**The Effect of State Loan Repayment Programs on the Number of Rural Physicians and Health Outcomes**

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**Abstract**

This paper examines if student loan repayment programs for physicians lead to greater numbers of physicians in rural areas in addition to improved health outcomes. The programs were categorized by funding source as either federal/state or state funded. I measured the impact of the programs using a two-way fixed effects regression model with county and time fixed effects. Specifically, I measured the impact of the programs on the number of physicians, number of primary care physicians, rate of preventable hospital stays, and the death rate. Both the federal/state and state funded programs led to percentage increases in the number of physicians and number of primary care physicians in rural areas. Additionally, both programs resulted in decreases in the number of preventable hospital stays and the death rate. However, I found that the federal/state funded programs were more effective than the entirely state funded programs in rural areas.

**Introduction**

Rural areas have long faced barriers to healthcare services which has led to adverse health outcomes and higher mortality rates for rural Americans. Compared to residents in urban areas, those in rural areas are 50% more likely to die from unintentional injuries (Centers for Disease Control and Prevention [CDC], 2017). Generally, those who reside in rural areas of the United States are older and in worse health. While 15% of the U.S. population lives in rural America, they are more likely to die from heart disease, cancer, chronic respiratory disease, and stroke relative to their urban counterparts (CDC, 2017). Given the health disparities faced by those in rural areas, my paper examines if student loan repayment programs for physicians work as intended by increasing the number of physicians and improving health outcomes.

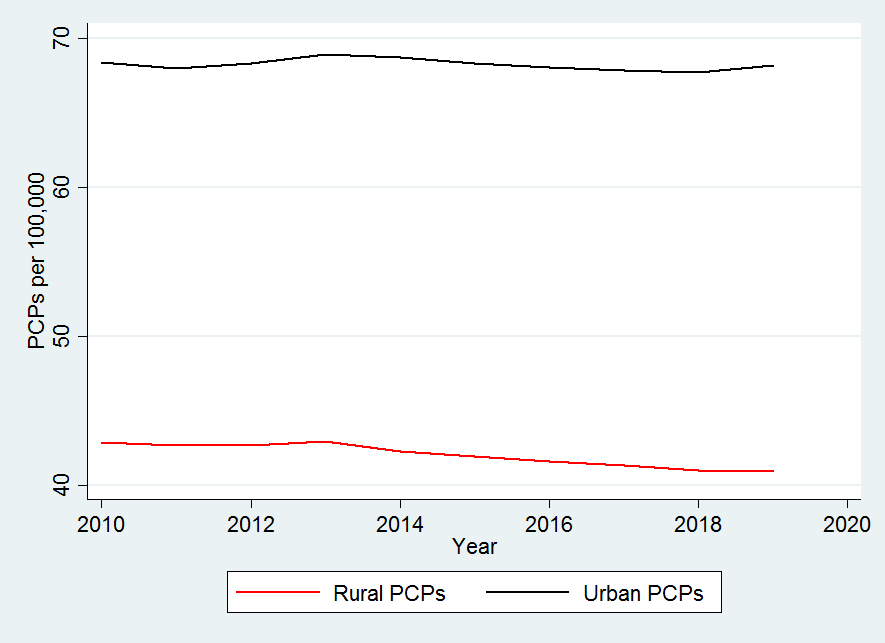
Due to the gaps in the literature, I seek to explore if these student loan repayment programs improve rural access by increasing the number of physicians. An increased supply of physicians should allow those in rural areas to receive more services, and therefore lead to improved health outcomes. Since many of these programs seek to expand access to preventive services in rural areas, the programs should be more impactful on primary care physicians as opposed to physicians more broadly. Moreover, increased access to healthcare services should result in fewer preventable hospital stays and fewer mortalities. Ultimately, I hypothesize that the effect of the loan repayment programs should be larger in more rural counties where physician shortages are of greater concern.

In order to explore potential solutions to address rural healthcare disparities, it is necessary to consider the barriers those in rural areas face, including distance, health insurance coverage, and shortages of healthcare professionals. Farther distances make it more costly for rural Americans to seek medical care due to greater transportation costs, and they oftentimes have to miss work to receive care. In rural areas, there is also a lack of public transportation, which makes it more difficult for elderly residents to receive necessary services (Rural Health Information Hub). Furthermore, health insurance coverage is another barrier to healthcare faced by rural Americans. Compared to urban areas, rural areas have lower median household incomes and higher uninsurance rates (Warshaw, 2017). The shortage of healthcare professionals limits the supply of services for those in rural areas. These shortages have only worsened as a result of rural hospitals closing at an increasing rate (Rural Health Information Hub). Additionally, the shortage of primary care physicians has been a mounting problem, especially for rural areas. Therefore, policies aimed at addressing the rural healthcare shortage have sought to increase healthcare access and increase the number of physicians in rural areas.

Given the dire nature of rural healthcare disparities, different solutions have been proposed in order to increase healthcare access for rural America. Telemedicine has been discussed as a means to improve healthcare access because it allows rural Americans to receive services without travelling long distances. The use of telemedicine was greatly expanded as a result of the COVID-19 pandemic; however, rural telemedicine still remains expensive to adopt (Centers for American Progress, 2022). Mobile clinics are another measure to increase access to preventative healthcare services in both rural and urban areas. While these mobile clinics have led to improved health outcomes, a lack of state funding has remained a pervasive issue (Centers for American Progress, 2022). Ultimately, both telemedicine and mobile clinics seek to make healthcare more accessible in rural areas.

In addition to improving healthcare access in rural areas, policymakers have also sought to increase the supply of healthcare providers in rural areas. As a result, many states have adopted or expanded their student loan repayment programs for healthcare professionals such as physicians. These programs repay a certain amount of debt and are conditional upon an individual spending several years providing their services in rural or underserved areas. The purpose of these programs is to draw individuals to practice in rural or underserved areas. Physicians with more debt tend to pursue higher paying specialties and are less inclined to practice in underserved areas (Pierson, 2021). Therefore, many of these programs are aimed at lower paying specialties such as primary care. Many states also have programs for other healthcare professionals, including mental health providers, nurse practitioners, and physician assistants. The reimbursement amounts for these programs vary based upon the state. Given how many states have viewed loan repayment as a means to improve rural healthcare access, it is paramount to examine the effectiveness of these programs. Therefore, my paper addresses the impact of state loan repayment on the physician shortage and health outcomes in rural America.

Figure 1: Trends in the Number of Primary Care Physicians in Rural and Urban Areas



**Literature Review**

Much of the literature regarding the impact of student loan repayment programs for physicians has been addressed in the field of medicine. Specifically, the medical literature has relied on survey data to examine the outcomes and satisfaction of program participants (Miller & Crittenden, 2001; Geletko et al., 2014). Additionally, the medical literature has examined physician migration. Ricketts and Randolph (2007) tracked physician movement from 1981 to 2003 and found that more net movement occurred from urban to rural areas, which may be due to programs that incentivize rural practice. In the economics literature, the impact of student loan repayment policies for physicians is yet to be addressed. However, the impact of student loan debt on career choices has been addressed extensively. With regard to rural physicians, predictors of rural practice have been assessed. Additionally, previous literature has looked at how rural populations are affected by different events and policies, such as maternity ward closures, Medicaid expansion, and medical education programs.

The literature pertaining to student loan forgiveness for healthcare professionals is limited; however, there is extensive literature pertaining to student loan debt and how it affects decisions, such as college major and job choice after college. In the early 2000s, a highly selective university decided to adopt a no-loans policy, which offered grant aid in place of loans to students (Rothstein & Rouse, 2011). The aim of this policy was to lessen the financial burden associated with applying and attending college; therefore, making college more accessible to low-income students. Rothstein and Rouse (2011) found that student loan debt prompted recent college graduates to choose higher paying jobs. Those who received financial aid had less debt and shifted toward lower-paying jobs after graduation as a result. Ultimately, student loan debt can prove instrumental when individuals make decisions pertaining to college major and occupation.

In order to address the problem of physician shortages in rural areas, it is necessary to address how these shortages first arose in the early twentieth century. During the first two decades of the twentieth century, medical schools began to require higher standards for admission, such as increasing the required amount of college from one year to two (Moehling et al., 2020). While higher standards and more rigorous training produced better trained physicians, it created barriers for individuals from rural areas who sought to attend medical school. Moehling et al. (2020) utilized data from the early twentieth century from four different states and used medical school characteristics as a proxy for where an individual is from. They found that those who attended medical school in a rural area were 3-8% more likely to set up practice in a rural area compared to those who attended medical school in an urban area. When focusing on North Carolina, they found that 73.8% of physicians born in rural areas of the state set up practice in rural areas. Since physicians born in rural areas also tended to practice in rural areas, making medical school less accessible to rural Americans contributed to a shortage of physicians in these areas.

Other factors aside from rural origin may also play a role in where physicians practice. While Hu et al. (2022) found that rural origin was a significant factor for rural practicing physicians, they also found that a better environment and lifestyle was the most cited reason for rural practice. Additionally, better compensation was the second most cited reason for rural practice. Similar to Moehling et al. (2020), the results from Hu et al. (2022) also suggest that physicians tend to practice in the same state they trained in.

Other studies have addressed how rural areas are affected by different events and policies. The increase in rural maternity ward closures has led to concerns regarding healthcare access. Battaglia (2022) sought to examine the effects of rural maternity ward closures on health outcomes for women and infants. For women in areas with closed maternity wards, the benefit of receiving better trained physicians outweighed the cost of increased travel distance. Additionally, women in areas with maternity ward closures had significant reductions in Cesarean births compared to women in non-closure areas. Considering the risk and complications posed by Cesarean births, the closures may provide some benefit for low-risk women who reside in rural areas.

Another study looked at how the expansion of Medicaid in 2014 affected those in rural and urban areas. Mandal (2020) utilized a difference-in-differences model to examine how Medicaid enrollment for rural and urban Americans differed in expansion and non-expansion states. Data obtained from the American Community Survey (ACS) and Behavioral Risk Factor Surveillance System (BRFSS) was utilized in order to address how increased insurance coverage impacted healthcare access. For patients in expansion states, there was a 11.4% decrease in the likelihood of being uninsured for those in rural areas. Those in urban areas did not have a statistically significant decrease in uninsurance rates. Furthermore, there was a rural-urban differential of 9.2% with regard to the likelihood of being uninsured. The impact of the policy on the likelihood of having a healthcare provider was addressed in addition to uninsurance rates. There were similar increases in the likelihood of having a healthcare provider in rural and urban areas of 3.7% and 3.1% respectively. Overall, the benefit received from Medicaid expansion was greater for rural residents relative to urban residents.

Medical education programs have also been developed in the hopes of addressing the rural physician shortage. Florida’s Program of Medical Sciences (PIMS) was created in 1971 in an attempt to supply more primary care physicians to rural parts of the state (Fournier & Henderson, 2005). The admissions committee for the program sought students from nontraditional or disadvantaged backgrounds that were committed to rural or primary care. As part of the program, these students started their medical education at Florida State University and transferred after one year to the University of Florida. The comparison groups consisted of the treated group that had been in the PIMS program and the control group that only studied at the University of Florida. The impact of the program on medical specialty and location after graduation was examined. Fourier and Henderson (2005) found no differences in the proportion of graduates in primary care between the two groups. Additionally, only 4.7% of in-state graduates who participated in PIMS practiced in rural counties, while 2.4% of in-state University of Florida graduates practiced in rural counties. These results suggest that the PIMS program was unsuccessful in influencing specialty and practice location.

**Policy Background**

Student loan repayment programs for physicians exist at both the state and federal level. The focus of my analysis is programs that were implemented at the state level. At the state level, there are programs that are funded by a combination of federal and state funds in addition to programs that are entirely state funded. The National Health Service Corps (NHSC) provides federal grants to states to assist with their own State Loan Repayment Programs (SLRP). This is a cost-sharing grant in which states are required to match every federal dollar that is provided using non-federal dollars (Health Resources & Services Administration [HRSA]). Participants of the NHSC SLRP must serve at a public and non-profit private entity that is located in a designated health provider shortage area (HPSA). An example of a NHSC SLRP is the Delaware SLRP, which allows healthcare professionals to practice in both urban and rural settings as long as it is a designated HPSA (Delaware Health and Social Services). In my paper, the NHSC SLRP are referred to as the federal/state funded programs or policy\_fs.

The majority of programs that are funded by a combination of federal and state funds or solely state funds are aimed at HPSA or medically underserved areas or populations (MUA/P). States that receive federal grants to support their SLRP tend to focus more on areas designated as HPSA. An HPSA designation may be administered for geographic areas or it may be targeted at certain populations within geographic areas, including low-income and homeless populations (HRSA, 2023). The three types of HPSA include primary care, dental, and mental health. MUA/P means that an area has a shortage of primary care services. MUA is based on a geographic area while MUP focuses on a subset of the population within a geographic area that faces economic, cultural, and linguistic barriers to primary care (Department of Health & Human Services [DHS], 2019). The difference between HPSA and MUA/P is that HPSA must be renewed every year while MUA/P never expires (Massachusetts Health Care Workforce Center). While student loan repayment programs are viewed as a potential solution to improve rural healthcare access, these programs generally include a wide array of areas and populations. However, student loan repayment programs that are entirely state funded tend to focus more on certain areas or populations. Essentially, programs that are solely state funded tend to focus more on improving healthcare access in rural areas. For instance, the Montana Rural Physician Incentive Program is a state funded program that is aimed at increasing the number of physicians in rural and MUA/P (Montana University System).

Table 1: Total Number of States with State and Federal/State Funded Loan Repayment Programs

**Data**

For my analysis, I collected data from 2010 to 2019. I decided to collect data prior to COVID-19 in order to avoid potential confounds; specifically, the increased demand for healthcare professionals that resulted from the pandemic. Furthermore, my dataset includes data from all of the fifty states with a mixture of state and county level data. The dependent variables in my regression models include the number of physicians, the number of primary care physicians, preventable hospital stays, and the death rate. Data for the number of physicians, the number of primary care physicians, and total deaths at the county level were obtained from the Area Health Resource Files (AHRF). The physicians variable was calculated by adding the total number of doctors of medicine (MDs) and doctors of osteopathic medicine (DOs) in each county. The primary care physicians variable is measured as the total number of primary care physicians in a county. The death rate variable was computed as the total deaths divided by the county population and then multiplied by 100,000. Therefore, the death rate is measured as the number of deaths per 100,000 people. Data pertaining to preventable hospital stays was obtained from the County Health Rankings and is at the county level. County Health Rankings describes its most recent data as the rate of hospital stays for ambulatory-care sensitive conditions per 100,000 Medicare enrollees. Prior to 2019, this rate was measured per 1,000 Medicare enrollees and included hospitalizations for a wider array of conditions, including chronic obstructive pulmonary disease, congestive heart failure, and hypertension (County Health Rankings, 2023). Due to definitional changes and changes in how the rate of hospital stays was calculated, my regression model for preventable hospital stays was run using years 2010-2018.

My independent variables of interest include my policy variables that are differentiated based upon their funding source. The policy state variable referred to as policy\_st is a binary variable that indicates if a state has a student loan repayment program funded entirely by state funds. The policy federal/state variable referred to as policy\_fs is also a binary variable and it indicates if a state has a loan repayment program that is funded by a combination of federal and state funds. Tables A1 and A2 specify which states have a state funded or federal/state funded program. Throughout 2010-2019, several states adopted loan repayment programs that are state or federal/state funded. Additionally, some states were unable to fund their state or federal/state loan repayment programs; therefore, these states were not treated during the entirety of this time span. Some states have adopted both a state funded and a federal/state funded loan repayment program. Another independent variable of interest in my regression models is the rural variable, which was composed using data from the U.S. Census Bureau. The rural variable was coded as 1 for counties that have a rural population percentage greater than 50% and 0 for counties with a rural population of 50% or below.

My control variables include Democrat governor, the portion of the population over 65, percent persons in poverty, population, and the portion of the population on Medicaid. Data for the Democrat governor and the Medicaid beneficiaries variables were obtained from the University of Kentucky National Welfare Data and are at the state level. The variable Democrat governor is a binary variable that is a 1 if a state has a Democrat governor and 0 if the governor is not a Democrat. In order to calculate the portion of individuals in a state receiving Medicaid benefits, I divided the total Medicaid beneficiaries by the state population. County level data pertaining to the total population over 65, percent of persons in poverty, and population were obtained from the AHRF. The portion of individuals over the age of 65 was calculated by dividing the total population over 65 by the county population. The poverty variable was calculated in the AHRF and this variable is measured as the number of those in poverty per 1,000 people.

Table 2: Dependent Variables

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **Variable Name** | **Level** | **Source** |
| Physicians | physicians | County | Area Health Resource Files (AHRF) |
| Primary Care Physicians | PCPs | County | AHRF |
| Preventable Hospital Stays | preventhospstays | County | County Health Rankings |
| Death Rate | deathrate | County | AHRF |

Table 3: Independent Variables

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **Variable Name** | **Level** | **Source** |
| Rural | rural | County | U.S. Census Bureau |
| Policy State | policy\_st | State | See Appendix A2 |
| Policy Federal/State | policy\_fs | State | See Appendix A1 |
| Democrat Governor | demgov | State | University of Kentucky National Welfare Data |
| Population Over 65 | over65 | County | AHRF |
| Percent Poverty | poverty | County | AHRF |
| Population | population | County | AHRF |
| Medicaid Beneficiaries | Medicaid | State | University of Kentucky National Welfare Data |

Table 4: Summary Statistics

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Obs** | **Mean** | **Std. Dev.** | **Min** | **Max** |
| physicians | 31,414 | 301.144 | 1245.579 | 0 | 32,332 |
| PCPs | 31,414 | 76.203 | 267.249 | 0 | 7413 |
| preventhospstays | 27,660 | 73.839 | 31.394 | 12.23 | 342.41 |
| deathrate | 31,412 | 1012.538 | 274.841 | 0 | 2712.161 |
| policy\_st | 31,492 | 0.489 | 0.500 | 0 | 1 |
| policy\_fs | 31,492 | 0.654 | 0.476 | 0 | 1 |
| rural | 31,492 | 0.601 | 0.490 | 0 | 1 |
| demgov | 31,492 | 0.331 | 0.471 | 0 | 1 |
| over65 | 31,414 | 0.178 | 0.046 | 0.035 | 0.582 |
| poverty | 31,404 | 162.420 | 64.064 | 26 | 567 |
| population | 31,414 | 101,492.9 | 325,625.7 | 71 | 10,200,000 |
| Medicaid | 31,492 | 0.190 | 0.056 | 0.090 | 0.429 |

**Methodology**

**Theoretical Model**

Given how student loan repayment programs seek to decrease the cost of becoming a physician, I developed a theoretical model to address the decision-making behind deciding to attend medical school. Individuals seek to maximize their utility when deciding whether or not to attend medical school. Therefore, this theoretical model compares the net present value of medical school to the net present value of no medical school. When individuals decide to attend medical school, they consider their wages after medical school (WMS), the cost (c), and income they earn while in medical school (WPT). This is then weighed against the wages the individual would earn if they do not attend medical school (WNMS). Wages in the model are also discounted by the real interest rate. If the NPV for medical school exceeds the NPV of no medical school, the individual will decide to attend medical school. Student loan repayment programs for physicians affect the c in the model by decreasing the cost of medical school attendance.

NPV(Medical School) > NPV(No Medical School)

**Regression Models**

Each regression model includes two-way fixed effects; specifically, county and time fixed effects. The use of county fixed effects allows me to control for differing county cultures and characteristics of a county that do not change over time. Furthermore, time fixed effects allow me to control for events that happened in a given year at the macroeconomic level. By using a two-way fixed effects model, I am assuming that the parallel trends assumption holds. This assumption states that in the absence of student loan repayment programs, each state would have followed the same trajectories for the number of physicians, number of primary care physicians, preventable hospitalizations, and mortalities. In order to address the causal impact of the policy, this assumption must hold. Each regression model is also weighted by population.

My independent variables of interest include the binary variables policy\_st and policy\_fs, which account for whether a state had a state funded or a federal/state funded program. Since I am interested in the impact of the policy on more rural counties, an interaction term between my policy variables and rural variable was included in each of my regression models. Therefore, the coefficient on the interaction term rural×policy\_st captures the additional effect of having a state funded student loan repayment program in rural areas. Similarly, the coefficient on the interaction term rural×policy\_fs captures the additional effect of having a federal/state funded student loan repayment program in rural areas.

My first regression model seeks to address the impact of the policies on the number of physicians. Physicians includes the total number of MDs and DOs. The total number of physicians appeared to follow a nonlinear pattern; therefore, the physicians variable was logged in my regression model. This model measures the percent change in the total number of physicians due to the policies.

lnphysiciansi = β0 + β1policy\_stc,t+ β2policy\_fsc,t+ β3ruralc,t + β4rural×policy\_stc,t + β5rural×policy\_fsc,t+ δt + ୪c + εi **(1)**

While physicians more broadly are included in student loan repayment programs, many policies are aimed at increasing the number of primary care providers in shortage areas. Therefore, another regression was run on primary care physicians. Similar to my first model, I logged the primary care physicians variable since the total number of primary care physicians appeared to follow a nonlinear pattern.

lnPCPsi = β0 + β1policy\_stc,t+ β2policy\_fsc,t+ β3ruralc,t + β4rural×policy\_stc,t + β5rural×policy\_fsc,t+ δt + ୪c + εi  **(2)**

A concern in rural areas is the lack of preventative services which contributes to higher rates of preventable hospital stays relative to urban areas. Preventable hospital stays is a variable that measures access to quality outpatient care as well as overuse of emergency rooms; therefore, preventable hospital stays may serve as a proxy for access to primary health care (County Health Rankings, 2023). Preventable hospital stays is measured as the rate of hospitalizations for ambulatory-care sensitive conditions per 1,000 Medicaid enrollees.

preventhospstaysi = β0 + β1policy\_stc,t+ β2policy\_fsc,t+ β3ruralc,t + β4rural×policy\_stc,t + β5rural×policy\_fsc,t+ δt + ୪c + εi  **(3)**

In rural areas, there are also higher mortality rates due to a lack of healthcare access and preventative services. The death rate is measured as the total number of deaths per 100,000 people.

deathratei = β0 + β1policy\_stc,t+ β2policy\_fsc,t+ β3ruralc,t + β4rural×policy\_stc,t + β5rural×policy\_fsc,t+ δt + ୪c + εi  **(4)**

**Results**

My first regression model suggests that both the state and federal/state funded programs led to a percentage increase in the total number of physicians. The state funded programs led to a 3.90% increase in the total number of physicians, while the federal/state funded programs led to a 14.32% increase in the total number of physicians in rural areas. Both of these results were statistically significant at the 1% level. Therefore, both of these policies work as I hypothesized by leading to a percentage increase in the total number of physicians. My second regression model measures the effect of the policies on primary care physicians. The state funded programs and federal/state programs were more impactful on primary care physicians as opposed to physicians. The state funded programs led to an 8.08% increase in the total number of primary care physicians in rural areas and had statistical significance at the 1% level. The federal/state funded programs led to a 15.49% increase in the number of primary care physicians in rural areas and also had statistical significance at the 1% level. Given how student loan repayment programs tend to focus on preventative care, these results suggest that the programs work as intended. Moreover, the results for both physicians and primary care physicians suggest that the federal/state funded programs are more effective than the state funded programs.

Both the federal/state and the state funded programs led to a reduction in the rate of preventable hospital stays in rural areas, and these results had statistical significance at the 1% level. The state program resulted in 4.70 less hospitalizations per 1,000 Medicare enrollees. Similarly, the federal/state program led to 5.23 less hospitalizations per 1,000 Medicare enrollees. Therefore, these results suggest that individuals may be utilizing preventative care services more, which would contribute to a decrease in the rate of preventable hospital stays. The state and federal/state funded programs also led to a decrease in the death rate in rural areas that was statistically significant at the 1% level. The state funded programs led to 25.92 less deaths per 100,000 people. The federal/state funded programs resulted in a much larger decrease in the death rate in rural areas. Specifically, the federal/state funded program led to 48.74 less deaths per 100,000 people.

While I found the federal/state programs to be more effective in rural areas, the opposite pattern was observed in urban areas with regard to the rate of preventable hospital stays and death rate. The state program led to 5.83 less hospitalizations per every 1,000 Medicaid enrollees. Additionally, the state program led to 31.59 less deaths per 100,000 people. Both of these results were statistically significant at the 1% level. However, in urban areas, the state program also led to a 15.3% decrease in the number of physicians and a 4.62% decrease in the number of PCPs, both of which had statistical significance at the 1% level. Considering how the programs led to greater percentage increases in rural areas, this suggests that loan repayment programs may incentivize physicians to migrate from urban to rural areas. These findings are similar to those of Ricketts and Randolph (2007), who found that more net movement occurred from urban to rural areas than rural to urban areas. However, the federal/state program was associated with a 3.89% increase in the number of primary care physicians in urban areas. Therefore, in both urban and rural areas, the federal/state programs appear to be more effective than the state programs at increasing the number of primary care physicians.

Ultimately, I found that student loan repayment programs for physicians were more impactful in rural areas, which was consistent with my hypothesis. In each of my regression models, I found the federal/state funded programs to be more effective in rural areas compared to the state funded programs. Therefore, in terms of economic significance, my results suggest that policymakers would be better off adopting the federal/state funded programs if they seek to improve rural healthcare access. However, I am not certain why the federal/state funded programs appear to be more effective. There may be fundamental differences between the two programs that affect each program’s effectiveness. Based upon Table 1, more states partake in the federal/state funded programs compared to the state programs. Furthermore, there could be differences in the sizes of these programs, including the amount of funding and the number of participants.

Table 5: Regression Results

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Model** | **(1)** | **(2)** | **(3)** | **(4)** |
| **Variables** | lnphysicians | lnPCPs | preventhospstays | deathrate |
| policy\_st | -0.153\*\*\* | -0.0462\*\*\* | -5.828\*\*\* | -31.59\*\*\* |
|  | (0.0149) | (0.00972) | (0.380) | (2.569) |
| policy\_fs | -0.0388\*\* | 0.0389\*\*\* | -4.788\*\*\* | 0.509 |
|  | (0.0160) | (0.00991) | (0.437) | (3.136) |
| ruralpolicy\_st | 0.192\*\*\* | 0.127\*\*\* | 1.124\* | 5.673 |
|  | (0.0209) | (0.0150) | (0.623) | (3.791) |
| ruralpolicy\_fs | 0.182\*\*\* | 0.116\*\*\* | -0.438 | -49.25\*\*\* |
|  | (0.0214) | (0.0151) | (0.666) | (4.373) |
| rural | -0.730\*\*\* | -0.412\*\*\* | 14.30\*\*\* | 78.23\*\*\* |
|  | (0.0354) | (0.0245) | (1.201) | (6.607) |
| demgov | 0.0503\*\*\* | 0.0361\*\*\* | -1.559\*\*\* | -13.14\*\*\* |
|  | (0.0141) | (0.00886) | (0.384) | (2.462) |
| over65 | 1.180\*\*\* | 1.369\*\*\* | -46.40\*\*\* | 3,973\*\*\* |
|  | (0.165) | (0.120) | (4.616) | (62.39) |
| poverty | -0.000526\*\*\* | -0.00120\*\*\* | 0.0953\*\*\* | 1.109\*\*\* |
|  | (0.000124) | (7.59e-05) | (0.00321) | (0.0249) |
| Medicaid | 0.238\* | 0.237\*\*\* | 47.19\*\*\* | 150.6\*\*\* |
|  | (0.125) | (0.0783) | (3.445) | (23.53) |
| lnpopulation | 1.255\*\*\* | 1.105\*\*\* | -2.738\*\*\* | -20.22\*\*\* |
|  | (0.00524) | (0.00328) | (0.141) | (0.972) |
| Constant | -9.327\*\*\* | -8.664\*\*\* | 97.23\*\*\* | 351.2\*\*\* |
|  | (0.0848) | (0.0537) | (2.233) | (17.56) |
| **Summed Coefficients** |  |  |  |  |
| policy\_st + ruralpolicy\_st | 0.039\*\*\* | 0.0808\*\*\* | -4.704\*\*\* | -25.92\*\*\* |
|  |  |  |  |  |
| policy\_fs+ruralpolicy\_fs | 0.1432\*\*\* | 0.1549\*\*\* | -5.226\*\*\* | -48.74\*\*\* |
|  |  |  |  |  |
| Year Fixed Effects | Yes | Yes | Yes | Yes |
| Year & Rural Fixed Effects | Yes | Yes | Yes | Yes |
|  |  |  |  |  |
| Observations | 29,998 | 29,329 | 27,169 | 31,402 |
| R-squared | 0.949 | 0.965 | 0.513 | 0.795 |
| Robust standard errors in parentheses | | | | |
| \*\*\* p<0.01, \*\* p<0.05, \* p<0.1 | |  |  |  |

**Conclusion**

Ultimately, my paper examined the impact of student loan repayment programs at the state level on the number of physicians, primary care physicians, rate of preventable hospital stays, and the death rate. My hypothesis was that the loan repayment programs would be more impactful in rural areas, where healthcare disparities remain a paramount issue. My analysis revealed that the federal/state funded loan repayment programs were more effective than the solely state funded loan repayment programs in rural areas. Compared to the state loan repayment programs, the federal/state loan repayment programs led to greater percentage increases in the number of physicians and primary care physicians. Additionally, the federal/state programs also led to greater decreases in the rate of preventable hospital stays and the death rate relative to the state loan repayment programs. My results suggest that a state would be better off adopting the federal/state funded loan repayment program because it had greater economic significance. However, future research could examine why the federal/state funded programs appear to be more effective.

For the purposes of my analysis, I focused on whether or not states had a state or federal/state funded program throughout 2010-2019. A concern with my dataset is that many states appeared to adopt their loan repayment programs in the 1990s and early 2000s. Therefore, including a more expansive time span would allow for the impacts of the loan repayment programs to be isolated better. In the future, this analysis could also be expanded upon by including the amount of funding for each program. Data regarding funding for these loan repayment programs could provide more insight into the effectiveness of the programs. During 2010-2019, there were some states that increased the funding for their loan repayment programs, while others decreased funding. Therefore, including funding amounts for these programs would allow for a dollar value to be assigned to the impact of the programs. Additionally, the number of participants in each program could be included as well. By including funding amounts and the number of participants, more insight would be provided regarding the size of each program. Specifically, a student loan repayment program could have a greater impact if it receives more funding or if more participants partake in the program. Furthermore, the impact of student loan repayment programs could be examined for other healthcare professionals, including physician assistants and nurse practitioners.

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**Appendix A**

States with Loan Repayment by Funding Type

Table A1: States with Federal/State Funded Loan Repayment Programs for Physicians

|  |  |
| --- | --- |
| **State** | **Source** |
| Alaska | https://alaskamentalhealthtrust.org/wp-content/uploads/2019/07/SHARP-onepager.pdf |
| Arizona | https://www.azauditor.gov/sites/default/files/00-6.pdf |
| California | https://www.cmadocs.org/newsroom/news/view/ArticleId/34129/California-State-Loan-Repayment-Program-now-accepting-applications |
| Colorado | <https://cchn.org/demand-for-primary-care-soaring-health-service-corps-meeting-needs-of-colorados-underserved-2/> |
| Connecticut | <https://www.ctpca.org/progservices/recruitment_jobapp> |
| Delaware | <https://dhss.delaware.gov/dhss/dhcc/slrp.html> |
| Georgia | <https://www.law.cornell.edu/regulations/georgia/Ga-Comp-R--Regs-R-195-20-.01> |
| Hawaii | https://www.capitol.hawaii.gov/sessions/session2023/bills/SB689\_.HTM |
| Idaho | <https://legislature.idaho.gov/statutesrules/idstat/title67/t67ch53/sect67-5339/> |
| Illinois | https://www.ilga.gov/legislation/ilcs/ilcs3.asp?ActID=2720&ChapterID=18 |
| Indiana | <https://www.adea.org/uploadedFiles/ADEA/Content_Conversion/advocacy/State_Information/State_Advocacy_Toolkit/2019_ADEA_Summary_of_Loan_Forgiveness_Programs.pdf> |
| Iowa | https://medicine.uiowa.edu/md/state-loan-repayment-programs#:~:text=Iowa%20PrimeCarre%20Loan%20Repayment%20Program,shortage%20areas%20of%20the%20state. |
| Kansas | <https://spl.cde.state.co.us/artemis/heserials/he1920010internet/he19200102011internet.pdf> |
| Kentucky | <https://medicine.uky.edu/centers/ruralhealth/state-loan-repayment-program> |
| Louisiana | <https://www.doa.louisiana.gov/media/4bpe0q1x/09a_department_of_health_and_hospitals.pdf> |
| Maine | <https://www.law.cornell.edu/regulations/maine/department-10/division-144/chapter-508> |
| Maryland | <https://health.maryland.gov/newsroom/Pages/Maryland-Department-of-Health-announces-expanded-educational-loan-repayment-programs-for-healthcare-professionals-.aspx#:~:text=The%20program%20has%20offered%20educational,the%20largest%20in%20its%20history.> |
| Massachusetts | <https://massleague.org/Programs/PrimaryCareProviderInitiatives/2018MLRPGuideMDPHandMLCHC.pdf> |
| Michigan | <https://www.michigan.gov/-/media/Project/Websites/mdhhs/Folder1/Folder18/MSLRP_Legislative_Report.pdf?rev=8d0e2e5c8f114f7ca73d5e6e44e511a1> |
| Minnesota | [https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjP0I7tq6GBAxVnjYkEHYNCDF4QFnoECBMQAQ&url=https%3A%2F%2Fwww.adea.org%2Fdental\_education\_pathways%2Fdocuments%2Ffederalandstateloanrepaymentprograms2008-07.pdf&usg=AOvVaw29P2sHApZEduBmd2ZzKsfX&opi=89978449](https://www.adea.org/dental_education_pathways/documents/federalandstateloanrepaymentprograms2008-07.pdf) |
| Missouri | <https://law.justia.com/codes/missouri/2022/title-xii/chapter-191/section-191-600/> |
| Montana | <https://leg.mt.gov/content/Committees/Interim/2009_2010/Children_Family/Assigned_Studies/SJR_35/sjr35-medical-training-and-incentives-jan-2010.pdf> |
| Nebraska | <https://www.unmc.edu/publichealth/chp/_documents/NLRP_94-19.pdf> |
| Nevada | <https://med.unr.edu/statewide/programs/nevada-state-office-of-rural-health/nevada-health-service-corps#:~:text=NHSC%20was%20established%20by%20the,that%20type%20of%20practitioner%20exists.> |
| New Jersey | <https://njafp.org/njafp-pac-3-2/#:~:text=The%20NJ%20Primary%20Care%25> |
| New Mexico | <https://spl.cde.state.co.us/artemis/heserials/he1920010internet/he19200102011internet.pdf> |
| North Carolina | <https://webservices.ncleg.gov/ViewDocSiteFile/20432> |
| North Dakota | [https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjP0I7tq6GBAxVnjYkEHYNCDF4QFnoECBMQAQ&url=https%3A%2F%2Fwww.adea.org%2Fdental\_education\_pathways%2Fdocuments%2Ffederalandstateloanrepaymentprograms2008-07.pdf&usg=AOvVaw29P2sHApZEduBmd2ZzKsfX&opi=89978449](https://www.adea.org/dental_education_pathways/documents/federalandstateloanrepaymentprograms2008-07.pdf) |
| Oregon | <https://www.oregon.gov/oha/HPA/HP-HCW/Documents/Provider%20Incentives%20Full%20Final%20Report%20July%202014.pdf> |
| Pennsylvania | [https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjd07fTvbeBAxVRL1kFHWrlD3oQFnoECCEQAQ&url=https%3A%2F%2Fgrants.hrsa.gov%2F2010%2Fweb2External%2FInterface%2FCommon%2FPublicWebLinkController.aspx%3FGrantNumber%3DH56HP31915%26WL\_WEBLINK\_ID%3D1&usg=AOvVaw1GLR\_o0EL-RBStHNQErjiN&opi=89978449](https://grants.hrsa.gov/2010/web2External/Interface/Common/PublicWebLinkController.aspx?GrantNumber=H56HP31915&WL_WEBLINK_ID=1) |
| South Dakota | [https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjP0I7tq6GBAxVnjYkEHYNCDF4QFnoECBMQAQ&url=https%3A%2F%2Fwww.adea.org%2Fdental\_education\_pathways%2Fdocuments%2Ffederalandstateloanrepaymentprograms2008-07.pdf&usg=AOvVaw29P2sHApZEduBmd2ZzKsfX&opi=89978449](https://www.adea.org/dental_education_pathways/documents/federalandstateloanrepaymentprograms2008-07.pdf) |
| Tennessee | [https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjP0I7tq6GBAxVnjYkEHYNCDF4QFnoECBMQAQ&url=https%3A%2F%2Fwww.adea.org%2Fdental\_education\_pathways%2Fdocuments%2Ffederalandstateloanrepaymentprograms2008-07.pdf&usg=AOvVaw29P2sHApZEduBmd2ZzKsfX&opi=89978449](https://www.adea.org/dental_education_pathways/documents/federalandstateloanrepaymentprograms2008-07.pdf) |
| Vermont | <https://legislature.vermont.gov/Documents/2018/WorkGroups/Senate%20Health%20and%20Welfare/AHEC/W~Elizabeth%20Cote~AHEC%20FY19%20Budget~2-20-2018.pdf> |
| Virginia | [https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjP0I7tq6GBAxVnjYkEHYNCDF4QFnoECBMQAQ&url=https%3A%2F%2Fwww.adea.org%2Fdental\_education\_pathways%2Fdocuments%2Ffederalandstateloanrepaymentprograms2008-07.pdf&usg=AOvVaw29P2sHApZEduBmd2ZzKsfX&opi=89978449](https://www.adea.org/dental_education_pathways/documents/federalandstateloanrepaymentprograms2008-07.pdf) |
| Washington | <https://wsac.wa.gov/sites/default/files/2019.FSLRP.HPLRP.Guide.pdf> |
| West Virginia | <https://www.wvhepc.edu/wp-content/uploads/2014/01/Health_Report_2012_lr.pdf> |
| Wisconsin | <https://docs.legis.wisconsin.gov/misc/lfb/budget/2009_11_biennial_budget/103_budget_papers/253_commerce_health_professions_loan_assistance_program.pdf> |
| Wyoming | <https://health.wyo.gov/wp-content/uploads/2020/05/WHLRP-Reverse-Impact-Report-5.18.20.pdf> |

Table A2: States with State Funded Loan Repayment Programs for Physicians

|  |  |
| --- | --- |
| **State** | **Source** |
| Alabama | <https://www.randomservices.org/UAB/BMSA/index.html> |
| Arizona | <https://www.azauditor.gov/sites/default/files/00-6.pdf> |
| Arkansas | <https://www.arkleg.state.ar.us/Home/FTPDocument?path=%2FAssembly%2FMeeting+Attachments%2F830%2FI14063%2FHandout+-+Rural+Healthcare+Practices.pdf> |
| California | <https://hcai.ca.gov/wp-content/uploads/2022/05/STLRP-Grant-Guide-FY-2022-23.pdf> |
| Georgia | <https://window.brenau.edu/featured/lasharn-hughes-not-finished-yet/> |
| Idaho | [https://stateimpact.npr.org/idaho/2012/10/04/how-idaho-is-trying-to-boost-its-number-of-doctors](https://stateimpact.npr.org/idaho/2012/10/04/how-idaho-is-trying-to-boost-its-number-of-doctors/)/ |
| Kansas | <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9224957/> |
| Minnesota | <https://www.revisor.mn.gov/statutes/2005/cite/144.1501> |
| Missouri | <https://www.sos.mo.gov/cmsimages/adrules/csr/current/19csr/19c10-4.pdf> |
| Montana | <https://leg.mt.gov/content/Committees/Interim/2021-2022/Children-Families/Studies/SJR-14/jan2022-mr-pip-oche-report.pdf> |
| Nebraska | <https://dhhs.ne.gov/RH%20Advisory%20Commission/RHAC%20Annual%20Report%202022.pdf> |
| New Hampshire | [https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjP0I7tq6GBAxVnjYkEHYNCDF4QFnoECBMQAQ&url=https%3A%2F%2Fwww.adea.org%2Fdental\_education\_pathways%2Fdocuments%2Ffederalandstateloanrepaymentprograms2008-07.pdf&usg=AOvVaw29P2sHApZEduBmd2ZzKsfX&opi=89978449](https://www.adea.org/dental_education_pathways/documents/federalandstateloanrepaymentprograms2008-07.pdf) |
| New York | <https://www.nyacp.org/files/DANY%20Overview%20and%20How%20To-%202015.pdf> |
| North Dakota | <https://www.wiche.edu/wp-content/uploads/2022/09/Behavioral-Health-Report-FINAL-COMPLETE.pdf> |
| Ohio | <https://www.dispatch.com/story/news/politics/2010/07/18/ohio-dips-into-fund-doctors/23853089007/> |
| Oklahoma | <https://law.justia.com/codes/oklahoma/2019/title-63/section-63-1-2720/> |
| Oregon | <https://www.oregon.gov/oha/HPA/HP-PCO/Pages/HC-Provider-Incentive.aspx> |
| Texas | <https://texreg.sos.state.tx.us/public/readtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=19&pt=1&ch=23&rl=62> |
| Utah | <https://health.utah.gov/wp-content/uploads/RuralPhysicianLoanRepayment_2016.pdf> |
| Washington | <https://wsac.wa.gov/sites/default/files/2019.FSLRP.HPLRP.Guide.pdf> |
| West Virginia | <https://www.wvhepc.edu/wp-content/uploads/2020/02/Series-34-4-14-09.pdf> |
| Wisconsin | <https://worh.org/wp-content/uploads/2022/02/LAP-Annual-Report-20-21.pdf> |
| Wyoming | <https://health.wyo.gov/wp-content/uploads/2020/05/WHLRP-Reverse-Impact-Report-5.18.20.pdf> |

**Appendix B**

Initial Regression Results

Table B1: Regression Results Without Control Variables

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Model** | **(1)** | **(2)** | **(3)** | **(4)** |
| **Variables** | lnphysicians | lnPCPs | preventhospstays | deathrate |
| policy\_st | 0.327\*\*\* | 0.364\*\*\* | -4.696\*\*\* | -93.12\*\*\* |
|  | (0.0387) | (0.0345) | (0.386) | (4.953) |
| policy\_fs | 0.0620 | 0.133\*\*\* | -6.108\*\*\* | -67.68\*\*\* |
|  | (0.0398) | (0.0344) | (0.442) | (5.290) |
| ruralpolicy\_st | -0.391\*\*\* | -0.362\*\*\* | -2.103\*\*\* | 69.29\*\*\* |
|  | (0.0483) | (0.0426) | (0.664) | (6.581) |
| ruralpolicy\_fs | -0.125\*\* | -0.136\*\*\* | -2.797\*\*\* | 58.25\*\*\* |
|  | (0.0494) | (0.0423) | (0.700) | (7.020) |
| rural | -3.314\*\*\* | -2.708\*\*\* | 24.50\*\*\* | 174.2\*\*\* |
|  | (0.0889) | (0.0778) | (1.285) | (10.96) |
| Constant | 7.027\*\*\* | 5.668\*\*\* | 77.62\*\*\* | 846.6\*\*\* |
|  | (0.0739) | (0.0656) | (0.807) | (8.047) |
| **Summed Coefficients** |  |  |  |  |
| policy\_st + ruralpolicy\_st | -0.064\*\* | 0.002 | -6.799\*\*\* | -23.83\*\*\* |
|  |  |  |  |  |
| policy\_fs+ruralpolicy\_fs | -0.063\*\* | -0.003 | -8.905\*\*\* | -9.43\*\* |
|  |  |  |  |  |
| Year Fixed Effects | Yes | Yes | Yes | Yes |
| Year & Rural Fixed Effects | Yes | Yes | Yes | Yes |
|  |  |  |  |  |
| Observations | 29,998 | 29,329 | 27,169 | 31,412 |
| R-squared | 0.607 | 0.606 | 0.436 | 0.412 |
| Robust standard errors in parentheses | |  |  |  |
| \*\*\* p<0.01, \*\* p<0.05, \* p<0.1 | |  |  |  |

**Appendix C**

Graphs of Treated and Not Treated States

Figure C1: Average Number of Primary Care Physicians in States With and Without a Federal/State Funded Program

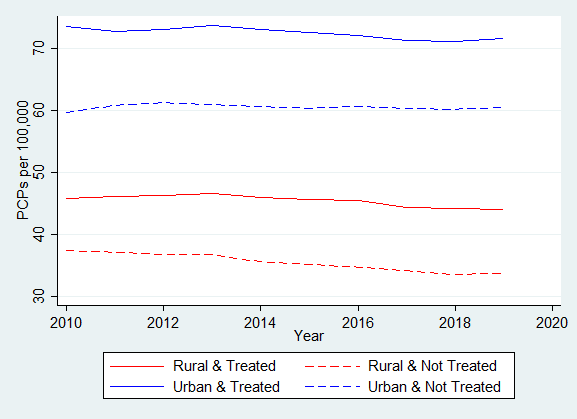


Figure C2: Average Number of Primary Care Physicians in States With and Without a Solely State Funded Program

