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ABSTRACT

Occupational licensing laws have been relaxed in a large number of U.S. states to give nurse practitioners the ability to perform more tasks without the supervision of medical doctors. We investigate how these regulations may affect wages, employment, costs, and quality of providing certain types of medical services. We find that when only physicians are allowed to prescribe controlled substances that this is associated with a reduction in nurse practitioner wages, and increases in physician wages suggesting some substitution among these occupations. Furthermore, our estimates show that prescription restrictions lead to a reduction in hours worked by nurse practitioners and are associated with increases in physician hours worked. Our analysis of insurance claims data shows that the more rigid regulations increase the price of a well-child medical exam by 3 to 16 %. However, our analysis finds no evidence that the changes in regulatory policy are reflected in outcomes such as infant mortality rates or malpractice premiums. Overall, our results suggest that these more restrictive state licensing practices are associated with changes in wages and employment patterns, and also increase the costs of routine medical care, but do not seem to influence health care quality.

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Introduction

Occupational licensing is among the fastest-growing labor market institutions in the U.S. economy. Estimates developed by Kleiner and Krueger (2013) show that the proportion of all workers covered by occupational regulations grew from about 5 percent in the early 1950s to almost 29 percent in 2008. Licensing also can be a restriction on the type of labor that can be used in the production of a good or service. In some situations, members of more than one licensed occupation may be capable of producing a particular good or service. Under a standard licensing procedure, the government determines which of the occupational groups will be permitted to do certain work-related tasks (Friedman and Kuznets, 1945, Friedman, 1962). The broad growth of occupational regulations over the past 60 years has created some situations in which licensing regulations created overlaps in the legally sanctioned tasks performed by occupational groups and in these situations occupations may compete for the same kind of work.

Recent analysis of occupational licensing has shown the influence of licensing when regulations are introduced or become more stringent (Cox and Foster, 1990; Kleiner and Todd, 2009; Cathles, Harrington, and Krynski, 2010). The objective of this study is to show the influence of occupational licensing on wages, employment, and prices when regulations are changed in ways that alter the boundaries and shared work space between two occupations. Economic theory implies that changes in occupational boundaries and tasks may influence wages and prices, but the specific outcomes of such regulations are not well understood. The health sector is particularly subject to occupational regulations. The core health occupations (e.g., physicians, nurses, and dentists) are universally licensed, and over 76 percent of non-physician health workers also work in licensed occupations (Kleiner and Park, 2010). Occupational regulations in the health sector go beyond the conventional licensing restrictions that form the basis of most microeconomic models of occupational regulations. In addition to licensure, it is common for regulations to limit the scope of practice of particular occupational groups, and require a formal supervisory relationship between members of two different occupational groups. A model using a basic production function with regulation suggests that licensing provisions could lead to health service markets with higher wages, higher service prices, and a less diverse range of options for receiving a particular service. These effects could reduce access to health services among some segments of the population. The effects of occupational regulations are particularly salient in the health sector: in 2009 the health sector accounted for about 18 percent of U.S. GDP, and expenditures on provider services represented about 21 percent of total expenditures on health services (Centers for Medicare and Medicaid Services, 2010). If regulations have even small effects on wages and prices, then the aggregate cost of the regulations could be large in an absolute dollar amount.

In the health sector, it is not uncommon for two or more occupational groups to consist of members with an overlapping set of skills and productive capacities. In some cases, it is natural to think of pairs of occupational groups in which one group is trained to perform a subset of the services that also may also be performed by another more highly trained group. Dentists and dental hygienists, for example, may have this relationship. But the subset analogy breaks down in other cases. Medical doctors (MDs) with different sub-specializations may have overlapping competencies without one group possessing a skill set that encompasses the skill set of the other group. The situation is even more complex when there is variation in the context of service provision that is important to consumers. Advanced practice nurses (i.e., nurse practitioners (NPs), physician assistants (PAs), midwives, and nurse anesthesiologists (NAs)) may provide services that are very similar to those provided by MDs, but with a greater emphasis on factors such as convenience, personal attention, or specialization that are important to some patients. Under these conditions, members of different occupational groups may operate as both substitutes and complements in markets for a particular service. Government regulations that limit the independence and scope of practice of these alternative health providers may cause economic harm by limiting the ability of the market to provide a flexible array of health service options which could lead to a misallocation of resources. On the other hand, regulations may reduce uncertainty about quality and effort in the eyes of the consumer (Arrow, 1963; Leland, 1979; Shapiro, 1986).

In this study, we analyze the influence of regulations that apply to NPs. NPs are registered nurses (RNs) who have acquired more advanced education and clinical training than is required by standard nursing licensing regulations. The typical NP receives additional training through a master's or PhD degree program (Harper and Johnson, 1998; Dueker et al., 2005). Such programs train NPs to diagnose and treat common illnesses and injuries, manage chronic illnesses, prescribe medications, and provide counseling. In most states, voluntary certification programs are in place and NPs do not require an additional license beyond the RN designation. Across different situations, the services of an NP may function as both a complement and a substitute for the services of other medical professionals such as RNs and MDs. NPs face a variety of occupational regulations that have varied across states and over time. Three important regulations for NPs are those that involve limitations on prescription authority, independent practice, and independent reimbursement.

Our empirical work shows that occupational regulations that require NPs to be supervised by MDs when prescribing controlled substances reduce NP wages by about 14 percent and increase physician wages by about 7 percent. We also find that prescription restrictions lead to a reduction in hours worked by NPs of between 6 to 14 percent per year. Depending on the empirical model used in the estimation, the regulations are also associated with increases in physician hours worked of between 6 to 9 percent. Our analysis of insurance claims data shows that the regulations increase the price of a well- child medical exam by 3 to 16 percent. In contrast, we find no evidence that the changes in regulatory policy are reflected in infant mortality rates or malpractice premiums. Overall, our results suggest that more restrictive state licensing practices increase the costs of medical care, change wages and employment patterns, and do not appear to influence health care quality as measured by changes in the infant mortality rate and in malpractice insurance premiums. In the rest of the paper we detail how we developed these results.

Medical Doctor and Nursing Licensure

The first physician licensing laws were passed in the 1870s by the states in order to stem what was viewed by physicians as uncontrolled access to the market. By 1881, half of the states had physician licensure. However, enforcement became more serious in the 1890s (Baker, 1984). Unlicensed medical practice was to be punished by fine or imprisonment. The publication of the Flexner report in 1910, sponsored by the American Medical Association (AMA), eventually led to AMA control of medical education and regulation of physicians and auxiliary workers. The main consequence of the rise of physician licensing is that MDs were required to pass additional exams after graduation from medical school in order to practice medicine. Relevant to our study, a large part of the restrictions for other health related occupations was that physicians also control what non-physicians can do to deliver medical services under state law or administrative rules established by state administrative boards.

In contrast, nursing licensure developed initially as certification or titling regulations imposed by state governments. By 1923, all of the then 48 states had legislation that required nurses to hold certain qualifications in order to use the title of nurse (Comer, 2007). New York enacted the first mandatory licensure legislation for nurses in 1947. Currently, all states require that nurses be licensed. The terms "registered nurse" and "licensed practical (vocational) nurse" are now legally protected titles. One must pass a pass a licensing examination and meet the requirements set by each state in order to practice as a nurse in that state (Eberly and Rooney, 2012).

NPs receive training to provide a range of health services, including the diagnosis and treatment of common acute and chronic conditions, the prescription of treatments including medication and medical devices, and the counseling and education of patients (ONet, 2013). The first nurse practitioner graduate program opened at the University of Colorado in 1965. There are about 325 NP programs offered at universities across the United States, and there are about 140,000 practicing NPs (Comer, 2006). Currently, there are no additional licensure requirements for NPs. National and state-level certification regimes are in place, and the American Academy of Nurse Practitioners estimates that 97 percent of practicing NPs maintain a national certification (Comer, 2007). Although licensure beyond the RN designation is not required, state governments regulate the activities of NPs in a variety of other ways by restricting which occupations may prescribe medication, receive direct reimbursement for services by public and private health insurers, and by requiring formal supervision relationships between NPs and physicians in certain types of practice environments.

In this paper we focus on regulations that affect the ability of NPs to practice independently and to provide a flexible array of health services to their clients. We mainly work with regulations that limit the ability of NPs to prescribe medications that are controlled substances, and with regulations that limit the ability of NPs to practice without the supervision of a medical doctor.

Policy Assessments of Nurse Practitioner Regulations

Several states have changed their laws during the period of our analysis to allow a greater number of tasks and more sophisticated tasks by NPs. It, however, can be difficult to assess the practical consequences of specific regulatory changes. That is, some restrictions do not affect the daily practice of an NP and so it is likely nonbinding because of the regulations. In contrast, other restrictions might have greater consequences for NPs if the restrictions make NPs a less desirable option for consumers or employers.

There are regulatory differences across states that lead to meaningful differences in the way that NPs do their jobs and interact with patients and other health professionals. For example, NPs who live on the border of Illinois and Missouri find that they are allowed to perform more tasks in Illinois than Missouri. One illustration is provided in the following comments:

> As an advanced nurse practitioner with offices in Illinois and Missouri, I have a unique perspective. … Treatment for bronchitis can include cough syrup with codeine, and back pain may require a pain medication. In Illinois, after examination and diagnosis, I can write prescriptions (for drugs such as cough syrup with codeine.) In Missouri, I need to delay the patient and interrupt the physician to have him prescribe the medications. This creates unnecessary delays and may require extra trips for the patient. (McQuaide, 2007)

Physicians have generally opposed broadening the scope of tasks that NPs are allowed to perform. The following comments reflect some of issues surrounding the debate on relaxing MD control of prescription benefits. For example, the Missouri State Medical Association was largely opposed to providing NPs with the ability to prescribe controlled substances. It supported alternatives in which NPs had only partial or short-term prescription rights:

> The medical association wants limits on how much nurse practitioners could prescribe capping the amount of medicine to enough for three to five days, for example, just to fill an immediate need before the patient could see a physician (Lieb, 2008).

This policy stance may be problematic in several ways. One concern involves the public health implications of emerging resistance to antibiotic medications. The obvious risk under a regulation that forces NPs to prescribe only small doses of antibiotics is that patients who see an NP for convenience reasons may be likely to forgo a second follow-up visit to an MD. The chances that they complete a partial dose of antibiotics are high. Besides the public health concern, the two-visit approach would seem to substantially diminish any efficiency gains from granting more authority to NPs. Regardless of the policy recommendations, the Missouri State Medical Association considers NPs to be competition for MDs because at least some patients would substitute NP visits for MD visits.

Doctors' advocacy groups are lobbying state politicians to preserve laws requiring MD supervision for NPs. For example, in a recent review in the popular press, Elizabeth Dears, a senior vice president for the Medical Society of the State of New York said in testimony to lawmakers that removing doctor oversight of NPs "would seriously endanger the patients for whom they care (Pettypiece, 2013)".

Prior Analysis of Occupational Regulations in the Health Sector

Earlier studies have identified the issue of potential complementarity and substitution of regulated occupations that provide similar services. When occupations are complementary, members of an incumbent occupation may have incentives to allow more individuals into the competing occupation. For example, when a patient first visits a nurse and is referred to a medical doctor, the two occupations are complements in the production of service functions (Persico, 2011). For simple procedures, however, doctors and nurses also can be substitutes if the nurse provides the service in place of a doctor. For example, Kleiner and Park (2010) show that occupational regulations that apply to dentists and dental hygienists affect the earnings of both occupational groups. In addition, Marier and Wing (2011) find that these regulations also influence the prevailing prices for basic dental services, with prices being lower in states that allowed hygienists to have greater autonomy. In these occupational substitution scenarios, there may be fewer incentives for incumbent occupations to support expansion in the other occupation. These simple assessments of self-interested lobbying can change if people act as both members of an occupation and owners of firms that may employ both types of workers. It seems plausible that owners of dental firms would find occupational regulations that distort their labor input allocation decisions to be a burden rather than a benefit.

More recently, studies in other medical specialties such as occupational therapy and physical therapy have shown the importance of laws and administrative procedures for the employment and earnings of each of the occupations, given that they are also both complements and substitutes in service delivery (Cai and Kleiner, 2013). Furthermore, in his examination of the impact of the scope of practice laws for RNs and PAs on consumers, Stange (2011) focuses on the changes in access, costs, and patterns of care and utilization for a broad population-based sample. Our study develops an analysis that is distinct from the one by developed by Stange (2011). Specifically, we study how the regulations affect the wages and employment of NPs and MDs, and prevailing prices for child well care visits, which is a homogenous health service. This narrower focus makes it easier for us to separate the regulatory price effects from general variations in prices of medical services.

A Basic Model of Medical Services Production with Regulation

The model uses a framework where the work of one occupation cannot legally be done without the inputs of the other occupation. The focus of the model serves as a basis to inform the empirical work, rather than as a fully specified general equilibrium model of medical production under regulation. The model uses a modified standard production function:

$$Q_p = HH = f(P(z),K) \quad (1)$$

$$Q_n = HL = f(P(z), N(z),K), \quad (2)$$

where Q_p is the output produced by the physician, which we will refer to as "high skilled patient services (*HH*)." Q_n is the output produced by the nurse, which we will refer to as "low skilled patient services (*HL*)." *P*(*z*) represents the physicians' labor, recognizing that output relies on their decision of personal input and *N*(*z*) represents the nurse's labor, recognizing that output relies on their decision of personal input. *K* represents the quantities of capital inputs used in a medical practice (Reinhardt, 1972).

An explanation of the theory with licensing can be written as follows for MDs:

$$HH = A\, L_p^{\alpha}\, K_p^{\beta}, \quad (3)$$

where *HH* is the high-skilled physician services (p) provided, *A* is the technology provided to produce *HH*, *L* is the labor input, and *K* is capital.

Similarly, the output for nurses can be given by the following expression:

$$HL = B\, L_n^{\gamma}\, K_n^{\delta}, \quad (4)$$

where *HL* is the relatively lower-skilled services provided by practical nurses (n) and *B* is the technology provided to produce *HL*.

By law, however, the technology needed to produce *HL* for nurses is tied to supervision by the physician. This expression can be written as follows:

$$B = \theta\, L_p. \quad (5)$$

Therefore, the production function for nurses can be written as follows:

$$HL = (\theta\, L_p)\, L_n^{\gamma}\, K_n^{\delta}, \quad (6)$$

where in the case of $L_p = 0$ (i.e., where no nursing services are offered) under regulation, there is no production of nursing services. In our specifications the inclusion of technology coefficients in the model accounts for total factor productivity for both high and low skilled labor within the production function (Jerzmanowski, 2007)

We also assume that $L_p + L_n = 1$. Therefore, $L_p \leq 1$ and $L_n \leq 1$.

The profit function for medical services can be written as

$$\rho B L^{\gamma}_{n} K^{\delta}_{n} - w_n L_n - r_n K_n \quad (7)$$

$$P_p A\, L^{\alpha}_{p} K^{\beta}_{p} + (1-\rho)(\theta L_p)\, L^{\gamma}_{n} K^{\delta}_{n} - w_p L_p - r_p K_p, \quad (8)$$

where $\rho = 1$ is the case of no regulation and $0 < \rho \leq 1$, and P is the price of the service.

The functional relationship shown in (7) is a profit function for the practical nurses if the price of the service is normalized as 1. Similarly, the functional relationship shown in (8) is a profit function for physicians, where $w_1 L_1$ is the cost of labor and $r_1 K_1$ is the cost of capital, and 1=p,n. Within this profit function, the nurse's wage is determined by the decisions of the doctor to use the nurse's labor input and technology mix by the high-skilled provider, *HH*, and is exogenous. As the nurse's wage goes down, the physician's wage will go up in the model.[1] However, if the nurses take on lower-skilled work, then physicians can work on higher-skilled and larger value-added tasks, resulting in higher earnings for them as well. In this sense, the skills of the nurse and those of the physician are complementary. Assuming that the skills of the

[1] Using traditional price theory, the first-order condition shows that $\rho B\gamma\, L^{\gamma-1}_{n} K^{\delta}_{n} - w_n = 0$, $\rho B\, \delta L^{\gamma}_{n} K^{\delta-1}_{n} - r_n = 0$, $P_p A\, \alpha L^{\alpha-1}_{p} K^{\beta}_{p} + (1-\rho)\theta\, L^{\gamma}_{n} K^{\delta}_{n} - w_p = 0$ and $P_a A\beta\, L^{\alpha}_{p} K^{\beta-1}_{p} - r_p = 0$. It implies that the nurse's wage will go down and the physicians wage will go up (Varian, 1992). If physicians see nurses' work as a source of revenue for low-priced services, that will allow physicians to do more high-skilled tasks and enhance their earnings.

nurse and the physician are the same for low-skilled tasks, the physician can allocate low-skilled tasks to the nurse and take on higher productivity and value-added tasks.

Nevertheless, within this profit function, the nurse's wage is tied to the decisions of the physician to use the nurse's labor input and technology mix to the high-skilled provider, *HH*. Regulation acts as a shifter of both the supply and demand curves. However, within the model, nurses can either raise their own earnings and those of physicians or raise their earnings at the expense of physicians. Physicians, who are generally in control of the production of these services, can allocate relatively low-skilled work, such as well child exams to NPs while taking on higher-skilled and value-added services such as caring for sick or injured children and thereby maximize rents for them as well as the NPs. These issues are empirical questions that the rest of the paper examines in addition to the influence of regulation on prices and quality of care.

Empirical Framework

We pursue a quasi-experimental approach to analyzing how NP occupational regulations affect the wages, employment levels, and service prices that prevail in the health services market. In the empirical analysis, states adopt one of three forms of NP prescription authority regulation: light regulation in which NPs are allowed to independently prescribe controlled substances, moderate regulation in which NPs are allowed to prescribe controlled substances if they have a supervisory relationship with an MD, and heavy regulation in which NPs are not allowed to prescribe controlled substances. Let $Y_{st}(L)$ represent the average wage, employment, or service price outcome that would prevail in state s at time t if the state has adopted the light regulation. $Y(M)_{st}$ and $Y(H)_{st}$ are the outcomes that would prevail if moderate or heavy regulations had been adopted in the same state and year. In other words, $(Y(L)_{st}, Y(M)_{st}, Y(H)_{st})$ measure state $\times$ year outcomes under light, moderate, and heavy NP regulations[2].

We estimate the standard generalized difference-in-differences regression models of the following form $Y_{st} = \beta^{(M)}M_{st} + \beta^{(H)}H_{st} + \theta_s + \theta_t + \varepsilon_{st}$ and interpret the estimated regulatory effects as averages of market specific effects. Depending on the outcome variable and the available data, we augment the standard framework by adding time varying covariates to improve statistical precision and further adjust for confounding variables. We also present a series of sub-analyses that are intended to assess the sensitivity and robustness of the main results to the most likely sources of potential bias.

The Data

Measures of Licensing Requirements

We collected information on state statutes regulating nurses from the *Nurse Practitioner*'s annual legislative updates for 1999–2010 (*Nurse Practitioner*, 1999–2010). While the occupational regulations take a variety of forms, such as restrictions on title protection, governing board structure, and scope of practice, we focused on the statutes regarding the authority to prescribe medications. Regulations that require a licensed MD to supervise the prescription activities of an NP, and permit an NP to prescribe medications including or excluding controlled substances are common ways in which states regulate the prescription authority of NPs.

We coded the regulation variables to emphasize the relative independence of prescription authority granted to NPs in different states and time periods. two statutory categories :

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[2] Classical linear additive fixed effects models proceed by assuming that the regulatory effects are constant across markets so that $\beta_{st}^{(M)} = \beta^{(M)}$ and $\beta_{st}^{(H)} = \beta^{(H)}$. Wooldridge (2005) shows that the methods designed to estimate these constant coefficients also produce valid estimates of the average of the distribution of unit specific coefficients under the additional assumption that the heterogeneous treatment effects are mean independent of the mean differenced regulation variables.

independent prescription authority and whether NPs could prescribe controlled substances. The reference case for our estimates include – Independent Prescription Authority – which describes a state and time period in which NPs are allowed to prescribe controlled medications independent of any supervision by a physician. We then specify two regulated work tasks. In the first case – Supervised/Delegated Prescription Authority — means that in a given state and time period, an NP was allowed to prescribe controlled medications under the supervision of a physician. In the second case – Limited Prescription Authority –are those cases in which regulations allow an NP to prescribe medications excluding controlled substances under the supervision of a physician.

The appeal of an NP to consumers involves access to basic medical care at convenient times and locations that are often difficult for traditional providers such as MDs to deliver. For example, NPs often work in retail-based clinics, walk-in clinics, and other convenience-oriented environments, but MDs generally do not. Thus, licensing regulations that limit the flexibility of NPs by making it more costly for NPs to practice independently and to provide common treatments that often involve controlled medications are likely to either reduce the availability of NPs to consumers or make NPs a less attractive option despite their availability, convenience, and lower wages.

The trend in the United States over the last 10 years has been toward greater autonomy for NPs. In Figure 1 we show how prescription authority regulations that apply to NPs have changed over time. The figure shows that in 2000, nine states did not allow NPs to prescribe controlled medications of any kind, but only two states did not by 2011. Similarly, the figure shows in the top line a slight growth in the number of states that allow NPs to independently prescribe controlled substances without the supervision of a licensed MD. Figure 1 shows that

NPs have been gaining greater autonomy in providing services to patients. The middle line shows that some of the largest changes in regulations come from the growth of regulations in which NPs are allowed to prescribe controlled medications, but are required to be supervised by a licensed MD. The regulations shown by the middle line in the figure can be seen as an intermediate step or partial deregulation of the prescription authority environment.

In Table 1 we show the states that changed their licensing requirements during the period 2000 through 2011. Eleven states relaxed their licensing requirements from 2000 to 2011 to allow more tasks for NPs. There does not appear to be any significant regional bias to the changers in both time periods that are shown in Table 1.

Labor Market Outcomes

To examine the effects of the regulations on wages and employment levels we pooled data from the 2002–2009 American Community Survey (ACS) to construct samples of NPs and MDs. The ACS does not separately identify NPs, so we devised a sample selection method that would capture practicing NPs. To create the sample, we started by limiting the sample to ACS respondents with occupational codes that correspond to registered nurses. From this sample, we retained only those nurses who held a master's degree, a professional degree, or a Ph.D. After imposing additional selection conditions based on the completeness of data on earnings, hours worked, and some key covariates, we were left with an NP sample of 21,276 observations and with a MD sample of 38,094 observations. Descriptive statistics from the ACS samples we used are in Table 2. Hourly earnings average about $33.78 in 2002 dollars per hour for our sample of NPs. This amount is about one-half the hourly earnings for physicians. The basic data in the table show that about 90 percent of all NPs are women and that 7 percent are black. For state regulation, the table shows that 66 percent of NPs are in states that allow for a supervised or delegated prescription authority, and 27 percent of NPs are in states that grant both independence and prescription authority. These legal provisions may allow nurses to complement or substitute for physicians in providing basic services. Based on the results in the theory section, this would result in costs going down if nurses are substitutes for physicians in providing services. If they are complements, then nurses would handle lower-skilled tasks and the physicians would focus on higher-skilled ones.

Medical Service Prices

The NP regulations could influence the prevailing prices of health services by altering the supply of health services and by changing the mix of providers available in the market for health services. As discussed earlier, some health services may be provided by both an NP and a more traditional provider such as an MD. The theory section shows that in many cases the services of an NP can be viewed as both a substitute for and a complement to the services of an MD. Since we do not expect the price effects to be very large in per-unit terms, we focus on a medical service that is commonly provided, and which is often serviced by both MDs and NPs. We also wanted to implement our analysis on a health service that was relatively standardized in delivery so that we did not detect price differences that arose mainly because we were pooling complicated and uncomplicated cases reflecting service heterogeneity across many different services. After detailed consultations with colleagues in the School of Nursing at the University of Rochester, we chose insurance claims for child well care exams because it met the criteria for plausible test cases[3]. Child well care visits are widely consumed annually by millions of families in the United States, they involve a standard set of tests and evaluations, and they are routinely

[3] We thank Irena Pesis-Katz at the University of Rochester School Of Nursing for helpful discussions about the appropriate choice of a health service for analysis.

provided by both family practice physicians and NPs. These exams are a strong test for the role of occupational regulations on the price of health services.

Our analysis of prices is based on a large database of private insurance claims that is maintained by FAIR Health, Inc., a non-profit organization that provides independent estimates of the distribution of charges for health services across the United States. The claims database is widely used by insurance companies and health care providers to better understand geographical variation in the prices of health services. As discussed earlier, we extracted insurance claims with Current Procedural Terminology (CPT) codes that are used to identify claims as well as care visits for children. Specifically, we extracted claims with CPT codes 99381–99384 and 99391–99394. Each insurance claim contains information on the type of claim, the geographical location of the office where the service was provided, the "billed charge" that was submitted by the provider, and the "allowed amount" that the insurance company ultimately paid the provider after allowing for negotiated discounts and the details of insurance plans. We analyze the allowed amount because it is closest to the transaction price of the health services. Table 3 reports the sample sizes for each type of insurance claim in our analysis and also shows the mean, median, and standard deviation of the allowed charge for each type of claim. There are almost 30 million total claims for these 8 health service categories over the period 2005–2010. The table shows that the price of a well care visit increases somewhat with the age of the child and those prices are higher for new patient visits than for established patient visits. In general, the well care visits that are the focus of our paper cost about $80–$100 and have a standard deviation across all claims of around $30.

The FAIR Health database consists of individual insurance claims provided by a large set of "contributing insurance companies" who operate in markets across the United States. Each contributing company agrees to submit a complete and unadulterated data set of the insurance claims it processed over a calendar year. The number of contributing companies varies somewhat over time. The structure of the insurance industry in the United States means that these companies may be affiliated with a larger parent company, and so it may not be reasonable to think of each contributor as an independent company.

Despite the large number of claims in the database, it is important to note that the claims are not the result of a formal random sampling process. They are, instead, the product of the decisions of individual health insurance firms to join the network of firms that contribute to the data: these decisions may mean that contributing firms are different from non-contributing firms in unknown ways. However, we think it is unlikely that firms select into the network of FAIR Health contributors on the basis of the distribution of prices they pay for well care visits or that these participation choices are correlated with responses to NP occupational regulations.

To examine and evaluate the representativeness of the database, we compared the data from the FAIR Health database to claims data from the Thomson Reuters MarketScan Research database. The MarketScan database is similar in construction to the FAIR Health database, but it consists of claims from self-insured employers rather than from independent health insurance companies. MarketScan is widely used in the academic literature.[4] We have FAIR Health data for the period 2005–2010, but for MarketScan we only have information for 2007, and so we limit our comparisons to claims for 2007.

Figure 2 shows kernel density estimates of the distribution of prices for established patient and well care visits for children ages 0–1 (99391), 1–4 (99392), 5–11 (99393), and 12–17

[4] Thomson Reuters maintains a bibliography of the scientific publications that make use of the MarketScan database. The bibliography contains entries for publications in a variety of fields including economics, health services research, medicine, nursing, statistics, and physiology. The bibliography is available online at http://interest.healthcare.thomsonreuters.com/content/DownloadLibrary-Pharma.

(99394). The line to the right or the green lines show the distribution of prices in the FAIR Health database, and the line to left or orange lines show the distribution of prices in the MarketScan database. The figure shows a remarkable similarity in the distribution of the prices across the two sources of data. Prices are slightly higher in the FAIR Health data; on average the price of a child well care visit is about $10 more in the FAIR Health data than in the MarketScan data. The two data sets lead to very similar inferences about the distribution of prices for well child care. These differences are statistically significant based on simple *t*-tests and on Kolmogorov-Smirnov tests for the equality of the two distributions. But these findings are not surprising, given the extremely large sample sizes in both data sets: even small differences are precisely measured with millions of observations. Overall, we think that the FAIR Health data and MarketScan data would lead to similar inferences about the influence of changes in regulations on the prices of these services.

Our analysis of the price data was always conducted at some level of aggregation rather than at the actual claim level. We conducted a state-level analysis by computing mean and median prices in state *x* year *y* product code cells. We also conducted some analyses of prices within selected Metropolitan Statistical Areas (MSAs) by classifying claims using the zip code of the provider location. We generally reduced the influence of outliers (which are likely data entry errors) by top coding the price data at $1,000 and removing prices that were missing or negative. We kept 99.8 percent of the price data observations.

Empirical Results

Regulation and Wage Determination

The model we implement is applied to log wages, and is a fixed effects version of the standard cross-sectional human capital wage equation, which leads to a few subtleties concerning how to construct the market level regulatory effect estimates. The basic earnings equations can be written as follows:

$$\ln\left(Earnings_{ist}^{P/N}\right) = \alpha + \beta R_{st} + \gamma X_{ist} + \delta_s + \eta_t + \varepsilon_{ist}, \qquad (9)$$

where $Earnings_{it}$ is the hourly earnings of physicians (P) or nurses (N) i in state s at time period t; R_{st} is the regulation that is in place for person i's state s in time period t; the vector $\boldsymbol{X}_{ist}$ includes covariates measuring the characteristics of each person; δ_s and η_t are state and year fixed effects, respectively; and ε_{ist} is the error term.

The model is a basic fixed effects approach that can also be viewed as a generalization of the conventional two-group two-period difference-in-difference model. We estimated the earnings equations using two different approaches. In the first approach, we estimated the model using the full micro-level data set and estimated standard errors that are robust to heteroskedasticity and clustering at the state level. In the second approach, we aggregated the data to the level of state x year cells using the two stage procedure described in Hanushek (1974), Amemiya (1978), and Conley and Taber (2011). In the first stage individual-level outcomes are regressed on covariates and a full set of state × time fixed effects. The coefficients on the state × time fixed effects represent state × time cell means that have been purged of the variation associated with the within-cell variation in the covariates. In the second stage, the covariate adjusted cell means are regressed on the policy variables, state fixed effects, and year fixed effects. The standard errors allow for clustering at the state level.

We estimated separate models of NP and MD hourly earnings and the results are in Table 4.[5] The first two columns show estimates from the model that prescription authority restrictions reduce the earnings of NPs relative to a policy in which they may prescribe controlled substances

[5] We also included time-varying state-level controls such as the state median household income but found that they have no explanatory power. Consequently, we do not show the results in this paper.

independently. Depending on whether the model is estimated using the micro level or aggregated data, the effect of requiring MDs to supervise the prescription authority including controlled substances of NPs reduces the earnings of NPs by about 14 %. These coefficients are precisely estimated. In contrast, estimates of the effects of regulations that limit prescription authority to NPs are smaller in the one-stage model and are not precisely estimated. Columns 3 and 4 of Table 4 show estimates of the effects of the regulation on the earnings of MDs. The results suggest that when states adopt laws that require NPs to prescribe only under MD supervision, MD earnings increase by approximately 7 percent relative to NPs having full access, which is consistent with the theoretical model. Moreover, the estimated effect of regulation that limit prescription authority to NPs are small and the standard error of the estimate is large enough so that we do not reject the null hypothesis that the regulations do not influence wages.

The estimates suggest an interpretation of our results is consistent with the theory section: that is, when a patient visits an NP, those visits come at the expense of a visit to a medical doctor. Moreover, these two specialists may be substitutes in the production of services, and these nurses may gain relative to physicians when they can do more tasks for the patient.

Employment

Consistent with the potential influence of these regulations on wages, the expectation is that a relaxation of licensing requirements would enhance the employment of NPs by allowing them to do more medical tasks as well as signal to the market that their skills are of a higher quality. We test this model in Table 5, using the ACS data and a model similar to the one estimated in Table 4 using a first- and second-stage model. The results show that annual hours worked is between 6 and 14 percent lower for NPs when they are limited in their ability to provide controlled substances without physicians' assistance in both estimation procedures. In all cases the coefficients are precisely estimated. Moreover, in the second part of the analysis in the table shown in the last two columns for physicians, their hours worked grows when NPs are limited in their ability to prescribe controlled substances. Again, the results suggest that there is some substitution of NPs for physicians. For example, physician hours worked grows between 6 and 9 percent, when NPs' tasks are limited.

To check robustness of the results shown in Tables 4 and 5, we also estimated the same two-stage models with lagged values of the regulations. Appendix A shows that the lagged regulations on both hourly earnings and annual hours worked are also significant, which confirms the robustness of the previous estimates.

Regulation and Prices

Consistent with theory, one would expect to find that as occupational regulations restrict the ability of NPs to perform certain tasks, the NP imposition should lead to higher prices for health services if the services are provided instead by more expensive practitioners such as physicians. One interpretation is that regulations limit the supply of optimal health services and that this practice drives up prices. Hedonic mechanisms, however, could also lead to higher prices. For instance, if NPs are able to provide health services at more convenient times and locations or with more appealing interpersonal relationships with patients, then these service attributes could be reflected in prices. Regulations that reduce the ability of NPs to compete on these margins are likely to make these service attributes less available to consumers, and will minimize the role of NPs in the market. Finally, regulations can simply increase the cost structure of an NP-led practice. For instance, if regulations require some type of costly supervisory relationship between NPs and MDs, then these monitoring costs could further drive up prices. For example, regulations that prohibit insurance companies from directly reimbursing

NPs could increase administrative costs for NPs and may reduce the service convenience for patients. All of these factors could drive up prices. The basic model for price determination mirrors the model we used for wage determination and is specified as follows:

$$Price_{st} = \alpha + \beta \mathrm{R}_{\mathrm{st}} + \rho Z_{st} + \delta_s + \eta_t + \varepsilon_{ist}. \quad (10)$$

In the equation, $Price_{st}$ is the median-allowed price in state *s* at time *t*; R_{st} is the licensing regulation in state *s* in time period *t*; the vector $\boldsymbol{Z}_{st}$ includes covariates measuring the characteristics of each state; δ_s and η_t are state and year fixed effects, respectively; and ε_{ist} is the error term.

Estimates of the state price effects using a variety of fixed effects model specifications are shown in Table 6. The estimates of the price effects show that more restrictive requirements for NPs increased prices for well care examinations. The intermediate level of regulation—Supervised/Delegated Prescription Authority—increases prices by about $6. The stronger level of regulation—Limited Prescription Authority—increases prices by about $16. Since the typical price of a well care visit is around $100, these price effects are relatively large.

Sensitivity Analysis

A concern with our difference-in-differences strategy is the demand for health services might vary over time within states. Such demand changes could bias our estimates of the effects of the regulations, if the demand changes are also associated with regulatory changes. To check the robustness and sensitivity of the estimated price effects to alternative interpretations of the results, we conducted several different analyses (Leamer, 2010). To examine this possibility, we collected insurance claims data for a set of 7 basic dental procedures: teeth cleaning, fluoride treatment, local anesthesia, nitrous oxide, sealant application, amalgam restoration, and x-rays. We reasoned that these dental services, which are widely consumed by children and have prices that are similar to child well care exams, should also be affected by the general demand for child health services in a given state and year. A characteristic of a valid comparison group in this case is that the markets for these dental services should not be affected by regulations that apply to NPs, since NPs and MDs do not provide these dental services, but should be driven by many of the same unobserved demand factors that affect the markets for child well care visits. We aggregated the dental claims data into state *x*, year *y*, procedure code cells and combined them with the data on the child well care visits. We then estimated triple-differenced regressions in which the dental data served as a control group for the well care data. The results are presented in Table 7 as a placebo or falsification test.

We present the results including a full set of state, year, and state × year fixed effects. The estimated regulatory effects are the difference in the estimated effect of the regulations on the well care visits, which should be affected by the regulations, and the dental visits but which should not be affected by the regulations. In the most complete model, which includes the fixed effects as well as a vector of time-varying state covariates, we find that the intermediate level of regulation increases the price of well care visits by about $5.52, and the more stringent regulation increases prices by about $4.05. The results are statistically significantly different from zero. These estimates are broadly consistent with the state-level results presented in Table 6, although the magnitude of the stronger regulation is substantially reduced when the dental data and regulations are used as a control group. The number of observations is halved in the estimates that include all the covariates. The regulation and price data have information from the period 2005–2010, but the covariates spanned the period 2008–2010. We also estimated models that assessed the effects of lagged and leading values of the regulations on contemporaneous prices as way of ruling out particular forms of reverse causality. The results show no significant changes in the trend lines prior to the passage of the changes in the regulations for NPs and they are shown in Appendix B.

Recent analysis has shown that nominal standard error estimates are often too small in the generalized difference-in-difference models that we have employed (see also Moulton, 1990; Bertrand, Duflo, and Mullainathan, 2004; Donald and Lang, 2007; Conley and Taber, 2011; Rosenbaum, 2002, 2009). In addition, Bertrand et al. (2004) and Conley and Taber (2011) have both shown that statistical tests based on permutation/randomization distributions seem to perform well even with clustered data with a relatively small number of groups.

To assess the robustness of our results, we conducted a series of permutation tests based on the state-level models. In the most basic implementation of the idea, we randomly selected a set of state *x* year cells and defined them as "pseudo regulated markets." Then we estimated the regression model using the placebo regulations instead of the real regulations and stored the coefficients on the pseudo regulations. We repeated this process 500 times to build up a distribution of placebo effects. On average, the placebo laws should have no effect on prices because they are simply randomly chosen cells. However, a placebo effect will happen by chance one in twenty times. By comparing the regulatory effect produced by the actual regulations to the empirical distribution of effect estimates produced by the placebo laws, we can understand the likelihood that our effect was observed by chance without appealing to the asymptotic distribution of a given estimator. In practice, we do not know the true "law generating process," and so we experimented by constructing placebo law distributions by randomly selecting cells across all state *x* year *y* product cells and also only within years and within states. Figure 3 shows kernel density plots of the distribution of estimated coefficients on the two regulation variables included in the model. The key point is that the placebo distributions represent the sampling distribution of the estimated coefficients under the null hypothesis that the regulations have no effect on prices. The vertical line in the graph shows the effect we observed in our actual sample, and it lies in the extreme tail of the placebo distribution. This is evidence that our results are not likely produced by statistical chance.

In order to further estimate and test the robustness of our price effects of regulation, we specify a model in which the data are limited to zip codes that belong to MSAs that fall on both sides of a state border that marks a change in the way that NPs are regulated. Here the experiment is to account for local demand and supply conditions that are common across the MSA (Card and Krueger, 1997; Holmes, 2006).

To implement the research design, we identified which zip codes were located in a metropolitan statistical area (MSA) that straddled state borders and had differing state regulations on either side of the MSA. Thirty-five MSAs met the criteria. We aggregated these data to state *x* year *y* time period cells and used the aggregate data to estimate the following model:

$$Price_{mstp} = \alpha + \beta R_{st} + \theta_m + \mu_p + \eta_t + \varepsilon_{mstp}, \qquad (11)$$

where $Price_{mstp}$ is the allowed price for product *p* at time *t* in state *s* in MSA *m*; R_{st} is the licensing regulation in state *s* in time period *t*; θ_m, μ_p, η_t are MSA, product, and year fixed effects, respectively; and ε_{mstp} is the error term. Table 8 gives the MSAs in our analysis that met the criteria of being on a state border where the legal restrictions differed across state boundaries. The MSAs represent a wide range of areas and do not appear to be systematically different across areas of the country or size of MSA. Figure 4 shows the number of MSAs that had either concordant/discordant regulations for practical nurses regarding their prescription authority**.** The results show that there is a clear movement toward states having similar statutes across MSAs.

Table 9 shows the influence of regulation on prices using our MSA analysis of different regulations in adjoining states. The results are similar to those from the analysis that used the dental services as an untreated comparison group. We find that the intermediate level of regulation increases the price of well care visits by about $3.67 and that the more stringent regulation increases prices by about $5.31.

Finally, we examine if the laws were passed in states with specific underlying economic characteristics. Table 10 shows a hazard model of time to the passage of a more relaxed law based on the characteristics of the state. The estimates show that none of the standard economic characteristics in the state is associated with the passage of the law, suggesting that economic conditions were not a source of bias in our results in terms of passing a more relaxed law governing NPs.

Reducing Regulations and Quality of Service Outputs

The analysis thus far suggests that prices were reduced as a consequence of the shift to more tasks by NPs. An additional issue is how such a shift may have affected the quality of health services that are available and that are consumed in the marketplace. Quality effects are conceptually difficult to measure. Moreover, the welfare implications of quality changes are not obvious because a given health service may represent a bundle of convenience and quality attributes. If deregulation led to an increase in services with lower quality, but higher convenience, consumers who value convenience would be better off. Still, qualities of health outcomes are one of the main arguments against deregulation. To assess the quality consequences of allowing NPs to provide more services, we examine evidence of an increase in major errors in medical treatment that could lead to serious injuries or death.

We implement two approaches for evaluating quality changes. First, we estimate the effects of the regulatory environment on infant mortality rates using state policy variations over time. Since mortality is an extreme outcome that may not capture smaller nonfatal changes in quality, we also examine the effects of relaxing the licensing requirements on the malpractice insurance rates of physicians in the states that changed their statutes. In Table 11 we estimate the influence of changing the statutes for NPs on mortality rates for children under the age of one using a lagged model. We use this approach to capture the changes that occur over time following the change in the statute on mortality. Specifically, we use infant mortality to adjust for the influence the year after the regulation was enacted. The estimates in Table 11 use the five-year mortality rate for the year after the regulation was changed, and then we subtracted the five-year mortality rate for the current year. The procedure differences out five years of infant mortality data, and we can estimate if the difference in mortality rates is affected by the changes in regulation. The results in the table for both supervised/delegated and independent prescription authorities show no influence of these changes in the regulatory law for infants who would likely be most vulnerable to poor-quality services.

As an additional robustness check on the influence of the changes in the statutory provisions on quality, we examined the effects on the malpractice insurance rates paid by physicians who were in states where the changes in statutory provisions occurred. We would assume that if NPs were lower-quality providers of services and, as a consequence, severe injuries occurred to children as a result of poor-quality care, then their malpractice insurance rates would rise. In Table 12 we show the impact of changes in the law for both supervised/delegated and independent prescription authorities for NPs on malpractice premiums from 1999 through 2004 for internal medicine, obstetrics and gynecology, and surgeons. In none of the estimates did the change in the regulatory laws that allowed NPs more flexibility in tasks statistically influence these malpractice premiums. All of the results for the influence of regulation on quality yielded imprecise estimates. We were not able to find any influence of the relaxation of the licensing statutes on blunt overarching, but important measures of health outcomes.

Conclusions

In this study we investigate how easing regulations that affect NPs may affect wages, employment, prices, and quality in health markets. Initially, we examined a basic theory of regulated labor inputs into the production of medical services. Next, we used data from the ACS for the period 2002–2009 to study how changes in state licensing regulations have affected the wages and hours worked of NPs and MDs. Subsequently, we analyzed a large database of private health insurance claims for well care exams to estimate the effect of the regulation changes on the supply prices of standard medical services. Our estimates show that more restrictive NP regulations tend to reduce the wages of NPs and to increase the prices of medical services. However, we also found evidence that more restrictive NP regulations tend to increase the wages of MDs. One interpretation of this finding is that NPs and MDs are substitutes in service production. For certain tasks, the abilities of NPs to provide more patient care result in declines in the hours worked and earnings of MDs.

We analyzed the sensitivity of our results using the prices of other routine health services (dental procedures) that should not be influenced by NP regulations. We also analyzed these policies at the level of MSAs to account for local supply and demand conditions using MSA fixed effects. In addition, we conducted placebo law tests that are robust to dependent error structures, and by examining the timing of the introduction of state regulations to determine whether regulatory changes appear because of changes in state characteristics.

Our analysis showed how regulating and relaxing provisions for the occupational groups involved in the delivery of health services can affect both wages and prices. We found that allowing NPs to independently provide prescriptions on their own is associated with a 14 percent increase in hourly wages for NPs relative to more restrictions on their tasks, and as much as a 7 percent increase in earnings for physicians when tasks for NPs are limited. These results suggest some substitutability of these occupations for one another. Our estimates from FAIR Health, Inc. show that changing occupational licensing laws to allow more autonomy by nurses lowers permitted prices by 3 to 16 %. However, we were not able to find any influence of these changes in the regulatory climate on infant mortality rates or malpractice insurance rates as indirect measures of the quality of the service provided. Relaxing regulations does not appear to change the most serious adverse medical outcomes.

The policy implications of our results suggest that the use of NPs may be an important way to enhance access to medical care for patients. For these routine tasks related to prescription of medications, allowing NPs to perform procedures leads to lower prices for the services we examined. The estimates from the models in this paper suggest that regulations that restrict the independence of NPs may cost the economy from a well-defined routine child well care visit.[6] These regulations likely affect the prices of other health services as well, and it seems clear that occupational regulations may be an important factor to consider in federal or state health care policies that are intended to reduce the costs of medical care under the Affordable Care Act. However, there is a need for additional analysis on more medical procedures, as well as further

[6] A simple "back of the envelope estimate" suggests that nationally relaxing these regulations could save about $600 million for this one medical procedure per year as an upper bound, if the savings are about $10 per visit and there are about 60 million procedures.

work on the implications for patient quality of care before these results can become the focus of new public policies.

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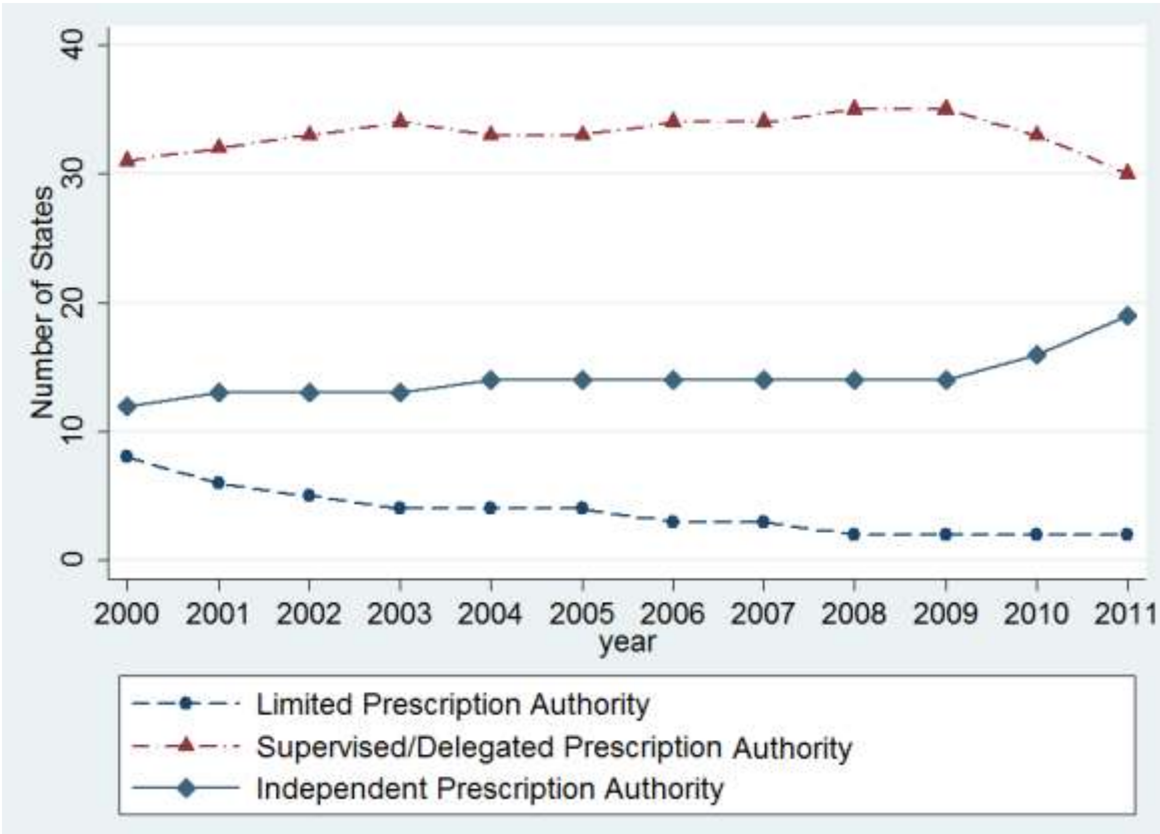
Figure 1: Growth in the Legal Requirements Allowing Nurses Greater Autonomy for Prescriptions, 2000–2011



Source: Authors' survey of licensing statutes for nurse practitioners, by state, from 2000 to 2011.

Figure 2: Well Child Exam Prices: FAIR Health vs. MarketScan

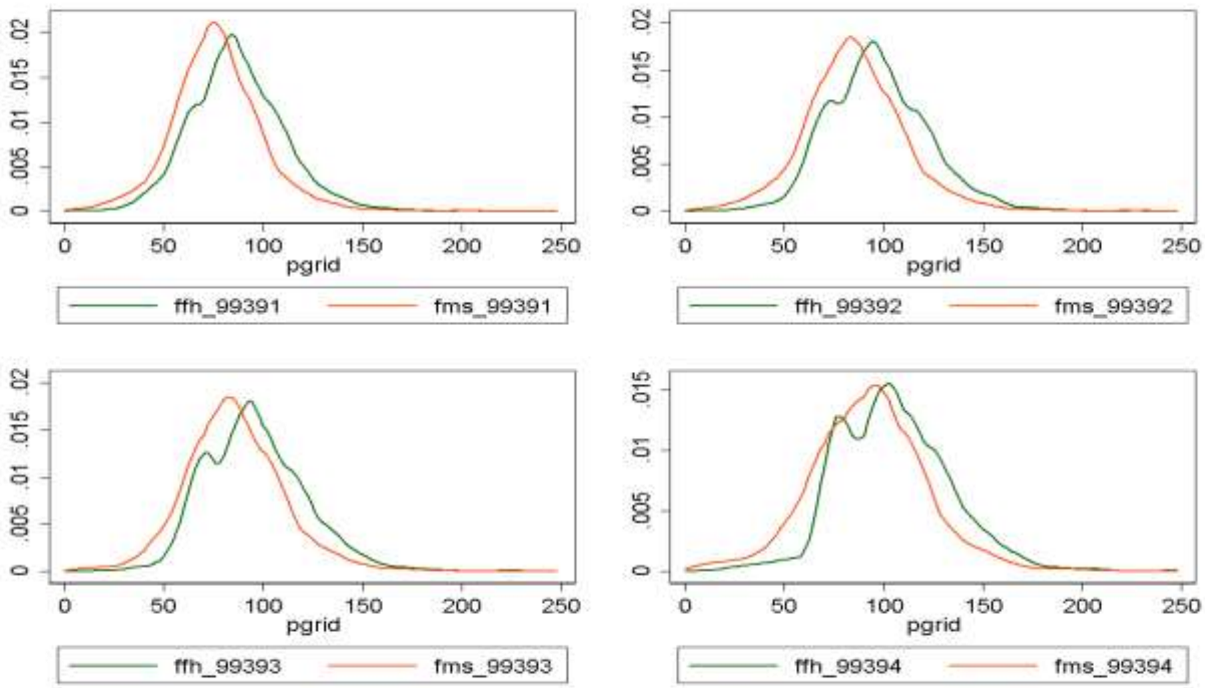
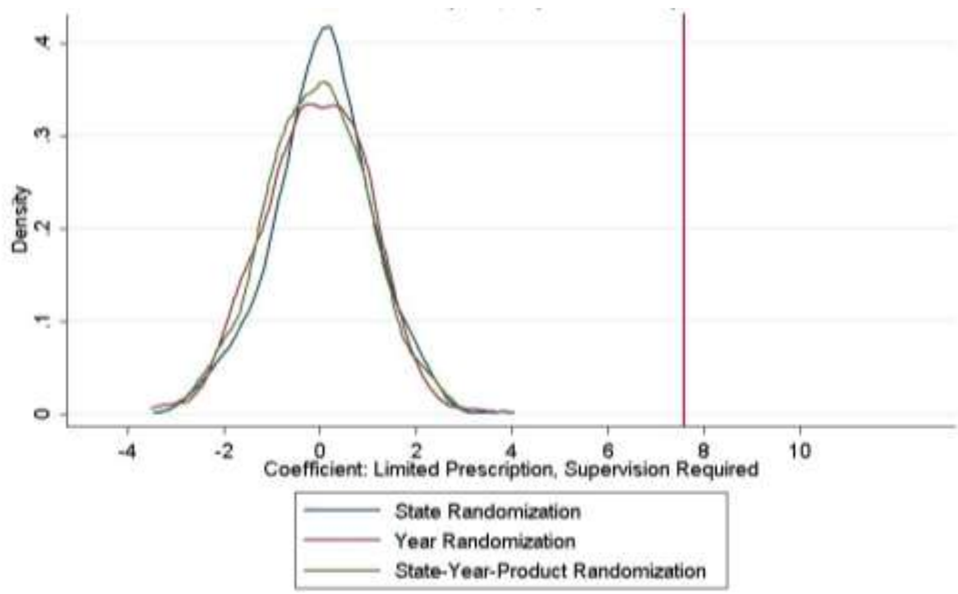


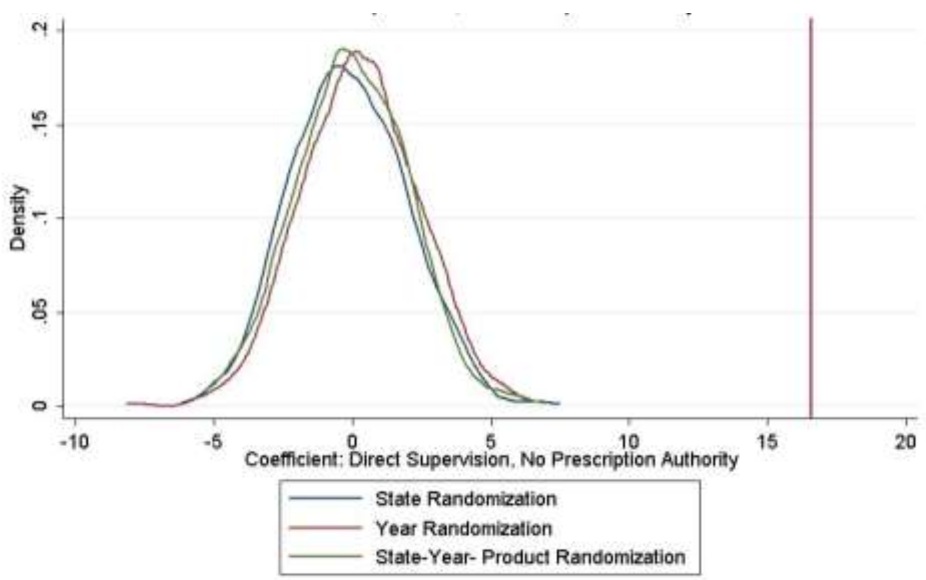
Figure 3: Falsification Tests of Regulation Effect: Permutation-Based Statistical Tests Using Kernel Density Plots

Figure 3.1 Regulation Effect: Supervised/Delegated Prescription Authority



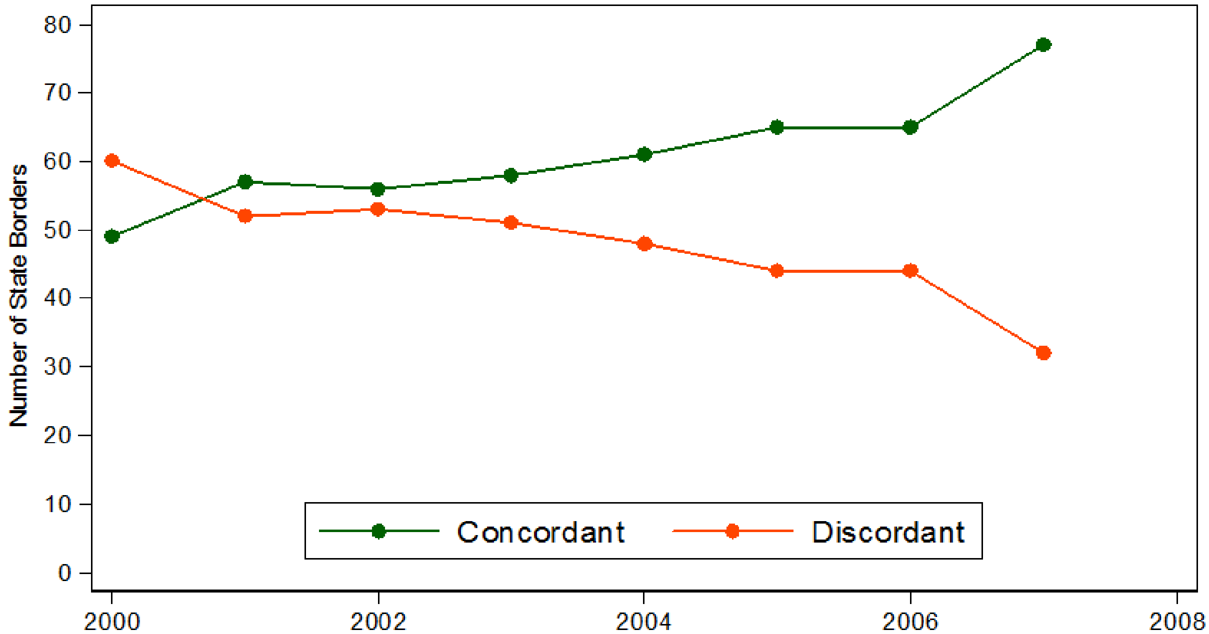
Note: Results are based from 500 permutations.

Figure 3.2 Regulation Effect: Limited Prescription Authority



Note: Results are based from 500 permutations.

Figure 4: Number of Metropolitan Statistical Areas with State Borders that Have Concordant/Discordant Regulations on Prescription Authority



Source: Authors' survey of licensing statutes for nurse practitioners, by state, from 2000 to 2011.

Table 1: States that Changed Licensing Laws on Permissible Tasks by Nurses, 2000-2011

Status	State	Changes in State Statues
No Changer	AL, FL	Limited prescription authority: Nurse Practitioners are not allowed to prescribe controlled substances from 2000 to 2011
	AR, CA, CT, DE, GA, IL, IN, KS, MA, MI, MN, NC, NE, NJ, NY, OH, OK, PA, RI, SC, SD, TN, VA, VT, WV	Supervised/Delegated prescription authority: Nurse Practitioners may prescribe controlled substances under MD supervision from 2000 to 2011
	AK, AZ, DC, IA, ME, MT, NH, NM, OR, UT, WA, WY	Independent prescription authority: Nurse Practitioners may prescribe controlled substances independent of MDs from 2000 to 2011
Changer	LA, NV	From “No prescription authority “ to “Supervised/Delegated” during 2000-2001
	WI	From “Supervised/Delegated” to “Independent” during 2000-2001
	MS	From “No prescription authority “ to “Supervised/Delegated” during 2001-2002
	TX	From “No prescription authority “ to “Supervised/Delegated” during 2002-2003
	ID	From “Supervised/Delegated” to “Independent” during 2003-2004
	KY	From “No prescription authority “ to “Supervised/Delegated” during 2005-2006
	MO	From “No prescription authority “ to “Supervised/Delegated” during 2006-2007
	CO, MD	From “Supervised/Delegated” to “Independent” during 2009-2010
	HI	From “Supervised/Delegated” to “Independent” during 2010-2011

Source: Authors' survey of licensing statutes for nurse practitioners, by state, from 2000 to 2011.

Table 2: Summary Statistics for Nurses and Physicians using the ACS, 2002–2009

Variable	Registered Nurses & Licensed Practical/Vocational Nurses (*n*=21,276)		Physicians & Surgeons (*n*=38,094)	
	Mean	Std. Dev.	Mean	Std. Dev.
Individual Level				
ln(hourly earnings)	3.52	0.51	4.15	0.76
Total hours of work	1,914.21	561.00	2,340.71	616.41
Age	47.43	9.64	45.67	9.91
Age-Squared(/100)	23.42	8.81	21.84	9.08
Age-Trippled(/10,000)	11.95	6.30	10.87	6.50
Female	0.90	0.30	0.34	0.47
Married	0.68	0.46	0.81	0.39
White	0.84	0.37	0.77	0.42
Black	0.07	0.26	0.04	0.20
PhD	0.02	0.15	0.11	0.32
Professional	0.24	0.43	0.84	0.36
For-Profit	0.47	0.50	0.39	0.49
Self-Employed	0.01	0.11	0.21	0.41
State Regulation (n=408 states by year)				
No prescription authority	0.07	0.25		
Supervised/Delegated	0.66	0.47		
Independence	0.27	0.44		

Table 3: Basic Price Data from FAIR Health Inc. for Child Care Visits

CPT Code	Descriptions	Age (Year)	Number of Claims	Mean Allowed Amount	Median Allowed Amount	SD Allowed Amount
99381	Preventive Visit New Patient	0–1	551,972	108.91	106	30.06
99382	Preventive Visit New Patient	1–4	353,231	119.57	117.44	32.22
99383	Preventive Visit New Patient	5–11	425,911	117.64	114.97	31.91
99384	Preventive Visit New Patient	12–17	508,421	124.58	122.4	36.24
99391	Preventive Visit Established Patient	0–1	8,040,000	86.72	84.9	23.99
99392	Preventive Visit Established Patient	1–4	8,390,000	96.86	94.7	26.2
99393	Preventive Visit Established Patient	5–11	6,238,129	96.1	93.53	26.2
99394	Preventive Visit Established Patient	12–17	5,074,770	104.85	102.47	29.59

Table 4: ACS Estimates of the Effects of Occupational Regulations on Log Hourly Earnings of Nurse Practitioners and Medical Doctors, 2002-2009

	Nurse Practitioner *ln*(Wage)		Physician *ln*(Wage)	
	(1) One-Stage Model	(2) Two-Stage Model	(1) One-Stage Model	(2) Two-Stage Model
Supervised/Delegated	-0.15***	-0.14***	0.078***	0.066***
prescription authority	(0.01)	(0.01)	(0.02)	(0.02)
Limited prescription	-0.09	-0.15**	0.01	0.000
authority	(0.06)	(0.05)	(0.03)	(0.04)
Individual Covariates	Yes	Yes	Yes	Yes
State-Fixed Effects	Yes	Yes	Yes	Yes
Year-Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.09	0.62	0.22	0.50
N/First-Stage *N*	21,279	21,279	38,078	38,078
Second-Stage *N*		408		408

Note: All models include indicators for gender, marital status, race (white and black vs. others), education (ph.d. vs. professional degree), industrial sector (for profit or self-employed vs. non-profit), and a quadratic function in age; the one stage models are estimated using OLS; the two stage models adjust for covariates in a first-stage regression of individual log wages on covariates and a full set of state × year fixed effects; in the second stage, the state × year fixed effects (covariate adjusted mean wages) are regressed on state- and year-fixed effects and the regulation variables; the second stage regressions are weighted by the inverse of the state × year cell sample sizes; * significant at the 0. 05 level; ** significant at the 0.01 level; *** significant at the 0.001 level; standard errors are constructed using the heteroskedasticity robust covariance matrix that allows for clustering at the state level.

Table 5: ACS Estimates of the Effects of Occupational Regulations on Annual Hours of Labor Supplied by Nurse Practitioners and Medical Doctors, 2002-2009

	Nurse Practitioner		Physician	
	(1) One-Stage Model	(2) Two-Stage Model	(1) One-Stage Model	(2) Two-Stage Model
Supervised/Delegated prescription authority	-160.20*** (15.28)	-219.46*** (14.27)	130.84*** (14.97)	144.02*** (14.33)
Limited prescription authority	-259.84*** (49.96)	-296.97*** (33.67)	131.05** (47.06)	186.51*** (42.74)
Individual Covariates	Yes	Yes	Yes	Yes
State-Fixed Effects	Yes	Yes	Yes	Yes
Year-Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.04	0.35	0.07	0.31
N/First-Stage *N*	21,276	21,276	38,094	38,094
Second-Stage *N*		408		408

Note: All models include indicators for gender, marital status, race (white and black vs. others), education (ph.d. vs. professional degree), industrial sector (for profit or self-employed vs. non-profit), and a quadratic function in age; the one stage models are estimated using OLS; the two stage models adjust for covariates in a first-stage regression of individual log wages on covariates and a full set of state × year fixed effects; in the second stage, the state × year fixed effects (covariate adjusted mean wages) are regressed on state- and year-fixed effects and the regulation variables; the second stage regressions are weighted by the inverse of the state × year cell sample sizes; * significant at the 0. 05 level; ** significant at the 0.01 level; *** significant at the 0.001 level; standard errors are constructed using the heteroskedasticity robust covariance matrix that allows for clustering at the state level.

Table 6: Estimates of the State Price Effects for Well Child Care Visits

	(1)	(2)	(3)	(4)
Supervised/Delegated prescription authority	3.85	6.63*	6.65*	6.50
	(10.57)	(3.66)	(3.69)	(4.41)
Limited prescription authority	17.92	16.41	16.43***	16.16**
	(11.21)	(6.01)	(6.06)	(7.14)
State Covariates	No	Yes	Yes	Yes
Year-Fixed	Yes	Yes	Yes	Yes
State-Fixed	Yes	Yes	Yes	Yes
Product-Fixed	Yes	Yes	Yes	Yes
Year × Product			Yes	Yes
State × Product				Yes
R-squared	0.64	0.65	0.65	0.79
N	2,110	1,054	1,054	1,054

Note: * significant at the 0. 05 level; ** significant at the 0.01 level; *** significant at the 0.001 level; standard errors shown in parentheses are clustered by state.

Table 7**:** Sensitivity Estimates of the State Price Effects Using Dental Regulations as a Falsification Test for Well Child Care Visits

	(1)	(2)
Supervised/Delegated prescription authority	11.60***	5.52**
	(3.13)	(2.87)
Limited prescription authority	8.73***	4.05**
	(1.88)	(1.61)
State Covariates	No	Yes
Year-Fixed	Yes	Yes
State-Fixed	Yes	Yes
Product-Fixed	Yes	Yes
Year × Product Fixed	Yes	Yes
State × Product Fixed	Yes	Yes
R-squared	0.98	0.99
N	612	306

Note: Triple-differenced results with median allowed price in State×Year×Product Cell as dependent variable are shown; * significant at the 0. 05 level; ** significant at the 0.01 level; *** significant at the 0.001 level; standard errors shown in parentheses are clustered by state.

Table 8: MSAs in the State Border Analysis on Prices for Well Child Care Visits

MSA	State 1	State 2	State 3	State 4
Augusta - Aiken	GA	SC		
Boston - Worcester - Lawrence	MA	NH	ME	CT
Chattanooga	TN	GA		
Chicago - Gary - Kenosha	IL	IN	WI	
Cincinnati - Hamilton	OH	KY	IN	
Clarksville - Hopkinsville	TN	KY		
Columbus	GA	AL		
Cumberland	MD	WV		
Davenport - Moline - Rock Island	IA	IL		
Evansville - Henderson	IN	KY		
Fargo - Moorhead	ND	MN		
Flagstaff	AZ	UT		
Fort Smith	AR	OK		
Huntington - Ashland	WV	KY	OH	
Johnson City - Kingsport - Bristol	TN	VA		
Kansas City	MO	KS		
La Crosse	WI	MN		
Las Vegas	NV	AZ		
Memphis	TN	AR	MS	
Minneapolis - St. Paul	MN	WI		
New York - Northern New Jersey - Long Island	NY	NJ		
Norfolk - Virginia Beach - Newport News	VA	NC		
Omaha	NE	IA		
Parkersburg - Marietta	WV	OH		
Portland - Salem	OR	WA		
Providence - Fall river - Warwick	RI	MA		
Sioux City	IA	NE		
St. Louis	MO	IL		
Steubenville - Weirton	OH	WV		
Washington D.C. - Baltimore	DC	MD	VA	WV
Wheeling	WV	OH		

Table 9: State Border MSA Analysis on Prices for Well Child Care Visits

	(1)	(2)	(3)	(4)
Supervised/Delegated prescription authority	-1.40	3.67**	3.87***	3.04*
	(3.79)	(1.36)	(1.41)	(1.57)
Limited prescription authority	-3.53	5.13**	5.31**	4.47*
	(5.26)	(2.01)	(2.03)	(2.32)
State Covariates	No	Yes	Yes	Yes
Year-Fixed	Yes	Yes	Yes	Yes
State-Fixed	Yes	Yes	Yes	Yes
MSA-Fixed	Yes	Yes	Yes	Yes
Product-Fixed	Yes	Yes	Yes	Yes
Year * Product			Yes	Yes
MSA*Product				Yes
R-squared	0.73	0.77	0.78	0.82
N	3,581	1,756	1,756	1,756

*Note***:** The results with median allowed price in MSA×State×Year×Product Cell as dependent variable are shown; * significant at the 0. 05 level; ** significant at the 0.01 level; *** significant at the 0.001 level; standard errors shown in parentheses are clustered by MSA.

Table 10: Determinants of the Passage of Laws Allowing Nurses to Have Greater Autonomy for Patient Care Using a Proportional Hazard Model

	(1)
log(Population)	1.034
	(0.211)
Black (%) (1×10^{12})	8.760
	(7.120)
Households per zip code	1.000
	(0.000)
Income per Household	1.000
	(0.000)
log(Average house value)	1.196
	(0.933)
$\chi^2(5)$	0.30
N	65

Note: Standard errors shown in parentheses are clustered by state.

Table 11: Effects on Infant Mortality Rates of Allowing Nurses to Have Greater Autonomy for Patient Care

	(1)	(2)	(3)	(4)
Supervised/Delegated prescription authority	-0.019	-0.020	0.080	0.050
	(0.032)	(0.033)	(0.040)	(0.050)
Independent prescription authority	-0.001	-0.001	0.010	-0.002
	(0.029)	(0.030)	(0.030)	(0.040)
Demographics	No	No	No	Yes
State Fixed	No	No	Yes	Yes
Year Fixed	No	Yes	Yes	Yes
R-squared	0.001	0.03	0.25	0.34
N	306	306	306	306

Note: * significant at the 0. 05 level; ** significant at the 0.01 level; *** significant at the 0.001 level; standard errors shown in parentheses are clustered by state.

Table 12: Effects on Physician Malpractice Insurance Premiums of Allowing Nurses to Have Greater Autonomy for Patient Care, 1999–2004

	(1) ln(Internal Medicine Premium)	(2) ln(OB-GYN Premium)	(3) ln(General Surgery Premium)
Supervised/Delegated prescription authority	0.086	0.035	0.111
	(0.134)	(0.100)	(0.184)
Independent prescription authority	-0.022	-0.146	-0.087
	(0.087)	(0.081)	(0.081)
Constant	10.940***	14.070***	13.010***
	(1.422)	(1.240)	(1.385)
State Fixed Effects	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes
R-squared	0.93	0.90	0.91
N	249	249	249

Note: * significant at the 0. 05 level; ** significant at the 0.01 level; *** significant at the 0.001 level; standard errors shown in parentheses are clustered by state.

Appendix A: ACS Estimates of the Effects of Occupational Regulations on Log Wage for Nurses, 2002–2009

	ln(Hourly Earnings)				Total Hours of Work			
	(1) Nurse Practitioners		(2) Physicians		(1) Nurse Practitioners		(2) Physicians	
Supervised/ Delegated$_t$		-0.09*** (0.02)		0.11*** (0.03)		-77.09*** (22.01)		202.70*** (24.46)
Limited$_t$		-0.14*** (0.04)		0.048 (0.03)		-59.153 (45.6)		330.30*** (48.56)
Supervised/ Delegated$_{t-1}$	-0.12*** (0.01)	-0.08*** (0.02)	0.03+ (0.02)	-0.04* (0.02)	-335.79*** (14.23)	-297.19*** (18.06)	118.00*** (14.06)	-19.88 (18.94)
Limited$_{t-1}$	-0.18*** (0.04)	-0.11** (0.04)	-0.02 (0.05)	-0.06 (0.04)	-427.22*** (34.96)	-398.12*** (51.48)	147.16*** (38.98)	-52.95 (76.59)
Year-Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-Fixed	No	No	Yes	No	No	Yes	No	Yes
R-squared	0.66	0.66	0.52	0.52	0.37	0.38	0.33	0.34
N	357	357	357	357	357	357	357	357

Note: * significant at the 0. 05 level; ** significant at the 0.01 level; *** significant at the 0.001 level; standard errors shown in parentheses are clustered by state.

Appendix B: Trends in the Prices of the Well Child Visits Prior to the Passage of the Regulation

	Supervised/Delegated Prescription Authority	Limtied Prescription Authority
State Effect During Year of Regulation	-0.003*	0.001
	(0.002)	(0.0009)
State Effect$_{t-1}$	-0.002*	0.0004
	(0.0007)	(0.0005)
State Effect$_{t-2}$	-0.003*	0.0007
	(0.001)	(0.001)
State Covariates	Yes	Yes
R-squared	0.35	0.18
N	129	129

Note: * significant at the 0. 05 level; standard errors shown in parentheses are clustered by state.