RESEARCH REPORT

Evaluation of Policy Options for Increasing the Availability of Primary Care Services in Rural Washington State

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Preface

The Washington State legislature has recently considered several policy options to address a perceived shortage of primary care physicians in rural Washington. These policy options include opening the new Elson S. Floyd College of Medicine at Washington State University (WSU) in 2017; increasing the number of primary care residency positions in the state; expanding educational loan–repayment incentives to encourage primary care physicians to practice in rural Washington; increasing Medicaid payment rates for primary care physicians in rural Washington; and encouraging the adoption of alternative models of primary care, such as medical homes and nurse-managed health centers, that reallocate work from physicians to nurse practitioners (NPs) and physician assistants (PAs).[1]

To inform comparisons between these policy options and others suggested by local experts, the Washington State Institute for Public Policy contracted with the RAND Corporation to project their effects on Washington State's rural primary care workforce through the year 2025. This report provides background on the primary care supply and workforce and relevant policies, describes the RAND team's methods and findings, outlines a logic model for examining policy options, and assesses seven policy options. Its three appendixes provide a literature review, expand the explanation of the methods used, and offer supplemental fit statistics for the workforce projection models.

The research reported here was sponsored by the Washington State legislature via the Washington State Institute for Public Policy. The report is intended primarily for policymakers in Washington State. Stakeholders throughout the United States who are considering options to address perceived primary care shortages constitute a potential secondary audience.

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[1] Medical homes (also called patient-centered medical homes) offer a mechanism to enhance access to primary care.

individual donors fund its work. In all its work, researchers meet exacting standards of integrity and objectivity, and all study results are published and made available to the public.

Questions or comments about this report should be sent to the project leader, Mark W. Friedberg (Mark_Friedberg@rand.org). For more information on RAND Health, see www.rand.org/health or contact the director at RAND_Health@rand.org.

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Purpose

The Washington State legislature has recently considered several policy options to address a perceived shortage of primary care physicians in rural Washington. These policy options include opening the new Elson S. Floyd College of Medicine at Washington State University (WSU) in 2017; increasing the number of primary care residency positions in the state; expanding educational loan–repayment incentives to encourage primary care physicians to practice in rural Washington; increasing Medicaid payment rates for primary care physicians in rural Washington; and encouraging the adoption of alternative models of primary care, such as patient-centered medical homes.

To inform comparisons between these policy options and others suggested by local experts, the Washington State Institute for Public Policy contracted with the RAND Corporation to project their effects on Washington State's rural primary care workforce through the year 2025.

Methods

To identify policy options for simulation, we conducted 39 key-informant interviews between November 2015 and March 2016. Interviewees included representatives of the legislative and executive branches of the Washington State government, professional associations, medical educational institutions, Medicaid managed care plans, and rural hospitals. Our interview protocol queried respondents' perceptions of primary care and other medical service shortages, current and past programs intended to alleviate these shortages, and additional ideas for increasing the availability of primary care services in rural Washington.

Using our interview notes, we generated a logic model displaying relationships between factors influencing the supply of primary care physicians and primary care services in rural Washington State. The logic model guided our selection of policy options for quantitative simulation.

For quantitative analyses, we used three separate empirical models. First, we constructed predictive models, drawing from national data sets, to forecast changes in the supply of primary care physicians in each Washington county. These predictive models, tailored to historical trends in provider supply and other characteristics of each county, established what we called our base-case projections—i.e., what would happen in the absence of new policy interventions. Second, we used longitudinal and cross-sectional inferential models, again drawing from national data sets, to estimate the effects that policy options would have on the supply of primary care physicians at the county level. We then applied these effect estimates to each Washington county and calculated cumulative effects of each policy option from 2017 to 2025. Third, we used a

microsimulation model, tailored to Washington State, to estimate the effects of changing Medicaid payment rates on the supply of primary care services. Finally, we used previously published estimates of the effects of new care-delivery models (medical homes and nurse-managed health centers [NMHCs]) on workforce composition to estimate the impact of expanding these models in rural Washington State.

Findings

Key-Informant Interviews

There was a lack of consensus regarding the degree of primary care shortage in rural areas of Washington. Some of this disagreement stemmed from differences between respondents' definitions of primary care shortages.

Interviewees agreed that the major policy options initially proposed for modeling (opening a new medical school, increasing the number of primary care residency positions, increasing loan-repayment incentives, increasing Medicaid payment rates, increasing the adoption of medical homes—all in rural Washington) had the *potential* to increase the supply of rural primary care physicians. However, multiple interviewees expressed skepticism that opening a new medical school, without a corresponding increase in rural primary care residency positions, would increase the supply of primary care physicians in rural Washington.

Although we did not prespecify improving the quality of education in rural kindergarten through grade 12 as a policy option (and did not solicit it with a dedicated interview question), there was surprisingly widespread agreement that an effective long-term strategy to increase the number of rural primary care physicians would be to improve rural education in kindergarten through grade 12. Some interviewees also noted that primary care providers tended to cluster around rural hospitals because they enjoy the clinical backup and camaraderie that hospitals provide. They suggested that stabilizing struggling rural hospitals might therefore be a policy lever to preserve rural access to primary care providers, who might relocate if nearby hospitals close. Given these observations, we added two scenarios to the list of policy options for quantitative modeling: increasing the quality of high school education and preserving rural hospitals.

Base-Case Projections of the Rural and Urban Primary Care Workforce

Our predictive models estimated declines in the number of primary care physicians per 100,000 population in both rural and urban areas from 2013 to 2025: 3.66 fewer primary care physicians per 100,000 population in rural counties by 2025, 4.14 fewer in urban counties, 5.07 fewer outside Seattle, and 3.22 fewer within Seattle. These estimated declines were driven largely by recent increases in the percentage of primary care physicians ages 55 and older, many of whom are likely to retire by 2025.

In contrast, we projected increases from 2013 to 2025 of 5.38 to 7.79 nurse practitioners (NPs) and 1.84 to 3.08 physician assistants (PAs) per 100,000 population in Washington State.

Table S.1, at the end of this section, lists the policy options we considered, the details of the scenarios we used to evaluate those options, and the projected effects of those options based on the parameters in those scenarios.

Open the Elson S. Floyd College of Medicine at Washington State University

We estimated that opening the new medical school in 2017, beginning with 60 students and reaching a steady-state enrollment of 320 students in 2022, would be associated with increases in 2025 of 0.39 primary care physicians per 100,000 population in rural Washington counties, 0.59 in urban counties, 0.76 in Seattle, and 0.39 in Washington counties outside Seattle. These estimated effects of the new medical school offset approximately 11 percent of the projected decrease in rural per capita primary care physician supply by 2025, 14 percent of the projected decrease in urban counties, 12 percent of the projected decrease within Seattle, and 15 percent of the projected decrease outside Seattle.

Increase the Number of Primary Care Residency Positions in Washington State

We modeled residency policy options ranging up to a 100-percent expansion (i.e., a doubling of primary care residency sizes outside Seattle). The estimated effects of 100-percent primary care residency expansion (adding 36 primary care residents) were larger than the estimated effects of opening the new medical school at WSU, without residency program expansion. However, none of the modeled residency scenarios had an estimated effect sufficient to offset the predicted decline in the number of rural primary care physicians (or primary care physicians outside Seattle) per 100,000 population. For the 100-percent residency size expansions, estimated effects ranged from 1.11 primary care physicians per 100,000 population (27 percent of the projected decrease) in urban counties to 2.00 primary care physicians per 100,000 population (55 percent of the projected decrease) in rural counties by 2025.

Increase the Availability of Educational Loan–Repayment Incentives

To estimate the effect of expanding state-funded loan-repayment incentives in rural areas, we analyzed relationships between the number of National Health Service Corps (NHSC) primary care positions and primary care supply in rural counties. We found that, for each new primary care NHSC position opened per 100,000 county population, the estimated increase was 0.24 primary care physicians per 100,000 county population. Therefore, we estimated that doubling the number of primary care NHSC positions in rural Washington State (by adding 30 more such positions to rural counties, with approximate cumulative population 700,000) would produce an increase of 1.03 primary care physicians per 100,000 population.

Improve the Quality of High School Education in Rural Washington State

Because we lacked longitudinal data on high school quality (measured as proficiency rates on standardized tests of mathematics and of reading and language arts), we fit cross-sectional models that estimated the effect of increasing proficiency rates on these standardized tests by 0.2 standard deviations among high schools in rural Washington counties. We estimated that this improvement in high school quality would be associated with an increase of 0.80 primary care physicians per 100,000 population in rural Washington, or approximately 22 percent of the projected decline in per capita rural primary care physicians expected by 2025. However, because these models were cross-sectional and the time required to improve school performance is unclear, we cannot estimate the number of years required to achieve this estimated effect.

Preserve Rural Hospitals in Washington State

We intended the rural hospital scenario to give a sense of the effects of closing an average-sized rural hospital, without specifying a particular year of hospital closure. This scenario was motivated by interviewees' concern that rural hospital closure would decrease the supply of local primary care physicians. We estimated, using our models based on national data, that the closure of an average-sized rural hospital would be associated with a same-county net decrease of 0.87 primary care physicians per 100,000 rural population four years later.

Increase Medicaid Payment Rates for Primary Care Physicians in Rural Washington State

Using the RAND Health Care Payment and Delivery Simulation Model, we estimated the effects that increasing Medicaid fee-for-service payment rates to primary care physicians in rural counties of Washington State by 10 percent and 25 percent, beginning in 2017 and continuing thereafter, could have on primary care physician productivity. We estimated that, by 2025, a 10-percent payment-rate increase would yield an effective increase of 0.40 primary care physicians per 100,000 population (offsetting approximately 11 percent of the projected decline in the number of primary care physicians), and a 25-percent payment-rate increase would yield an effective increase of 1.06 primary care physicians per 100,000 population (offsetting approximately 29 percent of the projected decline).

Increase the Adoption of New Practice Models, Such as Medical Homes and Nurse-Managed Health Centers

Informed by previously published analyses of survey data, we estimated the effective increases in productivity per primary care physician (measured by panel size) associated with 50 percent of current rural Washington primary care physicians adopting medical home practice models. In such medical homes, primary care services are reallocated from physicians to NPs and PAs. This increase in medical home adoption would result in an effective increase of

3.30 rural primary care physicians per 100,000 population, offsetting 90 percent of the projected decline by 2025. Achieving this level of medical home adoption would require an additional 2.87 NPs and 2.90 PAs per 100,000 population.

We also estimated the effects that 1 percent of rural primary care physicians joining newly created NMHCs in 2017 would have on productivity per primary care physician. This increase in NMHC adoption would result in an effective increase of 3.84 rural primary care physicians per 100,000 population, offsetting the projected decline completely by 2025. Achieving this level of NMHC adoption would require an additional 6.42 NPs per 100,000 population. This additional NP requirement is likely to be met by the projected increase in NPs by 2025, which ranges from 5.38 to 7.79 new NPs per 100,000 population, based on recent increases in the numbers of newly trained NPs nationwide.

Medical homes and NMHCs can be implemented in many ways, and they represent examples of a general point: Reallocating primary care services from physicians to NPs and PAs, either working independently or in teams with primary care physicians, can counterbalance the projected decline in the number of rural primary care physicians. Moreover, even without taking any new policy actions, we project that Washington State will experience increases in the numbers of NPs and PAs per capita that are sufficient to staff these new practice models.

Table S.1. Projected Effects That Policy Options Would Have on Washington State's Rural Primary Care Physician Workforce in 2025

Policy Option	Scenario Detail	Predicted Effect
Open the Elson S. Floyd College of Medicine at WSU.	Sixty students enroll in 2017 and 2018; 80 students enroll per year thereafter.	The number of primary care physicians per 100,000 population increases by 0.39.
Increase the number of primary care residency positions in Washington State.	All existing Washington State primary care residencies outside Seattle expand by 100 percent in 2017.	The number of primary care physicians per 100,000 population increases by 2.00.
Increase the availability of educational loan–repayment incentives.	Thirty new full-time primary care NHSC positions open in 2017 in rural Washington.	The number of primary care physicians per 100,000 population increases by 1.03.[a]
Improve the quality of high school education in rural Washington State.	Proficiency rates on standardized tests of math and of reading and language arts increase by 0.2 standard deviation.	The number of primary care physicians per 100,000 population increases by 0.80.[a]
Preserve rural hospitals in Washington State.	One rural acute-care hospital of average size is closed.	The number of primary care physicians per 100,000 population decreases by 0.87.[b]
Increase Medicaid fee-for-service payment rates in rural Washington State.	In 2017, Medicaid fee-for-service payment rates increase permanently by 25 percent.	Physician productivity increases by 1.06 primary care physician–equivalents per 100,000 population.
Increase the adoption of medical home practice models.	In 2017, 50 percent of existing rural primary care physicians adopt medical home practice models.	Physician productivity increases by 3.30 primary care physician–equivalents per 100,000 population.
Increase the adoption of NMHCs.	In 2017, 1 percent of existing rural primary care physicians join new NMHCs.	Physician productivity increases by 3.84 primary care physician–equivalents per 100,000 population.

[a] The estimate from cross-sectional model assumes that equilibrium is reached by 2025.
[b] The estimated effect occurs four years after the date of hospital closure.

Conclusions

Our analysis was not designed to determine whether primary care shortages currently exist in rural Washington, and key informants disagreed on this question. However, if there are shortages of primary care physicians and services in rural Washington, these shortages are likely to worsen in the coming decade. We estimate that the number of rural primary care physicians per capita will decrease by approximately 3.66 per 100,000 by 2025—a 7-percent reduction from 2013 levels. By comparison, we estimate that urban areas of Washington State will experience a reduction of 4.14 primary care physicians per 100,000—a 5-percent reduction from 2013 levels.

None of the policy options modeled in this report, on its own, will offset this expected decrease by relying on primary care physicians alone. However, combinations of these strategies, or partial reallocation of rural primary care services to NPs and PAs via such new practice models as medical homes and NMHCs, with resulting increase in per-physician panel sizes, are

plausible options for preserving the overall availability of primary care services in rural Washington through 2025.

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We also thank Joanne Spetz of the University of California, San Francisco, and Carter C. Price of RAND for their careful reviews of this report.

Abbreviations

AACOM	American Association of Colleges of Osteopathic Medicine
AAMC	Association of American Medical Colleges
ACA	Patient Protection and Affordable Care Act
ACGME	Accreditation Council for Graduate Medical Education
ACS	American Community Survey
AHRF	Area Health Resources File
AMA	American Medical Association
AOA	American Osteopathic Association
BLS	U.S. Bureau of Labor Statistics
CAH	critical access hospital
CAHPS	Consumer Assessment of Healthcare Providers and Systems
CI	confidence interval
DO	doctor of osteopathy
ED	emergency department
EHR	electronic health record
FQHC	federally qualified health center
FTE	full-time equivalent
GME	graduate medical education
HPSA	Health Professional Shortage Area
HRSA	Health Resources and Services Administration
IMG	international medical graduate
K–12	kindergarten through grade 12
MACRA	Medicare Access and CHIP Reauthorization Act of 2015
MD	medicinae doctor
MUA	medically underserved area
NHSC	National Health Service Corps

NMHC	nurse-managed health center
NP	nurse practitioner
NPI	National Provider Identification
NRMP	National Resident Matching Program
OB-GYN	obstetrics and gynecology
PA	physician assistant
PADSIM	RAND Health Care Payment and Delivery Simulation Model
PNWU	Pacific Northwest University of Health Sciences
RHC	rural health clinic
RUCC	Rural–Urban Continuum Code
RVU	relative value unit
USMG	U.S. medical graduate
WSU	Washington State University
WWAMI	Washington, Wyoming, Alaska, Montana, and Idaho

Chapter One. Introduction

The Washington State legislature has recently considered several policy options to address a perceived shortage of primary care physicians in rural Washington. These policy options include opening a new medical school at Washington State University (WSU) in 2017; increasing the number of primary care residency positions in Washington; expanding educational loan–repayment incentives to encourage primary care physicians to practice in rural Washington; increasing Medicaid payment rates for primary care physicians in rural Washington; and encouraging the adoption of alternative models of primary care, such as medical homes.

The project reported here began on September 8, 2015, with sponsorship from the Washington State legislature via the Washington State Institute for Public Policy. The project aimed to gather and synthesize key stakeholders' viewpoints on the type and severity of primary care shortages in rural Washington; to create a logic model that clarifies and illustrates the mechanisms through which each policy option to address primary care shortages is designed to affect the supply of primary care physicians and primary care services in rural Washington; and to estimate, for each policy option, the effect on the number and distribution of primary care physicians and primary care services in rural Washington through the year 2025.

Chapter Two of this report reviews published studies on the primary care workforce and its relationship to primary care shortages (in the United States, in Washington State specifically, and in rural areas specifically), recent policy interventions to address the primary care workforce in Washington State, and evidence on the effects of interventions to expand the supply of primary care services in the United States. In Chapter Three, we present our empirical methods; in Chapter Four, findings from the interviews; in Chapter Five, a description of the logic model; and, in Chapter Six, projections of the primary care workforce in rural Washington through 2025 and the effects that each policy option would have on the supply of primary care services in rural Washington through 2025.

Appendixes to this report include expanded versions of the literature review (Appendix A) and supplemental detail on the quantitative analytic methods (Appendixes B and C).

Chapter Two. Background

In this chapter, we review published data on national primary care shortages, Washington State's current primary care landscape, and effects of policies that might increase the supply of primary care providers and services.

Current and Projected Primary Care Shortages in the United States

Government programs generally define primary care shortages as occurring when the number of local primary care physicians per capita falls below a certain threshold. For example, the Health Resources and Services Administration (HRSA) identifies primary care Health Professional Shortage Areas (HPSAs) as areas with fewer than one primary care physician per 3,500 people or, in areas of high need, per 3,000 people. There are more than 6,000 primary care HPSAs in the United States, with a combined population of more than 60 million people. By HRSA's definition, alleviating shortages in all HPSAs would require more than 8,000 additional primary care physicians (HRSA, undated [e]; HRSA, 2015).

There are other definitions of primary care shortages. Under economic theory, a shortage of primary care services exists when patients who want to purchase primary care services at the current market price and are capable of doing so cannot actually obtain such services when desired (Nicolson and Propper, 2011). Signs of such shortages would include long waits for primary care appointments. Alternatively, a shortage of primary care providers might be defined as existing when adding another primary care provider would improve overall social welfare.

Most projections of U.S. primary care shortages assume that current provider-to-population levels are optimal or that national shortages exist already. Recent estimates of U.S. primary care shortages include Colwill and colleagues' 2008 projection of a shortfall of 35,000 to 44,000 adult generalists in 2025 (Colwill, Cultice, and Kruse, 2008); the Association of American Medical Colleges' (AAMC's) 2010 projection of a 65,000–primary care physician shortage by 2025, due in part to the Patient Protection and Affordable Care Act's (ACA's) (Pub. L. 111-148, 2010) insurance expansions (AAMC, 2010); and the AAMC's 2012 revised projections of a 12,500- to 31,100–primary care physician shortage by 2025 (accounting for NP and PA growth, census projection adjustments, changes in ACA impact on demand, and care-delivery changes) (Dall et al., 2015). Other recent primary care workforce projections vary widely in their assumptions about the delivery system. Petterson and colleagues projected a 52,000–primary care physician shortage by 2025, assuming that current care patterns remain stable (Petterson, Liaw, et al., 2012); the National Center for Health Workforce Analysis projected that a 20,000–primary care physician shortage would be reduced to 6,400 by rapid growth of numbers of NPs and PAs (HRSA, 2013); Auerbach and colleagues projected that a 45,000–primary care physician

shortage in 2025 would be reduced to 7,000 via growing use of PAs and NPs in new care-delivery models (Auerbach et al., 2013); and Green and colleagues projected that changes in care delivery and use of NPs and PAs could eliminate primary care shortages completely (Green, Savin, and Lu, 2013).

Primary Care Supply in the Rural United States

The ratio of primary care physicians to population in rural areas is less than half that in urban areas, and the majority of rural counties (77 percent of nonmetropolitan counties) are formally designated as primary care HPSAs (Miller, 2009; Bodenheimer and Pham, 2010). Migration of physicians in and out of rural areas appears roughly balanced over time, so these supply differentials seem likely to persist (McGrail, 2015). Compared with urban primary care physicians, rural primary care physicians are older and are more likely to be male and born in rural areas (Fordyce, Doescher, and Skillman, 2013; Brooks et al., 2002; Phillips et al., 2009; Rabinowitz, Diamond, Markham, and Paynter, 2001; Rosenblatt, Chen, et al., 2010; Rosenblatt and Hart, 2000; Hart, Salsberg, et al., 2002). Training-related factors influence the likelihood of rural practice. These include attending osteopathic medical schools or certain allopathic medical schools (those that disproportionately produce HPSA or rural primary care physicians), completing family medicine residencies, or training in rural areas (Brooks et al., 2002; F. Chen et al., 2010; Fink et al., 2003; Fordyce, Doescher, Chen, et al., 2012; Grumbach, Hart, et al., 2003; Hart, Salsberg, et al., 2002; Phillips et al., 2009; Rabinowitz, Diamond, Markham, and Paynter, 2001; Rosenblatt, Chen, et al., 2010). Average income is similar for rural and urban primary care physicians (even after adjustment for hours worked and other physician and practice characteristics), but work hours and visits per week are generally greater for rural physicians (Hart, Salsberg, et al., 2002; Reschovsky and Staiti, 2005). Initial recruitment and subsequent retention are both influenced by personal rural background, prior rural training, international training, service obligations, income, workload, professional environment and opportunities, family considerations, spousal employment opportunities, and community and lifestyle factors (Brooks et al., 2002; Hancock et al., 2009; Hart, Salsberg, et al., 2002; Kazanjian and Pagliccia, 1996; Mayo and Mathews, 2006; Pathman, Konrad, Dann, et al., 2004; Pathman, Konrad, and Ricketts, 1994; Rabinowitz, Diamond, Hojat, et al., 1999; Staiger, Marshall, et al., 2016).

International medical graduates (IMGs) are often cited as a critical component of the rural and underserved health care workforce (Patterson, Keppel, and Skillman, 2016). Although IMGs are more likely than U.S. medical graduates to specialize in primary care, they are not more likely to do so in HPSAs or rural areas (Fink et al., 2003; Fordyce, Doescher, Chen, et al., 2012; Hart, Skillman, et al., 2007; Rosenblatt, Chen, et al., 2010).

In the rural health care workforce, the share of nonphysician primary care providers varies between states. For NPs, this share ranges from 10 percent in Arizona and Texas to 60 percent in Vermont (Grumbach, Hart, et al., 2003; Skillman, Keppel, et al., 2015). Overall, 20 percent of

NPs and PAs practice in nonmetropolitan areas, compared with 14 percent of physicians, and have a visit volume per provider that is somewhat less than that for physicians (Doescher et al., 2014; Hart, Salsberg, et al., 2002). Compared with urban NPs, rural NPs are more likely to work in primary care settings, represent a greater proportion of the local primary care workforce, and report greater professional autonomy (Graves et al., 2016; Spetz, Skillman, and Andrilla, 2016). PAs' likelihood to practice in rural or underserved areas is greater than physicians', but this gap has narrowed over time (Shaffer and Zolnik, 2014).

The Primary Care Shortage: Implications

Greater supply of primary care providers has been associated with improved health outcomes (i.e., mortality, low birth weight, life expectancy, and self-rated health), increased receipt of preventive health care (e.g., earlier detection of some cancers), and reduction in disparities traceable to income inequality (Starfield, Shi, and Macinko, 2005; Macinko, Starfield, and Shi, 2007; Chang, O'Malley, and Goodman, 2016; Friedberg, Hussey, and Schneider, 2010). In geographic analyses, a greater primary care proportion of the physician workforce has been associated with increased quality and decreased utilization (Baicker and Chandra, 2004; Kravet et al., 2008; Starfield, Shi, Grover, et al., 2005). However, evidence is mixed regarding the effect that physician supply, including primary care physicians, can have on access to visits and needed services (Pathman, Ricketts, and Konrad, 2006; Asch et al., 2000; Kirby and Kaneda, 2006; Litaker, Koroukian, and Love, 2005; Grumbach, Vranizan, and Bindman, 1997; Liu, 2007), ambulatory care–sensitive hospital admissions (Ricketts et al., 2001; Laditka, Laditka, and Probst, 2005; Parchman and Culler, 1994; Laditka, 2004; Chang, Stukel, et al., 2011; Basu, Friedman, and Burstin, 2002), and emergency department (ED) visits (Chang, O'Malley, and Goodman, 2016; Richman et al., 2007; Gresenz, Rogowski, and Escarce, 2007), with some studies showing no association (Kirby and Kaneda, 2006; Litaker, Koroukian, and Love, 2005; Grumbach, Vranizan, and Bindman, 1997; Ricketts et al., 2001) and others showing worse access (Pathman, Ricketts, and Konrad, 2006; Asch et al., 2000; Liu, 2007), more admissions (Chang, Stukel, et al., 2011; Basu, Friedman, and Burstin, 2002), or more ED visits (Chang, O'Malley, and Goodman, 2016; Richman et al., 2007; Gresenz, Rogowski, and Escarce, 2007) with fewer physicians. Associations between primary care supply and costs are also mixed, with some finding lower costs in areas of higher primary care supply (Starfield, Shi, and Macinko, 2005; Baicker and Chandra, 2004; Welch et al., 1993), others finding higher costs (Chang, Stukel, et al., 2011), and another finding no impact on cost growth (Chernew et al., 2009). These mixed findings might stem from inconsistent relationships between primary care workforce headcounts and patients' true access to the main functions of primary care: first-contact care for new health problems, comprehensive care for the majority of health problems, long-term person-focused care, and care coordination across providers (Starfield, Shi, and Macinko, 2005; Friedberg, Hussey, and Schneider, 2010).

The Primary Care Workforce in Washington State

The Physician Primary Care Workforce

The University of Washington Center for Health Workforce Studies reported that the 2014 physician workforce in Washington included 19,260 physicians (275 per 100,000 population), of whom 15,421 were providing direct patient care (220 per 100,000 population, comparable to national levels), with a ratio of generalists to population of 79 per 100,000 population (higher than the national rate of 66 primary care providers per 100,000 population) (Skillman and Stover, 2014). AAMC data regarding Washington's primary care workforce were similar (AAMC, 2015). Full-time primary care physicians in Washington average 36.7 hours per week in direct patient care (out of 45.8 total hours worked), with mean and median panel sizes of 1,764 and 1,500 patients, respectively (Skillman, Fordyce, et al., 2012).

The Nonphysician Primary Care Workforce

The supply of advanced-practice registered nurses (NPs, certified nurse midwives, and certified registered nurse anesthetists) in Washington increased from 2,835 in 2004 to 5,158 in 2016, with an uneven geographic distribution by workforce development area (from 49 in Snohomish County to 108 per 100,000 population in Spokane) (Andrilla and Skillman, 2016). Full-time primary care NPs in Washington averaged 30.3 hours per week in direct patient care (out of 36.2 total hours worked) in 2012, with mean and median panel sizes of 1,621 and 1,000, respectively (Skillman, Fordyce, et al., 2012).

Full-time primary care PAs in Washington average 35.1 hours per week in direct patient care (out of 40.1 total hours worked) in 2012, with mean and median panel sizes of 1,873 and 1,329, respectively (Skillman, Fordyce, et al., 2012).

The Primary Care Workforce Pipeline in Washington State

Undergraduate Medical Education

In 2014, Washington had 20.3 medicinae doctor (MD) and doctor of osteopathy (DO) medical students per 100,000 population, below the national median of 30.4 among all states (AAMC, 2015).

The state's only current allopathic medical school is the University of Washington School of Medicine, whose 2015 entering class included 245 students, of whom 228 were from the WWAMI region (Washington, Wyoming, Alaska, Montana, and Idaho). Of the 217 members of the 2015 graduating class, 60 percent entered primary care fields (family medicine, internal medicine, or pediatrics) and 33 percent entered residencies in Washington State (Blakeley, 2015). The University of Washington School of Medicine has programs that focus on medicine for rural and underserved populations, including preclinical and clinical training sites spread throughout the WWAMI region (Allen et al., 2013; Kost et al., 2014; Greer et al., 2016;

University of Washington Medicine, undated). Among generalist physicians actively practicing in Washington in 2014, 18.4 percent had graduated from the University of Washington School of Medicine (Skillman and Stover, 2014).

Pacific Northwest University of Health Sciences (PNWU), an osteopathic medical school in Yakima, opened in 2008. Of the 140 students in its 2014–2015 first-year class, 67 percent were from a five-state area of Washington, Alaska, Idaho, Montana, and Oregon (47 percent from Washington) and nearly one-third were from underserved or rural areas. More than 40 percent of the most recent graduating class entered primary care specialties (PNWU, undated).

Graduate Medical Education in Washington State

In 2014, Washington had 1,873 residents and fellows in Accreditation Council for Graduate Medical Education (ACGME)–sponsored training programs, or 26.5 per 100,000 population (slightly below the state median nationally of 27.4 trainees per 100,000), with 9.9 residents and fellows per 100,000 population in ACGME primary care programs in 2014 (below the national median among states of 10.3 per 100,000) (AAMC, 2015). The University of Washington is the largest sponsor of graduate medical education (GME) in the region, with 1,335 trainees in 25 residencies and 80 clinical fellowship programs accredited by ACGME or approved by the American Board of Medical Specialties, and more than 100 additional clinical fellows in nonaccredited programs (University of Washington Medicine, 2015). Many of these clinical training programs include rural rotations or tracks (Allen et al., 2013).

The University of Washington's Family Medicine Residency Network and its rural training tracks have been successful in retaining residents in rural practice after graduation, but these programs are limited in size and face challenges in funding and logistics (Lesko, Fitch, and Pauwels, 2011; Maudlin and Newkirk, 2010). Washington State is also home to six Teaching Health Centers, which are ambulatory practice–based primary care medicine and dentistry residency training programs at community-based clinical training sites that focus on the underserved (Ku et al., 2015; HRSA, undated [f]). Among practicing Washington physicians in 2014, 32.2 percent had completed their residencies in the state (Skillman and Stover, 2014).

International Medical Graduates

In Washington, IMGs represent 14.1 percent of actively practicing physicians, below the national median of 18.7 percent (AAMC, 2015). A survey of recipients of J-1 visa waivers in Washington between 1995 and 2003 found that 84 percent of waiver recipients stayed with their employers longer than the required three- to five-year commitment, 57 percent remained in

Washington, and 91 percent were practicing in urban areas (Kahn, Hagopian, and Johnson, 2010).[2]

Educational Opportunities for Primary Care Providers Other Than Physicians

The University of Washington's MEDEX Northwest PA training program, with sites in Seattle, Spokane, Tacoma, and Anchorage, had a 2014 entering class of 116 master's and bachelor's program students, of whom 80 percent were WWAMI region residents (66 percent from Washington or Alaska) (University of Washington School of Medicine, undated). A 2001 survey of graduates revealed that 54 percent were working in primary care, 30 percent in nonmetropolitan communities, and 42 percent providing care for the medically underserved (Evans et al., 2006). However, the share of PAs entering primary care declined nationally; a similar decline might have occurred in Washington since 2001 (Morgan and Hooker, 2010; American Academy of Physician Assistants, 2014).

A new PA training program at Heritage University in Toppenish, Washington, has been provisionally accredited and planned to graduate its first class of 32 students in 2016 ("Heritage University Physician Assistant Program Receives Accreditation," undated).

Six institutions in Washington offer NP education: Gonzaga University, WSU, Pacific Lutheran University, Seattle Pacific University, Seattle University, and the University of Washington. In 2015, 1,177 students were in NP programs in the state of Washington. However, data were unavailable on how many of these students graduate each year or which specialties and practice locations they enter.

Provider Incentive Programs in Washington State

In addition to federal National Health Service Corps (NHSC) loan-forgiveness programs for health care providers who commit to a period of employment in an HPSA, Washington offers state-based loan-repayment programs to attract providers to underserved communities: a joint Federal–State Loan Repayment Program using federally matched funds, which awards $70,000 for a two-year contract with an eligible site, and the Health Professional Loan Repayment Program, which uses state funds to award $75,000 for a three-year contract with an eligible site (Washington Student Achievement Council, undated).

Estimates of Provider Shortages in Washington State

As of December 2015, Washington had 154 primary care HPSAs encompassing a population of 1,291,074. A total of 229 additional primary care physicians would be needed to remove HPSA designation from these areas (HRSA, undated [c]). Few state-specific projections of

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[2] The J-1 visa, or exchange visitor visa, is for nonimmigrants "approved to participate in work- and study-based" programs. See U.S. Department of State, undated. A waiver eliminates the requirement of a home residency period before allowing work.

primary care shortages exist, but the Robert Graham Center projected a 1,695-physician shortage by 2030 in Washington (Petterson, Cai, et al., 2013).

The Rural Primary Care and Workforce in Washington State

The Rural Washington State Primary Care Landscape

Washington is home to 26 HRSA federally qualified health center (FQHC) grantees and one FQHC look-alike (a clinic that is part of HRSA's Health Center Program but does not receive program funding) collectively operating 263 service delivery sites (79 in rural settings), 118 rural health clinics (RHCs), 39 free clinics (11 in rural settings), 39 critical access hospitals (CAHs), and three sole community hospitals (HRSA, undated [d]; HRSA, undated [b]; Washington State Department of Health, 2015; Washington State Hospital Association, 2012). In addition, six Indian Health Service clinics and 62 tribal health centers or stations serve 29 federally recognized tribes in the state (Indian Health Service, undated).

Despite a broad array of enhanced payments available, providers in rural Washington, like elsewhere in the rural United States, face significant financial and infrastructure challenges: low shares of patients with private insurance (which pays more than Medicaid), Medicaid payment delays (which can pose challenges for FQHCs and RHCs), health information technology that can be difficult to afford and implement in small rural clinics, and relatively limited availability of emergency medical services and public transportation (Washington State Hospital Association, 2012; Rural Health Work Group, 2014).

Composition of Washington State's Rural Primary Care Workforce

Washington has fewer physicians in rural than urban areas (117 versus 236 physicians and 57 versus 82 generalists per 100,000 population), and rural counties have greater shares of physicians ages 55 and older (Skillman and Stover, 2014). The distribution of primary care provider types varies across rural and urban parts of the state: King County region has the most primary care physicians per capita (112 per 100,000); the Spokane region has the most NPs per capita (38 per 100,000); and rural eastern Washington has the most PAs per capita (18 to 24 per 100,000) (Skillman, Fordyce, et al., 2012). Among primary care providers in rural Washington, family practice is the most common physician specialty (Grumbach, Hart, et al., 2003; Skillman and Stover, 2014). An analysis by the WWAMI Rural Health Research Center found that the distribution of physicians was associated with predicted income potential, and the authors concluded that, although some shortage areas in the state could support additional physician income, others could not (Wright, Andrilla, and Hart, 2011). Mental health providers and addiction services are also unevenly distributed throughout the state, with limited supply in rural areas (Skillman and Stover, 2014; Baldwin et al., 2006; Kvamme et al., 2013; Hutchinson et al., 2014; Quest et al., 2012).

Medicaid in Washington State

Apple Health, Washington's Medicaid program, provides health insurance coverage for 1.7 million adult and child beneficiaries, including more than 500,000 who gained coverage since the ACA's Medicaid expansion (Washington State Health Care Authority, undated [a]; Assistant Secretary for Public Affairs, 2015). Eighty-eight percent of Medicaid enrollees in Washington are enrolled in one of five Medicaid managed care plans (Henry J. Kaiser Family Foundation, 2014).

Because of the ACA, Medicaid payment rates for eligible primary care physicians were increased to Medicare service levels in 2013 and 2014. These enhanced Medicaid payments expired when federal support for the program ended in 2015 (Washington State Medical Association, 2015). According to a 2014 survey, nearly three in four Washington physicians reported that, if Medicaid reimbursement rates reverted to pre-2013 levels, they would stop accepting new Medicaid patients, limit the number of new Medicaid patients, or reduce or stop seeing current Medicaid patients (Patterson, Andrilla, et al., 2014).

In 2015, the Medicaid-to-Medicare fee index in Washington was 0.74 (i.e., for the same medical service, Medicaid paid $0.74 for every $1.00 paid by Medicare), compared with a national average of 0.66. For primary care services, this fee index was 0.64 in Washington, compared with 0.59 nationally (Zuckerman, Skopec, and McCormack, 2014).

Medicaid in Washington has greater provider participation than most other states, but many of these providers see few Medicaid patients or do not accept new Medicaid patients, citing low payment, administrative burdens, and the complexity of patients' needs as barriers (S. Long, 2013). The state's Office of Financial Management predicted that limited rates of acceptance of new Medicaid patients in some regions would produce uneven access to care for newly covered lives after the ACA's Medicaid expansion, with significant shortfalls in one urban region (Clark County) and all rural workforce development areas (Yen and Mounts, 2012). Potential access issues were reflected in Consumer Assessment of Healthcare Providers and Systems (CAHPS) survey ratings among adults enrolled in Washington's Medicaid managed care plans in 2014, which were below the 25th national percentile for getting needed care and between the 25th and 49th percentiles for getting care quickly (Washington State Health Care Authority, 2014).

Recent Policy Interventions to Address the Primary Care Shortage in Rural Washington State

A New Allopathic Medical School

In its 2015 session, the state legislature changed a law that had previously given the University of Washington the sole authority to operate a public medical school in the state and funded $2.5 million in start-up costs for a new medical school at WSU ("Washington State Moving Ahead with Medical School," 2015; Zak, 2015b). The new medical school, which

received preliminary accreditation from the Liaison Committee on Medical Education (LCME) in 2016, aims for provisional accreditation in spring 2018 and full accreditation in fall 2020 and is planning to matriculate its first class in 2017 (WSU, undated). Local experts in higher and medical education have expressed mixed opinions regarding the new medical school. Some questioned the costs of opening a new medical school, relative to expanding the University of Washington's WWAMI program ("WSU Med School Doesn't Pencil Out," 2015). Others predicted that the addition of medical students might have limited effects on physician supply in rural Washington, noting that the number of residency positions and limited income potential were more-important barriers to rural practice (K. Long, 2014). Proponents of the new medical school reported that the state's relatively low total medical student enrollment and perceived primary care shortages made a strong case for the new school (Mroch and Graham, 2014).

Residency Funding

In an additional effort to support the physician workforce pipeline, the 2015 legislative session allocated $24.4 million to support the state's primary care GME program, opening 117 family medicine residency network slots and expanding psychiatry residency slots at the University of Washington (Washington State Medical Association, 2015; University of Washington School of Medicine, 2015).

Loan-Forgiveness Programs

Washington's state-funded Health Professional Loan Repayment Program is designed to recruit providers into rural and underserved areas. In 2011, the program's budget was cut from $8.7 million to just over $1 million per biennium, prompting significant lobbying for return to prior funding levels (Health Workforce Council, 2014; Community Health Network of Washington and Washington Association of Community and Migrant Health Centers, 2014). In the 2015 legislative session, $9.6 million was reallocated to the program (Washington State Medical Association, 2015).

Medical Home Models

Medical homes (also known as patient-centered medical homes) offer a mechanism to enhance access to primary care. Washington has a variety of initiatives related to medical homes: a learning collaborative for practices engaging in medical home transformation, legislation specifying that direct primary care medical homes must be integrated within an issuer's qualified health plans for the Washington Health Benefit Exchange, participation in the Medicaid Health Homes Program, and a multipayer medical home demonstration (Patient-Centered Primary Care Collaborative, undated; Washington State Health Care Authority, undated [b]).

The Effects That Policy Options Can Have on the Primary Care Workforce: Evidence from Interventions in Other States

Undergraduate Medical Education

To support physician workforce development, several states have recently expanded extant medical schools or created new ones. Nationally, between 2002 and 2013, the number of accredited MD-granting schools increased from 125 to 141 (plus nine schools with applicant status) and DO-granting schools grew from 19 to 30 (plus 13 schools with applicant status) (Erikson, Whatley, and Hampton, 2015). Because of the new schools and expanded class sizes, total first-year medical student enrollment increased 39 percent, from 19,456 students in 2002 to 27,129 in 2014, and is expected to increase further to 29,628 by 2019 (Erikson, Whatley, and Hampton, 2015). However, the overall effects that opening new medical schools can have on local supplies of primary care physicians, net of any displacement of physicians trained elsewhere, have not been estimated.

Graduate Medical Education

Numbers of per capita residency positions vary significantly by state, and these positions might influence states' physician workforces (Beitsch, 2015; Mullan, Chen, and Steinmetz, 2013). The median in-state retention rate after residency is 44.5 percent (68.4 percent among physicians who completed both medical school and residency in the same state) (AAMC, 2015). Some states (Kansas, Minnesota, Missouri, and West Virginia) use Medicaid GME funding to support residencies in nonhospital sites ineligible for Medicare GME funding, and others (Michigan and Tennessee) allocate state GME funding to hospital-based primary care training programs (Spero et al., 2013; AAMC, 2013). Idaho funded rural rotations for residents, Georgia allocated matching funds for new residency programs, and Texas funded grants for new or expanded residency programs (Beitsch, 2015).

Continued growth of Teaching Health Centers offers another mechanism to expand GME slots in rural areas. These primary care residency programs at community-based ambulatory centers focus on underserved populations, are directly funded by HRSA, and are not subject to Medicare GME caps or funding streams via teaching hospitals (C. Chen, Chen, and Mullan, 2012). They have grown rapidly from ten medical and one dentistry residency program with 63 trainees in school year 2011–2012 to 57 medical and dental residency programs in 2014–2015 with 556 trainees. Evidence to date suggests that their graduates are more likely than graduates of other programs to practice in rural or underserved settings (Ku et al., 2015; Brown and Klink, 2015; Bazemore et al., 2015).

Expanded Loan-Forgiveness, Visa Waivers, and Direct-Incentive Programs

Community health centers, especially those in rural areas, face difficulties in recruiting physician staff and rely on NHSC scholarships, loan-repayment programs, and J-1 visa waivers to attract physicians (Rosenblatt, Andrilla, et al., 2006). Findings are mixed regarding the longer-term career trajectories and workforce contributions of NHSC programs and other loan-forgiveness and direct-incentive programs (i.e., bonuses not contingent on having educational debt), with some studies finding that recipients were more likely than nonrecipients to contribute disproportionately to the primary care workforce in rural or underserved communities both during and after their service obligations (Porterfield et al., 2003; Rosenblatt, Saunders, et al., 1996; Cullen et al., 1997) but others finding them less likely to do so than their peers who entered rural or underserved practice without an obligation (Singer et al., 1998; Pathman, Konrad, and Ricketts, 1992). A broad array of state-sponsored scholarships exists, including loan repayment and direct financial incentives for working in rural or underserved areas (Pathman, Taylor, et al., 2000). Rates of obligation completion and subsequent retention in service practice sites appear to be higher for loan-repayment or direct-incentive programs awarded after residency than for scholarships or loans awarded during medical school (Pathman, Konrad, King, et al., 2004; Pathman, Fannell, et al., 2012).

Chapter Three. Methods

Overview

In this project, we estimated the supply of primary care physicians and primary care services in rural and urban Washington State counties from 2015 to 2025, within the current policy environment and under a series of policy alternatives. To identify policy options for simulation, we conducted 39 key-informant interviews between November 2015 and March 2016. Interviewees included representatives of the legislative and executive branches of the Washington State government, professional associations, medical educational institutions, Medicaid managed care plans, and rural hospitals. The interviewee sample initially included those suggested by project sponsors at the Washington State Institute for Public Policy. We then supplemented this list with additional names referred by interviewees who had already participated (snowball sampling).

Our interview protocol queried respondents' perceptions of primary care and other medical service shortages in rural Washington, current and past programs intended to alleviate these shortages, and additional ideas for increasing the availability of primary care services in rural Washington. Each interview lasted 45 to 60 minutes and was conducted by one or more lead investigators (Mark Friedberg or Grant Martsolf) and a note-taker.

Using the interview notes, we generated a logic model displaying relationships between factors influencing the supply of primary care physicians and primary care services in rural Washington State. The logic model guided our selection of policy options for quantitative simulation.

For quantitative analyses, we used three separate empirical models. First, we constructed predictive models, drawing from national data sets, to forecast changes in the supply of primary care physicians in each Washington county, adjusting these predictions to historical trends in provider supply and other characteristics of each county. These predictive models established our base-case projections of what would happen in the absence of new policy interventions. Second, we used longitudinal and cross-sectional inferential models, again drawing from national data sets, to estimate the effects that various policy interventions could have on the supply of primary care physicians in counties of different population sizes. We then applied these effect estimates to each Washington county and calculated cumulative effects of each policy option from 2015 to 2025. Third, we used a microsimulation model, tailored to Washington State, to estimate the effects that changing Medicaid payment rates could have on the supply of primary care services. Finally, to estimate the effect of expanding these models in Washington State, we used previously published estimates of the effects that new care-delivery models (medical homes and

nurse-managed health centers [NMHCs]) would have on workforce composition. We present an overview of our methods here, with more-detailed discussions of our methods in Appendix B.

Data

We collected data on supply of MDs, DOs, NPs, and PAs from the Area Health Resources File (AHRF). The AHRF is a data set of county-level health information assembled by HRSA. The AHRF pulls information about health professionals, facilities, and demographics from more than 50 discrete data sources. We supplemented NP and PA data from AHRF with data from SK&A, which is a commercial data set of all office-based physicians, NPs, and PAs in the country (details available in Appendix B).

We also collected data to measure policy interventions. First, we obtained the location, founding date, accreditation status, and enrollment of every medical school in the United States from data sets maintained by the AAMC and American Association of Colleges of Osteopathic Medicine (AACOM). Second, we collected data on residency programs from the National Resident Matching Program (NRMP). Third, we obtained information from HRSA about location, specialty, and practicing hours of health professionals placed by the NHSC in each county. Fourth, we collected national data on high school achievement results for state assessments in mathematics and in reading and language arts from the U.S. Department of Education.[3] Fifth, we collected yearly numbers of short-term general hospitals and hospital beds in each county from the AHRF. Finally, we collected county-level demographic, business activity, and crime data from data sources listed in Appendix B.

Variables

Because the AHRF is a county-level data set, the county-year was the primary unit of analysis for all projections and simulations. For each county in the United States, we calculated the following variables for each data year:

- numbers of office-based primary care physicians (1995–2013), NPs (2008–2015), and PAs (2008–2015) in the county
- numbers of medical students enrolled in recently opened (eight years or less) medical schools within 100 miles, within 200 miles, and within the same state as the county (2001–2015)
- numbers of primary care residents within 100 miles, within 200 miles, and within the same state as the county (2003–2013)
- number of total full-time–equivalent (FTE) primary care NHSC slots within the county (2013)

[3] We could not collect national data on educational quality for grades before high school. Therefore, our kindergarten-through–grade 12 (K–12) educational improvement scenario focuses on only high school.

- mean standardized high school proficiency on mathematics and on reading and language arts within the county (school year 2012–2013)
- numbers of short-term hospitals and hospital beds within the county (2003–2013)
- within-county demographic, business activity, and crime variables (2003–2013; listed in Appendix B).

We then standardized all count variables (numbers of primary care providers, medical students, residents, NHSC slots, hospitals, and hospital beds) by dividing by the population of each county. Using 2013 Rural–Urban Continuum Codes (RUCCs), we designated each county as rural (RUCC levels 4–9) or urban (RUCC levels 1–3) for all data years.

Base-Case Models

To forecast the future primary care workforce through 2025 in Washington State, we estimated the number of primary care physicians, NPs, and PAs in each county in Washington for each year from 2014 to 2025 using national workforce models. We generated separate rural and urban county estimates for the physician models. We used Stata/MP 14.0 for all analyses.

Physician Models

To construct the predictive base-case models, we estimated county-year per capita counts of primary care physicians as a function of the age distribution of primary care physicians in previous years (lagged age bands) and other covariates likely to be associated with the supply of primary care physicians. For these models, we used data from 1995 to 2013.

To do this, we first constructed counts of primary care physicians per 100,000 population who were younger than age 35, ages 35 to 44, ages 45 to 54, ages 55 to 64, and ages 65 and older and lagged those counts three, five, and ten years (i.e., the model allowed each county's physician age distribution three, five, and ten years ago to affect current-year estimates of physicians per population). These lagged age bands allowed estimation of changes in supply that might be driven by two types of demographic variables: birth cohort and age in the observation year. Together, these demographic variables can improve prediction of workforce entry and exit that might be affected by time- and age-related factors, such as medical school enrollment, relocation from rural to urban areas due to age-related factors (e.g., when physicians' children enter high school), changes in spousal roles over time (captured in birth cohort) (Staiger, Marshall, et al., 2016), and retirement. In these models, we also included all of the other independent variables listed above, as well as a linear year term. To improve the accuracy of county-level workforce predictions within Washington State, we included the following interaction terms: Washington counties by year, rural status by year, and state by year.

We then used the parameter estimates from these models to forecast the number of providers per capita from 2014 to 2025. We calculated the future out-of-sample predictions by aging forward each county's physician population and setting other county-level covariates equal to

their 2013 values. This assumes that all characteristics of each county—other than the distribution of physician ages and county populations (which can change without affecting estimates on a per-population basis)—remain fixed in the future. More details on these models are presented in Appendix B.

We bootstrapped 90-percent confidence intervals (CIs) for the base-case models by resampling counties outside Washington State 1,000 times.

Nurse Practitioner and Physician-Assistant Models

The national NP and PA data sets available to us lacked data on clinician age and had short observation windows (2008 to 2015 for SK&A and 2010 to 2013 for the AHRF). Therefore, we could not construct NP and PA workforce prediction models that were similar to the physician models. To generate base-case projections for NPs and PAs, we instead applied national growth trends for NPs and PAs from previously published literature (Auerbach, 2012; HRSA, 2013) to Washington State from 2014 to 2025. Starting with SK&A NP counts for 2013 (the year most likely to contain accurate specialty information, among years overlapping the physician data), we used both a 4-percent and a 5-percent growth rate to forecast NP counts. For PAs, we also used 2013 SK&A data and applied both a 3-percent and 4-percent growth rate, which were also consistent with those in previous studies (Auerbach et al., 2013; HRSA, 2013). We then used state-level population growth estimates from the Census Bureau to project 1.28 percent annual growth of the total population of Washington State from 2014 to 2025 (U.S. Census Bureau, 2014b). From the resulting NP and PA count forecasts and population forecasts, we calculated NP and PA counts per 100,000 population for 2014 to 2025.

Policy-Option Models

For the majority of policy options (all but changes in Medicaid payment and adoption of new practice models), we used regression models to estimate effects on the future supply of primary care physicians in each county of Washington State for 2017 to 2025. For policy variables with available longitudinal data (medical school enrollment, residency enrollment, Medicaid payment rates, and hospital presence), we fit models to estimate associations between *within-county changes* in each policy-option variable and *county-level changes* in the supply of primary care physicians in a national county-level data set spanning 2003 to 2013.

In these longitudinal models, the unit of observation was the county-year, and the dependent variable was within-county change in the number of primary care physicians per 100,000 population, relative to 2003. The main independent variables corresponded to the policy options of interest, listed in Table 3.1, with time-lagged values to capture anticipated delayed effects (e.g., effects of opening a new medical school manifesting only five or more years later, after the first students graduate). To address potential confounding, the longitudinal models also included county demographics (percentages of the population who were black, who were under

the federal poverty guideline (sometimes called the federal poverty level), who were uninsured, who were Medicaid enrollees, who had educational attainment less than high school; per capita income), rates of violent and property crime, and average rent. Confounding by time-invariant unobserved variables was addressed by using within-county differences over time as both the dependent and independent variables.

Table 3.1. Model Types and Main Independent Variables for Each Policy Option

Policy Option	Model Type	Main Independent Variable
Open the Elson S. Floyd College of Medicine at WSU.	Longitudinal	• Number of medical students within 100 miles, lagged 5 years[a] • Number of medical students within 200 miles, lagged 5 years • Number of medical students in same state, lagged 5 years
Increase the number of primary care residency positions in Washington State.	Longitudinal	• Number of primary care residents within 100 miles, lagged 3–8 years • Number of primary care residents within 200 miles, lagged 3–8 years • Number of primary care residents in same state, lagged 3–8 years
Increase the availability of educational loan–repayment incentives.	Cross-sectional	• Number of FTE NHSC primary care positions within the county
Improve the quality of high school education in rural Washington State.	Cross-sectional	• Mean standardized high school proficiency on mathematics and on reading and language arts within the county
Preserve rural hospitals in Washington State.	Longitudinal	• Number of short-term hospitals and hospital beds within the county, lagged 0, 1, 2, and 3 years
Increase Medicaid fee-for-service payment rates in rural Washington State.	Microsimulation (PADSIM)	• Degree of increase in rural Medicaid payment rates to primary care providers
Increase the adoption of new practice models.	Extrapolation from published data	• Percentage of rural primary care physicians in medical homes and NMHCs

NOTE: PADSIM = RAND Health Care Payment and Delivery Simulation Model.
[a] In the main analyses, we included only medical students enrolled in new medical schools (i.e., those in existence for ten years or less). In sensitivity analyses, we included medical students in both new and longstanding medical schools that were primary care–centric, based on the propensity of their graduates to enter primary care careers (Mullan, Chen, Petterson, et al., 2010). These sensitivity analyses primarily captured the effects of expanding the class sizes of longstanding medical schools, rather than opening new medical schools. Medical student enrollments were not lagged further than five years because of the anticipated increasing enrollment of the WSU medical school between 2017 and 2021. If we had lagged medical school enrollment eight years, for example, only the initial entering class enrollment would have entered the model.

To mitigate the influence of outliers in the data, all dependent and independent count variables were winsorized at the 99th percentile of their values (i.e., the highest 1 percent of values set equal to the 99th percentile). All variables were then divided by county population (to yield a count per 100,000 population) and transformed to within-county changes relative to 2003 (by subtracting their 2003 values from values for each subsequent year).

To create more–equally sized units of analysis and to allow unequal coefficient estimates between larger and smaller counties, we fit separate regression models for each decile of county population up to the 70th percentile and for each third of a decile within the three most-populous deciles (where population ranges were greatest).

For policy variables with less than ten years of available data (NHSC positions and standardized health school proficiency scores), we fit cross-sectional models in which the dependent variable was each county's number of primary care physicians per 100,000 population in 2013, rather than longitudinal change in physician supply. The independent variables were the 2013 values of the same variables used in the longitudinal models. For the educational loan–repayment policy option, the models excluded counties lacking HPSAs.

Using these policy-option regression models, we then generated two sets of predicted numbers of primary care physicians per 100,000 population in each Washington county in each year from 2017 to 2025: one set at status quo (i.e., assuming that the policy option is not taken) and one set if the policy option is taken. We set all policy options to begin in 2017, the first year the Elson S. Floyd College of Medicine at WSU will enroll medical students. Policy-option details for making these predictions are listed in Table 3.2. For each year, we then calculated for each county the differences between status quo and policy-option predictions and separately summed these differences within all rural counties, all urban counties, greater Seattle counties, and non-Seattle counties in Washington State. For cross-sectional models, we calculated similar predictions and differences but without multiple years.

Table 3.2. Policy-Option Details for Predicting Effects on Washington State's Primary Care Physician Workforce

Policy Option	Scenario Detail
Open the Elson S. Floyd College of Medicine at WSU.	• Students are located primarily in Spokane. • The first class of 60 students enrolls in 2017. • Sixty students enroll in 2018, then class sizes increase to 80 students and remain at 80 in all subsequent years.
Increase the number of primary care residency positions in Washington State.	• All existing primary care residencies in Washington State outside Seattle have one-time expansions in 2017 that persist until 2025. • Three alternatives provide for 25-percent, 50-percent, and 100-percent increases in residency sizes.
Increase the availability of educational loan–repayment incentives.	• Thirty new full-time primary care NHSC positions open (a 100-percent increase from the number of such NHSC positions in rural Washington in 2013).
Improve the quality of high school education in rural Washington State.	• A 0.2–standard deviation increase[a] is achieved in proficiency rates on standardized tests of mathematics and of reading and language arts.
Preserve rural hospitals in Washington State.	• One rural acute-care hospital of average size (among current rural hospitals) is closed.[b]
Increase Medicaid fee-for-service payment rates in rural Washington State.	• Medicaid fee-for-service payment rates increase once, in 2017, and do not change again (i.e., the higher payment rate persists through 2025). • Two alternatives: 10-percent and 25-percent payment-rate increases
Increase the adoption of new practice models.	• Fifty percent of existing rural primary care physicians adopt medical home practice models. • One percent of existing rural primary care physicians join new NMHCs.

[a] A 0.2–standard deviation increase in proficiency corresponds to the lower bound of mean effect sizes observed among educational interventions performed in high schools, according to a recent meta-analysis (Hill et al., 2007).
[b] Because interviewees described the potential effects of hospitals closing, and no plans to open new hospitals were mentioned, we calculated predicted effects of closing a hospital.

We bootstrapped 90-percent CIs for all regression-based policy-option estimates, resampling at the county level 1,000 times.

To simulate the effects that increasing Medicaid fee-for-service payment rates might have on the volume of primary care services produced by primary care physicians in rural Washington State, we used PADSIM (White, Liu, et al., 2016).[4] We modeled two policy options: a 10-percent increase and a 25-percent increase in fee-for-service payment rates. In both scenarios, these increases were applied only to primary care physicians whose main practices were located in rural counties. We focused on two outcomes of interest: the percentage change in the volume of primary care services among physicians in rural Washington State (measured as estimated percentage increase in per-physician relative value units [RVUs]) and the change in spending on primary care services provided to Medicaid beneficiaries.

[4] We classified the following 18 counties in Washington State as rural based on RUCC levels 4 through 9: Adams, Clallam, Ferry, Garfield, Grant, Grays Harbor, Island, Jefferson, Kittitas, Klickitat, Lewis, Lincoln, Mason, Okanogan, Pacific, San Juan, Wahkiakum, and Whitman.

PADSIM is an economic model of health care provision that predicts amounts of services and spending based on patients' demand for services and provider payment policy. The model predicts amounts of services and spending separately for two key sectors—physician offices and hospitals[5]—and separately for five categories of health insurance coverage: Medicaid, Medicare, employer- or union-based group coverage, marketplace or other nongroup coverage, and uninsured.

In PADSIM, patient demand for services is determined by (1) the number of patients; (2) their ages, sexes, and health statuses; and (3) whether they are insured and, if so, the generosity of their coverage. Provider supply is determined by (1) the number of providers, (2) the payment rate, and (3) the degree of supply-side cost-sharing in the payment system, or what we term *prospectiveness* (Ellis and McGuire, 1993). So-called value-based payment arrangements are generally associated with higher degrees of prospectiveness, whereas cost reimbursement is associated with little or no prospectiveness. The amount of services that providers deliver, and that patients actually receive, is assumed to reflect a compromise between patient demand and provider supply.

One assumption used in PADSIM is that an increase in provider payment rates will increase providers' desired level of output, an assumption that is consistent with recent empirical findings (Clemens and Gottlieb, 2014; White and Yee, 2013). Also, an increase in the payment rates for one insurance category (e.g., Medicaid) will increase the share of output provided to people covered by that type of insurance.

To perform the current analysis, we customized PADSIM in three ways:

- *geography*. In the standard PADSIM, the unit of analysis is the state–year–provider type–insurance category. For this analysis, the model was disaggregated to the county level so that changes in Medicaid payment policy could be simulated independently at the county level.
- *border crossing*. The standard PADSIM is aggregated at the state level and does not account for patient crossing of borders to receive health care services. For this analysis, which uses the county as the geographic unit, it was necessary to recognize patient crossing of geographic boundaries to receive health care services. Otherwise, any patients living in counties with no providers would be predicted to receive no health care services. To simulate patient border crossing, we created a data set that includes service counts for each combination of patient county of residence and county of provider location. For hospital services, we used the Medicare hospital service area file to populate this county–county data set. For physician services, unfortunately, there is no corresponding publicly available data source. Therefore, as a proxy, we used county-to-county commuting patterns to simulate travel patterns for the use of physician services—this assumes that

[5] *Physician offices* corresponds to North American Industry Classification System code 6211 (offices of physicians). The services provided in that setting consist mainly of physician services, but they also include services provided by NPs, PAs, and other medical professionals. *Hospitals* includes the inpatient and outpatient units in Medicare-certified short-stay hospitals (postacute units and specialty hospitals are excluded).

travel patterns for the receipt of physician services are similar to patterns in commuting to workplaces (U.S. Census Bureau, 2014a). For each county, we simulated two separate amounts of services—the amount of services provided by providers located in that county and the amount of services received by patients residing in that county.

- *simulating a change in payment rates for primary care physicians.* The standard PADSIM aggregates all services provided in physician offices, including services provided by primary care physicians, specialist physicians, surgeons, and NPs. But the simulated increase in Medicaid payment rates would apply only to primary care physicians. Therefore, we used the 2014–2015 AHRF to measure the share of physicians in each county who were engaged in primary care. Then, we applied the simulated increase in Medicaid payment rates only to that share of spending on Medicaid beneficiaries in each county.

Limitations

Our projections of primary care workforce supply and the effects of each policy option are limited by the assumptions underlying the workforce models and the data available for analysis. First, although our base-case prediction models appear to be well calibrated through 2015, we cannot guarantee that these predictions will prove accurate through 2025. Unforeseen events other than the policy options we investigated (e.g., changes in national economic trends that affect physicians' propensity to retire) could result in deviations from these predictions. Second, for each policy option simulated using longitudinal models, we chose time-lag coefficients based on conceptual match (e.g., that training programs would require at least three years to manifest effects on the primary care workforce). We explored other time lags (e.g., four-year instead of five-year lags for medical school enrollment effects), with similar overall findings to those presented here, but the range of available time lags was limited at the year 2025. The effects of opening a medical school in 2017 could manifest later than 2025. Third, our models do not account for the Medicare Access and CHIP Reauthorization Act of 2015 (MACRA) (Pub. L. 114-10, 2015), which might have different effects on primary care practices in rural and urban areas. At the time of this writing, details of MACRA implementation are unclear, precluding regression- or microsimulation-based projections of its effects.

Fourth, for policy options simulated using cross-sectional models, we cannot estimate the time course over which effects might be produced. These cross-sectional models can be interpreted as estimates of achieving new steady states and do not reflect any transition periods that might still be underway in the year 2025 if these options are undertaken in 2017. Fifth, our estimates of the effects of adopting medical home and NMHC practice models carry the same limitations as the survey-based analyses from which they are drawn: Both surveys were modest in size, and the medical home survey was limited to one state (Pennsylvania). Therefore, the effects of increasing the adoption of medical homes and NMHCs might best be interpreted as two illustrative examples of how sensitive the supply of future primary care services is to new practice models, rather than precise quantitative estimates for the investigated scenarios.

Sixth, none of our models estimated the policy options' effects on the quality of care or patients' health outcomes. Seventh, with one exception (increasing Medicaid payment rates to rural primary care physicians), we could not estimate the costs of the policy options. Therefore, our analyses cannot support comparisons of relative cost-effectiveness among policy options. In particular, options for which costs could not be estimated should not be assumed to be low cost.

Eighth, we could not estimate telehealth's effects on primary care services in rural Washington. Telehealth can take many forms, and we lacked the empirical data necessary to estimate effects of any particular telehealth intervention on the availability of primary care services. However, multiple interviewees mentioned telehealth, which we included in the logic model.

Finally, all investigated policy options other than opening the Elson S. Floyd College of Medicine at WSU are hypothetical. Although we attempted to make these options as comparable as possible to the new medical school (e.g., by beginning them in 2017), their effect estimates are sensitive to scenario details (e.g., exact size of residency program expansion, the magnitude of Medicaid payment increase) and, by changing these details, the magnitudes of their effects could increase or decrease relative to opening the new medical school.

Chapter Four. Findings from Interviews

Beginning in November 2015, we conducted 39 key-informant interviews with representatives of the legislative and executive branches of the Washington State government, professional associations, medical educational institutions, Medicaid managed care plans, and rural hospitals. The interviews covered respondents' perceptions of primary care and other medical service shortages in rural Washington, data sources concerning these shortages (if any), current and past programs intended to alleviate these shortages, and ideas for additional approaches to increasing the availability of primary care services in rural Washington.

Themes from the key-informant interviews, by category, included those described in this chapter.

The Degree of the Primary Care Shortage

There was a lack of consensus regarding the degree of primary care shortage in rural areas of Washington. Some of this disagreement stemmed from differences between respondents in the definitions of primary care supply and primary care shortages. For example, the state Medicaid program has network adequacy requirements for Medicaid managed care plans, and, if these requirements are met in rural areas, some observers interpret these adequate networks as indicating that no primary care shortage exists. However, other observers have noted that, even when primary care provider network adequacy criteria are met, primary care capacity in a given area might not be sufficient to meet patients' needs (i.e., a true shortage, from the patient perspective, still might exist). This discrepancy exists because network adequacy criteria are met when plans establish contracts with local primary care providers, even if the supply of such providers is actually inadequate to meet local demand for primary care services. In the extreme case, a rural area with no primary care providers whatsoever would automatically meet network adequacy requirements if the health plan contracted with the closest primary care provider, who might actually be quite distant from the area in question. In effect, the network adequacy criteria take the distribution of primary care providers as a given and do not encourage recruitment of new primary care providers into underserved areas.

In general, Medicaid managed care plans reported being able to include rural primary care providers in their networks, even when there were few providers in an area, by paying them higher rates or by relaxing credentialing criteria (e.g., by waiving board certification requirements).

Some interviewees measured primary care shortages according to the number of unfilled positions in rural clinics or hospitals, which were commonly reported. This definition does not explicitly reflect unmet patient need, but it was readily observable by several interviewees.

In some rural areas, interviewees noted that shortages of obstetrical, dental, and behavioral health services are more pronounced than shortages of primary care services. Multiple interviewees noted that, in the past two decades, a declining share of family physicians have been providing obstetric care. Professional liability premiums and generation and cohort effects (i.e., younger family physicians providing less obstetric care, as a general rule) were both identified as possible contributors to this trend.

The Effects That Policy Options Can Have on Rural Primary Care Capacity

Interviewees agreed that the major policy options proposed for modeling (opening a new medical school, increasing the number of primary care residency positions, increasing loan-repayment incentives, increasing Medicaid payment rates, increasing the adoption of medical homes—all in rural Washington) had the *potential* to increase the supply of rural primary care physicians. However, multiple interviewees expressed skepticism that opening a new medical school, without providing a corresponding increase in primary care residency positions, would increase the supply of primary care physicians in rural Washington.

Although we did not prespecify rural K–12 educational quality as a policy lever (and did not solicit it with a dedicated interview question), there was surprisingly widespread agreement that an effective long-term strategy to increase the number of rural primary care physicians is to improve rural K–12 education, for two reasons. First, rural physicians tend to have grown up in rural areas, but weaknesses in rural K–12 education limit rural children's ability to eventually attend medical school. Second, rural physicians sometimes relocate to more-urban areas with better schools when their own children reach a certain age (most notably, when the oldest child reaches high school). Because this unexpected theme emerged from the interviews, we incorporated rural K–12 educational quality into the logic model and modeled the effects that improving high school quality could have on the rural primary care workforce.[6]

Some interviewees noted that primary care providers tended to cluster around rural hospitals because they enjoy the clinical backup and camaraderie that hospitals provide. Stabilizing struggling rural hospitals might therefore be a policy lever to preserve rural access to primary care providers, who might relocate if nearby hospitals close.

Other Factors Affecting Rural Primary Care Capacity

Some interviewees were concerned that medical home recognition and electronic health record (EHR) adoption requirements (e.g., through meaningful-use regulations) pose special challenges to rural primary care practices, which frequently lack economies of scale and

[6] We could not collect national data on educational quality for grades before high school. Therefore, our K–12 educational improvement scenario focuses on only high school.

sufficient capital reserves to invest in practice transformation or EHR adoption. These programs might have the effect of encouraging rural primary care practices to become hospital-owned. Hospital ownership offers access to capital, scale, and higher pay rates (via RHC conversion and greater negotiating leverage with payers). A small number of interviewees also reported that loss of practice ownership and local independence of practice style, as a consequence of investment requirements and greater external monitoring (e.g., as specified in MACRA), could reduce the attractiveness of rural primary care for both new recruits and currently practicing rural primary care providers.

Like with the quality of K–12 education, there was broad agreement that growing up in a rural hometown was one of the most powerful predictors of having a future career in rural medicine. Medical schools that preferentially recruit students of rural origin might produce disproportionate numbers of rural primary care providers as a consequence of these recruitment efforts.

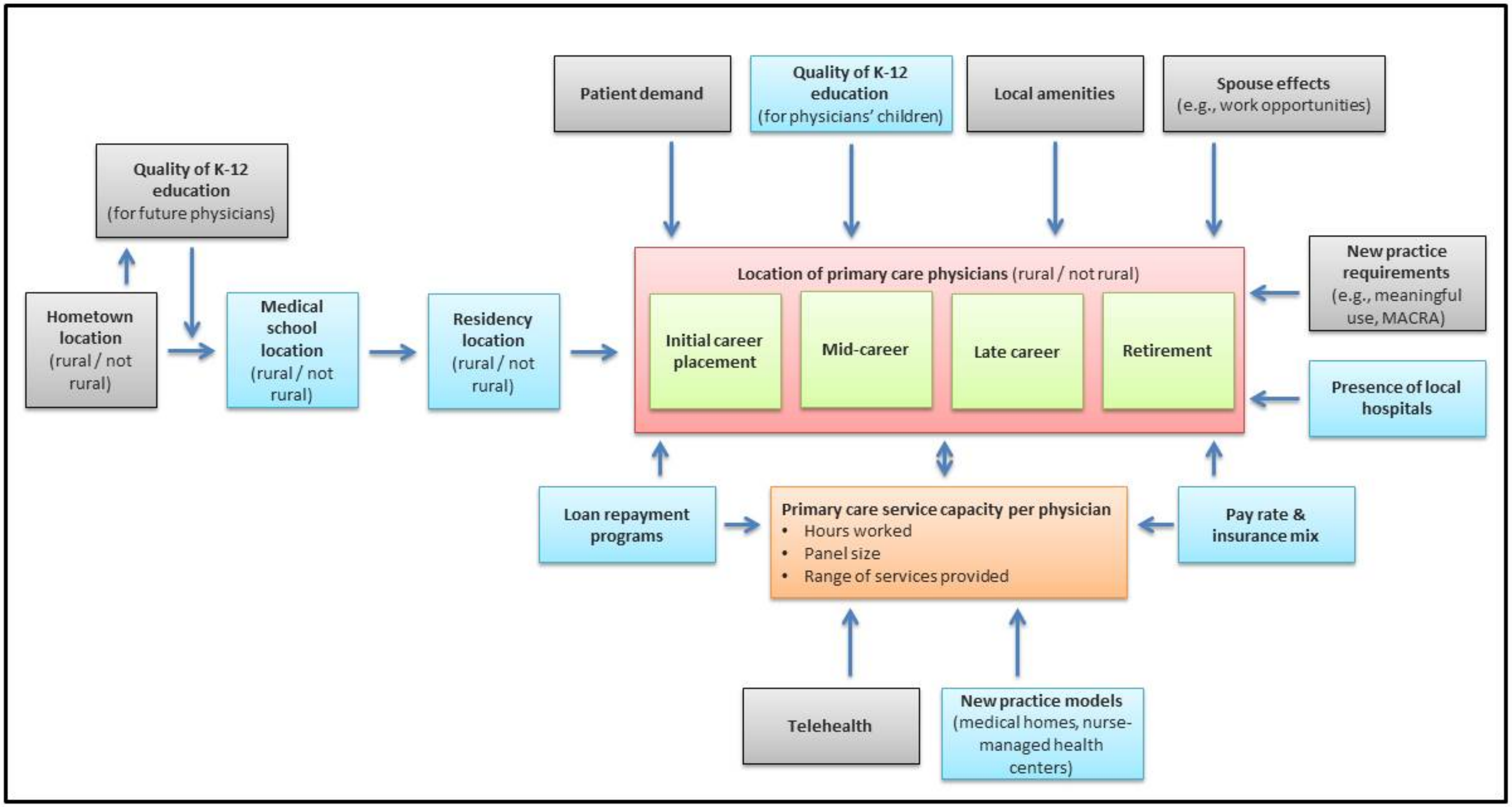
Interviewees also mentioned multiple forms of telehealth taking shape in rural Washington. These included clinician-to-clinician telephone or video consultation services with urban subspecialists, direct provision of subspecialty care (e.g., behavioral health services) to patients via video chat, and patient-initiated care for minor health problems through commercial virtual-visit services. Interviewees reported that all of these forms of telehealth could, in theory, affect the supply and range of available primary care services in rural Washington. However, there was also broad agreement that few, if any, data quantifying these effects exist.

Multiple interviewees reported that the spouses of primary care providers could affect their willingness to begin and maintain practice in a rural area—an observation consistent with recent research findings (Staiger, Marshall, et al., 2016). Two main reasons were cited: Spouses from more-urban areas might not find rural life appealing, and spouses (especially those with high educational attainment) might find few attractive rural opportunities for employment.

Chapter Five. Logic Model

The logic model displayed in Figure 5.1 follows a primary care physician's pathway from his or her hometown, through key training steps, and into his or her career as a fully trained provider, ending with retirement. The model also represents the primary care service capacity (i.e., primary care productivity) of each primary care physician.

Figure 5.1. Logic Model



NOTE: The gray boxes represent factors that are likely to affect the supply and capacity of primary care physicians in rural areas but for which we did not estimate the effects of corresponding policy options. The blue boxes represent variables that are likely to be more amenable to policy decisions that can produce effects on the supply and capacity of primary care physicians in rural areas within ten years. The green boxes represent stages of a primary care physician's career.

The gray boxes represent factors that are likely to affect the supply and capacity of primary care physicians in rural areas but for which we did not estimate the effects of corresponding policy options—either because they were not amenable to policy changes over a ten-year time horizon or because we lacked a method to produce such estimates. These factors include hometown location (rural or not); the quality of K–12 education for future providers who are growing up in rural areas; patient demand for primary care services in rural areas (based on population); local amenities (e.g., restaurants, cultural institutions); spouse effects (e.g., presence or absence of job opportunities for providers' spouses); new requirements of primary care practices that might make small, independent practice more difficult (e.g., requirements to adopt EHRs and submit quality performance data); and telehealth (e.g., e-consultation services).

The blue boxes in the logic model are variables that are likely to be more amenable to policy decisions that can produce effects on the supply and capacity of primary care physicians in rural areas within ten years. These include medical school location (i.e., opening a new medical school near rural areas); primary care residency program locations; quality of education for the children of current providers; proximity to hospitals; expansion of loan-repayment programs; changes in payment rates and insurance mix; and adoption of new practice models, such as medical homes and NMHCs. The simulations and predictions presented in this report correspond to these policy options.

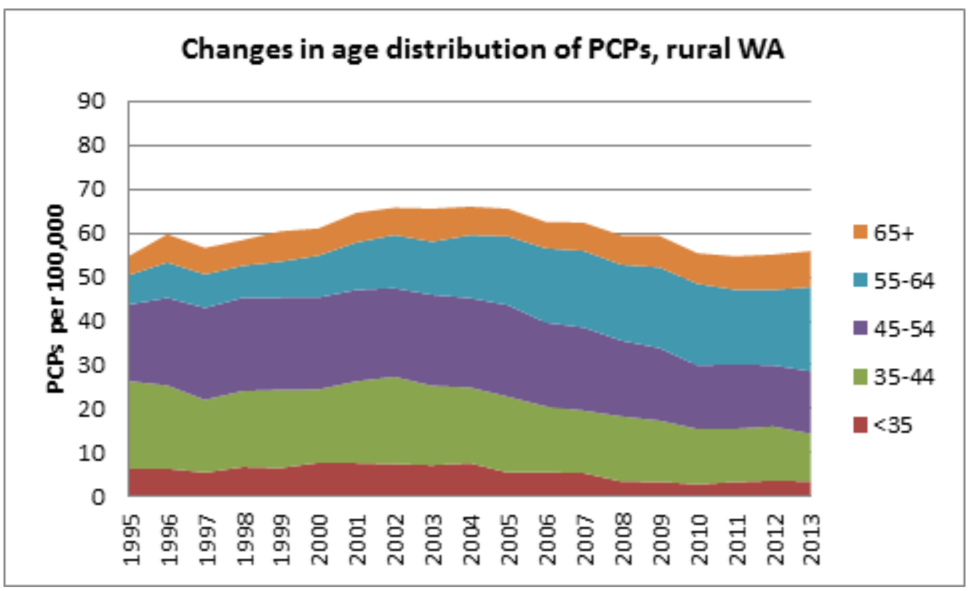
The green boxes represent stages of a primary care physician's career. The factors that influence the decision to practice in rural or nonrural locations might vary across these stages.

Chapter Six. Washington State's Primary Care Workforce: Projections Under Policy Options

Changes in the Supply and Age Composition of Washington State's Rural and Urban Primary Care Physician Supply Since 1995

As shown in Figures 6.1 and 6.2, the percentage of primary care physicians who are ages 55 and older grew from 1995 to 2013 in both rural and urban Washington counties. The overall supply of rural primary care physicians rose and then declined over this time period (with little net change), while the supply of urban primary care physicians increased by more than 12 physicians per 100,000 population.

Figure 6.1. Age Segmentation of the Observed Primary Care Workforce in Rural Washington State, 1995–2013



NOTE: PCP = primary care physician.

Figure 6.2. Age Segmentation of the Observed Primary Care Workforce in Urban Washington State, 1995–2013

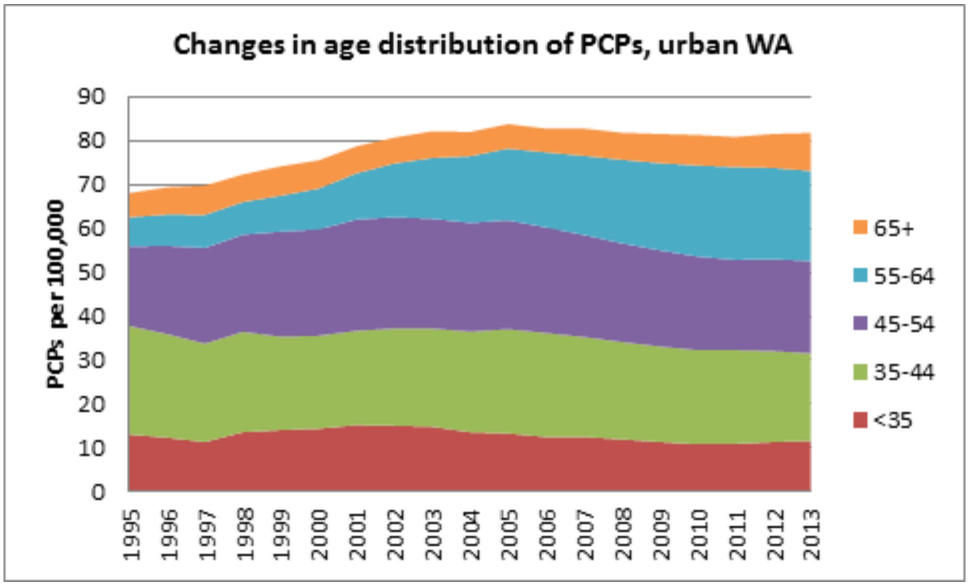
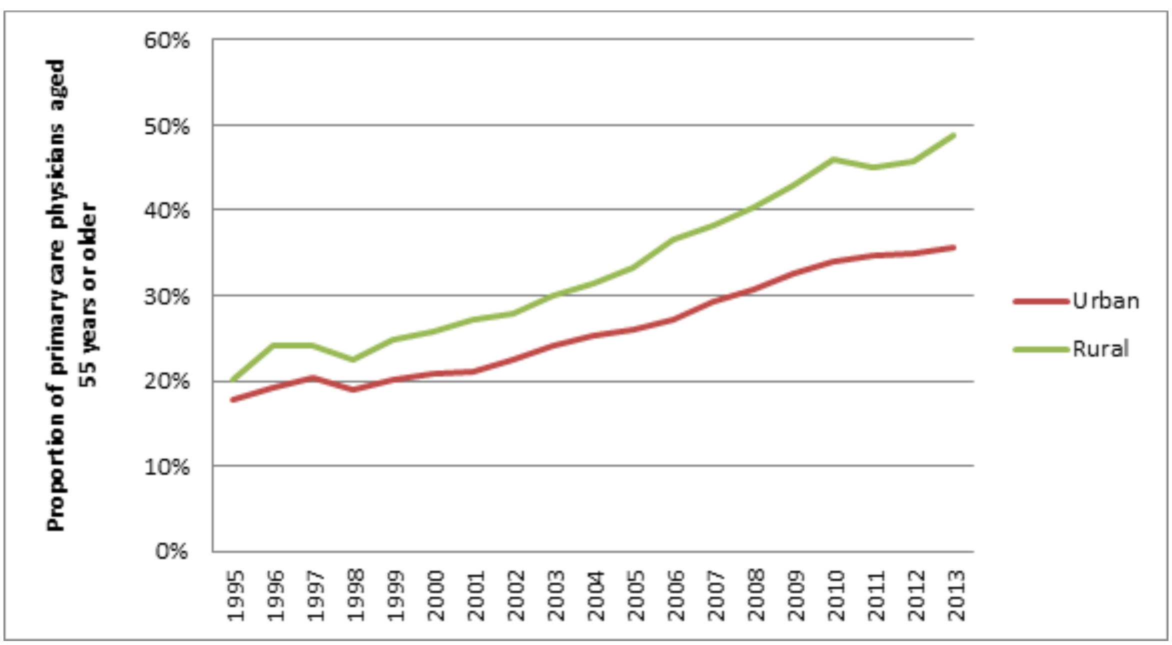


Figure 6.3 shows that growth in the percentage of primary care physicians who are ages 55 and older was greater in rural counties than in urban counties of Washington.

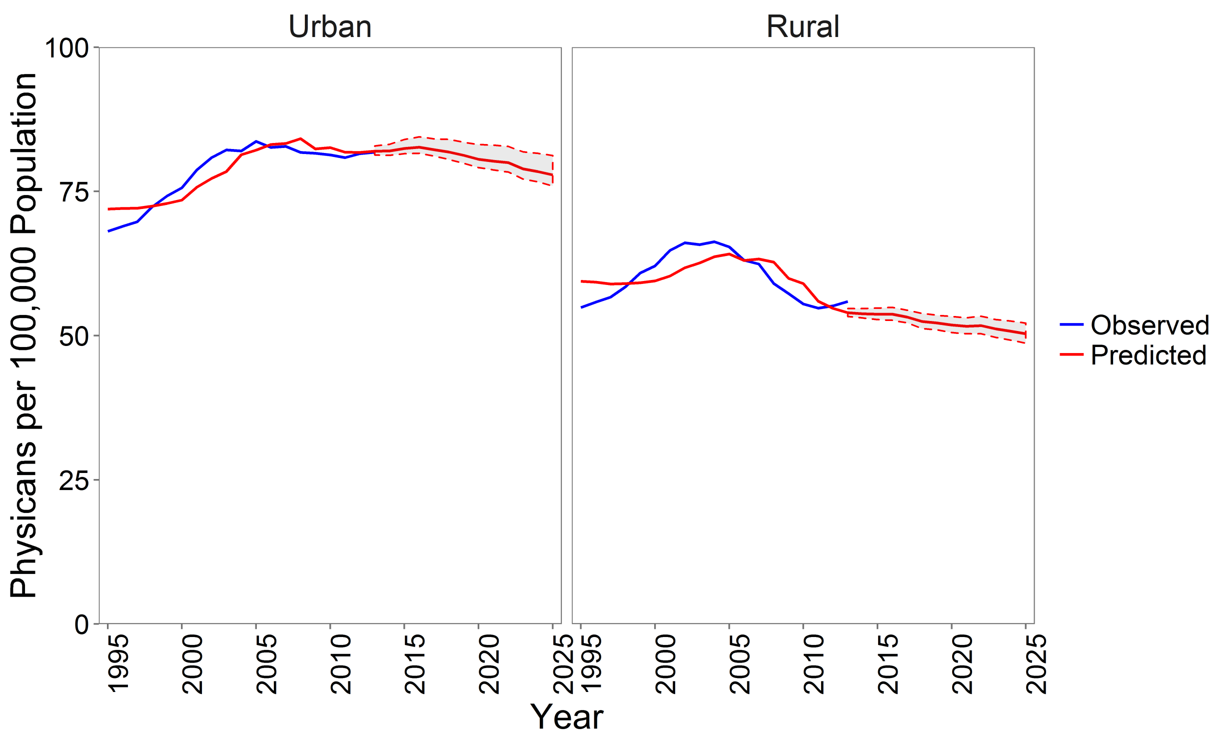
Figure 6.3. Share of Primary Care Physicians Ages 55 or Older in Rural and Urban Washington State Counties, 1995–2013



Base-Case Projections of the Rural and Urban Primary Care Workforce

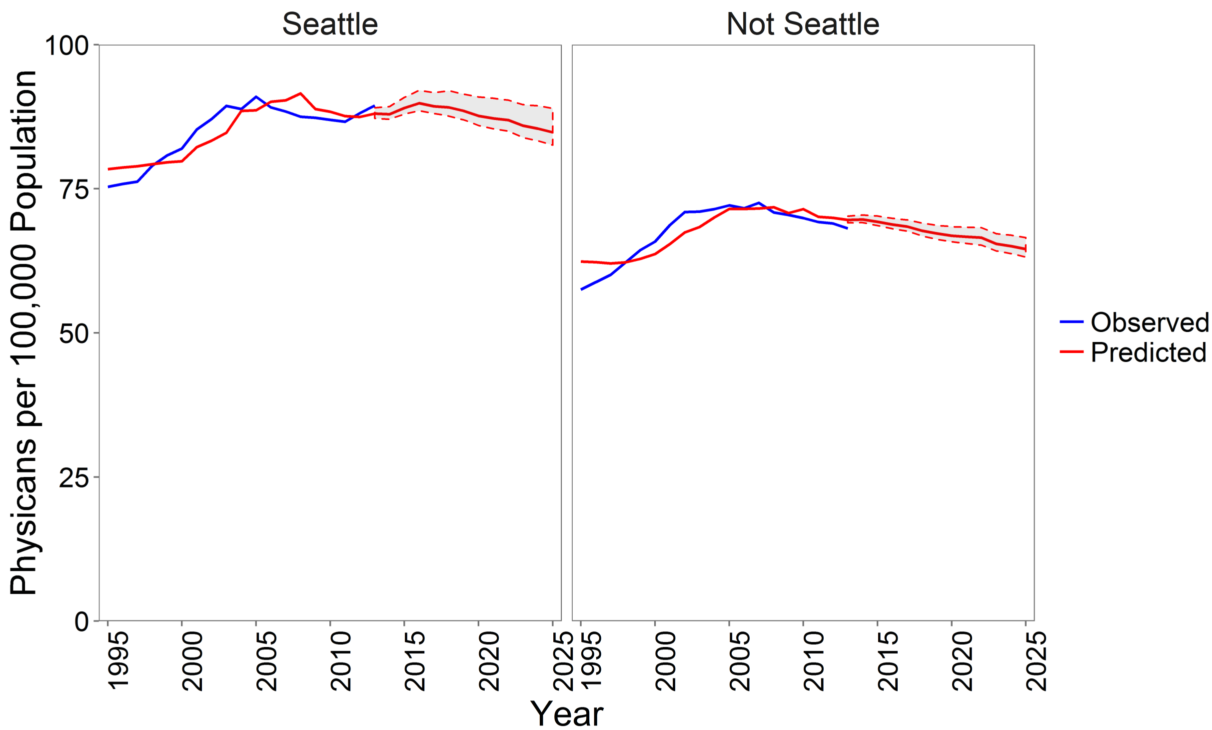
As shown in Figure 6.4, we estimate declines in the number of primary care physicians per 100,000 population in both rural and urban areas from 2013 to 2025. Figure 6.5 shows similar trends for Seattle and non-Seattle counties. Tables 6.1 and 6.2 display these declines numerically: 3.66 fewer primary care physicians per 100,000 population in rural counties by 2025, 4.14 fewer in urban counties, 5.07 fewer outside Seattle, and 3.22 fewer within Seattle.

Figure 6.4. Observed Versus Predicted Count of Primary Care Physicians per 100,000 Population in Washington State, Urban Versus Rural



NOTE: Dotted lines indicate bootstrapped 90-percent confidence limits for predicted data.

Figure 6.5. Observed Versus Predicted Count of Primary Care Physicians per 100,000 Population in Washington State, Seattle Versus Outside Seattle



NOTE: Dotted lines indicate bootstrapped 90-percent confidence limits for predicted data.

Table 6.1. Base-Case Primary Care Physician Workforce Projections in Rural and Urban Washington State, 2014–2025, per 100,000 Population, 90-Percent Confidence Intervals

	Rural		Urban	
Year	Number	Change Since 2013	Number	Change Since 2013
2013[a]	53.97	Not applicable	82.00	Not applicable
2014	53.79 (53.34, 54.31)	–0.18 (–0.63, 0.34)	82.03 (81.58, 82.66)	0.03 (–0.42, 0.66)
2015	53.72 (52.92, 54.55)	–0.25 (–1.05, 0.58)	82.45 (81.75, 83.58)	0.45 (–0.25, 1.58)
2016	53.72 (52.70, 54.74)	–0.25 (–1.27, 0.77)	82.67 (81.73, 84.20)	0.67 (–0.27, 2.20)
2017	53.22 (52.08, 54.34)	–0.75 (–1.89, 0.37)	82.24 (81.21, 83.91)	0.24 (–0.79, 1.91)
2018	52.46 (51.08, 53.87)	–1.51 (–2.89, –0.10)	81.83 (80.51, 83.91)	–0.17 (–1.49, 1.91)
2019	52.18 (50.80, 53.56)	–1.79 (–3.17, –0.41)	81.25 (79.90, 83.45)	–0.75 (–2.10, 1.45)
2020	51.83 (50.25, 53.37)	–2.14 (–3.72, –0.60)	80.57 (79.04, 83.08)	–1.43 (–2.96, 1.08)
2021	51.61 (50.01, 53.19)	–2.36 (–3.96, –0.78)	80.24 (78.60, 82.91)	–1.76 (–3.40, 0.91)
2022	51.73 (50.09, 53.41)	–2.24 (–3.88, –0.56)	79.98 (78.27, 82.68)	–2.02 (–3.73, 0.68)
2023	51.14 (49.34, 52.95)	–2.83 (–4.63, –1.02)	78.91 (77.00, 81.76)	–3.09 (–5.00, –0.24)
2024	50.74 (48.85, 52.65)	–3.23 (–5.12, –1.32)	78.46 (76.49, 81.53)	–3.54 (–5.51, –0.47)
2025	50.31 (48.36, 52.28)	–3.66 (–5.61, –1.69)	77.86 (75.83, 81.10)	–4.14 (–6.17, –0.90)

[a] 2013 estimates are observed and have no CIs; all subsequent levels and changes are projected and have 90-percent CIs.

Table 6.2. Base-Case Primary Care Physician Workforce Projections Outside and Within Seattle, 2014–2025, per 100,000 Population, 90-Percent Confidence Intervals

	Outside Seattle		In Seattle	
Year	Number	Change Since 2013	Number	Change Since 2013
2013[a]	69.60	Not applicable	88.03	Not applicable
2014	69.66 (69.34, 70.15)	0.06 (–0.26, 0.55)	87.96 (87.44, 88.69)	–0.07 (–0.59, 0.66)
2015	69.29 (68.84, 69.95)	–0.31 (–0.76, 0.35)	89.02 (88.05, 90.51)	0.99 (0.02, 2.48)
2016	68.81 (68.21, 69.60)	–0.79 (–1.39, –0.00)	89.84 (88.62, 91.88)	1.81 (0.59, 3.85)
2017	68.46 (67.73, 69.40)	–1.14 (–1.87, –0.20)	89.32 (87.98, 91.57)	1.29 (–0.05, 3.54)
2018	67.74 (66.87, 68.83)	–1.86 (–2.73, –0.77)	89.13 (87.48, 92.02)	1.10 (–0.55, 3.99)
2019	67.26 (66.33, 68.39)	–2.34 (–3.27, –1.21)	88.52 (86.84, 91.48)	0.49 (–1.19, 3.45)
2020	66.85 (65.80, 68.23)	–2.75 (–3.80, –1.37)	87.65 (85.85, 90.92)	–0.38 (–2.18, 2.89)
2021	66.66 (65.51, 68.15)	–2.94 (–4.09, –1.45)	87.21 (85.17, 90.75)	–0.82 (–2.86, 2.72)
2022	66.52 (65.28, 68.10)	–3.08 (–4.32, –1.50)	86.92 (84.74, 90.57)	–1.11 (–3.29, 2.54)
2023	65.45 (64.21, 67.07)	–4.15 (–5.39, –2.53)	85.94 (83.58, 89.78)	–2.09 (–4.45, 1.75)
2024	65.07 (63.76, 66.83)	–4.53 (–5.84, –2.77)	85.43 (83.02, 89.55)	–2.60 (–5.01, 1.52)
2025	64.53 (63.12, 66.39)	–5.07 (–6.48, –3.21)	84.81 (82.31, 89.21)	–3.22 (–5.72, 1.18)

[a] 2013 estimates are observed and have no CIs; all subsequent levels and changes are projected and have 90-percent CIs. Seattle is defined as King, Pierce, and Snohomish counties.

These predicted declines are consistent with Washington's aging primary care physician workforce, whose rate of retirement from 2014 to 2025 is likely to exceed their projected rate of replacement by newly trained primary care physicians (as a ratio of county population).

As indicated by close tracking of the observed and predicted counts of primary care physicians through 2013 (the most recent year of observed primary care physician supply), the prediction model fit was good, with county-year correlation coefficients of 0.88 for rural and 0.95 for urban Washington counties in this time frame. We present additional fit statistics in Appendix C.

Given national workforce trends among NPs and PAs, we estimate increases in the numbers of NPs and PAs per 100,000 population in Washington State from 2013 to 2025 (Tables 6.3 and 6.4). Because of data limitations described in the methods, these estimates are not subdivided according to rural status.

Table 6.3. Base-Case Nurse Practitioner Workforce Projections in Washington State, 2014–2025, per 100,000 Population

	4% Growth Rate		5% Growth Rate	
Year	Number	Change Since 2013	Number	Change Since 2013
2013[a]	14.36	Not applicable	14.36	Not applicable
2014	14.75	0.39	14.89	0.53
2015	15.15	0.78	15.44	1.08
2016	15.55	1.19	16.01	1.64
2017	15.97	1.61	16.59	2.23
2018	16.40	2.04	17.20	2.84
2019	16.84	2.48	17.84	3.47
2020	17.29	2.93	18.49	4.13
2021	17.76	3.40	19.17	4.81
2022	18.24	3.87	19.88	5.51
2023	18.73	4.36	20.61	6.24
2024	19.23	4.87	21.37	7.00
2025	19.75	5.38	22.15	7.79

[a] 2013 estimates are observed; all subsequent levels and changes are projected.

Table 6.4. Base-Case Physician-Assistant Workforce Projections in Washington State, 2014–2025, per 100,000 Population

	3% Growth Rate		4% Growth Rate	
Year	Number	Change Since 2013	Number	Change Since 2013
2013[a]	8.21	Not applicable	8.21	Not applicable
2014	8.35	0.14	8.43	0.22
2015	8.49	0.28	8.66	0.45
2016	8.64	0.43	8.89	0.68
2017	8.79	0.57	9.13	0.92
2018	8.93	0.72	9.38	1.16
2019	9.09	0.87	9.63	1.42
2020	9.24	1.03	9.89	1.68
2021	9.40	1.19	10.15	1.94
2022	9.56	1.35	10.43	2.21
2023	9.72	1.51	10.71	2.50
2024	9.89	1.67	11.00	2.78
2025	10.05	1.84	11.29	3.08

[a] 2013 estimates are observed; all subsequent levels and changes are projected.

Between 2014 and 2025, we estimate that the number of NPs per 100,000 population will increase by 5.38 under the 4-percent growth scenario and 7.79 under the 5-percent growth scenario. For PAs, we estimate increases of 1.84 per 100,000 population under the 3-percent growth scenario and 3.08 under the 4-percent growth scenario.

Policy Option: Open the Elson S. Floyd College of Medicine at Washington State University

Table 6.5 displays the projected workforce effects of opening the new medical school at WSU in 2017, with the first class graduating in 2021. Of note, the projected increases in primary care physician per unit population are greater in urban areas than in rural areas because Spokane is classified as an urban area. As expected, however, these increases are greater outside Seattle than within Seattle.

Table 6.5. Projections of Changes in the Primary Care Physician Workforce Associated with Opening a New Medical School at Washington State University in 2017, per 100,000 Population, 90-Percent Confidence Intervals

Year	Rural	Urban	Outside Seattle	In Seattle
2017	Not estimated	Not estimated	Not estimated	Not estimated
2018	Not estimated	Not estimated	Not estimated	Not estimated
2019	Not estimated	Not estimated	Not estimated	Not estimated
2020	Not estimated	Not estimated	Not estimated	Not estimated
2021	Not estimated	Not estimated	Not estimated	Not estimated
2022	0.08 (–0.16, 0.27)	0.13 (–0.07, 0.25)	0.16 (0.04, 0.29)	0.08 (–0.23, 0.27)
2023	0.17 (–0.32, 0.54)	0.25 (–0.14, 0.50)	0.33 (0.07, 0.58)	0.17 (–0.45, 0.54)
2024	0.28 (–0.54, 0.90)	0.42 (–0.24, 0.83)	0.54 (0.12, 0.97)	0.28 (–0.75, 0.90)
2025	0.39 (–0.75, 1.26)	0.59 (–0.33, 1.16)	0.76 (0.17, 1.36)	0.39 (–1.05, 1.27)

NOTE: The displayed figures are derived from models that include five-year medical school enrollment lagged effects. Seattle is defined as King, Pierce, and Snohomish counties.

The estimated effects of opening the Elson S. Floyd College of Medicine at WSU offset approximately 11 percent of the projected decrease in rural per capita primary care physician supply by 2025, 14 percent of the projected decrease in urban counties, 12 percent of the projected decrease within Seattle, and 15 percent of the projected decrease outside Seattle.

These projections assume that the first class at the Elson S. Floyd College of Medicine at WSU will enroll 60 students and that the school will reach a steady-state enrollment of 320 students in 2022. Underlying these projections is a set of longitudinal regression models that estimate associations between county-level supplies of primary care physicians and the numbers

of students enrolled in nearby, newly opened medical schools five years earlier. Therefore, these models implicitly assume that the local effects of opening a new medical school at WSU will be similar to the effects observed when new medical schools opened in other states between 1995 and 2008.

Sensitivity analyses based on expanding the enrollments of existing primary care–centric medical schools (rather than opening new medical schools) produced similar estimates.

Policy Option: Increase the Number of Primary Care Residency Positions in Washington State

The residency-expansion scenarios assume that all existing primary care residencies in Washington State outside Seattle will expand once in 2017 and remain at that level until 2025.

In the latest available data year (2013), 36 primary care residents worked in Washington State outside Seattle. Therefore, to generate residency expansions approaching the same approximate scale as the opening of the WSU medical school (60 students in 2017, 320 in 2022), we modeled residency scenarios ranging up to a 100-percent expansion (i.e., a doubling of primary care residency sizes outside Seattle). Projected effects of 25-, 50-, and 100-percent primary care residency expansions are displayed in Tables 6.6, 6.7, and 6.8, respectively.

Table 6.6. Projections of Changes in the Primary Care Physician Workforce Associated with Increasing the Sizes of Existing Primary Care Residency Programs Outside Seattle by 25 Percent in 2017, per 100,000 Population, 90-Percent Confidence Intervals

Year	Rural	Urban	Outside Seattle	In Seattle
2017	Not estimated	Not estimated	Not estimated	Not estimated
2018	Not estimated	Not estimated	Not estimated	Not estimated
2019	Not estimated	Not estimated	Not estimated	Not estimated
2020	0.05 (–0.17, 0.30)	0.06 (–0.05, 0.16)	0.12 (–0.02, 0.25)	0.00 (–0.15, 0.13)
2021	0.09 (–0.12, 0.37)	0.08 (–0.03, 0.19)	0.17 (0.02, 0.32)	0.01 (–0.16, 0.15)
2022	0.19 (–0.09, 0.54)	0.15 (0.00, 0.30)	0.27 (0.08, 0.46)	0.05 (–0.15, 0.26)
2023	0.35 (0.03, 0.72)	0.22 (0.07, 0.38)	0.34 (0.14, 0.55)	0.14 (–0.09, 0.36)
2024	0.47 (0.12, 0.88)	0.27 (0.10, 0.45)	0.37 (0.16, 0.59)	0.22 (–0.03, 0.46)
2025	0.56 (0.14, 0.98)	0.31 (0.11, 0.50)	0.39 (0.16, 0.63)	0.29 (0.01, 0.55)

NOTE: The displayed figures are derived from longitudinal models that include three-, four-, five-, six-, seven-, and eight-year residency size lagged effects. Seattle is defined as King, Pierce, and Snohomish counties. A 25-percent increase in primary care residencies outside Seattle is equivalent to nine additional residents.

Table 6.7. Projections of Changes in the Primary Care Physician Workforce Associated with Increasing the Sizes of Existing Primary Care Residency Programs Outside Seattle by 50 Percent in 2017, per 100,000 Population, 90-Percent Confidence Intervals

Year	Rural	Urban	Outside Seattle	In Seattle
2017	Not estimated	Not estimated	Not estimated	Not estimated
2018	Not estimated	Not estimated	Not estimated	Not estimated
2019	Not estimated	Not estimated	Not estimated	Not estimated
2020	0.08 (–0.25, 0.49)	0.11 (–0.06, 0.28)	0.22 (0.01, 0.44)	0.00 (–0.23, 0.21)
2021	0.17 (–0.18, 0.61)	0.16 (–0.03, 0.34)	0.32 (0.07, 0.55)	0.01 (–0.23, 0.25)
2022	0.35 (–0.10, 0.91)	0.29 (0.06, 0.52)	0.51 (0.21, 0.81)	0.10 (–0.24, 0.41)
2023	0.66 (0.15, 1.26)	0.41 (0.16, 0.67)	0.64 (0.33, 0.98)	0.25 (–0.12, 0.58)
2024	0.89 (0.31, 1.52)	0.51 (0.24, 0.80)	0.71 (0.36, 1.07)	0.41 (0.01, 0.78)
2025	1.05 (0.37, 1.70)	0.59 (0.28, 0.88)	0.74 (0.36, 1.10)	0.54 (0.09, 0.93)

NOTE: The displayed figures are derived from longitudinal models that include three-, four-, five-, six-, seven-, and eight-year residency size lagged effects. Seattle is defined as King, Pierce, and Snohomish counties.

Table 6.8. Projections of Changes in the Primary Care Physician Workforce Associated with Increasing the Sizes of Existing Primary Care Residency Programs Outside Seattle by 100 Percent in 2017, per 100,000 Population, 90-Percent Confidence Intervals

Year	Rural	Urban	Outside Seattle	In Seattle
2017	Not estimated	Not estimated	Not estimated	Not estimated
2018	Not estimated	Not estimated	Not estimated	Not estimated
2019	Not estimated	Not estimated	Not estimated	Not estimated
2020	0.16 (–0.04, 1.34)	0.20 (0.10, 0.74)	0.43 (0.25, 1.10)	0.00 (–0.19, 0.64)
2021	0.32 (0.08, 1.57)	0.30 (0.19, 0.87)	0.60 (0.36, 1.28)	0.02 (–0.20, 0.76)
2022	0.67 (0.39, 2.30)	0.55 (0.39, 1.29)	0.97 (0.59, 1.75)	0.19 (–0.07, 1.22)
2023	1.24 (0.79, 2.86)	0.78 (0.56, 1.58)	1.21 (0.83, 2.06)	0.47 (0.09, 1.57)
2024	1.68 (1.17, 3.41)	0.98 (0.68, 1.84)	1.34 (0.92, 2.33)	0.78 (0.26, 1.93)
2025	2.00 (1.40, 3.77)	1.11 (0.70, 2.00)	1.40 (1.01, 2.51)	1.02 (0.28, 2.15)

NOTE: The displayed figures are derived from longitudinal models that include three-, four-, five-, six-, seven-, and eight-year residency size lagged effects. Seattle is defined as King, Pierce, and Snohomish counties.

Consistent with the expectations of key informants is the fact that the estimated effects of 100-percent primary care residency expansion (adding 36 primary care residents) are larger than the estimated effects of opening the new medical school at WSU without residency program expansion. However, none of the modeled residency scenarios has an estimated effect sufficient to offset the predicted decline in the number of rural primary care physicians (or primary care physicians outside Seattle) per 100,000 population from the base-case models. For the 100-

percent residency size expansions, effects range from 27 percent of the projected decrease in urban counties to 55 percent in rural counties.

Underlying these projections is a set of longitudinal regression models that estimate associations between county-level supplies of primary care physicians and changes in the number of nearby primary care residents occurring three to eight years earlier. Therefore, these projections assume that the local effects of expanding primary care residencies in Washington State will be similar to the effects observed when other primary care residencies (throughout the United States) changed in size between 1995 and 2010. These projections also assume that new primary care residency positions will fill at the same rate as existing primary care residency positions.

Policy Option: Increase the Availability of Educational Loan–Repayment Incentives

Because we lacked longitudinal data on loan-repayment programs, we fit cross-sectional regression models that estimated the effect of adding primary care NHSC positions in rural counties. These projections assume that associations between county-level numbers of primary care physicians and NHSC positions per capita observed in national data are good estimates of the effects of creating new loan-repayment opportunities in rural Washington State.

For each new primary care NHSC position opened per 100,000 county population, the estimated increase was 0.24 primary care physicians per 100,000 county population (90-percent CI of –0.10 to 0.66). Therefore, we estimated that doubling the number of primary care NHSC positions in rural Washington State (by adding 30 more such positions to rural counties) would produce an increase of 1.03 primary care physicians per 100,000 population.

To offset the projected base-case decrease in rural primary care physicians (–3.66 per 100,000 population by 2025), we estimate that an additional 15 loan-repayment opportunities resembling primary care NHSC positions per 100,000 rural population would be required. With approximately 700,000 people living in rural Washington counties, this means approximately 105 new loan-repayment positions in rural areas would be expected to offset future projected decreases in the primary care physician workforce, assuming achievement of a new steady state by 2025.

Policy Option: Improve the Quality of High School Education in Rural Washington State

Because we lacked longitudinal data on high school quality (measured as proficiency rates on standardized tests of mathematics and of reading and language arts), we fit cross-sectional models that estimated the effect of increasing proficiency rates on these standardized tests by 0.2 standard deviations among high schools in rural Washington counties. We found that a 0.2–

standard deviation increase in proficiency rates was associated with an increase of 0.80 primary care physicians per 100,000 population in rural Washington (90-percent CI of 0.31 to 1.28), or approximately 22 percent of the projected decline in per capita rural primary care physicians by 2025. However, because these models were cross-sectional and the time required to improve school performance is unclear, we cannot estimate the number of years required to achieve this estimated effect.

Policy Option: Preserve Rural Hospitals in Washington State

The rural hospital scenario is intended to give a sense of the effects of closing an average-sized rural hospital in any given year. This scenario was motivated by interviewees' concern that rural hospital closure would decrease the supply of local primary care physicians. As shown in Table 6.9, the closure of an average-sized rural hospital is associated with a same-county net decrease of less than one primary care physician per 100,000 population over a four-year period.

Table 6.9. Projections of Decreases in the Primary Care Physician Workforce Associated with Closing One Rural Hospital in Year 1, per 100,000 Population, 90-Percent Confidence Intervals

Year	Rural
1	–0.52 (–1.32, 0.68)
2	–0.56 (–1.36, 0.68)
3	–0.69 (–1.48, 0.47)
4	–0.87 (–1.79, 0.37)

NOTE: Estimates are derived from longitudinal models that include zero-, one-, two-, and three-year lagged effects.

Underlying these projections is a set of longitudinal regression models that estimate associations between county-level supplies of primary care physicians and changes in the numbers of short-term hospitals and hospital beds occurring zero to four years earlier. These projections assume that the local effects of closing an average-sized rural hospital in Washington State will be similar to the effects observed when other, similarly sized rural hospitals closed between 1995 and 2013 in other states.

Policy Option: Increase Medicaid Fee-for-Service Payment Rates in Rural Washington State

We used PADSIM to simulate the effects of increasing Medicaid fee-for-service payment rates to primary care physicians in rural counties of Washington State by 10 percent and 25 percent beginning in 2017. The PADSIM starts with the base-case projections of the primary care physician workforce and then simulates the effects of these payment changes on provider

productivity, measured as the number of RVUs delivered by each primary care physician. Given the projected number of primary care physicians per 100,000 in each base-case year, we then computed effective increase in primary care physician capacity per 100,000 population (under the assumption that a primary care physician who is producing 10 percent more RVUs is equivalent to 1.1 base-case primary care physicians).

PADSIM also estimated the total cost to Washington State of instituting these payment changes. Effects were limited to rural areas; PADSIM estimated negligible changes in primary care provider productivity in urban areas under this policy option.

As displayed in Table 6.10, we estimated that a 10-percent increase in Medicaid payment rates in rural counties would produce an increase in the availability of primary care services equivalent to 0.48 primary care physicians per 100,000 population in 2017. Because of increases in county population and decaying effects of the payment increase over time, the effective increase would diminish to 0.40 primary care physicians per 100,000 population by 2025. Table 6.11 displays similar findings for a 25-percent increase in Medicaid payment rates: an effective increase of 1.28 primary care physicians per 100,000 population in 2017, falling to 1.06 primary care physicians per 100,000 population by 2025.

Table 6.10. Projections of Changes in Primary Care Physician Workforce Productivity and Capacity Associated with Increasing Medicaid Payment Rates by 10 Percent in Rural Washington State Counties in 2017

Year	Increase in Productivity, as a Percentage	Effective Increase in Primary Care Physician Capacity per 100,000 Population	Annual Cost, in Millions of Dollars
2017	0.9	0.48	2.20
2018	0.9	0.47	2.17
2019	0.9	0.47	2.22
2020	0.9	0.47	2.15
2021	0.8	0.41	2.11
2022	0.8	0.41	2.08
2023	0.8	0.41	2.04
2024	0.8	0.41	2.00
2025	0.8	0.40	1.88

NOTE: Total cost indicates the total cost to the state represented by estimated increases in Medicaid fee-for-service payments to primary care physicians.

Table 6.11. Projections of Changes in Primary Care Physician Workforce Productivity and Capacity Associated with Increasing Medicaid Payment Rates by 25 Percent in Rural Washington State Counties in 2017

Year	Increase in Productivity, as a Percentage	Effective Increase in Primary Care Physician Capacity per 100,000 Population	Annual Cost, in Millions of Dollars
2017	2.4	1.28	5.70
2018	2.3	1.21	5.62
2019	2.3	1.20	5.74
2020	2.3	1.19	5.57
2021	2.3	1.19	5.47
2022	2.2	1.14	5.37
2023	2.2	1.13	5.26
2024	2.1	1.07	5.16
2025	2.1	1.06	4.84

PADSIM was not designed to estimate effects of Medicaid payment rates on physicians' location decisions. In other words, we did not estimate the magnitude of any increase in the number of physicians choosing to practice in rural Washington counties because of their higher Medicaid payment rates. Therefore, PADSIM estimates can be interpreted as lower bounds on the effect that increasing rural payment rates has on the availability of primary care services in rural Washington.

Policy Option: Increase the Adoption of New Practice Models, Such as Medical Homes and Nurse-Managed Health Centers

There are no national data sets that allow longitudinal or cross-sectional estimation of how increased adoption of medical homes and NMHCs would affect the supply or productivity of primary care physicians. However, we have previously estimated the effects that these two models can have on the sizes of primary care physicians' patient panels according to two surveys we conducted (Auerbach et al., 2013). Informed by these surveys, we found the ratios of providers to patients in each practice model as shown in Table 6.12.

Table 6.12. Number of Primary Care Providers per 10,000 Patients

Model	Primary Care Physicians	NPs	PAs
Status quo primary care practice	6.9	1.7	0.9
Medical home	6.1	2.2	1.5
NMHC	0.8	10.4	0

SOURCE: Auerbach et al., 2013.

Using these ratios, we estimate the increases in productivity per primary care physician, with productivity measured by panel size, associated with a 50-percent increase in the adoption of medical homes in rural Washington in 2017 (and maintaining this 50-percent increase thereafter) (see Table 6.13).

Table 6.13. Projections of Changes in Primary Care Physician Workforce Productivity and Capacity Associated with 50 Percent of Existing Rural Washington State Primary Care Physicians Adopting Medical Home Practice Models in 2017 and Additional Nurse Practitioners and Physician Assistants Required for This Level of Medical Home Adoption

			Additional Providers Required per 100,000 Population	
Year	Increase in Primary Care Physician Productivity, as a Percentage	Effective Increase in Primary Care Physician Capacity per 100,000 Population	NPs	PAs
2017	6.6	3.49	3.04	3.07
2018	6.6	3.44	3.00	3.03
2019	6.6	3.42	2.98	3.01
2020	6.6	3.40	2.96	2.99
2021	6.6	3.38	2.95	2.98
2022	6.6	3.39	2.96	2.99
2023	6.6	3.35	2.92	2.95
2024	6.6	3.33	2.90	2.93
2025	6.6	3.30	2.87	2.90

The number of new NPs required to staff such medical homes (2.87 per 100,000 population by 2025) would absorb 37 percent of the new primary care NPs (7.79 new primary care NPs per 100,000 population) expected in Washington State by 2025 under the 5-percent growth scenario and about half of the new NPs under the 4-percent growth scenario (5.38 new primary care NPs per 100,000 population), assuming that the distribution of new NPs between urban and rural areas follows historical patterns. The number of new PAs required to staff such medical homes (2.90 per 100,000 population by 2025) would absorb nearly all of the supply of new primary care PAs (3.08 new primary care PAs per 100,000 population) expected in Washington State by 2025, assuming 4-percent growth, and would exceed the available supply of PAs assuming 3-percent growth (1.84 new primary care PAs per 100,000 population), again assuming that the distribution of new PAs between urban and rural areas follows historical patterns.

We also estimated the effects on productivity per primary care physicians, with productivity measured by panel size, associated with a one-time 1-percent increase in the percentage of rural primary care physicians joining newly created NMHCs in 2017 (and maintaining this one-time 1-percent increase thereafter) (see Table 6.14).

Table 6.14. Projections of Changes in Primary Care Physician Workforce Productivity and Capacity Associated with 1 Percent of Existing Rural Washington State Primary Care Physicians Joining New Nurse-Managed Health Centers in 2017 and Additional Nurse Practitioners Required for This Level of Nurse-Managed Health Center Adoption

Year	Increase in Primary Care Physician Productivity, as a Percentage	Effective Increase in Primary Care Physician Capacity per 100,000 Population	Additional Providers Required per 100,000 Population	
			NPs	PAs
2017	7.6	4.06	6.88	None estimated
2018	7.6	4.00	6.69	None estimated
2019	7.6	3.98	6.66	None estimated
2020	7.6	3.95	6.61	None estimated
2021	7.6	3.94	6.58	None estimated
2022	7.6	3.94	6.60	None estimated
2023	7.6	3.90	6.52	None estimated
2024	7.6	3.87	6.47	None estimated
2025	7.6	3.84	6.42	None estimated

Because the NMHC is a radically different practice model, its adoption can greatly increase the reach of primary care physicians who work with NMHCs. The number of new NPs required to staff such NMHCs (6.42 per 100,000 population by 2025) would absorb nearly all the new primary care NPs (7.79 new primary care NPs per 100,000 population) expected in Washington State by 2025 under the 5-percent growth scenario and exceed the available supply of new NPs under the 4-percent growth scenario (5.38 new primary care NPs per 100,000 population), assuming that the distribution of new NPs between urban and rural areas follows historical patterns.

Because no PAs worked in the NMHCs that responded to our survey, there are no estimates of the number of additional PAs required for this scenario, if any.

Chapter Seven. Conclusions

Our analysis was not designed to determine whether primary care shortages currently exist in rural Washington, and key informants disagreed on this question. However, if there are shortages of primary care physicians and services in rural Washington, these shortages are likely to worsen in the coming decade. We estimate that the number of rural primary care physicians per capita will decrease by approximately 3.66 per 100,000 population by 2025—a 7-percent reduction from 2013 levels. By comparison, we estimate that urban areas of Washington State will experience a reduction of 4.14 primary care physicians per 100,000 population—a 5-percent reduction from 2013 levels.

These projected declines are largely driven by increases in the past two decades in the share of primary care physicians who are ages 55 years or older, many of whom will retire by 2025. This cohort of aging physicians was trained during the rapid expansion of U.S. medical schools in the late 1960s and 1970s, which was triggered by workforce provisions of Medicare and Medicaid legislation in 1965 (HRSA, 2008). Because medical school enrollment remained relatively flat from the early 1980s to early 2000s (not keeping pace with population growth), younger cohorts of physicians will not fully replace these imminent retirees on a per-population basis.

We projected the effects that six policy options could have on the supply of primary care physicians and physician services in rural Washington State through the year 2025: opening the Elson S. Floyd College of Medicine at WSU, increasing the number of primary care residency positions in Washington State (outside Seattle), increasing the availability of educational loan–repayment incentives linked to primary care practice in rural health professional shortage areas, improving the quality of high school education in rural Washington State, preserving rural hospitals in Washington State, and increasing Medicaid fee-for-service payment rates in rural Washington State. In addition, we projected the effects of increasing the supply of primary care services by reallocating work from physicians to NPs and PAs, via increased adoption of two new models of primary care in rural areas: medical homes and NMHCs.

These projections are summarized in Table 7.1. Of the policy options focusing on physicians exclusively, doubling the number of primary care residency positions outside Seattle had the greatest projected effect, covering about half of the expected decrease in the ratio of rural primary care physicians per 100,000 population by 2025. Opening the new medical school at WSU had the most modest effect. However, opening the new medical school could have greater effects in years after 2025—as could the other policy options that are unlikely to reach a steady state by 2025 (e.g., increasing the number of residency positions). But such projections become increasingly speculative over longer time periods, which is consistent with the wider CIs surrounding our models' effect estimates in later years.

Table 7.1. Summary of Projected Effects of Policy Options on Washington State's Rural Primary Care Physician Workforce in 2025

Policy Option	Scenario Detail	Predicted Effects on Rural Primary Care Physician Workforce in 2025
Open the Elson S. Floyd College of Medicine at WSU.	Sixty students enroll in 2017 and 2018; 80 students enroll per year thereafter.	The number of primary care physicians per 100,000 population increases by 0.39.
Increase the number of primary care residency positions in Washington State.	All existing Washington State primary care residencies outside Seattle expand by 100 percent in 2017.	The number of primary care physicians per 100,000 population increases by 2.00.
Increase the availability of educational loan–repayment incentives	30 new full-time primary care NHSC positions open in 2017 in rural Washington	The number of primary care physicians per 100,000 population increases by 1.03.[a]
Improve the quality of high school education in rural Washington State.	A 0.2–standard deviation increase in proficiency rates on standardized tests of mathematics and of reading and language arts.	The number of primary care physicians per 100,000 population increases by 0.80.[a]
Preserve rural hospitals in Washington State.	One rural acute-care hospital of average size is closed.	The number of primary care physicians per 100,000 population decreases by 0.87.[b]
Increase Medicaid fee-for-service payment rates in rural Washington State.	A permanent 25-percent increase in Medicaid fee-for-service payment rates in 2017.	Physician productivity increases by 1.06 primary care physician–equivalents per 100,000 population.
Increase the adoption of medical home practice models.	In 2017, 50 percent of existing rural primary care physicians adopt medical home practice models.	Physician productivity increases by 3.30 primary care physician–equivalents per 100,000 population.
Increase the adoption of NMHCs.	In 2017, 1 percent of existing rural primary care physicians join new NMHCs.	Physician productivity increases by 3.84 primary care physician–equivalents per 100,000 population.

[a] The estimate from cross-sectional model assumes that equilibrium is reached by 2025.
[b] The estimated effect occurs four years after the date of hospital closure.

We advise against simply adding the projections listed in Table 7.1 when considering how combinations of them might affect the availability of primary care services (e.g., simultaneously opening the new medical school and increasing Medicaid payments to rural primary care physicians). These policy options could be synergistic or, conversely, might interfere with each other. Our models were not designed to estimate these potential interactions.

The modest estimated increases in the number of primary care physicians per capita associated with some policy options (e.g., opening a new medical school, expanding loan-repayment positions) might be counterintuitive at first blush. After all, if a medical school produces perhaps 20 or 30 new primary care physicians per year and approximately 700,000 people live in rural Washington State, one might reasonably expect a doubling of the rural primary care workforce within a few years of the first graduating class. But this expectation rests on two key assumptions: Nearly all such graduates stay in rural Washington, and no physicians who otherwise would have practiced in rural Washington are displaced by them. Our empirical models suggest that both of these assumptions are likely to be false. Model results,

which are based on observed changes in local primary care physician supply following the opening of new medical schools elsewhere in the United States, suggest that only a small proportion of such graduates will practice in rural Washington or in Washington State at all and that, if they do, they are likely to displace some physicians who trained in other states, thus limiting their effect on the overall number of rural primary care physicians. That a new NHSC position increases the local primary care physician supply by less than one such physician has a similar likely explanation: displacement of some physicians who otherwise might have practiced in the area. In addition, providers other than physicians are eligible for NHSC primary care positions (and currently approximately 37 percent of such positions are occupied by physicians nationally) (HRSA, undated [a]).

In other words, the factors primarily responsible for relatively small numbers of primary care providers in rural counties might not be changed by expanding the number of physician trainees. These factors, including local amenities, educational quality, and payer mix, might continue to discourage physicians from practicing in counties that have, to date, had the most difficulty attracting and retaining primary care providers. Therefore, solutions that influence these factors, such as improving rural payment rates and educational opportunities, are likely to be important complements to training program expansions.

Among the policy options we estimated, increasing the adoption of medical homes and NMHCs had the greatest estimated effects on the availability of primary care services. Although these two practice models can be implemented in many ways, and with different staffing ratios from those that underlay our estimates, they are useful as examples of a general point: Reallocating primary care services from physicians to NPs and PAs, either working independently or in teams with primary care physicians, can counterbalance the projected decline in the number of rural primary care physicians. Moreover, even without taking any new policy actions, we project that Washington State will experience increases in the number of NPs and PAs per capita that are sufficient to staff these new practice models. This reallocation of primary care services might be an inevitable consequence of shifting workforce composition in the coming decade.

In sum, none of the policy options modeled in this report, on its own, will offset expected declines in access to primary care services in rural Washington by relying on primary care physicians alone. However, combinations of these strategies, or partial reallocation of rural primary care services to NPs and PAs via such new practice models as medical homes and NMHCs are plausible options for preserving the overall availability of primary care services in rural Washington through 2025.

Appendix A. Expanded Literature Review

Overview

The legislature of the state of Washington has been considering policy options to address a primary care shortage in rural areas of the state, among them a new allopathic medical school affiliated with WSU. The circumstances and impact of primary care shortage in Washington can be understood in the context of the primary care shortages projected for the United States as a whole, the current provider workforce and pipeline in the state, features of the payer and provider landscape in the state, and the efforts of other states to expand or augment their rural primary care workforces.

Primary Care Shortages in the United States

To ensure access to health care for a population, a sufficient supply of providers is required. In particular, primary care providers represent first access and a regular point of contact to the health care system; as such, adequate supply thereof represents a critical resource. Understanding how the current and future workforce of physicians—specifically, primary care providers—compare to current and future demands for health care and, specifically, primary care, in the United States is of interest to a variety of stakeholders, including state and federal governments, provider and specialty organizations, and patient groups. Accordingly, ongoing efforts to forecast the physician and primary care workforce have been relied on to inform policies influencing the supply and distribution of providers.

Projections of the adequacy of the U.S. physician workforce to meet the needs of the population have varied over time. In the 1950s and 1960s, projections of physician shortages influenced policies surrounding medical education availability and its funding, as well as the role of foreign-trained physicians. Changes in health care–delivery patterns in the 1990s traceable to significant enrollment in health maintenance organizations resulted in projections of physician surplus. In the past ten to 15 years, forecasting efforts have generally projected physician shortages in the United States, of varying impact by specialty, which have led the AAMC to encourage growth in medical school training capacity, including calling for a 30-percent increase in the number of medical school graduates in the United States in 2006 (AAMC, 2006).

Primary Care Shortage: Definitions

Various definitions exist as to what constitutes primary care shortage in the United States. Most commonly, shortages are defined either on the basis of a current local physician workforce not achieving a given target or on the basis of a future projected supply of physicians for the broader health system not appearing adequate for a projected need for services. Still, others

might argue that shortages of primary care services should be defined altogether differently from either of these common approaches, accounting more directly for the likely lack of equilibrium in the present supply and demand for primary care services, the market forces underlying varying geographic distribution of providers (i.e., varying local demand for primary care services and consequent income potential for providers), and the other features of the economic model (i.e., willingness to pay or wait for services).

With regard to current regional shortages, the most–commonly used definitions are based on the uneven geographic distribution of physicians per capita, denoting areas of shortage to be a region with fewer physicians per population than others or than a set physician-to-population ratio (varying from one physician to 1,800 to 3,500 population). In some cases, an area of shortage is simply defined as a fewer physicians per capita than a given comparator region or set of regions. However, the most commonly used official definition of regional shortage is that of HRSA, which defines its primary care HPSA on the basis of a ratio of 3,500 people per primary care physician in a specific contiguous geographic area or a ratio of one primary care physician to 3,000 population in areas of unusually high primary care needs or insufficient capacity of existing providers (HRSA, undated [e]). HRSA acknowledges that others define adequate supply using different ratios (i.e., one primary care provider to 2,000 population) and that their own definitions fail to account for the role of NPs and PAs when calculating primary care supply. As of December 2015, more than 6,000 distinct areas across the United States were designated as primary care HPSAs, corresponding to a population of greater than 60 million and a need for more than 8,000 additional primary care physicians to remove those designations from these areas and another 8,000 primary care physicians to bring the current primary care HPSAs to a ratio of one primary care physician to 2,000 population (HRSA, 2015). HRSA's medically underserved area (MUA) designation also incorporates the ratio of primary care physicians to population but without a distinct cutoff point, also incorporating population age, poverty, and infant mortality rates (HRSA, undated [e]).

Definitions of primary care shortage rooted in health system–level projections have their basis in estimates of future supply of primary care providers and the presumed ability of those providers to meet the projected health care needs of a population. The results and underlying assumptions of several such projections are discussed below.

Primary Care Shortage: Projections

A variety of groups have made projections regarding the estimated need for primary care services in the United States, each reflecting the ability that a projected supply of primary care providers has to meet the projected demand of the population for primary care services. In recent years, most projections result in a mismatch in which demand outstrips supply and accordingly forecast primary care shortages in the United States.

These primary care supply projections vary in their approach and, consequently, in their overall estimates of shortage. Most model the demand for primary care services by projecting

current demand for primary care services per capita forward in time, accounting for population growth and demographic changes, and sometimes for changes in other factors, such as rates of health insurance. Estimates of primary care supply generally begin with the current provider workforce and project forward on the basis of factors influencing workforce entry, exit, and practice volume (i.e., age, sex, medical school graduation rates, specialization rates, or full- versus part-time practice). All these projections use the balance between current supply and demand to project forward to assess for changes in that balance, most assuming at or near equilibrium at present, ultimately labeling changes as shortages where demand grows faster than supply. These estimates vary in the degree to which they assume adequacy of the current supply of providers: Some use a baseline assumption that the current supply is adequate for the present demand; others account for numbers of physicians needed to ameliorate current shortages; and few address ongoing or worsening geographic maldistribution of providers. They also vary in the degree to which their projections account for other aspects of the delivery system to influence the supply of primary care services. Below, we review several recent, commonly cited projections of primary care supply.

A 2008 analysis by Colwill, Cultice, and Kruse projected a shortage of 35,000 to 44,000 adult-care generalists in the United States in 2025, with adequate supply for pediatric care. Using National Ambulatory Medical Care Survey data as a proxy for outpatient workload, assuming that the proportion of time spent in inpatient care and the proportion of outpatient primary care delivered by NPs and PAs would remain constant over time, this analysis projected the primary care workload forward on the basis of census population projections by age and employed HRSA's physician supply model to project future supply of generalists (i.e., family practitioners, general internists, and general pediatricians) using American Medical Association (AMA) Physician Masterfile data and current graduation and specialization rates for potential-generalist residents and fellows, adjusting supply for differences in hours worked by provider age and sex (Colwill, Cultice, and Kruse, 2008).

In 2010, the AAMC projected a shortage of 30,000 primary care physicians by 2015 and 65,000 primary care physicians by 2025 in the United States, in analysis that assumed increased demand for primary care services after enactment of the ACA (AAMC, 2010). A 2012 follow-up report provided new projections downgrading estimates of shortage to 12,500 to 31,100 primary care physicians by 2025, on the basis of assumptions of an increased role for NPs and PAs, downward revision of census population projections, increased GME completion rates, and a more accurate estimate of the ACA's impact on insurance rates and demand for primary care services. These revised estimates of demand for primary care services were derived from microsimulations accounting for population characteristics (from the Census Bureau's American Community Survey [ACS], the Centers for Disease Control and Prevention, and the Census Bureau's population projections), health care use (from the Medical Expenditure Panel Survey), and staffing patterns (from the Medical Group Management Association's Physician Compensation and Productivity Survey, the American Board of Internal Medicine practice

characteristics survey, and other surveys and studies), assuming demand to be in current equilibrium, except for the number of providers required to bring primary care and mental health HPSAs out of shortage designation. They estimated supply, again using microsimulation, to project future supply of physicians for all specialties on the basis of the number and characteristics of physicians in the current workforce and those projected to enter, accounting for hours worked and retirement patterns, on the basis of data from the AMA Physician Masterfile and current rates of graduation. A variety of scenarios were projected, including ACA-related expansions in insurance, greater use of integrated care–delivery models, growth in retail clinics, variable supply of NPs and PAs, growth in GME, varying retirement age, and shorter provider work hours (Dall et al., 2015).

Others have projected primary care provider shortages of varying sizes on the basis of diverse modeling assumptions, particularly with regard to evolution in the delivery system. Petterson and colleagues projected a shortage of 52,000 primary care physicians by 2025 carrying current visit patterns forward, adjusting for population growth, demographic shifts, and expanded insurance coverage (Petterson, Liaw, et al., 2012). The National Center for Health Workforce Analysis, within the HRSA Bureau of Health Professions, also projected primary care shortages but found them to be mitigated by growth in the numbers of PAs and NPs (i.e., with rapid growth in numbers of NPs and PAs, a shortage of more than 20,000 primary care physicians nationally would be reduced to 6,400 physicians) (HRSA, 2013). Auerbach and colleagues also projected that primary care physician shortages in 2025 would be lessened by growth in numbers of PAs and NPs, as well as changes in care-delivery models (i.e., medical homes, NMHCs, and increased panel sizes), which could alleviate a significant proportion of shortages from 45,000 primary care physicians under the status quo of primary care delivery to as low as 7,000 (Auerbach et al., 2013). Microsimulation-based analyses by Green and colleagues, employing delivery system innovation assumptions regarding patient access, panel sizes, team sizes, and use of nonphysician providers and electronic communication, estimated that previously projected shortages could be eliminated (Green, Savin, and Lu, 2013). An analysis by Huang and colleagues highlights that the projected mismatch between demand for and supply of primary care after ACA implementation would likely be highly variable by geographic area; proportional demand for additional primary care providers' services that would remain unmet was projected to vary from 0 percent to 76 percent among primary care service areas, with 7 million Americans living in primary care service areas with a 10-percent primary care supply deficit (Huang and Finegold, 2013).

The considerable variability in these primary care supply and shortage estimates highlights the important role that assumptions and techniques underlying these projections can have and underscores critiques of these projections. Some argue that mechanisms for calculation of primary care workforce needs and shortages, which often rely on an assumption that the number of patients for whom a provider can care will be stable over time, is fundamentally flawed; a greater role for nonphysician providers, increased patient care outside of face-to-face encounters,

and reductions in wasteful services could all increase the potential panel size of a typical primary care provider and consequently decrease shortage projections (P. Chen, Mehrotra, and Auerbach, 2014). Others highlight that, with the growth of medical home models, NPs and PAs offer some promise to alleviate the symptoms of shortage; among primary care practices currently implementing innovative care-delivery models, panel sizes have not uniformly increased, nor have technology changes (i.e., EHRs or electronic portals) consistently resulted in decreased in-person–visit volumes (Erikson, 2013). Uncertainty regarding the primary care supply implications of these current delivery system changes and ongoing evolution is accordingly borne out in variable resulting projections of shortage.

Primary Care Shortage: Rural United States

As implied by formal geographic definitions of primary care shortage, the supply of primary care services in the United States is not evenly distributed. Although not all areas of primary care shortage are rural, a significant proportion of rural counties are formally designated as shortage areas, with 77 percent of nonmetropolitan counties classified in whole or in part as HPSAs (Miller, 2009). Moreover, the ratio of primary care physicians to population in rural areas is less than half that in urban areas (Bodenheimer and Pham, 2010). Migration of physicians in and out of rural areas appears roughly balanced over time; as such, shortages remain (McGrail, 2015).

The composition of the primary care physician workforce varies between rural and urban settings in the United States. In general, rural areas and counties with lower socioeconomic status and lower population density have more primary care physicians who are at or near retirement age than other areas have (Fordyce, Doescher, and Skillman, 2013). Physicians born in rural counties are two to four times more likely to practice in a rural community than their peers not from rural areas, but concerns have been raised about the rural public schools' ability to successfully foster future physicians to support the rural health care workforce (Brooks et al., 2002; Rabinowitz, Diamond, Markham, and Paynter, 2001; Rosenblatt, Chen, et al., 2010; Phillips et al., 2009). Rural physicians remain disproportionally male, although this is declining with time (Rosenblatt, Chen, et al., 2010; Rosenblatt and Hart, 2000; Hart, Salsberg, et al., 2002). Training-related factors also appear to influence likelihood of rural primary care practice, including having attended certain allopathic medical schools, attended an osteopathic medical school, completed a family medicine residency, or trained in a rural area (Brooks et al., 2002; Rabinowitz, Diamond, Markham, and Paynter, 2001; Rosenblatt, Chen, et al., 2010; Phillips et al., 2009; Hart, Salsberg, et al., 2002; Fink et al., 2003; Grumbach, Hart, et al., 2003; F. Chen et al., 2010; Fordyce, Doescher, Chen, et al., 2012). Although adjusted income is not less for rural primary care physicians than for other providers, hours worked and visits per week appear to be greater for rural providers (Hart, Salsberg, et al., 2002; Reschovsky and Staiti, 2005). The lower visit volumes seen on average by female providers, NPs, and PAs has raised concerns about exacerbation of rural primary care shortages because these providers make up a greater proportion of the rural health care workforce overtime (Doescher et al., 2014). Initial recruitment

and subsequent retention are both influenced by personal rural background, prior rural training, international training, service obligations, income, workload, professional environment and opportunities, family considerations, spousal employment opportunities, and community and lifestyle factors (Brooks et al., 2002; Hart, Salsberg, et al., 2002; Pathman, Konrad, Dann, et al., 2004; Rabinowitz, Diamond, Hojat, et al., 1999; Hancock et al., 2009; Kazanjian and Pagliccia, 1996; Mayo and Mathews, 2006; Pathman, Konrad, and Ricketts, 1994; Staiger, Marshall, et al., 2016).

IMGs are often cited as a critical component of the rural and underserved health care workforce. The Conrad J-1 visa waiver programs have been noted as an important means to recruit physicians to rural and other underserved positions, though rates of retention at employment sites or rural or underserved areas in general are not systematically followed nationally and have been reported to vary widely after completion of a service commitment (Patterson, Keppel, and Skillman, 2016).[7] In general however, IMGs do not appear more likely than their U.S. medical graduate (USMG) counterparts to be rural primary care providers. IMGs play a significant, albeit proportionate, role in the staffing of CAHs, representing 24 percent of admitting physicians at CAHs, in range with their overall proportion of physicians nationally (Hagopian et al., 2004). The proportion of USMGs and IMGs in nonmetropolitan HPSAs was roughly even in 2000 (2.1 percent) (Fink et al., 2003), and, although proportionally fewer IMGs than USMGs were practicing in rural areas in 2001 (10.5 percent versus 13.8 percent), among rural primary care providers, IMGs are roughly proportionately represented (19.3 percent of rural primary care physicians and 22.2 percent of the clinically active U.S. workforce) and, of rural primary care providers, are more likely to be located in HPSAs (75.7 percent versus 67.2 percent) (Rosenblatt, Chen, et al., 2010; Fordyce, Doescher, Chen, et al., 2012; Hart, Skillman, et al., 2007).

Overall, approximately 20 percent of NPs and PAs practice in nonmetropolitan areas (Hart, Salsberg, et al., 2002), but rates of rural practice among nonphysician providers varies widely by state, with as few as 10 percent of NPs identified as practicing in rural areas in Arizona and Texas and as many as 40 percent in Kentucky and 60 percent in Vermont (Skillman, Keppel, et al., 2015). In Washington and California, NPs, PAs, and certified nurse midwives were disproportionately practicing in rural areas (Grumbach, Hart, et al., 2003). Overall numbers of NPs per capita are lower in rural areas than in urban ones, but rural NPs are more likely to be working in primary care settings, working more hours, and reporting greater professional autonomy (Spetz, Skillman, and Andrilla, 2016). Although research has found NPs to be more represented in the primary care workforce in rural areas than in urban ones and more accessible

[7] The Conrad program, named for Sen. Kent Conrad of North Dakota, who sponsored the legislation creating it in 1994, allows "each State's Department of Health to sponsor up to a certain number (initially 20, and now 30) international medical graduates (IMGs) each year for a waiver of the two-year home residency requirement of the physician's J1 visa" (Sherman Immigration Lawyers, undated).

on the whole in states with less restrictive scope-of-practice laws, these laws did not appear to make NPs more likely to locate in rural or low-access areas (Graves et al., 2016). Additionally, although the likelihood of PAs to practice in rural or underserved areas is greater than that of physicians, it appears to be declining over time (Shaffer and Zolnik, 2014). NPs and PAs have been seen as a means to meet increased rural primary care demand created by increased rates of insurance among rural patients as a result of the ACA (Larson et al., 2016).

Primary Care Shortage: Implications

A substantial literature has been devoted to understanding the implications of the supply of primary care services for the health and health care of patients. Starfield and colleagues found that a greater supply of primary care providers across a variety of geographic areas was associated with improved health outcomes (e.g., mortality), increased receipt of preventive health care (e.g., earlier detection of some cancers), partial amelioration of some of the health and health care disparities traceable to income inequality, and lower health care costs (Starfield, Shi, and Macinko, 2005). A subsequent meta-analysis assessing the impact of increased primary care physician supply per capita found that increased primary care physician supply was associated with improvement in a variety of health outcomes (i.e., all-cause, cancer, cardiovascular, stroke, and infant mortality; low birth weight; life expectancy; and self-rated health); pooled results indicated an average mortality reduction of 5.3 percent for every additional primary care physician per 10,000 population (Macinko, Starfield, and Shi, 2007).

The literature has also addressed relative supply of primary care physicians and specialist physicians. The health outcome improvements in areas with greater supply of primary care providers per capita have not been found for areas with greater specialist supply (Starfield, Shi, Grover, et al., 2005). Other studies have found that a greater proportion of the physician workforce devoted to primary care providers, instead of specialists, has been associated with increased quality, decreased utilization, and lower costs (Baicker and Chandra, 2004; Welch et al., 1993; Kravet et al., 2008).

Additional research has addressed associations between primary care supply and more-proximate outcomes reflecting access to and utilization of health care services. A small body of literature has assessed the effect that physician supply has on direct access to health care services; most found no associations between local physician supply, including primary care physicians, and access to care, suggesting that other patient, regional, or delivery system factors might play a role in patients' ability to access needed health care services (Pathman, Ricketts, and Konrad, 2006; Kirby and Kaneda, 2006; Litaker, Koroukian, and Love, 2005; Grumbach, Vranizan, and Bindman, 1997). However, in a small West Virginia study, HPSA residents reported worse health status and access to medical services than residents of areas without HPSA designations, and, in a nationwide study, Medicare beneficiaries living in HPSAs were less likely than beneficiaries living elsewhere to get needed services (Asch et al., 2000; Liu, 2007).

Evidence regarding the effect that physician supply, including primary care physicians, can have on access to visits and needed services (Pathman, Ricketts, and Konrad, 2006; Kirby and Kaneda, 2006; Litaker, Koroukian, and Love, 2005; Grumbach, Vranizan, and Bindman, 1997; Asch et al., 2000; Liu, 2007), ambulatory care–sensitive hospital admissions (Ricketts et al., 2001; Laditka, Laditka, and Probst, 2005; Parchman and Culler, 1994; Laditka, 2004; Chang, Stukel, et al., 2011; Basu, Friedman, and Burstin, 2002), and ED visits (Richman et al., 2007; Gresenz, Rogowski, and Escarce, 2007; Chang, O'Malley, and Goodman, 2016) is mixed, with some studies showing no association (Kirby and Kaneda, 2006; Litaker, Koroukian, and Love, 2005; Grumbach, Vranizan, and Bindman, 1997; Ricketts et al., 2001) and others showing worse access (Pathman, Ricketts, and Konrad, 2006; Asch et al., 2000; Liu, 2007), more admissions (Chang, Stukel, et al., 2011; Basu, Friedman, and Burstin, 2002), or more ED visits (Richman et al., 2007; Gresenz, Rogowski, and Escarce, 2007; Chang, O'Malley, and Goodman, 2016) with fewer physicians. Associations between primary care supply and costs are also mixed, with some finding lower costs in areas of higher primary care supply (Starfield, Shi, and Macinko, 2005; Baicker and Chandra, 2004; Welch et al., 1993), others finding higher costs (Chang, Stukel, et al., 2011), and another study finding no impact on cost growth (Chernew et al., 2009). These mixed findings might stem from inconsistent relationships between primary care workforce headcounts and patients' true access to the main functions of primary care: first-contact care for new health problems, comprehensive care for the majority of health problems, long-term person-focused care, and care coordination across providers (Starfield, Shi, and Macinko, 2005; Friedberg, Hussey, and Schneider, 2010).

Although the per capita supply of primary care providers appears to have implications for the health and health care of a population, it is important to acknowledge that per capita numbers only represent one dimension of the primary care supply. Increased numbers of providers alone might not be sufficient to achieve the full benefits of primary care in a health system; efforts to increase supply would ideally be coupled with policies that enhance providers' ability to serve as a usual and comprehensive source of care to a panel of patients and to augment the primary care orientation of the health system at large (Friedberg, Hussey, and Schneider, 2010).

Primary Care in Washington State

The Primary Care Workforce in Washington State

The Physician Primary Care Workforce

A University of Washington Center for Health Workforce Studies analysis of 2014 AMA Physician Masterfile data for Washington defined a workforce of 19,260 physicians (275 per 100,000 population), of whom 15,421 were providing direct patient care, corresponding to 220 physicians per 100,000 population, roughly comparable to national levels. The ratio of generalists to population in the state was 79 per 100,000, higher than the national rate of

66 primary care providers per 100,000. The mean age of generalists in Washington was 50.1 years, and 37.5 percent of physicians in the state were ages 55 and older (Skillman and Stover, 2014).

Data from the AAMC defined Washington's 2014 physician workforce in a similar range, with 18,975 active physicians, of whom 7,002 were primary care physicians, corresponding to 239.1 physicians per 100,000 population, of whom 99.2 were primary care physicians (both above the national medians of 225.6 and 90.4, respectively) (AAMC, 2015).

A survey of the state's primary care workforce in 2011 revealed that primary care physicians averaged 50.1 years of age and 15.3 years in practice and that 20.6 percent were planning to retire within the next five years. Full-time primary care physicians in Washington average 36.7 hours per week in direct patient care (out of 45.8 total hours worked), of whom 84.9 percent report that all or most of this time is spent in primary care; the mean and median panel sizes for a full-time provider (or number unique patients seen in a year) were 1,764 and 1,500, respectively. Of the primary care physicians in the state, 78 percent are accepting new patients, among whom 69.8 percent would be willing to accept some fraction of those patients as Medicaid patients (this willingness varies by region, however) (Skillman, Fordyce, et al., 2012).

The Nonphysician Primary Care Workforce in Washington State

For all advanced-practice registered nurses (NPs, certified nurse midwives, and certified registered nurse anesthetists), the number with active licenses has increased from 2,835 in 2004 to 5,158 in 2016; the average age of these providers has remained roughly steady at approximately 50 years; and the distribution is uneven across the state (varying from 49 per 100,000 population in a western rural region to 108 per 100,000 population in the Spokane region), with 6.1 percent of NPs practicing in rural areas, which have 8.5 percent of the state's population (Andrilla and Skillman, 2016).

With regard to primary care NPs' practice patterns, the previously cited survey of the state's primary care workforce in 2011 revealed that primary care NPs had an average 49.9 years of age and 11.7 years in practice and that 22.6 percent were planning to retire within the next five years. Full-time primary care NPs in Washington averaged 30.3 hours per week in direct patient care (out of 36.2 total hours worked), of whom 83 percent report that all or most of this time is spent in primary care; the mean and median panel sizes for a full-time provider were 1,621 and 1,000, respectively. Of the primary care NPs in the state, 85.4 percent are accepting new patients, among whom 82.2 percent would be willing to accept some fraction of those patients as Medicaid patients (Skillman, Fordyce, et al., 2012).

With regard to primary care PAs, the same survey revealed that primary care PAs in Washington averaged 47.8 years of age and 12.0 years in practice and that 18.5 percent were planning to retire within the next five years. Full-time primary care PAs in Washington average 35.1 hours per week in direct patient care (out of 40.1 total hours worked), of whom 91.9 percent report that all or most of this time is spent in primary care; the mean and median panel sizes for a

full-time provider were reported to be 1,873 and 1,329, respectively. Of the PAs in the state, 79.4 percent are accepting new patients, among whom 85.6 percent would be willing to accept some fraction of those patients as Medicaid patients (this willingness varies by region, however) (Skillman, Fordyce, et al., 2012).

The Primary Care Workforce Pipeline in Washington State

Undergraduate Medical Education

In 2014, Washington had 20.3 enrolled MD and DO medical students per 100,000 population, of whom 36.8 percent matriculated from within state (both below the state medians nationally of 30.4 and 69.2 percent, respectively). Washington retained 43.9 percent of physicians in state from undergraduate medical education, which was above the state median nationally of 38.6 percent (AAMC, 2015).

The extant allopathic medical school in Washington is the University of Washington School of Medicine, which defines itself via a multifaceted mission of serving as a research and technology center via its academic medical center but also seeking to supply the region's health care workforce, emphasizing primary care and care of the underserved (University of Washington Medicine, 2011). The 2015 entering class consisted of 245 students, of whom 228 were WWAMI-region residents; with regard to applicants, 1,316 in-region applicants applied and 254 were accepted, as compared with 6,724 out-of-region applicants, of whom 36 were accepted (University of Washington Medicine, 2011). Of the 217 members of the 2015 graduating class, 130 graduates (60 percent) entered primary care fields (family medicine, internal medicine, or pediatrics); 37 percent entered residency programs in the WWAMI region (33 percent within Washington); and more than one-third of the students whose initial sites were in Spokane matched into Spokane-based residency programs (Blakeley, 2015). Among physicians actively practicing in Washington, 14.7 percent graduated from the University of Washington School of Medicine (18.4 percent of generalists, 15.7 percent of obstetrician/gynecologists, and 16.2 percent of psychiatrists) (Skillman and Stover, 2014).

In addition to its focus on training regional students, the University of Washington School of Medicine has several curricular features designed to enhance student interest in primary care, rural medicine, and underserved care. The University of Washington School of Medicine's WWAMI program features a unique medical school training model with preclinical years split between home-state campuses and the main campus in Seattle, with clinical years at a broad array of locations across the five states, and uses recruitment and specialized tracks to foster student interest in rural and underserved communities. The WWAMI program medical students have greater-than–national average entry into primary care residencies, plans to practice in rural or underserved sites, and rates of return to practice in their home states or WWAMI states in general (Allen et al., 2013). The University of Washington School of Medicine also features a

longitudinal curricular focusing on rural health care (Targeted Rural Underserved Track) program based in a continuity community in which students spend a minimum of 23 weeks to support interest in caring for underserved patients; program participants have been shown to have greater rates of entry into primary care residencies, high rates of entry into residencies of regional need, and a 50-percent matriculation rate at residencies within the WWAMI region (Kost et al., 2014; Greer et al., 2016). In addition, the medical school offers several elective experiences to enhance and support interest in rural and underserved medicine: Rural/Underserved Opportunities Program, which provides a four-week elective immersion in community medicine between the first and second years of medical school; WWAMI Rural Integrated Training Experience, a 20-week rural clinical medical training experience for a selected group of third-year medical students; and WWAMI Track Program, which allows a select group of students to complete most of the required clerkships in one specific state or site throughout the WWAMI region in their third or fourth years (University of Washington Medicine, undated).

PNWU is a nonprofit, independent osteopathic medical school that opened in Yakima in 2008. For the 2014–2015 academic year, the total enrollment was 430 medical students, with a first-year class size of 140; the school recently doubled class sizes. In the class of 2019, 67 percent of the students are from the five-state catchment area (Washington, Alaska, Idaho, Montana, and Oregon [47 percent from Washington]), and nearly one-third are from rural or underserved areas (31 percent rural, 32 percent HPSA, and 30 percent MUA). The school employs a model using community-based hospitals and physician preceptor clinics in regional campuses throughout the northwest, and, although residency placements have varied from year to year, more than 40 percent of the graduating class placed into primary care specialties (26.8 percent family medicine, 11.3 percent internal medicine, and 5.6 percent pediatrics) (PNWU, undated).

Graduate Medical Education in Washington State

According to the AAMC, in 2014, Washington had 1,873 residents and fellows in ACGME-sponsored programs, or 26.5 per 100,000 population, ranking slightly below the state median nationally of 27.4 GME trainees per 100,000 population. There were 9.9 residents and fellows per 100,000 population in ACGME primary care programs in 2014, below the state median nationally of 10.3 per 100,000 population (AAMC, 2015).

For the 2015–2016 academic year, Washington had 22 institutions sponsoring 71 residency programs with 1,643 residents, which had increased in the past five years from 63 programs with 1,417 residents (ACGME, 2015). According to the NRMP, for the 2015–2016 academic year, Washington had 400 first-year slots available in the match for residency positions, of which 220 were for primary care specialties (NRMP, undated). In 2015, 28 postgraduate year 1 positions were available in the American Osteopathic Association (AOA) match, all in primary care

specialties (AOA, 2015). Changes in NRMP match policies in 2013 (with spots “outside the match” now included) make it difficult to trend numbers of resident physicians over time.

In 2012, Washington received $117 million in Medicare GME funding (Robert Graham Center, undated). An analysis of 2010 national GME payment data revealed that Washington ranked 38th nationally in GME funding per population (Mullan, Chen, and Steinmetz, 2013). The state government contributes another $111 million in Medicaid GME funding annually, applying payments through both its fee-for-service programs and managed care payments following Medicare’s methodology for GME payments; this amount ranks in the top ten states for cumulative Medicaid GME payments (AAMC, 2013).

The University of Washington is the largest sponsor of GME in the region, with 1,335 trainees in 25 residencies and 80 clinical fellowship programs accredited by ACGME or approved by the American Board of Medical Specialties and more than 100 additional clinical fellows in nonaccredited programs (University of Washington Medicine, 2015). Many of the Seattle-based programs offer rural rotations, and the affiliated Family Medicine Residency Network features specific rural training tracks (Allen et al., 2013).

The Family Medicine Residency Network and its rural training tracks are a segment of the state’s GME specifically aiming to contribute to the state’s rural primary care workforce; however, these programs are limited in size and face challenges in funding and logistics. The Family Medicine Spokane Rural Training Track, in particular, although successful in retaining residents as attending physicians in rural sites (77 percent of graduates), faced additional challenges in logistical sustainability (i.e., not enough faculty, facilities, or financial resources to comply with the ACGME requirement to take a resident each year or to meet the obstetric continuity requirement) that ultimately prompted closure of four of the five sites. These family medicine rural training tracks are community-based, ambulatory training programs and accordingly have faced challenges with regard to financial sustainability because they are not based at academic medical centers through which GME funding typically flows and because they have widely variable net costs per resident trained (Lesko, Fitch, and Pauwels, 2011; Maudlin and Newkirk, 2010).

Owing to a provision of the ACA, a new mechanism of funding for ambulatory-based primary care training called Teaching Health Centers is recently available. These ambulatory practice–based primary care medicine and dentistry residency training programs receive direct funding from HRSA (rather than through hospital-based programs, as is the case with Medicare GME funding) to support primary care at community-based clinical training sites with a focus on the underserved; 75 percent of Teaching Health Centers are FQHCs or FQHC look-alikes, and other sites include community mental health centers, RHCs, Indian Health Service or tribal clinics, and Title X clinics (family planning clinics) (HRSA, undated [f]).[8] Washington is home

[8] *Title X* refers to Title X of Pub. L. 91-572, 1970.

to six Teaching Health Centers (HealthPoint Auburn in Auburn, Community Health Care's Hilltop Family Medical Center in Tacoma, Central Washington Family Medicine in Yakima, Puyallup Tribal Health Authority in Tacoma, Spokane Teaching Health Clinic in Spokane, and Yakima Valley Farm Workers Clinic in Toppenish) (HRSA, undated [f]; Ku et al., 2015).

According to the AAMC, Washington retained 48.5 percent of physicians in state who completed their GME there and 70.2 percent of those who completed both undergraduate and graduate medical education in state (AAMC, 2015). Per a University of Washington Center for Health Workforce Studies analysis of 2014 AMA Physician Masterfile data, 32.2 percent of Washington physicians completed their residencies in the state (38.2 percent of generalists, 18.4 percent of obstetrician/gynecologists, and 43.1 percent of psychiatrists) (Skillman and Stover, 2014). This varies by region, with 20 percent of eastern Washington physicians having completed residency in the state but more than 33 percent of western Washington physicians having completed residency in the state (Skillman and Stover, 2014).

International Medical Graduates

A separate source of physicians for the physician workforce of Washington are IMGs, representing 14.1 percent of actively practicing physicians in the state, below the state median of 18.7 percent nationally (AAMC, 2015). J-1 visa waiver programs offer a mechanism to draw IMGs to underserved locations by waiving the two-year residence requirement of the J-1 exchange visitor program for physicians who are willing to commit to a period of employment at health care facilities in HPSAs or MUAs. A survey of recipients of J-1 visa waivers in Washington between 1995 and 2003 found that 84 percent of waiver recipients stayed with their employers an average of two years longer than the required three-year commitments for primary care waiver recipients or five-year waiver commitments for specialists; 57 percent remained in Washington when surveyed; and 91 percent were practicing in urban areas (63 percent had been assigned to urban areas for their waiver commitments) (Kahn, Hagopian, and Johnson, 2010).

Nonphysician Primary Care Workforce Training

The University of Washington MEDEX Northwest Physician Assistant Training program, founded in 1969, has a stated mission to contribute to the training of the primary care workforce in the WWAMI region and Nevada, using a decentralized didactic and clinical training system with sites in Seattle, Spokane, Tacoma, and Anchorage. For the 2014 entering class of 116 master's and bachelor's program students, 80 percent are WWAMI-region residents (66 percent from Washington or Alaska) (University of Washington School of Medicine, undated). A survey of graduates of the first 32 graduating classes (through the year 2000) revealed that 54 percent were working in primary care, 30 percent were working in nonmetropolitan communities, and 42 percent were providing care for the medically underserved (Evans et al., 2006). A new PA training program at Heritage University in Yakima received

provisional accreditation in 2016 and planned to graduate its first class of 32 students in 2016 ("Heritage University Physician Assistant Program Receives Accreditation," undated).

Six institutions in Washington offer NP training: Gonzaga University and WSU in Spokane; Pacific Lutheran University in Tacoma; and Seattle Pacific University, Seattle University, and the University of Washington in Seattle. Class sizes, graduates' practice specializations, and graduates' practice locations for these NP training programs are not systematically reported.

Provider Incentive Programs in Washington State

In addition to federal NHSC loan-forgiveness programs for health care providers (including physicians) willing to commit to a period of employment in HPSA areas, Washington has traditionally offered state-based loan-repayment programs to attract providers to underserved communities. Washington offers a joint Federal–State Loan Repayment Program, which uses matching federal grant funds to provide a maximum award of $70,000 for a two-year employment contract at an eligible site, as well as the Health Professional Loan Repayment Program funded by the state alone, which provides a maximum award of $75,000 for a three-year employment contract with an eligible site (Washington Student Achievement Council, undated). It is possible to renew or participate in more than one program.

Washington State–Specific Estimates of Shortages

Although the per capita numbers of physicians and generalists in Washington are comparable to national averages, the physician supply is not evenly distributed, with rural areas having fewer physicians per capita and older physicians on average (Skillman and Stover, 2014). As of December 2015, Washington had 154 primary care HPSAs designated on the basis of geography (27), population (30), and facilities (97), which encompass a population of 1,291,074, in which 45.59 percent of the need for primary care providers was met and a total of 229 primary care practitioners would be needed to remove the designation from these areas (HRSA, undated [c]). There are 47 designated MUAs and medically underserved populations in the state (HRSA, undated [c]). Washington-specific projections of primary care shortages are more limited than national projections. However, the Robert Graham Center used the Medical Expenditure Panel Survey, the AMA Physician Masterfile, and census data to predict a 1,695-physician shortage by 2030 in Washington and noted a primary care physician–to-patient ratio of 1:1,370, which is lower than the national average (Petterson, Cai, et al., 2013). A more conservative estimate of the gap between the projected number of MD graduates and the projected number of MD job openings in the state between 2017 and 2022 from the state's Employment Security Division found a shortfall of 118 physicians, on the basis of recent trends and national averages (Health Workforce Council, 2014).

In a report of focus groups of Washington physicians that addressed their perspectives on increasing access to primary care, these physicians reported feeling that perceptions of inferior social status and prestige coupled with lesser earning potential discouraged entry into primary

care but that changes in medical school recruitment and emphasis, mentoring of young physicians, and medical home structure and payments could improve interest in and sustainability of primary care careers in the state (Matthews and Mounts, 2012).

The Rural Primary Care and Workforce in Washington State

The Rural Washington State Primary Care Landscape

Compared with urban areas of the state, rural Washington has a population with greater age extremes, is more rapidly shifting in terms of racial diversity, has lower per capita income and household income, has a higher poverty rate, and has lower rates of educational attainment. Rates of smoking, obesity and mortality due to heart disease, accidents, and suicide are all higher in rural areas of the state. Compared with urban areas, hospitals in rural areas of Washington get a greater percentage of their revenue from Medicare (50.08 percent versus 37.59 percent), similar amounts from Medicaid (15.55 percent versus 16.91 percent), and less revenue from private payers (27.35 percent versus 38.57 percent) (Washington State Hospital Association, 2012). All of these features influence demand for primary care services in rural Washington.

Washington's rural health care landscape includes a variety of provider types. There are 26 HRSA FQHC grantees and one FQHC look-alike collectively operating 263 service delivery sites (of which 79 are in rural settings), 118 RHCs, 39 free clinics (11 in rural settings), 39 CAHs, and three sole community hospitals in Washington (Washington State Hospital Association, 2012; HRSA, undated [b]; HRSA, undated [d]; Washington State Department of Health, 2015). There are also six Indian Health Service clinics in the state and 62 tribal health centers or stations serving 29 federally recognized tribes in the state (Indian Health Service, undated). The local health care governance of Washington includes 56 public hospital districts, which operate hospitals, emergency services, clinics, and other local health care provisions and are governed by boards of citizens within the districts, as well as 35 local health departments and districts, which are local government agencies that are responsible for public and population health tasks as defined by statute and local priorities (Washington State Hospital Association, 2012).

Despite a broad array of enhanced payments available to the various provider organizations that make up the rural health care landscape, providers in rural Washington, like elsewhere in the rural United States, face challenges in recouping maximal reimbursement for the services they deliver: Common services provided at CAHs (i.e., hospital-based physician services, ambulance services, and charity care) are not considered allowed costs; primary care providers can, in some cases, provide enough specialty services that they might be disqualified for HPSA-bonus payments; and primary care providers have limited ability to cost-shift because of their low rates of private insurance (Washington State Hospital Association, 2012). Additional financial challenges that rural providers face include Medicaid recoupment and reconciliation delays,

which contribute to instability and budgeting challenges for FQHCs and RHCs, and challenges to health information technology affordability for smaller rural health care entities (Rural Health Work Group, 2014). In addition to financial challenges, other rural infrastructure hurdles exist, including a paucity of transportation (i.e., lack public transportation, limitations in largely volunteer-staffed emergency medical service capacity) and workforce challenges (e.g., difficulty recruiting and retaining primary care physicians, licensing challenges hindering rural practice for PAs, lack of mental health providers) (Rural Health Work Group, 2014).

Composition of the Washington State Rural Primary Care Workforce

According to analyses from the University of Washington Center for Health Workforce Studies, physician workforce characteristics vary across Washington, with fewer physicians in rural than urban areas (117 versus 236 physicians and 57 versus 82 generalists per 100,000 population) and fewer physicians in eastern counties than western counties (181 versus 231 physicians and 70.1 versus 81.0 generalists per 100,000 population), and older physicians in the most-rural counties (Skillman and Stover, 2014).

The distribution of primary care provider types varies across rural and urban parts of the state. An analysis of the AMA Physician Masterfile, California and Washington licensing information, and survey data demonstrates that, in both states, greater proportions of PAs than NPs and physicians practiced in rural settings (with 28 percent of PAs in Washington located in rural counties) and that family physicians were the most likely physician specialty to be practicing in rural Washington (Grumbach, Hart, et al., 2003). Although the King County region has the highest per capita number of primary care physicians in the state (11.2 per 10,000 population), the Spokane region has the highest per capita rate of NPs (3.8 per 10,000 population), and the highest rates of PAs are found in rural areas of eastern Washington (2.4 to 1.8 per 10,000 population in the combined workforce development areas in the eastern part of the state, excluding Spokane and Franklin and Benton counties) (Skillman, Fordyce, et al., 2012). Mental health providers are also unevenly distributed throughout the state. An analysis of 1998–1999 Washington State Department of Health licensing data revealed three times as many psychiatrists and 1.5 times as many nonpsychiatrist mental health providers in urban areas of Washington as in rural ones (Baldwin et al., 2006). Another study revealed twice as many psychiatrists in western Washington counties as in eastern (10.9 versus 5.1 per 100,000 population) (Skillman and Stover, 2014). Limited access to substance-abuse treatment has also been noted to be a problem within rural Washington, with uneven access to opiate treatment services especially in the most-rural areas and those not served by federally subsidized safety-net clinics, with providers citing lack of institutional, insurer, psychosocial, behavioral health, or colleague support as barriers (Kvamme et al., 2013; Hutchinson et al., 2014; Quest et al., 2012).

Health Care–Seeking Patterns for Primary Care in Rural Washington State

The care-seeking patterns in rural Washington and the distribution of providers there are mutually influential. Although patients in urban and large rural areas remain in their own community for the majority of their care, those in small rural areas travel to either large rural or urban areas for care a majority of the time (Rosenblatt, Baldwin, et al., 2001). An analysis by the WWAMI Rural Health Research Center modeling physician income in rural areas across Washington found that current distributions of physicians were associated with predicted income potential, and the authors concluded that, although some communities had sufficient demand for health care services to support enough additional physician income, other communities, especially those in HPSAs, could not (Wright, Andrilla, and Hart, 2011).

Medicaid in Washington State

Apple Health is Washington's Medicaid program and provides health care coverage for 1.7 million adult and child beneficiaries in the state, including the more than 500,000 beneficiaries who have gained coverage since the ACA's Medicaid expansion (Washington State Health Care Authority, undated [a]; Assistant Secretary for Public Affairs, 2015). Most Medicaid enrollees in Washington (88 percent) are enrolled in managed care plans, for which Apple Health contracts with five commercial managed care organizations (Henry J. Kaiser Family Foundation, 2014). In 2013 and 2014, Medicaid reimbursement rates for eligible primary care physicians were increased to Medicare service levels; absent continuing federal or state-level funding, this rate bump expired in 2015. As of 2015, the Medicaid-to-Medicare fee index in Washington was 0.74 (national average of 0.66) and, for primary care services, was 0.64 (national average of 0.59) (Zuckerman, Skopec, and McCormack, 2014).

An analysis of physician surveys and focus groups assessing options to expand Medicaid participation in Washington found broad participation in Medicaid but that few physicians serve large numbers of Medicaid patients (only 14.6 percent reported panels with more than 50 percent Medicaid) and that those physicians accepting new Medicaid patients were more likely to practice at FQHCs, RHCs, or community health centers (S. Long, 2013). Although physicians reported Medicaid reimbursement rates as a problem, administrative burdens, complexity of patients' needs, and limited access to specialists were all noted as disproportionate problems with Medicaid versus commercial insurance (Matthews and Mounts, 2012; S. Long, 2013).

Washington uses CAHPS surveys to assess access to care among Medicaid beneficiaries in the state. In 2014, when compared with National Committee for Quality Assurance national benchmarks, Washington's adult Medicaid program's CAHPS composite measures (reflecting access to care) were rated below the 25th percentile for getting needed care and at the 25th to 49th percentile for getting care quickly (Washington State Health Care Authority, 2014). For the children's Medicaid programs, both the composite CAHPS measures reflecting access to care (i.e., getting needed care and getting care quickly) were rated below the 25th percentile for

National Committee for Quality Assurance national benchmarks (Qualis Health, 2015). These measures reflect underlying regional variation in access to care for Medicaid patients. A 2012 report from the state Office of Financial Management addressing access to care for the predicted 375,000 new Medicaid-covered lives (ultimately found to be an underestimate) revealed adequate availability of primary care physician accepting new Medicaid patients at the state level but with underlying significant shortfalls in one urban and several rural regions (some with only 20 percent of the predicted capacity required) (Yen and Mounts, 2012).

Recent Policy Interventions to Address the Primary Care Shortage in Rural Washington State

A New Allopathic Medical School

During the 2015 session, the Washington legislature changed a long-standing state law that had given the University of Washington the sole authority to operate a public medical school in the state and funded $2.5 million in start-up costs for a new medical school at WSU. In the same legislative session, the University of Washington received $9 million in funding for 2015–2017 to expand its extant WWAMI rural education program based in Spokane from 40 to 60 students per year, now in partnership with Gonzaga University rather than WSU (“Washington State Moving Ahead with Medical School,” 2015; Zak, 2015b; Zak, 2015c).

Plans for a Washington State University Medical School

The planned new WSU medical school has hired a dean and is in the process of pursuing Liaison Committee on Medical Education accreditation with the goal of receiving provisional accreditation in the spring of 2018 and full accreditation in the fall of 2020. The school hopes to begin teaching its first class of students in fall 2017, with anticipated class sizes of 40 to 60 students per year for the first two years and 80 students per year thereafter.[9] The school plans to employ a community-based medical education model with clinical training sites in Spokane, the tri-cities, Vancouver, and Everett (WSU, undated).

Stakeholder Opinions

Local experts in higher and medical education have expressed mixed opinions regarding the new medical school. Some questioned the costs of opening a new medical school versus expanding the University of Washington’s WWAMI program (Lied et al., 2002). Others noted that adding medical students might have limited effects on physician supply in rural Washington, noting that the number of residency positions and limited income potential were more-important

[9] Email communication with John Tomkowiak, founding dean of the Elson S. Floyd College of Medicine at WSU, April 19, 2016.

barriers to rural practice (K. Long, 2014). Proponents of the new medical school reported that the state's relatively low total medical student enrollment and perceived primary care shortages made a strong case for the new school (Mroch and Graham, 2014).

Residency Funding

In another effort to increase the number of providers in the state's workforce pipeline, the 2015 legislative session in Washington expanded state residency funding, allocating $24.4 million in support of the state's primary care GME program, opening up 117 WWAMI Family Medicine Residency Network slots and expanding the number of psychiatry residency slots at the University of Washington (Lied et al., 2002; K. Long, 2014; Mroch and Graham, 2014). The legislature also created a new governance structure for the WWAMI Family Medicine Residency Network, enabling additional medical schools to join, and provided assistance for osteopathic residency programs to meet ACGME unified standards to allow the osteopathic programs to be part of the network (Washington State Medical Association, 2015; University of Washington School of Medicine, 2015). The state's Health Workforce Council, however, recognizing that funding might not be the only barrier to expansion of the number of residency slots, recommended creating a workgroup to explore concomitant administrative barriers (Health Workforce Council, 2014).

Loan-Forgiveness Programs

The budget for the state-only–funded Health Professional Loan Repayment Program was cut in 2011, from $8.7 million to just over $1 million per biennium, which prompted lobbying by the Community Health Network of Washington, the Washington Association of Community and Migrant Health Centers, the state Health Workforce Council, Washington State Medical Association, and others to restore funding, in light of community health centers' reliance on this program to recruit clinical staff (Health Workforce Council, 2014; Community Health Network of Washington and Washington Association of Community and Migrant Health Centers, 2014). In the 2015 legislative season, $9.6 million was ultimately allocated to the program, an amount that surpassed the requested allocation by more than $1 million (Washington State Medical Association, 2015).

Medicaid Payment Increases

Washington provided enhanced payment for primary care services provided to Medicaid patients in 2013 and 2014, with Medicaid reimbursement rates equaling those for Medicare, owing to a provision in the ACA in which the federal government covered the full cost of this increase. Estimates of the fee increases seen by physicians for Medicare reimbursement at this time varied from 52 percent over the 2009 rates to 70 percent for child services and 80 percent for adult services (Patterson, Andrilla, et al., 2014). Though the governor's budget allocated $79 million in state general funds to extend the program and potentially enhance access to

primary care for Medicaid patients in the state, the legislature's budget ultimately did not continue the enhanced Medicaid reimbursement (Washington State Medical Association, 2015).

Prior to this legislative outcome, a variety of groups investigated the implications of enhanced Medicaid reimbursement in the state. A survey of primary care physicians showed inconsistent awareness of the payment increases and whether one's practice had received them, and a greater impact of the rate increases on the willingness to see additional Medicaid patients among self-employed physicians or those with a majority Medicaid panel. Many physicians (73.5 percent) reported that, if Medicaid reimbursement rates were to revert to pre-2013 levels, they would restrict access; this was less true for rural physicians, those with majority-Medicaid panels, and those not self-employed or in private practice (Patterson, Andrilla, et al., 2014).

Telehealth

The 2015 state legislative session also marked the enactment of a telehealth parity law; insurers in the state are required to reimburse services provided through telemedicine and store-and-forward technology if the plan covers the service when delivered in person, the service is medically necessary, and the service is recognized as an essential health benefit under the ACA.[10] This established visit-based criteria for billing for these services, as well as conditions for the credentialing of providers of telehealth services in the state (Washington State Medical Association, 2015; Peisch, 2015). The bill and effort had been supported by the Washington State Medical Association and touted as a mechanism to increase access for rural patients and those in areas of primary care shortage, as well as to reduce costs (Zak, 2015a). The state's Rural Health Work Group and Health Workforce Council had previously identified telehealth as a priority for the rural health care network and identified policy, infrastructure, and logistical steps that would be required to support broad implementation (Health Workforce Council, 2014; Rural Health Work Group, 2014).

Medical Home Models and Increased Complementary Services for Primary Care Practices

Washington has seen a variety of initiatives surrounding the implementation of medical homes, which could enhance and augment primary care delivery by the existing workforce. State legislation in 2008 and 2009 established a learning collaborative for practices engaging in medical home transformation and several reimbursement pilot projects, including a multipayer medical home demonstration project that provided a $2.50-per-member-per-month care-management fee and shared-savings incentives, incorporating five commercial and two Medicaid health plans and eight primary care groups (Patient-Centered Primary Care Collaborative,

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[10] Store-and-forward technology allows "for the electronic transmission of medical information. . . through secure email transmission" (Center for Connected Health Policy, undated).

undated; Washington State Health Care Authority, undated [b]). The state has additional engagement in formal medical home efforts via legislation specifying that direct primary care medical homes must be integrated within an issuer's qualified health plans for the state Health Benefit Exchange, as well as participating in the Medicaid health home program (Patient-Centered Primary Care Collaborative, undated). The Washington Healthcare Improvement Network offers support for practices to develop and strengthen medical homes, managing patients with multiple chronic conditions, improving care transitions, and providing assistance for providers collaborating with primary care practices (behavioral health teams, case managers or care coordinators, pharmacists, naturopathic doctors, and consultant specialty providers) (Washington State Department of Health, undated).

Washington also is home to the Mental Health Integration Program, a statewide, patient-centered integrated-care program using a collaborative primary care team-based model for the treatment of common mental health and substance-abuse needs (Patient-Centered Primary Care Collaborative, undated). Surveys and semistructured interviews of mental health clinicians in safety-net primary care clinics in the state employing this integrated primary care and mental health program revealed that both rural and urban clinicians agreed that patients benefited from the program but that rural settings presented challenges to implementation of the program (limited clinician awareness of the program, scarcity of resources, and competing responsibilities for providers) (Williams et al., 2015).

Evidence from Interventions in Other States

Undergraduate Medical Education

Although targeted recruitment and curricular efforts, such as medical school rural training tracks, have been shown to increase the likelihood that medical school graduates will enter into and remain in rural practice (Rabinowitz, Diamond, Markham, and Wortman, 2008; Rabinowitz, Petterson, et al., 2012; Rabinowitz, Diamond, Markham, and Santana, 2013), many such programs are already present at the University of Washington School of Medicine, and these medical school policies and programs might not currently represent feasible state-level policy options.

In recent years, several states have undertaken the expansion of extant medical schools or the creation of new medical schools as a mechanism to support the health care workforce in their states. Between 2002 and 2013, the total number of accredited MD-granting schools increased from 125 to 141 because the Liaison Committee on Medical Education granted full, provisional, or preliminary accreditation to 16 new medical schools, with an additional nine schools with applicant or candidate status (Erikson, Whatley, and Hampton, 2015). Between 2002 and 2013, the total number of DO-granting schools increased from 19 to 30, as the Commission on

Osteopathic College Accreditation accredited 11 schools established since 2002; an additional 13 schools had applicant status in 2013 (Erikson, Whatley, and Hampton, 2015).

Accordingly, total first-year medical student enrollment increased 39 percent, from 19,456 students in 2002 to 27,129 in 2014, and is expected to increase further to 29,628 by 2019 (4,812 additional MD students projected and 4,816 additional DO students projected). Enrollment in MD-granting medical schools grew from 16,488 first-year students in 2002 to 20,343 in 2014, a 29-percent increase (Erikson, Whatley, and Hampton, 2015). Two-thirds of the growth in MD graduates projected by 2019 is attributable to an increase in class size at extant schools and one-third to new schools. Enrollment in DO-granting medical schools increased from 2,968 first-year students in 2002 to 6,786 in 2014, a 129-percent increase (Erikson, Whatley, and Hampton, 2015).

Limited information is available about the workforce implications of these newest medical schools. However, a new medical school in Florida established shortly before this wave provides some early insights. In 2000, Florida signed legislation establishing a new allopathic medical school, the Florida State University College of Medicine. Having graduated its first class in 2005, the school uses admission practices to focus on students with specific interests (primary care, geriatrics, and underserved populations) and supports these interests through curricular offerings (i.e., a department of family medicine, rural training tracks, and partnerships with local organizations) and distributed regional campuses with an emphasis on the ambulatory setting for clinical clerkships (Hurt and Harris, 2005). Thus far, this model has resulted in high student satisfaction, faculty retention, and matching into primary care specialties (55 percent into family medicine, pediatrics, internal medicine, and obstetrics/gynecology [OB-GYN]) and retention in state (60 percent of graduates ultimately practicing in the state of Florida) (Fogarty et al., 2012). However, the overall effects that opening this medical school has had on the supply of primary care physicians in Florida, net of any displacement of physicians trained elsewhere, have not been estimated.

Graduate Medical Education

State-level policy options to enhance the rural primary care workforce might exist through modulation and expansion of GME funding and support of targeted training programs.

Residency-Slot Expansions and Funding

Although the number of medical schools and medical students has markedly increased in the past several years, growth in GME has been slower, owing to a cap on the number of Medicare-supported residency slots from the 1997 Balanced Budget Act (Pub. L. 105-33). Marked geographic disparities exist in the number of residency slots per capita by state, making many states net exporters of residents relative to their medical student graduates (Mullan, Chen, and Steinmetz, 2013; Beitsch, 2015). The 2003 Medicare Prescription Drug, Improvement, and Modernization Act (Pub. L. 108-173) redistributed nearly 3,000 residency positions, with the

explicitly stated aim of increasing training of primary care and rural providers; however, ultimately, non–primary care training programs received more than double the number of primary care redistributed slots, and few rural hospitals received additional positions (12 rural hospitals out of 304 overall, less than 3 percent of positions redistributed) (P. Chen, Mehrotra, and Auerbach, 2014). Residency training slots affect states' primary care workforces. Nationally, the median proportion of physicians ultimately practicing in the states where they did their training varies by the stage of training: After completing medical school, the median proportion of graduates practicing in state is 38.6 percent; for residency, the median proportion is 44.5 percent; and, among those completing both medical school and residency in the same state, the median proportion is 68.4 percent practicing in state (AAMC, 2015).

Some states are using state funding to shape or expand GME. Idaho's 2015 budget included $240,000 to support rural rotations for medical residents (Spero et al., 2013), Georgia has allocated $14 million in matching funds for hospitals developing new residency programs, and Texas has planning and development grants totaling up to $400,000 per institution to establish new residency programs and grants of $65,000 to add slots to extant programs (Beitsch, 2015). Although the contributions of Medicaid relative to other streams of GME funding are small, some states use their ability to control this funding more closely to affect their workforce planning. Some states (Kansas, Minnesota, Missouri, and West Virginia) use Medicaid GME funding to support nonhospital training sites that are ineligible for Medicare GME funding, while others target funding on the basis of primary care training slots (Michigan separates a pool of money just for primary care specialties, and Tennessee allocates monies to teaching hospitals according to each hospital's share of primary care residents in the state) (AAMC, 2013; Spero et al., 2013).

The Teaching Health Center Program

The ACA established a stream for funding primary care medicine (and dentistry) residency trainings directly through HRSA, paying community-based ambulatory centers called Teaching Health Centers (most often, community health centers, RHCs, and other safety-net settings) directly for direct and indirect GME expenses, which is distinct from the Medicare GME funding stream, which flows through teaching hospitals (C. Chen, Chen, and Mullan, 2012). These Teaching Health Centers have grown rapidly: from ten medical and one dentistry residency program supporting 63 trainee positions in 2011–2012 to 57 medical residency programs (37 family medicine, eight internal medicine, three OB-GYN, three pediatrics, four psychiatry, and two geriatrics) and three dentistry programs in 2014–2015 supporting 556 trainee positions (Brown and Klink, 2015). In a small study of family medicine residency graduates in 2014, those who graduated from Teaching Health Centers were more likely to be anticipating initial practice with underserved populations (33 percent versus 18 percent, $p = 0.004$) and were taking jobs in rural settings at almost twice the rate of traditional graduates (Ku et al., 2015; Bazemore et al., 2015).

Family Medicine Residency Rural Training Programs

Some have argued that specific, rural-focused GME programs could represent a mechanism to increase physician recruitment and retention to rural areas. Despite a stated mission of supplying rural areas with physicians, only a small fraction of family medicine training programs are located in rural areas (7.6 percent), and only a small portion of urban programs offer rural training sites (2.3 percent) (Rosenblatt, Schneeweiss, et al., 2002). Family medicine rural training tracks offer a means to increase entry into rural family practice but are unevenly distributed across the country, are limited in number (declining from 35 programs in 2000 to 25 in 2010), produce relatively few graduates (1.5 residents per program per year), and face challenges in terms of finances (often operating in hospitals or clinics that do not receive Medicare GME funding) and human resources (recruitment of residents and faculty alike) (Patterson, Longenecker, Schmitz, Skillman, et al., 2011; Patterson, Longenecker, Schmitz, Phillips, et al., 2013; Rosenthal, 2000). Nonetheless, graduates of family medicine rural training tracks have been found to be two to three times more likely to practice in rural areas (44.8 percent by their third postgraduate year, compared with 22 percent among all family medicine residency graduates) and frequently practicing in underserved areas (27 percent of graduates planned to practice in HPSAs and 48 percent in FQHCs, RHCs, or CAHs). More broadly, rural-centric family medicine training programs in general (i.e., rural training tracks, urban programs with rural requirements, and rural-located programs) appear more likely to enter rural practice or practice in primary care HPSAs (Patterson, Keppel, and Skillman, 2016).

Expanded Loan-Forgiveness, Visa Waivers, and Direct-Incentive Programs

Community health centers, especially those in rural areas, face difficulties in recruiting physician staff, reporting a reliance on NHSC scholarships, loan-repayment programs, and J-1 visa waiver programs for IMGs (Rosenblatt, Andrilla, et al., 2006).

Although several studies have been conducted addressing the career trajectories and workforce contributions of the NHSC and other loan-forgiveness and direct-incentive programs, their findings are mixed. NHSC recipients appear more likely to practice in rural or underserved areas than their colleagues nationally: One study noted that more than half of NHSC alumni continued to work with underserved communities (Porterfield et al., 2003); another analysis of rural family medicine NHSC alumni noted that more than half were still practicing in their original counties or other rural areas for an average of six years (Rosenblatt, Saunders, et al., 1996), and approximately 40 percent of NHSC medical school scholarship recipients practiced in their initially assigned counties or other rural areas (Cullen et al., 1997). However, when comparing NHSC recipients with physicians choosing to go into rural or underserved practice without the NHSC service obligation, the NHSC program’s effect on the likelihood of retention is less clear. A comparison of retention of physicians at community health centers with and without NHSC obligations revealed a median tenure of three years for both groups but that 36 percent of physicians without obligations remained at practice sites at five years, compared

with only 17 percent with NHSC obligations (Singer et al., 1998). This parallels results from an earlier cohort of physicians in rural practice, which found that, at eight years, NHSC physicians were less likely to remain at their index practice sites (12 percent versus 39 percent) and in rural practice in general (29 percent versus 52 percent) (Pathman, Konrad, and Ricketts, 1992).

In addition to HRSA-sponsored NHSC funds, many states offer scholarships, loan repayment, or direct incentives for working in rural or underserved areas. In 1996, 82 state programs not supported by federal funding intending to increase primary care supply in underserved areas existed, which provided incentives to student, resident, and practicing physicians; NPs; PAs; and nurse midwives in a wide variety of forms (loan repayment, scholarships, loans, or direct incentive or support) (Pathman, Taylor, et al., 2000). A study of 69 state programs providing financial support to medical students, residents, and practicing physicians found that loan repayment, direct incentives, and resident-support programs had higher rates of obligation completion (93 percent combined) than student-oriented loan (44.7 percent) and scholarship programs (66.5 percent) and that, compared with nonobligated rural generalists, obligated physicians were more likely to work in rural and underserved areas, were more satisfied with their positions, and had greater rates of retention in their positions (55 percent versus 52 percent retention at five years) (Pathman, Konrad, King, et al., 2004). However, an analysis of a survey of NHSC and state loan-repayment program participants revealed widely variable rates and duration of anticipated retention at their assigned service sites after their obligations, despite overall positive ratings of their work environments and experience in the community (Pathman, Fannell, et al., 2012). Concordant with these findings is a broader review of return-of-service programs in the United States, Canada, and New Zealand that revealed success with short-term recruitment to rural and underserved areas but more-limited long-term retention (Sempowski, 2004).

Increased Medicaid Payment Rates

Increased Medicaid payment rates offer an opportunity to increase access to primary care for Medicaid physicians and to bolster incomes of physicians in rural or otherwise-underserved areas of the state, with the potential to indirectly improve physician supply. Data directly linking supply of primary care services to the extension of the ACA’s enhanced Medicaid primary care reimbursement are limited. What information there is about states’ experiences is largely anecdotal, owing to delayed implementation; some states noted little to no impact on provider participation; others reported decreased provider dropout; and some reported increased provider participation (Crawford and McGinnis, 2014; Snyder, Paradise, and Rudowitz, 2014).

Other studies directly address the effect that Medicaid reimbursement rates have on the provider workforce and acceptance of Medicaid patients. An analysis of data from the 2008 Health Tracking Physician Survey revealed that Medicaid reimbursement rates tended to be higher in states with smaller per capita primary care physician workforces; that, on average, 41 percent of primary care physicians were accepting new Medicaid patients; and that the impact

of a 10-percent increase in the Medicaid-to-Medicare fee ratio results in a 2.1-percent increase in acceptance of new Medicaid patients over the effect that other provider and practice-setting factors have on rates of Medicaid acceptance (Cunningham, 2011). Additional research is concordant with the observation that, although higher rates of Medicaid reimbursement are associated with increased probability that physicians will accept Medicaid patients, they do not necessarily lead to higher levels of physician Medicaid acceptance in a given area (Cunningham and Nichols, 2005). For example, an analysis of 2011 National Ambulatory Medical Care Survey electronic medical record supplement data found that a 10-percentage-point increase in the Medicaid-to-Medicare fee ratio was associated with a 4-percent increase in willingness to accept Medicaid patients (from a national average of 69 percent of office-based physicians accepting new Medicaid patients) (Decker, 2012).

Appendix B. Expanded Methods

Data: Detailed Descriptions

Area Health Resources File

The AHRF is a data set of county-level health information assembled by HRSA that is commonly used to describe and project the health care workforce (Staiger, Auerbach, and Buerhaus, 2009; Graves et al., 2016). The AHRF pulls information about health professionals, facilities, and demographic information from more than 50 discrete data sources. From the AHRF, we extracted data on counts of MDs, DOs, NPs, PAs, and various county characteristics. Because the AHRF aggregates data from multiple sources, we briefly describe the relevant original source material:

1. *the AMA Physician Masterfile:* Physician variables are derived from the AMA Physician Masterfile. We collected counts and characteristics (e.g., ages) on MDs from 1995 to 2013, as well as for DOs from 2003, 2004, 2007, and 2010 to 2013.
2. *the AOA:* The AMA only recently began collecting information for DOs. So, counts of DOs for previous years (2004, 2007, 2008, and 2009) were collected from AOA licensing data.
3. *the Centers for Medicare and Medicaid Services National Provider Identification (NPI) file:* The NPI is a unique provider identifier that is used by health plans for administrative and financial transactions. We used these data available in the AHRF to calculate the total number of NPs and PAs in each county in the United States.
4. *the Census Bureau's Population Estimates Program:* Each year, the U.S. Census Bureau uses current data on births, deaths, and migration to calculate population change since the most recent decennial census. We used these data to estimate annual population counts by age and various sociodemographic characteristics for every county in the United States. We used these data available within the AHRF to calculate population counts in each county.

SK&A

SK&A maintains a commercial data set of all office-based physicians, NPs, and PAs in the United States. To construct its initial frame of providers, SK&A uses data sources, such as licensing data and NPI numbers, and then confirms the location of all providers within the sampling frame and identifies providers not in the original sampling frame every six months via such methods as phone calls to the offices and review of websites and practice directories. The SK&A data are audited by the independent consulting firm BPA (SK&A, undated). Although little information exists about the accuracy of the SK&A data, several research studies have used SK&A (Gresenz, Auerbach, and Duarte, 2013; Dunn and Shapiro, 2014; Dunn and Shapiro, 2015; Baker, Bandorf, and Kessler, 2015; Richards et al., 2014; Richards et al., 2016; Rhodes et

al., 2014; Frech et al., 2015). One study has attempted to validate the SK&A against other data sources, such as AMA Physician Masterfile, finding that SK&A was more accurate than the AMA Physician Masterfile for identifying the location of physicians (DesRoches et al., 2015). To our knowledge, there are no published validation studies of NP or PA counts in the SK&A data, and few external comparison data sets exist for NPs and PAs. We attempted to validate the overall NP and PA counts with Bureau of Labor Statistics (BLS) and AHRF estimates in Table B.1 below. We found that estimates of office-based NPs in the SK&A data are similar to BLS estimates; for PAs, SK&A estimates are persistently lower than BLS estimates but with similar trends over time.

Table B.1. Comparisons of Office-Based Nurse Practitioner and Physician-Assistant Counts from SK&A and Bureau of Labor Statistics Data

	National Count of Office-Based NPs		National Count of Office-Based PAs	
Year	**SK&A**	**BLS**	**SK&A**	**BLS**
2010	54,605	—	41,063	54,660
2011	69,910	—	44,042	55,960
2012	64,284	62,520	46,186	56,470
2013	68,189	67,410	48,154	59,260

American Community Survey Public Use Microdata Sample

The ACS is an annual ongoing survey performed by the U.S. Census Bureau. The ACS surveys a monthly sample of a small percentage of the U.S. population to produce annually updated population estimates for census tracts and block groups. The response rate for the ACS is extremely high (greater than 95 percent). The Public Use Microdata Sample is a publicly available file of individual-level responses to the survey questions that has been deidentified but includes weights to construct nationally representative estimates.

National Resident Matching Program

The NRMP is a private, nonprofit organization that provides a mechanism for matching the preferences of applicants for U.S. residency positions with the preferences of residency program directors. We downloaded public-use files from the NRMP website that provide information about location of residency programs and match results by state and specialty from 2004 through 2013.

Association of American Medical Colleges

The AAMC represents all 145 accredited medical schools in the United States plus 17 accredited Canadian medical schools. We obtained information from the AAMC about

location, founding time, accreditation status, and enrollment (MD program) of medical schools in the United States.

American Association of Colleges of Osteopathic Medicine

AACOM represents the 31 accredited colleges of osteopathic medicine in the United States. We obtained information from AACOM about location, founding time, accreditation status, and enrollment (DO program) of osteopathic medical schools.

ZIP Code Business Patterns

ZIP Code Business Patterns is an annual series of data files assembled by the U.S. Census Bureau that provides ZIP Code–level information about the number of business establishments by employment size and industry in the United States.

National Health Service Corps

The NHSC is a federal program enacted as part of the Emergency Health Personnel Act of 1970 (Pub. L. 91-623). Its charge is to place physicians, dentists, and other health professionals in underserved areas by providing scholarships to health profession students and by repaying educational loans for young practicing clinicians who commit to work in select HPSAs. We obtained information from the AHRF on the location, specialty, and practicing hours of health professionals placed by the NHSC in communities across the United States in 2013.

U.S. Department of Education Data Files

We obtained school year 2012–2013 achievement results for state assessments in mathematics and in reading and language arts for high schools across the United States (U.S. Department of Education, 2016).

Inter-University Consortium for Political and Social Research Crime Data

The Inter-University Consortium for Political and Social Research at the University of Michigan compiles the original source data from Federal Bureau of Investigation (FBI) Uniform Crime Reporting.

Variables: Detailed Descriptions

Because the AHRF is a county-level data set, the county-year was the primary unit of analysis for all projections and simulations.

Outcome Variables

Counts of Primary Care Physicians per 100,000 Population

We constructed this variable by adding the total number of primary care MDs and DOs in each county-year combination and dividing by the total population in that year. MD and DO data are measured separately and coded differently in the AHRF. The AHRF has counts of office-based MDs by specialty. For MDs, self-reported practice setting (e.g., office-based) is available in the AHRF through the AMA Physician Masterfile. We classified MDs as primary care physicians if they were office-based and in any of the following specialties: family medicine (general), general practice, internal medicine, general preventive medicine, OB-GYN (general), or pediatrics (general). We classified DOs as primary care physicians in a similar fashion, with one exception: Because the AHRF lacks data on DOs in each possible combination of specialty and location, we assumed that the proportion of DOs in primary care specialties practicing in office-based locations was the same as for all DOs, regardless of specialty. Because the AHRF contained DO data for only the years 2003, 2004, 2007, and 2010 through 2013, we used a linear interpolation within each county to impute DO counts for missing years. We then summed the MD and DO counts in each county-year and divided by the same-year county population.

Counts of Primary Care Nurse Practitioners per 100,000 Population

Using data from SK&A from 2008 through 2013, we counted the number of office-based primary care NPs for each county-year. We counted NPs as primary care if they reported any of the following specialties: family medicine, general practice, internal medicine, general preventive medicine, OB-GYN, or pediatrics. We also counted NPs with missing specialty designations who worked in primary care practices. For NPs who worked in multispecialty practices but had missing specialty designations, we imputed specialties based on 2013 specialty designations in such practices. The unit of analysis in SK&A is the individual provider, so we aggregated the provider counts to the county level. As a sensitivity check, we also estimated the number of office-based primary care NPs from AHRF data. Because the AHRF lacks data on specialty and practice setting for NPs, we multiplied total NP counts in the AHRF by 0.27, a conversion factor previously used to estimate the counts of primary care NPs in the AHRF settings (Graves et al., 2016).

Counts of Primary Care Physician Assistants per 100,000 Population

We estimated counts of primary care PAs using the same procedures we used for NPs. Like we did for NP counts, we also estimated the counts of primary care PAs using AHRF data. To do this, we multiplied the total number of PAs in each county by 0.28 (Graves et al., 2016).

Key Policy-Option Variables

Geographic Proximity Variables for Medical School Enrollment

Using geographic information system software and data from the AAMC and AACOM, we calculated distances between the centroid of each county in the United States and each medical school within straight-line 100- and 200-mile radii of the county centroid. We then calculated, for each U.S. county in each study year, the number of medical school enrollees within 100 miles, within 200 miles, and within the same state as each county. We further calculated the number of such medical school enrollees from medical schools that had opened eight or fewer years before the observation year (corresponding to the simulation time frame ending in 2025, with WSU enrollment beginning in 2017). For the WSU policy scenario, we obtained anticipated WSU enrollment figures beginning in 2017.

Geographic Proximity Variables for Primary Care Residencies

Using geographic information system software and NRMP data, we calculated, for each U.S. county in each study year, the number of primary care residents within 100 miles, within 200 miles, and within the same state as each county. We further calculated the number of such residents who were being trained in rural areas.

National Health Service Corps Sites

Using the AHRF data, we calculated the number of FTE NHSC primary care positions in each county in 2013.

Education

We estimated average high school mathematics and reading and language arts proficiency rates for all public schools in each U.S. county. Because standardized mathematics and reading and language proficiency rates were highly collinear, we constructed a single educational quality variable by calculating their means (giving equal weight to mathematics and reading and language arts scores). We then aggregated this variable to the county level by taking the average of all high school proficiency rates, weighted by the enrollment of each high school. Because each state administers its proficiency tests differently, scores could not be compared between different states. Therefore, we standardized every county score to the average score of the state by calculating the state-level mean and state-level standard deviation in each year for each test. We then subtracted the state-level mean from the county's weighted proficiency rate and divided by the state-level standard deviation to get a z-score. Thus, the educational quality variable measured differences between a given county's standardized proficiency rates and mean proficiency rate among all counties in the state.

Medicaid-to-Medicare Payment Ratios

We used previously published 2012 Medicaid payment rates for a market basket of physician services for state-run fee-for-service programs (Zuckerman and Goin, 2012). Because no data on within-state variability in Medicaid payment ratios were available (if any such variability exists), this was a state-level variable.

Other Independent Variables

Counts of Primary Care Physicians, by Age Band, per 100,000 Population

The AHRF reports the number of primary care physicians by the following age bands: under 35, 35 to 44, 45 to 54, 55 to 64, 65 to 74, and 75 and older. Because relatively few practicing physicians were over the age of 75, we combined the categories of 65 to 74 and 75 and older. These are standard age bands available within the AHRF and are based on the reported birth date in the AMA Physician Masterfile. The AHRF, however, does not report office-based physicians by age band. To calculate the total number of office-based primary care physicians by age band, we multiplied the counts of primary care providers in each age band by the proportion of primary care providers in that county and year that was office-based. This imputation method assumes that primary care physicians are equally likely to be office-based across age bands. We did not have reliable age-band data for office-based primary care DOs, so we assumed that the age distribution was the same for MDs and DOs. We then used population size estimates to calculate the number of physicians in each age band per 100,000 population in each county.

County Rural Status

The rural status of the counties was measured using nine different binary variables constructed from county-level RUCCs available in the AHRF and derived from the U.S. Department of Agriculture's Economic Research Service (Economic Research Service, 2016): (1) counties in metro areas of 1 million population or more; (2) counties in metro areas of 250,000 to 1,000,000 population; (3) counties in metro areas of fewer than 250,000 population; (4) urban population of 20,000 or more, adjacent to a metro area; (5) urban population of 20,000 or more, not adjacent to a metro area; (6) urban population of 2,500 to 19,999, adjacent to a metro area; (7) urban population of 2,500 to 19,999, not adjacent to a metro area; (8) completely rural or less than 2,500 urban population, adjacent to a metro area; and (9) completely rural or less than 2,500 urban population, not adjacent to a metro area. For the current analyses, we classified RUCC levels 1 to 3 as urban and levels 4 to 9 as rural. RUCC designations can change within counties over time. However, to show effects based on the most current RUCC designation, we applied each county's 2013 RUCC to all data years.

Proportion of Population by Minority Status

Using census data in the AHRF, we estimated the proportion of residents in a county who were black and the proportion of Hispanic ethnicity.

Income and Poverty

Using census data in the AHRF, we estimated the proportion of each county's households that were under the poverty line as a single continuous variable measured 0 to 1, as well as the average per capita income.

Proportion of Population by Insurance Status

Using census data in the AHRF, we estimated the proportion of county residents ages 18 to 64 who were uninsured and the proportion of all residents on Medicaid.

Proportion of Population with Less Than High School Education

Using census data in the AHRF, we estimated the proportion of county residents ages 18 and older who had less than high school education.

Total Number of Rural Health Clinics

Using facility data from the AHRF, we calculated the total number of RHCs from 1999 to 2014.

Total Number of Hospitals

Using facility data from the AHRF, we calculated the total number of short-term general hospitals and short-term general hospital beds in each county.

Health Provider Shortage Area

Using data from the AHRF, we coded each county using a three-level primary care HPSA designation: None of the county is classified as HPSA, some of the county is classified as HPSA, or the entire county is classified as HPSA.

Crime Rates

Using data from the Inter-University Consortium for Political and Social Research, we calculated county-level rates of property and violent crime (including murder, rape, robbery, and aggravated assault).

Housing Costs

We used ACS data to estimate a measure of housing costs using average rents in each county, following a previously published method (Albouy and Lue, 2014).

Malpractice Premiums

Using data from *Medical Liability Monitor*, we generated county-level medical-malpractice insurance premiums for internal medicine, general surgery, and OB/GYN. We used the county-level malpractice insurance premiums for internal medicine to represent malpractice premiums for all primary care physicians, including internal medicine, family medicine, and pediatrics. We used insurance market-share data from National Association of Insurance Commissioners to weight the above–county-level malpractice insurance premiums.

Amenities

We use the ZIP Code Business Patterns data to construct two variables reflecting local amenities: number of full-service restaurants and number of performing arts venues and museums.

Predictive Base-Case Models: Detailed Description

To forecast the future primary care workforce through 2025 in the state of Washington, we estimated the number of primary care physicians, NPs, and PAs in each county in Washington for each year from 2015 to 2025 using national workforce models. We estimated these models separately for physicians, NPs, and PAs and separately for rural and nonrural counties.

Physician Models

To construct the predictive base-case models, we estimated county-year per capita counts of primary care physicians as a function of the age distribution of primary care physicians in previous years (lagged age bands) and other covariates likely to be associated with the supply of primary care physicians. For these models, we used data from 1995 through 2013.

To do this, we first constructed counts of primary care physicians per 100,000 population who were under age 35, 35 to 44, 45 to 54, 55 to 64, and 65 and older and lagged those counts three, five, and ten years. These lagged age bands allowed estimation of changes in supply that might be driven by two types of demographic variables: birth cohort and age in the observation year. Together, these demographic variables can improve prediction of workforce entry and exit that might be affected by time- and age-related factors, such as medical school enrollment, relocation from rural to urban areas because of age-related factors (e.g., when physicians' children enter high school), changes in spousal roles over time (captured in birth cohort), and retirement. In these models, we included all of the policy variables and the other independent variables, as well as a linear year term.

To improve the accuracy of county-level workforce predictions within Washington State, we included the following interaction terms: Washington counties by year, rural status by year, and state by year. We estimated a linear regression model and clustered standard errors within the county to account for autocorrelation:

$$y_{c,t} = \beta_0 + C_c\beta + A_{c,t-3,5,10}\beta + Yr_t\beta + C_cYr_t\beta + S_cYr\beta + R_cYr_t\beta + R_cS_c\beta + R_c\beta + X_{c,t}\beta + X_{c,t}\beta + \varepsilon_{c,t},$$

where

- y represents the count of primary care physicians in each county and year per 100,000 population
- c is the county index
- t is the time index
- β_0 represents the regression intercept
- C represents a vector of fixed effects (dummy variables) for each county in Washington State
- A represents a vector of fixed effects for each age band, lagged at $t-3$, $t-5$, and $t-10$
- Yr represents year as a continuous variable
- CYr represents a vector of Washington county × year interaction terms
- SYr represents a vector of state × year interaction terms
- RYr represents a vector of interaction terms between rural status and year
- RQ represents a vector of interaction terms between rural status and cohorts
- X represents a vector of other independent variables (listed in the "Other Independent Variables" section above).

We then used these models to predict the number of primary care providers in each county from 2014 to 2025. The future out-of-sample predictions were calculated by aging forward each physician and setting each of the covariates equal to its 2013 value. This assumes that all characteristics of each county—other than each physician's age and county populations—remain fixed in the future.

We assessed the fit of the regression model using R-squared (for national estimates) and correlations between observed and predicted data (for Washington State–specific estimates).

To assess its predictive validity, we reestimated the model using only the years 1995 to 2011 (i.e., reserving the last two years of available observed data for the purposes of comparison) and then used the results to compare our predicted results to observed results in 2012 and 2013.

We used STATA/MP 14.0 for all analyses.

Nurse Practitioner and Physician-Assistant Models

Due to limitations of the NP and PA data—most notably, the absence of age cohort data and short observation windows in both the SK&A (2008–2015) and AHRF data sets (2010–2014)—we were unable to construct prediction models similar to the physician supply prediction model. Furthermore, after examining the SK&A data, we concluded that the specialty information

appeared to be inconsistent over time, and the AHRF included no specialty information for NPs or PAs.

Therefore, we used national growth trends for NPs and PAs from previously published literature and applied these national trends to Washington State from 2014 to 2015. Using SK&A NP counts in 2013 (the year most likely to contain accurate specialty information), we used both a 4-percent and a 5-percent growth rate to forecast NP counts. The growth rate range was consistent with estimates in the literature. For PAs, we also used 2013 SK&A data and applied both a 3-percent and 4-percent growth rate, which were also consistent with previous studies. We then used state-level population growth estimates from the Census Bureau to project the total population in Washington State from 2014 to 2025. Using Census Bureau estimates, we project a 1.28-percent annual growth in population from 2014 to 2025. We use the NP and PA count forecasts and the population forecasts to calculate the counts per 100,000 population.

RAND Health Care Payment and Delivery Simulation Model: Detailed Description

We performed the simulations of the effects of increasing Medicaid fee-for-service payment rates using PADSIM. That model is described in detail in a freely downloadable RAND research report (White, Liu, et al., 2016). In this section, we describe the general framework of the model and the specific assumptions used to model increases in Medicaid payment rates in Washington State.

Equilibrium Concept

PADSIM is, at its heart, a model of the supply and demand for health care services. Equilibrium, in PADSIM, is a situation in which the market for health care services clears, meaning that the amount of services that providers want to supply equals the amount of services that patients demand. The equilibrium condition holds, by assumption, for every combination of county, year, provider type, and coverage category:

$$Q^{supp}_{g,c,p,y} = Q^{dem}_{g,c,p,y} \forall g,c,p,y, \tag{B.1}$$

where

- g indexes geographic units (for this project, the geographic units are counties, whereas, for other applications of PADSIM, the geographic units are states)
- c indexes health insurance coverage (Medicare, Medicaid, private group, nongroup, and uninsured)
- p indexes provider types (physicians or hospitals)
- y indexes years.

In a conventional supply-and-demand model, prices are assumed to adjust freely to maintain equilibrium. PADSIM differs from a conventional supply-and-demand model in two key ways. First, rather than there being a single price, PADSIM uses two separate concepts:

- *payment policy*, meaning the arrangements that determine the revenues that health care providers receive from health plans and patients and how those revenues vary with the amount of services provided to patients
- *out-of-pocket costs*, meaning the amounts that patients must pay to receive health care services.

Second, in PADSIM, payment policy and out-of-pocket costs do not adjust freely to maintain equilibrium; they are instead treated as exogenous inputs into the model. This approach reflects the fact that payment policy and the level of out-of-pocket costs are set in legislation in the Medicare and Medicaid programs and constrained in the small-group and nongroup health insurance markets. In large-group commercial plans, providers and plans negotiate payment policy, and plans are free to adjust out-of-pocket costs, but the current structure of PADSIM is not designed to determine private payment policy and out-of-pocket costs endogenously.

Instead of prices adjusting freely, we introduce the concept of congestion and use it to maintain equilibrium in PADSIM. The concept of congestion includes all nonprice factors that reduce patient demand for services and either increase or leave unchanged provider supply. An example of congestion is a delay between when a patient calls a physician's office and the date of the first available appointment. That type of delay is a nonprice factor—it does not relate to the out-of-pocket amount paid by the patient, nor to the payment to the provider—that could dissuade some patients from receiving services. If a physician notices that patients are having to wait many days for an available appointment, the physician can respond by expanding office hours to accommodate more appointments each day; this is an example of a supply response to congestion.

The equilibrium condition in Equation B.1—which simply states that supply equals demand—can be decomposed into the following:

$$e^{\ln S^{no-cong}_{g,c,p,y} + cong_{g,c,p,y}\lambda_p + \varepsilon^{supp}_{g,c,p,y}} = e^{\ln D^{no-cong}_{g,c,p,y} + cong_{g,c,p,y}\delta_p + \varepsilon^{dem}_{g,c,p,y}}, \tag{B.2}$$

where

- $S^{no-cong}_{g,c,p,y}$ is a predicted amount of services that provider type p would prefer to provide to patients with coverage type c in county g in year y if those patients faced no congestion (hence, *no-cong*)
- $D^{no-cong}_{g,c,p,y}$ is a predicted amount of services that patients with coverage type c in county g in year y would prefer to receive from provider type p if they faced no congestion
- $cong_{g,c,p,y}$ is the level of congestion in the utilization of services of provider type p among patients with coverage type c in county g in year y
- λ_p is the elasticity of supply of provider type p with respect to the level of congestion (assumed to be zero or positive)

- δ_p is the elasticity of patient demand for services from provider type *p* with respect to the level of congestion (assumed to be negative)
- $\varepsilon^{supp}_{g,c,p,y}$ and $\varepsilon^{dem}_{g,c,p,y}$ are residuals.

We can then further decompose the no-congestion desired supply of provider type *p* as follows:

$$\ln S^{no-cong}_{g,c,p,y} = \ln N_{g,p.y} + \ln \phi_p + \ln\left(\frac{\overline{Pay}_{g,p.y}}{\overline{Pay}_{g,p,y0}}\right)\gamma_p + \overline{Pro}^{own}_{g,p,y}\eta^{own}_p + \sum_{q \neq p}\left(\overline{Pro}^{cross}_{g,p,q,y} - 1\right)\eta^{cross}_{p,q} + \ln Sshare^{no-cong}_{g,c,p,y}, \tag{B.3}$$

where

- $N_{g,p,y}$ is the number of providers of type *p* in county *g* in year *y*
- ϕ_p is a supply intercept for provider type *p*
- $\overline{Pay}_{s,p,y}$ is the weighted average real (inflation-adjusted) payment rate for provider type *p* in county *g* in year *y*
- $y0$ is a base year
- γ_p is the elasticity of supply of provider type *p* with respect to the payment rate
- $\overline{Pro}^{own}_{g,p,y}$ is the own-prospectiveness of provider type *p* (i.e., prospectiveness of revenues to provider type *p* with respect to the cost of services provided by provider type *p*) in county *g* in year *y*
- η^{own}_p is the elasticity of desired supply by provider type *p* with respect to own-prospectiveness
- $\overline{Pro}^{cross}_{g,p,q,y}$ is the cross-prospectiveness of provider types *p* and *q* (i.e., prospectiveness of revenues to provider type *q* with respect to the cost of services provided by provider type *p*) in county *g* in year *y*—note that cross-prospectiveness only affects supply if it differs from 1
- $\eta^{cross}_{p,q}$ is the elasticity of supply of services of provider type *p* with respect to cross-prospectiveness of provider types *p* and *q*
- $Sshare^{no-cong}_{g,c,p,y}$ is the share of output that provider type *p* in county *g* in year *y* would prefer to provide to patients with coverage type *c*, if no patients faced any congestion.

Congestion

Congestion plays a key role in the equilibrium condition in PADSIM, but we do not directly observe or measure the level of congestion. Instead, we define congestion as a function of the no-congestion levels of supply and demand, which are, in turn, calculable from observable data and the behavioral parameters:

$$cong^*_{g,c,p,y} = \ln\left(\frac{D^{no-cong}_{g,c,p,y}}{S^{no-cong}_{g,c,p,y}}\right)\left(\frac{1}{\lambda_p - \delta_p}\right). \tag{B.4}$$

We can then substitute this estimate of congestion into Equation B.2 and rearrange

$$\ln Q_{g,c,p,y} = \ln \hat{Q}_{g,c,p,y} + \varepsilon_{g,c,p,y}, \tag{B.5}$$

where

$$\ln \hat{Q}_{g,c,p,y} = \ln S^{no-cong}_{g,c,p,y}\left(1 - \frac{\lambda_p}{\lambda_p - \delta_p}\right) + \ln D^{no-cong}_{g,c,p,y}\left(\frac{\lambda_p}{\lambda_p - \delta_p}\right). \tag{B.6}$$

As is clear from this expression of the equilibrium condition, the relative elasticities of supply and demand with respect to congestion, i.e.,

$$\frac{\lambda_p}{\lambda_p - \delta_p},$$

is crucial. The equilibrium can be thought of a blend of two extremes:

- If providers of type p are perfectly congestion-elastic—i.e., if $\left(\lambda_p / \left(\lambda_p - \delta_p\right)\right) = 1$ — then the amount of services provided will be determined by the level of patient demand. In this scenario, providers will expand output if they perceive that patients are facing access problems, regardless of the generosity of the payments they receive.
- If patients are perfectly congestion-elastic—i.e., if $\left(\lambda_p / \left(\lambda_p - \delta_p\right)\right) = 0$ — then the amount of services provided will be determined by providers' preferred level of output, which is, in turn, determined by the generosity of payment. In this scenario, providers are unmoved by patients' access problems, and the level of congestion adjusts to reduce patient demand to the level providers choose to supply.

Allocation of Provider Output to Patients with Different Types of Insurance Coverage

Increasing Medicaid payment rates will increase the average payment rates that providers receive and will make patients covered by Medicare more financially attractive to providers. In the analysis of the impacts of a change in payments for Medicaid enrollees, one key question is whether and how providers will reallocate their output based on the change in the relative desirability of Medicaid patients.

We simulated providers' desired allocation of output following these steps:

1. Simulate demand shares for each health insurance coverage type:

$$Dshare^{no-cong}_{g,c,p,y} = \frac{D^{no-cong}_{g,c,p,y}}{\sum_{c} D^{no-cong}_{g,c,p,y}}. \tag{B.7}$$

2. Calculate a demand-weighted average payment rate and demand-weighted average prospectiveness:

$$\overline{Pay}^{Dwtd}_{g,c,p,y} = \sum_{c} Dshare^{no-cong}_{g,c,p,y} Pay_{g,c,p,y}. \tag{B.8}$$

$$\overline{Pro}^{Dwtd}_{g,c,p,y} = \sum_{c} Dshare^{no-cong}_{g,c,p,y} \left(Pro^{own}_{g,c,p,y} + \sum_{q \neq p} \left(Pro^{cross}_{g,c,p,q,y} - 1 \right) \right). \tag{B.9}$$

3. Calculate a relative average payment rate and a relative prospectiveness for each coverage category:

$$RelPay^{Dwtd}_{g,c,p,y} = \ln \left(\frac{Pay_{g,c,p,y}}{\overline{Pay}^{Dwtd}_{g,c,p,y}} \right). \tag{B.10}$$

$$RelPro^{Dwtd}_{g,c,p,y} = Pro^{own}_{g,c,p,y} + \sum_{q \neq p} \left(Pro^{cross}_{g,c,p,q,y} - 1 \right) - \overline{Pro}^{Dwtd}_{g,c,p,y}. \tag{B.11}$$

   These reflect the difference between the payment policy for coverage category *c* and the average payment policy for all coverage categories.
4. Calculate a relative desirability of each coverage category:

$$RelDesir_{g,c,p,y} = RelPay^{Dwtd}_{g,c,p,y} \gamma_p + RelPro^{Dwtd}_{g,c,p,y} \eta_p. \tag{B.12}$$

   A relative desirability of 1 can reflect one of two situations: The first is that payment policy for coverage category *c* is equally desirable to the provider as the average for all coverage categories, and the second is that the provider is unresponsive to payment policy (i.e., $\gamma_p = 0$ and $\eta_p = 0$). A relative desirability greater than 1 would occur if the payment policy for coverage category *c* is more generous than the average and less than 1 if payment policy is less generous.
5. Apply a Gini power factor:

$$RelDesir^{Gpowered}_{g,c,p,y} = \left(RelDesir_{g,c,p,y} \right)^{G_p}. \tag{B.13}$$

   Setting the Gini power factor, G_p, equal to 0 produces relative desirabilities for all coverage categories equal to 1—this would be appropriate if providers ignore the relative desirability of the payment policy for different coverage types when allocating their services. Setting a Gini power factor greater than 0 is appropriate if providers choose how to allocate their services based, in part, on relative desirability of the payment policy of

different coverage types. This factor is referred to as the Gini power because it affects the degree of inequality in providers' desired output to different patient types.

6. Calculate the share of services that providers would prefer to supply to each coverage category:

$$Sshare^{no-cong}_{g,c,p,y} = \frac{Dshare^{no-cong}_{g,c,p,y} RelDesir^{scaled}_{g,c,p,y}}{\sum_c Dshare^{no-cong}_{g,c,p,y} RelDesir^{scaled}_{g,c,p,y}}.$$

Residuals

For this analysis, we used historical data on amounts of services for historical years 2010 through 2014. For each of those historical years, we calculate logged quantity residuals (i.e., the difference between the natural logarithm of actual quantity and predicted quantity) for every combination of coverage, provider type, and geography:

$$\varepsilon_{g,c,p,y} = \ln Q_{g,c,p,y} - \ln \hat{Q}_{g,c,p,y}. \tag{B.14}$$

These residuals are used in two ways. First, when simulating quantities in the projection years (2015 and beyond), we include the residuals from the last historical year, *lasthisty* (i.e., 2014):

$$Q^{projected}_{c,g,p,y} = e^{\ln \hat{Q}_{g,c,p,y} + \varepsilon_{g,c,p,lasthisty}}. \tag{B.15}$$

This approach is a simple form of autocalibration, in the sense that projected quantities in the last historical year will, by definition, precisely equal actual quantities in that year. Autocalibration has the advantage of incorporating the most-recent historical data and ensuring a seamless transition between historical and projected quantities. Second, the full set of residuals (i.e., from all historical years) can be used to test and improve model fit, although, for this analysis, we did not undertake that type of calibration exercise.

Behavioral Parameters

For this analysis, the relevant behavioral parameter settings are listed in Table B.2.

Table B.2. Relevant Behavioral Parameter Settings

Behavioral Parameter	Symbol	Value
Elasticity of supply of physician services with respect to the level of congestion	λ_{phys}	0.3
Elasticity of demand for physician services with respect to the level of congestion	δ_{phys}	–1
Physician supply intercept	ϕ_{phys}	10,251
Elasticity of supply of physician services with respect to the payment rate	γ_{phys}	1.5
Gini power factor for physician services	G_p	0.5

These behavioral parameter settings assume that physician output is heavily influenced by payment policy and not just patient demand for services (i.e., λ_{phys} is below 1) (Hadley et al., 2010), that physicians are highly elastic with respect to the payment rate (i.e., γ_{phys} is above 1) (Clemens and Gottlieb, 2014), and that physicians will reallocate their output somewhat in response to changes generosity of payment for one payer relative to others (i.e., G_p is greater than 0).[11]

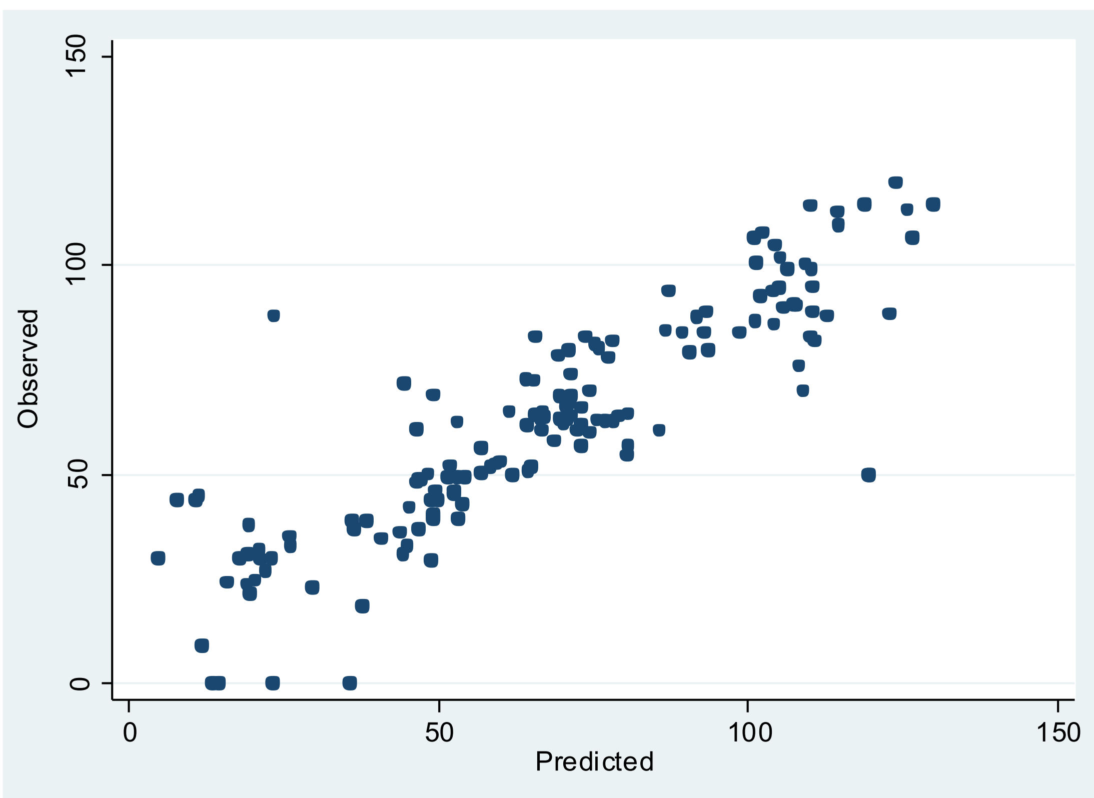
[11] For evidence on reallocation of output in response to changes in demand, see Glied, 2014.

Appendix C. Supplemental Fit Statistics for Predictive Model

Table C.1. Assessing Model Fit Based on All Observed Data Years: 1995–2013, Full Model

Statistic	Urban	Rural
R^2	0.924	0.805
Correlation between observed and predicted county-level supplies of primary care physicians per 100,000 population in Washington State	0.9485	0.8793
Correlation between observed and predicted county-level supplies of primary care physicians per 100,000 population nationally	0.9375	0.8470

Figure C.1. Model Predictions, Observed Versus Predicted, Count of Primary Care Physicians per 100,000 Population in Washington State, 2010–2013



NOTE: Each dot represents one Washington county in one year. So there are four dots for each county (one each for 2010, 2011, 2012, and 2013).

In this model, predictions of the years 2010 to 2013 were based on 1995–2009 data. These 2010–2013 predictions were then compared with observed data from 2010 through 2013. Correlation = 0.880 between observed and predicted values for 2010 through 2013.

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