Diffusion of Physicians and Access To Primary Care: The Role of Person, Program, and Place

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I. Executive Summary/Key Findings

The local supply of physicians in any community, especially smaller and rural communities, depends on a flow of physicians into those communities from the places where they train or from more populous places that may have more than enough physicians to meet population needs. The factors that influence whether a physician will move from one place to another depends on their ***personal*** characteristics, the ***places*** from and to which they move, and the ***programs*** that support or inhibit those moves. The federal government administers over 30 programs designed to address the needs of underserved areas and populations designated as Health Professional Shortage Areas (HPSAs). Those programs need to know which physicians are more likely to go into which communities to better target their resources for recruiting physicians to underserved communities. This research brief explores whether it is possible to predict that a place will become more or less underserved based on the personal characteristics of physicians, especially primary care physicians, the characteristics of the counties from and to which they move, and their likelihood to move into or out of rural places. Our goal is to develop guidance for federal policies that encourage physicians to practice in underserved places or that support physicians in those communities. We also wish to determine if it is possible to identify places that may become underserved and eligible for HPSA status or, conversely, to identify those places that may lose HPSA designation.

CONCLUSIONS AND IMPLICATIONS FOR POLICY

1) **It is not currently possible to generate models that predict who will move into or out of a rural HPSA or which rural HPSAs are more or less likely to attract physicians.**
2) **Federal programs and incentives that seek to promote practice in underserved communities are only one of a number of factors that influence a physician's choice of practice location.**
3) **We have seen an overall steady and relatively well-distributed pattern of growth in physician supply. At the same time we have seen an overall increase in the number of areas designated as HPSAs despite growth in provider supply.**
4) **Analyses need to be conducted over a longer time period at a more fine-grained level to better understand the role of physicians serving in underserved places.**
5) **The cumulative effect of federal policies in reducing or eliminating geographic shortages is not known. A comprehensive evaluation is needed to judge the effects of current policies and factors that influence choice of location or the potential for emerging underservice.**

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We analyzed multiple years (2006, 2011, and 2013) of individual physician characteristics for all physicians in active practice in the United States, as well as the characteristics of US counties. We used descriptive analysis to characterize the physicians who moved into and out of underserved areas and we also examined the characteristics of the counties from and to which they moved. Physicians, primary care and specialists alike, continue to move between places: from one county to another and from state to state. In the seven-year period 2006-2013, 36.4% of all active physicians moved from one county to another and 18.6% moved from one state to another. A substantial portion of physicians were "diffusing" from urban places to rural, but also, returning to urban places from rural places. These moves took place in a background of an overall 2.8% growth in the number of active, practicing physicians between 2010 and 2012.

We focused our analyses on diffusion of primary care physicians into and out of rural underserved (HPSA) counties as these places have potentially the greatest need for primary care practitioners and the lowest levels of access. These are also the places on which multiple federal programs focus their efforts to enhance access. We found that selected physician characteristics were associated with a greater likelihood of a physician moving from any urban place to a rural underserved area. These factors included recently completing a residency and attending a public (state-supported) US medical school. We also found that females and medical specialists were less likely to move to underserved areas—despite the fact that females, overall, were more likely to move from one county to another county than relative to males. These tendencies suggest that it might be possible to focus programs on specific sets of physicians, but the tendencies observed were not sufficiently strong enough to recommend targeting specific physicians for recruitment into programs.

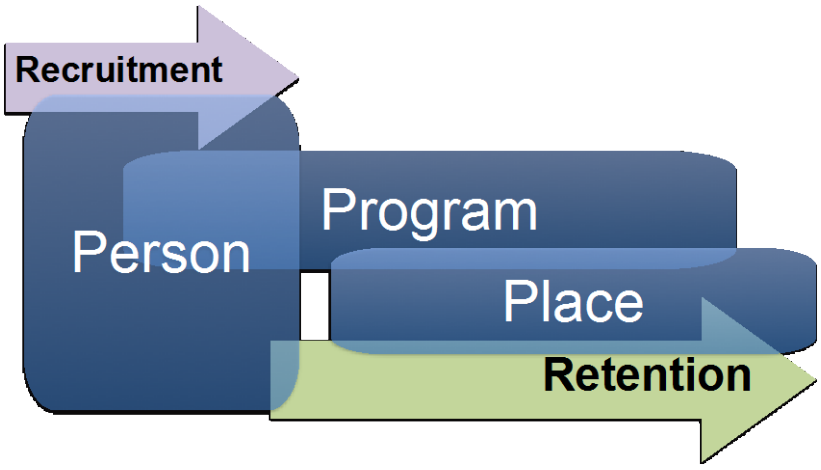
We also found a similar pattern when we examined county characteristics and the likelihood of one type of county attracting more physicians than another, or, more importantly, fewer physicians. Few of the variables that described the counties were strongly associated with the likelihood of having a physician move into a rural underserved area. We did find that the presence of a Critical Access Hospital was an attractor of physicians to a rural underserved area, while the location of a Federally Qualified Health Center (FQHC) in such a county tended to be negatively associated with such a move.

The overall results were not strong and were somewhat counterintuitive. The data did not support the idea that a strong and reliable model predicting physician movement into or out of HPSAs could be generated. Nor was it possible to predict which counties would become more or less in need of federal support and designation or withdrawal of designation as a HPSA. The analyses need to be conducted over a longer time period at a more fine-grained level to better understand the role of physicians serving in underserved places.

II. Background

Federal and state policies try to influence physician location choices using a combination of **programmatic** or extrinsic factors (e.g. bonus payments, subsidized loans) and **personal** or intrinsic factors (e.g. promoting volunteerism, orienting trainees to underserved populations and selecting motivated students) to encourage physicians to practice in communities where the population has difficulty accessing medical care.[1] A useful review of federal incentive and support programs can be found in a Congressional Research Service summary issued in 2013.[2] Prior research on the factors that affect physician practice location have focused primarily on programmatic and personal factors that influence recruitment and retention, with less attention to the third class of influences, the role of the **place** (e.g. infant mortality rate, unemployment rate, per capita income, presence of a Community Health Center or Critical Access Hospital, etc.) in determining practice location. These "domains" of influence on recruitment and retention are depicted graphically in **Figure 1** with a rough approximation of the temporal influence of the three factors on the choice of location. This figure is based upon prior research on recruitment and retention cited in the text that follows.

Figure 1. Domains of Factors Affecting Recruitment and Retention in Underserved Communities



The literature on this process falls primarily into two classifications: "recruitment" to underserved places and "retention" within those places. This work is generally restricted to primary care physicians with some attention being paid to general surgeons[3] and psychiatrists.[4] The research into these topics finds that most of the sociodemographic or individual characteristics of the health care provider (e.g., age, gender, specialty within primary care) do not have much effect on the likelihood of a physician being recruited or retained in an underserved community. Personal motivation and a background in rural or underserved communities are associated with higher rates of recruitment and retention.[5,6] There are specific programs whose characteristics are associated with higher rates of overall placement into underserved communities[7] and with some program factors associated with long-term retention.[8] These programs include those with a specific focus on placement in rural and underserved areas through selective admissions and specific training in the sites, including so-called "Rural Training Track" programs (see **Appendix 1**) and Health Center programs, but their contribution to the overall numbers of practitioners going into underserved places is relatively small. As of August 2015, there were approximately 39 such programs and their combined first-year

enrollment was 162.[i] These programs are supplemented by other focused medical school efforts, such as the Physician Shortage Area Program (PSAP) at Thomas Jefferson University Kimmel Medical College that selects students likely to practice in underserved areas and directs them into the appropriate residency programs. Their impact may be substantial, but not necessarily sufficient to reverse the problem of physician maldistribution. Also, the impact of these programs is small compared to the "natural" flow of physicians into and out of rural underserved areas. Over a typical five year period in the past two decades, approximately 1,500 physicians across the United States move into a whole-county, rural underserved area[9] and approximately 8-10 times that number into part-county rural HPSAs.[ii] Most physicians who go into underserved areas are trained in programs intended to influence their choice of practice location.

Given the current output of rural-focused residency programs it is likely that there are fewer than 250 physicians per year with this preparation in a residency. This number does not include the physicians with a portion of their residency training in rural AHEC centers or rural clinic placements. The AHEC program is one of several HRSA efforts intended to influence physician location and specialty choice.[2] These include multiple subsections of Title VII of the Public Health Services Act including §§747-749 supporting training in primary care especially §749A to support Teaching Health Centers and §749B that authorizes grants to institutions to train physicians to work in rural communities. The Area Health Education Centers Program (§751) has funded outreach and distributed training programs, as well as conducted extensive recruiting efforts. These are not all of the programs supported through federal policy designed to place physicians into or promote retention in rural areas. For example, the Veterans' Administration supports rural clinics and telemedicine programs and the Indian Health Service funds clinics and hospitals in rural underserved places. These federal programs combined with state programs promote a web of support to eliminate or reduce geographic imbalances in physician distribution. Unfortunately, there has not been a combined evaluation of these efforts, making it difficult to assess the actual effects of federal and state programs.

The central hypothesis of this project is that physician diffusion can be estimated based on the characteristics of the places physicians go to and come from. These characteristics may reflect the need for primary health care services in a community as well as the influence of institutions such as hospitals or other health services infrastructure that act as a “magnet” for the physician workforce. The focus of this report is on locations that are eligible for placement incentives from the federal government based on their designation as Health Profession Shortage Areas (HPSAs), but which may or may not have physicians recruited to them, as well as those places that could become HPSAs. The literature on place-based effects of the migration or "diffusion" of physicians has examined multiple cohorts of practitioners and their locations over time and has built on older economic studies of physician practice location choice for primary care physicians. These studies have summarized the patterns of location change, but are not specific to underserved areas[10,11,12,13,14,15,16,17,18,19,20] and surgeons.[2]

[i] https://www.raconline.org/rtt/rtt_list see **Appendix 1** for a list of the programs and their annual output of physicians.
[ii] These estimates are extrapolated from data reported in Ricketts, T. C. and R. Randolph. 2007. “Urban-rural flows of physicians.” *J Rural Health* 23(4): 277-85, Ricketts, T. C. and R. Randolph. 2008. “The diffusion of physicians.” *Health Aff (Millwood)* 27(5): 1409-15.

III. Methods

This analysis makes use of multiple years of the American Medical Association's (AMA) Physician Masterfile® that have been linked by the unique identifier for each physician in the files. The individual-level data sets included all physicians in the Masterfile at the end of calendar years 2006 and 2013. The data for physicians change over time to reflect changes in location, practice activity, training and specialty. Thus, the 2013 file may show a different practice location, activity status, and even specialty for any given physician compared to earlier years. The Masterfile has recognized flaws, especially in the timeliness of the data for retiring and expiring physicians, but remains the sole source of continuously and consistently collected data on individual physicians.[22,23,24] The match process involved a merge of two separate files linked by the unique physician identifier assigned by the AMA. We excluded physicians identified as inactive and "dead". Those over 79 years of age and those in federal employment were also excluded. The resulting files were compared to published reports from the AMA, the Federation of State Medical Boards, and HRSA describing the physician supply.[25,26,27] This comparison serves as a quality control mechanism to assess the quality and accuracy of the data. Individual physician data from the Masterfile were linked with county level data compiled in the Area Health Resources File (AHRF) that include US county-level data including demographics, health care resources, payment data for Medicare and Medicaid and selected designation data for Health Professions Shortage Areas (HPSAs). Core Based Statistical Area designations were used to designate non-Core and Core counties (from this point we will use the term rural instead of non-Core, and urban instead of Core). Findings from this analysis were compared to earlier work that examined physician diffusion patterns between 2006 and 2011 and earlier years.[28,18]

The analysis was divided into two parts: the first was the analysis of the moves of physicians from place to place over time. As primary care physicians are the group of practitioners targeted in most federal programs, the analysis focused on that group. The locations of practice in 2006 and 2013 were available by address including ZIP code and county. Physicians who moved from one ZIP code to another, from one county to another, and from one state to another were flagged. The distance of each move was also calculated by a ZIP code to ZIP code distance algorithm (GEODIST in Stata). The primary focus of the analysis was on the characteristics of the physicians who moved, especially those who moved into and out of rural underserved areas (HPSAs). This builds on the study of migration of physicians reported by Ricketts et al.[21,28,18] The second part of the analysis was to merge county-level data to each physician file in order to describe the local community factors. County-level data may not accurately characterize urban areas, but are more likely to provide accurate depictions of local conditions for most rural areas as there is more often one dominant community in a rural county. These county characteristics were used to characterize those rural underserved counties where physicians went to or left from.

V. Results

Changes in Overall Primary Care Physician Supply

To place the movement of physicians in context we can look at the national change in physician supply, as this is likely to influence patterns of movement if more or fewer physicians enter practice.

Overall, the United States saw a rise in the number of all actively practicing patient care physicians between 2010 and 2012 from 857,976 to 882,597 (2.8%). This growth in numbers also applied to primary care physicians delivering patient care, which increased from 229,154 to 237,346 (3.6%).[iii] The change in supply was not consistently positive across all counties, **Table 1** summarizes the numbers of counties that saw gains of greater than 3% (1,267 or 39.2% of counties); losses of greater than 3% (972 of 30.1%) and those counties that showed changes of less than 3% in either direction (991 or 30.7%).

Rural underserved counties, which are the focus of our analysis, saw an overall growth rate less than half the national rate. The total supply of active primary care physicians increased on average by 3.5% across all US counties. Urban counties had 3.6% growth; rural HPSAs had an overall gain of 1.4%. Interestingly, rural non-HPSAs showed an overall 1.6% loss. In contrast to the overall proportional change across the categories of counties, there were nearly equal proportions of individual counties in each group who saw gains or losses.

Table 2 shows that rural HPSAs more often gained in their physician-to-population ratio (n=272) than lost (n=167) with a similar number keeping roughly the same ratio. These patterns of change suggest progress is being made to distribute primary care physicians to these places. The categorization of the HPSAs also offers a framework in which to study the movement of individual physicians into and out of these counties and a basis to evaluate HRSA programs.

Table 1. Change in Primary Care Physician to Population Ratio, US Counties 2010-2012

Change of >3%±	Number counties	Percent.
Gain	1,267	39.2%
Loss	972	30.1%
None	991	30.7%
Total	3,230	100.00

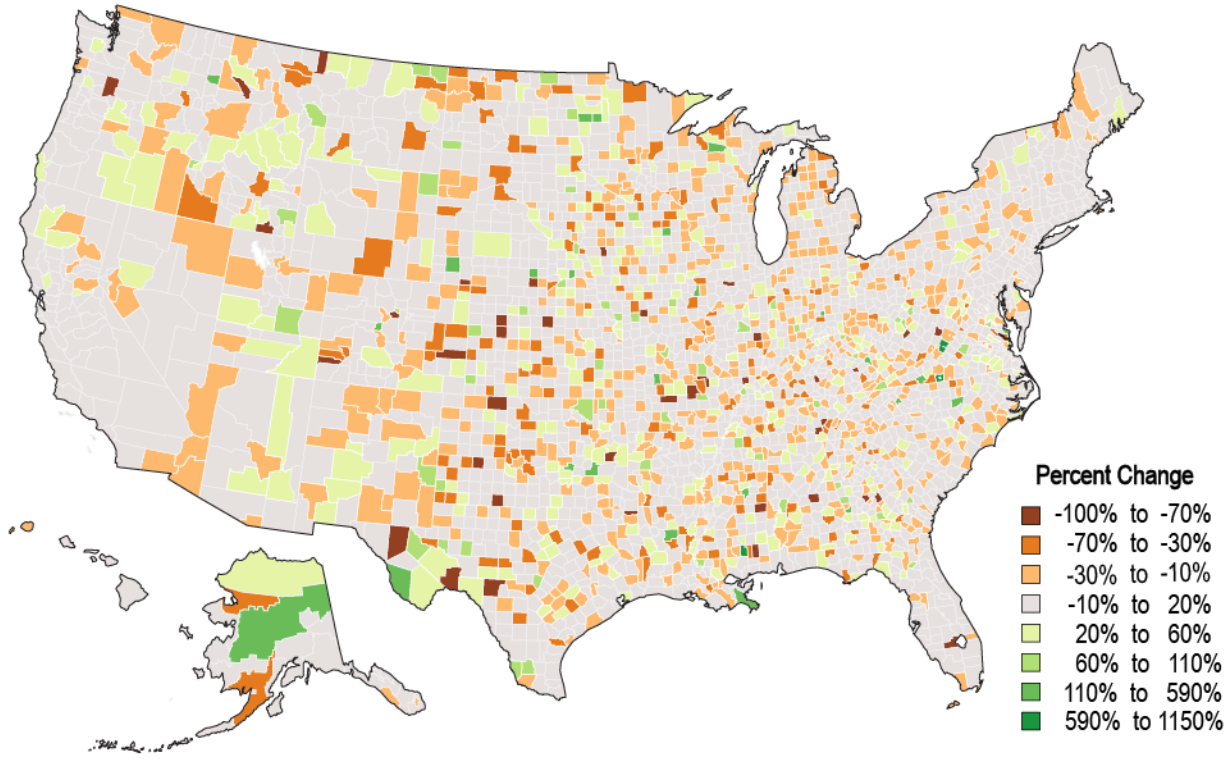
Table 2. Change in Primary Care Physician to Population Ratio, US Counties by HPSA Status 2010-2012

Change of >3%±	Urban	Rural HPSA	Rural Non-HPSA	Total
Gain	948 (38.2%)	272 (43.7%)	47 (37.9%)	1,267 (39.2%)
Loss	758 (30.5%)	167 (26.8%)	47 (37.9%)	972 (30.1%)
None	777 (31.3%)	184 (29.5%)	30 (24.2%)	991 (30.7%)
Total	2,483 (100%)	623 (100%)	124 (100%)	3,230 (100%)

[iii] These changes are based on AHRF data for 2010 and 2012 included in the 2014 version of the file

The overall change in supply and the gains and losses of physician in rural and urban counties may have had a specific geographic pattern. However, a map of counties in the United States with net change between 2010 and 2013 (using the AMA data) does not show any regional trends in the gain or loss of primary care physicians to population. (**Figure 2**)

Figure 2. Percent Change in Primary Care Physician to Population Ratio, 2010-2013, US Counties



Source: Carolina Health Workforce Research Center, Program on Health Workforce Research and Policy, Cecil G. Sheps Center for Health Services Research, University of North Carolina at Chapel Hill, with data derived from the American Medical Association Physician Masterfile, 2010-2013.

Patterns of Diffusion—Physicians in all Specialties

While the focus of the analysis of underserved areas is on primary care physicians, we examine the background of overall movement of all specialties and examine primary care physicians as an analytic component. For the period 2006-2013, of the 791,503 physicians actively practicing in the 50 United States and the District of Columbia and included in the AMA Masterfile files for those years, 288,486 (36.4%) physicians moved to a different county. This compares to 26.9% making an inter-county move between 2006 and 2011.[iv] In the analysis of the 2006-2011 moves, physicians who were in post-graduate (residency) training in 2006 were much more likely to have moved to another county or state in 2011 (64.07% and 47.4%, respectively). In the analysis of the 2006-2013

[iv] The data include physicians who report an active practice in both years. Since the data are based on the baseline year of 2006, the results for both 2011 and 2013 will include the same total of physicians. Physicians may have moved prior to or after the initial date but left the file either through retirement or death.

data, again, physicians who were residents-in-training in 2006 were also much more likely to make a geographic move: 74.5% of 111,103 physicians in residency training in 2006 had moved to another county by 2013 compared to 30.2% and 12.8% of physicians who were not in training in 2006. The volume of inter-county and inter-state migration between 2006 and 2013 continued the trends observed in the 2006-2011 comparisons. **Table 3** summarizes the physicians who moved between counties and states between 2006 and 2013.

Table 3. Inter-County and Inter-State Movers, 2006-2013

2013	Not in Training in 2006	%	Resident in 2006	%	Total	%
Same State	593,178	87.2%	51,095	46.0%	644,273	81.4%
Move State 2013	87,222	12.8%	60,008	54.0%	147,230	18.6%
Total Movers	*680,400*		*111,103*		*791,503*	
Same County	474,705	69.8%	28,312	25.5%	503,017	63.6%
Move County 2013	205,695	30.2%	82,791	74.5%	288,486	36.4%
Total Movers	*680,400*		*111,103*		*791,503*	

In the earlier 2006-2011 analysis, we attempted to identify demographic characteristics of physicians that were associated with the likelihood of moving. The analysis used logistic regression (Stata *Logistic* command) to contrast those physicians who had moved and those who did not. Logistic regression estimates the relative influence of a series of variables on the bivariate (yes-no, or one-zero) outcome of moving or not. The results indicated that female physicians and osteopathic physicians were slightly more likely than males and allopathic physicians (MDs) to have moved between counties. Primary care physicians and surgeons (in contrast to medical specialists and other specialties including radiology and pathology), US medical school graduates compared to international medical graduates (IMGs), and older physicians were less likely to move. These were marginal tendencies in that the coefficients were small and the analysis had very little predictive power with overall marginal estimation accuracy of 3%.

Whole County HPSAs and the Flows of Physicians

The analysis of physician flows into and out of HPSAs is complicated by the large number and types of designations of HPSAs. As of July, 2015, there were 6,184 primary care HPSAs in the United States and its territories; 1,332 were classified as whole-county geographic area HPSAs. To focus the analysis, only non-Core Based Statistical Area (CBSA) counties designated as whole county geographic HPSAs were included in the analysis. Of these, 623 counties or county equivalents were nonmetropolitan (non-Core), whole county HPSAs with a total population of 8,286,340. Those counties also included 3,309 active, patient care, primary care physicians; 1,432 physician assistants and 2,727 nurse practitioners (All data are derived from the AHRF 2013-14 version). This analysis focused on this rural subset of these HPSAs.

In our longitudinal file of individual physicians, there were 9,499 physicians in all specialties and 3,528 primary care physicians in both the 2006 and 2013 files who were located in a rural primary care geographic HPSA in 2013. **Table 4** describes the breakdown of physicians who moved between states in 2006-13 by Core-HPSA status. Physicians who were in a rural HPSA county in 2013 were more likely to have made an interstate move between 2006 and 2013 than physicians in urban counties or rural, non-HPSA counties.

Table 4. Location of Physicians (all specialties) Who Did/Did Not Make an Interstate Move, 2006-2013, by HPSA/CBSA status

Move State to State 2006-2013	CBSA Urban County 2013	CBSA Rural HPSA County 2013	CBSA Rural, Non-HPSA, 2013
Did not move	638,836 (81.5%)	4,603 (78.1%)	1,512 (82.6%)
Moved	145,022 (18.5%)	1,292 (21.9%)	319 (17.4%)

Diffusion and the Personal Characteristics of Primary Care Physicians Going Into and Out of Primary Care HPSAs

To examine the individual characteristics of physicians who moved into and out of HPSAs using the linked AMA data, we identified those who, between 2006 and 2013, moved into whole county, rural HPSAs from urban counties (n=1,467) and from non-HPSA rural counties (n=114). The urban counties may have had a HPSA designation of some form. For this part of the analysis we also limited the population to primary care physicians, specifically, those eligible for support in primary care HPSAs. We identified the primary care physicians who moved away from rural, whole county HPSAs to urban counties (n=2,116) and to other non-HPSA rural counties (n=92). **Table 5** summarizes the total number of physicians in each category of movers and categorizes them into nine types of moves (Categories 0-8). Three of those movement types will be the specific focus for analysis (Category 1: physicians who moved from an urban county to a rural HPSA county; Category 3: physicians who moved from a rural HPSA county to an urban county; and Category 4, physicians who were retained in a rural HPSA). The majority of primary care physicians either remained in an urban county or moved from one urban county to another urban county (n=240,831). By the same token, 1,806 were retained in rural whole-county HPSAs.

Table 5. Summary of Primary Care Physician Movement Between and Across Rural and Urban Whole County HPSAs, active, non-federal, <80 years in 2013

2006	2013		
	Urban	Rural HPSA	Rural Non-HPSA
Urban	240,831 Remain Urban (Cat 0)	1,386 from urban to rural HPSA (Cat 1)	412 from Urban to rural non HPSA (Cat 2)
Rural HPSA	1,960 from Rural HPSA to Urban (Cat 3)	1,806 retained in rural HPSA (Cat 4)	83 from rural HPSA to rural non HPSA (Cat 5)
Rural Non-HPSA	655 from rural non HPSA to Urban (Cat 6)	109 rural Non HPSA to HPSA (Cat 7)	571 retained in rural non HPSA (Cat 8)

Table 6. Characteristics of All Physicians by Category of Movement, 2006-2013

Characteristic	From Urban to Rural HPSA (Cat1)	From Rural HPSA to Urban (Cat3)	Retained in Rural HPSA (Cat4)	Total
Percent Female	11.7%	25.5%	22.5%	24.2%
Age (mean, std Dev)	50.9 (10.7)	51.6 (9.7)	54.9(9.6)	51.1 years (10.3)
Attend US Public Med School	47.8%	47.8%	52.5%	97,897 39%
Resident in 2006	18.3%	2.4%	0.07%	25,219 10.2%
IMG	20.4%	26.1%	16.9%	70,668 27.6%

Table 6 summarizes the univariate characteristics of the three types of movers the analysis focuses on. The training status of a physician in the baseline year 2006, is of interest as those in residency in that year will have likely finished their training and were more likely to make a move of some form after residency. Among physicians who were residents in 2006, 496 were in a rural HPSA in 2013 and 139 were in a rural, non-HPSA; this is less than one-half of one percent of all physicians who were in training in 2006.

We analyzed the characteristics of primary care physicians who were in each of the three focus categories of movers (Categories 1, 3 and 4) using logistic regression. The models sequentially used each category of movers as the outcome variable in contrast to the remainder of physicians. This approach allows for a general assessment of the characteristics of the physicians in that category compared to all others. Thus, if a variable is a significant predictor of a physician making one of these moves, then the proper interpretation is to say that they are more or less likely than all other physicians to make that move. These sequential models do not provide a summary assessment of the effect of moving from county to county or of moving into or out of a HPSA for each physician, rather, it provides contrasts between the characteristics of the physicians in each group.

Table 7 summarizes the results of three separate logistic regressions using each of the categories as the dependent variable. The numbers represent the logistic coefficients for each variable and are based on the distribution and unit of analysis of the variable. Thus, a coefficient of +3.88 for the Category 1 movers who attended a US Public Medical School indicates that a physician with that characteristic is 3.88 times more likely than a Private Medical School graduate to move from an urban county to a rural-HPSA county. One useful way to interpret the results is to see if there are changes in the signs of the coefficients as well as proportionately large changes in the values of the coefficients between the two for the contrasting models of movers into and movers out of rural HPSAs. We can see from the data that the coefficients for the age of the physician and whether they were in a residency in 2006 changes between those two models. We can thus interpret that older physicians, US medical graduates versus IMGs, and those in residency in 2006 are more likely to move into rural HPSAs. Consistent with this are the signs that indicate that older physicians are less likely to move away from rural HPSAs. Physicians who were residents in 2006 were less likely to go from a rural HPSA to an urban county, but also less likely to be retained in a rural HPSA. Female physicians were less likely to make either move, or, in a somewhat contradictory result, be retained in a rural HPSA. Physicians attending a US Public Medical School were more likely to move into a rural HPSA and remain there, but again, in a contradictory result less likely to move from a rural HPSA to an urban county.

Table 7. Personal Characteristics Correlates of Move Categories (Logit Z scores)

Characteristic	From Urban to Rural HPSA (Cat1)	From Rural HPSA to Urban (Cat3)	Retained in Rural HPSA (Cat4)
Attend US Public Med School	+3.88	+8.11	+7.07
Age (years)	+3.37	-5.05	+8.66
Resident in 2006	+11.51	-10.82	-7.98
Female	-7.18	-8.63	-7.96
USMG vs IMG	+4.36	-4.99	+4.41
constant	-33.61	- 28.51	-40.97

We extended the analysis to examine the characteristics of the counties in each of the categories with the intention of identifying "push" and "pull" factors in the communities that might include the rate of movement (a separate analysis, below, reports the combined effects of place and personal characteristics). The "place" variables were drawn from the 2014-2015 version of the Area Health Resources File (AHRF). Again, three separate logistic regressions were run with the focus categories being the dependent variables. The results are not intended to be precise measures of the weight of association with these types of moves, but are intended to suggest whether there are differences in the direction of influence or association. The variables were selected to be representative of the conditions that a primary care practice might face in a community and which have been shown in prior work to be associated with the movement of physicians.[28,18] These include the 2006-10, five-year infant mortality rate, county per capita income in 2012, and the unemployment rate in 2012. Also included were variables describing the presence of health care facilities that might support physicians recruited into underserved areas including the presence of an FQHC, the number of

National Health Service Corps (NHSC) primary care sites in the county, and the number of Critical Access Hospitals (CAHs) in the county. We also included primary care supply measured as the ratio of primary care physicians per 10K population and the change in that ratio between 2010 and 2012. Three variables that reflected the insurance coverage for the county were also included in the model, the percent of people under 65 with no health insurance in 2012, the per capita Medicare payments in 2007 and the standardized per capita Medicare payments in 2013. The latter two variables also reflected the relative costs of care in the community.[29] Finally, the area of the county in square miles was included as a rough indicator for large, sparsely populated, rural counties.

Table 8 summarizes the results of those logistic models with negative coefficients indicated in red. The regression that summarizes the location characteristics more or less likely to predict a move into a non-core HPSA is the most robust with a pseudo r-square of 0.26, the other models have moderate predictive power (r-square= 0.12). These models are far more predictive of the movement of a primary care physician into a particular type of county than the ones that just include personal characteristics. An important indicator of relative strength of factors is the comparison of the signs between the Category 1 and the Category 3 models for selected variables

Table 8. Logistic Regression Results for Characteristics of 2013 Counties for Categories of Movers

Variable	From Urban to Rural HPSA (Cat1)	From Rural HPSA to Urban (Cat3)	Retained in Rural HPSA (Cat4)
Per ben. Medicare payment 2007	-.0001043	-0.0006611	0.0000291
Std. Medicare payment 2013	-.0003406	0.0001581	*0.0000008*
Number of CAHs in county, 2011	.8633498	0.5171872	0.9352105
FQHCS in county, 2012	-.2197231	-0.0152739	-0.0964991
NHSC Site in county 2013	-.3046817	-0.026371	-0.4040279
Infant Mortality Rate, 2006-20	.0706961	0.0536535	0.1205122
Per capita income, 2012	-.00002	-0.000035	-0.0000406
Unemployment rate, 2012	.1064037	-0.0400126	0.1182797
County area, (Sq miles)	-.0000663	-0.0000719	*-0.0000148*
Pop to Primary care 2012	-.3044455	-0.0513457	-0.2011584
Change in PC-Pop ratio 2010-12	.2537438	0.171863	0.1439535
Percent with no Health Ins, 2012	.0564196	0.0176015	0.0464477
_cons	.202929	0.5213667	0.7374968
R square	0.2611	0.1198	0.1198

Italics=not significant p=0.95

The models present only one interesting contrast. The signs for the standardized Medicare per capita payment rates in 2013 change for the physicians going into compared to those leaving the rural HPSAs (note that the coefficients are scaled to the size of the underlying variable, in this case dollar ranges that could be as large as $1,000. For CAHs, the range is 0-3 with most counties having either the zero or one, thus the coefficient is a likelihood of a CAH being in the county). Lower average per beneficiary Medicare payments in both years predict that physicians are less likely to go

into rural HPSAs with those characteristics, but higher payment rates in 2013 in urban counties are associated with a physician moving away from a rural HPSA. The change in the signs for the unemployment rate also fits general economic notions that physicians are less likely to migrate to where there is higher unemployment, but the characteristics of underserved communities including unemployment rates are associated with physicians being more likely to go into rural HPSAs. Surprisingly, having either an FQHC or NHSC primary care approved site is negatively associated with migration into or out of rural HPSAs, while having a CAH in the county is positively associated with such a move.

A companion logistic regression was run with the personal ***and*** community variables combined and the dependent variable being the movers by category. The results stayed stable with the overall power of the model (pseudo-R-square) increasing to 0.27 for Category 1 movers and to 0.29 for Category 4 but dropping to 0.136 for Category 3 movers (see **Appendix 2** for a full summary of statistics for one model). The general tendencies of the earlier models remain with a few exceptions (**Table 9**). The size of the coefficient for US Public Medical School increases dramatically for those moving from rural HPSAs to urban counties and there is a contrast in the effect of unemployment with lower unemployment rates associated with a move from a rural HPSA to an urban county compared to the urban to rural HPSA movers. The "Resident in 2006" and age contrasts remain.

Table 9. Logistic Regression Results Characteristics of 2013 Counties and Personal Characteristics for Categories of Movers

Variable	From Urban to Rural HPSA (Cat1)	From Rural HPSA to Urban (Cat3)	Retained in Rural HPSA (Cat4)
Per ben. Medicare payment 2007	-.0001413	-.0006726	.0000299
Stand. Medicare payment 2013	-.0003294	.0001314	7.45e-06
Attended US Public Med School	.0085273	.2711529	.0142587
Female	-.0686342	-.2223954	-.0446353
Infant Mortality Rate, 2006-20	.0746351	.0540299	.1201319
Per capita income, 2012	-.0000192	-.0000345	-.0000395
Percent with no Health Ins, 2012	.0561306	.0186396	.0441617
Unemployment rate, 2012	.114716	-.0491835	.1165932
County Area (Sq. Mi)	-.0000527	-.0000741	1.18e-06
Change in PC-Pop ratio 2010-12	.2389356	.1738212	.1467504
Pop to Primary care 2012	-.3000316	-.0450314	-.1921736
NHSC Primary Care Sites 2013	-.3097979	-.0273019	-.3930859
CAH in county, 2011	.853821	.5239797	.9165811
FQHCS in county, 2012	-.2170909	-.0132523	-.1083417
US Grad vs IMG	-.0027718	-.8250965	.0598224
Resident in training, 2006	1.12021	-1.476055	-2.293562
Age	.0041167	-.0132856	.0183408
Osteopath, 2013	.5383414	.4662579	.1216779
Constant	-.161645	2.093614	-.4919269

V. Discussion

Interpreting these results is difficult as there are no dramatic contrasts or "smoking gun" relationships apparent in the data. The art and science of predicting where physicians will move is not precise. What we do know is there is a relatively large amount of diffusion of physicians, perhaps 15% of all physicians in any given year will make a substantial move (at least to another county). Clearly, those who have just finished training will be more likely to move away from their training location, but there is a substantial volume of movement among those who are "established" physicians.

Predicting who will be more likely to go into an underserved, rural community is also not an easy process. It may not surprise some to see women moving less often into and out of rural shortage areas, but more often overall and to see international medical graduates (IMGs) more likely to move into HPSAs. What is disappointing is that these tendencies are marginal and are not likely to yield a predictive formula that can help those who must target physicians for recruitment. The role of "place" factors in the choice of a new location for a physician and their relative role in moving physicians into rural, underserved areas is also something that can only be hinted at. Overall, research has found that physicians respond to apparent market factors when they go into higher income areas, and, in a way that reinforces a finding in spatial economics, the so-called Hotelling paradox, physicians are more likely to go to places where there are more physicians.[30] The idea of differentiating underserved locations into those that are likely to escape their condition and those that are likely to persist is, again, a difficult thing to do. This study has developed an approach that may, with more analytical attention, provide some clues as to which places will do better and which will do worse.

VI. Conclusions/Implications for Policy

The main lesson from this analysis is that it is not currently possible to generate models that predict who will move into or out of a rural HPSA or which rural HPSAs are more or less likely to attract physicians. However, it is possible to see trends and to understand that physician supply is a dynamic component of access to care. It is also possible to see that the process of influencing choice of physician practice location through federal programs and incentives is only one option among many choices made regularly by practicing physicians. It has been suggested that we might refine the classification of underserved areas using more precise geography and more current or reliable physician practice data. Using smaller geographic units such as PCSAs may assist analysis, but if used for designation it also may create a system where underserved populations hidden within small areas might be overlooked. This would be the case where a small area might have a concentration of underserved in one place in a county while there is a general spread of low access people across the remainder of the county. The cumulative effect of the characteristics of the low-access population across the county might make that area "designatable," but would split off the part that was above a threshold if fine-grained geography were used. The suggestion that we need more accurate data on primary care practitioners remains true.

The problem of assessing local primary care capacity currently and in the future continues to be a challenge. The data used in this analysis could be challenged as could the data used to develop the currently applicable rules and regulations. The fact that other primary care professionals (PAs and NPs) remain excluded from the count of capacity skews the system and likely results in over-designation.

We have seen an overall steady and relatively well-distributed pattern of physician supply growth (see **Table 1** and **Figure 2**). At the same time we have seen an overall increase in the number of areas designated as HPSAs and areas remaining designated as HPSAs despite growth in supply. Communities and applicants have been able to construct geographies and population descriptions that have resulted in an expansion of the number of designations in the face of a growing overall supply of physicians and PAs and NPs. This is a paradoxical situation that suggests that there is gaming and manipulation in the system. HRSA and the Administration should consider re-visiting the HPSA designation process and implementing those rules and regulations that have been stalled in review. Likewise Congress needs to update the structures and systems developed in the 1960s and 1970s to make them more applicable to the realities of primary care access in the 21st century. The current system relies on self-reported surveys and is backed up by locally unreliable national inventories including the AMA Masterfile. The suggestion that the National Provider Identifier (NPI) files maintained by the Centers for Medicare and Medicaid Services (CMS) can be used to help designate HPSAs has not been backed up by careful tests of the reliability of that file.

The cumulative effect of federal policies in reducing or eliminating geographic shortages is not known. Neither HRSA nor DHHS has undertaken a comprehensive assessment of the combined effects of the many programs that are now in place. Commissioning a comprehensive evaluation is a necessary first step before current policies can be judged or the effects of factors that influence choice of location or the potential for emerging underservice can be assessed. Without a clear understanding of the overall effects of policies, it is difficult to accurately analyze trends in physician supply at the local level and attribute them to policy or economic or personal forces.

This current analysis made use of counties and a subset of whole-county primary care HPSAs to represent underserved communities. Repeating the analysis at the PCSA level is possible, but with very substantial data management costs as information available only at the county levels must be allocated to PCSAs. Nevertheless, it may prove useful to do such an analysis to attempt to identify "at risk" communities as well as those that are solving their access problems.❖

Appendix 1. Rural Training Track (RTT) Programs, August 2015

RTT Program	Residents in 1st year
Arkansas UAMS	3
Shasta CHC	2
Northern Colorado	1
Georgia Health Sciences University	2
Fam Med Res Idaho	15
Dixon RTT Illinois	2
St. Claire, Kentucky	2
LSU Shreveport, LA	3
Central Maine	7
Western Montana	6
Nebraska (4 sites)	19
Nevada Las Vegas Winnemucca	2
NH Dartmouth	8
Northern NM	4
Hidalgo, NM	2
SUNY Buffalo	2
NC Union County	2.3
North Carolina MAHEC	4
UND Hettinger	5
UND Williston	3
Oklahoma Ramona	2
Oregon Hood River	2
Pennsylvania, Altoona	5
SC Seneca lakes	5
Texas Tech	2
UTMB	10
Virginia Bon Secours	2
Washington, Central WA	8
Colville, WA	10
St Peter Chehalis, WA	7
Marshall WV	8
Monroe, WI	2
UW Baraboo	2
UW Eau Claire	2
Total	161.3

Appendix 2. Example output from Stata Logistic command

Combined Logit model of personal and county variables with Category 1 movers

Cat1	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
percapmcar2007	-.0001413	.0000263	-5.37	0.000	-.0001929	-.0000898
strapcmcare13	-.0003294	.0000379	-8.68	0.000	-.0004038	-.0002551
USStateSch	.0085273	.0744051	0.11	0.909	-.137304	.1543586
female	-.0686342	.0641584	-1.07	0.285	-.1943823	.0571139
IMR0610	.0746351	.0112933	6.61	0.000	.0525007	.0967695
PCI2012	-.0000192	5.42e-06	-3.54	0.000	-.0000298	-8.56e-06
PCTnoHI2012	.0561306	.0065963	8.51	0.000	.043202	.0690592
UNEMP2012	.114716	.011662	9.84	0.000	.0918588	.1375732
AREASQMI2010	-.0000527	.000014	-3.76	0.000	-.0000801	-.0000252
difratio12_10	.2389356	.0357567	6.68	0.000	.1688538	.3090174
pcratio2012	-.3000316	.014616	-20.53	0.000	-.3286786	-.2713847
NHSCPCSites2013	-.3097979	.0266775	-11.61	0.000	-.3620848	-.2575109
CAHs2011	.853821	.0376112	22.70	0.000	.7801043	.9275376
FQHCS2013	-.2170909	.0175318	-12.38	0.000	-.2514525	-.1827292
yr2006_usgrad	-.0027718	.090933	-0.03	0.976	-.1809972	.1754537
yr2006_resident	1.12021	.0918911	12.19	0.000	.9401071	1.300314
age2012_2013	.0041167	.003257	1.26	0.206	-.0022669	.0105003
do_2013	.5383414	.0844819	6.37	0.000	.37276	.7039228
_cons	-.161645	.4606184	-0.35	0.726	-1.06444	.7411504

References

1. Barnighausen T, Bloom DE. 2009. Financial incentives for return of service in underserved areas: a systematic review. *BMC Health Serv Res*. 9: 86.
2. Reyes-Akinbileje B. 2013. Heath Workforce Programs in Title VII of the Public Health Service Act. Washington, DC: Congressional Research Service.
3. Jarman BT, Cogbill TH, Mathiason MA, O'Heron CT, Foley EF, Martin RF, Weigelt JA, Brasel KJ, Webb TP. 2009. Factors correlated with surgery resident choice to practice general surgery in a rural area. *J Surg Educ*. 66(6): 319-24.
4. Rosenblatt RA, Andrilla CH, Curtin T, Hart LG. 2006. Shortages of medical personnel at community health centers: implications for planned expansion. *JAMA*. 295(9): 1042-9.
5. Duffrin C, Diaz S, Cashion M, Watson R, Cummings D, Jackson N. 2014. Factors associated with placement of rural primary care physicians in North Carolina. *South Med J*. 107(11): 728-33.
6. Pathman DE, Konrad TR, Schwartz R, Meltzer A, Goodman C, Kumar J. 2012. Evaluating Retention in BCRS Programs Final Report. Chapel Hill, NC: The University of North Carolin at Chapel Hill/Quality Resoruce Systems, Inc.
7. Vela MB, Kim KE, Tang H, Chin MH. 2010. Improving underrepresented minority medical student recruitment with health disparities curriculum. *J Gen Intern Med*. 25 Suppl 2: S82-5.
8. Savageau JA, Ferguson WJ, Bohlke JL, Cragin LJ, O'Connell E. 2011. Recruitment and retention of primary care physicians at community health centers: a survey of Massachusetts physicians. *J Health Care Poor Underserved*. 22(3): 817-35.
9. Ricketts TC, Randolph R. 2007. Urban-rural flows of physicians. *J Rural Health*. 23(4): 277-85.
10. Barnett JR. 1993. Does the geographic distribution of physicians reflect market failure?: an examination of the New Zealand experience, 1981-7. *Environment and Planning*. A 25(6): 827-46.
11. Ernst RL, Yett DE. 1985. Physician Location and Specialty Choice. Ann Arbor, MI: Health Administration Press.
12. Fruen MA, Hadley J, Korper SP. 1980. Effects of financial incentives on physicians' specialty and location. *Health Policy and Education*. 1(2): 143-59.
13. Gray BH, Stockley K, Zuckerman S. 2012. American primary care physicians decisions to leave their practice: evidence from the 2009 Commonwealth Fund survey of primary care doctors. *Joural of Primary Care & Commuity Health*. online before print.
14. Henderson T, Farmer C, Szwarc S. 2003. Practice location of physician graduates: Do states function as markets? pp. 1-15. Washington DC: National Conference of State Legislatures Institute for Primary Care and Workforce Analysis.
15. Jiang HJ, JBegun JW. 2002. Dynamics of change in local physician supply: an ecological perspective. *Social Science & Medicine*. 54(10): 1525-41.
16. Krishnan V. 1992. A macro model of change in specialty and spatial distribution of physicians. *Socieoeconomic Planning Sciences*. 26(2): 111-27.
17. Phillips R L, Dodoo M, Patterson S, Xierali I, Bazemore A, Teevan B, Bennett K, Legagneur V, Rudd J, Phillips J. 2009. Specialty and Geographic Distribution of the Physician Workforce: What Influences Medical Student and Resident Choices? Washington, DC: The Robert Graham Ceter.
18. Ricketts TC, Randolph R. 2008. The diffusion of physicians. *Health Aff (Millwood).* 27(5): 1409-15.
19. Rosenthal MB, Zaslavsky A, Newhouse JP. 2005. The Geographic Distribution of Physicians Revisited. *Health Services Research*. 40(6 pt. 1): 1931-52.
20. Willke RJ. 1991. Practice mobility among young physicians. *Medical Care*. 29(10): 977-88.
21. Ricketts TC. 2010. The migration of surgeons. *Ann Surg*. 251(2): 363-7.
22. Cherkin D, Lawrence D. 1977. An Evaluation of the American Medical Association's Physician Masterfile as a Data Source—One State's Experience. *Medical Care*. 15(9): 767-69.
23. Konrad TR, Slifkin RT, Stevens C, Miller J. 2000. Using the American Medical Association physician masterfile to measure physician supply in small towns. *J Rural Health*. 16(2): 162-7.
24. Williams PT, Whitcomb M, Kessler J. 1996. Quality of the family physician component of AMA Masterfile. *Journal of the American Board of Family Practice.* 9(2): 94-9.
25. National Center for Health Workforce Analysis. 2013. Projecting the Supply and Demand for Primary Care Practitioners Through 2020. Rockville, MD: U.S. Department of Health and Human Services, Health Resources and Services Administration, National Center for Health Workforce Analysis.

26. Smart D. 2006. Physician Characteristics and Distribution in the US, 2006 Edition. Chicago: American Medical Association.
27. Young A, Chaudhry H, Rhyne J, Dugan M. 2010. A census of actively licensed physicians in the United States, 2010. *Journal of Medical Regulation*. 96(4): 10-20.
28. Ricketts TC. 2013. The migration of physicians and the local supply of practitioners: a five-year comparison. *Acad Med*. 88(12): 1913-8.
29. Chen C, Petterson S, Phillips R, Bazemore A, Mullan F. 2014. Spending patterns in region of residency training and subsequent expenditures for care provided by practicing physicians for Medicare beneficiaries. *JAMA.* 312(22): 2385-93.
30. McGuire T. 2000. Physician Agency. In Handbook of Health Economics, edited by A. J. Culyer and J. P. Newhouse, pp. 462-528: Elsevier Science.

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