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What Drives the Distribution of Rural Doctors?

Rebekka Dudensing,[1] Craig W. Carpenter, [1] and Jyh C. Liu[2]

[1]Dept. of Agricultural Economics, Texas A&M AgriLife Extension Service, Texas A&M University System, College Station, TX, rmdudensing@tamu.edu corresponding
2Dept. of Computer Science & Engineering, Texas A&M University, College Station, TX

Abstract
A number of media stories document a "shortage" of doctors in rural communities. The distribution of primary care physicians (PCP) is remarkably similar to the distribution of other services, including grocery stores, suggesting the role of regional economic factors in determining doctor location. This national study examines variables associated with the number of PCP per 100,000 people at the county level. Demographic factors significantly associated with the PCP rate include population density, the share of the population living outside urban cluster or urbanized areas, and the share of Hispanic residents. Economic factors include post-secondary education, out-commuting, the share of the workforce in agriculture and natural resource industries, employer law establishments per 100,000 people, and the presence of broadband. Being located in a Medicaid expansion state was the only significant insurance-related variable, but significance was sensitive to how expansion status was determined. Results suggest that decision makers should be cognizant of the role of economic changes in affecting, as well as reflecting, changes in the healthcare sector.

Introduction

The availability of healthcare has been a prominent topic in US news and politics in recent years, since the debate of the Affordable Care Act (ACA) and continuing through the 2016 presidential elections and proposals to repeal and replace the ACA. The fate of rural hospitals and health systems has been an important part of this discussion, especially because rural voters are believed to have helped Donald Trump win the presidency.

Amidst the political debates, rural healthcare providers and the national news media have been sending distress signals. A number of recent media articles describe hospital closures and threats of additional closures. Medicare and Medicaid reimbursement policies are often cited as a reason for closure (Harper, 2013; Dillard, 2014; Wilemon, 2014), as are declining patient bases (Guenther, 2014; Wilemon, 2014). In fact, current closures rates are in line with those from previous decades (Probst et al., 1999; Holmes et al., 2006; North Carolina Rural Health Research Program, 2017), and hospitals close at a lower rate than overall economic churn (Dudensing, 2017a). Furthermore, many closing hospitals are located nearby other facilities (Dudensing, 2017a), and often closed hospitals retain some form of health services such as clinics or emergency rooms (Hart, Pirani, and Rosenblatt, 1991).

Other popular press articles in major news outlets describe physician shortages in rural areas (Khazan, 2014; Jordan, 2017; Siegler, 2017). Many articles and social media posts focus only on the negative impacts (as opposed to causes) of healthcare losses. Some of these articles put hospital closures and doctor "shortages" in the context of communities and economies losing residents and businesses. Still, these articles tend to consider only community or county economies. At least in Texas, most counties lacking a doctor do have at least one physician within their labor market area (Dudensing, 2017b).

Numerous studies have noted there are many types of rural areas and that the relationship between rural and urban areas is changing (Deller et al., 2001). Many rural areas, especially those near urban centers or with natural amenities of interest to tourist, have experienced or are experiencing a renaissance, while remote rural counties with economies based in agriculture and mining have tended to struggle and lose population.

This paper addresses the interplay of rural healthcare and rural socioeconomic measures. The next section provides a brief overview of academic literature on rural healthcare shortages, particularly as the allocation of healthcare resources relates to local economies. The third section discusses the data for this paper and the model. Results are provided in the fourth section. A discussion of what these findings may mean for rural areas and possible next steps is provided in a concluding section.

Literature

A robust literature considers the economic impact of the healthcare system including specifically the contribution of rural hospitals to their local economies. These studies all find that health systems and/or their components, including hospitals, make a positive economic contribution to their host communities. Christianson and Faulkner (1981) are considered pioneers in studying the economic contribution of hospitals. Specifically, they looked at direct and indirect community income related to hospital expenditures. Doeksen et al. (1998) presented a methodology for a contribution analysis by health sector using input-output multipliers, which the Rural Health Works team updated, refined, and expanded for several years. The authors noted the importance of the health sector in rural communities, citing Doekson, Cordes, and Shaffer (1992) that the health system is often the second largest employer, following the school district.

A number of studies estimates the effects of hospital closures on local economies. Many studies consider the effects on healthcare access, but a number focus on economic effects. The results of these studies are mixed. Holmes et al. (2006) considered hospital closures from 1990 to 2000 and found that closure of the sole hospital in a county decreased per capita income and increased unemployment. On the other hand, they found no long-term economic effects from the closure of a hospital in a county with another hospital(s). Several studies find no or few impacts due to a hospital closure. For example, Pearson and Tajalli (2003) found no changes in trends in Texas counties with hospital closures relative to comparison counties. Conversely, Probst et al. (1999) found that earned income (exluding farm and mining income) and labor force growth were slower in counties with hospital closures in the mid-1980s relative to comparable counties without closures. Population change was not affected by closures. They also found that post-closure use of a hospital facility was more important to determining the county's fate than was the issue of whether the facility was the county's sole hospital.

Importantly, Probst et al. noted that hospitals to not close at random, and trends in counties with hospital closures were less positive than those in comparison counties even prior to closures. Capps, Dranove, and Lindrooth (2010) picked up on this theme, noting that insolvency usually signals inefficiency and/or weak demand. As an example, they cited Lindrooth et al.'s (2003) finding that closed hospitals had experienced lower occupancy rates than surviving hospitals as evidence that local residents did not value the local hospital above other sources of care. While conceding that hospitals have social benefits, they also noted that boards of non-profit hospitals often have a desire to keep local hospitals open, and these desires are further enabled by the fact that local residents bear almost all hospital benefits while local, state, and federal sources share the costs of maintaining the hospital. Hilsenrath and Fischer

(2013) concurred that a reallocation of healthcare resources is be painful but that it will make rural healthcare more efficient. Allen et al. (2015) found that rural Kentuckians were willing to pay more to support a rural hospital than a clinic and that they are not interested in paying more for specialized services available in larger healthcare facilities.

Weigel et al. (2017) found that rural residents bypass their local hospital for almost half of surgical procedures. People who are younger and have younger and have private insurance were more likely to bypass rural hospitals, and low-volume hospitals were also more likely to be bypassed. This last finding may suggest a signaling mechanism or feedback loop, but Weigel et al. recommended that rural hospitals may be able to overcome bypass trends by improving community awareness of services and perceptions of quality. They found that obstetrics had a lower bypass rate. Kozhimannil et al. (2014) noted that childbirth is the most common reason for hospitalizing in the U.S. but that the availability of rural obstetric services has decreased from half of rural hospitals in the 1980s to just one fifth in the early 2000s. Hospitals have cut obstetric units to save costs, but this decision may have deleterious effects for both economies and patients, including obstetric and general surgical care (Moscovice and Rosenblatt, 1985a; Klein et al., 2002).

Rural hospitals often operate in declining economies with limited resources (Moscovice and Rosenblatt, 1985b; Succi, Lee, and Alexander, 1997). Hart, Pirani, and Rosenblatt (1991) surveyed mayors of rural towns with hospitals that closed between 1980 and 1988. Economic effects were most commonly noted by mayors as one of the most important outcomes of hospital closure, with more 63.4 percent counting them among the top three outcomes. In fact, more than 90 percent said their community's economic status was worse following the closure. Among the top three reasons for closure, government reimbursement policies ranked first (40.1 percent of respondents), followed by physician shortages (38.4). Interestingly, the role of structural issues such as population and poverty ranked fifth with much smaller than the share (26.5) that identified reimbursements and physician shortages as among the top three reasons for closure.

The ability to recruit and retain health professionals is a critical aspect of maintaining rural hospitals (Moscovice and Rosenblatt, 1985b; Allen et al., 2015). Only 12 percent of physicians serve the quarter of Americans who live in rural areas, and the average rural surgeon is more than 50 years old (Avery and Wallace, 2016; Halverson et al., 2013). Moscovice and Rosenblatt noted the symbiotic relationship between doctors and hospitals with doctors needing the hospital to provide comprehensive care and for income and hospitals needing doctors to "fill hospital beds" (p. 26). They posited that the loss of just one doctor can be fatal to a rural hospital and cite reasons for difficulty in attracting and retaining doctors from Davis and Marshall (1977): "lack of complete medical facilities; professional isolation; limited support services; insufficient continuing medical education opportunities; inadequate organizational frameworks, including lack of group practices; excessive workload and time demands; economic disincentives; insufficient social, cultural, and educational opportunities; and spouse influence" (Moscovice and Rosenblatt, 1985b, p. 27). Those same reasons still hold true 40 years later. They suggested that regional health centers may balance the needs of both rural physicians and patients. Several studies estimate demand for health care providers by specialty in terms of population ratios (Hicks and Glenn, 1991; Fields, Bigbee, and Bell, 2016). Fields, Bigbee, and Bell found that the population ratio for providers decreased with as rurality (measured by rural urban continuum codes) increased.

Data

To estimate the effects of various social and economic factors on the density of primary care physicians, county level data were collected from several publically available data sources. Many studies of rural areas rely on county-level data to facilitate data availability. Certainly, many rural communities and areas are found within urban counties. For example, as of 2013, Oldham County, Texas, falls within the Amarillo Metropolitan Statistical Area (MSA) based on residents' commuting patterns, even though the county's 2010 population of only 2,052 was 100 percent rural with no urban clusters let alone urbanized areas. On the other hand almost 50,000 people live in rural areas within Harris County, Texas's most populous county. The rural population of Harris County exceeds the entire populations of 191 individual Texas counties as well as the combined population of the state's least populous 29 counties.

However, county level data, including doctors per capita, is publically available at the county level but not at finer levels of resolution. Further, in rural counties, hospitals and medical centers tend to serve the county. They may be located in the largest town in the county, often but not always the county seat, and serve the populations of other towns and rural areas within in or beyond the county. The availability of doctors in rural areas is a growing concern. The number of physicians working in each county is collated by the Robert Wood Johnson Foundation's County Health Rankings Program (2017) based on data from Area Health Resource File (U.S. Department of Health & Human Services, 2017).

The population served within a county is measured by the county population. Counties with smaller populations or less dense populations might be expected to have fewer doctors. Declining populations might also signal a need for fewer physicians. While older populations may need more care, they can also signal decline, and low Medicare reimbursement rates have been called out as a reason for rural hospital closures. There is some evidence that areas with high minority populations have less access to healthcare services (Kaufman et al., 2016; Ko, Cummings, and Ponce, 2016). County population totals and populations breakdowns by ethnicity and age were collected from 2000 and 2010 U.S. Census Data and the 2016 5-year estimates from the American Community Survey. Only 5-year estimates are available for rural locations so these estimates were used for all counties. Counts of the rural and urban populations within each county were only available from the 2010 U.S. Census (2017c). Rurality was expected to reflect cluster of populations. Specific data tables within each source are provided in Table 1.

In addition to analyzing the percent of the rural population living in rural areas, counties were classified based on the USDA-ERS rural-urban continuum, which includes counties within metropolitan areas under codes 1, 2, and 3, on to counties with smaller populations at codes 8 and 9 (Parker, 2013). The typologies were used in classifying county rurality for descriptive purposes; however, the Census data on rural populations was more useful for modeling purposes. For example, Oldham County, Texas, described above, is coded as a 2 (counties in metro areas of 250,000 to 1 million population) in 2013. Prior to 2013, Oldham County was classified as an 8 (nonmetro county completely rural or less than 2,500 urban population, adj. to metro area) in the 2003 ERS typology.

Table 1. Variables and Sources.

Variable	Data Year	Source
Primary Care Physicians per 100,000 population	2016	Robert Wood Johnson Foundation's County Health Rankings Program (2017); U.S. Department of Health & Human Services (2017)
Population total	2000	U.S. Census Bureau, 2000 Census
Population total	2010	U.S. Census Bureau, 2010 Census
Population total	2016	U.S. Census Bureau, 2016 Population estimates
Population density	2016	U.S. Census Bureau, 2016 Population estimates and land area (2010)
Population over age 65	2016	U.S. Census Bureau, 2016 ACS 5-year estimates
Population by race & ethnicity	2010	U.S. Census Bureau, 2010 Census
Population by race & ethnicity	2016	U.S. Census Bureau, 2016 ACS 5-year estimates
Urban/rural population	2010	U.S. Census Bureau, 2010 Census
Rural-urban continuum code	2013	U.S. Dept. of Agriculture, 2013
Frontier status	2010	National Center for Frontier Communities, 2012
% of residents uninsured	2016	U.S. Census Bureau, 2016 ACS 5-year estimates
% public and private insurance (including Medicare and Medicaid)	2016	U.S. Census Bureau, 2016 ACS 5-year estimates
Medicaid expansion state	2017	Kaiser Family Foundation
Population in poverty	2016	U.S. Census Bureau, 2016 ACS 5-year estimates
Population with some college	2016	U.S. Census Bureau, 2016 ACS 5-year estimates
Workforce working inside the county	2016	U.S. Census Bureau, 2016 ACS 5-year estimates
Workforce working in agriculture and natural resources	2016	U.S. Census Bureau, 2016 ACS 5-year estimates
Households without broadband	2016	U.S. Federal Communications Commission
Law offices per 100,000 population	2015	U.S. Census Bureau, Business Patterns, NAICS 54111
Supermarkets per 100,000 population	2015	U.S. Census Bureau, Business Patterns, NAICS 445110

Frontier status was considered as a means to capture a host of measures related to less dense, more remote populations that tend to lack a number of services (Hart, Pirani, and Rosenblatt, 1991; National Center for Frontier Communities, 2012). State offices of rural health collaborate with the National Center for Frontier Communities to designate frontier counties, although Arizona, California, and Hawaii use designations of alternative places, such as sub-county areas. Most frontier counties are located west of the Mississippi River, although some are scattered throughout the U.S. Frontier status was associated with the rate of physicians in Texas, but was correlated with and deemed to represent other variables, including remoteness, density (Dudensing, 2017b).

Concerns about the effects of insurance status and reimbursement policies on the viability of rural hospitals and health systems (Capps, Dranove, and Lindrooth, 2010; Kaufman et al., 2016) led to the inclusion of Census data on uninsurance, public insurance (both Medicare and Medicaid), and private insurance (U.S. Census Bureau, 2017a). A dummy variable was included to denote Medicaid expansion under the ACA (Kaiser Family Foundation, 2018), as expansion has been linked to fewer hospital closures within a state (Lindrooth et al., 2018). Thus expansion might also be expected to be associated with an increase in doctors within a state. Expansion was linked to higher probabilities of having health insurance and was found to increase Medicaid coverage more in rural than urban areas, some of which may have been due to switching from private insurance to Medicaid (Soni, Hendryx, and Simon, 2017). Non-expansion states were found to have a larger share of rural and black populations (Soni, Hendryx, and Simon, 2017), which may have an interesting relationship with findings that minority populations tend to be underserved in healthcare as described above and with findings that Southern states have historically faced a larger number of hospital closures relative to other regions (Hart, Pirani, and Rosenblatt, 1991; Probst et al., 1999; North Carolina Rural Health Research Program, 2017).

Poverty and educational attainment were included as estimates of the county's economic health and prosperity (U.S. Census Bureau, 2017a). The share of the county workforce that worked within the county (U.S. Census Bureau, 2017a) was included to measure the county's ability to retain residence within the county as out-commuting is assumed to indicate economic and service opportunities may be greater outside the county, indicating reduced demand for local health services, at least among employed populations.

The percent of households in the county without broadband (U.S. Federal Communications Commission, 2016) was included to reflect infrastructure and technology available to both doctors and to other local businesses and households. Broadband is increasingly important to medical systems, especially with electronic records (Hilsenrath and Fischer, 2013; Skillman et al., 2015). Broadband is also a measure of the opportunity for local business owners to conduct e-commerce and of quality of life infrastructure for households in an age where people are increasingly likely to watch “television” online rather than on the actual television. Telemedicine may provide opportunities to enhance patient care in rural areas. Telecommunication has long been seen as a method to help rural health professionals access colleagues and services in larger communities (Mosovice and Rosenblatt, 1985b).

The number of law offices was collected from County Business Patterns data (U.S. Census Bureau, 2017b). Law offices per capita were intended as a proxy for other professional services available locally. The measure also provides a rough estimate of other educated professionals with whom doctors might find common ground as several articles note that highly educated doctors tend to eschew rural areas in favor of urban areas with more cultural opportunities and like-minded people. Of course, this measure does not address the concern that doctors in rural areas have fewer colleagues with whom to share workloads and discuss patient diagnoses. The number of supermarkets in the county was similarly considered as a reflection of the availability of key local services and also due to related news media articles regarding rural grocery stores and their closures.

Model

A simple OLS regression model is used in this paper. Spatial relationships were not found to be significant in previous work in Texas (Dudensing, 2017). However, they will be included in future work by the authors, as this is paper reflects early, exploratory stages of this analysis. Essentially, the number of primary care physicians (PCP) per 100,000 people in a county is expected to reflect the demographics (population density, rurality, race, ethnicity, poverty, education, and age) and demographic change (increases or decreases in population) of the county, the shares of uninsured and insured (private and public, including Medicare and Medicaid) residents, and the county economy (out-commuting, agriculture and natural resource employment, the presence of other professional services, and the availability of broadband). Unsurprisingly, several of these explanatory variables are correlated; for example, the various insurance measures are inter-correlated and also correlated with other measures, including share of the population in poverty and over age 65. Potential variables were culled to reflect all aspects expected to influence the physician rate while minimizing correlations that suggest variables may be measuring similar factors and unduly biasing estimators. The equation for the number of primary care doctors per 100,000 people in a county is represented:

(1) $$PCP100K = \beta_0 + \beta_1\%Rural + \beta_2 PopDensity + \beta_3\%ChPop00\text{-}16 + \beta_4\%Hispanic + \beta_5\%Black + \beta_6\%Uninsured + \beta_7\%Medicare + \beta_8\%Medicaid + \beta_9\%Expansion + \beta_{10}\%College + \beta_{11}\%Commute + \beta_{12}\%ANREmp + \beta_{13}Law100K + \beta 1_4\%woBroadband + \varepsilon,$$

where β are estimated coefficients, variables are defined in Table 2 below, and ε is an error term. The error term is expected to be large as many other intangible factors are also likely to influence physician's location choices.

Table 2. Regression Variable Descriptions

Variable Name	Description
PCP100K	# of primary care physicians per 100,000 population (2016)
%Rural	% of county residents living outside urbanized areas or urban clusters (2010)
PopDensity	# of people per square mile of land area (2016)
%ChPop00-16	% change in total population between 2000 and 2016 (2000, 2016)
%Hispanic	% of 2016 population that is Hispanic (2012-2016)
%Black	% of 2016 population that is African American (2012-2016)
%Uninsured	% of civilian, noninstitutionalized population that lacks health insurance (2012-2016)
%Medicare	% of civilian, noninstitutionalized population with Medicare health coverage alone (2012-2016)
%Medicaid	% of civilian, noninstitutionalized population with Medicaid health coverage alone (2012-2016)
Expansion	Dummy = 1 if county in state that expanded Medicaid in response to the Affordable Care Act (ACA) (2017)
%College	% of population over age 25 with any post-high school education (2012-2016)
%Commute	% of workers age 16 and over commuting outside the county to work (2012-2016)
%ANREmp	% civilian employed population working in agriculture, forestry, fishing and hunting, and mining industries (2012-2016)
Law100K	# of employer law establishments per 100,000 population (2015)
%woBroadband	% of population without broadband access (2016)

Results

Overall, regression results conform to most prior literature and anecdotal evidence, but with an R^2 of 0.354, the results are not exceptionally robust. As expected, there are many factors in the error term, some of which may be intangible and others of which are variables not captured in much of the literature or by the creativity of the authors. Population and economy variables were more significant than were variables related to health insurance despite literature and media interviews discussing the role of insurance (Table 3).

Table 3. Results of Primary Care Physicians per 100,000 population estimation.

Variable	Coefficient	Standard Errors	t-test	Prob(t)
Intercept	**20.1198**	**6.8711**	**2.9282**	**0.0034**
%Rural	**-0.1218**	**0.0267**	**-4.5551**	**0.0000**
PopDensity	**0.0011**	**0.0003**	**3.5090**	**0.0005**
%ChPop00-16	**-0.1075**	**0.0352**	**-3.0511**	**0.0023**
%Hispanic	**-0.2082**	**0.0510**	**-4.0857**	**0.0000**
%Black	-0.0855	0.0895	-0.9545	0.3399
%Uninsured	0.0738	0.1598	0.4619	0.6442
%Medicare	0.5079	0.3547	1.4322	0.1522
%Medicaid	0.0963	0.1296	0.7428	0.4576
Expansion	**3.1834**	**1.2603**	**2.5260**	**0.0116**
%College	**1.1547**	**0.0790**	**14.6160**	**0.0000**
%Commute	**-0.4853**	**0.0357**	**-13.5912**	**0.0000**
%ANREmp	**-0.7111**	**0.0987**	**-7.2043**	**0.0000**
Law100K	**0.0432**	**0.0120**	**3.5990**	**0.0003**
%woBroadband	**-0.0752**	**0.0211**	**-3.5738**	**0.0004**

R^2 = 0.354, Adj. R^2 = 0.351

Within demographic variables, the percent of the population residing in rural areas, or the percent of the county population residing outside urbanized areas or urban clusters, was associated with fewer PCP per 100,000 people. The number of PCP increased with higher county population densities. These two variables measure different concepts with population density being a measure of the population across a standardized size metric (miles) and the percent rural measuring the dispersion of people within the county. Between two counties with similar densities, one may have dispersed population with no urban cluster and fewer PCP while the other may have a strong urban cluster that may be more attractive to doctors.

Population growth between 2000 and 2016, as a percent of 2000 population, was associated with fewer PCP per 100,000 residents, which initially appears counterintuitive. However, this likely indicates that the population of PCP does not grow as quickly as the general population. The PCP rate in less populous counties often exceeds that of more populous counties simply because the denominator is smaller. Population growth increases the denominator. There is also evidence in rural healthcare discussions that doctors in rural counties may be “sticky;” that is, counties are reluctant to give up their hospital and doctor as they decline, resulting in a higher PCP. There is also evidence that rural doctors may age in place and remain in service in their county.

Counties with larger shares of minorities had fewer PCP per 100,000 people. The Hispanic share of the population had a significant negative association with the PCP rate. Despite literature the describing the relationship of minorities and rural healthcare provision, the Black share of the population was not significant in any regressions, although it was consistently negative. The magnitude of the coefficient was also smaller in absolute value than the coefficient on the Hispanic population share. Both the Black and Hispanic shares were moderately correlated with the share of the noninstitutionalized civilian population without health insurance (0.36 and 0.41, respectively). There was also a modest correlation (0.25) between percent Black and the share of the noninstitutionalized civilian population on Medicaid. In both cases, the Black population share remains insignificant even when these insurance variables are excluded from the model. Despite commentary on the number of Southern states that did not expand Medicaid, dummy variables for Census regions were not significant.

The percent of the noninstitutionalized civilian population without health insurance (uninsured), with Medicare alone, and with Medicaid alone all had positive coefficients, which was unexpected. However, these variables were not significant. Medicaid and Medicare shares were correlated with the share of the population in poverty and the share over age 65 (0.71 and 62). Replacing Medicaid with the share of the population in poverty resulted in a negative (expected sign) but insignificant coefficient. Interest in following the literature in examining the effects of Medicaid were given emphasis in this study. It is possible that increased adoption of Medicaid, especially the increase following implementation of the ACA, increased demand for doctors in these counties.

In alternative regressions, the coefficient on the population over age 65 was positive and significant at the $\alpha=5\%$ level. A larger share of the population over 65 would be expected to increase the need for doctors as people generally need more healthcare as they age. The variable measuring the share of the population on Medicare alone may be overwhelmed by the positive effect of older populations. However, many older Americans have both Medicare and private insurance.

The coefficient for the dummy variable indicating the states that had expanded Medicaid in response to the Affordable Care Act (ACA) was significant and positive. However, the expansion variable was very sensitive to variable coding. Maine voted to expand Medicaid in November 2017; clearly expansion had not occurred prior to 2016. When Maine was coded as not having expanded, the expansion variable was not significant. Wisconsin was coded as having expanded access to Medicaid due to its state program allowing Medicaid up to 100% of the federal poverty level even though the state has not voted for ACA-related expansion. Without the state being coded as having expanded access, significance was only at the α=10% level. The relative instability of this result is disconcerting given that states have adopted expansion rules at different times so the data is not clear-cut. However, the positive coding for Maine and Wisconsin were deemed appropriate as the legislation in those states demonstrates a dialog and attitude toward Medicaid access more in line with states that had adopted expansion. At minimum, the results provide a point for further study and discussion.

All economic variables were significant. The share of the population with some post-high school education was positively related to the number of PCP per 100,000 population. The share of the workers who commuted outside the county to work had a negative association with the PCP rate. People who are already leaving the county for work may seek other services outside the county as well. The share of the population working in agriculture, forestry, fishing and hunting, and mining industries also had a negative relationship to the PCP rate. Many workers in these industries are self-employed and live in remote and frontier areas; stories of farmers struggling to find and afford insurance providers on the open exchange abound.

The number of employer law establishments in a county was positively and significantly associated with the PCP rate, perhaps reflecting the presence of a trade or service center. A place with demand capable of supporting law firms may be more likely to be able to support more was doctors as well. The law establishment variable may also represent the presence of other educated, professionals in the county. The share of the county population without access to broadband was significantly and negatively associated with PCP per 100,000 population. Broadband reflects local infrastructure, and it is a key infrastructure for healthcare in an age of electronic records, telemedicine, and patient web portals.

Discussion and Conclusion

Much of the discussion surrounding closures of rural hospitals and shortages of rural doctors focuses on the economic and health outcomes of a community losing a health care facility or provider. Yet, as noted by Probst et al. (1999), closures do not occur at random. This study does not attempt to establish causality but rather relationships between the local economy and the rate of primary care physicians (PCP) per 100,000 people at the county level. Demographic and economic variables were found to be more significant in determining the PCP rate than were insurance- related variables.

These findings are in line with the existing literature. Rurality and Hispanic share of the population were negatively associated with the PCP. This study measures rurality based on the share of the population living outside urbanized areas and urban clusters, which provides a somewhat different view of rurality than relying on rural urban continuum codes while commuting patterns are including as economic variables. Population density had a positive association with the PCP rate, and percent change in the population from 2000 to 2016 had a negative association, suggesting that changes in the physician population lag changes in the broader population.

Economically, the shares of out-commuting workers, agriculture and natural resource employment, and population without broadband access were negatively associated with the PCP rate. Share of the population with a college degree and the number of employer law establishments per 100,000 people had a positive relationship to the PCP rate, possibly indicating the importance of the county as a regional trade center or the importance of an educated, professional class in attracting and retaining physicians.

Public insurance reimbursement rates are often cited as a major challenge for rural health facilities. However, being located in a Medicaid expansion state was the only insurance variable significantly associated with the PCP rate, and significance of that variable was dependent upon how expansion was defined, including the time frame considered for expansion and the adoption of similar policies but not actual ACA expansion legislation. More work should be done to explore the effects of expansion.

This work is still in early stages and much work remains to be done. While spatial aspects were not found useful to modeling the PCP rate in Texas counties, they may be of interest at the national level. There are continually more variables of interest, and future research is planned to address inclusion of additional health facility and health outcome data. The role of trade centers and labor market areas in healthcare provision should also be included at the national scope.

Healthcare is an important service to individuals and families, and it plays a significant role in rural economies. However, as provider ratio studies suggest, some counties may not be able to support a hospital or physician on their own. Results of this study should encourage economists and community leaders to consider rural communities' impending healthcare losses in the light of broader economic and demographic trends. As noted by Moscovice and Rosenblatt (1986b) more than 30 years ago, regional service provision may meet the needs of both doctors and the rural patients they serve.

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