	30.6	0.781	30.7	30.6	30.4
Previous cesarean birth	0.106	0.010	0.109	0.100	0.108
HMO enrollment	0.222	0.125	0.214	0.262	0.120
Medicaid coverage	0.099	0.029	0.099	0.111	0.090
Medicare coverage	0.013	0.005	0.013	0.013	0.014
Military health coverage	0.034	0.019	0.032	0.037	0.035
Uninsured	0.174	0.050	0.153	0.195	0.186
Diabetes	0.025	0.007	0.027	0.022	0.024
Anemia	0.020	0.010	0.022	0.014	0.022
Pregnancy-related hypertension	0.032	0.010	0.033	0.028	0.035
Hydramnios or Oligohydramnios	0.010	0.005	0.012	0.008	0.009
Eclampsia	0.004	0.002	0.004	0.002	0.004
Fetal distress	0.042	0.012	0.042	0.042	0.041
Breech presentation or Malpresentation	0.038	0.006	0.040	0.036	0.037
Premature rupture of membrane (>12 hours)	0.031	0.011	0.038	0.025	0.025
Dysfunctional labor (failure to progress)	0.029	0.016	0.034	0.023	0.028
Cesarean delivery	0.217	0.025	0.214	0.213	0.225
Forceps or vacuum	0.090	0.027	0.084	0.092	0.096
Maternal deaths /100,000 births	8.041	4.239	7.92	7.89	8.32
Neonatal deaths /100,000 births	524.7	114.0	526.1	488.3	552.1
5-min Apgar score (1-10)	8.944	0.09	8.969	8.895	8.924
Birthweight (grams)	3330	44.8	3333	3346	3314

Means were calculated at the state-year level, weighting observations by number of births. "Early" states had midwifery reimbursement laws by 1989, "sample" states adopt during the sample period, and "non" states do not have midwifery reimbursement laws by 1999.

Table 4: Factors Associated with Certified-Nurse Midwifery

The dependant variable is the fraction of births attended by midwives in (1) and (2) and an indicator of midwife attended birth in (3).

		(1)	(2)	(3)
Reimbursement Laws (state-level)	MWR Law	0.009**	0.006*	0.005**
		[0.002]	[0.003]	[0.001]
	AWP Law	-0.005+	-0.005	-0.006**
		[0.003]	[0.004]	[0.002]
Pregnancy Risks (individual-level)	Anemia	0.411**	0.137*	0.050**
		[0.104]	[0.062]	[0.001]
	Cardiac Disease	-2.074**	-0.298	7.2 E -05
		[0.457]	[0.212]	[0.003]
	Genital herpes	0.167	0.606**	0.003
		[0.331]	[0.183]	[0.002]
	Hypertension	-0.579**	-0.190+	-0.010**
		[0.152]	[0.099]**	[0.001]
	Uterine bleeding	-0.708*	-0.539**	-0.008**
		[0.275]	[0.144]	[0.002]
	Previous infant > 4000 grams	0.025	0.634**	0.030**
		[0.275]	[0.167]	[0.002]
Financial Factors (state-level)	% Managed Care	0.0002+	0.0001	0.0001+
		[0.0001]	[0.0002]	[0.0001]
	% Uninsured	0.001*	0.001+	0.0001
		[0.00025]	[0.00038]	[0.0001]
	Female Labor Force	-0.0561+	-0.086+	-0.033+
		[0.031]	[0.047]	[0.017]
	Income ($100,000)	0.600**	0.332**	0.375**
		[0.122]	[0.093]	[0.049]
Other Factors (individual-level)	Married	-0.078**	-0.017	-0.009**
		[0.022]	[0.036]	[0.001]
	Previous cesarean	-0.245*	-0.243**	-0.038**
		[0.123]	[0.076]	[0.001]
	Hospital	-0.674**	-0.613**	-0.491**
		[0.207]	[0.061]	[0.003]
	Observations	548	4076	1,400,456
	R-squared	0.970	0.870	0.0378

Each column represents a linear regression, including a full set of controls. (1) uses state-year level data, (2) county-level (3) individual birth-level (5% sample). Year fixed effects are in all regressions. State fixed effects are in (1), while county fixed effects are in (2) and (3). Some coefficients were suppressed for readability.
Standard errors in brackets. + significant at 10%; * significant at 5%; ** significant at 1%

Table 5: Midwife Reimbursement Laws Effect Timing

	% Midwife	% C-section
	County-Year Level	
	(1)	(2)
Before	-0.00318 [0.00484]	0.00131 [0.00195]
After	0.01137* [0.00480]	0.00312 [0.00193]
	State-Year Level	
	(3)	(4)
Before	-0.00391 [0.00265]	0.00025 [0.00197]
After	0.00701** [0.00258]	0.00065 [0.00191]

In (1) and (3), the dependant variable is % births attended by midwives, in (2) and (4), cesarean section rates. The full set of demographic, regional, and time controls were included. "Before" and "After" are dummy variables equal to one in states preceding and following the passage of midwifery reimbursement laws.

Standard errors in brackets. * significant at 5%; ** significant at 1%

Table 6: Midwifery and Major Birth Interventions

Dependant Variable	Vaginal Unassisted			Cesarean Delivery			Vacuum/Forceps	
Controls	No County F.E.s	County F.E.s	Labor Progress	No County F.E.s	County F.E.s	Labor Progress	No County F.E.s	County F.E.s
Regression	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
OLS: Regressor of Interest = Fraction of births attended by midwives = MW								
β_{MW}	0.760**	0.574**	0.539**	-0.203**	-0.199**	-0.143**	-2.042**	-1.125**
Robust Standard Error	[0.055]	[0.061]	[0.058]	[0.038]	[0.050]	[0.043]	[0.161]	[0.154]
N	4503	4503	4021	4503	4503	4021	4502	4502
R-squared	0.51	0.86	0.89	0.74	0.89	0.91	0.45	0.88
DID: Regressor of Interest = Midwife reimbursement law = MWL								
β_{MWL}		-0.034	-0.026		0.023*	0.018+		0.0445
Robust Standard Error		[0.021]	[0.018]		[0.011]	[0.011]		[0.047]
N		4503	4021		4503	4021		4502
R-squared		0.86	0.89		0.89	0.91		0.88
IV: Regressor of Interest = Fraction of births attended by midwives = MW								
β_{MW}		-5.976	-6.223		4.021	4.232		7.757
Robust Standard Error		[4.359]	[5.224]		[2.706]	[3.142]		[8.168]
N		4307	4274		4307	4274		4306
R-squared		0.41	0.40		0.64	0.63		0.75

All regressions use county-year as the unit of observation, and include a full set of demographic, health and time controls. County fixed effects in all specifications but (1), (4) and (7). Specifications (3) and (6) include additional factors describing the progress of labor.

Robust standard errors (clustered at the state-year level) in brackets; + significant at 10%; * significant at 5%; ** significant at 1%.

Table 7: Midwifery and Neonatal Mortality

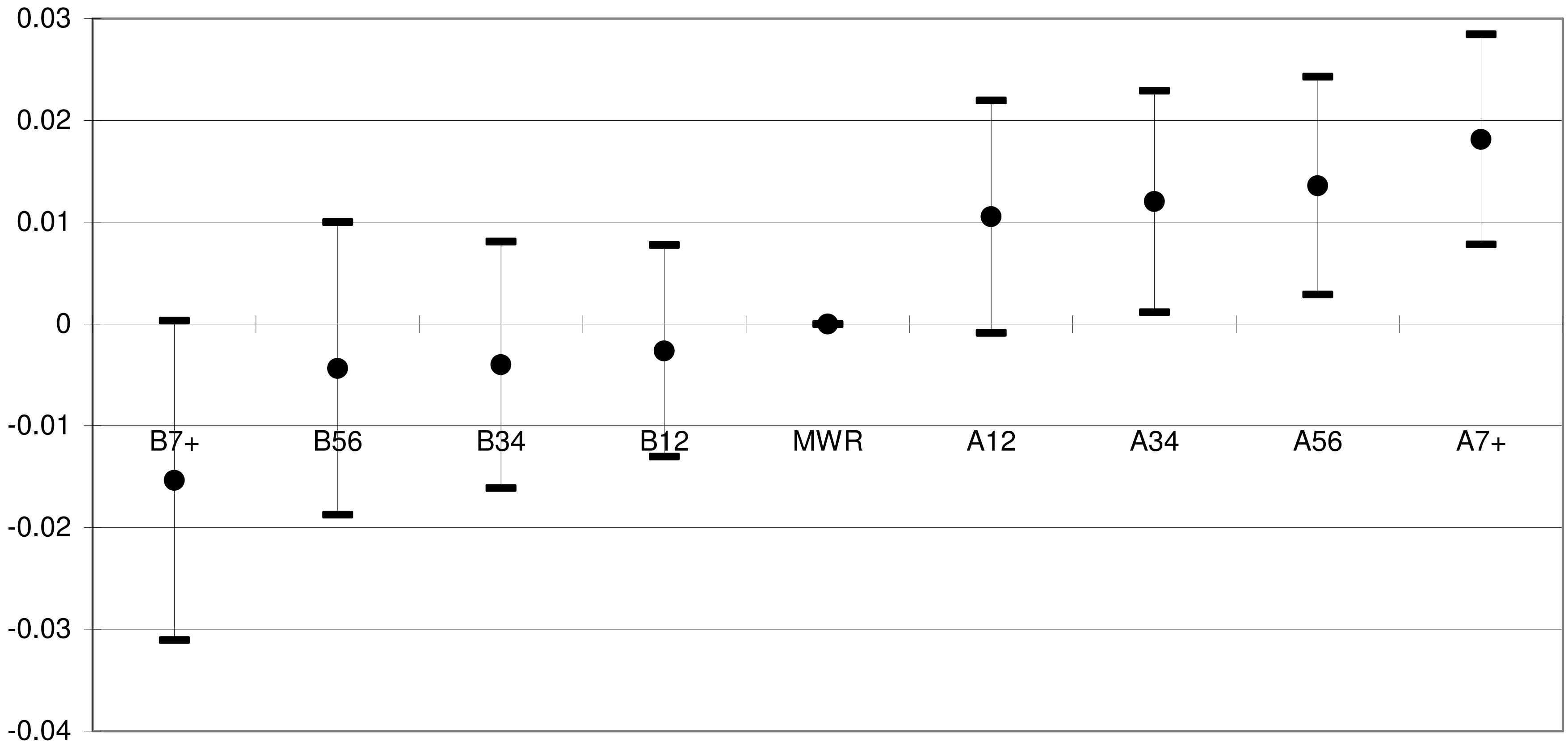
Dependant variable= Log-odds of neonatal mortality rate

Regression	(1)	(2)	(3)	(4)	(5)	(6)
Method	OLS	OLS	OLS	OLS	OLS	
Controls	None	No State F.E.s	State F.E.s	Labor Progress	County Level	
β_{MW}	-1.947**	0.487*	-0.107	-0.365	-0.476	
Robust Standard Error	[0.239]	[0.209]	[0.382]	[0.402]	[0.316]	
N	561	548	548	535	772	
R-squared	0.09	0.88	0.94	0.93	0.83	
Method			DID	DID	DID	DID
Controls			State F.E.s	Labor Progress	County Level	State Cluster
β_{MWL}			-0.034*	-0.045*	-.024	-0.034*
Robust Standard Error			[0.014]	[0.018]	[0.035]	[0.017]
N			548	535	772	548
R-squared			0.94	0.94	0.88	0.94
Method			IV	IV	IV	
Controls			State F.E.s	Labor Progress	County Level	
β_{MW}			-3.811+	-5.196*	-3.78	
Robust Standard Error			[2.057]	[2.403]	[6.56]	
N			548	535	772	
R-squared			0.92	0.91	0.85	

State-year unit of observation for all but column (5), which is county-year (only includes large counties). All regressions include a full set of demographic, health and time controls. State fixed effects are in (3), (5) and (6), with county fixed effects in (5). (4) and (7) include additional controls for labor complications. Standard errors are clustered at the state-year level for (5) and at the state level for (6)

Standard errors in brackets; + significant at 10%; * significant at 5%; ** significant at 1%.

Figure 1: Midwifery Prevalence in the Years Preceding and Following Reimbursement Laws



Results are from a regression predicting the fraction of births attended by midwives at the county-year level. Dots represent coefficient estimates for years leading and following (7+ before, 5-6 before, 3-4 before, 1-2 before, 1-2 after, 3-4 after, 5-6 after, 7+ after) adoption of midwife reimbursement legislation. The bars mark off 95% confidence intervals for each point estimate. The full set of health, demographic, regional, and time controls were included.