HEALTH CARE COSTS AND BARRIERS TO ENTRY: DO LABOR MARKET REGULATIONS FOR NURSING HAVE A RELATIONSHIP WITH STATE-LEVEL HEALTH CARE COSTS?

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By

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ABSTRACT

U.S. healthcare costs are rising at an alarming rate. While this paper mentions healthcare market effects, the focus of this paper is on the supply side, specifically regulations that affect the number of healthcare staff. Currently, the United States has many variations in state nursing regulations. Through licensing procedures, the states control the supply of nurses; this may influence healthcare costs. The hypothesis is that states with more restrictive licensing requirements for nurses have higher healthcare costs as a percentage of the state’s GDP compared to states that allow full authority and scope of practice. Current trends show states restricting nursing authority to practice within a physician-nurse framework tend to have higher health care costs than states not confining nursing authority to practice independently. However, regression analysis yields inconclusive results that do not fully support this hypothesis, which may be due to omitted variable bias. There needs to be further research with additional variables and observations concerning what may affect income with health care costs and nursing regulations.
ACKNOWLEDGEMENTS

To my parents, friends, and professors.

Thank you so much,

Prakesha Mathur
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INTRODUCTION

Rising healthcare costs are a global problem. Huber and Orosz (2003) confirmed that almost all the major Organization for Economic Cooperation and Development (OECD) countries had increased Health Care Expenditures from 1970 to 2017 (see Figure 1.), but this trend is especially true for the United States. They propose that this is due to some common factors such as public expectations, population growth, and health-positive technological change; however, this may not explain the drastic increase for the United States.

![Figure 1](image)

**Figure 1** Total Healthcare Spending as % of GDP per Country: 1970 to 2017 (OECD, 2018)

Figure 1 shows the United States as having clear rising long-term healthcare costs. In 1970, most OECD countries spent between 2.21% and 6.61% of their GDP, increasing from 3.43% to 12.26% of their GDP by 2017. Meanwhile, U.S. healthcare costs have been moving steadily upward from 6.23% (already in the higher end of the 1970s) to now over 17% of their GDP; this appears to be an outlier concerning the
general range of the other OECD countries. Almost 11 percentage point increase indicates a higher and
sharper uptrend than in other countries; Fruits (2008), moreover, states that this increase may surpass the
rate of inflation. High healthcare costs can have a widespread impact because budget allocation affects
virtually all policies. If the government is spending disproportionately more on healthcare, it becomes
harder to support other important initiatives, such as education and security.

Although there are several reasons behind rising U.S. healthcare cost, this paper will focus on the
role of nurses. Specifically, does state regulation of nurses play a part in increasing cost? For example,
currently, there is variation between states on the scope of practice (SOP) for nurses. With physicians
earning a lot more than nurses, the U.S. healthcare system needs to allow greater SOP or authority for
nurses. There is compelling evidence that including more nurses do not lower healthcare quality; on the
contrary, nurse practitioners, in states that allow full authority, provide an equal or higher level of care
and assessments as physicians (Huang, 2015).

For example, Massachusetts could save anywhere from $4.2 up to $8.4 billion over ten years if
they allowed nurse practitioners unrestricted access to their roles, according to Eibner, Hussey, Ridgely,
and McGlynn (2009). Snodgrass (2017) showed that despite having both physicians and nurse
practitioners at Native American reservations, nurses’ end up being more productive by providing more
services at a lower cost. Rural Alaska is an example of a low-density population that has limited access
to health. Alaska has to rely mainly on nurse practitioners (Chan, 2017). Chan, who commented on
nurses having lower costs, continues that Native American reservations have continued to count on
nurses as they were historically more readily available. The government could help the healthcare
systems become more cost-effective by standardizing state-by-state regulations to allow nurses the full
authority to practice according to their title. Despite having nationally standardized education and
certification, nurses have to navigate state-specific restrictions when they move across states. The state-
by-state nursing regulations could also encourage relocation and lead to higher local costs due to limited nurses in some states. In summary, relying more on qualified, and more authoritative, nurses may help lower healthcare costs.

Figure 2 Spending Per Year vs. Nursing Scope of Practice by State: 1999 to 2014

Figure 2, above, shows the SOP for each state (full authority versus restricted authority) and the healthcare costs per GDP from 1999 to 2014, illustrating the average healthcare cost is increasing over time. The figure shows that the states with full SOP (blue) authority tend to keep healthcare cost down;
that is, they spend a lower share of GDP than the states with limited SOP authority (orange). However, there are controls for important factors that this paper will cover using regression results.

**Literature Review**

*Demand-side factors*

The U.S. healthcare system whereby employers cover their workers is somewhat unique among OECD countries. Most countries have a government-funded system. In the post-world war II era, companies in America were desperate to attract workers, so the employment contract included healthcare coverage through a third-party payer system (Fruits, 2008). However, after some years, the federal government started paying for the elderly (Medicare) and sponsoring the poor (Medicaid) for healthcare access. Overall costs have ballooned. There are several factors account for this upward trend, such as increasing aging population, personal income, medical visits, productivity, and technological change (Fruits, 2008; Newhouse, 1992; Schneider & Guralnik, 1990). Newhouse (1992) estimates that the income-healthcare demand relationship is stable whereby personal income growth could explain 35 to 70 percent of the expenditure increase in healthcare. More prosperous states may spend more on healthcare. GDP per capita will be included as a control variable, using spending as both a percentage of GDP and GDP per capita in terms of purchasing power parity (PPP; Gupta, Verhoeven, & Tiongson, 2000) to account for prosperity differences with the different states.

On the other hand, the trend since 1970 has been fewer patients but more frequent visits. Newhouse (1992) argued that physicians have increased “defensive medicine,” or use of unnecessary checks and processes resulting in patients coming back more often. That is, fewer patients seek medical help but in turn, they have more office visits.
Baumol (1988) states that there have been more services, productivity increase, of over 1,000 percent in the U.S. healthcare industry. If the medical service prices keep in line with the remaining economy, then there will be an increase in medical costs. Even though expenditures concerning technology only appear as incrementally rising, usually there are still high start-up costs billed to insurance payouts (Fruits, 2008). Even with technology advancing at a slower rate, Bodenheimer (2005) argues that technology in countries with systems with tight financial constraints (e.g., Canada and HMOs) can still increase costs slowly. This cost increase could be because while we know technology can aid in care and treatment, there is little evidence evaluating the benefits of more effective but expensive services as sufficient for increasing costs (Orszag & Ellis, 2007).

A study by Martin, Hartman, Washington, Catlin, and National Health Expenditure Accounts Team (2016) cites increased private health care spending on hospital, specifically on medical professional staff services, as primary factors driving the fast growth in total healthcare spending. In 2017, Dieleman also looked at other general factors contributing to the increased health care spending, noting a positive correlation with population and aging. He argued that service point and intensity (more spending per level of service) correlates with more than 50% of the increase in health care spending between 1996 and 2013.

Kim, Tanner, Foster, and Kim (2015) added that patients appear as the most responsible for increasing costs with their lifestyle choices, more-so than societal factors, such as health care providers, pharmaceutical companies, and inefficient governments. Individual responsibility dovetails with Dieleman (2016) who focused on spending by disease category and found that the highest expenses were for diabetes, a form of heart disease, and pain in neck and lower back. Given the strong individualism in U.S. political structure, it would make sense to focus on the
individuals. As such, Kim et al. (2015) consider making societal changes to the government or providers as unpopular or too drastic. Longden, Wong, Haywood, Hall, and van Gool (2018) found that pharmaceuticals were more likely to be the highest cost for healthcare for patients who did not have high healthcare costs over consecutive years. Longden et al. (2018) saw hospital treatment contributing to high charges for patients over many years.

To view healthcare costs consistently through the states, Kaiser Foundation, a small insurance network, compiles national data on healthcare. As the U.S. Federal Government primarily funds Medicare and Medicaid¹, states have the option of expanding Medicaid with more specific regulations of their own, affecting their state spending. However, as Medicare and Medicaid are price agreements between the U.S. government and the local healthcare market, the Federal and State governments end up paying a lot more than if the government could determine the prices on their own as the sole insurance provider (Hussey & Anderson, 2003; Orszag & Ellis, 2007). As U.S. prices are rapidly increasing, one can look at the effects of competition by evaluating state variation in regulations, notably when a state may have expanded to include Medicaid something that might be related to both nursing regulations and healthcare costs (Advisory Board, 2018).

Supply-side factors

A less obvious, but potentially important factor influencing cost is the availability of nurses. Many studies argue that advanced primary care nurses can mean high patient satisfaction while providing safe and effective care (Bauer, 2018; Bonsall & Cheater, 2008; Hansen-Turton, Ware, & McClellan, 2009; Brooten et al., 2002; Callaghan, 2008; Martin-Misener et al., 2015). They also

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¹ According to Department of Health and Human Services (2015), Medicare is federally-provided insurance that uses trust funds serving people over 65 and younger patients who may be disabled or going through dialysis. Patients still have to pay part of the costs through deductibles and monthly premiums. Medicaid is a federal-state program for people with low-to-no income where the patients pay little or no payment and it varies state to state. For more information, please see https://www.hhs.gov/answers/medicare-and-medicaid/what-is-the-difference-between-medicare-medicaid/index.html
conclude that nurses enhance communication and best practice while facilitating patients (Williamson, Twelvetree, Thompson, & Beaver, 2012). They also increase appointment availability for Medicaid patients (Richards & Polsky, 2016). In exceptional cases, having more nurses also means lower cost in managing chronic care patients (Lutfiyya, 2017) and equal or better productivity on Navajo reservations (Snodgrass, 2017). With more than 70% of general medical practitioners surveyed, including doctors and nurses, general medical practitioners were receptive to the growth of an advanced nurse practitioner service within emergency units (Griffin & Melby, 2006).

However, using the title Advanced Primary Care Nurses (APCN; Bonsall & Cheater, 2008), an umbrella term for all advanced nursing practice roles (e.g., nurse practitioner, advanced nurse practitioner) can cause some confusion. Some barriers to advanced nursing practice, described by Jones (2005) and supported by both Bryant & Lukosius and Pinelli, J. (2004) and Gardner, G., Chang, A., and Duffield (2007), include relationships with other health professionals and role ambiguity. According to Lowe, Plummer, O’Brien, and Boyd (2012), title standards, and SOP for advanced nurses require better role definitions. Unclear roles can correlate with the variance in state professional protocols. Gittleman (2018) argues that the occupational regulations refer to having an “exclusive right to a title” where it is illegal to practice without meeting those requirements. There are better employment benefits correlated with more SOP and licensing, such as higher salary and retirement plans (Gittleman, Klee, & Kleiner, 2018). Currently, state statutes (Ritter & Hensen-Turton, 2007) govern prescription authority for nurse practitioners because licensing nurses essentially control their supply in the labor market.
Inefficiencies can lead to variation in regulations at the state level. The focus here will be on government regulations affecting the medical labor market, specifically the market supply of nurses, as a possible contributor towards rising physician and clinical services prices. These labor regulations, under state legislatures’ authority, help local governments carry out public policy to ensure high quality, low-cost patient care. However, regulations can lead to higher prices (Biscourp, 2013; Cette, Lopez, & Mairesse, 2016). When it comes to health policy, they can also affect quality. The government should remove unwarranted restrictions and standardize state nursing laws to maximize the quality of care (Naylor & Kurtzman, 2010). Other studies agree that to develop a policy system that is more sustainable; nurses should have full autonomy to function as nurses without required supervision from or agreement with physicians (Chan, 2017; Furlong & Smith, 2005; Pohl, Hanson, Newland, & Cronenwett, 2010). Kleiner, Marier, Park, and Wing (2016) found that with less restrictive regulations for nurse practitioners, they were able to perform more wellness check-ups for children. Less obstructive regulations decreased the price parents paid by 3-16 percent while wages for doctors increased. Richards and Polsky (2016) also found lower prices for office visits and Medicaid patients when there were more non-physician clinicians in states that have granted full practice autonomy. Peterson (2017) found slightly different results with a correlation between full prescriptive authority and higher fees for office visits but lower fees for acute coronary syndrome-related emergency visits. In the case of health policy, this can mean a range of SOP for nurses from having no authority to full authority to act like their title roles.

Another important caregiving concept is a team approach. As there is evidence that teams do better than single nurses and physicians (Crawford & Price, 2003), Virginia’s law on a joint patient-care team, of one physician and four-to-six nurse practitioners, is seen as one of the best state models (Iglehart, 2013). Both the Boards of Nursing and Medicine in Virginia developed this team. However,
while doctors and nurses may agree on identification, having such groups can create tension with incompatible authority on the level of consultation and outcomes, limiting the impact of APCN services (Bonsall & Cheater, 2008). Kleiner et al. (2016) also found that as nurse practitioners worked more and doctors earned more, the ability to provide patient care would decline for nurse practitioners.

Nevertheless, patient care teams allow more flexibility than entirely restricting nurses, as there can be liability concerns. Hansen-Turton, Ware, and McClellan (2009) argue that nurses are less likely to be accused of medical malpractice. They conclude that there should be more nurses to provide better access to health care with more medical providers. However, the American Medical Association and College of Physicians want to avoid increased competition (Chan, 2017; Naylor & Kurtzman, 2010). This increased competition fear may be valid. Kleiner et al. found that as nurse wages went up, there was compensation for the extra loss by having the physicians’ wages go down. There should be a comparison of the number of physicians and nurses per capita in each state to examine the income effects of the rising costs of physicians and how such costs decrease demand (Newhouse, 1992). Substitution can be for services provided (e.g., physicians duties fulfilled by nurse practitioners) which can return sufficient savings (Eibner et al., 2009; Rouse & Serban, 2014). These income and substitution effects would help illustrate regulation variation. However, this paper will not examine these comparisons.

Many studies evaluate the causes of rising healthcare costs in the United States from the demand side. Bryan, Rhoads, and Graboyes (2016) have been looking at each state’s laws and regulations to understand better how they raise quality and cost, in addition to rising insurance costs. However, there is little research on how states manage healthcare costs by looking at labor market licensing reform. This paper will fill that gap.
METHODOLOGY

Hypothesis

In the United States, states regulate the requirements for doctors and nurses to practice medicine. Mandatory requirements for nurses may change the price of healthcare costs. The hypothesis is that labor market entry regulations at the state-level in the nursing field are positively related to health care costs in that state, as a percent of GDP.

Model

An Ordinary Least Squares (OLS) and Random Effects Model (RE) are used with a cross-section/time series data (Kleiner et al.) to evaluate the effects of ACNP scope of practice regulations on healthcare cost. The F-Test suggested that Pooled Least Squares (OLS) may be more appropriate than Fixed Effects. However, as there may be state-dependent results, Fixed Effects and Random Effects are still considered. There is no Heteroscedasticity or variability of the spending being unequal across the range of values of the authority level. A scatterplot of the residuals created an equal spread. The Breusch-Pagan / Cook-Weisberg test for heteroscedasticity confirmed what the scatterplot indicated.

When testing for FE or RE per the Hausman test, RE was preferred. The RE model is a particular case of a Fixed Effects (FE) model whereby when surveying states of their laws on allowing nurses, the states that have such a law may be random. However, random-effects do not control for state-specific variables that are not consistent over time or time-specific variables that are not consistent through the states. All the diagnostics are in the Appendix A: Diagnostic Tests.

The model includes relevant variables per the literature that can affect healthcare costs that vary over time over the states. They include state population (which the spending per capita variable considers) as well as the supply of nurses, expansion of Medicaid, and percentage of the retired
population accounting for individuals that are 65 or older. The dependent variable is the healthcare cost observed in state \(s\) at time \(t\) as a percent of state GDP.

The model used for this analysis is as follows:

\[
\text{SpendingPercentage}_{st} = \alpha_s + B_1\text{Auth}_{st} + B_2\text{NumOfNurses}_{st} + B_3\text{GDPPerCapita}_{st} + \epsilon
\]

Below are the variable definitions, predicted relationships, and sources.

**Table 1 Regression variables with predictions**

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Definition</th>
<th>Predicted Relationship</th>
<th>Previous Studies</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>SpendingPercentage</td>
<td>Healthcare costs per state (s) at time (t), as a percent of state GDP</td>
<td>N/A</td>
<td>N/A</td>
<td>Kaiser Foundation and Bureau of Economic Analysis from 1991 to 2014.</td>
</tr>
<tr>
<td>Auth</td>
<td>A dummy variable indicating if the state allows full SOP (1 if there is some restriction) for state (s) at time (t)</td>
<td>Negative: States allowing full SOP will likely have lower spending</td>
<td>Hypothesis</td>
<td>Nurse Practitioner Journal from 1999 to 2016</td>
</tr>
<tr>
<td>NumOfNurses</td>
<td>number of nurse practitioners per state at year (t)</td>
<td>Negative: More nurse practitioners would be associated with lower cost</td>
<td>Lutfiyya, 2017</td>
<td>Bureau of Labor Statistics only had this data, on Nurse Practitioners, after 2012</td>
</tr>
<tr>
<td>GDPPerCapita</td>
<td>GDP per Capita per state (s)</td>
<td>Positive: Wealthier states spend more on healthcare.</td>
<td>Gupta, Verhoeven, and Tiongson, 2002; Newhouse. 1992</td>
<td>GDP is from the Bureau of Economic Analysis, while population is from the U. S. Census for 2010 - 2014</td>
</tr>
</tbody>
</table>
Data

Data for this analysis come from several sources. Total healthcare costs per state are available from the Kaiser Foundation that compiled Healthcare Costs. Kaiser Foundation also had population information for those above 65 years of age, which we define as the percentage of retired population per state. The Bureau of Labor Statistics has the most current information on the total number of physicians and nurse practitioners per state. State GDP information is from the Bureau of Economic Analysis, and population data is from the U. S. Census. The annual state-specific nursing Scope of Practice (SOP), as the authority variable, is from the Nurse Practitioner Journal. While there are over 1000 observations for the scope of practice for states over several years, the limiting variable is the Medicaid Expansion as there are only 152 observations for three years of data, 2014 to 2016.

RESULTS

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>mean</th>
<th>OLS</th>
<th>OLS1</th>
<th>Full OLS</th>
<th>FE</th>
<th>RE</th>
<th>RE1</th>
<th>Full RE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auth</td>
<td>0.280</td>
<td>-0.0102***</td>
<td>-0.0154**</td>
<td>-0.0156***</td>
<td>-0.0156***</td>
<td>-0.00481***</td>
<td>-4.48e-05</td>
<td>-0.000335</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-4.146)</td>
<td>(-2.596)</td>
<td>(-2.792)</td>
<td>(-2.770)</td>
<td>(-2.986)</td>
<td>(-0.0236)</td>
<td>(-0.210)</td>
</tr>
<tr>
<td>NumOfNurses</td>
<td>2,461</td>
<td>-3.80e-06***</td>
<td>-3.80e-06***</td>
<td>(-3.974)</td>
<td>(-4.007)</td>
<td>-2.25e-06**</td>
<td>-1.45e-06</td>
<td>(-1.452)</td>
</tr>
<tr>
<td>GDPPerCapita</td>
<td>0.00779</td>
<td>0.469</td>
<td>(0.158)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13.06***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(6.279)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.123***</td>
<td>0.170***</td>
<td>0.166***</td>
<td>0.166***</td>
<td>0.122***</td>
<td>0.161***</td>
<td>0.0575***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(38.91)</td>
<td>(31.45)</td>
<td>(7.198)</td>
<td>(9.949)</td>
<td>(31.04)</td>
<td>(33.11)</td>
<td>(3.348)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>816</td>
<td>153</td>
<td>153</td>
<td>153</td>
<td>816</td>
<td>153</td>
<td>153</td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>0.182</td>
<td>0.075</td>
<td>0.076</td>
<td>0.076</td>
<td>0.724</td>
<td>0.187</td>
<td>0.495</td>
<td></td>
</tr>
</tbody>
</table>

There are many states (72%), on average that restrict or reduce the nursing scope of practice, showing that it is more common to restrict than to allow full rights. Twenty-one states changed their
SOP regulations on nurses to full scope. The average healthcare cost across the states is around 14 percent of the state’s GDP, with the average GDP per capita being 0.7 percent.

The results do not fully support that healthcare spending and giving nurses more authority are negatively related. With 50% of the variation explained in the limited sample of 153 observations, there was not a significant relationship between healthcare costs and scope of practice for the states at 90% confidence. However, GDP per capita was significant with 99% confidence. For every percentage increase GDP per Individual, there is a 130% increase in spending per GDP, holding everything else constant in the model. The income effect was in line with what Gupta, Verhoeven, and Tiongson (2002), and Newhouse (1992) studied. Similarly, when looking at the pooled OLS regression, the number of nurses were negatively correlated with healthcare spending as a function of GDP per state, similar to Lutfiyya (2017) findings. The Scope of Authority was significant with a negative correlation, as predicted until the random effects models added controls for Number of Nurses and GDP Per Capita.

Model Specification

In the process of adding variables and figuring out which model to use, there were instances of multicollinearity. Such as, there was a correlation between Number of Nurses and Number of Physicians, so both would not be beneficial in the same model. Also, the Linktest showed the model was specified adequately until the regressions had Number of Nurses added; then the Ramsey Reset test passed for minimizing omitted variable bias.

Recommendations

Governments are to carry out public policy that ensures quality care and low costs. Here, despite it not being conclusive to the hypothesis, the policy recommendation is to look at further
research as to what can increase both the number of nurses and healthcare costs per state and try to be more consistent throughout the states to decrease variation. The decrease in variation will have fewer states with extremely high and low costs and try to decrease the average national cost. Furthermore, consistency would allow for better, more targeted resources within each state. Uniformity between state regulations would allow for states to support education and security more independently while the federal government tries to stabilize healthcare costs as the leading nation in spending.

With the significance and the direction of the primary variable changing with the addition of the number of nurses, there may be a need for further research as there may be other variables that have a relationship with both healthcare costs and nursing regulations. One theory could be environmental factors or welfare subsidies that affect both the cost and number of nurses. Another theory, concerning the model, could be that there may be more economical or persistent effects that a dynamic panel model would have been more accurate or contain variables that are exogenous, as in may affect healthcare costs without being affected by healthcare costs. A dynamic panel model would assume that there are panel-specific effects, there can be further controls, and the model could have included a lag to remove or account for any panel- or auto-correlation. This kind of model adjustment would measure the relationship between a current value of a variable and another year. For example, if the GDP of a state affects the spending of another state, then there is inter-correlation because there is annual data comparison.

Furthermore, as there are exogenous variables, such as income that may affect healthcare costs but may not be affected by healthcare costs, other instrumental variables, or proxy variables, could be added to evaluate further variables that may not be as accessible as a time-series. Finally, for any other issues with the residuals, it may be beneficial to either scale or taking the log of the variables. There
were attempts made for interaction or scaling, but those models still had issues with diagnostic testing. Please see

Appendix B: Other Regressions for the results of these regressions.

As there is a shortage of physicians, there should be an evaluation on the growing use of nurses nationally and internationally. The literature review shows that nurses more than make up for the shortage of physicians even though they are not clear substitutes. On the other hand, there is more liability with physicians and potential for wage loss; they get more malpractice lawsuits than nurses (Hansen-Turton, Ware, and McClellan, 2009) and there may be lowered salaries for physicians as compensation for employing more nurses (Kleiner et al., 2016). Thus, once the SOP is more standardized nationally or closer to the role definition, it would be easier to argue for less role ambiguity internationally as well. There also needs to be more research on international health practitioner efforts and regional wars raising costs.

Once CMS releases spending data for the last five years, after 2014, it would be beneficial to look at healthcare costs by comparing the average change for nearby states for states that have different regulations, or for adjacent counties for a state that changed the SOP for nurses, between 2014 and 2015. The latter could help show more geographic (urban versus rural) effects that may not be present at the state level through county comparison. Future studies can also elaborate on the former example by comparing Physicians’ offices’ density to see restricted medical access.
**APPENDIX A: DIAGNOSTIC TESTS**

The following image shows the correlation matrix indicating high multicollinearity issues with Number of Nurses and Number of Physicians.

```
.pwcorr, star(.05)
(State ignored because string variable)
(FullAuthority ignored because string variable)
(MedicaidExpansion ignored because string variable)

<table>
<thead>
<tr>
<th></th>
<th>Year</th>
<th>NumOfIN's</th>
<th>NumOff's</th>
<th>Spendi~e</th>
<th>GDPFe<del>r</del>e</th>
<th>Retire~c</th>
<th>Statel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>1</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NumOfNurses</td>
<td>0.1294*</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NumOfPhysi~s</td>
<td>0.0286</td>
<td>0.8984*</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SpendingPe~e</td>
<td>0.4947*</td>
<td>-0.1603*</td>
<td>-0.1768*</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDPPerCapita</td>
<td>0.2871*</td>
<td>-0.0613</td>
<td>0.0080</td>
<td>-0.0013</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RetiredAge~c</td>
<td>0.4724*</td>
<td>-0.0317</td>
<td>-0.0372</td>
<td>0.6293*</td>
<td>0.2310*</td>
<td>1.0000</td>
<td></td>
</tr>
<tr>
<td>Statel</td>
<td>0.0000</td>
<td>-0.0444</td>
<td>-0.0088</td>
<td>0.1576*</td>
<td>-0.0078</td>
<td>0.0738</td>
<td>1.0000</td>
</tr>
<tr>
<td>Auth</td>
<td>0.0610</td>
<td>-0.4214*</td>
<td>-0.3494*</td>
<td>-0.1207*</td>
<td>0.1051</td>
<td>-0.0750</td>
<td>0.0356</td>
</tr>
<tr>
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<td>-0.0257</td>
<td>0.0588</td>
<td>-0.2318</td>
<td>0.3656*</td>
<td>0.0283</td>
<td>-0.1119</td>
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</table>

<table>
<thead>
<tr>
<th></th>
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<th>ExpMed~d</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>ExpMedicaid</td>
<td>0.2517*</td>
<td>1.0000</td>
</tr>
</tbody>
</table>
```

The regressions only use one of the numbers of medical professional variables as there was multicollinearity between the number of nurses and physicians.

**Breusch-Pagan / Cook-Weisberg test for heteroskedasticity**

\[ \text{Ho: Constant variance} \]

Variables: fitted values of SpendingPercentage

\[
\begin{align*}
\text{chisq}(1) &= 1.09 \\
\text{Prob > chi2} &= 0.2960
\end{align*}
\]

When it comes to a standard OLS, Spending Per GDP = B*Auth + Constant, model, The Breusch-Pagen test above shows that there was no heteroscedasticity. The link test below shows the model was specified correctly.
However, as there were a limited number of variables (there was only an independent and dependent variable) in the initial model, the omitted variable bias test could not run.

Including Number of Nurses still had a similar Linktest but the omitted variable bias test improved.

**Ramsey RESET test using powers of the fitted values of SpendingPercentage**

Ho: model has no omitted variables

F(3, 145) = 0.19
Prob > F = 0.9031

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of obs = 153</th>
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<tbody>
<tr>
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<td>2</td>
<td>0.005577691</td>
<td>F(2, 150) = 6.35</td>
</tr>
<tr>
<td>Residual</td>
<td>0.131741266</td>
<td>150</td>
<td>0.000870275</td>
<td>Prob &gt; F = 0.0023</td>
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<tr>
<td>Total</td>
<td>0.142896648</td>
<td>152</td>
<td>0.000940111</td>
<td>R-squared = 0.0781</td>
</tr>
<tr>
<td>Adj R-squared = 0.0658</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root MSE = 0.02964</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| SpendingPer-e | Coef.    | Std. Err. | t       | P>|t|       | [95% Conf. Interval] |
|---------------|----------|-----------|---------|-----------|---------------------|
| _hat          | 6.064351 | 7.615266  | 0.80    | 0.427     | -8.982694 to 21.1114 |
| _hat sq       | -16.36411 | 24.5894  | -0.67   | 0.507     | -64.95043 to 32.2222 |
| _cons         | -0.3906025 | 0.5886482 | -0.66   | 0.508     | -1.553716 to 0.7725106 |
Adding GDP per Capita for evaluating income effects also had similar Linktest and Ramsey Reset tests as when initially adding Number of Nurses.

**Ramsey RESET test using powers of the fitted values of SpendingPercentage**

| Ho: model has no omitted variables | F(3, 144) = 0.28 | Prob > F = 0.8399 |

<table>
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<tr>
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<th>MS</th>
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<td>.0055587558</td>
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<tr>
<td>Residual</td>
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<td>150</td>
<td>.000878144</td>
<td>Prob &gt; F = 0.0022</td>
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<tr>
<td>Total</td>
<td>0.142896649</td>
<td>152</td>
<td>.00094011</td>
<td>R-squared = 0.0782</td>
</tr>
</tbody>
</table>

| Adj R-squared = 0.0659 | Root MSE = .02963 |

| SpendingPe-e | Coef.   | Std. Err. | t      | P>|t| | [95% Conf. Interval] |
|--------------|---------|-----------|--------|------|----------------------|
| _hat         | 5.909284 | 7.662269  | 0.77  | 0.442 | -9.230635 21.0492 |
| _hatsq       | -15.86199| 24.73981 | -0.64 | 0.522 | -64.74552 33.02154|
| _cons        | -.3786637| .5922925  | -0.64 | 0.524 | -1.548978 .7916503|

**Tests for the most appropriate model**

The Hausman test shows that OLS may be more appropriate, as we fail to reject the null hypothesis that the preferred model is fixed. The Hausman test results indicated that OLS is more appropriate than Fixed-Effects.

**Test: Ho: difference in coefficients not systematic**

\[
\text{chi2}(16) = (b-B)'[(V_b-V_B)^{-1}](b-B)
\]

\[
= 15.47
\]

\[
\text{Prob}>\text{chi2} = 0.4908
\]

We do reject the null hypothesis that the coefficients for all years are jointly equal to zero, so we should add in time fixed-effects.
Then there was a test to see if Random Effects or Fixed Effects is a more appropriate model for the panel data. The results showed that Random Effects might be more appropriate, rejecting the null. Using an OLS regression might not account for the differences across years and states.

Breusch and Pagan Lagrangian multiplier test for random effects

\[
\text{SpendingPercentage}_{\text{State1,t}} = Xb + u_{\text{State1}} + e_{\text{State1,t}}
\]

Estimated results:

<table>
<thead>
<tr>
<th>Var</th>
<th>sd = sqrt(Var)</th>
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</thead>
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<td>Spendin-c</td>
<td>0.006919</td>
</tr>
<tr>
<td>e</td>
<td>0.000609</td>
</tr>
<tr>
<td>u</td>
<td>0.0007186</td>
</tr>
</tbody>
</table>

Test: \ Var(u) = 0
\[
\text{chibar2 (OL)} = 5173.14 \\
\text{Prob > chibar2} = 0.0000
\]

Another Hausman test confirms that RE may be more appropriate, as we fail to reject the null hypothesis that the preferred model is Random Effects.

Test: Ho: difference in coefficients not systematic
\[
\text{chisq (16)} = (b-B)'[(V_b-V_B)^{-1}](b-B) = 0.49 \\
\text{Prob>chisq} = 1.0000
\]
## APPENDIX B: OTHER REGRESSIONS

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<th>VARIABLES</th>
<th>mean</th>
<th>OLS1</th>
<th>OLSX</th>
<th>OLSY</th>
<th>OLSZ</th>
<th>OLS3</th>
<th>OLS4</th>
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<th>RE1</th>
<th>RE2</th>
<th>RE3</th>
<th>RE4</th>
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<td>-0.0104</td>
<td>-0.00465</td>
<td>-0.0112***</td>
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<td>-0.00790</td>
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<td>(-1.294)</td>
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<td>NurseGDPPerCapita</td>
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<td></td>
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<td>(0.939)</td>
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</table>
REFERENCES


