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ESSAYS ON THE REGULATIONS OF ADVANCED PRACTICE NURSES AND THE HEALTHCARE SYSTEM

BY
RACHEL E. WILSON

A DISSERTATION SUBMITTED TO THE GRADUATE SCHOOL AT MIDDLE TENNESSEE STATE UNIVERSITY IN PARTIAL FULLFILLMENT OF THE REQUIREMENT FOR THE DEGREE

DOCTOR OF PHILOSOPHY/ECONOMICS

MUFREESBORO, TN

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TO MY HUSBAND CHAD

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Abstract

This dissertation consists of three essays on the effects of the regulations of Advanced Practice Nurses (APNs) on the healthcare system. The first essay, "Health Insurance: Can Liberalized Regulations of Advanced Practice Nurses Help Curb Soaring Employment-Based Health Premiums?" considers the effect of APN regulations on employment-based health insurance premiums. The purpose of this study is to investigate whether employees receive lower health insurance premiums in states with liberalized APN regulations. My findings show that the average family health insurance premium is up to 18 percent lower in states with liberalized regulations. The second essay, "Advanced Practice Nurses Impact on Various Health Expenditure Categories" considers the impact of APN regulations on various categories of healthcare expenditures. I find that states with liberalized APN regulations have significantly lower overall personal healthcare. The final essay, "The Impact of Regulations of Advanced Practice Nurses on the Prevalence of Physician Types," considers the effect of APN regulations on the mix of physicians in a state. I find robust results suggesting that liberalized APN regulations reduce the prevalence of family practice physicians. There is also some evidence that liberalized APN regulations have an impact on other physician types depending on the age grouping of the physicians considered. The results of these studies have important policy implications for effective regulations of APNs.

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Introduction

This dissertation consists of three essays on the impact of Advanced Practice Nurses (APNs) on the healthcare system. APNs have begun to take an increasing role in the provision of healthcare in the past few decades. The current literature establishes their role in extending access to care and providing cost-savings for those organizations that extensively utilize their services. This dissertation adds to the literature by systematically looking at their impact on employment based health insurance premiums, state health expenditures, and the mix of physicians in a state. Variation in APN regulations within and between states provides an avenue to study the effect of APNs on these aspects of the healthcare system. Information on state regulations of APNs comes from *The Nurse Practitioner* journal

The first essay, "Health Insurance: Can Liberalized Regulations of Advanced Practice Nurses Help Curb Soaring Employment-based Health Premiums?" investigates the extent to which greater professional independence of Advanced Practice Nurses (APNs) impacts employment-based health insurance premiums. Specifically, I use data on employment-based health insurance premiums from the *Medical Expenditure Panel Survey*. My findings show that the average employment-based family health insurance premium is up to 18 percent lower in states with liberalized regulations. If the results extend to other sources of insurance, liberalization may have a sizeable effect on government programs such as Medicare.

The second essay, "Advanced Practice Nurses Impact On Various Health Expenditure Categories," examines which type of medical spending is most impacted by

the liberalization of APN regulations. I use state health expenditures collected by the *Centers for Medicare & Medicaid Services* to investigate the impact of APN regulations on various healthcare costs. Overall *personal healthcare* expenditures appear to be 2.69% less in states that liberalize APN regulations. Of the eight specific categories considered, the following three are significantly impacted by the regulatory variables: *physician and clinical services, other non-durable medical supplies* and *other personal healthcare.* A greater understanding of APNs impact on healthcare spending can help increase the effective use of these cost-saving clinicians for health insurance companies, the uninsured, and the federal government.

The final essay, "The Impact of Regulations of Advanced Practice Nurses on the Prevalence of Physician Types," investigates the impact of state regulations of APNs on the prevalence of physician types. I use the *Community Tracking Physician Surveys (CTPS)* to examine the impact of liberalized APN authority on the mix of physicians in a community. I find robust results suggesting that liberalized APN authority reduces the prevalence of family practice physicians. There is also some evidence that liberalized APN authority has an impact on other physician types depending on the age grouping of the physicians considered. The results of this research have implications not only for the policies aimed at adjusting the mix of generalists and specialists but also for the labor market and structure of the healthcare system in the United States.

HEALTH INSURANCE: CAN LIBERALIZED REGULATIONS OF ADVANCED PRACTICE NURSES HELP CURB SOARING EMPLOYMENT-BASED HEALTH PREMIUMS?

I. Introduction

Rising health insurance premiums have become one of the largest financial responsibilities to employers that provide health insurance. Over the last two decades, employment-based health insurance premiums have grown considerably faster than both inflation and worker's earnings in every year but 1996 (Kaiser Family Foundation, 2005). Controlling these growing premiums is a major concern for all businesses regardless of their size.

Employees are also paying attention. Each year the number of employers offering health insurance falls. Between 1987 and 2006, the number of workers with employment-based insurance fell from 70% to 59% (National Coalition on Healthcare, 2008). Workers who obtain employment-based insurance often face a trade-off. Studies have shown that rising health insurance premiums have led employers to offer lower wages or to increase work hours as an alternative (Gruber and Krueger, 1991; Sheiner, 1995; Cutler and Madrian, 1998).

The increasing reliance on Advanced Practice Nurses (APNs) is often publicized as a promising supply-side approach to reduce healthcare costs. Concerned employers and employees may consider APNs as an option to help reduce insurance premiums. While researchers find cost-savings for medical practices, managed-care companies and

hospitals that use APNs, it is unclear whether these cost-savings are shared with the healthcare consumer. The healthcare industry may not be structured to pass savings directly to the consumer at the point of service through lower prices or co-pays. Rather, any cost-savings are most likely to show up as reduced (or not increasing) health insurance premiums.

In the past, many states limited the scope of APNs through tight regulations that required physician supervision and/or restricted prescription-writing capabilities. Thus, the impact of APNs on healthcare costs had been dampened. Over the past few decades, however, many states have liberalized their regulations by reducing or eliminating the requirement of supervision or by allowing APNs to write more prescriptions (or both). Economic theory suggests that as regulations are liberalized, markets become more competitive. Competition decreases healthcare costs which should translate into lower health insurance premiums. However, it is also possible that liberalizing regulations could raise health insurance premiums either by increasing the absolute number of medical visits (i.e. increasing the healthcare consumption of consumers) or by altering the choices of rent-seeking entities. For instance, liberalization could lead physician practices or hospitals to substitute away from APNs in favor of alternative mid-level practitioners.

No research has considered whether liberalized APN regulations affect consumers via reduced health insurance premiums. This paper uses exogenous variation in the timing of state regulations to identify the impact of liberalized regulations of APNs on health insurance premiums. Specifically, it uses data on employment-based health

insurance premiums from the *Medical Expenditure Panel Survey* in conjunction with state-level classifications on regulations for APNs from *The Nurse Practitioner* journal.

The results from the preferred empirical specification indicate that the average family health insurance premium per enrolled employee is up to 18 percent lower in states that liberalize their regulations on the use of APNs. These findings confirm that liberalization of APN regulations provides a monetary benefit to some consumers, specifically those families that receive health insurance through employment. The results for employment-based family premiums may have significant implications for major healthcare savings by private and government employers or government sponsored programs. For instance, the federal government pays a significant amount of healthcare cost. Current projections have the government paying for almost 50 percent of healthcare by 2016 (Poisal, 2007). Growth in Medicare alone is forecasted to average 7.6 percent per year from 2008 to 2016 (Poisal, 2007). If the results extend to other sources of insurance, liberalization may have a sizeable effect on government programs such as Medicare.

The rest of this paper is organized as follows. Section II provides background information on APNs and the structure of the health insurance market. Section III provides a review of applicable literature. Section IV examines the data. Section V discusses the empirical specification. Section VI investigates whether liberalized regulations and thus APN autonomy lowers health insurance premiums. Finally, Section VII concludes with a discussion of the implications of the results and areas for future research.

II. Advanced Practice Nurses and the Health Insurance Market

APNs fall under the broader category of mid-level practitioners. While used for decades in rural and underserved areas, mid-level practitioners are taking an increasing role in the provision of medical care nationwide (Weiner, 1986). There are two main forms of mid-level practitioners. The first is the advanced practice nurse (APN), such as the nurse practitioner, certified nurse midwife, or the nurse anesthetist. APNs are registered nurses who have advanced training, typically a master's degree in a specific field of specialty such as midwifery or anesthetics.

The second type of mid-level practitioner is the physician's assistant (PA). In general, PAs are not required to have an undergraduate degree in a medical field. They are trained through a post-baccalaureate two-year program, such as a master's degree program. PAs do not normally specialize in their training program.[1]

Both APNs and PAs are permitted to diagnose and treat acute minor illness such as sinusitis, and non-acute chronic conditions such as diabetes or hypertension. However, the regulations governing APNs and PAs can vary widely from state to state. In many states, APNs can function independently from a physician and frequently have broad prescribing rights. In contrast, PAs must always work under the supervision of a physician and often have severely limited prescribing rights.

Another significant difference is the reimbursement of APNs versus PAs from health insurance. In states where APNs have the greatest professional independence and are directly billed, they are often reimbursed at a lower rate than is a physician. PAs are

[1] For more information on APNs and PAs see the Bureau of Labor and Statistics, Occupational Outlook Handbook 2008-2009.

always salaried employees of an organization, and thus, are never billed as a separate provider. As salaried employees, PAs often allow the physician or hospital to be reimbursed at a rate immaterial of whether the consumer is seen by a physician or a PA. Thus, the physician's or hospital's ownership interest in the entity may allow them to more easily extract rents from using a PA over an APN.

This study focuses on APNs for three reasons. Most importantly, there is no comprehensive account of the development of state regulations governing PAs like there is for APNs. Second, APNs are the only mid-level practitioners able to be billed as a separate provider. As such there is no reason to believe that the use of PAs would generate cost savings for insurance companies and, therefore, consumers. Third, APNs are able to open stand-alone practices in highly liberalized states. This professional independence provides a direct avenue to reduce consumer costs.

The variation in APN regulations within and between states provides an avenue to study the impact of APNs on health-insurance premiums. That is, this variation in the timing of the reforms across states allows for a natural experiment. Those states that maintain their standard regulations serve as the comparison group while those states that change their regulations are the treatment group.

To understand the impact of APNs on health insurance premiums, it is necessary to recognize some of the peculiarities that distinguish the health insurance market from other insurance markets. Unlike other types of insurance, health insurance is generally bought on a group basis, typically through employment. Additionally, health premiums are not exclusively determined in an actuarial process like other forms of insurance. Firms often self-insure or use experience ratings which base premiums on previous

period claims plus loading charges, which are mark-ups that cover such costs as administrative or marketing (Jensen, 1990). Health insurance plans may also be legally required to cover routine and predictable cost such as annual exams or minor sicknesses depending on state mandates. The most widespread form of health insurance, managed care, establishes pricing contracts with healthcare providers before claims are made.

Over the last few decades, the health insurance industry has moved from indemnity insurance to a managed care system. An indemnity arrangement relies on demand cost-sharing and utilizes a percentage of service co-payment, thus, the consumer's cost varies based on the cost of healthcare services. For example, under an indemnity plan, a consumer's out-of-pocket expenses would be higher if he saw a physician, versus an APN. Until the 1970s, most health insurance plans were indemnity plans.

In 1973, congress passed the *Health Maintenance Organization Act*, which ushered in a new era of health insurance plans known as managed care. As a result, from 1988 to 1999, the percentage of workers in indemnity plans decreased from 73% to 9% as workers moved to managed care plans (Gabel, 1999). It is estimated that during the 1990s almost three-fourths of all covered workers were enrolled in managed care plans (Jensen, 1997).

Managed care is found in three main forms: Health Maintenance Organizations (HMO), Preferred Provider Plans (PPO), and Point-of-Service Plans (Health Insurance, 2008). Unlike indemnity plans, managed care plans rely on supply-side constraints and primarily use fixed co-payments for services. While health insurance in general obscures the true marginal cost to consumers, managed care systems further mask the costs by

charging a fixed co-payment per service rather than a percentage of cost. Under managed care plans, the consumer co-payment does not typically vary by provider type. Such a system does not allow for a direct impact from the use of APNs on healthcare cost to consumers at the point of service.

Managed care plans compete even further on price by pre-negotiating contracts with providers and labs to establish a network of providers. Plan members are limited or financially enticed by cheaper co-payments to use providers within the network. Such actions bolster the competitive environment of the industry. Hurley and Mayes (2006), and Moon and Shinn (2007), among others, contend that the brief fall in the growth rate of health insurance premiums in the mid-1990s is a result of the extremely competitive techniques of managed care. Both cite the populist backlash against managed care due to plan restrictions as a major contributing factor in the surge of premium growth rates in the beginning of the millennium.

Since the current structure of health insurance masks the true cost of medical care to the consumer, be it a business or individual, the most plausible way for consumers to share in the use of cost-saving labor is through reduced (or non-increasing) premiums. Health insurance companies would be compelled to share some of the APN derived cost-savings with consumers if the insurance market is competitive. Assuming that the health insurance market is competitive is legitimate because health insurance is a homogenous product. It is purchased in a national market before it is needed by large buyers that can easily evaluate and contrast different contracts (Getzen, 1996).

Even if the health insurance market is competitive, the regulations of APNs may not have a significant impact on health insurance premiums due to the distinctive nature

of the market. If liberalized APN regulations do not reduce health insurance premiums, then other possibilities must be considered. It is possible that APNs and physicians are not good substitutes but rather complements serving as physician extenders. For example, Baxter et al. (1997) and Record et al. (1980) suggest that APNs spend more time evaluating and educating patients. Consumers may respond to APNs by increasing their absolute number of visits. Indeed, research shows that the extensive use of APNs increases the absolute number of visits for physician offices and clinics. Chang et al. (2004) find that "faced with a constrained budget and backed by policies favorable to NPs (nurse practitioners), VA medical centers substantially increased the numbers of NPs used in primary care and saw 40% more patients between 1996 and 1999." An absolute rise in medical visits could ultimately raise insurance premiums.

Another possibility is that APNs and PAs may be considered as substitutes for each other. As APNs become more independent, they become less of a revenue source for the physician, or hospital. PAs may also have a further advantage over APNs in productivity. Record et al. (1980) found that PAs spend less time with patients compared to APNs. This increases the productivity rate of PAs to a level comparable to that of a physician. PA's greater cost-effectiveness may further contribute to a substitution towards PAs over APNs. Table 1 summarizes these possible effects.

III. Related Studies

While studies have shown that mid-level practitioners can provide cost-effective labor, little or no empirical research has been conducted to see whether these savings are

passed on to consumers. This research extends the existing literature by examining the relationship between the APN regulations and health insurance premiums to draw implications for containing the tremendous growth in health insurance premiums.

In a recent study of the impact of state regulations on the earnings of APNs over time, Dueker et al. (2005) find that liberalizing state regulations leads to a reduction in the earning's of APNs. Economic theory suggests that deregulation should increase supply and lead to wage reductions. Dueker et al. (2005) propose that this decline in earnings could be a premium for independence or a reflection of hospitals and primary care practices hiring the most productive APNs. They, also find that in states with fewer restrictions on APNs, PAs' salaries rise, perhaps, because hospitals and primary care practices substitute PAs for APNs. This substitution may occur due to concerns of direct competition from a less expensive rival or from legal or insurance complications from the professional independence of APNs.

Adams et al. (2004) address the use of mid-level practitioners by managed care organizations as an approach to reduce labor cost. Their study covers approximately two million visits to 26 different primary care practices from 1997 through 2000. It finds total and average cost savings, ranging from 4-6 percent[2] for those primary care practices that extensively utilize mid-level practitioners.

By estimating the theoretical consumer surplus lost from underutilizing APNs, Nichols (1992) shows that regulations restricting APNs from treating patients they are capable to treat reduce consumer surplus. While acknowledging the likelihood of monopolistic pricing for medical care services, the study does not take address the price

[2] The range of 4-6 percent is dependent on the type of practice.

wedge that develops under the widespread third-party payment system from health insurance. Nichols (1992) further outlines the parameters needed for estimation, but does not conduct any empirical analysis.

Numerous other studies also investigate the link between physician shortages and the increased use of mid-level practitioners. Sekscenski et al. (1994) find a larger supply of mid-level practitioners in states with both favorable practice environments and shortages of primary care physicians. However, they were unable to establish whether the supply of mid-level practitioners caused the favorable practice environments or vice versa.[3]

Other studies show the connection between appointment expansion and increased access to medical care from using mid-level practitioners. As previously mentioned, Chang et al. (2004) finds that 40 % more patients were seen when the number of nurse practitioners in Veteran Affairs medical centers were considerably increased. Lowes (1998) discusses benefits to patients when allowed immediate access to a mid-level practitioner rather than having to wait for an appointment with a physician. Lowes found one practice that was committing 85% of its same day appointments just for mid-level practitioners.

[3] Hooker and Berlin (2002) document that 23 % of mid-level practitioners work in rural areas compared to only 13 % of physicians.

IV. Data

A. Regulatory and Health Premiums

To explore the impact of APN regulations on health insurance premiums, data on the degree of APN regulation by state is derived from the yearly review of legislative issues affecting APNs conducted by *The Nurse Practitioner* (*TNP*) journal. *TNP* began collecting this information in 1989. In the 1994 January issue, *TNP* began classifying each state on both the degree of legal authority and prescriptive rights for APNs. These classifications are used to create two variables to capture the degree of autonomy APNs have in their practice (*authority*) and in their prescription writing (*prescribe*).

TNP's classification of legal authority reflects three main areas: physician involvement, title protection and scope of practice. States can differ widely in their requirements for physician involvement. At one extreme are states that grant APNs complete independence from physician involvement. On the other extreme are states that limit APN autonomy by requiring collaboration, or direct supervision by a physician.

States also vary in the title protection of APNs. According to the New York Nurses Association, "title protection is another means by which the public is assured that the individual, who is providing care, has met the standards for licensure" (Title Protection, 2007). Title protection, which not all states grant, essentially legitimizes a position.

Finally, states also differ as to which board(s) authorize(s) the scope of practice. In some states, the scope of practice is determined solely by the Board of Nurses; in others, it is determined exclusively by the Board of Medicine; and still in others, it is

determined jointly by the two boards. *TNP* suggests that having the scope of practice determined by any board other than the Board of Nursing is a form of professional regulation.

The *authority* variable is assigned a value of one if *TNP* classifies the state as having no requirement of physician involvement, the scope of practice is solely determined by the Board of Nurses, and there is title protection. *Authority* equal to one is referred to as "full authority." In these states, APNs have the most autonomy and can operate independently from physicians.

The rest of *TNP* authority classifications require some type of physician involvement, and differ in matters of title protection and/or board(s) that authorize the scope of practice. This study is concerned with the impact of the competitive aspect of the regulations (autonomy) on health insurance premiums. The APN's right to practice independently is the requisite mechanism for competition. This study is not interested in the impact of title protection or in which board authorizes the scope of practice on health insurance premiums. Any state not meeting the requirement for a one, is assigned a zero for the *authority* variable. *Authority* equal to zero is referred to as "limited authority."

TNP also considers prescriptive rights. These classifications reflect the ability of APNs to write prescriptions for certain types of drugs and the requirement of physician involvement in prescription writing. States either grant APNs the capacity to write prescriptions for all drugs, for all drugs except for controlled substances, or for none. The requirement for physician involvement varies from complete autonomy to some physician involvement in writing prescriptions. An indicator variable, *prescribe_full*, is created for states allowing APNs to write for all drugs without any requirement of

physician supervision. Another indicator variable, *prescribe_limited*, is constructed for states that have any requirement of physician involvement, regardless of the type of prescriptions the APNs are permitted to write. Finally, another indicator variable, *prescribe_no*, is created for all states that do not allow APNs to write prescriptions. By 1998 all states allowed prescription-writing and thus no states had a value of one for *prescribe_no*. *Prescribe_full* is referred to as "full prescriptive rights", *prescribe_limited* is referred to "limited prescriptive rights", and *prescribe_no* is referred to as "no prescriptive rights." Both the authority and the prescriptive classifications from *TNP* are summarized in Table 2.

It would be ideal to have household data on health insurance premiums; however such data is difficult to obtain for two reasons. First, many publicly-available data sets (such as the *Consumer Expenditure Survey*) suppress the state information for a large majority of observations at the individual level because of privacy issues. This makes it impossible to match an individual to the data on state APN regulations. Second, most data sets report only the out-of-pocket cost of health insurance premiums to the consumer. Though these data sets often indicate whether an employer or other organization pays for an additional part of the premium, they do not report the amount. Thus, the total cost of the premium is masked when a premium is not paid entirely by the consumer. Since most health insurance is employment-based, the most practical solution is to use state-level averages of health insurance premiums per enrolled employee as reported by the *Medical Expenditure Panel Survey* (*MEPS*).

The Agency for Healthcare Research and Quality began conducting the *MEPS* in 1996. The *MEPS* collects data at the individual level, but it does not release the state

identifier to the public over privacy concerns. As a result, this study uses the *MEPS Insurance Component* from 1996 to 2005. The *Insurance Component* surveys private employers about their health insurance plans. The collected information is published in tabular form at the national, state, and regional level. The state-level tables are used to create two data sets: one for each state's average *family* health insurance premium per enrolled employee at private firms and one for each state's average *individual* health insurance premium per enrolled employee at private firms. Premiums are reported for the following firm sizes: less than 10 employees, between 10-24 employees, between 25-99 employees, between 100-999 employees, and more than 1000 employees. The data contain 2,127 observations for family premiums and 2,136 observations for individual premiums. Both are unbalanced panels, i.e., not every state is observed in each period.

The average health insurance premium by regulatory group per family and individual employees is presented in Table 3. This table also displays the percentage of states with each classification from 1996 to 2005. The majority of states have limited authority and limited prescriptive rights. In general, states have moved progressively toward greater liberalization; however, some states have moved away from liberalization. During this study's time horizon eight states moved from limited authority to full authority while three states moved from full authority to limited authority. Four states moved from no prescriptive rights to limited prescriptive rights, three states moved from limited prescriptive rights to full prescriptive rights, one state temporarily moved from limited prescriptive rights to no prescriptive rights, one state temporarily moved from full prescriptive rights to limited prescriptive rights, and one state moved from full prescriptive rights to limited prescriptive rights. It is possible that those states which

moved away from liberalization had APNs on a temporary regulation and new legislation was not passed when the temporary order expired. *TNP* refers specifically to legal defeats as the cause of these setbacks.

According to Table 3, the average inflation-adjusted premium is $2659 for a family and $1080 for an individual payer. In both the family and individual samples, the premium is lower in states with limited authority ($2624 for family and $1073 for individual) compared to full authority. The premium is lowest in states with no prescriptive rights ($2272 for family and $948 for individual) compared to limited prescriptive rights and full prescriptive rights. When considered jointly, the premium is lowest in the full authority and no prescriptive rights category ($2169 for family and $861 for individual).

The descriptive statistics of health insurance premiums from Table 3 imply that in states with liberalized regulations, health insurance premiums are higher. However, these statistics may be picking up correlation and not causation (or unobserved state-level heterogeneity). While the premiums are adjusted for inflation, they do not control for other factors. In order to test for causal effects, it is important to control for both constant and time-varying trends that may influence a state's premium. This is done through multivariate regression analysis. The precise econometric specification is described in section V.

B. Additional Controls

This paper examines the impact of APN regulations on the determination of health-insurance premiums. However, many other factors are expected to affect health

insurance premiums. Including state indicator variables in a multivariate regression or using a fixed-effects estimator will remove the influence of time-invariant, state-level, unobserved effects correlated with the regulatory efforts. The inclusion of year indicators controls for national trends in health-insurance premiums. For example, the effect of the Balanced Budged Act of 1997 that allowed APNs to be reimbursed regardless of the place of service, is captured in the year fixed effects. Previously, APNs were limited to direct reimbursement only in underserved areas. Including an interaction between state indicators and a linear time trend will help to control for unobserved state specific time-varying trends. Adding an interaction between state indicators and the square of a linear time trend will help to control for non-linear state trends[4]. A number of additional controls that might be expected to affect the determination of health insurance premiums in a time-varying scheme are described here.[5]

The proliferation of managed care could substantially impact health insurance premiums. Cutler et al. (2000) found that from 1993 to 1997 medical care spending was below its fifty-year trend, due to the rise of managed care and the accompanying cost savings from supply-side constraints. States with more favorable environments for managed care may have similar regulations for APNs. If managed care trends are not controlled for, then estimates for APN regulations may reflect the impact of managed care. A proxy for managed care in a state comes from the Managed Care Digest Series

[4] I acknowledge that there is no guarantee that either of these state and time interactions are the exact functional forms. These two terms are the best attempt to control for broad trends that could be impacting state health insurance premiums. Including an interaction between state indicators and year indicators was not possible because of multicollinearity with the regulation variables.

[5] Unfortunately, data could not be found for each state's APN population. I attempted to contact each state's board of nursing and many states did not keep such records.

report on HMO's (from 1996 to 2005). Specifically, controls are created for the penetration of HMOs into the state's healthcare market (ratio of enrollment to the state's population) and the total number of HMOs in a state. These controls not only vary across states, but within states as well. For example, Alaska has no HMO plans for the entire period while Florida dropped from 64 in 1996 to 44 in 2005.

Also used is a 2005 Blue Cross and Blue Shield Association publication on state mandates for health insurance. Each state has specific mandates for health insurance coverage such as requiring plans to cover certain screening tests, or mental health treatments. A count variable is created for the number of mandates per state. The number of mandates varies from state to state. In 2000, Florida had 52 mandates while Idaho had only 9 mandates. Not every insured consumer is impacted by state mandates. Self-insured companies and individual purchasers are usually exempted from required mandates (Frech, 2002). However, excessive mandates have the potential to make health insurance premiums greater. One could imagine a scenario where states with many mandates are also heavily regulated. If the tendency to have more mandates is not accounted for, then such a trend could confound the true impact of APN regulations.

A state's political climate may impact the degree of regulation for APNs as political environments set the stage for attitudes towards regulations. Data from the Americans for Democratic Action (ADA), an independent liberal lobbying organization, is used to control for the state's political climate. Each year this organization selects what it considers to be the twenty most important congressional votes of the session. Politicians are given points for voting "with" the ADA. The ADA forms a liberal quotient based on these points. The individual politician's quotient is used to determine

two state quotients: one for the house and one for the senate ranging from zero to one, zero being conservative and one being liberal. Additionally, a control is included for the governor's party affiliation. For each year, this variable is given a one if the governor is a Democrat and a zero if Republican.

A final measure of the political climate is the maximum amount awarded for a family of three under Temporary Assistance for Needy Families (TANF). While this is a federal program, it allows for state discretion and the amount can vary from state to state over time. This information is from the Urban Institute.

The local economy of the state could also impact the trend in health insurance premiums. Since the majority of households receive insurance through their employers, the state unemployment rate may impact health insurance coverage and thus is an important factor to control for. The unemployment rate for each state, as reported by the Bureau of Labor and Statistics, is included as a control. Total state income is also used as a general measure on the state's economy. Total state income and the state population count, are taken from Regional Economic Information System, which is run by the Bureau of Economic Analysis.

The underlying health status of each state could also affect the health insurance premiums. The following four measures from the Center for Disease Control's Behavioral Risk Factor Surveillance System are included in order to capture the general health of each state: the percent of the residents who have ever been told they have diabetes; the percent of adults who are current smokers; the percent of residents who have any access to healthcare coverage; and, a self-reported measure for general health status.

Perhaps the most difficult factor to control for is the quality of the health insurance. Premiums may be trending because of "benefit buy-downs" such as reduced coverage or decreased employer cost sharing. One study estimated that the benefit buy-down in 2002 was two to three percent (Gabel et al, 2002). The percent of firms offering at least one plan that required no employee contribution is included as a proxy for benefit buy-downs. This information comes from the *MEXP*.

Table 4 provides descriptive statistics for all of the variables.

V. Empirical Model

The purpose of this research is to examine the relationship between liberalized APN regulations and healthcare costs, measured by health insurance premiums. As such, the dependent variable used in this analysis is the logged average amount paid for health insurance per enrolled employee in a state, adjusted for inflation. Health insurance premiums are calculated based on data from previous periods. If a state liberalizes its regulation of APNs, the current premium could not be affected until the next renewal period. Therefore in estimating health insurance premiums, a lag is used for all authority and prescriptive classifications. The empirical model can be written:

$$\begin{aligned} AHI_{it} = {} & \alpha_{it} + \beta_1 authority_{it-1} + \beta_2 prescribe\_full_{it-1} + \beta_3 prescribe\_limited_{it-1} \\ & + \beta_4 authority_{it-1} * prescribe\_full_{it-1} + \beta_5 authority_{it-1} * prescribe\_limited_{it-1} \\ & + \beta_6 State_i + \beta_7 Year_t + \beta_8 FS_i + \beta_9 State * Time + \beta_{10} State * Time^2 + \beta_{11} STVC_{it} + \varepsilon_{it} \end{aligned}$$

where i indexes the state, t indexes the years, *AHI* is the logged average health insurance premium, *State* is a vector of indicators for state, *Year* is a vector of indicators for year, *FS* is a vector of indicators for firm size, *STVC* is a vector of state time-varying

controls, *State*Time* is an interaction between state indicators and a linear time trend, *State*Time*^{2} is an interaction between state indicators and time squared and $\hat{a}$ is a disturbance term[6].

VI. Results

Results for the regulatory variables are presented in Table 5. Model 1, includes $authority_{t-1}$, $prescribe\_full_{t-1}$, $prescribe\_limited_{t-1}$, state indicators, firm size indicators and time indicators. In the family sample, $authority_{t-1}$ is positive, while $prescribe\_full_{t-1}$ and $prescribe\_limited_{t-1}$ are negative. $Prescribe\_full_{t-1}$ *is* significant at the 5% level, implying that premiums are 12.56% lower in states with full prescriptive rights compared to states with no prescriptive rights. In the individual sample, $prescribe\_full_{t-1}$ is negative, while $authority_{t-1}$ and $prescribe\_limited_{t-1}$ are positive. No regulatory variables are significant in the individual sample.

To control for unobserved time-varying state trends, model 2 adds two interaction terms: a state indicator and linear time trend and a state indicator and linear time trend squared. In the family sample, $authority_{t-1}$ becomes negative and significant at the 5% level. This suggests that premiums are 10.82% lower in states with full authority compared to states with limited authority. $Prescribe\_full_{t-1}$ loses its significance and $prescribe\_limited_{t-1}$ becomes positive but remains insignificant. In the individual sample, $prescribe\_full_{t-1}$ becomes positive and $authority_{t-1}$ becomes negative. No regulatory variables are significant in the individual sample.

[6] No prescriptive rights is the excluded variable for prescribe, 2005 is the excluded year and more than 999 employees is the excluded firm size.

Model 3 adds the time-varying state controls described in section IV.B. In the family sample, none of the regulatory variables change sign. $Authority_{t-1}$ remains significant at the 5% level implying 10.66% lower premiums in states with full authority compared to states with limited authority. In the individual sample, $authority_{t-1}$ becomes positive; however, no regulatory variables are significant.

Models 1 through 3 assume that the joint impact of authority and prescriptive rights are independent. For example, this would mean that the impact of full authority is constant regardless of the level of prescriptive rights. In this case, simply summing the coefficients of authority and one of the prescribe coefficients would capture the total effect. However, this may not be the case. Instead, authority and prescriptive rights may magnify or even dampen each other. A state that has both full authority and full prescriptive rights may experience an effect that differs significantly from a state with full authority and limited prescriptive rights. Thus, the last model, model 4, adds two interaction terms: an interaction between $authority_{t-1}$ and $prescribe\_full_{t-1}$, and an interaction between $authority_{t-1}$ and $prescribe\_limited_{t-1}$.

Adding the coefficients on $authority_{t-1}$ and the interaction of $authority_{t-1}$ and $prescribe\_full_{t-1}$ considers the impact of full authority in states with full prescriptive rights. This gives a coefficient of -.1848 which an F-test confirms is statistically significant at the 10% level. This implies that full authority states with full prescriptive rights have 18.48% lower health insurance premiums than full authority states with no prescriptive rights. The combination of authority in full prescriptive states is the only pair that is significant. Again, in the individual sample no combinations of regulatory

variables are significantly different from zero. The results for the combined coefficients are displayed in Table 6.[7]

Perhaps a more meaningful way to think about the impact of the regulatory variables is to look at the difference in predictions of the premiums under different regulatory environments. In comparison to the full sample prediction, all of the full authority combinations are predicted to have a lower premium. For the limited authority, only the combination with full prescriptive rights is predicted to have a lower premium. For the prescriptive rights, full prescriptive rights are predicted to have lower premiums in both full authority and limited authority states. Limited prescriptive rights and no prescriptive rights only have lower predicted premiums in states with full authority. Table 7 reports differences in the predictions of the family health insurance premiums for the various combinations of regulatory categories.[8]

VII. Conclusion

This study finds that liberalized regulations and, thus APN autonomy, lower health insurance premiums. In the most complete specification, states with full authority and full prescriptive rights have 18.48 % lower health insurance premiums. Authority appears to be the driving force behind the cost-lowering effect of APN regulations on family health insurance premiums. One explanation for this effect may be that when

[7] A joint F-test of the two interaction terms rejects that authority and prescriptive rights are jointly significant in explaining the variation in health premiums. However, it makes intuitive sense to consider their interaction.

[8] The predictions use the specification of model 4. Only family premiums were estimated since none of the regulatory variables were significant in the individual sample.

APNs have full authority, they can open stand alone practices that directly compete with physicians.

The impact of full authority is magnified when coupled with full prescriptive rights. This may reflect APNs greater inclination towards non-drug therapies. As noted by Baxter et al (1997), APNs spend more time educating patients. This education may include a greater amount of non-drug therapy. One study of a large HMO found that nurse practitioners wrote the fewest number of prescriptions when compared to PAs or Physicians (Hooker, 1993). Prescription drug expenses are a significant cost to insurance companies. If APNs write for a smaller amount of prescriptions, then prescriptive rights could be the dominant force in lowering health insurance premiums.

One of the most notable results is the difference between the family and individual samples. APN regulations appear to only impact the average family premium. None of the specifications show a statistically significant effect on the average individual premium. However, this difference itself is worth mentioning. In general, families are the larger consumers of primary care, especially families with children. If the hypothesis is that APNs primarily reduce the cost of office visits (which shows up in reduced or non-increasing premiums), then family premiums would be affected more by liberalized regulations. While the use of APNs may reduce office visit fees across the board, individual payers may not go to the doctor enough to get a statistically significant reduction in premiums. The effect for individuals may be so small that it is hard to pick up in state-level aggregate data.

The results of this study suggest that consumers do obtain monetary benefits from the liberalization of APN regulations. Policy implications from these results could be

extensive. Business leaders and employees are consistently faced with rising premiums. States with stricter regulations of APNs may be prompted to liberalize their regulations in order to help local businesses. All states may consider extending further professional independence to PAs which could springboard the medical market to a more competitive industry.

The increased use of APNs seems to offer a promising way to help control the rising cost of health insurance. The premise of this work depends on the underlying assumption that the most common structure of health insurance is fixed co-payments preventing a direct consumer benefit to using APNs. However, this may not be the case. Further research needs to be conducted to determine if there is a benefit to out-of-pocket medical expenses other than health insurance premiums.

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Tables

Table 1:Possible Effect Of APN Regulations On Health Insurance Premiums

Possible Effects	Predicted Relationship with Cost of Health Insurance
1: Liberalized APN regulations provide a mechanism for healthcare labor cost-savings that are shared with the consumer via reduced health insurance premiums	negative
2: Liberalized APN regulations increase the absolute number of office visits and thus ultimately raise heath insurance premiums.	positive
3: Liberalized APN regulations lead rent seeking entities such as private practices and hospitals to substitute PAs for APNs.	positive

Table 2: Regulatory Classifications

Variable	*TNP classification*
Authority=1 *Full Authority*	*States with nurse practitioner title protection; the board of nursing has sole authority in scope of practice, with no statutory or regulatory requirements for physician collaboration, direction, or supervision.*
Authority=0 *Limited Authority*	*Any state not meeting the criteria of Full Authority. Differ in terms of title protection and the board authorizing the scope of practice. All require some type of physician collaboration or supervision.*
Prescribe_full =1 *Full prescriptive*	*States where nurse practitioners can prescribe (including controlled substances) independent of any required physician involvement in prescriptive authority.*
Prescribe_Limited =1 *Limited prescriptive*	*States where nurse practitioners can prescribe (including or excluding controlled substances) with some degree of physician involvement or delegation of prescription writing.*
Prescribe_no =1 *No prescriptive*	*States where nurse practitioners do not have statutory or regulatory prescribing authority.*

Source Nurse Practitioner Journal "Annual Legislative Update"

Table 3: Average Health Insurance Premium By Regulatory Category

	Family			Individual		
	Percent	Mean	SD	Percent	Mean	SD
Full Sample		26.59	6.78		10.8	3.1
By Regulation Group						
Full Authority $_{t-1}$	44.17	27.03	6.78	44.31	10.9	3.06
Limited Authority $_{t-1}$	55.83	26.24	6.76	55.69	10.73	3.13
Full Prescribe $_{t-1}$	21.9	27.01	7.19	21.97	10.91	2.98
Limited Prescribe $_{t-1}$	76.3	26.56	6.69	76.23	10.8	3.15
No Prescriptive Rights $_{t-1}$	1.81	22.72	3.36	1.8	9.48	2.22
By Combined Regulation Group						
Full Authority $_{t-1}$, *Full Prescribe* $_{t-1}$	19.17	27.56	7.21	19.21	11.06	3.01
Full Authority $_{t-1}$, *Limited Prescribe* $_{t-1}$	24.54	26.73	6.42	24.64	10.81	3.11
Full Authority $_{t-1}$, *No Prescribe* $_{t-1}$	0.46	21.69	2.68	0.46	8.61	1.75
Limited Authority $_{t-1}$, *Full Prescribe* $_{t-1}$	2.73	23.18	5.82	2.76	9.85	2.59
Limited Authority $_{t-1}$, *Limited Prescribe* $_{t-1}$	51.76	26.49	6.81	51.59	10.8	3.17
Limited Authority $_{t-1}$, *No Prescribe* $_{t-1}$	1.34	23.07	3.54	1.34	9.78	2.3

Notes: Premium in hundreds

Table 4: Descriptive Statistics

Variable	Mean	SD
Full authority$_{t-1}$	0.43	0.5
Full prescribe $_{t-1}$	0.21	0.41
Limited prescribe $_{t-1}$	0.77	0.42
No prescribe $_{t-1}$	0.02	0.13
Interaction of full authority $_{t-1}$ and full prescribe$_{t-1}$	0.18	0.38
Interaction of full authority $_{t-1}$ and limited prescribe $_{t-1}$	0.25	0.43
Interaction of full authority $_{t-1}$ and no prescribe$_{t-1}$	0	0.07
Number of state mandates	29.84	10.01
HMO penetration rate	26.74	13.15
Number of HMOs	17.54	13.6
Liberal quotient (Senate)	0.48	0.34
Liberal quotient (House)	0.43	0.24
Indicates governor is democrat	0.41	0.49
Maximum TANF for family of three	402.32	152.56
Unemployment rate	4.77	1.11
Total state personal income (in thousands)	1,079.34	1,152.02
Population level (in thousands)	6,383.72	6,392.33
Percent of private firms that offer at least one health insurance plan that requires no contribution from the employee for family coverage	0.26	0.06
Percent of private firms that offer at least one health insurance plan that requires no contribution from the employee for single coverage	0.45	0.08
Percent of residents reporting ever having been told they have diabetes	6.25	1.41
Percent of adults who are current smokers	22.78	3.20
Percent of residents reporting any kind of health care coverage	86.04	4.20
Percent of residents reporting good, very good or excellent health status	85.15	3.36

Notes: Number of observations for family is 2,117 and for individual is 2,121

Table 5: Linear Regression On Health Insurance Premiums

	Family				Individual			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Full Authority t-1	0.0258	-0.1082**	-0.1066**	-0.2715	0.0283	-0.0123	0.0463	0.2222
	(0.0224)	(0.0478)	(0.0499)	(0.1930)	(0.0281)	(0.0600)	(0.0646)	(0.2470)
Prescribe_full t-1	-0.1256**	-0.0392	-0.0336	-0.0146	-0.0241	0.0232	0.0312	-0.0010
	(0.0609)	(0.1060)	(0.1110)	(0.1280)	(0.0768)	(0.1350)	(0.1420)	(0.1620)
Prescribe_limited t-1	-0.0034	0.0989	0.1092	0.0781	0.0127	0.0816	0.0605	0.0957
	(0.0406)	(0.0679)	(0.0693)	(0.0764)	(0.0511)	(0.0865)	(0.0882)	(0.0976)
Full Authority y t-1 * Prescribe_full t-1				0.0867				-0.0709
				(0.2140)				(0.2720)
Full Authority t-1 * Prescribe_limited t-1				0.1869				-0.2079
				(0.1850)				(0.2350)
R2 (overall)	0.2686	0.3136	0.3219	0.3225	0.1415	0.1774	0.1848	0.1855
State Indicator* Year & State Indicator * Year2	no	yes	yes	yes	no	yes	yes	yes
State Varying Time Controls	no	no	yes	yes	no	no	yes	yes

*Notes: * is for significance at the 10% level, ** at the 5% level, *** at the 1% level. Standard error in parentheses.*

Table 6: Combined Results For Model 4

	Family	Individual
Full Authority t-1 in a Full Prescribe t-1 state	-0.1848***	0.1513
	(2.5500)	(1.0800)
Full Authority y t-1 in a Limited Prescribe t-1 state	-0.0846	0.0143
	(1.6600)	(0.4100)
Full Prescribe t-1 in a Full Authority t-1 state	0.0721	-0.0719
	(.0800)	(0.0400)
Limited Prescribe t-1 in a Full Authority t-1 state	0.2650	-0.1122
	(0.1690)	(0.6100)

*Notes: * is for significance at the 10% level, ** at the 5% level, *** at the 1% level. F-stat in parentheses.*

Table 7: Predicted Difference Of Family Health Insurance Premiums By Regulatory Categories

Regulatory Environment	Difference From Full Sample Predictio
Full Authority $_{t-1}$ & *Full Prescribe* $_{t-1}$	-557.60
Full Authority $_{t-1}$ & *Limited Prescribe* $_{t-1}$	-12.10
Full Authority $_{t-1}$ & *No Prescribe* $_{t-1}$	-635.90
Limited Authority $_{t-1}$ & *Full Prescribe* $_{t-1}$	-89.40
Limited Authority $_{t-1}$ & *Limited Prescribe* $_{t-1}$	203.70
Limited Authority $_{t-1}$ & *No Prescribe* $_{t-1}$	118.10

ADVANCED PRACTICE NURSES IMPACT ON VARIOUS HEALTH EXPENDITURE CATEGORIES

I. Introduction

Among developed countries, the United States ranks the highest in per capita healthcare spending (Anderson and Hussey, 2001). Within the United States, per capita health expenditures vary considerably from state-to-state. For example, in 2004 the average per capita spending on healthcare was $6,683 in Connecticut, but only $4,103 in Arizona (Barron et al., 2007). What's more, the geographic variation in per capita healthcare spending does not appear to be narrowing (Congressional Budget Office Report, 2008).

With healthcare spending growing faster than gross domestic product, exploring reasons for such a difference is important (Kaiser, 2005). Many studies credit a significant amount of the variation to different socioeconomics and demographics, as well as the diversity in healthcare practice patterns and market forces (Hinman et al., 2002; Rice and Thornton, 2008). For example, the number of managed care plans within a state can vary considerably between states. In 1996, Alaska had no managed care plans while Florida had sixty-four plans (Managed Care Digest Series Report on HMO's, 2000). Cutler and Sheiner (1997) link differences in the growth of managed care within a state to a reduction in total healthcare spending.

Although greater healthcare spending can lead to improved health outcomes, some of the variation may be a direct result of differing policy issues among states (Xu,

2006). Compared with the United States, countries with centrally planned health care systems, such as Canada and the United Kingdom, have less geographic variation in healthcare spending (Congressional Budget Office Report, 2008). This suggests that state-level legislative issues could be an important factor in explaining a portion of the variation. For example, the number of mandated health insurance benefits varies significantly across states. According to a Blue Cross Blue shield publication, Minnesota had 43 mandates while Idaho had only 9 mandates in 1998 (Crawford et al., 2007). States with greater numbers of mandates have been linked to higher health insurance premiums (Guppy, 2002; Goodman, 2003). In this study, I consider how differences in state regulations of Advanced Practice Nurses (APNs) impact healthcare spending. Liberalized regulations of APNs should increase the prevalence of these cost-effective healthcare providers and create a source of competition with physicians, thereby reducing healthcare expenditures.

APNs (e.g. nurse practitioners and nurse midwives) that have existed since the mid 1960s, are registered nurses with advanced training, typically at the master's level (Mundinger, 1994, American Association of Colleges of Nursing, 2002). Nurse practitioners, for example, can treat non-acute illnesses such as bronchitis and manage chronic diseases such as diabetes. Essentially, APNs are lower-cost providers. For example, APNs are reimbursed by Medicare at 85% of the physician fee schedule (Evans and Frakes, 2006)

According to O'Brien (2003), for the first three decades of their existence, the role of APNs was limited to areas of shortage, such as rural areas, where they received

limited provider status[1]. APNs were salaried employees of a physician or hospital, operating under a physician's provider number. Overtime, grassroots efforts at the state-level led to an expansion of APN status and practice rights in many states. The Balanced Budget Act of 1997 solidified the role of the APN at the federal level by giving APNs "provider status" regardless of the area they worked in, i.e. underserved areas. Provider status legitimized the APN's position and allowed them to bill Medicare directly for their services. Before the passage of this act, APNs were allowed to directly bill Medicare in only underserved areas.

Despite their progress towards greater provider recognition, however, not all states allow APNs to work independently of a physician. According to a recent legislative update slightly more than half of states require APNs to practice under physician collaboration or supervisions (Phillips, 2007). While all states granted some form of prescription writing in 2007, only thirteen states and the District of Columbia permitted full prescribing rights, i.e. no requirement of physician involvement (Phillips, 2007).

Research supporting the cost-savings benefits of APNs will be helpful for many state legislatures as they grapple with effective regulation of APNs and other mid-level providers. In this research, I use the variation in state regulations of APNs to conduct a quasi-natural experiment of the impact of APNs on various categories of state health expenditures. Those states that do not change their regulations serve as the control group, while those that do change their regulations act as the treatment group. I find that states

[1] Provider status is typically established once a provider is eligible for direct reimbursement from insurance or government payers.

with liberalized APN regulations have lower healthcare costs for overall personal healthcare expenditures. Specifically, overall *personal healthcare* expenditures appear to be as much as 2.69% less in states that liberalize the regulation of APNs. Of the eight specific categories considered, the following three are significantly impacted by the regulatory variables: *physician and clinical services, other non-durable medical supplies* and *other personal healthcare.*

The rest of this paper is organized as follows. Section II reviews pertinent literature. Section III explains the data. Section IV discusses the empirical specification. Section V considers the results of the impact of liberalized regulations of APNs on overall healthcare expenditures and across various categories of health expenditures. Finally, Section VI closes with a discussion of the findings.

II. Related Literature

Barron et al. (2007) explore trends in health spending across states from 1991 to 2004. They compare and contrast characteristics among the top and bottom states in terms of per capita personal health care spending[2]. Many of the top states have some of the highest personal incomes per capita and highest concentration of physicians to population while also having the lowest levels of uninsured populations. On the whole, the bottom states have below average Medicare and Medicaid spending per enrollee, less access and availability of physicians and hospitals, and younger populations.

[2] Top states: Massachusetts, Maine, New York, Alaska, Connecticut, Delaware, Rhode Island, Vermont, West Virginia, and Pennsylvania. Bottom states: Utah, Arizona, Idaho, New Mexico, and Nevada

By estimating an empirical model for healthcare spending at the state-level, Rice and Thornton (2008) find significantly higher levels of spending in states with "higher income, less education, fewer uninsured residents, less healthy lifestyles, larger proportion of elderly residents, greater availability of medical care providers and less urbanization." Their results lead them to suggest that greater health education is a solution to rising healthcare costs.

Of course, lower per capita spending is often at odds with the goals of increasing positive health outcomes. In exploring the long documented positive correlation between income and health, Xu (2006) attributed that up to 80% of the variation in health outcomes is due to socioeconomics. A potential pathway to aligning the goals of lowering healthcare spending and increasing positive health outcomes is a greater reliance on APNs since they have the potential to provide significant cost savings while maintaining a high standard of care.

Numerous studies have documented the capability of APNs to increase access to care and provide high-quality care (Avorn and Baker, 1991; Cawley, 1993; Dowd et al., 2003; Fish et al., 1982; Greenfield et al., 1978; Hooker, 1993; Hooker and McCaig, 2001; Kane et al., 2000; Levine et al., 1976; Mundinger, 1994; Osterweis and Garfinkel, 1993; Venning et al., 2000). In one of the most robust studies, Mundinger et al. (2000) conduct a randomized trial of 1,316 patients from 1995 to 1997. Patients were randomly assigned to a nurse practitioner or a physician in a primary care clinic and interviewed twice after the original appointment: once at six months and once at one year. Patient outcomes, measured by patient satisfaction, health status, and service utilization, were comparable across provider type. Chang et al. (2004) document how Veteran Affairs medical centers

are able to see up to forty percent more patients from the expanded use of nurse practitioners. Lowes (1998) describes the patient benefits of increased access to medical care for practices that rely on mid-level practitioners.

The majority of economic research focuses on the impact of APNs for organizations that utilize APNs. For example, Adams et al. (2004) document labor cost-savings for managed care organizations that use mid-level practitioners such as APNs. Analyzing over two million visits at twenty six primary care practices, they find significantly lower per visit labor costs the greater the use of APNs and PAs by a practice.

Wilson (2008) hypothesizes that the current structure of the healthcare industry prevents consumers from receiving cost-savings at the point of services and predicts that the cost-savings are shared with consumers via reduced or non-increasing premiums. Using state-level data from the *Medical Expenditure Panel Survey*, she finds that employment-based health insurance premiums to be significantly lower for states that liberalized APNs regulations.

I extend the literature by examining the effect of greater professional independence for APNs on state-level health expenditures. One of the main benefits of APNs is their role in increasing access to care. While this could potentially increase medical costs by increasing the absolute number for visits, the results from the Wilson (2008) study suggest that APNs save healthcare costs as evidenced by reduced or non-increasing premiums. The most direct impact of APNs on healthcare costs should come through a greater supply of APNs induced by liberalized regulations, which should also

lead to price competition with physicians, among APNs, and other mid-level practitioners.

Increased access to care could also have a dampening effect on costs if access improves disease management or preventative care. O'Brien (2003) explains how APNs increase disease management in rural areas where the closest physician is hours away. As a result, the patient may wait to seek care when he or she is very sicker and thus incurs higher medical bills. Increased supply of APNs could help to avoid more expensive medical care through greater access to preventative care. If liberalized regulations result in greater access to care and thus better disease management, healthcare costs may fall.

Another area where APNs may impact healthcare costs is in prescription drugs and other non-durable medical spending. Numerous studies show that APNs focus more on preventative care and non-drug therapies in comparison to physicians or physician assistants (Hooker et al., 2002; Aparasu and Hegge, 2001; Hooker and McKaig, 2001; Coulter et al., 1998; Beck and Ragan, 1992; Campbell et al., 1990; Drass, 1988; Fisher, 1991). For example, Hooker and McKaig (2001) found that therapeutic and preventative services are ordered more often by APNs relative to both physicians and physician assistants. This distinction is often ascribed to the different focuses in the original education and training of APNs as nurses, which is more holistic. Since prescription drugs account for ten cents of every medical dollar spent, this could be a significant avenue for cost savings (Kaiser, 2007).

III. Data

In this study I use annual state-level total *personal healthcare* expenditures from the Centers for Medicare and Medicaid Services (*CMS)* from 1995 through 2004[3]. For the period, the average inflation-adjusted health expenditure is $84.17 million with a real growth of 25.29%. The smallest amount is $5.26 million (Wyoming, 1995) and the largest amount is 520.36 million (California, 2004).

Personal healthcare spending is comprised of many categories. Over fifty percent of national health expenditures are comprised of physician and clinical services and hospital care. While prescription drugs account for only ten percent of total expenditures, they account for fourteen percent of the growth in healthcare expenditures (Kaiser, 2007). The *CMS* breaks personal healthcare into the following ten sub-categories: *hospital care, physician and clinical services, other professional services, dental services, home healthcare, nursing home care, prescription drugs, other non-durable medical products, durable medical products, other personal healthcare.* I analyze all of these sub-categories, except for dental services and durable medical products[4].

Hospital care is the largest category of the health expenditure categories. It includes only those services that are billed by the hospital. Thus it excludes any physician fees that are billed independently of the hospital. The average inflation-adjusted amount of *hospital care* during the period is $31.32 million with real growth of

[3] I begin the analysis with 1995 because many of the important covariates are first reported in 1995. In addition, updates on regulations of APNs are most consistent for this period.

[4] *Dental service* includes all business receipts for dental care. *Durable medical products* include expenditures for optical goods. *Dental service and durable medical* products are not analyzed because APNs do not work in the areas of dental or eye care

16.06%, ranging from a minimum of $2.19 million (Wyoming, 1995) and a maximum of $181.1 million (California, 2004).

Physician and clinical services is the next largest category of healthcare expenditures. They include private offices and laboratories as well as clinics run by the Department of Veterans Affairs and Indian Health Service. The average inflation-adjusted amount of *physician and clinical services* is $21.29 million with real growth of 24.54% ranging from a minimum of $1.05 million (Wyoming, 1995) and a maximum of $155.13 million (California, 2004).

Other professional services combine payments for licensed individuals. For example, this category would include payments to independent APNs, optometrists, or chiropractors. The average inflation-adjusted amount is $2.88 with real growth of 28.64% ranging from a minimum of $.18 million (Wyoming, 1995) and a maximum of $19.62 million (California, 2004).

Home healthcare reports expenditures in freestanding home healthcare agencies and government paid home health services. The average inflation-adjusted amount for the period is $2.52 million ranging from a minimum of $.03 million (Alaska, 1995) and a maximum of $19.68 million (New York, 2004). This category, however, retracts 2.4% in real terms from 1995 to 2004.

Nursing home care consists of payments for services from both private and public freestanding nursing homes. It does not include long-term care units in hospitals, which are counted in the hospital care. The average inflation-adjusted amount is $6.95 million ranging from a minimum of $.15 million (Alaska, 1995) and a maximum of $41.65

million (New York, 2004). The expenditure category has the smallest amount of growth with 8.3% of real growth from 1995 to 2004.

Prescription drugs include expenditures in retail pharmacies. It is the third largest category. The average inflation-adjusted amount is $8.45 million ranging from a minimum of $.43 million (Wyoming, 1995) and a maximum of $53.44 (California, 2004). This category has the largest amount of growth with 117.32% of real growth from 1995 to 2004.

Other non-durable medical products consist of expenditures on over-the-counter medications and other non-prescription medical items. The average inflation-adjusted amount is $2.18 million ranging from a minimum of $.12 million (Wyoming, 1995) and a maximum of $14.20 million (California, 2004). This expenditure category retracts during the period with a decline of 10.9% in real terms.

Other personal healthcare is comprised of occupational healthcare services that private and public employers provide for their employees. This includes medical care provided at industrial plants, schools, and military field stations. The average amount is $2.68 million with a range of a minimum of $.20 million (Wyoming, 1995) and a maximum of $22.5 million (New York, 2004). This expenditure category has the second largest amount of growth with 63.33% of real growth from 1995 to 2004[5]. Table 1 displays the averages, minimums, maximums, and real growth rates for all of the categories.

[5] For more information see the CMS publication on State of Provider Definitions and Methodology, 1980-2004 (February 2007) at http://www.cms.hhs.gov/NationalHealthExpendData/downloads/prov-methodology2004.pdf

Figures 1 through 9 display plots of the inflation-adjusted total expenditure for each category over time. All but three categories, *nursing home care*, h*ome healthcare* and *other non-durable medical products* appear to have a roughly upward trend. *Nursing home care* rises until 1998 beyond which point it falls and becomes relatively flat. *Home healthcare* rises until 1998 and then falls dramatically until 2000 when it begins rising again. *Other non-durable medical products* appear to have a downward trend.

The *CMS* compiles this data in two formats: by the state of the provider and by the state of the resident. I use the state of provider data because theses reflect spending for services performed in a particular state and thus can be merged with regulations of APNs in that state.

In order to investigate the impact of APN regulations on health expenditures, I link state health expenditures to yearly classifications of APN state regulations obtained from the annual update of legislative issues affecting APNs compiled by *The Nurse Practitioner* (*TNP*) journal. I consider two areas of regulations. The first area of regulation concerns matters of practice authority. The most liberally regulated states allow APNs to operate in complete independence from a physician. Other states require varying degrees of physician involvement in an APN's practice. According to *TNP's* classifications, this can vary from loose collaboration to daily supervision. *TNP* does not distinguish between collaboration and supervision in the earliest legislative updates. Therefore, I create one indicator variable to reflect complete independence. Any state classified as having no requirement of physician involvement in an APN authority is assigned a one for *full authority*; all others are assigned a zero. States with a value of zero for *full authority* are referred to as states with "limited authority."

The second area of regulation that *TNP* covers is the prescriptive rights of APNs. The most liberally regulated states allow APNs to prescribe for controlled and non-controlled drugs without physician involvement. The most regulated states do not permit APNs to prescribe at all. In the middle are states that require physician involvement and may also limit the type of prescription writing for just non-controlled substances. I condense *TNP*'s classifications of prescriptive rights into the following three indicator variables: *full, limited, and no prescriptive rights*. *Full prescriptive* indicates states that permit APNs to prescribe all drugs and have no requirement of physician oversight. *Limited prescriptive* denotes states that require some type of physician involvement and in some cases limits the type of drugs permitted, for example, only non-controlled substances. *No prescriptive* indicates states where APNs are not allowed to write prescriptions. All states permit APNs to write for at least non-controlled prescriptions with physician involvement by 1998.

Both the authority and the prescriptive classifications from *TNP* are summarized in Table 2. Since *TNP's* annual legislative update is in the January issue, the regulations actually refer to the previous year. Therefore, a lag of the regulations is used in order to allow the law changes to have time to penetrate the healthcare system. During this period, almost thirty percent of states changed their regulations regarding authority and just over fifty percent of states changed their regulations involving prescription writing. In general, the changes were towards greater independence.

Table 3 displays the average amount of the eight healthcare expenditure categories by the regulatory groupings, adjusted for inflation. Across all categories, the average expenditures for states with full authority is lower than limited authority.

Likewise, the average expenditures for states with full prescriptive rights is lower than for both limited prescriptive rights or no prescriptive rights. When the regulatory categories are considered jointly, the more liberalized groupings have lower average expenditures. States with full authority and full prescriptive rights have the lowest average expenditures across all categories. These simple descriptive statistics imply that liberalized regulations are correlated with lower health expenditures.

Other state specific variables are merged with the above data to help control for state specific factors that are likely to influence health expenditures and could confound the impact of the regulatory variables. Four covariates are included to control for the underlying "health" of each state. The first is the percent of the residents who have ever been told they have diabetes, on average 5.8%. The second is the percent of adults who are current smokers, on average 23%. The third is the percent of residents who have any access to healthcare coverage, on average 86%. The final covariate is a self-reported measure for general health status that is transformed into five indicator variables for excellent, very good, good, fair and poor health status. The average health status is 13%, 34%, 29%, 10%, and 4% respectively. These variables come from the *Center for Disease Control's Behavioral Risk Factor Surveillance System.*

The growth of managed care during the 1990's could also affect healthcare spending. During the mid 1990s, there was a short period of below-trend growth for healthcare spending. One study attributed this below-trend growth to the proliferation of managed care and its accompanying supply-side constraints (Cutler et al., 2000). I include two controls as proxies for managed care in a state. The first is the enrollment rate of residents in HMOs, which on average is 26%. The second is the total number of

HMOs in a state, which on average is 17. This information comes from the *Managed Care Digest Series* report on HMOs.

States also vary in their legal requirements for specific coverage by health insurance companies. Such requirements are known as mandates and differ considerably over time and across states. I use the 2005 Blue Cross and Blue Shield Association publication on state mandates to construct a count variable for the total mandates per state. On average, there are 27 mandates in a state.

Political, demographic, economic, and welfare controls are also included for each state. A liberal quotient is included to capture the degree to which the state's congressional delegation cast liberal votes. This comes from the *Americans for Democratic Action* (*ADA*), an independent liberal lobbying organization. The average for the house is .43 and for the senate is .49. In addition, an indicator is included for the governor's party affiliation, where a one indicates the governor is a Democrat and a zero indicates Republican. On average, 40% of the states have Democratic governors.

The unemployment rate, which comes from the Bureau of Labor and Statistics, is included for each state. The average unemployment rate is 4.75%. Total state income and the state population counts are also included. The average inflation-adjusted state income is $160,000 million and the average state population count is 5,636 thousand. These measures come from the *Regional Economic Information System* conducted by the *Bureau of Economic Analysis*. Finally, each state's maximum benefit paid for a family of three under *Temporary Assistance for Needy Families (TANF)* is included. The average amount is $406. This information comes from the *Urban Institute.* Table 4 displays descriptive statistics for the state time-varying controls.

IV. Empirical Model

While the descriptive statistics identify an inverse relationship between liberalized APN regulations and health expenditures, it does not establish causation. To move beyond correlation, I use multivariate regression analysis. The independent variables of interest are the various state health expenditures. The key explanatory variables are the regulations for APNs. Formally, I estimate:

$$HE_{it} = \alpha_{it} + \beta_1 authority_{it-1} + \beta_2 prescribe\_full_{it-1} + \beta_3 prescribe\_limited_{it-1} + \beta_4 State + \beta_5 Year_t + \beta_6 STVC_{it} + \beta_7 State * Time + \beta_8 State * Time^2 + u_i + \varepsilon_{it} \quad (1)$$

where i indexes the state, t indexes the years, HE is a vector of logged health expenditures, $State$ is a vector of state indicators to control for state-specific effects, $Year$ is a vector of year indicators to control for year specific effects, $STVC$ is a vector of state time-varying controls describe at the end of section III, $State*Time$ is an interaction between state indicators and a linear time trend to control for linear state-year specific effects, $State*Time^2$ is an interaction between state indicators and time squared to control for non-linear state-year specific effects, and $\acute{a}$ is a disturbance term[6].

Because the authority regulations and the prescriptive rights may not be independent of each other, I also estimate another model that considers the interaction of the two regulations. Formally, I estimate:

$$HE_{it} = \alpha_{it} + \beta_1 authority_{it-1} + \beta_2 prescribe\_full_{it-1} + \beta_3 prescribe\_limited_{it-1} + \beta_4 authority_{it-1} * prescribe\_full_{it-1} + \beta_5 authority_{it-1} * prescribe\_limited_{it-1} + \beta_6 State + \beta_7 Year_t + \beta_8 STVC_{it} + \beta_9 State * Time + \beta_{10} State * Time^2 + u_i + \varepsilon_{it} \quad (2)$$

[6] No prescriptive rights is the excluded variable for prescribe, and 1995 is the excluded year.

V. Results

First, I consider the effects of the authority and prescriptive regulations, independent of each other, in three different specifications. Model 1 includes the regulations, state indicators, and time indicators. Model 2 adds an interaction of state indicators and a linear time trend plus an interaction of state indicators and a linear time trend squared. Model 3 adds the state time-varying controls. Results for the regulatory variables are presented in Table 5, Table 6, and Table 7 respectively[7].

In model 1, *full authority* is negative and statistically significant for two expenditure categories: o*ther non-durable medical supplies* and *nursing home care.* This implies that in comparison to states with limited authority, states with full authority have 4.13% lower expenditures on o*ther non-durable medical supplies* and 3.71% lower expenditures on *nursing home care. Full authority* is positive and statistically significant for *home healthcare.* This suggests that full authority states have 9.11% higher expenditures on *home healthcare.*

Other professional services, prescription drugs, and *other personal healthcare* are positive and statistically significant for *full prescriptive* in model 1. This indicates that in comparison to states with no prescriptive rights, states with full prescriptive rights have 5.08% higher expenditures on *other professional services*, 3.6% higher expenditures *on prescription drugs*, and 12.52% higher expenditures on *other personal healthcare.*

Other professional services, prescription drugs, nursing home care and *other personal healthcare* are positive and statistically significant for *limited prescriptive* in model 1. This implies that in comparison to states with no prescriptive rights, states with

[7] Results for the other covariates are available upon requests.

limited prescriptive rights have 6.07% higher expenditures on *other professional services*, 5.49% higher expenditures *on prescription drugs*, 4.64% higher expenditures on *nursing home care*, and 9.24% higher expenditures on *other personal healthcare. Limited prescriptive* has a statistically negative effect on *hospital care.* This suggests that *limited prescriptive* states have 1.85% less expenditures on *hospital care.*

The results from model 1 may be spurious since model 1 does not account for time-varying trends at the state-level. In model 2, I add an interaction between state indicators and a linear time trend and an interaction between state indicators and a linear time trend squared in an effort to control for non-linear trends. *Full authority* remains negative and statistically significant for *other non-durables* and positive and statistically significant for *home healthcare. Nursing home care* is no longer statistically significant; however, overall *personal healthcare* is positive and statistically significant. These results indicate that *full authority* states have 1.29% less expenditures on o*ther non-durable medical supplies* and 3.8% less expenditures on *other personal healthcare.* Full authority states have .74% greater expenditures on overall *personal healthcare* and 8.77% greater expenditures on *home healthcare.*

In model 2, *prescription drugs* and *other personal healthcare* remain positive and statistically significant, while *other personal healthcare* loses its significance for states with full prescriptive rights. *Nursing home care* becomes positive and statistically significant. These results imply that states with full prescriptive rights have 3.74% greater expenditures for *prescription drugs*, 4.33% greater expenditures for *nursing home care*, and 8.14% greater expenditures for *other personal healthcare.* Three categories become negative and statistically significant: *personal healthcare, hospital care* and

physician and clinical services. This suggests that states with full prescriptive rights have 2.13%, 3.19% and 7.26% less expenditures respectively.

Limited prescriptive has an even more dramatic impact in model 2 with all but home healthcare having a statistically significant impact. *Other professional services, prescription drugs, nursing home care* and *other personal healthcare* are all positive. This indicates that states with limited prescriptive rights have 6.26%, 4.32%, 3.81% and 5.38% greater expenditures respectively. Overall *personal healthcare, hospital care, physician and clinical services,* and *other non-durable medical supplies* are all negative. This implies that states with limited prescriptive rights have .59%, 2.51%, 3.03%, and 1.25% less expenditures respectively.

Even with the interaction terms added in model 2, the abundance of significant results suggests there may be some important controls omitted. In model 3, I add the state-level time-varying controls discussed in the data section. Only two categories, *other non-durable medical supplies* and *other personal healthcare*, remain significant for *full authority*. This indicates that states with full authority have 1.36% less expenditures on *other non-durable medical supplies* and 4.3% less expenditures for *other personal healthcare*.

Only two categories, overall *personal healthcare* and *physician and clinical services*, remain significant for *full prescriptive*. This implies that states with full *prescriptive* rights have 2.31% less expenditures for overall *personal healthcare* and 6.51% less expenditures for *physician and clinical services*. No categories remain statistically significant from zero for *limited prescriptive*.

In model 4, I consider the joint impact of authority and prescriptive rights by adding an interaction of *full authority* and *full prescriptive* as well an interaction as *full authority* and *limited prescriptive*. Table 8 displays the results from these regressions. While it appears that only *full prescriptive* remains statistically significant for overall *personal healthcare* and *physician and clinical services*, this is not the complete interpretation of the results. To interpret the results, each regulation must be added to its corresponding interaction term and then tested jointly with its corresponding interaction term. For example, to consider the impact of *full authority* in a state with full prescriptive rights, add the coefficients on *full authority* and *full authority*full prescriptive* and conduct a joint F-test. Table 9 displays the results for each combination of regulations.

Full authority in a state with full prescriptive rights is statistically significant in o*ther non-durable medical supplies* and *other personal healthcare.* This implies that *full authority*, in states with full prescriptive rights, have 3.38% and 10.30% lower expenditures, respectively. These are both greater than when *full authority* is considered alone. Full prescriptive rights seem to magnify the affect of *full authority. Full authority* in a state with *limited prescriptive* rights, is not significantly different from zero in any of the expenditure categories.

Full prescriptive in states with *full authority*, is statistically significant for overall *personal healthcare* and *physician and clinical services.* This implies that *full prescriptive* in a state with full authority, have 2.69% and 7.31% less expenditures respectively. Again, this is greater than when *full prescriptive* is considered alone. *Limited prescriptive* in states with full authority, is not significant for any categories.

VI. Conclusions

Overall *personal healthcare* expenditures appear to be less in states that liberalize the regulation of APNs. *Full prescriptive* rights seem to be the driving force for overall *personal healthcare*. When considered independently, the most complete model, model 3, shows -2.31% lower expenditures. When considered jointly with *full authority*, the impact of *full prescriptive* is slighter larger at -2.69%. For the period, overall *personal healthcare* is on average $84.17 million. Thus, a reduction of 2.31 to 2.69% in *personal healthcare* is $1.94 million to $2.26 million.

Of the eight categories, three are impacted by the regulatory variables: *physician and clinical services, other non-durable medical supplies* and *other personal healthcare.* When considered independently, model 3 shows *full prescriptive* reduces *physician and clinical services* by 6.51%. When considered jointly with *full authority*, the affect of *full prescriptive* is slighter larger at 7.31%. The average expenditure for *physician and clinical services* is $21.29 million for the period. Thus, *full prescriptive* rights, on average, reduces expenditures on *physician and clinical services* by $1.39 million to $1.56 million.

When considered independently, model 3 shows 1.36 and 3.38% lower expenditures on *other non-durable medical supplies* and *other personal healthcare,* respectively, for *full authority*. When considered jointly with *full prescriptive*, the affect of *full authority* is larger at 3.38% and 10.30% respectively. The average expenditure is $2.18 million for *other non-durable medical supplies* and $2.68 million for *other personal healthcare* for the period. Thus *full authority,* on average, reduces *other non-*

durable medical supplies $30 thousand to $74 thousand and *other personal healthcare* $115 thousand to $276 thousand.

The impact on *physician and clinical services* seems the most straightforward. As states liberalize regulations of APNs, patients and insurance companies opt for the less expensive provider. Furthermore, primary care physicians may lower their fees in an effort to compete with the less expensive provider.

The impact on *other personal healthcare* is also very plausible. Recall that *other personal healthcare* includes healthcare services that private (industrial plants etc.) and public (schools and military field stations etc.) employers provide for their employees. Assuming the healthcare provided is basic primary care, then it is very reasonable to imagine that these industrial plants or schools would substitute towards the less expensive provider as the regulations are liberalized and make such substitution possible.

The reduction in *other non-durable medical supplies* may be the most obscure, albeit credible. Recall that research shows APNs to have a greater tendency towards non-drug therapies and patient education in comparison to physicians and physician assistants (Mundinger, 1994). As states liberalize their regulations and APN popularity grows, a reduction in *other non-durable medical supplies* may reflect a difference in APN practice patterns

A greater understanding of APNs impact on healthcare spending can help increase the effective use of these cost-saving clinicians for health insurance companies, the uninsured, and the federal government. For example, from 1960 to 2002, the share of healthcare paid by the federal government grew from nine percent to thirty-four percent (Morgan, 2004). Based on the CMS data, the total US expenditure on *physician and*

clinical services was $393 billion dollars in 2004. The governments share of approximately thirty-four percent is over $133 billion dollars. A savings of 6.51- to 7.31% from liberalizing APN regulations would be $8.66 billion to $9.72 billion!

As the share of healthcare paid by the federal government continues to grow, federally sponsored healthcare programs may be particularly interested in which areas of healthcare spending are most impacted by APNs. This paper provides evidence that greater APN autonomy can result in significant cost savings in three particular areas: o*ther non-durable medical supplies, other personal healthcare,* and *physician and clinical services.*

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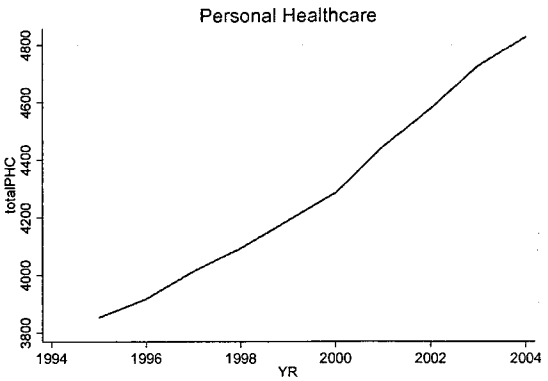
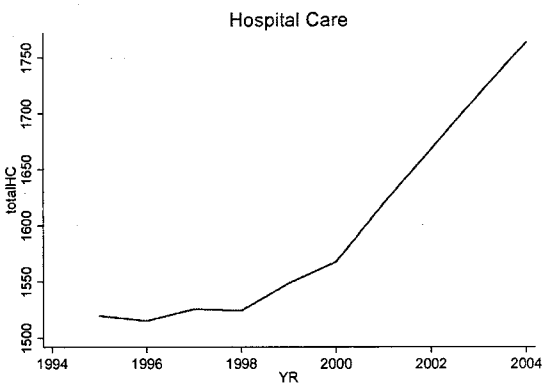
Figures

Figure 1: Personal Healthcare



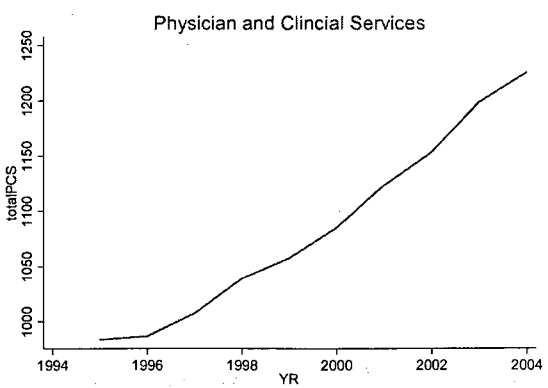
Notes: Amounts are in millions of dollars and adjusted for inflation

Figure 2: Hospital Care



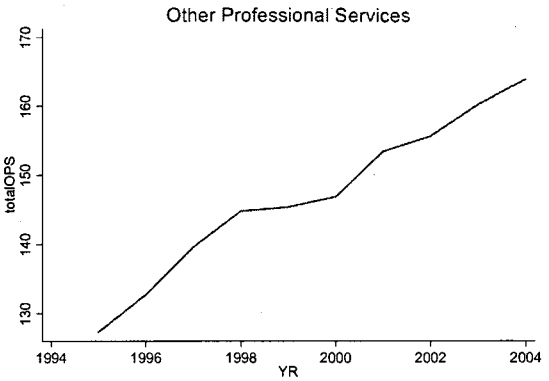
Notes: Amounts are in millions of dollars and adjusted for inflation

Figure 3: Physician and Clinical Services



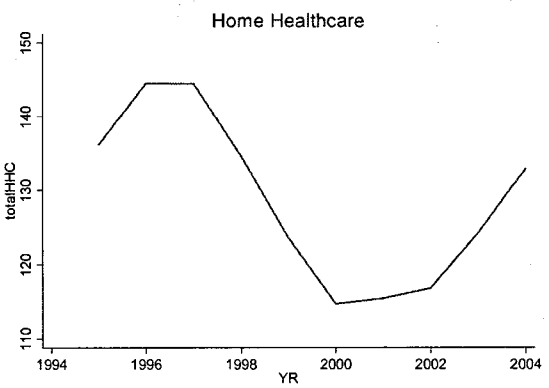
Notes: Amounts are in millions of dollars and adjusted for inflation

Figure 4: Other Professional Services



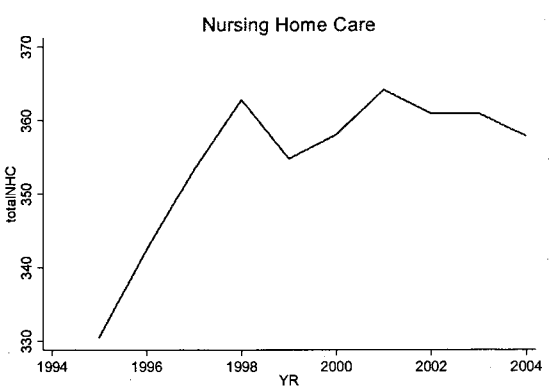
Notes: Amounts are in millions of dollars and adjusted for inflation

Figure 5: Home Healthcare



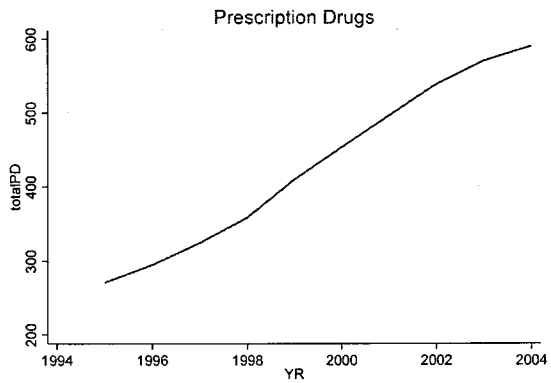
Notes: Amounts are in millions of dollars and adjusted for inflation

Figure 6: Nursing Home Care



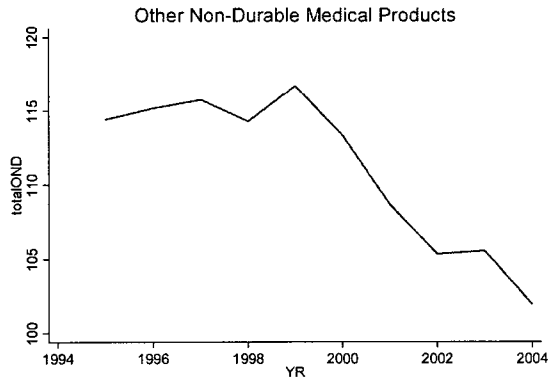
Notes: Amounts are in millions of dollars and adjusted for inflation

Figure 7: Prescription Drugs



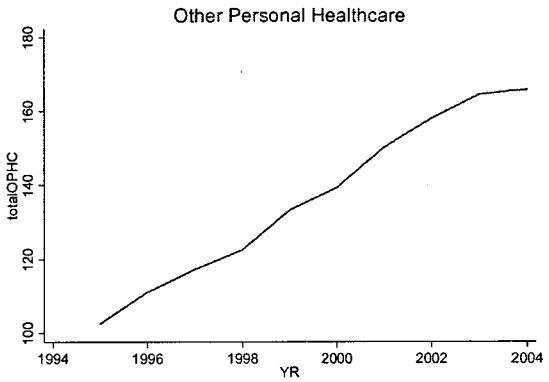
Notes: Amounts are in millions of dollars and adjusted for inflation

Figure 8: Other Non-Durable Medical Products



Notes: Amounts are in millions of dollars and adjusted for inflation

Figure 9: Other Personal Healthcare



Notes: Amounts are in millions of dollars and adjusted for inflation

Tables

Table 1: State Health Expenditures From The Centers For Medicare And Medicaid Services

Expenditure	Average	Min	Max	Growth 1995-2004
Total Personal Healthcare	$84.17	$5.26	$520.36	25.29%
Hospital care	$31.32	$2.19	$181.10	16.06%
Physician and clinical services	$21.29	$1.05	$155.13	24.54%
Other professional services	$2.88	$0.18	$19.62	28.64%
Home healthcare	$2.52	$0.03	$19.68	-2.40%
Nursing home care	$6.95	$0.15	$41.65	8.30%
Prescription drugs	$8.45	$0.43	$53.44	117.32%
Other non-durable medical products	$2.18	$0.12	$14.20	-10.90%
Other personal healthcare	$2.68	$0.20	$22.50	63.33%

Notes: Amounts are in millions of dollars and adjusted for inflation

Table 2: Summary Of Regulation Variables

Variable	*TNP classification*
Authority=1 *Full Authority*	*States with no statutory or regulatory requirements for physician collaboration, direction, or supervision. Scope of practice is determined solely by the board of nursing. Title protection for nurse practitioners.*
Authority=0 *Limited Authority*	*Every state not satisfying the conditions for full authority. All of these states mandate physician collaboration or supervision. These states vary in which boards authorize the scope of practice and granting of title protection.*
Full prescriptive =1 *Full prescriptive*	*States where there is no requirement of physician involvement in prescriptive writing for APNs. APNs may write prescriptions for both controlled and non-controlled substances.*
Limited prescriptive =1 *Limited prescriptive*	*States that require some type of physician involvement in APN prescription writing. Some of these states limit the type of prescriptions to just non-controlled substances that APNs can write for*
No prescriptive =1 *No prescriptive*	*States prescription writing is not legally permitted for APNs.*

Table 3: Average Health Expenditure By Regulatory Category

		Hospital Care		Physician and Clinical Services		Other Professional Services		Prescription Drugs		Other Non-Durable Medical Supplies		Nursing Home Care		Other Personal Healthcare		Home Healthcare	
ALL	Obs	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Full Sample	612	19.10	2.75	11.99	2.96	1.61	2.93	5.15	2.94	1.27	2.98	3.86	3.12	1.57	2.61	1.16	3.85
By Regulation																	
Full Authority	241	12.99	2.39	7.99	2.65	1.13	2.72	3.38	2.70	0.83	2.76	2.43	2.82	1.22	2.27	0.72	3.56
Limited Authority	320	25.76	2.73	16.57	2.87	2.18	2.83	7.31	2.78	1.72	2.86	5.53	2.97	2.03	2.68	1.72	3.59
Full Prescriptive Rights	127	9.68	2.14	5.90	2.45	0.85	2.49	2.35	2.39	0.63	2.66	1.68	2.75	0.98	2.07	0.50	3.01
Limited Prescriptive Rights	371	23.82	2.64	15.36	2.80	2.07	2.80	6.43	2.80	1.54	2.86	5.08	2.85	2.00	2.58	1.54	3.70
No Prescriptive Rights	12	44.13	1.94	26.70	1.96	3.58	1.92	9.88	2.02	2.93	1.87	9.25	2.04	3.01	1.88	3.48	1.32
By Combined Regulations																	
Full Authority, Full Prescriptive Rights	111	9.31	2.03	5.55	2.32	0.80	2.36	2.24	2.29	0.59	2.56	1.55	2.68	0.95	2.08	0.45	3.03
Full Authority, Limited Prescriptive Rights	127	17.27	2.48	10.93	2.68	1.52	2.80	4.67	2.74	1.10	2.73	3.56	2.54	1.53	2.31	1.05	3.59
Full Authority, No Prescriptive Rights	3	16.76	1.02	9.86	1.04	1.52	1.05	3.57	1.07	1.18	1.02	3.71	1.03	1.22	1.09	2.52	1.07
Limited Authority, Full Prescriptive Rights	16	12.69	2.85	8.98	3.17	1.29	3.16	3.08	2.99	0.93	3.19	2.97	2.82	1.22	1.95	0.97	2.25
Limited Authority, Limited Prescriptive Rights	244	28.16	2.62	18.34	2.74	2.43	2.70	7.55	2.73	1.83	2.81	6.12	2.88	2.31	2.64	1.88	3.60
Limited Authority, No Prescriptive Rights	9	60.94	1.44	37.21	1.42	4.75	1.60	13.88	1.48	3.97	1.43	12.54	1.70	4.06	1.45	3.88	1.25

Notes: Amounts are in millions of dollars and adjusted for inflation

Table 4: Descriptive Statistics For State Time-Varying Controls

	Mean	Standard Deviation	Minimum	Maximum
Percent of residents reporting ever having been told they have diabetes	5.80	1.42	2.80	11.00
Percent of adults who are current smokers	23.00	3.09	10.50	32.60
Percent of residents reporting any kind of health care coverage	86.27	4.11	72.20	94.50
Percent of residents reporting very good health status	33.96	2.90	24.90	43.90
Percent of residents reporting good health status	28.74	2.29	22.10	37.20
Percent of residents reporting fair health status	10.47	2.00	6.40	16.40
Percent of residents reporting poor health status	4.03	1.61	1.60	9.20
Number physicians in state	13,966.40	16,605.49	1,028.00	92,907.00
Number physicians in state per 100k people	237.77	57.85	137.00	450.00
Indicates state grants some type of prescription rights to PAs	0.87	0.34	0.00	1.00
HMO penetration rate	25.81	13.69	0.00	65.00
Number of HMOs	16.70	13.42	0.00	75.00
Number of state mandates	27.45	10.23	5.00	59.00
Average medical malpractice payment in a state	212,419.60	77,951.29	50,946.60	554,404.20
House liberal quotient (measures the amount of liberal votes cast by the state's House Representatives)	0.43	0.26	0.00	1.00
Senate liberal quotient (measures the amount of liberal votes cast by the state's Senate members)	0.49	0.33	0.00	1.00
Governor (= 1 if governor is a Democrat)	0.40	0.49	0.00	1.00
Unemployment rate	4.74	1.16	2.26	8.14
Total state personal income (in millions, inflation adjusted)	160,000.00	190,000.00	12,200.00	1,270,000.0
Population level (in thousands)	5,635.59	6,164.20	589.00	35,800.00
Maximum TANF for family of 3	406.41	156.29	120.00	923.00

Notes: Observations 470

Table 5: Multivariate Regression On Logged Health Expenditures, Model 1

	Personal Healthcare	Hospital Care	Physician and Clinical Services	Other Professional Services	Prescription Drugs	Other Non-Durable Medical Supplies	Nursing Home Care	Other Personal Healthcare	Home Healthcare
Full Authority$_{t-1}$	0.0053	0.0081	0.0105	-0.0134	-0.0105	-0.0413***	-0.0371***	-0.0351	0.0911***
	(0.0076)	(0.0093)	(0.0127)	(0.0151)	(0.0087)	(0.0155)	(0.0124)	(0.0221)	(0.0338)
Full Prescriptive$_{t-1}$	0.0169	0.0091	0.0109	0.0508***	0.0360***	0.0253	0.0068	0.1252***	0.0480
	(0.0119)	(0.0146)	(0.0200)	(0.0237)	(0.0136)	(0.0243)	(0.0195)	(0.0346)	(0.0530)
Limited Prescriptive$_{t-1}$	0.0059	-0.0185*	-0.0017	0.0607***	0.0549***	-0.0064	0.0464***	0.0924***	0.0249
	(0.0077)	(0.0095)	(0.0130)	(0.0155)	(0.0089)	(0.0159)	(0.0127)	(0.0226)	(0.0345)

*Notes: * is for significance at the 10% level, ** at the 5% level, *** at the 1% level. Standard errors in parentheses. 492 observations.*

Table 6: Multivariate Regression On Logged Health Expenditures, Model 2

	Personal Healthcare	Hospital Care	Physician and Clinical Services	Other Professional Services	Prescription Drugs	Other Non-Durable Medical Supplies	Nursing Home Care	Other Personal Healthcare	Home Healthcare
Full Authority$_{t-1}$	0.0074**	0.0037	0.0154	-0.0018	0.0045	-0.0129**	0.0074	-0.038**	0.0877***
	(0.0034)	(0.0055)	(0.0095)	(0.0138)	(0.0040)	(0.0051)	(0.0101)	(0.0152)	(0.0268)
Full Prescriptive$_{t-1}$	-0.0213***	-0.0319***	-0.0726***	0.0326	0.0374***	0.0125	0.0433***	0.0814***	0.0044
	(0.0054)	(0.0088)	(0.0151)	(0.0220)	(0.0064)	(0.0081)	(0.0162)	(0.0243)	(0.0427)
Limited Prescriptive$_{t-1}$	-0.0059*	-0.0251***	-0.0303***	0.0626***	0.0432***	-0.0125**	0.0381***	0.0538***	0.0269
	(0.0036)	(0.0058)	(0.0100)	(0.0145)	(0.0043)	(0.0053)	(0.0107)	(0.0161)	(0.0283)

*Notes: * is for significance at the 10% level, ** at the 5% level, *** at the 1% level. Standard errors in parentheses. 492 observations.*

Table 7: Multivariate Regression On Logged Health Expenditures, Model 3

	Personal Healthcare	Hospital Care	Physician and Clinical Services	Other Professional Services	Prescription Drugs	Other Non-Durable Medical Supplies	Nursing Home Care	Other Personal Healthcare	Home Healthcare
Full Authority$_{t-1}$	-0.0003	0.0012	0.0034	-0.0140	-0.0059	-0.0136**	-0.0101	-0.0430**	0.0402
	(0.0039)	(0.0068)	(0.0110)	(0.0164)	(0.0042)	(0.0060)	(0.0107)	(0.0184)	(0.0303)
Full Prescriptive$_{t-1}$	-0.0231**	-0.0008	-0.0651**	0.0046	-0.0080	0.0089	-0.0089	0.0219	-0.0786
	(0.0096)	(0.0165)	(0.0269)	(0.0402)	(0.0104)	(0.0147)	(0.0261)	(0.0451)	(0.0741)
Limited Prescriptive$_{t-1}$	-0.0070	-0.0064	-0.0073	0.0221	-0.0039	0.0015	-0.0076	0.0236	-0.0592
	(0.0072)	(0.0125)	(0.0203)	(0.0302)	(0.0078)	(0.0111)	(0.0197)	(0.034)	(0.0558)

*Notes: * is for significance at the 10% level, ** at the 5% level, *** at the 1% level. Standard errors in parentheses. 492 observations.*

Table 8: Multivariate Regression On Logged Health Expenditures With Interaction Terms Of Regulatory Variables

	Personal Healthcare	Hospital Care	Physician and Clinical Services	Other Professional Services	Prescription Drugs	Other Non-Durable Medical Supplies	Nursing Home Care	Other Personal Healthcare	Home Healthcare
Full Authority$_{t-1}$	0.0048	-0.0051	0.0222	-0.0673	-0.0342	-0.0184	0.0164	-0.149	0.2461
	(0.0198)	(0.0342)	(0.0556)	(0.0828)	(0.0214)	(0.0303)	(0.0539)	(0.0926)	(0.1530)
Full Prescriptive$_{t-1}$	-0.0226**	0.0015	-0.0702**	0.0093	-0.0157	0.0187	-0.005	0.0352	-0.0587
	(0.0114)	(0.0196)	(0.0319)	(0.0475)	(0.0122)	(0.0174)	(0.0309)	(0.0531)	(0.0875)
Limited Prescriptive$_{t-1}$	-0.0061	-0.0077	-0.0034	0.012	-0.0085	-0.0001	-0.0031	0.0032	-0.023
	(0.0079)	(0.0137)	(0.0223)	(0.0332)	(0.0086)	(0.0122)	(0.0216)	(0.0372)	(0.0612)
Full Authority$_{t-1}$ * Full Prescriptive$_{t-1}$	-0.0043	-0.0001	-0.0029	0.0269	0.0335	-0.0154	-0.0254	0.046	-0.1764
	(0.0222)	(0.0383)	(0.0623)	(0.0929)	(0.0240)	(0.034)	(0.0605)	(0.104)	(0.1710)
Full Authority$_{t-1}$ * Limited Prescriptive$_{t-1}$	-0.0054	0.0074	-0.0216	0.058	0.0274	0.0082	-0.0269	0.1167	-0.2117
	(0.0194)	(0.0334)	(0.0544)	(0.0811)	(0.0209)	(0.0297)	(0.0528)	(0.0907)	(0.1490)

*Notes: * is for significance at the 10% level, ** at the 5% level, *** at the 1% level. Standard errors in parentheses. All models include state indicators, year indicators, state-year linear interactions, state-year^2 linear interactions, and state time-varying controls.. 492 observations.*

Table 9: Combined Results For Regulatory Groupings From The Multivariate Regression On Logged Health Expenditures With Interaction Terms

	Personal Healthcare	Hospital Care	Physician and Clinical Services	Other Professional Services	Prescription Drugs	Other Non-Durable Medical Supplies	Nursing Home Care	Other Personal Healthcare	Home Healthcare
Full Authority $_{t-1}$ in a *Full Prescribe* $_{t-1}$ state	0.0005	-0.0052	0.0193	-0.0404	-0.0007	-0.0338*	-0.0090	-0.1030**	0.0697
	(0.03)	(0.06)	(0.33)	(0.83)	(1.28)	(2.75)	(0.10)	(3.88)	(0.10)
Full Authority y $_{t-1}$ in a *Limited Prescribe* $_{t-1}$ state	-0.0006	0.0023	0.0006	-0.0093	-0.0068	-0.0102	-0.0105	-0.0323	0.0344
	(0.05)	(0.07)	(0.08)	(0.40)	(1.98)	(1.29)	(0.54)	(2.20)	(0.54)
Full Prescribe $_{t-1}$ in a *Full Authority* $_{t-1}$ state	-0.0269*	0.0014	-0.0731**	0.0362	0.0178	0.0033	-0.0304	0.0812	-0.2351
	(2.82)	(0.00)	(3.19)	(0.11)	(1.22)	(0.58)	(0.17)	(0.59)	(0.17)
Limited Prescribe $_{t-1}$ in a *Full Authority* $_{t-1}$ state	-0.0115	-0.0003	-0.0250	0.0700	0.0189	0.0081	-0.0300	0.1199	-0.2347
	(0.51)	(0.16)	(0.14)	(0.52)	(0.98)	(0.04)	(0.20)	(1.06)	(0.20)

*Notes: * is for significance at the 10% level, ** at the 5% level, *** at the 1% level. Standard deviation in parentheses. 492 observations.*

The Impact of Regulations of Advanced Practice Nurses on the Prevalence of Physician Types

I. Introduction

In the fall of 1997 Columbia Advanced Practice Nurse Associates opened the first ever, independent nurse practitioner group in Manhattan (Flanagan, 1998). Everyone from physicians to journalists took notice. *The Wall Street Journal, U.S. News & World Report,* and *60 Minutes* all ran stories focusing on the group's ability to compete with more expensive primary care physicians (Flanagan, 1998).[1] The *American Academy of Family Physicians* (*AAFP*) responded to the group's opening by noting in its magazine, *Family Practice Management,* that "changes in state laws and strong consumer support make a discussion of the role of independent nurse practitioners unavoidable" (Flanagan, 1998). Indeed, the impact of Advanced Practice Nurses (APNs), such as nurse practitioners, is an area of major discussion by policymakers as well when they consider the effective regulation of APNs. A particular concern of policymakers may be the displacement of primary care physicians by APNs.

Physicians are divided into two broad types: primary care physicians (PCPs) and specialists. PCPs include physicians in the areas of family, general internal, and general pediatrics (*AAFP*, 2009a).[2] Compared to other industrialized countries, the United States proportion of PCPs to total physicians is 20 to 40% lower (Sandy and Schroeder, 1993).

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[1] See Winslow R. "Nurses to Take Doctor Duties, Oxford Says." The Wall Street Journal. Feb. 7, 1997; Lardner J. "For Nurses, a Barrier Broken." U.S News & World Report. 1998; and the 60 Minutes segment titled "The Nurse Will See You Now," hosted by Morley Safer.

[2] Obstetrics and gynecological practices are sometimes included in PCP.

During the last two decades of the twentieth century, the number of specialists in the United States increased by 118 % while the number of family practice physicians increased by only 18 % (Goodman, 2004). The abundance of specialists through the very nature of their education and the American fee-for-service system has long been criticized for driving up healthcare costs (Sandy and Schroeder, 1993).

Public health officials have extensively debated the imbalance of PCPs and specialists. Studies conducted by both the Council on Graduate Medical Education and the Physician Payment Review Commission alerted Congress of the need to address this imbalance of PCPs to specialists (Colwill and Cultice, 2003). Consequently, during the late 1980s and early 1990s, the federal government responded by taking a greater role in the regulation of training programs focusing efforts on limiting the number of entrants into specialty residencies either directly through quotas or indirectly through strategically subsidized loan programs (Simon et al., 1998; Thornton, 2000; Salsberg, 2002). However, research shows that the government's efforts have found little success. For example, Thornton (2000) analyzes graduates from Arizona medical schools and finds that the federal government's effort in influencing the allocation of physicians through debt and loan programs is relatively small. Fournier and Henderson (2005) study the impact of a non-pecuniary state-level program in Florida and find it to be ultimately unsuccessful at generating a more balanced physician workforce.

Market forces seem to have played a more influential role in promoting PCPs during the 1990s. The most prominent market force was the managed care movement of the 1990s that relied on PCPs to serve as the gatekeepers to costly specialists (Simon et

al. 1998). Another important market mechanism was the increase of female physicians who consistently select family practice (Colwill and Cultice, 2003). Although the combination of market forces and government efforts in the mid-1990s lead to a greater growth rate of PCPs in the late 1990s, the absolute growth of non-PCPs was still greater than that of PCPs (Salsberg and Forte, 2002).

The regulation of APNs may also play an influential role in the supply of PCPs in the United States. In so much as state regulations permit, APNs act both as complements and substitutes for physicians. Economic theory and empirical evidence suggest that physicians may respond to increased competition from APNs by encouraging tighter regulations of APNs (Nichols, 1996). States with liberal regulations of APNs have the potential to increase the competition faced by physicians and thereby decrease the incomes of physicians. Indeed, Dueker et al. (2005) find that the incomes of both APNs and physicians fell as prescriptive regulations of APN were liberalized. Coupled with studies documenting the positive effect of expected income on medical student's choice to specialize, the liberalization of APN regulations may have an unintended consequence of further reducing the number of PCPs relative to specialists (Sloan, 1970; Bazzoli, 1985; McKay, 1990; Esposto and Thornton, 2002; Nicholson, 2002; Gagne, 2005).

Although there is growing interest in the relationship of Advanced Practice Nurses (APNs) and physicians, to my knowledge, no study has every empirically investigated the impact of state regulations of APNs on the prevalence of physicians. The primary goal of this study is to examine the impact of liberalized state regulations of APNs on the "practice type" choice of physicians. In this paper, I use the *Community*

Tracking Physician Surveys (CTPS) to conduct a quasi-natural experiment to investigate the impact of liberalized state APN regulations on the mix of physicians in a community. Communities in states that change their APN regulations serve as the treatment group while communities in states that do not change their APN regulations serve as the comparison group. I find robust results suggesting that liberalized APN regulations reduce the prevalence of family practice physicians. There is also some evidence that liberalized APN regulations have an impact on other physician types depending on the age grouping of the physicians considered. The results of this research have implications not only for the policies aimed at adjusting the mix of generalists and specialists but also for the labor market and structure of the healthcare system in the United States.

The rest of this paper is organized as follows. Section II expands upon the profession of APNs. Section III reviews related literature. Section IV describes the data. Section V explains the empirical specification. Section VI discusses the results of liberalized regulations of APNs on the mix of physicians. Section VII concludes with a discussion of the results.

II. Advanced Practice Nurses

According to the American Association of Colleges of Nursing (2002), APNs are registered nurses with advanced training at the master's level. APNs include four specific categories: nurse practitioners, clinical nurse specialists, certified nurse-midwives, and certified registered nurse anesthetists. Nurse practitioners account for almost half of all APNs. APNs are permitted to perform varying degrees of primary care,

depending upon the stipulations of state regulations. Physicians and hospitals often employ APNs in their practices and some states allow APNs to open their own practices independent of a physician.

Although 90% of nurse practitioner graduates enter primary care, their presence in primary care is not always plainly documented (Calder, 2000). For example, the 1999 summary report of the *National Ambulatory Medical Care Survey* (NAMCS) shows that only 1.1 to 1.8% of all office-based visits are seen by mid-level practitioners[3] (Hooker and McCaig, 2001). However, when Hooker and McCaig (2001) analyze the 1995 to 1999 *NAMCS*, they find the use of mid-level practitioners to be more pronounced and find that one-fourth of primary care physicians use mid-level practitioners in their offices. Of these primary care physicians, 82% used mid-level practitioners for up to 20% of visits, which Hooker and McCaig (2001) believe to be a lower bound for two reasons. First, the *NAMCS* only questions physicians who are the direct supervisors of mid-level practitioners. Second, the *NAMCS* only captures private practices and neglects hospitals or federal agencies that utilize mid-level practitioners. On a relatively smaller analytical scale, Berkowitz (2003) finds that mid-level practitioners provided about 21% of the general outpatient care between 1998 and 1999 in the state of Washington.

The profession of APNs emerged largely in response to shortages of PCPs in rural and urban areas during the 1960s (Mundinger, 1994). However, as the profession grew, APNs began to lobby state legislatures for greater rights. Consequently, APN career opportunities grew beyond the areas of shortage (O'Brien, 2003).

[3] Mid-level practitioners include both APNs and physician assistants (PAs).

Numerous studies document the ability of APNs to extend access to care while providing care comparable to that of physicians (Levine et al., 1976; Greenfield et al., 1978; Fish et al., 1982; Avorn and Baker, 1991; Cawley, 1993; Hooker, 1993; Osterweis and Garfinkel, 1993; Mundinger, 1994; Kane et al., 2000; Mundinger et al., 2000; Venning et al., 2000; Hooker and McCaig, 2001; Dowd et al., 2003). One of the most recent and robust, Mundinger et al. (2000), uses a randomized trial of 1,316 patients from 1995 to 1997 in a primary care clinic. Patients were randomly seen by either a nurse practitioner or a physician and then interviewed at six months and one year after their original appointment. The results document that patient outcomes, such as patient satisfaction, health status, and service utilization, are essentially equivalent across provider type.

A few find cost savings for both organizations that use APNs and consumers in states with liberalized APN regulations. Adams et al. (2004) show labor cost savings for practices that employ APNs. Wilson (2008) show cost savings for consumers in the form of lower health insurance premiums in states with liberalized regulations. Similarly, Wilson (2009) shows that states with liberalized APN regulations have significantly lower state healthcare expenditures across many categories.

III. Related Studies

Many studies have been conducted to analyze the various factors expected to influence a medical student's decision to specialize. Bazzoli (1985), Esposto and Thornton (2002), and Nicholson (2002) find a positive effect of a specialist's earnings on

a medical student's choice to specialize while Thornton (2000) finds a negative effect. Thornton (2000) suggests that his negative finding is a reflection of two dramatic changes that took place in the healthcare industry during his analysis period (1991-1995). The first was the change in the Medicare fee schedule that shifted towards favoring primary care physicians. The second was the proliferation of managed care that shifted market power to PCPs from specialists.

The majority of these studies use average income as a proxy for the expected income of physicians. Although Gagne (2005) uses a Canadian data set, this allows him to gain a more exogenous measure of the impact of income on the decision to specialize. In Canada, all fees are predetermined nationally and based on the specific service and the physician specialty as opposed to any other endogenous characteristic such as local markets. Thus, Gagne (2005) provides a robust estimate of the positive effect of expected earnings on the probability of a resident specializing.

Other studies consider factors such as the growth of managed care, expected work hours, and length of additional education on the decision to specialize. For example, Simon et al. (1998) employ a two-stage least squares method to isolate the exogenous impact of managed care on the earnings of a primary care physician versus a specialist. They find that as managed care grows, the earnings of specialists decline relative to primary care physicians. McKay (1990) finds that while the relative expected hours worked affect the percent of residents in a specific specialty, the relative length of training period of a specialty does not seem to impact a resident's choice.

Newhouse (1990) examines the uneven distribution of specialists and primary care physicians across the country. Using traditional economic theory that assumes physicians locate in order to maximize profits, Newhouse (1990) considers hypotheses that explain the variation in PCPs and specialists location preferences. He finds empirical evidence to support the theory that specialists opt for more populated cities and PCPs look for less competitive smaller towns.

Dueker et al. (2005) consider the impact of state regulations of APNs on physician income. Using data from the March *Current Population Survey,* Dueker et al. (2005) investigate the impact of state regulations governing the prescriptive rights of APNs on the earnings of APNs, registered nurses, physician assistants (PAs), and physicians. They find a statistically significant reduction in the income of APNs and physicians as states extend prescription rights to APNs. Interestingly, they also find a statistically significant increase in the wages of PAs and no statistically significant impact on the wages of registered nurses. The authors conclude that states with liberalized prescriptive rights for APNs tend to substitute PAs for APNs.

No study to my knowledge considers the impact of state regulations of APNs on the prevalence of primary care physicians and specialists. It seems plausible to assume that liberalized regulations of APNs should have a greater effect on the income of PCPs as PCPs are more likely to compete with APNs. The Dueker et al. (2005) finding of a negative impact of liberalized regulations on physician earnings coupled with studies that show a positive association with expected earnings and a physician's decision to specialize, suggests that regulations may reduce the probability of a physician choosing

primary care. However, this conclusion is not certain in that APNs may not be substitutes for PCPs, but rather compliments for PCPs. For example, PCPs may prefer states with more liberalized APN regulations so that APNs can supplement the income of PCPs. According to Ginsburg and Tu (2006), the real income of physicians declined by 7% between 1995 and 2003. The income of PCPs fell the most by 10.2%, followed by surgeons whose income fell by 8%.[4] With falling incomes, PCPs may choose to use APNs to extend their office capabilities in an effort to help mitigate falling real incomes. The primary objective of this study is to determine the actual effect of state regulations of APNs on a physician's specialty choice.

III. Data

I use four cross-sections of the *Community Tracking Physician Survey (CTPS)* to examine the effect of a state's regulations of APNs on a physician's specialty choice. The *CTPS*, conducted by the Center for Studying Health System Change, is a nationally representative probability sample of 60 communities across the United States, excluding Hawaii and Alaska. Its purpose is to provide researchers with data to follow changes in the healthcare system across communities.[5] Physicians are randomly selected if they provide at least twenty hours a week of direct patient care, are not federal employees, and are not temporarily licensed foreign medical school graduates. Permission was obtained

[4] During this same period the average household experienced real income growth (http://www.census.gov/hhes/www/income/histinc/h01AR.html)

[5] Since the data are both nationally representative and "community" representative, the findings should be interpreted as the impact of liberalized APN regulations on communities in states with liberalized APN regulation rather than the impact of liberalized APN regulations on states with liberalized regulations.

to use restricted portions of the data that identify the state of the physician's practice location thus providing an avenue to link observations with state APN regulations.

I use the 1996-1997, the 1998-1999, the 2000-2001 and the 2004-2005 *CTPS* cross sections for my empirical analysis.[6] The original surveys contain 12,578, 12,304, 12,406, and 6,698 observations respectively.[7] In order to avoid small sample bias, I drop fourteen states that had sixty or fewer observations combined, leaving Kentucky as the smallest state with 150 observations and California as the largest state with 4,326 observations.[8]

Within a survey, the *CTPS* does not designate a specific year that the information is collected. As a result, I use the 1995 APN regulations for the 1996-1997 survey, the 1997 APN regulations for the 1998-1999 survey, the 1999 regulations for the 2000-2001 survey, and the 2003 APN regulations for the 2004-2005 survey. When an observation is from a state that changed its law during the two year survey period, I do not include it in my sample. For example, Arizona changed it law in 2000, therefore I do not use observations from Arizona for the 2000-2001 wave. I refer to this sample as my "full sample."

Even if the APN regulations are correctly linked to the *CTPS* surveys, another concern may be the ability of the full sample to capture the impact of the regulation changes if overall physician migration is small. Using data from the American Medical Association (AMA) registries, Williams (2009) finds that between 2000 and 2004 the

[6] The *CTPS* was not conducted in 2002-2003.
[7] The *CTPS* reduced the sample size starting with the 2004-2005 sample.
[8] The fourteen states dropped are Delaware, Idaho, Kansas, Mississippi, Montana, Nebraska, New Mexico, North Dakota, South Dakota, Vermont, Rhode Island, Iowa, New Hampshire, and Wyoming. Only New Mexico changed regulations regarding authority during this analysis.

percentage of physicians who left patient care in one state for patient care in another state ranges from more than 17% (Alaska, New Mexico, North Dakota, and Wyoming) to less than 8% (California, Florida, New Jersey, Oregon, Texas, and Wisconsin). Asghari et al. (2007) use the 1981 and the 2003 AMA registries to examine movement of active primary care physicians between the four Census regions (Northeast, Midwest, South, and West). They find 13.2% of the physicians moved from one region to another between 1981 and 2003. Using 1971-1983 AMA data Marder (1990) finds an annual physician mobility rate of 5%.

If physician migration is small, then the impact of changes in state regulations at the margins of entry and exit should be examined. For example, a law change could influence a current resident's decision to add a specialty. Residents can complete a primary care residency such as pediatrics and then decide to add a specialty like allergy/immunology or cardiology. Indeed, five of the residency programs detailed by the *American Academy of Family Practices* (2009b) require an initial primary care residency. Additionally, the migration of young physicians may be affected by the perceived competition from APNs across states. States with liberal APN regulations may have more difficulty attracting physicians in fields or specialties where APN competition is greatest.

Likewise, a physician's retirement decision may be influenced by increased competition from liberalized APN regulations. Using AMA data, Williams (2009) finds that between 2000 and 2003 the percentage of physicians who retired varied from less than 2% (Alaska, Massachusetts, and New York) to greater than 5% (Iowa, Oklahoma,

and South Dakota). Indeed, Powell and Nakata (2001) estimate that for every dollar decline in hourly net income, there is a 1.46% increase in the population of inactive physicians within two years. If liberalized APN regulations reduce physician income as detailed by Dueker et al. (2005), physicians on the margins of retirement may be pushed to retire earlier.

Accordingly, I examine a sub-sample of "young doctors" and "older doctors." I consider physicians to be young if they graduated from medical school within ten years from the survey date. For example, I use physician who graduated from medical school prior to 1987 for the 1996-1997 survey. According to the American Academy of Family Physicians (2009b), the typical primary care residency last three years while the average specialty residency is four to five years with some lasting up to six or seven years. I chose a ten-year cutoff to allow physicians with longer residencies to be included in the sample. For a sub-sample of older doctors, I consider a doctor to be older if he is at least 61 years of age in the survey.

The *CTPS* provides information on whether a physician indicates that he spends the majority of her time in primary care. The *CTPS* also reports if a physician is considered to be in one of seven broad sub-categories: internal medicine, pediatric, medical specialist, surgical specialists, psychiatry, obstetrics, and family practice. I drop the psychiatry observations as psychiatrists compete with other mid-level practitioners like psychologists. I also combine the surgical specialists with medical specialist as surgical specialists are less common in the surveys. Thus, there are five fields for my analysis: internal medicine, pediatric, specialist, obstetrics, and family practice. After

these final modifications, there are 38,736 observations in the full sample, 6,816 observations in the young doctor sub-sample, and 4,725 observations in the older doctor sub-sample.

Almost all internal, pediatric, and family practice physicians indicated they are PCPs. Only nine internal physicians and four pediatric physicians indicated they are not PCPs. Similarly, all but 146 of the obstetric physicians indicated they are not PCPs. All of the specialists indicated that they are not PCPs.

The *CTPS* covers utilization of time, type and size of practice, medical care management, physician-patient interactions, practice revenue, and physician compensation methods as well as basic physician demographics. Thus, the *CTPS* provides information on many important physician characteristics that serve as useful controls in the empirical analysis. Table 2 displays descriptive statistics of the *CTPS* covariates included in my analysis.

Information on APN regulations comes from *The Nurse Practitioner* (*TNP*) journal. For the past few decades, *TNP* has been compiling an annual update on legislative issues affecting the regulations of APNs. Specifically, *TNP* reviews regulations concerning the authority and the prescriptive rights of APNs. I use these updates to create an indicator variable, *full authority* which reflects the level of authority across states. *Full authority* is equal to one for states that permit APNs to practice independent of physician collaboration or supervision, and zero otherwise. *Full authority*

equal to zero is referred to as "limited authority." During the sample period, nine of the states analyzed change their regulations governing APN authority.[9]

TNP also reports information on regulations of prescriptive rights of APNs. Prescriptive rights vary in two respects. The first variation is the requirement of physician involvement in prescription writing. Some states require physician involvement or delegation while others do not require any physician participation. The second variation between state regulations is the type of prescriptions an APN is permitted to write. Some states restrict the type of prescriptions to only non-controlled substances while others allow non-controlled and controlled substances. Prior to 1998 a few states did not permit APNs to write prescriptions at all.

I create three indicator variables to control for the prescriptive rights in a state. *Full prescriptive* equals one for states that fully allow APNs to write for non-controlled and controlled substances, and zero otherwise. *Limited prescriptive* equals one for states that require physician involvement and may or may not limit the type of prescriptions to only non-controlled substances, and zero otherwise. *No prescriptive* equals one for states that do not permit APNs to write prescriptions, and zero otherwise.

With only four years of observations, only six states change their prescriptive rights. The variation is further reduced by the multifaceted nature of the prescriptive changes, i.e. some states change from no prescriptive rights to limited prescriptive rights while others change from limited to full prescriptive rights. Thus, I control for the prescriptive rights in a state but focus my analysis on the impact of changes in regulations

[9]The following states changed authority regulations: Arkansas, Arizona, Connecticut, Indiana, Kentucky, Maine, New Jersey, Tennessee, and Wisconsin.

governing practice authority. Table 2 also reports descriptive statistics for the regulation variables.

In the empirical analysis, time invariant, unobserved state-level heterogeneity is controlled for by including state indicators. However, time-varying, unobserved state-level heterogeneity could bias estimates. To minimize time-varying omitted variable bias at the state level, I include a number of state-level medical and health related controls as well as socioeconomic and political controls.

The first state-level medical and health related variable is a control for managed care. Simon et al. (1998) link managed care growth with a decline in the earnings of specialists relative to primary care physicians. To control for managed care within a state I include an enrollment rate (the number of enrollees divided by the state population) and the total number of HMOs in a state which come from the *Managed Care Digest.*

I also control for the supply of both physicians and nurses in a state by including a count of all non-federal physicians and nurses per 100,000 residents. This information comes from *U.S. Census Bureau* statistical abstracts.

Physician Assistants (PAs) are another type of mid-level practitioners. Unlike APNs, all states require PAs to operate under the supervision of a physician. In addition, there is a significant amount of variation across states in the type of prescriptions PAs are permitted to write for and the level of mandated physician involvement in prescribing. Some states granted initial prescriptive rights for PAs during the period of my analysis. I include an indicator equal to one if a state allows PAs to write any type of prescriptions

and equal to zero for states that do not permit PAs to write prescriptions. This information comes from the *American Academy of Physician Assistants.*

State legislatures mandate that health insurance plans cover certain types of preventative care and treatments. However, there is a large amount of variation among states in the number of mandates. States with a greater amount of mandate regulation could potentially have similar APN regulations. In order to control for differences in mandates across states, I include a count variable for the number of mandates each state requires. This information comes from a Blue Cross Blue Shield pamphlet (2007) on state legislative issues.

The malpractice environment also differs from state-to-state and could impact the prevalence of various types of providers. Recent studies find a positive relationship between physician supply in a state and malpractice reform and limits on damage awards (Becker et al., 2005; Encinosa and Hellinger, 2003). The *National Practitioner Data Bank* (*NPDB*) collects information on every malpractice payment made in a state since 1990. I use the *NPDB* to create an average malpractice payment for each state.

I include four variables from the *Center for Disease Control's Behavioral Risk Factor Surveillance System* in order to control for the general health status of each state. The first is the percentage of residents reporting good, very good or excellent health. Second is the percent of residents who report having any access to healthcare coverage. Third is the percent of the residents who report they have diabetes. Fourth is the percent of adults reporting they currently smoke.

Certain physician types may be inclined towards particular socioeconomic groups. Therefore, I include four broad socioeconomic controls. First is the state unemployment rate from the *Bureau of Labor Statistics*. Second is the maximum amount awarded for *Temporary Aid to Needy Families* for a family of three which comes from the *Urban Institute*. Finally, I include the state's income and the state's population, which both come from the *Regional Economic Information System* conducted by the *Bureau of Economic Analysis*.

The political environment could also influence the regulatory environment of a state and thus influence APN regulations. The final state-level controls attempt to capture the political environment of the state. Each year, the Americans for Democratic Action (ADA) choose what it believes to be the twenty most significant congressional votes. The ADA forms a liberal quotient based on a congress person's voting record on these twenty bills. I use this liberal quotient to create averages for a state's House of Representatives and Senators. Finally, I include an indicator variable for the governor's party affiliation where a one indicates a Democrat and a zero signifies a Republican. Table 3 reports the descriptive statistics for the state-level variables.

IV. Empirical specification

Although the primary aim of this study is to investigate the impact of state regulations of APNs on the mix of physician types in a state, the impact of the regulations on the overall supply of physicians in state should first be considered. Thus, I first

estimate a multivariate linear regression on the number of active physicians per 100,000 residents. Formally, I estimate the following:

$$D_{s,t} = \alpha_0 + \alpha_1 full\ authority_{s,t-1} + \alpha_2 P_{s,t-1} + \alpha_3 State_{s,t} + \alpha_4 YR_t + \alpha_5 STVC_{s,t} + \varepsilon_{s,t} \quad [1]$$

where s denotes state, t denotes time, D is the number of active physicians per 100,000 residents in a state, *full authority* indicates a state with full authority of APNs, P is a vector of prescriptive right indicators, *State* is a vector of indicators for state, *YR* is a vector of year indicators, *STVC* is a vector of state time-varying controls, and $\mathring{a}$ is a disturbance term.[10]

The empirical specification for the principal part of my analysis uses both the logit and multinomial logit functional form. Formally, the logit empirical model is:

$$Y_{i,s,t} = \beta_0 + \beta_1 full\ authority_{s,t-1} + \beta_2 P_{s,t-1} + \beta_3 State_{s,t} + \beta_4 YR_t + \beta_5 X_{i,s,t} + \beta_6 STVC_{s,t} + \varepsilon_{i,s,t} \quad [2]$$

where i denotes individual, s denotes state, t indexes time. Y is a vector of indicators for primary care physicians; *full authority* indicates a state with full authority; P is a vector of prescriptive right indicators; *State* is a vector of indicators for state; *YR* is a vector year indicators; X is a vector of physician characteristics, *STVC* is a vector of state time-varying controls, and $\mathring{a}$ is a disturbance term.

Formally, the empirical model for the multinomial logit is:

$$M_{i,s,t} = \delta_0 + \delta_1 full\ authority_{s,t-1} + \delta_2 P_{s,t-1} + \delta_3 State_{s,t} + \delta_4 YR_t + \delta_5 X_{i,s,t} + \delta_6 STVC_{s,t} + \varepsilon_{i,s,t} \quad [3]$$

[10] The state-level controls are the same used in the multinomial logit model except for the supply of nurses. There is an unexplained gap in the reporting of the number of nurses in the *US Statistical Abstracts* from 2001-2003.

where i denotes individual, s denotes state, t indexes time. M is a vector of indicators for internal medicine, family practice, pediatrics, specialist, and obstetrics; *full authority* indicates a state with full authority; P is a vector of prescriptive right indicators; *State* is a vector of indicators for state; *YR* is a vector year indicators; X is a vector of physician characteristics, *STVC* is a vector of state time-varying controls, and $\acute{a}$ is a disturbance term.

V. Results

A. Primary Results

In each of my analyses, I estimate three models in which I successively add state-level time-varying controls in order to examine the sensitivity of the estimates to the inclusion of various controls. Model 1 includes state and time indicators, and physician characteristics. Model 2 adds medical and health state-level controls. Model 3 adds socioeconomic and political state-level controls.

I begin by first considering the impact of *full authority* on a state's supply of physicians. Table 4 reports the results of *full authority* for the multivariate regression of the log of physicians per 100,000 residents of a state. *Full authority* is not statistically significant from zero in any of the models, thus it appears that the liberalization of APN authority does not reduce the quantity of physicians in a state.

Since *full authority* does not seem to impact the supply of physicians in a state, I investigate the impact of *full authority* on the mix of physicians in a state next. I begin by first estimating a logit model where the outcome variable is equal to one if a physician

indicates that he spends most of his time in primary care, and zero otherwise. The marginal effects of *full authority* for the full sample, young doctor sub-sample and older doctor sub-sample are presented in Tables 5, 6, and 7, respectively.

While the marginal effect of *full authority* is negative in all three models for the full sample, it is not statistically significant from zero. The marginal effect of *full authority* is also negative in all three models for the young doctor sub-sample. However, in the young doctors sample it is statistically significant in the third model at the 10% level. This indicates that *full authority* reduces the prevalence of PCPs in the young doctor sub-sample by 11.2%. The marginal effect of *full authority* is positive in all three models for the older doctor sub-sample; however, it is not statistically significant from zero. The lack of robust significant results suggests that the liberalization of APN authority has virtually no impact on the prevalence of PCPs in a state. However, using the broadest categorization of PCP versus non-PCP eliminates considerable variation in the physician type and perhaps masks the effect of *full authority*.

A multinomial logit model takes advantage of additional variation in the types of physicians by allowing the dependent variable to have more than two outcomes. Therefore, I estimate a multinomial logit model where the dependant variable takes on one of the following five physician types: internal, pediatrics, specialists, obstetrics, and family practice. The marginal effects of *full authority* for the full sample, young doctor sub-sample and older doctor sub-sample are presented in Table 8, 9, and 10, respectively.

In the full sample, the marginal effect of *full authority* is not statistically significant for internal, pediatrics, specialists, and obstetrics in any of the models.

However, it is statistically significant in all three models for family practice. Model 1 indicates that *full authority* reduces the prevalence of family practice physicians by 1.89% at the 5% significance level. In model 2, the marginal effect increases in magnitude and significance implying that *full authority* reduces the prevalence of family practice physicians by 2.59% at the 1% significance level. In model 3, the marginal effect increases slightly in magnitude to 2.69% and remains significant at the 1% level. In the full sample, the inclusion of additional state-level controls increases both the magnitude and the significance of the effect of *full authority* on family practice physicians.

In the young doctors sub-sample, the marginal effect of *full authority* is not statistically significant for internal or pediatrics in any of the models. The marginal effect of *full authority* is positive and statistically significant at the 5% level for specialist in model 3, implying that *full authority* increases the prevalence of specialists by 7.19%. Similarly, the marginal effect of *full authority* is positive and statistically significant at the 10% level for obstetrics in model 3 indicating that *full authority* increases the prevalence of obstetric physicians by 3.68%. The marginal effect of *full authority* for family practice is negative and statistically significant at the 5 % level in model 3. This implies that *full authority* reduces the prevalence of family practice physicians by 7.60% which is almost 5 percentage points greater that the marginal effect of *full authority* in the full sample for model 3. The effect of *full authority* on specialists, obstetrics and family practice is not statistically significant in model 1 or 2. Thus, for the young doctors sub-sample, the significance of the marginal effect of *full authority* on the practice types

appears sensitive to the inclusion of state-level controls. The sensitive results could be a consequence of a smaller sample size relative to the full sample.

The results for the older doctors sub-sample seem to be more robust across model specification relative to the young doctors sub-sample. The marginal effect of *full authority* is positive and statistically significant for pediatrics in all three models. The magnitude of the marginal effect of *full authority* ranges from 3.02% (at the 10% level) in model 1, to 3.74% (at the 5 % level) in model 2, to 3.65% (at the 5% level) in model 3. All three models imply that *full authority* increases the prevalence of pediatrics. For obstetrics, the marginal effect of *full authority* is negative across all three models. However, it is only statistically significant in models 1 (at the 5 % level) and 3 (at the 5 % level). Models 1 and 3 imply that *full authority* reduces the prevalence of obstetrics by 1.68% and 1.27% respectively. The marginal effect of *full authority* for family practice is negative and statistically significant at the 5% level across all three models. The magnitude of the marginal effect falls from -8.36% in model 1 to -6.67% in model 3. The marginal effect of *full authority* for family practice implies that *full authority* reduces the prevalence of family practice physicians. Relative to the full sample, the impact of *full authority* on older family physicians is more than twice the size. The marginal effect of *full authority* for internal and specialist is not statistically significant in any of the three models.

Another way to see the effect of *full authority* is to use the full sample to estimate equations 2 and 3 with an indicator for young doctor, an indicator for older doctor, an interaction term of *full authority* and the young doctor indicator, and an interaction term

of *full authority* and the older doctor indicator. This estimation uses the full sample to provide separate marginal effects for young doctors, older doctors and the remaining doctors. The marginal effects for *full authority* for the logit and the multinomial logit models are presented in Table 11 and 12, respectively.

In all three models, the marginal effect of *full authority* is not statistically significant from zero for any of the age groupings in the logit model with interaction terms. This is not surprising as the logit models without the interaction terms only produced one significant result.

In the multinomial logit model with interaction terms, family practice physicians are the only doctor type with robust significant marginal effects for *full authority.* The marginal effect of *full authority* is negative and significant at the 1% level for the older family practice physician in all three models. This result suggests that the liberalization of APN authority reduces the prevalence of older family practice physicians from 4.3% to 5%. Interestingly, the marginal decision of entry as seen by the effect on young doctors is not statistically significant in any of the models under the interaction specification. The marginal effect of *full authority* is negative and significant (at the 5% level for model 1 and 3, at the 1% level for model 2) for the remaining family practice physicians in all three models. This result suggests that the liberalization of APN authority reduces the prevalence of the remaining family practice physicians from 1.93% to 2.7%. The magnitude of the effect is larger on the older family practice physicians. Except for the effect on older pediatricians in model 3, the rest of the marginal effects of *full authority* are not statistically significant.

B. Supplemental Results

I conduct numerous empirical analyses on supplemental models that are discussed here. First, I re-estimate the logit and multinomial logit models using just the beginning (1996-1997) and ending (2004-2005) surveys in order to avoid regulations that change within a survey sample. The analysis is limited to just the full sample because the smaller sub-samples produce unrealistic results, i.e. marginal effects of 100%. Results for these estimates are in the appendix tables A1 and A2. The major difference between the primary results and this approach is that the majority of the marginal effects are significant. This difference most likely reflects the presence of additional cross sections in the primary results, which provide additional variation and thus give a more precise estimate of the effect of *full authority* over time.

Table A3 displays results for estimates of the preferred specification (model 3) multinomial logit model for additional medical school graduation cutoffs including the 10-year cutoff discussed above. Due to longer residencies more specialist will be included in the sample as the time frame increases. As seen in table A2, the significance varies depending on the cutoff. The positive effect of *full authority* on specialists appears most robust with 60% of the young samples showing significance. *Full authority* is positive and significant on the obstetrics labor market for 40% of the young doctors sub-samples. Similarly, *full authority* is negative and significant on family practice physicians for 40% of the young doctors sub-samples. The marginal effect of *full authority* is not significant for internal or pediatrics across any of the young doctors sub-samples.

The appendix also contains estimates for the preferred specification (model 3) multinomial logit model for additional sub-samples of older doctors. Table A4 displays the results. Again the results change with different age cutoffs. The positive marginal effect of *full authority* on pediatrics appears most robust with 87% of the older doctors sub-samples showing significance. The negative marginal effect of *full authority* on family practice physicians also seems robust with 71% of the older doctors sub-samples showing significance. The marginal effect of *full authority* is negative and significant on internal and family practice for 43% of the older doctors sub-samples. The marginal effect of *full authority* is not significant for specialists.

The appendix also contains results for estimates without prescriptive rights in order to see if prescriptive rights significantly affect the impact of *full authority*. Tables A5 through A10 display these results. Excluding prescriptive rights does not substantially change the significance of the results, but only the magnitudes of the marginal effects. In fact, the only effect that loses significance is the marginal effect of *full authority* on obstetrics in the older doctors multinomial logit model for model 3.

Marginal effects for additional covariates for the full sample, model 3, are also in the appendix. Table A11 displays the logit model. Males appear to significantly choose primary care less often relative to females. Younger physicians seem to significantly select PCP more frequently. The rest of the individual characteristics are likely to be endogenous. Thus, it is not surprising that the majority of these variables are significant.

Both the *number of HMOs* and the *HMO enrollment rate* are significant but have opposite signs, the former negative and the latter positive. Perhaps the *number of HMOs*

captures the level of competition among managed care in a state, where as the *HMO enrollment rate* captures the penetration of managed care into the state's healthcare system. The *percent of residents reporting any kind of healthcare coverage* appears to significantly reduce the prevalence of PCPs. This may suggests that healthcare coverage induces the use of specialists.

Both the liberal quotient for the senators and representatives seems to be significantly related to an increase in the prevalence of PCPs. *Total state personal income* appears to have a significantly positive relationship with the prevalence of PCPs. The state's *population level* appears to have a significantly negative relationship with the frequency of PCPs.

Table A12 displays the results for additional covariates for the multinomial logit model. Males appear to significantly choose pediatrics and obstetrics less often relative to females but significantly choose specialist more often relative to females. Younger doctors seem to significantly prefer internal, family practice and pediatrics while significantly not preferring specialty fields.

The *number of HMOs* appears to significantly reduce the prevalence of internal and family practice physicians but significantly increases the incidence of specialists. The *HMO enrollment rate* seems to significantly reduce the frequency of obstetricians. The results suggest that granting PAs some type of prescriptive rights significantly increases the prevalence of internists but reduces the incidence of pediatricians. The *number of state mandates* appears to significantly reduce the prevalence of pediatricians. A positive health status seems to significantly increase the number of family practice

physicians while reducing the number of specialists. The results suggest that access to healthcare coverage significantly decreases the prevalence of internal and family practice physicians while increasing the prevalence of specialists. The *percent of residents reporting they have diabetes* is the only state-level variable to significantly effect all five physician types. It appears to significantly increase the frequency of family practice, pediatric, and obstetric physicians while reducing the prevalence of internists and specialists.

The *liberal quotient for the House of Representatives* seems to have a significantly positive relationship with the frequency of family practice physicians. Democratic governors appear to have a significantly positive effect on the prevalence of internists. The results suggest that a higher unemployment rate is significantly related to an increase in the incidence of internists. Total state personal income appears to significantly increase the prevalence of internists while significantly reducing the frequency of specialists. Finally, the state's population level seems to have a significantly positive relationship with specialists.

VI. Conclusion

APNs are a valuable part of the healthcare system. Private practices, hospitals and patients are all depending on APNs in greater capacities. However, the impact of regulations governing APNs on the various aspect of the healthcare system is not clearly understood. This paper takes a first step at investigating the impact of APN regulations on the mix of physicians in a community.

The results of this research provide robust evidence that the liberalization of APN regulations reduces the prevalence of family practice physicians. This is expected as APNs are most prevalent in family practice and thus provide the most competition for family practice doctors. The magnitude and significance of liberalized APN authority appears somewhat sensitive to the age of the doctors considered. It is most robust among older family practice physicians.

Indeed, the impact on older family practice physicians appears to be the largest with various models showing a 5 to 8.36% decrease in the prevalence of older family practice physicians. Some of the results indicate that the prevalence of older obstetricians is also reduced by the liberalization of APN regulations. The results also give some indication that liberalized APN authority has a positive effect on the prevalence of older pediatricians.

For younger doctors, the results suggest that liberalized APN regulations reduce the prevalence of family practice physicians, albeit less robust. There is also weak evidence suggesting that liberalized regulations increase the prevalence of younger specialists and obstetricians. It is interesting that the effect of liberalized regulations on obstetricians is positive for the younger doctors but negative for the older doctors. Perhaps, older obstetricians choose to exit rather than compete with APNs while younger obstetricians use APNs as complements in their practice.

It is not clear whether the impact of liberalized APN authority on the prevalence of family practice physicians is sustainable. This is especially true if the impact is strongest on older physicians who are leaving the market and weakest on younger

physicians who are entering the market as the results suggests. It may be the case that older physicians see liberalized APN authority as an intrusion to their established practice and thus are pushed towards an earlier retirement. Younger doctors may view the presence of APNs as the status quo and thus their response to a change in the authority of APNs is insignificant.

Even if the reduction in the prevalence of family physicians is sustainable, the policy implications from these results are not well-defined. While the profession of APNs may have been formed in response to physician shortages, the achievement of independent practice is more likely a result of effective lobbying by the nursing organizations (O'Brien, 2003). These results seem to suggest that the independence of APNs may be granted at the expense of family practice physicians, specifically older family practice physicians. However, this unintended consequence may result in a net benefit to society.

If APNs can provide care comparable to that of a physician at a lower cost, then they may be the more efficient choice for the majority of basic primary care. Indeed, APNs may play a pivotal role in the current debate of healthcare reform as seen by a recent Reuters (Strongin, 2009) article titled, "Nurse Practitioners in the Front Lines of Obama Health Care Reform Era." Many experts believe that collaborative practice between primary care physician and APNs offers a more comprehensive and cost effective care (Mundinger, 1994). The total benefit to society is even greater when one accounts for the educational cost saving for APNs. For example, the cost of training a nurse practitioner is four-to-five times less relative to a physician training (American

College of Nursing, 2000). As a side note, having more physicians in specialty care, while potentially more costly, may lead to greater advancements in medical innovation also benefiting society.

These results should not be considered as the conclusive answer to the impact of liberalized APN authority on the mix of physicians in a state. Rather they should be seen as the beginning of an empirical investigation into this important policy question. This research is limited by the nature of the CTPS that typically surveys a single community in a state rather than the whole state. Additional research with a larger more comprehensive data set is worthwhile.

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TABLES

Table 1 Physician Type

	Full	Young	Older
PCP	61.08%	70.79%	64.09%
Internal	20.22%	24.33%	18.10%
Pediatric	14.36%	17.19%	12.67%
Specialist	34.96%	24.27%	31.70%
Obstetrics	4.29%	5.13%	4.67%
Family	26.17%	29.08%	32.86%
Observations	39,736	6,816	4,725

Table 2 Descriptive Statistics for Community Tracking Physician Survey and Regulations

	Full		Young		Older	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std
CTPS Variables						
Large Metro (= 1 if greater than 200,000)	0.87	0.34	0.85	0.36	0.89	
Small Metro (= 1 if less than 200,000)	0.03	0.18	0.04	0.18	0.02	
Non Metro (= 1 if not a metro)	0.10	0.30	0.12	0.32	0.09	
Medical Doctor (= 1 if MD, i.e. not DO)	0.92	0.27	0.87	0.34	0.93	
US Graduate (= 1 if graduate from a US medical school)	0.79	0.41	0.92	0.27	0.75	
Male (= 1 if male)	0.76	0.43	0.60	0.49	0.93	
Year of Birth	1952	10.66	1964	5.32	1932	
Medical School Graduation Year	1979	11.00	1992	3.10	1959	
Part Owner (= 1 if part owner of a practice)	0.23	0.42	0.18	0.38	0.17	
Not an Owner (= 1 if not an owner of a practice)	0.46	0.50	0.69	0.46	0.34	
Solo Or 2 (= 1 if solo or 2 physician practice)	0.35	0.48	0.23	0.42	0.54	
Group Practice (= 1 if group practice)	0.29	0.45	0.31	0.46	0.20	
Group HMO Practice (= 1 if group HMO practice)	0.06	0.23	0.07	0.25	0.03	
Medical School Practice (= 1 if medical school practice)	0.08	0.26	0.09	0.29	0.05	
Hospital Practice (= 1 if hospital practice)	0.12	0.33	0.17	0.38	0.08	
Other (= 1 other type of practice)	0.10	0.30	0.13	0.34	0.10	
Year began practicing	1984	10.74	1996	3.18	1965	
Net Income (inflation adjusted, in hundreds)	960.68	520.78	749.83	392.35	840.38	
Regulations						
Full authority (=1)	0.32	0.47	0.34	0.47	0.28	
Full Prescriptive (=1)	0.13	0.33	0.13	0.34	0.10	
Limited Prescriptive (=1)	0.84	0.36	0.84	0.37	0.87	

Table 3 Descriptive Statistics for State-Level Time-Varying Controls

	Full		Young		Older	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Medical state-level controls						
Number of HMOs	29.33	17.37	27.79	16.61	31.12	17.79
HMO enrollment rate	32.09	13.31	31.51	13.46	32.71	13.15
Number physicians in state per 100k residents	254.90	65.89	251.50	65.22	259.04	67.58
Number nurses in state 100k residents	811.77	151.66	810.70	152.24	811.22	150.57
Indicates state grants some type of prescription rights to PAs	0.80	0.40	0.80	0.40	0.80	0.40
Average malpractice award (in thousands)	207.93	71.63	207.98	71.51	208.30	72.84
Number of state mandates	29.95	9.03	29.81	8.93	30.03	9.24
Percent of residents reporting health status as good, very good or excellent	85.32	2.70	85.31	2.75	85.32	2.60
Percent of residents reporting any kind of health care coverage	85.88	4.03	85.97	4.08	85.71	4.00
Percent of residents reporting they have diabetes	5.75	1.18	5.79	1.17	5.71	1.19
Percent of residents reporting they smoke	22.67	3.14	22.77	3.22	22.60	3.09
Socioeconomic Controls						
Liberal Quotient for House Representatives	0.45	0.19	0.45	0.19	0.46	0.19
Liberal Quotient for Senators	0.54	0.33	0.51	0.33	0.56	0.33
Govern (= 1 if Democrat)	0.36	0.48	0.38	0.48	0.33	0.47
Maximum amount of Temporary Aid for Needy Families for family of 3	411.02	150.44	406.17	151.24	416.11	150.36
Unemployment rate	4.75	1.08	4.65	1.07	4.84	1.08
Total state personal income (in billions)	329.00	282.00	316.00	281.00	349.00	286.00
Population level (in 100,000s)	113.00	90.55	108.00	89.01	120.00	92.41

Table 4 Multivariate Regression Analysis of Logged Number of Physician per 100k Residents

	Model 1	Model 2	Model 3
Full authority	0.0028	0.0042	0.0018
standard error	0.0103	0.0098	0.0087
State Indicators & Year Indicators	Yes	Yes	Yes
Physician Characteristics	Yes	Yes	Yes
State Time Varying Controls – Medical & Health	No	Yes	Yes
State Time Varying Controls - Socioeconomics & Political	No	No	Yes
R square	0.8218	0.8431	0.8533

*Notes: Standard errors are clustered at the state year level. 295 observations. * is for significance at the 10% level, ** at the 5% level, *** at the 1% level.*

Table 5: Marginal Effect from the Logit for Primary Care Physicians, Full Sample

	Model 1	Model 2	Model 3
Full authority	-0.0117	-0.0138	-0.0207
standard error	0.0193	0.0178	0.0188
State Indicators & Year Indicators	Yes	Yes	Yes
Physician Characteristics	Yes	Yes	Yes
State Time Varying Controls – Medical & Health	No	Yes	Yes
State Time Varying Controls - Socioeconomics & Political	No	No	Yes
Pseudo R-square	0.1729	0.1732	0.1734

*Notes: Standard errors are clustered at the state year level. 39,736 observations. *p < 0.10, **p < 0.05,* and
***p < 0.01.

Table 6: Marginal Effect for the Logit for Primary Care Physicians, Young Doctor Sub-Sample

	Model 1	Model 2	Model 3
Full authority	-0.0342	-0.0602	-0.1120***
standard error	0.0433	0.0391	0.0402
State Indicators & Year Indicators	Yes	Yes	Yes
Physician Characteristics	Yes	Yes	Yes
State Time Varying Controls - Medical & Health	No	Yes	Yes
State Time Varying Controls - Socioeconomics & Political	No	No	Yes
Pseudo R-square	0.1929	0.1961	0.1981

Notes: Standard errors are clustered at the state year level. 6,816 *observations.* *$p < 0.10$, **$p < 0.05$, and ***$p < 0.01$.

Table 7: Marginal Effect for the Logit for Primary Care Physicians, Older Doctor Sub-Sample

	Model 1	Model 2	Model 3
Full authority	0.0018	0.0030	0.0294
standard error	0.0447	0.0414	0.0381
State Indicators & Year Indicators	Yes	Yes	Yes
Physician Characteristics	Yes	Yes	Yes
State Time Varying Controls - Medical & Health	No	Yes	Yes
State Time Varying Controls - Socioeconomics & Political	No	No	Yes
Pseudo R-square	0.1373	0.1400	0.1422

Notes: Standard errors are clustered at the state year level. 4,725 *observations.* $*\underline{p} < 0.10$, $**\underline{p} < 0.05$, and $***\underline{p} < 0.01$.

Table 8: Marginal Effects of Full Authority for the Multinomial Logit, Full Sample

	Model 1	Model 2	Model 3
Internal	0.0014	-0.0008	-0.0049
standard error	0.0072	0.0064	0.0074
Pediatric	0.0051	0.0076	0.0089
standard error	0.0096	0.0079	0.0072
Specialist	0.0079	0.0115	0.0166
standard error	0.0169	0.0167	0.0185
OB	0.0042	0.0075	0.0063
standard error	0.0079	0.0081	0.0086
Family	-0.0186**	-0.0259***	-0.0269***
standard error	0.0091	0.0087	0.0103
State Indicators & Year Indicators	Yes	Yes	Yes
Physician Characteristics	Yes	Yes	Yes
State Time Varying Controls - Medical & Health	No	Yes	Yes
State Time Varying Controls - Socioeconomics & Political	No	No	Yes
Pseudo R-square	0.1310	0.1317	0.1319

Notes: Standard errors are clustered at the state year level. 39,736*observations.* *$p < 0.10$, **$p < 0.05$, and ***$p < 0.01$.

Table 9: Marginal Effects of Full Authority for the Multinomial Logit, Young Doctor Sub-Sample

	Model 1	Model 2	Model 3
Internal	-0.0172	-0.0160	-0.0344
standard error	0.0434	0.0386	0.0345
Pediatric	0.0113	-0.0019	0.0018
standard error	0.0272	0.0228	0.0238
Specialist	0.0154	0.0333	0.0719**
standard error	0.0266	0.0262	0.0318
OB	0.0214	0.0277	0.0368*
standard error	0.0209	0.0213	0.0197
Family	-0.0309	-0.0431	-0.0760**
standard error	0.0396	0.0397	0.0368
State Indicators & Year Indicators	Yes	Yes	Yes
Physician Characteristics	Yes	Yes	Yes
State Time Varying Controls - Medical & Health	No	Yes	Yes
State Time Varying Controls - Socioeconomics & Political	No	No	Yes
Pseudo R-square	0.1613	0.1657	0.1684

*Notes: Standard errors are clustered at the state year level. 6,816 observations. *$p < 0.10$, **$p < 0.05$,* and ***$p < 0.01$.

Table 10: Marginal Effects of Full Authority For The Multinomial Logit, Older Doctor Sub-Sample

	Model 1	Model 2	Model 3
Internal	0.0206	0.0104	0.0222
standard error	0.0432	0.0374	0.0364
Pediatric	0.0302*	0.0374**	0.0365**
standard error	0.0160	0.0170	0.0174
Specialist	0.0496	0.039	0.0207
standard error	0.0414	0.0454	0.0429
OB	-0.0168**	-0.0065	-0.0127*
standard error	0.0069	0.0069	0.0073
Family	-0.0836**	-0.0804**	-0.0667**
standard error	0.0358	0.0357	0.0333
State Indicators & Year Indicators	Yes	Yes	Yes
Physician Characteristics	Yes	Yes	Yes
State Time Varying Controls - Medical & Health	No	Yes	Yes
State Time Varying Controls - Socioeconomics & Political	No	No	Yes
Pseudo R-square	0.1314	0.1377	0.1414

Notes: Standard errors are clustered at the state year level. 4,725 *observations.* *$p < 0.10$, **$p < 0.05$, and ***$p < 0.01$

Table 11 Marginal Effects for the Logit with Interaction Terms

	Model 1	Model 2	Model 3
Full authority on Young Doctor	0.0227	0.0178	0.0158
Standard Error	0.0304	0.0289	0.0283
Full authority on Older Doctor	0.0129	0.0056	0.0023
Standard Error	0.0290	0.0281	0.0281
Full authority on Remaining Doctors	-0.0202	-0.0258	-0.0281
Standard Error	0.0197	0.0189	0.0197
State Indicators & Year Indicators	Yes	Yes	Yes
Physician Characteristics	Yes	Yes	Yes
State Time Varying Controls - Medical & Health	No	Yes	Yes
State Time Varying Controls - Socioeconomics & Political	No	No	Yes
Pseudo R square	0.1746	0.1749	0.1751

Notes: Standard errors are clustered at the state year level. 39,736*observations.* *$p < 0.10$, **$p < 0.05$, *and* ***$p < 0.01$.

Table 12 Marginal Effects for the Multinomial Logit with Interaction Terms

	Model 1	Model 2	Model 3
Internal			
Full authority on Young Doctor	0.0081	0.0063	0.0026
Standard Error	0.0163	0.0154	0.0157
Full authority on Older Doctor	0.0322	0.0281	0.0226
Standard Error	0.0314	0.0296	0.0291
Full authority on Remaining Doctors	-0.0027	-0.0046	-0.0086
Standard Error	0.0069	0.0068	0.0078
Pediatric			
Full authority on Young Doctor	0.0090	0.0127	0.0148
Standard Error	0.0188	0.0170	0.0164
Full authority on Older Doctor	0.0182	0.0205	0.0218*
Standard Error	0.0135	0.0129	0.0129
Full authority on Remaining Doctors	0.0026	0.0053	0.0067
Standard Error	0.0093	0.0077	0.0070
Specialist			
Full authority on Young Doctor	-0.0123	-0.0108	-0.0068
Standard Error	0.0254	0.0259	0.0269
Full authority on Older Doctor	-0.0006	0.0030	0.0091
Standard Error	0.0335	0.0328	0.0329
Full authority on Remaining Doctors	0.0115	0.0148	0.0193
Standard Error	0.0180	0.0176	0.0194
OB			
Full authority on Young Doctor	-0.0144	-0.0090	-0.0105
Standard Error	0.0196	0.0203	0.0206
Full authority on Older Doctor	-0.0064	-0.0024	-0.0035
Standard Error	0.0262	0.0271	0.0263
Full authority on Remaining Doctors	0.0078	0.0106	0.0096
Standard Error	0.0073	0.0074	0.0081
Family			
Full authority on Young Doctor	0.0098	0.0009	-0.0001
Standard Error	0.0207	0.0202	0.0214
Full authority on Older Doctor	-0.0434***	-0.0491***	-0.05***
Standard Error	0.0155	0.0154	0.0157
Full authority on Remaining Doctors	-0.0193**	-0.0260***	-0.0270**
Standard Error	0.0102	0.0096	0.0112
State Indicators & Year Indicators	Yes	Yes	Yes
Physician Characteristics	Yes	Yes	Yes
State Time Varying Controls - Medical & Health	No	Yes	Yes
State Time Varying Controls - Socioeconomics & Political	No	No	Yes
Pseudo R Square	0.1342	0.1350	0.1352

Notes: Standard errors are clustered at the state year level. 39,736*observations.* *$p < 0.10$, **$p < 0.05$, and ***$p < 0.01$.

APPENDIX

Table 1A: Marginal Effect for the Logit For Primary Care Physicians, Full Sample Using Only The 1996 and 2004 Surveys

	Model 1	Model 2	Model 3
Full authority	-0.0041	-0.0305*	-0.1191***
standard error	0.0219	0.0171	0.0304
State Indicators & Year Indicators	Yes	Yes	Yes
Physician Characteristics	Yes	Yes	Yes
State Time Varying Controls - Medical & Health	No	Yes	Yes
State Time Varying Controls - Socioeconomics & Political	No	No	Yes
Pseudo R-square	0.1666	0.1673	0.1678

*Notes: Standard errors are clustered at the state year level. 17,150 observations. *p < 0.10, **p < 0.05,* and ***p < 0.01.

Table 2A Marginal Effect of Full Authority for the Multinomial Logit for Primary Care Physicians, Full Sample Using Only the 1996 And 2004 Surveys

	Model 1	Model 2	Model 3
Internal	0.0164	-0.0167***	-0.0404***
standard error	0.0115	0.0064	0.0152
Pediatric	-0.0050	0.0036	0.0323*
standard error	0.0124	0.0135	0.0189
Specialist	0.0080	0.0143	0.1208***
standard error	0.0201	0.0212	0.0316
OB	-0.0047	0.0202*	-0.02**
standard error	0.0095	0.0110	0.0082
Family	-0.0147*	-0.0214**	-0.0928***
standard error	0.0091	0.0094	0.0106
State Indicators & Year Indicators	Yes	Yes	Yes
Physician Characteristics	Yes	Yes	Yes
State Time Varying Controls - Medical & Health	No	Yes	Yes
State Time Varying Controls - Socioeconomics & Political	No	No	Yes
Pseudo R-square	0.1300	0.1316	0.1325

*Notes: Standard errors are clustered at the state year level. 17,150 observations. *$p < 0.10$, **$p < 0.05$,* and ***$p < 0.01$.

Table 3A Marginal Effects of Full Authority for the Multinomial Logit for Model 3, Various Young Doctor Sub-Samples

	Medical school graduation cutoff 11 years	Medical school graduation cutoff 10 years	Medical school graduation cutoff 9 years	Medical school graduation cutoff 8 years	Medical school graduation cutoff 7 years
Internal	-0.0381	-0.0344	-0.0178	-0.0116	0.0215
standard error	0.0264	0.0345	0.0381	0.0422	0.0724
Pediatric	0.0083	0.0018	-0.0018	-0.0179	0.0144
standard error	0.0248	0.0238	0.0263	0.0269	0.0393
Specialist	0.0404	0.0719**	0.0875***	0.0822*	-0.0197
standard error	0.0301	0.0318	0.0324	0.0467	0.0551
OB	0.0331**	0.0368*	0.0077	0.0038	0.0026
standard error	0.0161	0.0197	0.0164	0.0281	0.0208
Family	-0.0436	-0.0760**	-0.0756**	-0.0566	-0.0189
standard error	0.0282	0.0368	0.0357	0.0411	0.0578

Notes: Standard errors are clustered at the state year level. $*p < 0.10$, $**p < 0.05$, and $***p < 0.01$

Table 4A Marginal Effects of Full Authority for the Multinomial Logit for Model 3, Various Older Doctor Sub-Samples

	60	61	62	63	64	65	66
Internal	0.0087	0.0222	0.0358	0.0672*	0.0537	0.0639*	0.0699*
standard error	0.0298	0.0364	0.0346	0.0378	0.0339	0.0372	0.0370
Pediatric	0.0322**	0.0365**	0.0472*	0.0706**	0.0818**	0.0741*	0.0478
standard error	0.0158	0.0174	0.0254	0.0323	0.0383	0.0419	0.0389
Specialist	0.0317	0.0207	-0.0240	-0.0708	-0.0578	-0.0334	-0.0029
standard error	0.0388	0.0429	0.0406	0.0553	0.0583	0.0646	0.0620
OB	-0.0240***	-0.0127*	-0.0158*	-0.0158***	-0.0171**	-0.0105	-0.006
standard error	0.0074	0.0073	0.0091	0.0061	0.0074	0.0214	0.0157
Family	-0.0487	-0.0667**	-0.0432	-0.0512	-0.0606	-0.0941*	-0.1088*
standard error	0.0342	0.0333	0.0336	0.0440	0.0541	0.0501	0.0589

Notes: Standard errors are clustered at the state year level. *$p < 0.10$, **$p < 0.05$, and ***$p < 0.01$

Table 5A Marginal Effects for the Logit for Primary Care Physicians Full Sample, No Prescription Regulations in Models

	Model 1	Model 2	Model 3
Full authority	-0.0102	-0.0138	-0.0207
Standard Error	0.0186	0.0178	0.0188
State Indicators & Year Indicators	Yes	Yes	Yes
Physician Characteristics	Yes	Yes	Yes
State Time Varying Controls - Medical & Health	No	Yes	Yes
State Time Varying Controls - Socioeconomics & Political	No	No	Yes
Pseudo R square	0.1729	0.1732	0.1734

Notes: Standard errors are clustered at the state year level. 39,736*observations.* $*p < 0.10$, $**p < 0.05$, and $***p < 0.01$.

Table 6A Marginal Effects for the Logit for Primary Care Physicians Young Doctor Sub-Sample, No Prescription Regulations in Models

	Model 1	Model 2	Model 3
Full authority	-0.0274	-0.0466	-0.1013**
Standard Error	0.0427	0.0399	0.0417
State Indicators & Year Indicators	Yes	Yes	Yes
Physician Characteristics	Yes	Yes	Yes
State Time Varying Controls - Medical & Health	No	Yes	Yes
State Time Varying Controls - Socioeconomics & Political	No	No	Yes
Pseudo R square	0.1927	0.1956	0.1978

*Notes: Standard errors are clustered at the state year level. 6,816 observations. *p < 0.10, **p < 0.05,* and ***p < 0.01.

Table 7A Marginal Effects for the Logit for Primary Care Physicians Older Doctor Sub-Sample, No Prescription Regulations in Models

	Model 1	Model 2	Model 3
Full authority	0.0083	0.0077	0.0301
Standard Error	0.0416	0.0419	0.0371
State Indicators & Year Indicators	Yes	Yes	Yes
Physician Characteristics	Yes	Yes	Yes
State Time Varying Controls - Medical & Health	No	Yes	Yes
State Time Varying Controls - Socioeconomics & Political	No	No	Yes
Pseudo R square	0.1370	0.1397	0.1422

Notes: Standard errors are clustered at the state year level. 4,725 observations. $*p < 0.10$, $**p < 0.05$, and $***p < 0.01$.

Table 8A Marginal Effects for the Multinomial Logit for Full Sample, No Prescription Regulations in Models

	Model 1	Model 2	Model 3
Internal	0.0015	0.0004	-0.0008
standard error	0.0071	0.0064	0.0064
Pediatric	0.0074	0.0096	0.0076
standard error	0.0097	0.0078	0.0079
Specialist	0.0059	0.0069	0.0115
standard error	0.0165	0.0163	0.0167
OB	0.0029	0.0055	0.0075
standard error	0.0077	0.0080	0.0081
Family	-0.0178**	-0.0224**	-0.0259***
standard error	0.0089	0.0090	0.0087
Pseudo R square	0.1309	0.1316	0.1319
State Indicators & Year Indicators	Yes	Yes	Yes
Physician Characteristics	Yes	Yes	Yes
State Time Varying Controls - Medical & Health	No	Yes	Yes
State Time Varying Controls - Socioeconomics & Political	No	No	Yes

Notes: Standard errors are clustered at the state year level. 39,736*observations.* *$p < 0.10$, **$p < 0.05$, and ***$p < 0.01$.

Table 9A Marginal Effects for the Multinomial Logit for Young Doctor Sub-Sample, No Prescription Regulations in Models

	Model 1	Model 2	Model 3
Internal	-0.0069	-0.0088	-0.0298
standard error	0.0416	0.0377	0.0332
Pediatric	0.0130	0.0011	0.0056
standard error	0.0269	0.0227	0.0240
Specialist	0.0079	0.0197	0.0657**
standard error	0.0269	0.0285	0.0329
OB	0.0222	0.0252	0.0323*
standard error	0.0226	0.0201	0.0192
Family	-0.0362	-0.0372	-0.0737**
standard error	0.0377	0.0373	0.0358
Pseudo R square	0.1608	0.1654	0.1680
State Indicators & Year Indicators	Yes	Yes	Yes
Physician Characteristics	Yes	Yes	Yes
State Time Varying Controls - Medical & Health	No	Yes	Yes
State Time Varying Controls - Socioeconomics & Political	No	No	Yes

*Notes: Standard errors are clustered at the state year level. 6,816 observations. *$p < 0.10$, **$p < 0.05$,* and ***$p < 0.01$.

Table 10A Marginal Effects for the Multinomial Logit for Older Doctor Sub-Sample, No Prescription Regulations in Models

	Model 1	Model 2	Model 3
Internal	0.0208	0.0095	0.0201
standard error	0.0431	0.0376	0.0364
Pediatric	0.0385**	0.0466**	0.0463**
standard error	0.0171	0.0185	0.0201
Specialist	0.0323	0.0259	0.0112
standard error	0.0418	0.0454	0.0408
OB	-0.0111**	-0.0051	-0.0134
standard error	0.0058	0.0065	0.0092
Family	-0.0805**	-0.0770**	-0.0641**
standard error	0.0358	0.0357	0.0326
Pseudo R square	0.1306	0.1373	0.1410
State Indicators & Year Indicators	Yes	Yes	Yes
Physician Characteristics	Yes	Yes	Yes
State Time Varying Controls - Medical & Health	No	Yes	Yes
State Time Varying Controls - Socioeconomics & Political	No	No	Yes

*Notes: Standard errors are clustered at the state year level. 4,725 observations. *$p < 0.10$, **$p < 0.05$,* and ***$p < 0.01$.

Table 11A: Additional Marginal Effects for the Logit Model, Model 3

Variable	Marginal Effect
Full Prescriptive (=1)	0.0319
standard error	0.0274
Limited Prescriptive (=1)	0.0062
standard error	0.0191
1996	0.1016***
standard error	0.0278
1998	0.0795***
standard error	0.0266
2000	0.0690***
standard error	0.0212
Year began practicing	-0.0132***
standard error	0.0015
Large Metro (= 1 if greater than 200,000)	-0.1047***
standard error	0.0192
Small Metro (= 1 if less than 200,000)	-0.1510***
standard error	0.0238
Medical Doctor (= 1 if MD, i.e. not DO)	-0.1777***
standard error	0.0219
US Graduate (= 1 if graduate from a US medical school)	-0.1167***
standard error	0.0126
Male (= 1 if male)	-0.0930***
standard error	0.0095
Year of Birth	0.0136***
standard error	0.0014
Full Owner (= 1 if full owner of practice)	0.0471***
standard error	0.0170
Part Owner (= 1 if part owner of a practice)	0.0031
standard error	0.0144
Solo Or 2 (= 1 if solo or 2 physician practice)	-0.1184***
standard error	0.0195
Group Practice (= 1 if group practice)	-0.0964***
standard error	0.0194
Group HMO Practice (= 1 if group HMO practice)	0.0514*
standard error	0.0288
Medical School Practice (= 1 if medical school practice)	-0.2622***
standard error	0.0137
Hospital Practice (= 1 if hospital practice)	-0.0240
standard error	0.0239
Net Income (inflation adjusted)	0.0000***
standard error	0.0000

Notes: Standard errors are clustered at the state year level. *$p < 0.10$, **$p < 0.05$, and ***$p < 0.01$.

Continued Table 11A: Additional Marginal Effects for the Logit Model, Model 3

Variable	Marginal Effect
Number of HMOs	-0.0015***
standard error	0.0006
HMO penetration rate	0.0012***
standard error	0.0006
Number physicians in state per 100k residents	0.0003
standard error	0.0005
Number nurses in state 100k residents	0.0000
standard error	0.0001
Indicates state grants some type of prescription rights to PAs	0.0241
standard error	0.0171
Average malpractice award (in thousands)	0.0000
standard error	0.0000
Number of state mandates	-0.0020
standard error	0.0013
Percent of residents reporting health status as good, very good or excellent	0.0028
standard error	0.0028
Percent of residents reporting any kind of health care coverage	-0.0041*
standard error	0.0024
Percent of residents reporting they have diabetes	0.0056
standard error	0.0051
Percent of residents reporting they smoke	0.0020
standard error	0.0026
Liberal Quotient for House Representatives	0.0648*
standard error	0.0345
Liberal Quotient for Senators	0.0535***
standard error	0.0208
Govern (= 1 if Democrat)	0.0104
standard error	0.0121
Maximum amount of Temporary Aid for Needy Families for family of 3	-0.0001
standard error	0.0001
Unemployment rate	-0.0006
standard error	0.0059
Logged total state personal income (in billions)	0.4263**
standard error	0.2114
Logged population level (in 100,000s)	-0.5091*
standard error	0.2660

Notes: Standard errors are clustered at the state year level. *$p < 0.10$, **$p < 0.05$, and ***$p < 0.01$.

Table 12A: Additional Marginal Effects for the Multinomial Logit Model, Model 3

	Internal	Family Practice	Pediatric	Specialist	Obstetric
Full Prescriptive (=1)	-0.0059	0.0435**	0.0258	-0.0589**	-0.0045
standard error	0.015	0.0208	0.0194	0.0263	0.0174
Limited Prescriptive (=1)	-0.0270**	0.0295**	0.0008	-0.017	0.0138
standard error	0.0109	0.013	0.0106	0.0166	0.0118
1996	0.1581***	0.1273**	-0.0362*	-0.2472***	-0.0021
standard error	0.0527	0.0552	0.0215	0.0625	0.0363
1998	0.1336***	0.0876**	-0.0334*	-0.1845***	-0.0032
standard error	0.0394	0.0374	0.0173	0.0486	0.0292
2000	0.0944***	0.0590***	-0.0302**	-0.1220***	-0.0012
standard error	0.0216	0.0217	0.0126	0.0303	0.0181
Year began practicing	-0.0014**	-0.0071***	-0.0044***	0.0144***	-0.0015**
standard error	0.0006	0.0013	0.00053	0.0016	0.0008
Large Metro (= 1 if greater than 200,000)	0.0066	-0.1114***	0.0195***	0.0756***	0.0097
standard error	0.0118	0.0175	0.0062	0.0184	0.008
Small Metro (= 1 if less than 200,000)	-0.0356**	-0.0911***	0.0112	0.0750***	0.0405**
standard error	0.0143	0.0109	0.0142	0.0237	0.0175
Medical Doctor (= 1 if MD, i.e. not DO)	0.0460***	-0.2600***	0.0421***	0.1638***	0.0081
standard error	0.0096	0.0203	0.0045	0.0236	0.0089
US Graduate (= 1 if graduate from a US medical school)	-0.0732***	-0.0037	-0.0328***	0.1019***	0.0078
standard error	0.007	0.0072	0.0066	0.0146	0.0064
Male (= 1 if male)	0.0067	-0.0024	-0.0952***	0.1811***	-0.0901***
standard error	0.0049	0.006	0.0055	0.012	0.0073
Year of Birth	0.0036***	0.0057***	0.0043***	-0.0144***	0.0008
standard error	0.0006	0.0013	0.00058	0.0016	0.0008
Full Owner (= 1 if full owner of practice)	0.0349***	0.0031	0.0102*	-0.0696***	0.0213**
standard error	0.0118	0.0098	0.0059	0.0176	0.0096
Part Owner (= 1 if part owner of a practice)	-0.0062	-0.0078	0.0189	-0.0091	0.0042
standard error	0.0077	0.0077	0.006	0.0158	0.0069
Solo Or 2 (= 1 if solo or 2 physician practice)	-0.0444***	-0.0414***	-0.0243***	0.0903***	0.0198
standard error	0.0106	0.0121	0.0066	0.0226	0.0126
Group Practice (= 1 if group practice)	-0.0242***	-0.0700***	0.0043	0.0758***	0.0142
standard error	0.0093	0.0098	0.0073	0.0216	0.0113
Group HMO Practice (= 1 if group HMO practice)	0.0535***	-0.0136	0.0198*	-0.0819***	0.0222
standard error	0.0153	0.0194	0.0103	0.0306	0.0172
Medical School Practice (= 1 if medical school practice)	-0.0836***	-0.1230***	-0.0408***	0.2578***	-0.0105
standard error	0.0061	0.0063	0.0052	0.02	0.0142
Hospital Practice (= 1 if hospital practice)	0.0035	-0.0195	-0.0017	0.0101	0.0077
standard error	0.0112	0.013	0.0077	0.0278	0.012
Net Income (inflation adjusted)	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
standard error	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: Standard errors are clustered at the state year level. *$p < 0.10$, **$p < 0.05$, and ***$p < 0.01$.

Continued Table 12A: Additional Marginal Effects for the Multinomial Logit Model, Model 3

	Internal	Family Practice	Pediatric	Specialist	Obstetric
Number of HMOs	-0.0006*	-0.0008**	0.0000	0.0013**	0.0001
standard error	0.0003	0.0003	0.0002	0.0005	0.0003
HMO enrollment rate	0.0002	0.0006	0.0004	-0.0005	-0.0006*
standard error	0.0003	0.0004	0.0003	0.0006	0.0003
Number physicians in state per 100k residents	-0.0008**	0.0001	0.0001	0.0002	0.0004
standard error	0.0004	0.0004	0.0003	0.0006	0.0004
Number nurses in state 100k residents	0.0000	0.0000	0.0000	0.0000	0.0000
standard error	0.0001	0.0001	0.0001	0.0001	0.0001
Indicates state grants some type of prescription rights to PAs	0.0176**	0.0132	-0.0204**	0.0013	-0.0117
standard error	0.0085	0.0105	0.0084	0.0179	0.0103
Average malpractice award (in thousands)	0.0000	0.0000	0.0000	0.0000*	0.0000***
standard error	0.0000	0.0000	0.0000	0.0000	0.0000
Number of state mandates	-0.0006	0.0006	-0.0011**	0.0011	0.0000
standard error	0.0007	0.0008	0.0005	0.0012	0.0007
Percent of residents reporting health status as good, very good or excellent	0.0015	0.0041**	-0.0002	-0.0046*	-0.0009
standard error	0.0016	0.0017	0.0014	0.0026	0.0017
Percent of residents reporting any kind of health care coverage	-0.0054***	-0.0035***	0.0014	0.0082***	-0.0008
standard error	0.0013	0.0013	0.0013	0.0022	0.0017
Percent of residents reporting they have diabetes	-0.0064**	0.0054*	0.0051***	-0.0129**	0.0087**
standard error	0.0027	0.0032	0.0020	0.0056	0.0035
Percent of residents reporting they smoke	0.0021	0.0002	0.0001	-0.0010	-0.0013
standard error	0.0015	0.0016	0.0011	0.0026	0.0018
Liberal Quotient for House Representatives	0.0056	0.0672***	-0.0175	-0.0619	0.0066
standard error	0.0293	0.0221	0.0167	0.0421	0.0322
Liberal Quotient for Senators	0.0206	0.0148	0.0044	-0.0199	-0.0199
standard error	0.0126	0.0132	0.0089	0.0198	0.0149
Govern (= 1 if Democrat)	0.0088**	0.0007	-0.0056	-0.0036	-0.0003
standard error	0.0044	0.0073	0.0043	0.0101	0.0041
Maximum amount of Temporary Aid for Needy Families for family of 3	0.0000	0.0000	-0.0001**	0.0001	0.0000
standard error	0.0001	0.0001	0.0001	0.0001	0.0001
Unemployment rate	0.0077*	0.0043	-0.0054	-0.0050	-0.0016
standard error	0.0045	0.0042	0.0033	0.0072	0.0037
Logged total state personal income (in billions)	0.3693***	0.2090	-0.0755	-0.4583**	-0.0446
standard error	0.1175	0.1556	0.0829	0.2192	0.1396
Logged population level (in 100,000s)	-0.2128	-0.2883	-0.1039	0.5198*	0.0852
standard error	0.1468	0.2020	0.1015	0.2743	0.1726

Notes: Standard errors are clustered at the state year level. *$p < 0.10$, **$p < 0.05$, and ***$p < 0.01$.