Working Paper

April 2001 #45

How Many Physicians Can a Rural Community Support?

A Practice Income Potential Model for Washington State

by

George E. Wright, Ph.D.
C. Holly A. Andrilla, M.S.
L. Gary Hart, Ph.D.

WWAMI RURAL HEALTH RESEARCH CENTER

UW University of Washington

School of Medicine

Department of Family Medicine

About the Center

The WWAMI Rural Health Research Center (RHRC) is one of six centers supported by the Federal Office of Rural Health Policy (FORHP), a component of the Health Resources and Services Administration (HRSA) of the Public Health Service. The major focus of the WWAMI RHRC is to perform policy-oriented research on issues related to rural health care. Specific interests of the Center include the training and supply of rural health care providers and the content and outcomes of the care they provide; the availability and quality of care for rural women and children, including obstetric and perinatal care; and access to high-quality care for vulnerable and minority rural populations.

The WWAMI Rural Health Research Center is based in the Department of Family Medicine at the University of Washington School of Medicine, and has close working relationships with the WWAMI Center for Health Workforce Studies, Programs for Healthy Communities (PHC), and the other health science schools at the University, as well as with other major universities in the five WWAMI states: Washington, Wyoming, Alaska, Montana, and Idaho. The University of Washington has over 25 years of experience as part of a decentralized educational research and service consortium involving the WWAMI states, and the activities of the Rural Health Research Center are particularly focused on the needs and challenges in these states. The WWAMI RHRC also works closely with the associated Area Health Education Centers.

The Rural Health Working Paper Series is a means of distributing pre-publication articles and other working papers to colleagues in the field. Your comments on these papers are welcome, and should be addressed directly to the authors. Questions about the WWAMI Rural Health Research Center should be addressed to:

L. Gary Hart, PhD, Principal Investigator and Director
Roger A. Rosenblatt, MD, MPH, Co-Investigator
Denise Lishner, MSW, Associate Director/Editor
WWAMI Rural Health Research Center
Department of Family Medicine
School of Medicine
University of Washington
Box 354696
Seattle, WA 98195-4696
E-mail: wwamirhrc@fammed.washington.edu
WWW: http://www.fammed.washington.edu/wwamirhrc/

The WWAMI Rural Health Research Center is supported by the Federal Office of Rural Health Policy, Health Resources and Services Administration, Public Health Service (grant #1UICRH00035-01, $500,000, 100%).

About the Authors

George E. Wright, PhD, is an Associate Professor in the Department of Family Medicine, University of Washington School of Medicine.

C. Holly A. Andrilla, MS, is a Biostatistician for the WWAMI Rural Health Research Center, Department of Family Medicine, University of Washington School of Medicine.

L. Gary Hart, PhD, is Director of the WWAMI Rural Health Research Center and Professor in the Department of Family Medicine, University of Washington School of Medicine.

How Many Physicians Can a Rural Community Support?

A Practice Income Potential Model for Washington State

George E. Wright, Ph.D.
C. Holly A. Andrilla, M.S.
L. Gary Hart, Ph.D.

April 2001

This work was funded by a grant from the Federal Office of Rural Health Policy. Particular thanks are to Peter Clitherow for his programming of Medicare Part B physician claims files, to all the staff of the WWAMI Center for Health Workforce Studies who developed counts of FTE primary care physicians from Washington State licensure and associated survey data, and to the Washington Academy of Family Physicians for generously allowing the use of their 1996-97 physician survey.

Abstract

Background: This paper addresses a long-standing issue for smaller and underserved rural communities--their ability to financially support needed physicians. Whether because of their small population base, isolation, poor insurance coverage of residents, or competition from larger places, communities report losing out in the competition for physicians because the market realities limit the income potential of physician practice. In sum, we posit that in competing for physician services, many underserved towns are in fact "demand deficient"—too small, to poor, or too disadvantaged in geographic competition to support sufficient viable private practices. To measure the extent of the problem, this paper reports on an experimental simulation model that projects potential practice income for primary care physicians in rural communities of Washington State as of 1997. We then compare the number of full-time equivalent (FTE) physicians who could be potentially supported, with actual physician supply. The prevalence of communities with physician supplies below their economic potential is estimated, as is the degree to which communities in Health Professional Shortage Areas (HPSAs) can be characterized as having inadequate physician income potential.

Methods: We use detailed data available for Washington State to test the feasibility of constructing physician income potential models. The units of analysis are all rural Census places and their surrounding areas (included as Census-defined Minor Civil Divisions). The radius of the area differs according to town size. The total spending for primary care physicians is estimated using age-sex-poverty status coefficients from the National Medical Expenditure Survey, supplemented by unique Part B Medicare data on the proportion of rural physician revenue from non-office based services. Just as important as total expenditures on physician services generated by a community is expected market share. Community size and the distance to other cities and towns are crucial determinants of market share and thus the capacity of small towns to attract and support primary care practices. A unique feature of the research is the modeling of the expected share of expenditures that would flow to a rural town given the distance to competing loci of care. Medicare Part B patient data are used to estimate a market share model and the results used to estimate the influence of neighboring towns in reducing potential income.

Results: The distribution of physicians among towns follows predicted economic potential. That potential varies dramatically even among towns with similar populations due to the pull of competing locations for primary care. The pull of larger regional centers is difficult to model, primarily because of the wider geographic reach of their market areas. Surprisingly, the types of rural communities

most likely to have fewer physicians than suggested by the projected potential are not small isolated towns, but larger communities with above average population growth, closer proximity to metropolitan areas and somewhat lower average family incomes. Towns in HPSAs turned out to be predominately constrained by demand deficits. They were either operating at or above projected capacity and still short or had the demand to support more physicians but not sufficient demand to lower their primary care physician ratio to 1:3000 population.

Policy Conclusions: The nature of the barriers faced by rural communities has implications for public policy. Strategies such as the National Health Service Corps use a one-time "signing bonus" to overcome physicians' initial reluctance to locate in an underserved area. An alternative approach is to address long-term income disadvantages by offering continuous subsidies such as the enhanced Medicare payments for certified Rural Health Clinics or the 10 percent Medicare supplemental payments for care provided in a HPSA. The one-time "signing bonus" approach posits as the principal problem overcoming initial reluctance to practice in rural communities, which otherwise have sufficient demand to support the long-term retention of awardees. Thus the effectiveness of loan forgiveness programs compared to ongoing income supplements depends in part on the nature of the problem.

Our results from Washington State speak to the adequacy of current incentives to address the problems of underserved rural communities. First, physicians do in fact face strong spatial competition, even for highly localized demand for primary care. Small-town physicians lose significant market share—not so much to cities but to regional rural centers. An understanding of how these centers have emerged is clearly relevant to helping other communities build their own capacities.

Second, the correspondence between projected capacity and number of physicians points to rational location decision making by physicians. A simple planning model available to sponsoring hospitals and practitioners that included expected market share could be a useful tool in local expansion decisions.

Third, most communities located in HPSAs predominately appear to suffer from demand deficits. At a minimum, a one-size-fits-all policy to support shortage areas does not respond to the different constraints faced by communities. In particular, demand-constrained towns will require continuous subsidies to make up for an insufficient volume of paying patients, patients that nonetheless lack geographically proximate sources of care. The National Health Service Corps

strategy of a single up-front incentive payment assumes that sufficient demand is present. The results of this study call this assumption into question.

Extending the project model to other states would be useful but difficult since detailed data and specific adjustments appear to be required. A further challenge is understanding the nature of physician markets in places where actual physician supply significantly diverges from projected income potential.

Introduction

Some years ago a psychiatrist moved into a small town in eastern Montana. The high prevalence of substance abuse and depression coupled with the lack of any other mental health providers meant that she was busy and the community grateful for her care. After two years, however, she closed her office and left town unable to create an economically viable practice. Despite the long-standing concern over physician shortages in rural America, anecdotal evidence such as this true story attests to the economic difficulties confronting rural practice. Programs designed to alleviate health personnel shortages generally define shortage areas in terms of the gap between population-based norms and the actual number of providers. Thus, the national standard for primary care geographic Health Professional Shortage Areas (HPSAs) is generally 1 to 3,500 residents. A relevant question, however, is how many of the communities failing to meet this standard have populations insufficient to actually support an economically viable physician practice. Indeed, one long-standing criticism of HPSA designation criteria is that they ignore the economic realities of small town practice (Kehrer et al., 1990).

Communities with high shares of the old, underprivileged socioeconomic groups, or families with poor insurance coverage, may lack a sufficient revenue base to support the practices needed to meet minimal access standards. Such deficits can be multiplied by proximity to larger market centers that effectively siphon off younger insured patients, leaving the small-town doctor marooned with disproportionate shares of patients who are too poor or too old to travel for care. Thus rural physicians, particularly those in underserved settings, often feel overworked but nonetheless may not welcome the arrival of a new practice in town. More generally, regions with decreasing population, declining economies, and improving transportation find that more and more of their towns are too small to support more than one (overworked) physician or any physician at all.

This paper posits that rural communities can experience two distinctly different types of handicaps in competing for physician services: *"demand- deficient"* communities, which are too small, too poor, or too disadvantaged in geographic competition to support sufficient viable private practices, and *"ambiance-challenged"* towns (for want of a better term), which have a sufficient patient revenue base but have too many other deficits to effectively compete for health personnel.

For primary care physicians, *demand-deficient towns* may be characterized by a small population base, low income, high rates of Medicaid or inadequate insurance coverage, residents who traditionally avoid physician visits, low population density

of surrounding natural market area, and short travel distances to proximate alternative sites of care. The problem of a weak competitive position due to the growing dominance of a few commercial centers or the historic pull of well-established practices in other towns has received comparatively little attention. Previous research has, however, repeatedly demonstrated its implications through the influence of economic incentives on physician location decisions (Escarce et al., 1998; Rosko & Broyles, 1988). Particularly relevant to underserved communities, Pathman and colleagues (1992; 1994) tracked the retention of physicians locating in low-income and isolated rural towns and found low professional income to be the primary factor associated with elevated exit rates. Similar findings have been reported for a cohort of graduates from Jefferson Medical College (Rabinowitz et al., 1999). Even when physicians do locate in demand-deficient towns, an unknown portion of their rapid turnover is related to the termination of their two-year salary guarantees.

Ambiance-challenged communities suffer from an often related, but conceptually different problem. They serve enough potentially paying patients to support one or more practices but also have well-known disincentives such as isolation, unattractive geographic setting, lack of educational or employment opportunities for family members, limited cultural amenities, or poor quality public services. More generally, they may lack community cohesion, organization, or leadership. Some of these factors, such as a high incidence of poverty, detract from both potential demand and ambiance. There is extensive research on the personal characteristics of physicians related to specialty and location choice. Location-specific barriers such as those listed above have been repeatedly documented (Council on Graduate Medical Education, 1998). The amount of literature on the rural community characteristics related to success in physician recruitment and retention is far less voluminous. Using county data, Kindig and Movassaghi (1989) demonstrated the negative effect of a small population base and low population density. Unpublished research by Wright (1985) found that controlling for population, rural towns with low per capita income, geographic isolation, lack of post secondary institutions, and high shares of minority populations relative to a surrounding county all significantly reduced the probability of attracting a new primary care physician.

In sum, an ambience deficit is not an objectively defined barrier but a multi-dimensional reality that will be viewed differently by different physicians. Given a stock of individual physicians willing to consider rural practice, the question for each community is its competitive position relative to other locations. While a town's high ambience may compensate for the low economic potential of a new practice, we posit here that a far more common requirement is that a community be

able to economically support the needed number of physicians. This is particularly true if higher income is needed to compensate for perceived low ambience. Since rural fees tend to be lower than urban, meeting minimum practice income expectations is highly dependent on patient volume (American Medical Association, 1997; Wright, 2001).

The nature of the barriers faced by rural communities has implications for public policy. One public strategy uses one-time "signing bonuses" for newly recruited physicians to overcome initial reluctance to locate in an underserved area. Examples of this approach include the loan repayment incentives of the National Health Service Corps (NHSC) or Australia's incentive payments for practicing in remote settings (Cameron, 1998; General Accounting Office, 1995). An alternative approach is to make up for long-term income disadvantages, related to either insufficient patient volume or disproportionate reliance on the low reimbursements of public insurance programs, by long-term, continuing subsidies. This is the strategy underlying the Medicare Incentive Payment Program, which offers bonus payments for physicians located in an HPSA or the Medicare and Medicaid Rural Health Clinic (RHC) program. The former offers a 10 percent supplemental payment made for every patient encounter in a geographic primary care HPSA; the latter pays a cost-based encounter rate (subject to a maximum) for qualifying rural practices located in designated shortage areas or serving an underserved population (General Accounting Office, 1996; General Accounting Office, 1999).

The one-time "signing bonus" approach posits that ambience deficits are the principal problem and assumes that practice sites otherwise have sufficient demand to support long-term retention of awardees. In contrast, the long-term subsidy approach directly addresses demand deficits. Thus, the effectiveness of the loan repayment provisions compared to ongoing income supplements depends in part on the nature of the problem. If NHSC sites have insufficient demand or public subsidies, the resulting income penalty will undermine the stated goal of retention.

Ideally, an up-front payment could be set high enough to equal the present discounted value of a stream of future income subsidies. In practice, NHSC inducements are related to educational debt acquired in the past and not to future income needs. Indeed, low incomes paid by the NHSC practice sites are a source of discontent for over 40 percent of current NHSC physicians obligated by scholarship (Konrad et al., 2000, Table III.5). The alternative long-term subsidy policy can also be construed as directed at both deficits—offsets to income gaps as well as professional disadvantages and other ambience problems. In practice, the HPSA bonus payments are criticized as too small and scattered to have much effect on

physician decision making, and the more considerable financial assistance of the RHC program depends not on shortfalls in income potential but on the share of Medicare in practice revenue and substantial state-to-state variations in Medicaid policy (General Accounting Office, 1996; General Accounting Office, 1999; Ormond et al., 2000). Without information on the size of income shortfalls the subsidies are designed to address, or indeed whether income difficulties are the binding problem facing rural communities, the effectiveness of these programs is difficult to measure.

Thus a key workforce issue is the interplay of three measures of primary care physician supply—the number actually practicing, the potential number that a community could support, and the number needed to meet minimum access requirements such as a ratio of 1 physician per 3,000 population. What proportion of underserved communities essentially lack demand sufficient to support minimum access standards? We do not know, for example, what proportion of HPSA communities are capable of supporting the required number of physicians without continuing practice subsidies.

On the community and physician practice level, modeling physician income potential could assist in more realistic planning and act as a basis for assessing the actual capacity of a community to support the desired number of physicians. A simplified template or model available to local hospitals and group practices could prevent recruiting efforts based on unrealistic projections of future income streams. Simple norms of expected visits per person that are currently used in planning need to be adjusted for the realities of poverty, income inequalities, and competition from alternative locations.

In response to these information gaps, this study presents an experiment in modeling the income potential of primary care physicians in each of Washington State's 135 rural towns. The model is based on national utilization norms and the experience of similar communities statewide. Limiting the research to one state allows for the use of extensive state-specific data that substantially enhances the realism of the model. This paper reports on the estimating model, applies the model to Washington's towns and tests the implications of the results. This research addresses the following questions:

- To what degree do demographic and income profiles differ among rural towns of similar size and are these differences important factors in the economic viability of physician practices?
- How closely do projections of the number of primary care physicians that can be supported by a community correlate with actual physician location statistics?

- What community characteristics correlated with unusually high or low supply relative to projected financial capacity?
- What proportion of underserved communities suffer from apparent demand deficient handicaps?

A final goal of the study has been to test the possibility of creating a multi-state or national projection model. Some of the key data sources were selected with an eye toward future application.

Methods

We project the number of physicians that can be supported by a particular community by (1) defining market areas, (2) calculating expected expenditures for physician services based on population characteristics, (3) estimating the market share of the area that would flow to any one town given the distance to those neighboring communities with competing physicians' offices, and (4) applying a normative estimate of the minimum gross income required per primary care physician full-time equivalent (FTE). The focus of this study is not on measuring the actual income received by physicians, but on the *potential* income that could be expected to flow to physicians setting up practice in a rural community. Actual income will of course depend on a myriad of unmeasured factors including the tenure, primary care specialty, and personality of local physicians.

Defining Market Areas

Rural Towns: Since the geographically large counties in Washington State extend Metropolitan Statistical Areas (MSAs) into functionally rural areas, we define "rural" in terms of the ZIP-code based generalist Health Service Areas (HSAs) originally developed by the University of Washington's WWAMI Rural Health Research Center and adopted by the state's Department of Health (Washington State Department of Health, 1994). Within these rural HSAs, the unit of analysis is the "town" and not the county or market area. We use this micro geography because virtually all physicians are located within town boundaries that are also the locus of all health care services. The question of how many physicians a community needs is typically discussed in terms of a local town. This is particularly true in western states with their geographically large counties.

Operationally, the universe of towns was defined as all Census places that are also recognized as a postal place by the US Postal Service. Both restrictions are required in order to generate community-level Census data and to locate physicians by mailing address. In Washington State only four Census-defined rural places were not also recognized by the Post Office. Some 15 towns (mostly on islands in the Puget Sound) were recognized by the Post Office but not the Census Bureau. Also excluded were military bases and places in Indian reservations. A somewhat bigger problem is posed by the phenomenon of "Census Designated Places," unincorporated settlements that are identified by the Census Bureau as places but may not be recognized by the Post Office. The result is an artificial balkanization of a central place. For this reason we excluded from the study a regional center in central Washington, Wenatchee, which is defined by the Census as a cluster of six contiguous places. In sum, of the 152 towns in our Census universe, 135 are retained by the study.

Market Areas: The paper does not identify the actual market areas of Washington's rural towns, but defines a consistent market area around each town and then estimates the town's expected share of that market. The geographic building blocks of these market areas, Minor Civil Divisions (MCDs), are the primary subdivisions of counties, often termed "townships" in northeastern states. In states such as Washington that have no such administrative units, MCDs are defined by the Census Bureau.

For small towns under 10,000 population, the market area included all MCDs that fell within an eight-mile radius. For larger places the radius was expanded to 14 miles. The eight-mile radius is consistent with 20 minutes of travel time to a primary care physician, a common access norm. According to the National Health Interview Survey, the mean travel time for a physician visit in nonmetropolitan areas is 20 minutes (Office of Technology Assessment, 1990, Table 10.20). The wider radius reflects the greater drawing power of larger places. The market areas were edited in particularly mountainous areas or where large bodies of water are involved. To increase the realism of the model, we assumed that physicians in smaller towns would not draw patients from neighboring larger places. That is, when two or more towns were located in an MCD, the population of larger places was not included in the market area of smaller places.

An important feature of the model is that the circular market areas of each town may overlap. Thus MCDs are not uniquely allocated to only one town's service area but can be shared by different competing towns. While the use of smaller Census tracts would increase the precision of radius-defined market areas,

we elected to use MCDs as the geographic building blocks because they had been previously defined for all rural places in the U.S. (Wright, 1998). We also use MCDs to calculate "Local Regions"—standardized areas surrounding each town. Counties are poor units of observation with which to gauge a community's immediate region since they differ greatly in size, and the relationship of any town to the center of its county is hardly fixed. Similar to market areas, we draw a radius averaging 15.93 miles around each town (generating 797 square miles, which equals the median geographic area of all US counties) and include as a "Local Region" all MCDs whose centroids fall within the radius. The radius is flexible depending on terrain and travel speeds. Local Regions are used to measure the relative geographic status of towns (e.g., poverty rates relative to the surrounding region).

Physician Supply: The number of practitioners located in a town is measured in terms of FTEs and not simple head counts of physicians. This approach reflects the fact that physicians can work part time or operate in two or more separate offices. Although recent research at the WWAMI Rural Health Research Center emphasizes the critical role of nurse practitioners and physician assistants in meeting primary care needs, we simplify the analysis and focus only on physicians (Larson et al., 2000). Primary care physicians include family medicine, general practice, general pediatrics, and general internal medicine. The counts of physicians by FTE are derived from ongoing work of the WWAMI Center for Health Workforce Studies with Washington State's 1999 licensure data that include a questionnaire covering weeks worked per year, weekly hours and patient visits. Manual checks of physicians in small towns verified and updated the licensure counts. The adjusted licensure data were found to be more complete than the American Medical Association's Masterfile. The full-time standard used to assign FTEs was 105 ambulatory visits a week.

Projecting Expenditures on Primary Care Physicians

We project total spending for primary care physician services from each market area in three steps: (1) estimate total spending for physician office visits, (2) restrict these dollars to the share going to primary care physicians rather than to specialists, and (3) add to visit expenditures an estimate for nonoffice care such as physician charges during hospital stays and emergency department visits. Total spending is projected as the product of population counts and estimated spending per capita. In sum, the components of this task add up to defining the total size of the market—a step that precedes consideration of dividing up the market among competing locations of physician offices.

Physician Office Visit Expenditures: In the first step, we estimated spending on physician office visits using a version of the 1987 National Medical Expenditure Survey (NMES) in which expenditures were adjusted to 1997 prices. Per capita annual expenditures were calculated for 14 age/sex groups in the nonmetropolitan West region. The demographic groups were further disaggregated by cells above and below the federal poverty line. Appendix Table A1 displays these expenditure coefficients. It would be preferable to incorporate a fuller adjustment for geographic variations in the average income of families above the poverty line. However, in all but a few cases income variations above the poverty line among Washington's rural communities are not sufficient to shift projected demand significantly (Wright, 2001).

Share of Primary Care Physicians: Only a minority of spending on physician visits flows to primary care doctors. There is, however, limited information on the division of expenditures by specialty. As a proxy measure, we use a previously developed 100 percent Medicare Part B claims file for Washington residents in 1994. We extracted from this administrative data set a subset of all claims from physicians for Medicare beneficiaries residing in the state and receiving no care outside of the state during the year. The self-designated specialty of billing physicians was determined by merger to the AMA Masterfile (Rosenblatt et al., 2000). These claims were used to calculate the population-based proportion of all allowed charges for physician visits submitted by primary care physicians. Since it is likely that the primary care share varies according to the local availability of specialists, the share was calculated for four types of rural areas classified by whether they were adjacent to an MSA and whether they contained a hospital with more than 100 beds. As displayed in Appendix Table A2, elderly residents who are geographically isolated from centers of specialty care tend to devote a higher proportion of all visit expenditures to primary care physicians. Thus, in independent rural centers with a larger hospital, primary care physicians attracted only 34.7 percent of all physician visit charges while in small towns their share jumped to 42.5 percent. The coefficients in Appendix Table A2 were used to define the share of primary care in total physician visit expenditures.

Hospital-Based Income: The third step in calculating total expenditures recognized that physicians often earn important additional income outside of their offices in their local hospital. We used the same Medicare physician claim data described above to estimate the proportion of primary care physician income coming from outside the office. Note that unlike the previous tabulation, the results in Appendix Table A3 posit physicians, and not patients, as the unit of analysis and examine the sources of physician Medicare revenue by place of service. Unexpectedly,

there proved to be very little difference by type of community area. Among primary care physicians in urban areas, office visits as a proportion of total allowed charges ran 76.7 percent. The share in rural areas varied between 71.9 and 70.2. Using these data, we calculated a hospital-based income markup that is applied to estimates of total office visit income. However, elderly Medicare patients may require an above-average proportion of physician expenditures in hospital settings.

The application of these adjustments is shown in Table 1, which displays the actual data for three illustrative Washington rural towns. As indicated by the basic town characteristics, Quincy has a relatively young population with low average incomes and a high poverty rate. Friday Harbor is a well-to-do resort-oriented community, the principal town in the San Juan Islands of Puget Sound. Sequim has a remarkable proportion of retirees with average incomes and poverty rates. When the spending per capita coefficients on office visits in Appendix Table A1 are applied to the demographic profile of these three towns, the spending per capita in Sequim of $433 is over 65 percent above that of younger, low-income Quincy. Note, however, that the spending per capita is a weighted average of all the MCDs included in the market area of each town.

The next step in Table 1 is to restrict expenditures for all office visits to the share flowing to primary care physicians. Since both Quincy and Friday Harbor are not close to a center of specialty care, the primary care share is 42.3 percent compared to 34.7 percent for Sequim. The second adjustment is a multiplier for hospital-based income that increases projected expenditures on primary care physicians by about one-third, with a small range of variation between the three communities.

The net effect of the two adjustments for share of primary care physicians and out-of-office income is to narrow the initial differences and change the rank order. The retirement-oriented community of Sequim, with its high demand for Medicare-financed services, ends up in second place behind Friday Harbor in per capita spending because so many of the visits are siphoned off to specialists. The total size of the market of course depends both on per capita spending and on the market area's population. The last two lines in Section II of Table 1 illustrates the effect of the greater population density surrounding Sequim than the other towns. The low number for Friday Harbor illustrates the not unexpected failure of the model to properly define the market area in a county composed entirely of islands.

Market Share Calculation

Once we have projected the total purchasing power for primary care physician services of the market area surrounding a town, the next step is to estimate the market share that each rural town can expect. (Note that while market share is often defined in terms of utilization measures, we measure here proportions of expenditures.) To project potential market share, we assume that the number of physicians locating in a town is the same as the average for all places with similar populations. Given a town's size as well as the sizes and distances to alternative sources of physician care, how much of the surrounding market could its physicians expect to attract? The starting point of our market share analysis is that even for very localized primary care markets, no town can expect to retain 100 percent of its local patients. While we have defined market areas, there is no presumption that their residents "belong" to the physicians in each town. Indeed, all patients are potentially subject to the competing pulls of different locations.

Figure 1 illustrates the simple model of spatial competition developed here. Residents live in an administratively defined geographic area with the choice of different physician office locations. Figure 1 posits one town as a potential physician office site located 10 miles from the area's centroid. There are three other alternatives, each with at least one existing practice, and one of which is within the area's boundaries. Given the distance to these alternative sources of care (measured as straight-line miles) and their relative attractiveness (measured as population), what proportion of all visits coming from the area can physicians locating in the index town expect? There are two important features of this model. First, if a town's market consists of several areas, the analysis is run separately for each component area. Second, the same geographic area can appear repeatedly in the market areas of each of the surrounding places. As noted previously, there is no unique one-to-one assignment of MCD areas to towns.

To estimate the potential market share of Washington's rural towns, we used the 1994 100 percent Medicare primary care physician claims data for Washington State described earlier. Patients and physician offices were located by ZIP code, and the flows of visits to primary care physicians from residential ZIP codes to office ZIP codes were measured. The market shares for any rural place (termed an "index town") were then calculated for each ZIP code shown to be actually contributing patients. A set of ordinary least squares (OLS) regression models estimated these market shares as a function of (1) the population of the index town, (2) the distance to the geographic centroid of the ZIP code, (3) the distance (measured from the ZIP

code's centroid) to the nearest MSA, and (4) the distances to the closest other towns of different size classes having at least one physician billing Medicare.

The regression modeling was complicated by the need to disaggregate the analysis both by town size and region. For town populations, we expected and found that an index town's market share would decline with the distance to a nearest competitor and that the size of this association would decrease for smaller potential competitors. A complication is that these effects also depend on the population of the index town. That is, the market share of a town of 8,000 is less sensitive to the distance to a town of 2,000 than if the index town itself has only 2,000 residents. To further complicate the analysis, Washington State has highly differentiated geographic regions, such that the effects of distance and population differ east and west of the Cascade Mountains.

Given this complex of interactions, we used a data set with a total of 846 paired observations of index town and ZIP codes in their market areas as a basis for estimating a set of five regressions for five different population size categories of index towns. The regression model is shown in Appendix Table A4. As summarized in Appendix Table A5, the explanatory fits were high with R-squares ranging from 0.52 to 0.74.

The estimates from these market share models are indicative of geographically localized rural markets for primary care physician services. Table 2 summarizes for the entire state the effect on market share of increasing distances by one mile. The patterns generally follow expectations. Among the largest towns in column 1, an increase in distance from 10 to 11 miles from the centroid of the market area reduces the index town's expected market share by 1.06 percentage points. Spatial insulation of the market area from competing metropolitan areas has the opposite effect. An additional mile between a ZIP code and the center of an MSA increases a rural town's market share by 0.76 of a percentage point. Note that this effect drops off quickly with distance—an increase from 20 to 21 miles has only half the effect of an increase from 10 to 11. Even for the largest towns in column 1, increased distance between small competing towns and the centroid of a ZIP code raises market share of the index town from between 0.2 and 0.4 percent. Surprisingly, there are few variations in the incremental effect of distance by the size of the competing town. These small effects are additive such that general isolation of a ZIP code from alternative towns of all size categories adds up to 1.6 percent of additional market share for the index town per mile from all potential competitors.

The results of the market share analysis lend some support to the notion of a segmented market. Even though demand for primary care is generally thought to

be highly localized, there is widespread anecdotal evidence that rural families drive past their local physician in favor of care in a larger community that offers more choice and perceived quality. In this spatial competition, Washington rural towns of different sizes appear to have different geographic frames of reference. Large rural places compete with cities, small places compete with each other and those in the middle compete with everybody. Thus in Table 2, only the shares of the largest rural places over 10,000 are influenced by proximity to an MSA. For smaller places, the coefficient on the log of MSA distance is not significantly different from zero. On the other side of the scale, for index towns under 1,000, distance to competing towns with over 2,500 population was not significant. Their frame of reference is thus entirely local.

This complex interaction of community size and geographic location illustrates the key role that calculating market share plays in projecting the economic capacity of small towns to attract and support primary care practices. We use the sets of regression coefficients from Medicare patients and apply them to the entire population living in the MCD-based market areas surrounding rural communities. Since older patients are less likely to travel than younger families, the Medicare data may overestimate the market shares flowing to small towns (Adams & Wright, 1991).

The third section of Table 1 demonstrates the results of applying our market share model to the three illustrative towns. The residents of Quincy's market area are projected to spend $2.8 million annually on primary care physicians. Yet the town lies 20 and 30 miles from two much larger market centers. If the residents of the area behave as those elsewhere in rural Washington, Quincy is projected to retain only 25.5 percent of the potential market. The projection for Friday Harbor is higher, but because of the unusual nature of an island community, the average relationships probably underestimate patient retention rates. Sequim enjoys a much larger market area, but because of the presence of a large rural center 15 miles away it is projected to retain only 12.7 percent of expenditures.

Establishing Minimum Physician Practice Income Requirements

A key parameter of the model is the estimated gross practice income target needed to support a full-time rural primary care physician. This is obviously critical since the income standard translates projections of spending into estimates of FTE physicians that can be supported. A key resource for estimating this standard is a 1997-98 detailed survey of Washington family practice physicians that was

conducted for a state professional organization (Hart, 1998). Of the 1,344 clinically active respondents (from an overall response rate of 68 percent), 1,034 answered a question on net practice income, though fewer answered a question on percent of overhead paid the previous year. Of these responses, 253 were from nonmetropolitan physicians. These self-reported measures of practice income are summarized in Table 3 for three groups of rural family physicians: all full-time rural FPs, full-time FPs in solo practice and full-time rural FPs on salary or working in a group practice. We limit ourselves to full-time physicians because the analysis is in terms of FTEs. The mean full-time net FP income before taxes is estimated at $122,000, somewhat lower than the national average of $129,000 for rural FPs in the same year as reported by the American Medical Association (American Medical Association, 1997).

There is some doubt over the estimate of overhead expenditures. We assume that the higher response rate to the question about overhead costs by self-employed physicians compared to those with less direct experience in practice management reflects more accurate data. The estimated overhead rate of 57.7 percent is close to the 58.9 percent implied in published AMA data for self-employed FPs (American Medical Association, 1997). However, the rate for others, such as employees of hospital-based Rural Health Clinics, is far less certain. The 47.1 percent reported by survey respondents on salary or practicing in groups is still higher than the national average reported by Medicare. Since 1992, the Medicare Fee Schedule includes separate components for physician work, practice expenses and liability insurance. In 1996 the two overhead components amounted to 43.5 percent of total payments to physicians and other practitioners—a rate that does not take into account differences among specialties and locations (Medicare Payment Advisory Commission, 1998, Ch. 4).

Averaging the 57.7 and 47.2 overhead rates in Table 3, and applying the resulting proportion of 52.4 percent to the expected $122,033 net income of all full-time providers, generates a standard of $256,372 gross practice receipts as the expected gross revenue required to support a rural primary care physician. That is, expected gross revenue per FTE physician equals $122,033 in compensation plus $134,339 in overhead (52.4% times $256,372). The lower this standard, the higher the number of physicians that can be supported by any specified level of aggregate spending on physician services. However, the choice of a particular income standard has a profound influence on this study's results.

The results of this calculation are demonstrated at the bottom of Table 1 with the three illustrative towns. By dividing total market capacity by the $256 thousand

standard, we project that Quincy has the economic capacity to support 2.8 FTE primary care physicians. Since Quincy actually has 1.2 FTEs, the town was operating under capacity. This could reflect a transitory gap in physician supply created by an unexpected retirement or delay in the projected arrival of a new physician. There may also be an unusually large role played by unmeasured midlevel providers. If, however, the gap persists, there is no apparent economic constraint to increasing physician supply. Thus the low supply of physicians relative to projected capacity must be due to other factors. This is particularly important since Quincy is designated as part of a Health Professions Shortage Area. The opposite situation holds in the other two towns where the number of FTE physicians exceeds the projected capacity. In the case of Friday Harbor, this is surely an artifact of the projection model's underestimate of capacity due to the unusual island setting. Sequim must be able to support its very large number of primary care physicians relative to population by retaining a larger-than–projected portion of its service area. It is also true that the 1990 Census for both these rapidly growing areas may inaccurately reflect their current population base and income.

Results

Comparing projected economic capacity with the actual supply of primary care physicians, we find that although capacity is estimated independently of actual supply, the actual number of primary care practices track estimated potential. Physician location tends to follow projected demand. However, most towns located in HPSAs confront significant demand deficits. The four research questions provide the framework for presenting findings.

How Is Physician Projected Capacity Related to Community Characteristics?

As we have seen, our projections of economic capacity take into account population size, demographic profile, incidence of poverty, and geographic competition. How is capacity distributed among communities, and how important are community characteristics in shifting the ability of towns of similar size to support needed primary care practices? The data suggest four key patterns evident in the projections.

Most Rural Physicians Practice in a Few Large Rural Communities: As with many states, almost one-third of rural towns (n=41) are very small places with fewer

than 500 residents in 1990. Another 20 percent (n=29) have populations of under 1,000. The average projected market for such small places is $51,000, only 20 percent of what we project would be needed to support a single full-time physician practice. Clearly, very small places generally only have the demand to support a part-time provider, but five each actually have a physician. (Three of these are unusual cases of notable isolation.) In sum, towns with less than 1,000 population constitute a majority of rural places (51.8%) but are home to only 6 percent of either projected capacity or actual supply of rural primary care physicians (calculable from means in Table 4).

In contrast, larger rural towns dominate primary care. Although in Table 4 only 12 of the 135 rural towns have more than 10,000 inhabitants, these dozen places account for over half (51.1%) of projected rural primary physician income. This accords well with both projected capacity and the actual supply of FTE physicians. With an average of 16.5 FTE primary care physicians per larger town, these dozen rural centers are home to 50.9 percent of all rural primary care physician FTEs included in this study.

Most Rural Communities Retain a Small Fraction of Their Expenditures on Primary Care Physicians: As expected, in Table 4 town population is positively related to both total physician payments and market share. The average rural town is projected to retain only 21 percent of all local area payments to primary care physicians. However, the expected market share of expenditures increases significantly with town size from 11.6 percent for towns under 500 to 52.1 percent for those over 10,000. A notable exception is for communities between 2,000 and 5,000 that are projected to have a lower market share than their smaller neighbors.

In the Aggregate, Projected Capacity and Actual Supply are in Balance: Note that the number of practicing physicians per town (2.9) is virtually identical to projected capacity (2.8). This means that the model projects an overall balance, even a slight general surplus of primary care physicians in rural Washington. However, this finding of a balance between potential capacity and supply is sensitive to estimates of the minimum income needed to attract, support, or retain a physician and the practice overhead costs each physician must cover. Moreover, these averages will be dominated by larger towns and potentially ignore differential income patterns that may exist in small town practice.

Projected Capacity Is Not Systematically Related to Poverty and Geographic Isolation: How strongly is our estimated capacity related to key barriers communities face in the competition to attract and retain physician services? Given town size, do poorer or more isolated communities face significant additional

barriers to their ability to support primary care practices? To test how the descriptive statistics interact, we regressed projected capacity for FTE primary care physicians on a set of community characteristics (Table 5). Given the large number of very small places unlikely to have a physician, the regression limits towns to those with over 500 inhabitants. Explanatory variables include population level, density, and growth as well as income, poverty rates and geographic isolation, the latter measured as the distance to the nearest hospital offering obstetric services. The model also measures the status of towns relative to their surrounding areas. Both population growth and poverty rate are also specified as the ratio of the town's value to the surrounding Local Region. The results indicate that for each additional 1,000 residents, projected capacity increases by nine-tenths of an FTE—a large effect. However, no other variable comes close to statistical significance. We further explored the lack of relationships by using the same model to examine two components of the projection model: per capita expenditures on primary care physicians in the market area and the index town's market share (data not shown). Market area per capita expenditures are positively related to a town's per capita income but are not significantly correlated with other relevant characteristics such as population size, growth, or geographic isolation. Surprisingly, the town poverty rate was also not associated with average primary care physician expenditures, even though area poverty rates formed part of the projection model. A second model component, average market share (the percentage of total area expenditures flowing to a town), is only correlated (negatively) with miles to the nearest hospital with obstetric services.

In sum, although our capacity projection estimates take into account population, age structure, population relative to other surrounding communities, distance to known competing towns, and poverty rates, the resulting projections are not correlated with town characteristics. This may be due, in part, to the fact that we measure the characteristics of towns but not their surrounding market areas, and the relationship between the two may not be consistent. Towns with the same population may face very different surrounding environments in terms of population size and composition. An important consequence of this finding is that the results of the model are not correlated with common indicators of ambience barriers—the nonfinancial drawbacks experienced by communities competing for physician services. Statistically they are separate phenomena.

How Closely Correlated Are Projected Capacity and Actual Supply?

How is the projected capacity of rural towns to support primary care physicians, related to the actual numbers of practicing physicians? The following generalizations are suggested by the data.

Primary Care Physician Supply Closely Tracks Projected Economic Capacity: Although there are clearly some places such as Friday Harbor that the modeling process is unable to correctly analyze, the general correlation is high. The Pearson correlation coefficient between capacity and actual supply for all 135 towns is 0.882. The distribution of towns by projected capacity versus actual supply is illustrated in Figure 2. For clarity of presentation, 41 towns with less than 500 residents are excluded, as well as one larger place with over 30,000 residents. The solid line indicates the point where actual FTE primary care physician supply equals projected capacity. Towns below the line are termed "below capacity" in the sense that actual FTEs are less than projected capacity. These communities have leeway to expand the number of their primary care practices. Towns above the line are termed "high supply" with actual FTEs in excess of projected capacity. Other factors being equal, physicians in these communities would be expected to be less enthusiastic about new colleagues (competitors).

The significant correlation between actual supply and projected capacity suggests that the market for primary care physician services "works" in the sense that there appear to be relatively few places with high potential that have not attracted physicians. This pattern is consistent with the argument made years ago by a research team from The Rand Corporation that location decisions follow economic incentives (Newhouse et al., 1982; Williams et al., 1983).

The Projection Model Reflects Very Different Physician Supplies in Towns of Similar Size: The correlation between supply and projected capacity also means that the projection model successfully captures highly disparate spatial behavior. This is illustrated with the six points in Figure 2 that are labeled with their 1990 populations. Given the narrow range (6,031 to 7,241 inhabitants), the variation in physician supply is noteworthy. The number of FTE primary care physicians actually practicing in these similarly sized communities varies between 0.8 and 13.5. The projection model captures most of this range of variation (with FTE capacity ranging between 0.1 to 13.5). To the degree that one believes that actual location decisions follows market opportunity, the correspondence between projection and supply is evidence that the modeling effort represents a significant improvement

over fixed physicians per 1,000 population ratios or other planning or administrative normatives.

There are Large Differences Between Projected Capacity and Supply for Some Rural Towns: While the overall distributions of actual and potential in Figure 2 and Appendix B tend to mirror one another, there are significant discrepancies between the two. The 135 study towns host the practices of 553 primary care physicians (388 FTEs). In towns with a greater supply than their projected capacity, there are a total of 111 "surplus" FTEs. These are balanced by a total deficit of 77 FTEs in communities where physician supply lags behind projected capacity. We have noted previously the aggregate balance between projected capacity and supply. Overall, the total difference between the numbers above versus below capacity amounts to only 34 FTE primary care physicians—less than 9 percent of current supply. Yet the 92 deficit FTEs amount to 30.9 percent of all FTE physicians practicing in these deficit towns. In some communities the gaps can run more than 100 percent of their current complement of physicians. The question is, What accounts for these gaps? Are they random or systematically related to community characteristics?

What Characterizes Rural Towns with Physician Supplies Over and Under Capacity?

Larger Rather than Small Towns Are More Likely to Be Under Capacity: One surprising finding is that larger rather than medium size towns tend to have deficits. Five towns with less than 5,000 residents stand out as high-supply primary care centers with far more physicians than their size and location would suggest. At least two of these towns were originally National Health Service Corps sites whose physicians stayed on to found practices that pull patients from an unusually large service area. On the opposite extreme are four larger towns with over 10,000 inhabitants but physician supplies substantially below projected capacity. These rural centers tend to have relatively high unemployment or low household incomes and have not generally shared in the Puget Sound's economic boom. Of the 12 towns with over 10,000 population, two are closely balanced between capacity and supply, three are categorized as high supply, and seven lie below the line in the below-capacity zone.

Table 6 examines these differences more systematically by contrasting three groups according to whether their actual supply versus projected capacity differ by more or less than plus or minus one-half a FTE. By construction, most very small towns belong to a "balanced" group within the 0.5 FTE boundary. There are slightly

more relatively high-supply places (n=33) whose physician endowments are above potential than there are low-supply communities (n=28).

Places operating under capacity with supply less than projected potential tend to be larger, with mean populations of 6,535, 45 percent higher than the mean of 4,509 for over capacity towns. Given the many complaints by small communities of difficulties recruiting physicians, the finding that towns in which supply exceeds projected capacity are disproportionately small is surprising. Moreover, the differentially larger under-capacity towns have traditionally enjoyed faster population growth (8.4% between 1980 and 1990 compared to 3.4% for high-supply towns) and are more likely to have grown as fast as their surrounding market areas. Although suggestive, the standard deviations around these group means are so large that none of the population differences are statistically significant.

The Gap Between Actual and Projected Potential Physicians Is Correlated with Neither Income Nor Poverty: While there is weak evidence of differences between over- and under-capacity towns by population, there are no notable differences in levels or growth of average family income. However, under-capacity towns appear to have somewhat higher poverty rates, particularly in relation to their surrounding areas. Their poverty rate averages 29 percent higher than that of their surrounding Local Regions (i.e., that relative poverty ratio is 1.29). To control for the joint effects of different community characteristics, the last column in Table 5 regresses the difference between actual physician supply and projected capacity on the series of community characteristics. The result reinforces the fact that none of the characteristics were statistically significant predictors of the gap between supply and projected capacity.

The lack of association between town characteristics and projected gaps raises the possibility that the gaps reflect only random error in the capacity projection model. Arguing against a random error hypothesis is the fact that towns operating over capacity have 2.03 actual FTE physicians per 1,000 population, far more than the 0.54 average for under-capacity towns (Table 6, second to last line). This suggests that the projections are not simply systematic underestimates, but reflect the reality of physician location. Moreover, the lack of association with towns' economic and social status (SES) is perhaps not surprising given the weak statistical relationships with actual supply (Table 5, column 3). Thus, an alternative explanation for the finding that gaps between projected capacity and supply are uncorrelated with SES is that physician location decisions are driven primarily by unmeasured characteristics such as cultural amenities, staff relationships, or the presence of strong local hospitals and institutions.

What Proportion of Underserved Communities Suffer from Apparent Demand Deficiency Handicaps?

Is it an advantage or disadvantage to be an over-capacity town with more physicians than projected capacity to support them? The answer depends on whether a town's population has ready access to physician services sufficient to meet basic health care needs. For example, a community may be rated with a low market capacity because of low household incomes and attendant high rates of uninsurance. Such a community may thus need more care than it can support with its own market resources. This is the demand deficiency problem described in the introduction. Among towns classified as underserved, those that are over-capacity are *demand deficient*—they need more medical care but they already have more physicians than communities of their size and income can be expected to support. In contrast, under-capacity towns have the market potential to expand the number of primary care practices. The fact that they have not done so in the face of high relative need suggests that such communities are *ambience deficient*—they lack the competitive position to attract sufficient physicians even though they have an apparently sufficient market base.

Estimating the relative incidence of these two deficiencies requires the comparison of three indicators: (1) a nonmarket indicator of physician shortages—whether a town is located in a geographic primary care HPSA, (2) whether the community's physician supply is under or over capacity, and (3) an indicator of whether the capacity, even when fully utilized, is sufficient to meet established access standards—one primary care FTE physician per 3,000 population. We used the official listing of HPSAs to code which of the 135 Washington towns were located in a geographic HPSA. While the bureaucratic nature of HPSA designation means that they are not always indicators of differential shortages, they are relevant since they are the key criterion for many public workforce interventions.

To measure whether a town had the projected capacity to support a minimum number of physicians, we need to move beyond the town's boundaries to measure physician population ratios. We therefore use the town's identified home sub-county MCD as the population base for measuring the number of physicians needed to reach a 1:3000 ratio. This was compared to the projected capacity of all towns in an MCD. (Two-thirds of the rural towns shared a home MCD with at least one other town). Although the core criterion for HPSA designation is a minimum ratio of 1:3500, we use a lower standard to reflect the fact that the benchmark of the lowest quartile of counties has been steadily increasing (T.C. Ricketts, unpublished tabulations of changes over time in the bottom quartile of primary care physician-to-

population ratio by county, 2000). Much lower ratios, such as 1:2500, have been proposed in the past (Council on Graduate Medical Education, 1998).

The results of the cross-tabulation of these three measures are displayed in Table 7; of the 94 rural Washington towns with more than 500 population, 32 were located in an HPSA and 62 were not. Within the HPSA status categories, the columns in Table 7 divide towns according to whether they were operating under or over projected capacity. Of the 32 HPSA towns, 19 had fewer FTEs practicing than could be supported. Another 13 were operating over capacity. The rows in Table 7 also divide towns by whether all towns sharing a home MCD have the collective capacity to support at least 1 physician per 3,000 population. The towns divided 50-50 on this standard—47 fell below, 47 above. Of the 32 HPSA towns, two-thirds (20) had insufficient projected capacity to meet the minimum 1:3000 standard.

A remarkable proportion of the rural towns not located in a HPSA apparently face potential physician shortfalls. Among the 62 non-HPSA towns, 43 percent (27) lack the projected capacity to meet the 1:3000 population ratio. And most of these (15) have physician supplies below projected potential. The 17 non-HPSA towns that are operating over capacity include the smaller unusual rural centers for primary care noted previously.

We can use the array in Table 7 to address the core question raised by this paper and define demand and ambience deficiencies. Of Washington's 94 rural towns, 32 are located in a primary care geographic HPSA and 62 in non-HPSA areas. Both of these groups are divided according to whether they are over or under capacity. Under capacity means that their actual FTE physician complement is less than their projected market potential, while over capacity means actual supply is greater than projected. Of the 32 HPSA towns, 13 percent are operating over predicted capacity. They are supporting more physicians than expected, but the town still does not have enough physicians to meet minimum requirements and qualifies for federal and state subsidies and assistance. These are demand-deficient towns.

Table 7 further divides the study towns by comparing their projected capacities to a minimum standard of one physician per 3,000 inhabitants. This comparison is done at the small region defined by each town's home MCD. The number of physicians required for each 3,000 of the MCDs population is compared to the joint projected capacity of all towns located in an MCD. In situations where capacity is "less than need," total projected capacity does not add up to the number of physicians required to meet the 1:3000 standard. Of the 32 HPSA towns, 20 (15 plus 5) are in this situation. Of the 19 HPSA towns that are operating under capacity, four have sufficient capacity in the local area to meet the 1:3000 standard.

Thus these four have the capacity to eliminate the shortage, but the communities have been unable to recruit or retain sufficient physicians to fill the gaps. These are cases of ambience deficits. Finally, there are 15 towns that, even if they used all their capacity, would still not meet the 1:3000 standard. In this sense they are demand deficient. But even with this limited capacity to meet minimal needs, their actual physician supplies are below what could be supported. This set of 15 towns faces both demand and ambience deficits. In sum, of the 32 HPSA towns, 13 face demand deficits only, 4 face an apparent ambience deficit, and 15 confront both demand and ambience deficits.

The same categorization can be applied to non-shortage towns outside of a HPSA. Over capacity characterizes 29 of the 62 communities. Unlike HPSA towns, the majority serve areas where capacity is greater than need (18 plus 17 equals 35). Also unlike HPSA towns, 18 of the 62 (29 percent) are ambience, not demand constrained.

This categorization is summarized in Table 8, which communicates a strong conclusion: towns located in designated HPSAs overwhelmingly face demand sufficiency problems. Forty percent (13 of 32) have more physicians than expected capacity but are still in shortage. Another 47 percent (15 out of 32) face a double constraint of both an ambience and a demand deficit. The latter, even if they overcame the evident ambience problems and operated at projected capacity, still would not reach minimal supply levels. These groups of towns are distinctly different. The few ambience deficit-only towns are larger (mean population of 8,796) and not notably isolated from hospital services (an average of 2.9 miles to a hospital with obstetric services). Demand deficit-only towns are smaller and more isolated, but those facing both deficits are notably small (mean population of 1,219) and isolated (mean miles to the nearest hospital with obstetric services equals 18.1 miles).

The demand deficiency problem is even more prevalent since it is also apparent among non-HPSA towns. The 15 towns that are both operating under capacity and (even though not designated as a HPSA) have projected capacities insufficient to support a ratio of one primary care physician per 3,000 population. This is the same combined deficit problem facing a similar number of HPSA towns, and indeed their average size (but not distance) is the same as the HPSA towns. The interpretation of the demand deficit only and ambience deficit only for non-HPSA towns differs in that these places do not have shortage indicators. The two categories differ in the degree to which further growth of primary care physician supply may be limited by local demand constraints.

In sum, while research and policy have focussed on the barriers experienced by underserved rural communities in attracting more physicians—the ambience problem, the results in Table 8 suggest that the problem of insufficient demand deserves more attention. This is particularly true since the results incorporate all licensed physicians—including NHSC scholars and loan repayers as well as the staff of Community and Migrant Health Centers. The gaps between capacity and supply in underserved areas are thus likely to be understated in terms of private practice.

Conclusions and Implications

This study of the market forces behind primary care physician shortages in rural Washington State is a story of three measures of physician supply: what is (current number of FTEs), what could be (the number of physicians a community can be expected to support), and what should be (population-based access standards). The focus is on the second measure of the projected potential of rural communities to economically support primary care physicians. The market orientation means the effects of federal and state subsidy programs are not taken into account. While the many barriers faced by small towns in competing for physicians are well documented, this paper explores the problem of what we have termed demand deficiency—the lack of a sufficient economic base caused by low population, low income, and weak competitive position relative to surrounding communities. The case study for Washington State uses detailed state-specific data not often available to generate projections for 1997 and comparisons with 1999 physician FTE supply data.

There are four unique features of the study's methodology. First, it makes rural towns and not counties the unit of analysis. Central places are where physicians are located, and are the entities typically in competition with each other. Second, the economic capacity projection model moves beyond physician population ratios and attempts to estimate total dollar expenditures on primary physician care available to local practitioners. The paper uses Medicare claims data linked to the AMA Masterfile to adjust expenditure projections for the proportions devoted to primary care and the shares of physician income generated by hospital versus office settings. Third, the paper attempts to estimate expected market share, given the competitive environment. This analysis is based on a realistic, but rarely applied premise—all patients (at least those with private insurance and the ability to pay) are competed for so that no community can claim an exclusive market area. A uniform potential market area was defined for each town and then the market share

from each component MCD projected on the basis of regression models estimated from 100 percent Medicare physician claims. The regressions themselves had good explanatory power. Finally, the model compares estimated potential with the actual FTE of primary care physicians located in each town using highly accurate licensure files (supplemented with questionnaire data) that allow us to measure both projected capacity and supply in FTEs.

The projection modeling worked remarkably well. The gross income standard for a supportable practice established from an independent survey turned out to be close to the amount needed to account for all the physicians actually practicing in rural Washington.

Limitations

This study was undertaken as an experiment to test the feasibility of modeling the income potential for primary care physicians among rural communities. The goal was to use surveys and Medicare claims analysis to establish parameters that could be applied to universally available secondary data on rural communities. The limitations inherent in this process are obvious. Error is introduced by interweaving data from different time periods. While the income data are from 1996 and 1997, the population data are from 1990, and the physician supply numbers are for all those practicing as of May 1999 (as estimated in 2000). There is a further mismatch in the geographic areas used. The analysis of Medicare data to establish market share parameters used ZIP codes. These were applied to Census data at the MCD level. While the MCD data were available nationwide, the unit of analysis in Washington State is problematic. The areas are often large and are less fine a unit of analysis than in other U.S. regions.

Defining the market area of a community proved to be a difficult problem. The original intention was to abstract from the common practice of defining primary market areas for each rural community and instead define an arbitrary area generated by a radius around all communities. The market share model was then to sort out the actual core of patients to be attracted to any one location. This proved to be an incorrect assumption. Even for the highly localized markets for primary care physicians, larger places draw from wider geographic areas than do smaller places. We therefore moved to two radii, 8 and 14 miles. This is arbitrary and far more work needs to be done on the propensity to travel for primary care. This difficulty is exacerbated by the errors inherent in measuring distances by straight-line miles rather than road miles in an area with as complex topography as Washington. Finally, the market share coefficients are based on Medicare data, and the elderly are

known to be far less likely to travel for care than younger patients (Adams et al., 1991; Adams & Wright, 1991). We have therefore likely overestimated local market retention rates.

Finally, rural Washington is generally so lightly populated that there are less than 100 towns with over 500 population. The numbers are thus too low to draw statistically meaningful results on the incidence of the problems faced or differences in towns with apparent demand versus ambience deficits. This small sample size is compounded by the high variability of actual physician location patterns and the willingness of many rural physicians to accept below-average pay. While the study took into account poverty rates, it may not adequately reflect geographic differences in third party coverage. In particular, the sum of Medicaid and a state-only subsidized program for the uninsured account for as much as 40 percent of the population in rural Washington counties, with demonstrable adverse consequences for practice revenue (Hicks et al., 2000; unpublished data from the Washington State Department of Health, 2000).

Applying the results of this modeling effort to the circumstances of specific communities has further important limitations. Expected market shares from surrounding communities would need to be adjusted to reflect relative commercial attractiveness and the realities of existing local health systems. Equally important is the availability of safety net providers and the degree to which private practices must shoulder the burden of the uninsured or the low reimbursements offered by Medicaid. Furthermore, physicians in each community will have their own financial arrangements that may substantially modify basic market conditions (e.g., subsidies from hospitals, hospital-based practice income, and revenue sharing arrangements within practices). Finally, there are the difficult-to-measure attributes of "ambience" such as community cohesion and leadership and collegial relationships among local physicians that condition the competitive potential of a rural community.

Policy Relevance of Findings

For all the potential for error, the results track the actual distribution of physicians and have implications on both the community and state policy-making level. The key issue raised by this study is how many primary care physicians a rural town can be expected to support. Are physician-owned and hospital-based practices expanding their practice sizes appropriately, or, in their fear of too much competition, are they too conservative in recruitment? Conversely, hospital surveys from the early 1990s indicated that over 80 percent of small rural hospitals were recruiting physicians (Wooldridge et al., 1995). In their zeal to build a referral base,

have rural hospitals been too expansive in their recruitment plans and ignored the limitations of the local market? For public policy, different subsidies and supports for rural physicians respond to different barriers. The question raised by this report is the adequacy of incentives in the programs such as the National Health Service Corps, Medicare's HPSA incentive payment program, community health center employment, or rural health clinics. Are they directed at the most urgent constraints or are they of sufficient magnitude to counterbalance the competitive disadvantages of underserved locations? Three conclusions speak to these questions.

First, the results of the market share model indicate that physician perceptions of significant spatial competition, even for the highly localized demand for primary care, are correct. The results are a warning that practices should not overestimate their potential market share. In the case of the two example towns highlighted in this report, both with 3,500 to 3,750 population range and reasonably isolated from larger places (over 15 miles on two-lane roads), both are projected to retain less than 25 percent of local area expenditures on primary care physicians. The estimated share obviously depends on the geographic extent specified for the market, but the radius of the market area for these sampled towns was only 8 miles. While we have not traced the source and destination of patients in this paper, work with the same Medicare data by Professor Gary Hart and his colleagues indicate that the flow of primary care patients is not primarily to metropolitan centers (Hart et al., in press). Instead, small rural places lose local patients to larger rural centers. While the pull of these local centers is closely related to population, the study has located a number of small towns with far more physicians than projected capacity. An understanding of how these small-scale centers of care have emerged would clearly be relevant to helping communities build their capacities.

Second, to the degree that projected capacity captures local potential demand, the results are consistent with rational location decision making by physicians. While some of the gaps between potential and supply are the result of random local idiosyncrasies, not all of them are. For example, the lead author has had the opportunity to visit two notably high-supply towns—places with far more physicians than their size, income, or isolation would warrant. In both, physicians reported a sense of oversupply, and difficulty attracting sufficient patient volumes. A simple planning model available to sponsoring hospitals and practitioners that factored in not only population, but also income and expected market share would be a useful tool in hiring and expansion decisions.

Third, for public policy many communities with physician shortage confront insufficient capacity to economically support the needed physicians. Most towns

located in HPSAs are either at or above projected capacity, or have failed to hit a capacity target that would still leave them with less than 1 physician per 3,000 population. In the terminology used in this study—they are handicapped by demand deficits or demand combined with ambience deficits. At the minimum, a one-size-fits-all policy to support shortage areas will not work. Different towns face different constraints and demand constrained towns will require continuous subsidies to make up for an insufficient volume of patients that nonetheless lack geographically proximate source of care.

References

Adams, E. K., Houchens, R., Wright, G. E., Robbins, J. (1991). Predicting hospital choice for rural Medicare beneficiaries: the role of severity of illness. *Health Services Research*, 26(5), 583-612.

Adams, E. K., Wright, G. E. (1991). Hospital choice of Medicare beneficiaries in a rural market: why not the closest? *Journal of Rural Health*, 7(2), 134-152.

American Medical Association (1997). *Economic Characteristics of Medical Practice, 1997.* Chicago, IL: AMA Center for Health Policy Research.

Cameron, I. (1998). Retaining a medical workforce in rural Australia [editorial; comment]. *Medical Journal of Australia*, 169(6), 293-294.

Council on Graduate Medical Education (1998). *Tenth Report: Physician Distribution and Health Care Challenges in Rural and Inner-City Areas.* Rockville, MD: Health Resources and Services Administration.

Escarce, J. J., Polsky, D., Wozniak, G. D., Pauly, M. V., Kletke, P. R. (1998). Health maintenance organization penetration and the practice location choices of new physicians: a study of large metropolitan areas in the United States. *Medical Care*, 36(11), 1555-1566.

General Accounting Office (1995). *National Health Service Corps: Opportunity to Stretch Scarce Dollars and Improve Provider Placement.* : GAO/HEHS-96-28.

General Accounting Office (1996). *Rural Health Clinics: Rising Program Expenditures Not Focused on Improving Care in Isolated Areas.* : GAO/HEHS-97-24.

General Accounting Office (1999). *Physician Shortage Areas: Medicare Incentive Payments Not an Effective Approach to Improve Access.* : GAO/HEHS-99-36.

Hart, L. G. (1998). *Washington Academy of Family Physicians 1996-97 Survey of Family Physicians.* Seattle, WA: University of Washington Department of Family Medicine.

Hart, L. G., Rosenblatt, R. A., Lishner, D. M., Friedman, H., Baldwin, L.-M. (in press). *Where Do Elderly Rural Residents Obtain their Physician Care? A Study of Medicare Patients in Washington State.* Rural Health Working Paper #51. Seattle, WA: WWAMI Rural Health Research Center, University of Washington.

Hicks, B., Coyne, J., Rosenman, R., Tarnai, J. (2000). Washington State medical practice economic survey: analysis and final report. In Washington State Medical-Education and Research Foundation (Ed.), *Washington's Ailing Health Care System: Will Your Doctor Be There for You?* Seattle, WA: Author.

Kehrer, B. H., Wooldridge, J., Szapira, N. (1990). *Evaluation of Health Manpower Shortage Area Criteria.* Report to the Bureau of Health Professions Document 80-83. Princeton, NJ: Mathematica Policy Research.

Kindig, D. A., Movassaghi, H. (1989). The adequacy of physician supply in small rural counties. *Health Affairs*, 8(2), 63-76.

Konrad, T. R., Leysieffer, K., Stevens, C., Irvin, C., Martiniz, R. M., Nguyeun, T. T. H. (2000). *Evaluation of the Effectiveness of the National Health Service Corps.* Report to Health Resources and Services Administration, National Health Service Corps. Chapel Hill, NC: Cecil G. Sheps Center for Health Services Research.

Larson, E. H., Hart, L. G., Ballweg, R. (2000). *National Estimates of Physician Assistant Productivity.* Rural Health Working Paper #57. Seattle, WA: WWAMI Rural Health Research Center, University of Washington.

Medicare Payment Advisory Commission (1998). *Report to the Congress: Context for a Changing Medicare Program 1998.* Washington, DC

Newhouse, J. P., Williams, A. P., Bennet, B. W., Schwartz, W. B. (1982). *The Geographic Distribution of Physicians: Is the Conventional Wisdom Correct?* Santa Monica, CA: Rand Corporation.

Office of Technology Assessment (1990). *Health Care In Rural America.* OTA-H-434. Washington, DC: U.S. Government Printing Office.

Ormond, B. A., Wallin, S., Goldenson, S. M. (2000). *Supporting the Rural Health Care Safety Net.* Assessing the New Federalism Occasional Paper Number 36. Washington, DC: Urban Institute.

Pathman, D. E., Konrad, T. R., Agnew, C. R. (1994). Studying the retention of rural physicians. *Journal of Rural Health*, 10(3), 183-192.

Pathman, D. E., Konrad, T. R., Ricketts, T. C. d. (1992). The comparative retention of National Health Service Corps and other rural physicians. Results of a 9-year follow-up study. *JAMA*, 268(12), 1552-1558.

Rabinowitz, H. K., Diamond, J. J., Hojat, M., Hazelwood, C. E. (1999). Demographic, educational and economic factors related to recruitment and retention of physicians in rural Pennsylvania. *Journal of Rural Health*, 15(2), 212-218.

Rosenblatt, R. A., Wright, G. E., Baldwin, L. M., Chan, L., Clitherow, P., Chen, F. M., Hart, L. G. (2000). The effect of the doctor-patient relationship on emergency department use among the elderly. *American Journal of Public Health*, 90(1), 97-102.

Rosko, M. D., Broyles, R. W. (1988). *The Economics of Health Care: A Reference Handbook.* New York, NY: Greenwood Press.

Washington State Department of Health (1994). *Staffing the New Health System: the 1995-1997 Biennial Report of the Health Personnel Resource Plan Statutory Committee.*

Williams, A. P., Schwartz, W. B., Newhouse, J. P., Bennett, B. W. (1983). How many miles to the doctor? *New England Journal of Medicine*, 309(16), 958-963.

Wooldridge, J., Cheh, V., Thompson, R., Moreno, L., Holden, N. (1995). Do transition grants help rural hospitals? *Health Care Financing Review*, 17(1), 39-52.

Wright, G. E. (1985). *Community Characteristics and the Competition for Physicians in Rural America, 1971-1981.* Report to the Office of the Assistant Secretary for Planning and Evaluation. Silver Spring, MD: Macro Systems.

Wright, G. E. (1998). *File Description for the Universe of Rural Places.* Seattle, WA: WWAMI Rural Health Research Center, University of Washington.

Wright, G. E. (2001). The economics of rural practice. In J. Geyman, T. Norris, & L. G. Hart (Eds.), *Textbook of Rural Medicine* New York, NY: McGraw Hill.

Table 1: Illustration of Projected Expenditures on Primary Care Physicians in Three Washington Rural Communities

	Quincy	Friday Harbor	Sequim
Town Profile, 1990:			
Population	3,738	1,492	3,616
% over 65	11.8%	23.3%	48.1%
Average family income	$24,052	$42,858	$28,203
Poverty rate	22.1%	5.1%	10.4%
Expenditures on Physicians in Market Area:			
Area total population	17,384	5,049	55,011
Spending per capita for office visits	$292	$337	$344
% visit expenditures for primary care	42.3%	42.3%	34.7%
Spending per capita for primary care office visits	$123	$143	$119
Hospital as % of office visit expenditures	31.9%	31.9%	35.3%
Total spending on primary care physicians per capita	$163	$189	$161
Total market for primary care physicians ($1,000s)	$2,831	$954	$8,840
Town's Estimated Share of Expenditures:			
Estimated expenditure share for physicians in town	25.5%	36.8%	12.7%
Town market capacity ($1,000s)	$723	$351	$1,121
Number of Physicians:			
Number of supportable FTE physicians at $256,372 per physician	2.82	1.37	4.38
Actual FTEs, 1999 (as estimated in March 2000)	1.22	3.59	6.10

Table 2: Percent Change in Physician Market Share Due to Increasing Travel Distance by One Mile to Competing Office Locations in Rural Washington State (measured in percentage points)

Distance Measures	Population Size Group of Towns with Physician Office				
	More than 10,000	5,000 -9,999	2,500 -4,999	1,000 -2,499	Less than 1,000
Miles to office	-1.065	-0.613	-0.607	-0.401	-0.395
Miles to nearest MSA	0.762	-0.195##	0.582##	0.539##	0.497##
Miles to nearest alternative town:					
Over 10,000	0.433	0.294	0.286	0.533	0.187##
5,000-10,000	0.346	0.368	0.381	0.433	0.308##
2,500-4,999	0.206	0.338	0.274	0.442	0.123##
1,000-2,499	0.401	0.271	0.383	0.497	0.255
Under 1,000	0.300	0.201##	0.161##	0.749	0.587

Source: Part B Medicare bills from all in-state primary care physicians in Washington State, 1994.

Note: ## = statistically not significantly different from zero. All other coefficients significant at the 0.01 level.

The incremental effects are estimated from regression coefficients for all rural places in the state as the log of distance. The nonlinear effect of increasing distance by one mile is evaluated here at a distance of 10 miles from ZIP code of residence. At 20 miles distance the effect of an additional mile is approximately one-half that shown in the table.

Table 3: Annual Income Measures for Rural Family Practitioners, Washington State, 1996

Income Measure	All Full-Time Rural Physicians	Full-Time Rural Physicians in Solo Practice or Partnerships	Full-Time Rural Physicians Employed or in Group Practices
Net practice income	$122,033 n = 183 sd = 30,206	$121,408 n = 141 sd = 31,201	$124,126 n = 42 sd = 26,836
Practice expenses as a percentage of gross income	55.72% n = 145 sd = 15.03	57.69% n = 118 sd = 11.54	47.15% n = 27 sd = 23.63
Projected gross practice income	$275,594	$286,951	$234,865

Source: Calculated from data files described in Hart, L. G. (1998). *Washington Academy of Family Physicians 1996-97 Survey of Family Physicians.* Seattle, WA: University of Washington Department of Family Medicine.

Notes:
[a] Full-time physicians defined as those reporting 40 or more hours of patient care activities.
[b] Net practice income calculated from the midpoint of a series of categories each covering a range of $20,000.
[c] Projected gross practice income is calculated on the basis of average responses to net practice income and practice expenses as a percentage of gross income.

Table 4: Distribution of Actual and Potential Primary Care Physicians by Town Population

Town Characteristics	Number of Rural Towns	Projected Market Demand[a]		Number of Potential vs. Actual Primary Care Physicians[a]	
		Market Share = % of Total Demand	Mean ($1,000s)	FTE Capacity	Actual FTEs[b]
Town Population:					
< 500	41	11.6%	$ 51	0.18	0.14
501-1,000	29	13.9	123	0.51	0.63
1,001-2,000	26	24.1	410	1.60	2.00
2,001-5,000	19	20.7	562	2.19	3.37
5,001-10,000	8	38.9	2,255	8.79	6.40
10,001-49,999	12	52.1	3,920	16.51	16.67
Total Towns	135	21.0	561	2.81	2.91

Notes:
[a] Mean values are calculated across towns in each category.
[b] Actual FTE counts from Washington State licensure data as analyzed by the WWAMI Center for Health Workforce Studies.

Table 5: Comparison of Regressions for Alternative Physician Supply Measures in Towns with > 500 Population (parameter estimates with t values in parentheses)

Independent Variables	Mean Values (STD)	Dependent Variables (FTE Counts)		
		Actual Supply (mean = 4.10, std = 6.51)	Projected Capacity (mean = 3.74, std = 6.61)	Gap: Supply Less Capacity (mean = 0.36, std = 4.28)
Town population (1,000s)	4079 (5885)	**1.146***** (10.697)	**0.916***** (5.818)	0.0002 (1.396)
Population growth, 1980-90	6.2% (26.2)	0.023 (1.471)	0.0128 (0.560)	0.010 (0.421)
Town/county population growth	-0.82 (2.76)	0.143 (1.029)	0.115 (0.560)	0.029 (0.133)
% of population > 65	18.4% (6.8)	**0.131*** (2.106)	-0.017 (-0.191)	0.148 (1.551)
% of population below poverty, 1990	17.1% (5.4)	-0.081 (-1.212)	-0.099 (-1.005)	0.018 (0.173)
Town/county % below poverty	1.13 (0.37)	-0.962 (-1.119)	1.077 (0.853)	-2.039 (-1.542)
Average family income, 1989	31,183 (5888)	**-0.021#** (-1.832)	0.014 (0.809)	**-0.035*** (-1.963)
Miles to nearest hospital with obstetrics (log)	1.40 (1.44)	**-0.551*** (-2.334)	-0.373 (-1.076)	-0.177 (-0.489)
Miles to nearest MSA (log)	3.98 (0.45)	0.027 (0.036)	0.247 (0.226)	-0.220 (-0.192)
Miles to nearest MSA* population > 10,000	0.49 (1.28)	-0.722 (-1.557)	-0.337 (-0.495)	-0.385 (-0.540)
County population per square mile	35.2 (55.8)	-0.005 (-0.744)	0.0003 (0.031)	-0.005 (-0.513)
Intercept	NA	7.119 (1.460)	-3.687 (-0.515)	10.806 (1.441)
R-square (F value)	NA	0.836*** (37.897)	0.656*** (14.238)	0.099 (0.823)

Significance levels: *** = 0.0001, ** = 0.01, * = 0.05, and # = 0.10.
Number of cases = 93.

Table 6: Characteristics of Rural Towns by Direction of Gap Between Projected Capacity and Supply of FTE Primary Care Physicians: Group Means and (sd)

Town Characteristics	A Under Capacity: Supply Less than Potential (n = 28)	B Over Capacity: Supply Greater than Potential (n = 33)	C Balanced: Supply within +/- 0.5 FTEs of Potential (n = 33)
Population:			
1990 population	6,535 (7742)	4,509 (5859)	1,563 (1933)
Growth 1980-90	8.4% (18.0)	3.4% (12.5)	7.1% (39.3)
Town /county growth	0.98 (1.70)	0.70 (1.36)	0.63 (3.93)
Population density—county	61.2 (94.8)	26.4 (18.8)	21.9 (16.1)
Income:			
Average family income 1989	$31,570 (6064)	$33,153 (6191)	$28,885 (4670)
Family income growth 1979-89	62.0% (23.3)	62.2% (27.9)	52.2% (18.3)
Town/county average family income 1989	0.91 (0.14)	0.96 (0.15)	0.85 (0.12)
Town poverty rate 1989	19.8% (8.8)	15.3% (5.3)	17.2% (7.1)
Town/county poverty rate	1.29 (0.14)	1.02 (0.32)	1.11 (0.40)
Geography:			
Miles to nearest hospital with obstetrics	6.3 miles (6.6)	6.6 miles (7.7)	12.4 miles (9.7)
Miles to nearest MSA	56.0 miles (25.4)	60.7 miles (28.2)	59.1 miles (21.8)
Physician Supply:			
FTE primary care physicians per 1,000 population	0.54 (0.53)	2.03 (1.38)	0.41 (0.47)
% towns in an HPSA	32.1% (47.6)	33.3% (47.9)	36.3% (48.8)

Note: County data, except for population density, refers to a standardized Local Region composed of MCDs, the centroids of which fall within a variable radius.

Table 7: Distribution of Towns by Shortage Designation, Projected Capacity, and Physician FTE Supply (census rural places > 500 population)

Population Need For Primary Care Physicians Relative to Projected Capacity	Total Towns > 500 Population	Town Shortage Designation			
		Non-Shortage (not in an HPSA) (n = 62)		Shortage (located in an HPSA) (n = 32)	
		Under Capacity (actual < potential)[a]	Over Capacity (actual > potential)[a]	Under Capacity (actual < potential)[a]	Over Capacity (actual > potential)[a]
Capacity less than need (< 1:3000)[b]	47	15	12	15	5
Capacity greater than need (> 1:3000)[b]	47	18	17	4	8
Total towns	94	33	29	19	13

Notes:
[a] Towns classified as over or under capacity according to whether their actual FTE supply was greater or less than projected capacity.
[b] Comparison of capacity versus need made at the level of each town's home Minor Civil Division (MCD) by comparing the projected capacity for all towns in an MCD with a standard of 1 primary care physician per 3,000 population.

Table 8: Estimate of Demand Versus Ambience Deficit Towns (census rural places > 500 population)

Type of Constraint or Deficit Faced	Town Shortage Designation					
	Nonshortage (not in an HPSA)			Shortage (located in an HPSA)		
	Number of Towns	Mean Population	Mean Miles to Hospital	Number of Towns	Mean Population	Mean Miles to Hospital
Demand constrained (demand deficit) only	29	4,532	6.6	13	2,368	8.7
Non-demand constrained (ambience deficit) only	18	8,294	3.0	4	8,796	2.9
Both demand and ambience deficits	15	1,210	10.7	15	1,219	18.1
Total towns	62	4,820	6.5	32	2,633	12.3

Note: Demand Constrained Towns defined from Table 7 as those with physician supplies over their own projected capacity. Non-Demand constrained towns are those operating under capacity but in MCDs with sufficient capacity to meet a 1:3,000 physicians per population ratio. Towns with both constrains are those where the town was not only operating under capacity but had insufficient capacity to meet the 1:3000 ratio.

Figure 1: Schematic Diagram of Market Share Determination

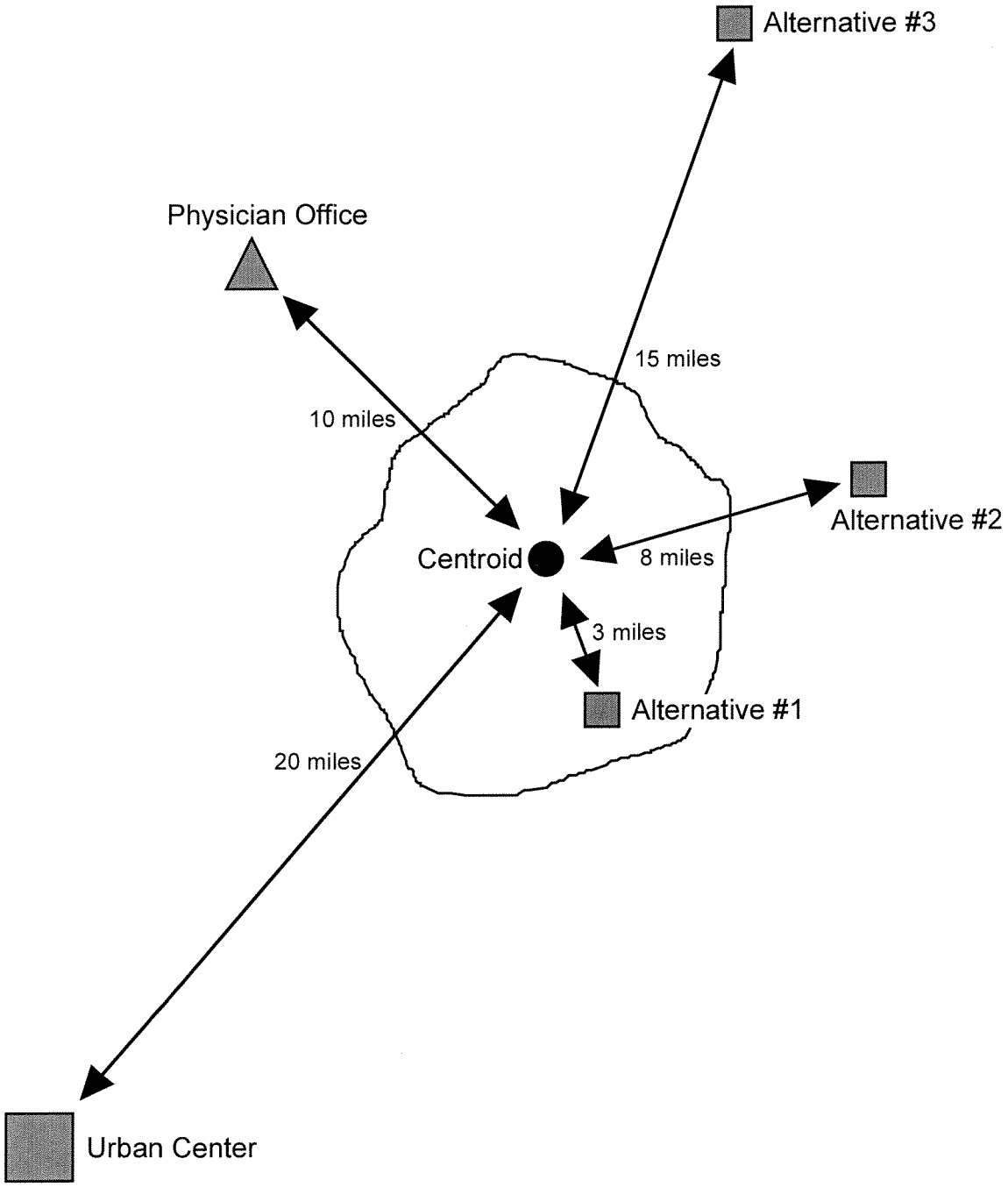
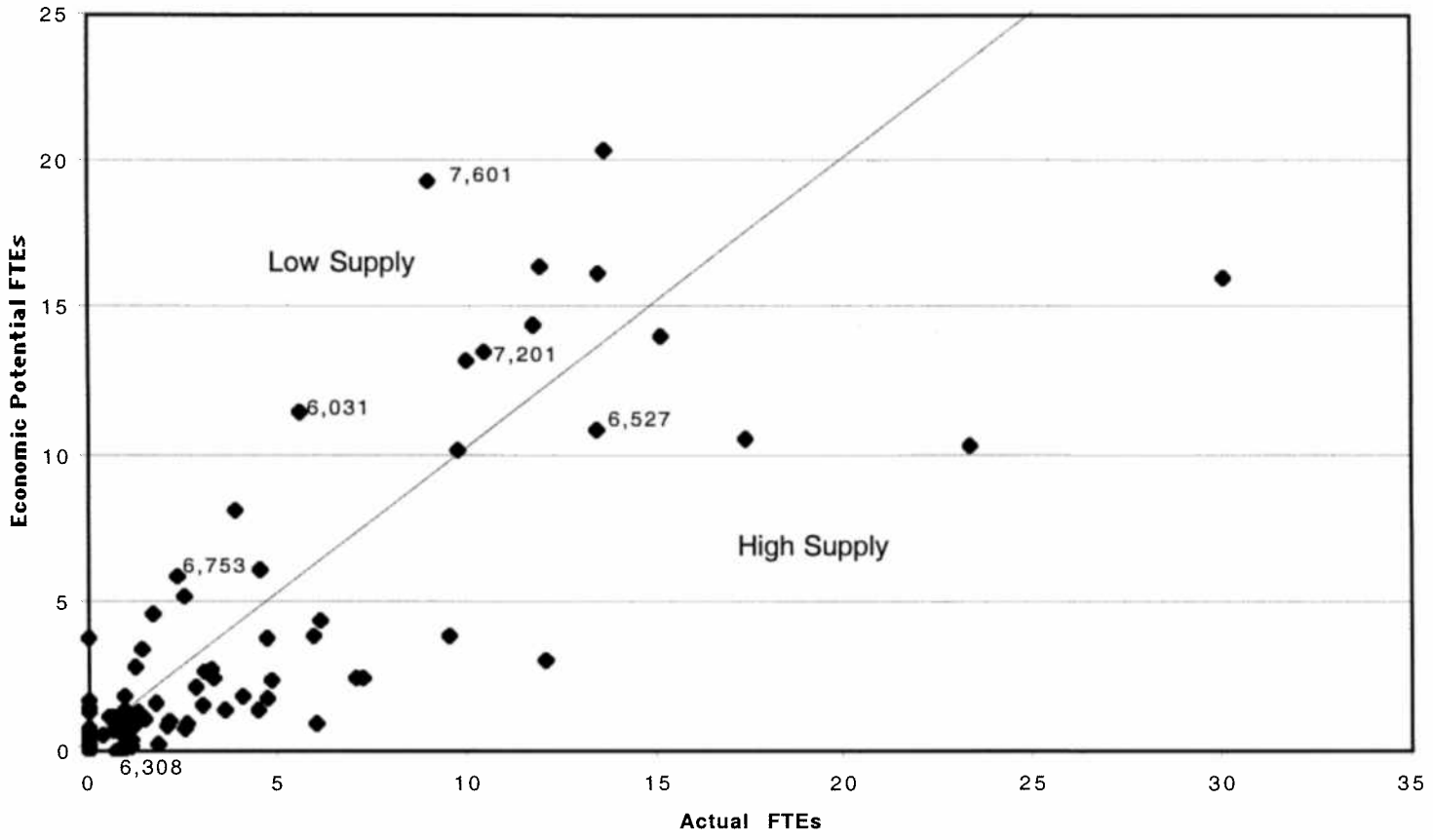


Figure 2: Distribution of Rural Towns by Actual Versus Potential FTE Primary Care Physicians



Notes: Towns have a 1990 population of 500 or more. One large town with a potential of over 40 FTEs is not shown. Population indicated to the right of six towns. The solid line indicates equality between actual and potential primary care FTEs. Pearson correlation coefficient = 0.869.

Table A1: Per Capita Spending for Physician Office Visits in 1997 by Age Group and Poverty Status

Age Category	Below Federal Poverty Line	Above Federal Poverty Line
Children under 18	$ 38.85	$ 73.97
Women 18-34	98.68	158.96
Men 18-34	86.36	106.93
Women 35-64	126.21	158.70
Men 35-64	216.30	142.06
Elderly 65-74	356.65	402.09
Elderly 75 and older	316.10	467.95

Source: Tabulations from the National Medical Expenditure Survey, 1987, updated by the National Center for Health Statistics to 1997 prices. Averages are for nonmetropolitan areas in the West census region.

Table A2: Percentage of Medicare Allowed Charges for Physician Services submitted by Primary Care Physicians (Washington State, 1994)

Type of Community	Percentage of Charges for Office Visits Only	Percentage of All Physician Charges, Including Hospital-Based Services
Adjacent to metro area and has a large hospital	40.1%	25.5%
Adjacent to a metro area and has only a small hospital	43.5	35.7
Not adjacent with large hospital	34.7	26.3
Not adjacent with small hospital	42.5	35.5
All metro areas	28.4	18.3

Source: Calculated from 100 percent of all Medicare charges for beneficiaries who received all their care in Washington State during calendar year 1994. The geographic classification was accomplished by clustering the ZIP codes of patient residence into 123 Health Service Areas. The geographic classification is according to whether the area contains a hospital with over 100 beds and/or is adjacent to a metropolitan area. However, metropolitan area designations do not follow standard MSA county-based classification.

Table A3: Percentage Distribution of Primary Care Physician Medicare Allowed Charges by Place of Service (Washington State, 1994)

Type of Community	Place of Service				
	Office	Inpatient Hospital	Outpatient Department	Emergency Room	Other (e.g., SNF, ASC)
Adjacent, large hospital	71.9%	16.9%	3.2%	2.6%	5.4%
Adjacent, small hospital	70.2	17.2	1.7	4.8	6.0
Not adjacent, large hospital	71.1	17.9	5.2	1.6	4.2
Not adjacent, small hospital	71.7	17.0	2.3	3.6	5.4
All metro	76.7	18.0	2.3	1.9	1.1

Source: See Table A2. The unit of analysis is physicians who are grouped by the location of their primary office. Rows add to 100 percent.

Table A4: OLS Regression Model to Estimate the Market Share of Medicare Physician Payments by ZIP Code of Patient Residence

Study Population	
Unit of Analysis	All Washington ZIP codes contributing Medicare patients to rural primary care physicians.
Index Town	A town whose ZIP code(s) that include at least one billing primary care physician paired with the rural ZIP codes of their patients. Seven such towns not recognized by the Census Bureau are excluded.
Sample Size	312 Residential ZIP Codes paired with 45 rural places with at least one billing primary care physician, for a total of 843 observations.
Dependent Variable	
Market Share	Total allowed charges flowing from a residential ZIP code to a town with primary care physicians serving those residents as a proportion of all billed charges for residents by primary care physicians (no matter where their offices are located).
Independent Variables	
Population of Index Town	1990 Census population.
Distance to Index Town	Log of linear miles between the centroid of the ZIP code and the centroid of the index town with the physician office.
Distance to the Nearest MSA	Log of linear miles between the centroid of the ZIP code and centroid of the nearest Metropolitan Statistical Area.
Distance to Town >10,000	Log of linear miles between the centroid of the ZIP code and centroid of the nearest rural place with a 1990 population > 10,000.
Distance to Town 5-10k	Log of linear miles between the centroid of the ZIP code and centroid of the nearest rural place with a 1990 population between 5,000 and 10,000.
Distance to Town 2.5-5k	Log of linear miles between the centroid of the ZIP code and centroid of the nearest rural place with a 1990 population between 2,500 and 5,000.
Distance to Town 1-2.5k	Log of linear miles between the centroid of the ZIP code and centroid of the nearest rural place with a 1990 population between 1,000 and 2,500.
Distance to Town < 1,000	Log of linear miles between the centroid of the ZIP code and centroid of the nearest rural place with a 1990 population less than 1,000.
Regional Dummy Terms	Series of 19 dichotomous indicator variables for substate-regions in which the index town is located. Number of such variables included in models varied between 2 and 8.

Table A5: Summary of Market Share Regressions: Adjusted R-Squares and the Number of Observations

Town Size Category	Central/Eastern	Puget Sound/Vancouver	Statewide
All places	0.422 (n = 383)	0.451 (n = 458)	0.432 (n = 846)
10,000+	0.689 (n = 119)*	0.542 (n = 132)*	0.549 (n = 252)
5,000-10,000	0.835 (n = 28)	0.684 (n = 99)	0.708 (n = 128)*
2,500-5,000	0.568 (n = 119)*	0.697 (n = 71)*	0.508 (n = 191)
1,000-2,500	0.616 (n = 80)*	0.724 (n = 104)*	0.532 (n = 185)
> 1,000	0.614 (n = 33)	0.563 (n = 48)	0.520 (n = 82)*

Note: Asterisk (*) indicates the eight models used to estimate market share.

Previous WWAMI Rural Health and Health Workforce Research Center Working Papers

The WWAMI Rural Health Research Center was established in 1988. The WWAMI Center for Health Workforce Studies was established in 1998.

1. Hart, L. Gary; Rosenblatt, Roger A.; and Amundson, Bruce A. Is There a Role for the Small Rural Hospital? January 1989.
2. Hart, L. Gary; Rosenblatt, Roger A.; and Amundson, Bruce A. Rural Hospital Utilization: Who Stays and Who Goes? March 1989.
3. Amundson, Bruce A. and Hughes, Robert D. Are Dollars Really the Issue for the Survival of Rural Health Services? June 1989.
4. Nesbitt, Thomas S.; Rosenblatt, Roger A.; Connell, Frederick A.; and Hart, L. Gary. Access to Obstetrical Care in Rural Areas: Effect on Birth Outcomes. July 1989.
5. Schleuning, Dianne; Rice, George; and Rosenblatt, Roger A. Addressing Barriers to Rural Perinatal Care: A Case Study of the Access to Maternity Care Committee in Washington State. October 1989.
6. Rosenblatt, Roger A.; Whelan, Amanda; and Hart, L. Gary. Rural Obstetrical Access in Washington State: Have We Attained Equilibrium? January 1990.
7. Rosenblatt, Roger A; Weitkamp, Gretchen; Lloyd, Michael; Schafer, Bruce; Winterscheid, Loren C.; Vaughn, J. Daniel; and Hart, L. Gary. Are Rural Family Physicians Less Likely to Stop Practicing Obstetrics Than Their Urban Counterparts: The Impact of Malpractice Claims. April 1990.
8. Rosenblatt, Roger A.; Whelan, Amanda; Hart, L. Gary, Long, Constance; Baldwin, Laura-Mae; and Bovbjerg, Randall R. Tort Reform and the Obstetric Access Crisis: The Case of the WAMI States. June 1990.
9. Hart, L. Gary; Pirani, Michael; and Rosenblatt, Roger A. Causes and Consequences of Rural Small Hospital Closures from the Perspectives of Mayors. September 1990.
10. Welch, H. Gilbert; Larson, Eric H.; Hart, L. Gary; and Rosenblatt, Roger A. Readmission Following Surgery in Washington State Rural Hospitals. January 1991.
11. Amundson, Bruce A.; Hagopian, Amy; and Robertson, Deborah G. Implementing a Community-Based Approach to Strengthening Rural Health Services: The Community Health Services Development Model. February 1991.
12. Hoare, Geoffrey; Katz, Aaron; Porter, Alice; Dannenbaum, Alex; and Baldwin, Harry. Rural Health Care Linkages in the Northwest. April 1991.
13. Whitcomb, Michael E.; Cullen, Thomas J.; Hart, L. Gary; Lishner, Denise M.; and Rosenblatt, Roger A. Impact of Federal Funding for Primary Care Medical Education on Medical Student Specialty Choices and Practice Locations (1976-1985). April 1991.
14. Larson, Eric H.; Hart, L. Gary; and Rosenblatt, Roger A. Is Rural Residence Associated with Poor Birth Outcome? June 1991.
15. Williamson, Harold A.; Rosenblatt, Roger A.; Hart, L. Gary. Physician Staffing of Small Rural Hospital Emergency Departments: Rapid Change and Escalating Cost. September 1991.
16. Hart, L. Gary; Pirani, Michael J.; Rosenblatt, Roger A. Rural Hospital Closure and Local Physician Supply: A National Study. December 1991.
17. Larson, Eric H.; Hart, L. Gary; Hummel, Jeffrey. Rural Physician Assistants: Results from a Survey of Graduates of MEDEX Northwest. May 1992.
18. Hart, L. Gary; Robertson, Deborah G.; Lishner, Denise M; Rosenblatt, Roger A. Part 1: CEO Turnover in Rural WAMI Hospitals. Part 2: Rural Versus Urban CEOs: A Brief Report on Education and Career Location Patterns. August 1992.
19. Williamson, Harold; Hart, L. Gary; Pirani, Michael J.; Rosenblatt, Roger A. Rural Hospital Surgical Volume: Cutting Edge Service or Operating on the Margin? January 1993.
20. Rosenblatt, Roger A.; Saunders, Greg; Tressler, Carolyn; Larson, Eric H.; Nesbitt, Thomas S.; Hart, L. Gary. Do Rural Hospitals Have Less Obstetric Technology than their Urban Counterparts? A Statewide Study. March 1993.
21. Williamson, Harold A.; Hart, L. Gary; Pirani, Michael J.; Rosenblatt, Roger A. Market Shares for Rural Inpatient Surgical Services: Where Does the Buck Stop? April 1993.
22. Geyman, John P.; Hart, L. Gary. Primary Care at a Crossroads: Progress, Problems and Policy Options. May 1993.
23. Nesbitt, Thomas S.; Larson, Eric H.; Rosenblatt, Roger A.; Hart, L. Gary. Local Access to Obstetric Care in Rural Areas: Effect on Prenatal Care, Birth Outcomes, and Costs. August 1993.

24. Grossman, David; Hart, L. Gary; Rivara, Frederick P.; Rosenblatt, Roger A.; Maier, Ronald V. From Roadside to Bedside: The Regionalization of Motor Vehicle Trauma Care in a Remote Rural County. October 1993.

25. Baldwin, Laura-Mae; Hart, L. Gary; West, Peter A.; Norris, Tom E.; Gore, Edmond. Two Decades of Experience in the University of Washington Family Medicine Residency Network: Practice Differences Between Graduates in Rural and Urban Locations. November 1993.

26. Statewide Office of Rural Health and Washington Rural Health Association. Implementing Health Care Reform: Setting a Course for Rural Washington. Summary of a Workshop, November 9-10, 1993, Seattle, Washington. January 1994.

27. Williamson, Harold A.; West, Peter A.; Hagopian, Amy. Scope of Rural Medical Services: A Workbook for Hospital Trustees. March 1994.

28. Cullen, Thomas J.; Hart, L. Gary; Whitcomb, Michael E.; Lishner, Denise M.; Rosenblatt, Roger A. The National Health Service Corps: Rural Physician Service and Retention. September 1994.

29. Neighbor, William E.; Baldwin, Laura-Mae; West, Peter A.; Bezy, Judith M.; Hart, L. Gary. Experience of Rural Hospitals with the National Practitioner Data Bank. October 1994.

30. Rosenblatt, Roger A.; Mattis, Rick; Hart, L. Gary. Access to Legal Abortions in Rural America: A Study of Rural Physicians in Idaho. November 1994.

31. West, Peter A.; Norris, Thomas E.; Gore, Edmond J.; Baldwin, Laura-Mae; Hart, L. Gary. The Geographic and Temporal Patterns of Residency-Trained Family Physicians: University of Washington Family Practice Residency Network. February 1995.

32. Hart, L. Gary; Dobie, Sharon A.; Baldwin, Laura-Mae; Pirani, Michael J.; Fordyce, Meredith; Rosenblatt, Roger A. Rural and Urban Differences in Physician Resource Use for Low-Risk Obstetrics. March 1995.

33. Rosenblatt, Roger A.; Saunders, Greg; Shreffler, Jean; Pirani, Michael J.; Larson, Eric H.; Hart, L. Gary. Beyond Retention: National Health Service Corps Participation and Subsequent Practice Locations of a Cohort of Rural Family Physicians. April 1995.

34. Dobie, Sharon; Hart, L. Gary; Fordyce, Meredith; Andrilla, Holly; Rosenblatt, Roger A. Content of Obstetric Care for Rural, Medicaid, and Minority Women. June 1995.

35. Melzer, Sanford M.; Grossman, David C.; Hart, L. Gary; Rosenblatt, Roger A. Hospital Services for Rural Children in Washington State: Where Do They Go for Care and Who Takes Care of Them? October 1995.

36. Larson, Eric H.; Hart, L. Gary; Rosenblatt, Roger A. Is Rural Residence a Risk Factor for Poor Birth Outcome? A National Study. December 1995.

37. Norris, Thomas E.; Reese, Jennifer W.; Rosenblatt, Roger A. Are Rural Family Physicians Comfortable Performing Cesarean Sections? March 1996.

38. Lishner, Denise M.; Richardson, Mary; Levine, Phyllis, Patrick Donald. Access to Primary Health Care Among Persons with Disabilities in Rural Areas: A Summary of the Literature. April 1996.

39. Dunbar, Peter J.; Mayer, Jonathan D.; Fordyce, Meredith A.; Lishner, Denise M.; Hagopian, Amy; Spanton, Ken; Hart, L. Gary. A Profile of Anesthesia Provision in Rural Washington and Montana. May 1996.

40. Perrin, Edward B.; Hart, L. Gary;, Goldberg, Bruce; Grossman, David; Skillman, Susan M.; Paul, Britt. Patient Outcomes and Medical Effectiveness Research in Rural Areas for Racial/Ethnic Populations: Issues and Recommendations. July 1996.

41. Perrin, Edward B.; Hart, L. Gary; Skillman, Susan M.; Paul, Britt; Hanken, Mary Alice; Hummel, Jeffrey. Health Information Systems and Their Role in Rural Health Services: Issues and Policy Recommendations. August 1996.

42. Saver, Barry; Casey, Susan; House, Peter; Lishner, Denise; Hart, Gary. Antitrust and Action Immunity in Rural Washington State. Part I: User's Guide to Antitrust and Rural Health Care Environments. Part II: Antitrust Issues in Rural Washington State. January 1997.

43. Dyck, Sarah; Hagopian, Amy; House, Peter J.; Hart, L. Gary. Northwest Rural Hospital Governing Boards. November 1997.

44. Doescher, Mark P.; Ellsbury, Kathleen E.; Hart, L. Gary. The Distribution of Rural Female Generalist Physicians in the United States. February 1998.

45. Wright, George E.; Andrilla, C. Holly A. How Many Physicians Can a Rural Community Support? A Practice Income Potential Model for Washington State. April 2001.

46. Saver, Barry G.; Bowman, Robert; Crittenden, Robert A.; Maudlin, Robert K.; Hart, L. Gary. Barriers to Residency Training of Physicians in Rural Areas. April 1998.

47. Larson, Eric H.; Hart, L. Gary; Goodwin, Mary-Katherine; Geller, Jack; Andrilla, Catherine. Dimensions of Retention: A National Study of the Locational Histories of Physician Assistants. April 1998.

48. Baldwin, Laura-Mae; Rosenblatt, Roger A.; Schneeweiss, Ronald; Lishner, Denise M.; Hart, L. Gary. Rural and Urban Physicians: Does the Content of their Practices Differ? May 1998.

49. Geyman, John P.; Hart, L. Gary; Norris, Thomas E.; Coombs, John B.; Lishner, Denise M. Physician Education and Rural Location: A Critical Review. February 1999.

50. Hart, L. Gary; Morrill, Richard; Cromartie, John. A Guide to the Use of Rural and Urban Commuting Areas (RUCAs) in Health Care Analyses. (forthcoming)

51. Hart, L. Gary; Rosenblatt, Roger A.; Lishner, Denise M.; Friedman, Harvey; Baldwin, Laura-Mae. Where Do Elderly Rural Residents Obtain their Physician Care? A Study of Medicare Patients in Washington State. (forthcoming)

52. Ellsbury, Kathleen E.; Doescher, Mark P.; Hart, L. Gary. The Production of Rural Female Generalists by U.S. Medical Schools. January 1999.

53. Lishner, Denise M.; Rosenblatt, Roger A.; Baldwin, Laura-Mae; Hart, L. Gary. Emergency Department Use by the Rural Elderly. November 1998.

54. Baldwin, Laura-Mae; Grossman, David C.; Casey, Susan; Hollow, Walter; Sugarman, Jonathan R.; Freeman, William L.; Hart, L. Gary. Perinatal and Infant Health Among Rural and Urban American Indians/Alaska Natives. June 1999.

55. Larson, Eric H.; Hart, L. Gary; Muus, Kyle; Geller, Jack. Content of Physician Assistant Practice: Results from a National Survey. May 1999.

56. Richardson, Mary; Casey, Susan; Rosenblatt, Roger A. Local Health Districts and the Public Health Workforce: A Case Study of Wyoming and Idaho. November 1999.

57. Larson, Eric H.; Hart, L. Gary; Ballweg, Ruth. National Estimates of Physician Assistant Productivity. January 2000.

58. Hart, L. Gary; Norris, Thomas E.; Lishner, Denise M. Attitudes of Family Physicians in Washington State Toward Physician-Assisted Suicide. May 2001.

59. Rosenblatt, Roger A.; Baldwin, Laura-Mae; Chan, Leighton; Fordyce, Meredith A.; Hirsch, Irl B.; Palmer, Jerry P.; Wright, George E.; Hart, L. Gary. The Quality of Care Received by Diabetic Patients in Washington State: A Rural-Urban Comparison. March 2000.

60. Wright, George E.; Paschane, David M.; Baldwin, Laura-Mae; Domoto, Peter; Cantrell, Diana; Hart, L. Gary. Distribution of the Dental Workforce in Washington State: Patterns and Consequences. March 2001.

61. Rosenblatt, Roger A.; Casey, Susan; Richardson, Mary. Rural-Urban Differences in the Public Health Workforce: Findings from Local Health Departments in Three Rural Western States. January 2001.

62. Ellsbury, Kathleen E.; Baldwin, Laura-Mae; Johnson, Karin; Runyan, Sue; Hart, L. Gary. Gender-Related Factors in the Recruitment of Generalist Physicians to the Rural Northwest. February 2001.

63. Norris, Thomas E.; Hart, L. Gary; Larson, Eric H.; Tarczy-Hornoch, Peter; Masuda, David; Fuller, Sherrilynne; House, Peter J.; Dyck, Sarah M. Low-Bandwidth, Low-Cost Telemedicine Consultations Between Rural Family Physicians and Academic Medical Center Specialists: A Multifaceted Satisfaction Study. February 2001.

64. Larson, Eric H.; Palazzo, Lorella; Berkowitz, Bobbie; Pirani, Michael J.; Hart, L. Gary. The Contribution of Nurse Practitioners and Physician Assistants to Generalist Care in Underserved Areas of Washington State. June 2001.

65. Rosenblatt, Roger A.; Rosenblatt, Fernne Schnitzer. The Role and Function of Small Isolated Public Health Departments: A Case Study in Three Western States. June 2001.