Evidence from the Medical Expenditure Panel Survey on Patient Cost of Care Provided by Nurse Practitioners

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Abstract

Nurse practitioners (NPs) are able to complete training and enter the workforce faster than physicians, and they have labor cost advantages. Since they are able to provide many of the same primary care services as physicians, utilizing them as independent providers may help improve access to healthcare and contain costs. Prior evidence has shown NPs achieve patient satisfaction and health outcomes that are on par with or better than those of physicians. There is also some evidence to indicate that NP practice patterns result in similar or lower patient medical expenditures when compared to physician care. However, this evidence is limited, with little study at the national level. In an effort to contribute evidence, I use data from the 2015 and 2016 Medical Expenditure Panel Survey (MEPS) to examine whether a greater ratio of patient NP visits to total NP and physician visits is associated with a lower level of expenditures. Because of unobserved confounders, particularly those associated with the generally healthier case mixes of NPs, I estimate both an OLS and a 2SLS model. The 2SLS model uses as an instrument the percentage of providers at the respondent's usual source of care who are NPs or PAs. Patients' capacity for choice at the facility level is expected to be less than that at the provider level within facilities, thereby reducing the magnitude of selection bias. I find from the OLS model that an increase of one point in the percentage of visits to NPs is associated with a statistically significant decrease in expenditures of .24%. The corresponding 2SLS estimate is a decrease of 1.13%, but based on the commonly used cutoff of an F-statistic of 10, the instrument appears to be weak. I cannot rule out the possibility that these estimates are negative only because of selection bias. An extension of this analysis involving applying for access to restricted geographic information would enable merging MEPS data with county-level NP and physician counts from the Area Health Resource Files. County provider distribution may be a less endogenous instrument, alleviating concerns over selection bias.

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Section 1 Introduction

1.1 Nurse Practitioners as Independent Providers

Many sources point to an ongoing and projected shortage of primary care physicians, with an insufficient number of new medical students going into primary care to meet growing demand (Naylor and Kurtzman 2010; Petterson, Liaw, Tran, and Bazemore 2015). Some argue that this "shortage" arises not from a lack of physicians in total, but from a misallocation of physicians across geographical areas (Gudbranson, Glickman, & Emanuel 2017). Regardless, it is clear that there are gaps in access to primary care in the US. Nurse practitioners (NPs) are able to provide many of the basic services that primary care physicians do, including diagnosing patients and prescribing medications. NPs thus represent an opportunity to fill gaps in access to care.

However, even in the context of basic primary care services for less medically complex patients, there remains resistance from the physician community to the idea of NPs operating without physician supervision. In 2017, the American Medical Association (AMA) adopted a blanket resolution to oppose any new state laws that would grant independent practice authority to NPs in states that have not already granted it (AMA 2017). This issue is known as scope of practice expansion, and in 2019, the AMA claimed to have won dozens of state legislative victories in their fight against "scope of practice expansions that threaten patient safety" (AMA 2019). The view that independent NP practice is a patient safety threat persists despite the extensive evidence that NPs achieve outcomes in terms of quality of care and patient health and satisfaction that are on par with or better than those of physicians. This evidence has been documented in multiple systematic literature reviews, including Naylor and Kurtzman (2010), Newhouse et al. (2011), and Jennings et al. (2015).

According to the website of the American Association of Nurse Practitioners, 21 states have laws that restrict NP scope of practice, preventing NPs from independently diagnosing patients, prescribing medications, or otherwise practicing without physician supervision. These laws are a barrier to the potential for NPs filling gaps in access to care. Evidence has shown that NPs tend to move from states that restrict their practice to those that do not, and that lifting restrictions leads to improved health outcomes and increased utilization among underserved populations (Naylor and Kurtzman 2010; Xue et al. 2016; Traczynski and Udalova 2018). An analysis of Medicare claims data from 2008-2014 finds that most care provided by NPs or PAs without physician supervision was provided in rural areas, suggesting these providers improve access in those areas (Xue et al. 2017). This evidence, combined with the fact that an estimated 85% of NPs are trained to work in primary care (Riley, Litsch, and Cook 2016), suggests that state laws restricting NP scope of practice stand in the way of NPs who might otherwise be inclined to practice in areas that suffer from primary care provider shortages.

NPs are also well suited to addressing provider shortages in that they are able to complete their training faster and at lower cost than physicians. While one can become an NP with an 18-24 month Masters Degree, there has been a transition from the Master of Science in Nursing to the Doctor of Nursing Practice (DNP), which is preferred by the American Association of Colleges of Nursing as the more appropriate path for aspiring NPs (Riley, Litsch, and Cook 2016). Even so, DNP programs commonly require approximately three years of full-time post-baccalaureate study, and DNP students do not have to complete a multi-year post-graduate residency. This allows them to enter the primary care workforce as independent providers faster than medical students. On top of this, Riley et al. (2016) estimate that the per-year cost of a DNP program is just 40% of that of medical school.

NPs have a further cost-effectiveness advantage in terms of labor costs. An analysis performed by Roblin et al. (2004) of the labor costs of a set of primary care practices in a Managed Care Organization finds that practices employing a relatively high number of NPs and physician assistants (PAs) achieve labor costs per visit 3-6% lower than those of practices relying more extensively on physicians. One would expect NPs to be associated with lower labor costs given the NP and physician earnings gap; the Bureau of Labor Statistics' estimate of the 2018 median wage for NPs was $107,030, while the corresponding figure for physicians classified as family or general practitioners was over $200,000 (Bureau of Labor Statistics 2019a; Bureau of Labor Statistics 2019b).

Care provided independently by NPs can also directly save money for insurers. Medicare reimburses independently practicing NPs at 85% of the physician level, with many state Medicaid programs and private insurance companies employing similar reimbursement differentials (Brooks and Fulton 2019). There are, however, some caveats to this source of savings. First, NPs who are directly supervised by physicians may be reimbursed at the physician rate if they bill under the physician's provider number. This practice is likely more common in states with laws that prevent NPs from practicing independently (Perloff, DesRoches, and Buerhaus 2016), though the number of states that have such laws has been shrinking in recent years. Second, the practice of reimbursing NPs less than physicians for providing the same service is controversial, with some arguing that NP reimbursement rates should be brought up to physician rates (National Association of Pediatric Nurse Practitioners 2016). If basic primary care services provided by NPs are similar when compared to physician-provided services, it would seem sensible from an economic perspective that NP- and physician-provided services be priced at the same level, and the aforementioned evidence on NP patient health and satisfaction outcomes strengthens this argument. However, it is not clear what the ideal reimbursement level is. Raising NP reimbursement to the physician level could constitute a missed opportunity to take advantage of a rightward shift in the supply curve for primary care services, while reducing physician reimbursement down to the NP level could exacerbate gaps in the supply of providers. Whatever the theoretically ideal reimbursement scheme is, and however reimbursement practices may be changed in the future, the environment as it currently stands adds another cost advantage to the employment of NPs.

1.2 Literature on Expenditures of NP Patients

While NPs have advantages in education and labor costs, there is little evidence on whether the practice patterns of NPs differ from those of physicians in such a way as to increase patient medical expenditures, for example if NPs order lab tests more frequently. Few studies, particularly at the national level, have examined how the expenditures of NP-managed patients compare to those of physician-managed patients (Perloff, DesRoches, and Buerhaus 2016). Since patients are not typically randomly assigned to NPs or physicians, confounders such as unobserved health differences between patients make it difficult to obtain estimates of causal effects, with estimates expected to be biased by the relatively greater medical complexity of physicians' case mix. Perloff et al. perform, to their knowledge, the first long-term national study attempting to estimate the relationship between tendency to see NPs and patient expenditures. They use 12 months' worth of Medicare claims data from 2009-2010 and employ a propensity score weighted regression approach in an effort to address bias, but acknowledge that unobserved patient characteristics may still have biased their results. They attribute patients to either an NP or a physician based on whichever provider was associated with the greatest proportion of expenditures, with a minimum threshold of 30% required for attribution to a single provider. The claims data allow them to adjust for the NP reimbursement differential, and they find that adjusted Medicare Part B office-based expenditures were 18% lower among patients assigned to NPs. The difference unadjusted for the reimbursement differential was 29%.

Kralewski et al. (2015) also use Medicare claims, linking them to data on 85 medical practices from the Medical Group Management Association 2009 survey. This enables an analysis of the effect of employing NPs at the practice level. They specify the independent variable of interest as the ratio of NPs to NPs plus physicians at the practice. They find the relationship between this variable and Medicare costs to be non-linear, with the cost-maximizing ratio being .32 and costs declining as the ratio increases above .32. Again, however, Kralewski et al. acknowledge the endogeneity coming from the ability of practices to choose how many NPs to employ.

Additional local studies have focused on expenditures at retail clinics in Minnesota, which are relatively new provider settings that are located within retail stores to provide convenient access to care. The clinics are staffed primarily by NPs and PAs.

Mehrotra et al. (2009) examine costs and outcomes of care for patients with one of three acute conditions in a large Minnesota health plan. They find a $100 cost reduction for episodes of care initiated at retail clinics as compared to physician offices.

1.3 Goal and Organization of Paper

The goal of this paper is to contribute to the body of research on the medical expenditures of NP patients. I use data from the 2015-2016 Medical Expenditure Panel Survey (MEPS), a nationally representative survey of the non-institutionalized civilian US population. The main effect of interest is that of the tendency to see NPs during office-based visits on patient office-based medical expenditures. I estimate this effect at the patient level using patient-reported visit history. I use both ordinary least squares (OLS) and two-stage least squares (2SLS) models, with the instrument being the percentage of primary care providers at the respondent's usual source of care who are NPs or PAs. The idea behind this 2SLS approach is that patients' capacity for choice at the facility level is likely less than that for providers within facilities, thereby reducing the effect of selection bias on the results.

The remainder of this paper is organized as follows. Section 2 describes the data, explaining the structure of the MEPS and the variables used in the analysis. Section 3 provides a discussion of the specification of the models and the assumptions required to make causal interpretations from them. Section 4 presents descriptive statistics and model results, and Section 5 contains a summary of the findings, limitations, and possible extensions of this analysis.

Section 2 Data

2.1 MEPS Sampling Scheme

MEPS data are released each year by the Agency for Healthcare Research and Quality (AHRQ). This section contains a general overview of the structure of the survey, but a more detailed description may be found in documentation produced by the AHRQ for each survey year (AHRQ 2018c). Most of the data used in this paper come from the 2015 and 2016 MEPS Household Component (HC), which contain data at the patient level. The only variable used in this analysis that does not come from the HC is the instrumental variable, the percentage of providers at the respondent's usual office-based source of care who are NPs or PAs. That information comes from the Medical Organizations Survey (MOS), which was performed only in 2015 and 2016. This is the reason for limiting this analysis to only two years of data from the MEPS HC. The MOS data are available on the AHRQ website and contain HC respondents' ID numbers so that the two datasets can be merged. While HC data are also available on the AHRQ website, the HC data used in this paper were downloaded through IPUMS, a part of the Institute for Social Research and Data Innovation at the University of Minnesota (Blewett et al. 2019). The IPUMS website contains tools for selecting particular years of MEPS data and sets of variables, all with a single download. IPUMS researchers have also added some variables to the data, which provide additional value by, for example, combining information from MEPS variables that have changed slightly over time. Changes in the possible responses to a question about respondents' educational attainment, for instance, can make using MEPS variables across time difficult. IPUMS versions of these variables can combine these sets of codes into a single variable.

The MEPS employs an overlapping panel design, with a new panel selected for sampling each year and followed up with during the following year. Thus, each year of data contains respondents from two panels. Data are collected from each panel over the course of five rounds interspersed through the two years. MEPS data are actually collected from a subsample of respondents to the National Health Interview Survey, which uses a multi-stage stratified sampling design. The US land area is first split into primary sampling units (PSUs), usually defined by one or more counties. PSUs are split into strata based on the density of racial and ethnic minorities, with blacks, Hispanics, and Asians being oversampled. Sampling is performed at the household level. In the case of multiple families living within a single household, data are collected from one individual in each family. "Family" includes, but is not limited to, those related by blood, marriage, or foster care. College students living away from home during the school year are considered to be living in their parents' household. The final HC dataset for a given year contains one line per household per individual. The combined response rate for the two panels in the 2015 HC is 47.7%, and the rate for the 2016 HC is 46.0%. Those respondents who identified a usual source for office-based care and visited that source at least once during the year were eligible for sampling in the MOS. The response rate for the 2015 MOS is 86.2%, though sampling was done after removing approximately 2,000 MEPS respondents who refused to grant permission to contact their usual source of care from the pool of 15,000 who would have been eligible. The 2016 response rate is 76.6%, after removing roughly 2,000 of 14,000 eligible individuals.

MEPS HC data are collected through a combination of computer assisted interviews, self-administered questionnaires, and the MEPS Medical Provider Component (MPC). MPC data are obtained directly from respondents' medical providers and are used to supplement or replace information gathered through the interviews and self-administered questionnaire, improving the quality of the HC data. MOS data were obtained from individuals working at respondents' usual sources of care, and a variety of collection methods, including phone and email, were used.

The full 2015-2016 MEPS HC sample contains 70,082 observations, but the analysis requires substantially cutting the sample down. First, because the instrumental variable used in this analysis is a characteristic of respondents' usual source of care, respondents must report having such a source. This brings the sample down to 52,224 observations. Since the instrumental variable is taken from the MOS results, respondents must also have participated in that survey, leaving 15,611. The independent variable of interest is defined as the ratio of office-based NP visits to NP plus physician visits, which results in a case of division by zero for any individual with both zero physician visits and zero NP visits. Thus, 183 respondents who saw neither an NP nor a physician during the year are excluded. Some individuals report an implausibly high number of annual visits, so an additional 215 observations with greater than 52 visits are also dropped. Information on chronic medical conditions, important for controlling for differences in the case mixes of NPs and physicians, is only available for adults aged 18 or older, leaving 10,102 observations. Finally, some observations have zero expenditures despite having at least one visit. AHRQ documentation notes that this could occur in several scenarios: (1) care was provided pro bono, (2) the respondent was charged but did not pay, and (3) the visit was part of a series of visits covered under one payment. Scenario (3) can occur because MEPS expenditure variables attribute a given payment to the first visit that payment covers. This means, if a payment covers three visits but the first of those three occurred in 2014, and the second two occurred in 2015, expenditure in 2015 could be zero while the count of visits is two. Because these observations appear to have lower expenditures than they actually do, I drop them from the sample, leaving 10,037 observations for analysis.

A further limitation of the HC data is that they contain some individuals who were part of the civilian non-institutionalized population for only part of the year. This is referred to as being "out of scope" and it affects variables whose values accumulate over time, such as expenditures and the number of medical visits. For example, suppose an individual accumulates $500 of expenditure in January-August, joins the military beginning in September, and has an additional $200 in costs from September-December. Because the additional $200 was accumulated while the individual was out of scope, that individual's annual expenditure will appear in the data as $500. Approximately .6% of observations in the sample are affected by this issue. Mean annual totals will have a slight downward bias, but assuming that all impacted variables are biased downward in the same way, this issue should not adversely affect regression estimates.

2.2 Dependent Variable

The dependent variable for this analysis, patient office-based medical expenditures, includes both out of pocket and insurer expenditures. I considered using total medical expenditures, including those from hospital inpatient and outpatient care, as the dependent variable. However, I use office-based expenditures instead because the relationship between type of office-based provider seen and expenditures is likely stronger for office-based than for total expenditures. To the extent that less healthy patients are more likely to require hospital care, unobserved case mix bias is also expected to be stronger for total expenditures.

MEPS expenditure variables are heavily edited and missing data are imputed by AHRQ researchers. These edits incorporate information from the MPC, supplementing expenditure information obtained from patients themselves with information gathered directly from their sources of care. Issues addressed by AHRQ include estimating expenditure under capitated payment arrangements and the lack of awareness on the part of respondents that insurers generally pay discounted amounts. A more detailed description of this process can be found in the MEPS HC documentation produced by AHRQ (AHRQ 2018c). Approximately 75% of observations in the final dataset for analysis have partially or fully imputed expenditures. As a sensitivity analysis, results from a model estimated with these observations excluded is shown in Section 4.2.

Given the debate over reimbursement parity for physicians and NPs, it may be of interest to examine what portion of any cost differences between the two provider types is driven by the reimbursement differential. This cannot be done with MEPS data. However, to the extent that lower reimbursement rates for NPs may be considered an advantage of NP-provided care, it may be desirable to retain the reimbursement differential in the expenditure data. As long as the differential continues to exist, not adjusting for it should provide a more accurate picture of the effect of a transition toward independently provided NP care on expenditures. There will also be instances of NPs billing under a physician, in which case the reimbursement will be at the full physician rate. This will make the reimbursement differential less impactful on the results than a situation in which all NP care is billed independently, and the US could move closer to that situation if states continue to trend toward allowing NPs greater independence. That is, in a future in which the reimbursement differential is retained and more NPs bill independently, those two factors combined may contribute further to a possible association of NP-provided care with lower expenditures.

2.3 Independent Variable of Interest and Instrument

The independent variable of interest is the ratio of annual office-based NP visits to NP plus physician visits, expressed as a percentage, i.e. NP/(NP+physician)*100. This variable is calculated at the patient level using patient-reported visit history. "Office-based" excludes care provided in hospitals, nursing homes, and private homes. Because of the endogeneity arising from the ability of some patients to choose which provider type to see, I estimate the effect of this variable in a 2SLS model with the percentage of providers at the respondent's usual source of care who are NPs or PAs as the instrumental variable (IV). This variable is expected to be correlated with patients' percentage of visits to NPs while being less endogenous, presuming that the capacity for choice at the facility level is less than that at the provider level within facilities. As shown in Figure 1, the model makes assumptions about the relationships between the outcome, endogenous regressor, instrument, and unobserved confounders, which are discussed in Section 3.2.

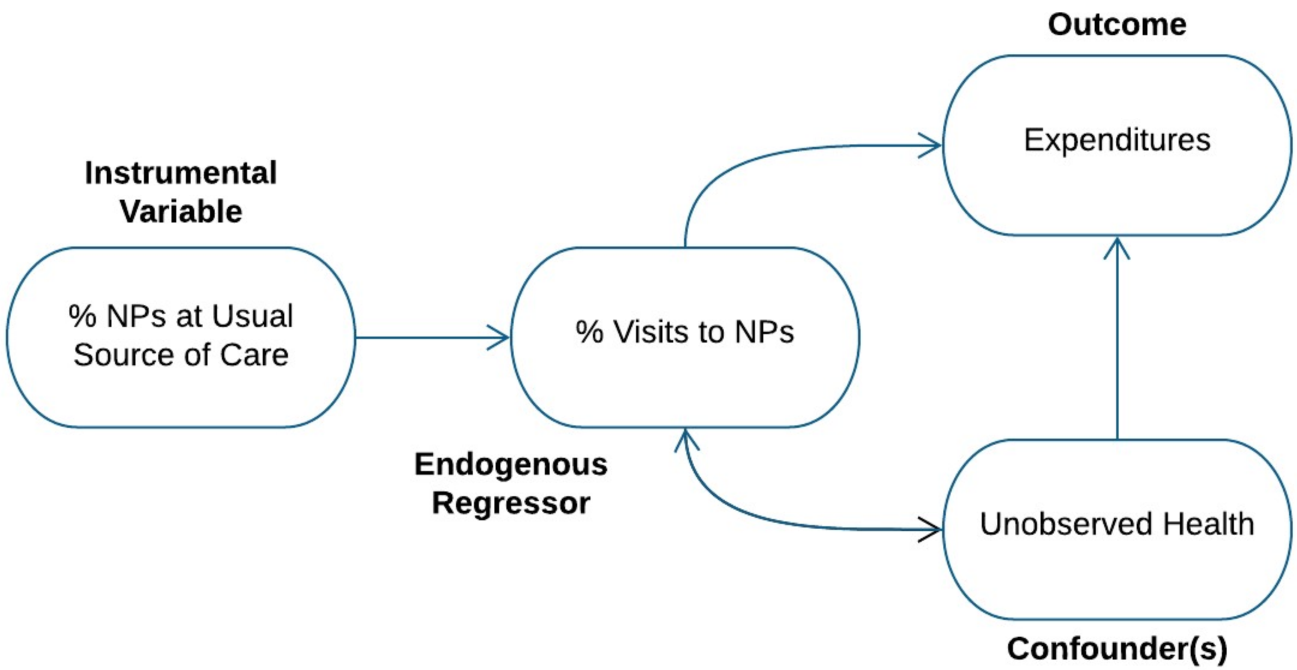
This IV has some limitations which may inhibit its strength. First, the lack of distinction made between NPs and PAs in the available provider counts causes the IV to be less correlated with visits to NPs than it would be if a count of NPs alone was available. Since NPs and PAs receive very different training, they may have different impacts on patient expenditures. Note, however, that the inclusion of PAs in the count does not result in a blurring of the estimated effect of NP-provided care with PA care; for the purposes of the 2SLS model, the IV may be thought of as a tool used only to identify the portion of the endogenous regressor that is unrelated to the unobserved confounder. Second, the count of NPs and PAs includes both part-time and full-time providers, with no weighting based on the number of hours worked. Thus, a facility could report having a relatively large number of NPs, but still have a relatively small number of patient visits to NPs if those NPs work few hours per week. Finally, the numbers of NPs/PAs and physicians at facilities were top-coded at the 99th percentile to preserve confidentiality. That is, for a facility with a number of providers equal to more than the 99th percentile in the raw data, the provider numbers are set at the 99th percentile in the public version of the data. This may have the effect of reducing the strength of the IV for patients at the largest facilities.

2.4 Controls

Because NPs tend to have healthier case mixes than physicians, it is important to control for patient health to the extent possible; uncontrolled health differences may result in the models conflating the effects of provider practice patterns and patient health. The models include two sets of health measures. The first set comes from the 12-item Short Form Survey (SF-12), developed by Ware Jr., Kosinski, and Keller (1996). SF-12 respondents answer a series of questions about how they feel and whether their health has interfered with their activities. The responses are combined into two scores designed to measure general health, the physical component score (PCS) and the mental component score (MCS). The scores generally range from 0 to 100 (negative values are possible but rare), with a higher score indicating better health. The scores cannot be computed unless information from all 12 questions is available, but cases of missing information are imputed by AHRQ using a proprietary method (AHRQ 2018c).

The second set of health measures is a series of indicators for ever having had medical conditions identified by AHRQ as “Priority Conditions” because of their prevalence and the existence of appropriate care standards for them. The list contains cancer, angina pectoris, arthritis/lupus/fibromyalgia, coronary heart disease, high cholesterol, diabetes, emphysema, heart attack, other heart condition, hypertension, and stroke. In a systematic review of multimorbidity measures, Diederichs, Berger, and Bartels (2011) note a lack of standardized practices for controlling for multimorbidity while avoiding overfitting. Nicholson, Almirall, and Fortin (2019) suggest three measures as possible candidates for this purpose. Two of the three, developed by Crabtree et al. (2000) and Bayliss, Elliss, and Steiner (2005), use a sum of conditions weighted by severity. However, using the exact versions of these measures is made difficult by the required use of a custom survey to compute the score and by differences between the lists of conditions included in the scores and those available in MEPS HC data. The third, developed by Upsher et al. (2012), uses a simple sum of conditions. For simplicity, I take this last approach, using indicators for having had one, two, three, or four or more Priority Conditions.

Figure 1. Instrumental Variable Chart.



The status of NP scope of practice law within a MEPS respondent's state would also seem to be an important factor to control for as it is likely related to the incidence of NPs billing under physicians, and it is possible that NPs working in states with different scope of practice laws have different practice patterns. Unfortunately, the publicly available MEPS data lack detailed geographic information, providing only census region. Geographic data down to the county level are available in a restricted dataset, which can be accessed through any of the Census Bureau's Federal Statistical Research Data Centers located throughout the country, but the application process for this would have taken too long to be feasible for this thesis.

To make use of what geographic information is available, I construct a variable for exposure to full NP scope of practice law for each possible combination of census region and year. The variable could range from zero to one and is weighted by (1) the number of states in a given census region during a given year that allowed full NP scope of practice, and (2) the states' populations. The calculation is done as follows: states that allowed full practice before the start of the year are assigned a one. Those that began allowing full practice during the year are assigned a number between zero and one based on the number of days in which the full practice law was in effect. These values are then weighted by the population of each state and summed by census region. For example, consider a state with a population of one million that expanded scope of practice on the 100^{th} day of 2015, located in a census region with a population of 10 million. For 2015, this state would be assigned a weighted exposure of $(1 - 100/365) \times 1{,}000{,}000/10{,}000{,}000 = .0726$. The exposures would be totaled for all states in that census region, and that total would be used as the final value of exposure for any individual living in that region.

The information on the passage of scope of practice expansion in each state is compiled primarily from the AANP website (2018) and the 22nd-25th Annual APRN Legislative Updates (Phillips 2010-2013), with supplemental information on specific dates of passage from various sources (Madler, Kalanek, and Rising 2012; Redmond, Palumbo, and Rambur 2012; Vestal 2013; North Dakota Legislative Branch; Gale 2017; Health Law Group Robinson & Cole 2019). State population data are taken from the US Census Bureau (2019). Table 1 shows the values of the variable, expressed as percentages, for each census region and study year. In the Midwest and especially in the Northeast and South, few people lived in states that allowed full scope of practice during 2015 and 2016. There was substantially more exposure among those living in the West; almost every state in that region allowed full scope of practice, but the exception of California keeps the exposure measure under 50%.

Table 1. Measure of Exposure to Full NP Scope of Practice.

Year	Census Region			
	Midwest	Northeast	South	West
2015	16.09%	7.75%	3.73%	44.67%
2016	16.64%	7.77%	5.47%	44.85%

Classification of state law as constituting an allowance of full NP scope of practice is taken primarily from the American Association of Nurse Practitioners (2018) and Phillips (2010-2013). Exposure calculated based on the population of each state and number of days during the year for which full scope of practice was allowed in a given state.

In order to account for the potential that the effects of scope of practice expansion may not be seen for a period of time after the expansion becomes law, I also consider versions of the variable with a one-year lag and a five-year lag. In the one-year version, the hypothetical state above would be treated as though the expansion took place on the 100th day of 2016. However, I find no meaningful change in results with either version (tables shown in Appendix A), and the non-lagged version is used for the results presented in Section 4. Because of this variable's very small number of distinct values and its conflation with geography, its effect should be interpreted with extreme caution.

I also control for insurance coverage, as it is expected to be related to patient health, utilization of care, and medical expenditures, with research showing links between these factors in multiple directions (Aron-Dine et al. 2013; Geruso and Layton 2017; Sommers, Gawande, and Baicker 2017). I control for respondents' coverage as the percentage of months during the year for which the individual had coverage from any private or public source on at least one day of the month. Approximately .4% of observations have monthly insurance data that is incomplete, with coverage information being missing for some months. It appears this can be almost entirely explained by individuals being out of scope for part of the year; only two observations are marked as being in scope the entire year and have incomplete insurance data. For those with incomplete data, the base of the percentage is adjusted downward from 12, so that an individual with 8 months of data and coverage on 4 of those 8 months would have a value of 50% for this covariate.

Finally, the models include a number of socioeconomic controls. Given links between health, access to care, and socioeconomic factors including income, education, race, and rurality (Braveman and Gottlieb 2014; Purnell et al. 2016; Thornton et al. 2016) these additional controls may serve to adjust for access to care and for health differences that the direct health measures discussed above are unable to capture. The control for family income contains payments from many sources other than employment, including business profits and losses, government welfare payments, and social security. Missing values are imputed by AHRQ (AHRQ 2018c). To preserve confidentiality, income is top-coded at the 99th percentile for each income source; that is, for any individual with income above the 99th percentile in the raw data, income is set at the 99th percentile in the publicly available data. To the extent that the marginal effect of income on medical expenditure is small for very high levels of income, this is not expected to cause significant problems in the regressions. There are also three cases of negative income, but these are left as is since they could plausibly be cases of business losses being greater in magnitude than the total of all positive income sources. Education is controlled for as a series of indicators for having completed a high school or associates degree, bachelors degree, graduate/professional degree, and other degree. This last category contains several hundred observations that have a code simply defined as “other degree,” as well as 33 observations for which the education data are missing. Covariates for race/ethnicity place respondents into categories for white non-Hispanic, black (including mixed black and other race), Hispanic non-black, and other (which includes Asian and indigenous peoples). Gender, expressed in MEPS data as a simple male vs. female binary, and age in years are controlled for as well. Finally, indicators for having a large family (four or more members) and living 1-2 hours and greater than 2 hours from one’s usual source of care are found to be predictive of expenditures and are also included. Travel time may be related to geography and access to care, while family size may help capture the effects of social relationships and having children.

Section 3 Methodology

3.1 Model Specification

Stratification, clustering, and subsetting the sample to adults with at least one office-based visit are accounted for in the estimation of standard errors using Stata's survey commands, "svyset" and the "svy" prefix, which estimate standard errors using Taylor linearization (StataCorp 2013). Stratification and PSU estimation variables from the MOS are used since participation in that survey is a more restrictive criterion than participation in the HC. There are also weights provided in the MOS data, which are intended to correct for HC nonresponse, HC respondents' denial of permission to contact their usual sources of care, nonresponse from their usual sources of care, and oversampling of racial/ethnic minorities (AHRQ 2018a). Applying the weights is necessary to obtain nationally representative descriptive statistics, but it is less clear whether survey weights are necessary in the context of regression analysis for the purpose of inference. In an article dedicated to this topic, Bollen et al. (2016) note a lack of standard practices among researchers, with the application of weights often being determined by tradition in the researcher's field rather than any analytical foundation. Empirical tests for the necessity of weighting exist but they are not well known, and they are often not easily implemented in commonly used statistical software. Use of these tests is further complicated in the context of this paper since most of them do not account for clustering. Weighting "just to be safe" is not necessarily the best practice either because unneeded weighting does not reduce bias and it reduces statistical power.

Solon, Haider, and Wooldridge (2015) also note widespread confusion on this subject, but they provide guidance with three potentially valid rationales for weighting: "(1) to achieve precise estimates by correcting for heteroskedasticity, (2) to achieve consistent estimates by correcting for endogenous sampling, and (3) to identify average partial effects in the presence of unmodeled heterogeneity of effects" (p. 301). Rationale (1) refers not to the use of survey weights specifically but rather to the more familiar use of WLS to correct for heteroskedasticity when the form of the weights for doing so is known. This can arise in situations where individual observations are actually group-level averages among groups of different sizes, in which case observations may be weighted by group size. This is not the situation for this analysis, and while heteroskedasticity seems likely in the context of medical expenditures, the weights to correct for this are not known. Rationale (2), however, is applicable to this analysis since MEPS weights are constructed using census region, race/ethnicity, sex, age, and most importantly, Metropolitan Statistical Area (MSA) status. MSA status is not provided in the publicly available data and therefore is not controlled for in this paper's models. Thus, to the extent that the dependent variable (expenditures) is related to the probability of sample selection through MSA status, it is important that the models be weighted. Rationale (3) also may apply if the effect of seeing NPs rather than physicians differs by race/ethnicity (since minorities were oversampled) or by any of the characteristics used to adjust the weights for nonresponse. However, Solon et al. note that even if there is unmodeled heterogeneity of effects, applying weights does not necessarily yield a consistent estimate of the population average partial effect because of differences between population subgroups in the variance of the predictor. These differences may cause inconsistency to be greater with weights, and weighting is thus not strictly preferred in this scenario. Since rationale (3) does not provide clear-cut guidance, I use weights on the basis of rationale (2).

Equation (1) below shows the OLS model (adjustment for weights is not shown for readability), where *log(ObExp)* is the natural log of the office-based medical expenditures of the respondent for the year, *PctNpVis* is the ratio of the respondent's office-based NP visits to the sum of their NP and physician visits (expressed as a percentage), *PctScopeExp* is exposure to state NP full scope of practice law (expressed as a percentage), and X is a vector of the controls discussed in Section 2: medical condition count, with the groups 0, 1, 2, 3, and 4+; physical and mental health score from the SF-12; income in thousands; the percentage of months during the year for which the respondent had insurance coverage on at least 1 day; age expressed as a categorical variable with the groups 18-39, 40-59, 60-79, and 80+; an indicator for male; race/ethnicity, with the groups white non-Hispanic, black, Hispanic, and other; educational attainment, with the groups less than high school, high school or associate's, bachelor's, graduate or professional, and other; an indicator for a family size of 4 or more; and, finally, travel time to usual source of care, with the groups less than 1 hour, 1-2 hours, and over 2 hours.

$$log(ObExp) = \beta_0 + \beta_1 PctNpVis + \beta_2 PctScopeExp + BX + \epsilon \quad (1)$$

$$PctNpVis = \alpha_0 + \alpha_1 PctNpPaUsc + \alpha_2 PctScopeExp + AX + \nu \quad (2)$$

$$log(ObExp) = \gamma_0 + \gamma_1 \widehat{PctNpVis} + \gamma_2 PctScopeExp + \Gamma X + u \quad (3)$$

$$log(ObExp) = \lambda_0 + \lambda_1 PctNpVis + \lambda_2 PctNpVis \times MedCon1 + \lambda_3 PctNpVis \times MedCon2 + \lambda_4 PctNpVis \times MedCon3 + \lambda_5 PctNpVis \times MedCon4Plus + \lambda_6 MedCon1 + \lambda_7 MedCon2 + \lambda_8 MedCon3 + \lambda_9 MedCon4Plus + \Lambda X' + \theta \ (4)$$

$$log(ObExp) = \omega_0 + \omega_1 PctNpVis + \omega_2 PctNpVis \times PCS + \omega_3 PCS + \Omega X'' + \psi \ (5)$$

Equations (2) and (3) show the 2SLS model, where *PctNpPaUsc* is the instrumental variable. It is defined as the ratio of the sum of NPs and PAs to the sum of NPs, PAs, and physicians at the respondent's usual source of care, expressed as a percentage. A limitation of a 2SLS model with only one instrument is that interaction effects involving the endogenous variable cannot be estimated. If NP practice patterns actually cause increases in expenditure, one might expect those increases to be greater among more medically complex patients. I thus explore the interaction of the percentage of visits to NPs with medical condition count and PCS only in additional OLS models, shown in Equations (4) and (5) respectively. Model results are presented in Section 4.

3.2 Assumptions Required for Causal Interpretation

A number of strict assumptions are required for causal interpretation of the estimated effect of seeing NPs. One important area of concern is measurement error. For a causal estimate, one must assume the error in expenditures is not correlated with the tendency to see NPs. That is, there must be no systematic overreporting or underreporting of expenditures among patients who see NPs compared to those who see physicians, or vice versa. AHRQ's imputation and editing process, which made use of some data taken directly from respondents' sources of care, may alleviate this concern. Measurement error in the percentage of visits to NPs is also of concern, particularly because the mean percentage of visits to NPs in the sample is substantially lower than the mean percentage of providers at respondents' usual sources of care who are NPs or PAs. This suggests that visits to NPs are sometimes reported as visits to physicians. Details on these descriptives are discussed in Section 4, but the reporting of NPs as physicians would bias the estimated effect of seeing NPs toward zero.

In the OLS model, one must assume that the tendency to see NPs is uncorrelated with the error term after controlling for the other predictors in the model, which is not likely to be the case. Because some patients have access to more than one provider type and can choose whether to see an NP or a physician, the OLS estimate is likely biased. The most obvious source of bias is unobserved health differences between patients who tend to see NPs and those who see physicians. NPs generally have healthier case mixes, meaning that an increase in the percentage of visits to NPs may be associated with lower expenditures because NP patients are healthier when they walk in the door. Thus, even if one compares the expenditures of NP- and physician-managed patients, and finds that NP patients tend to have lower expenditures, this difference could not necessarily be attributed to provider practice patterns. The difference could instead be driven by pre-existing differences in patient health that the provider has no influence over. In other words, propensity to see an NP is expected to be associated with better health, and better health is expected to be associated with lower expenditures. Thus, the coefficient on *PctNpVis* in Equation (1) is expected to be biased downward. It is also possible that a preference for NPs or physicians is associated with the way in which patients respond to provider care. For instance, if patients who prefer NPs are more likely to follow up on providers' suggestions for referrals or tests, expenditures may be affected. However, the direction of this potential source of bias is unclear.

An ideal scenario in which this bias could be addressed would be the availability of data from a randomized controlled trial in which a sample of patients is randomly assigned to either an NP or a physician as their primary care provider. Expenditures could then be tracked over time and compared among patients in the two groups. Any systematic differences could be attributed to provider type without worry of conflation from other patient characteristics since, on average, they would be the same due to the random assignment. However, no such data are available, and such an experiment would face constraints including availability of participants and other resources. An alternative best-case scenario would be access to data that captures all patient characteristics that are associated with both the tendency to see NPs and expenditures. These factors could then be controlled for in the OLS model, pulling them out of the error term so that seeing an NP is no longer correlated with the error. As discussed above, perhaps the most important such factor is patient health. Access to more detailed health information that might enable further multimorbidity measures, for instance, might reduce the degree of bias in the estimated effect of seeing NPs.

An alternative to both of the above scenarios is the use of the 2SLS model. Referred to as the exclusion restriction, the model assumes that the instrument's only effect on the outcome occurs through the endogenous regressor (referring back to Figure 1, the only arrow running from the IV bubble goes to the endogenous regressor). This is a strong assumption, and it is often difficult to find a variable that both meets it and is correlated with the endogenous regressor. One might try to imagine an exogenous shock in the supply of NP's, such as the implementation of an educational subsidy program at a particular point in time or in a randomly selected set of states. Patient exposure to the shock could then potentially be assumed to be associated with a greater likelihood to see an NP, without otherwise being correlated with health expenditures.

Given the lack of data from such an exogenous shock, one must make do with other potential instruments. One might propose, for instance, exposure to full NP scope of practice law. While patients as a collective may influence the politics of their states, the vast majority of patients presumably have little or no direct control over the law in their state at an individual level, which may mitigate concerns over patient selection. However, the measure of exposure available in the public MEPS data is extremely coarse. Despite the evidence cited in Section 1.2 that NPs tend to move to states that lift scope of practice restrictions, and that health care utilization among underserved populations increases in those states, I find that the measure does not have a statistically significant association with the tendency to see an NP. Access to restricted geographic data containing the state each patient resides in would give the measure variation within census region, and perhaps a significant association could be detected. Without such access, I am left with the instrument presented in this analysis, namely the percentage of providers at the patient's usual source of care who are NPs/PAs.

Given this available instrument, patient selection becomes a concern at the facility level rather than the provider level. To the extent that patients have less capacity for choosing a facility with a larger number of their preferred provider type than they do for choosing their preferred provider within facilities, bias due to unobserved health effects and other patient characteristics will be lessened. Since patients who prefer to see a physician over an NP may still seek out facilities where physicians are more readily available, even after controlling for observed health and socioeconomic factors, I cannot claim that the instrumental variable is completely exogenous. However, the instrument may help to lessen the degree of bias and bring estimates closer to the true causal effect than they otherwise would be.

Unfortunately, the correlation between the instrument and any health factors remaining in the error term of Equation (1) cannot be empirically estimated. However, if one assumes a similar degree of correlation between (a) the observed health factors and the instrument, and (b) unobserved health factors and the instrument, a finding of correlation between the former two factors would imply correlation between the latter two. This would be a cause for concern in attempting to make causal inference. I test for this by estimating a model with the instrument as the outcome, shown in Equation (6) (weights not shown for readability). The results are shown in Appendix B. With the exception of MCS, none of the observed health factors have a statistically significant relationship with the instrument. The effect of MCS is found to be weakly significant, which may cast some doubt on whether the 2SLS estimated effect has a lesser degree of bias than that estimated by OLS. However, from the results of an F-test for joint significance (also shown in Appendix B), the observed health factors taken as a collective are not statistically significantly associated with the instrument.

$$\begin{aligned} PctNpPaUsc = {} & \phi_0 + \phi_1 MedCon1 + \phi_2 MedCon2 + \phi_3 MedCon3 \\ & + \phi_4 MedCon4Plus + \phi_5 PCS + \phi_6 MCS + \Phi\Pi + \xi \quad (6) \end{aligned}$$

Use of 2SLS requires two further assumptions. First, the instrument must not be weak; that is, the percentage of providers at the respondent's usual source of care who are NPs/PAs must be sufficiently correlated with the percentage of the respondent's visits to NPs. In Figure 1, this assumption is shown as the arrow running from the instrument to the endogenous regressor. If the instrument is weak, 2SLS estimates may actually be further away from the true causal effect than OLS estimates. This assumption is tested in Section 4. Second, the monotonicity assumption must be satisfied; that is, there must not be individuals who see physicians rather than NPs as a result of their usual source of care having more NPs or PAs. Monotonicity cannot be empirically tested, but substantial violation of it would seem counterintuitive. If all of the requisite assumptions are met, the 2SLS estimate may be interpreted as the estimated effect among those for whom a greater number of NPs at their usual source of care prompts them to see NPs more often. Some individuals may seek out their preferred provider type regardless of the provider type distribution at their usual source of care. If NP-provided care affects these individuals' expenditures differently, the 2SLS estimated effect will be distinct from the population average effect. Patients in need of specialist care may fall into this camp if they have essentially no choice but to see a physician. However, these individuals fall outside NP scope of practice and are thus of less interest in a policy debate over whether independently practicing NPs can provide safe, cost-effective care in absence of the restrictive state scope of practice laws discussed in Section 1.

Section 4 Results

4.1 Descriptive Statistics

Descriptive statistics for continuous and categorical variables are shown in Tables 2 and 3 respectively, with both unweighted and weighted versions where applicable. As explained in Section 2.1, variables whose values accumulate over the course of the year, such as expenditures and insurance coverage, are affected by a small number of patients who went out of scope for part of the year. These are patients who became ineligible for continued participation in the survey at some point during the year. For example, a patient who begins military service would exit the civilian population. Any medical expenditures incurred during such service would not be included in the annual total. As expected, the skewness of medical expenditures is evident in the substantial gap between the mean and median expenditures. The minimum expenditure in the sample is $1, seemingly odd, but because AHRQ went through an editing and imputation process to improve the quality of the expenditure data, I do not re-edit observations with very small values. The minimum of income is actually negative, but as noted in Section 2, this is plausible as income includes business losses. The range of the full NP scope of practice exposure variable is substantial; a relatively large proportion of states in the West allow full NP practice, compared to a very small proportion in the South.

Also of note in Table 2 is the gap between the mean percentage of patient visits to NPs, 7.9%, and the percentage of NPs and PAs at patients' usual source of care, 28.1%. Given the large sample size, this difference is highly statistically significant; a statistically significant difference could be detected with a two-tailed z-test of two proportions even if the former figure was as high as 26.9% (see Appendix C for calculation). This raises the question of whether NP visits tend to be mistakenly reported as physician visits. There appears to be little in the way of studies examining whether patients have a tendency to confuse NPs and physicians. Studies such as Ritter et al. (2001) have examined how the number of self-reported medical visits compares to the number in medical records, but the focus is not on the misreporting of provider type. Ritter et al. document a series of 19 NP visits for allergy shots that were mistakenly coded as physician visits, but they do so in the context of explaining why physician visits might be miscounted, providing no data on the incidence of this particular mistake.

Some surveys have been conducted that ask patients about the difference between an NP and a physician. Maul et al. (2015) analyze results from one such survey with 371 patients in two outpatient clinics, approximately half of whom had seen an NP. They find that 83% reported having an understanding of how an NP differed from a physician. In a survey conducted on behalf of the AMA in 2018, 39% of respondents thought the holder of a "Doctor of Nursing Practice" was a medical doctor and 19% thought "nurse practitioner" was a type of medical doctor (American Medical Association 2018). However, the results of the survey do not appear to have been published in an academic journal and few details are provided beyond the sample size of 850, the method of contact (internet), the firm that conducted the survey, and the margin of error (+/- 3.5%). It does seem likely from these results that patients mistake NPs for physicians, but the precise extent of this confusion is unclear. This is especially so in the MEPS context of answering a multiple-choice question about the type of provider seen in which both “physician” and “nurse practitioner” are listed as possible answers, with respondents

Table 2. Descriptive Statistics.

Variable	Mean	Median	Std. Dev.	Min	Max	Mean - Weighted	Std. Dev. - Weighted
Office-based expenditures	1,672	727	3,248	1	98,531	1,832	3,253
% NP visits	7.9	0.0	20.4	0.0	100.0	8.5	21.1
% NPs & PAs at usual care source	28.1	25.0	23.0	0.0	100.0	27.4	22.2
% Full scope exposure	17.2	7.8	16.1	3.7	44.9	16.5	15.6
Family income	64,602	47,894	59,537	-204,643	582,848	79,425	66,454
PCS	45.3	49.4	15.6	0.0	100.0	46.2	14.7
MCS	49.5	52.8	14.9	0.0	100.0	50.5	13.7
% Months with insurance	91.8	100.0	24.9	0.0	100.0	94.3	20.7

N=10,037. Statistics are computed on MEPS Household Component data from 2015-2016 (see Section 2.1 for sample restrictions). NP – nurse practitioner. PA – physician assistant. PCS – 12-item Short-Form Health Survey physical component score. MCS – 12-item Short-Form Health Survey mental component score. % NP visits is patient's annual # of office-based visits to NPs divided by the total of NP and physician office-based visits, multiplied by 100. Patient usual source of care is identified by the patient via survey. % NPs & PAs at source is percentage of physician and non-physician providers. Scope of practice exposure is calculated by census region, based on states' population size and whether states allowed full NP scope of practice during the study period (see Section 2.4 for details).

Table 3. Frequencies.

	Unweighted %	Weighted %
Medical Condition Count		
0	24.2	24.1
1	20.3	20.9
2	18.4	18.4
3	15.3	15.1
4+	21.8	21.5
Age		
18-39	24.5	23.5
40-59	36.1	35.0
60-79	31.3	33.0
80+	8.2	8.5
Gender		
Female	61.5	58.6
Male	38.5	41.4
Race/Ethnicity		
White non-Hispanic	49.7	70.4
Black	18.8	11.0
Hispanic	23.4	11.2
Other	8.1	7.3
Education		
Less than high school	21.1	13.1
Bachelor's	15	18.6
Graduate/professional	9.5	13.2
High school or associates	47.7	48.1
Other	6.6	7.1
Family Size		
Less than 4	73.9	78.7
4 or more	26.1	21.3

	Unweighted %	Weighted %
Travel Time to Usual Source of Care		
60 minutes or less	98.5	98.6
61-120 minutes	1.3	1.2
Over 120 minutes	0.2	0.3

N=10,037. Frequencies are computed on MEPS Household Component data from 2015-2016 (see Section 2.1 for sample restrictions). Medical condition count is count of MEPS-defined Priority Conditions (see Section 2.4 for list). Patient usual source of care is identified by the patient via survey.

perhaps inferring from the presence of both answers that there is a difference between the two provider types.

Another possible explanation for the gap between reported visits and the number of NPs at care sources is that NPs tend to see fewer patients per week than physicians. Unfortunately, workweek length is not adjusted for in the Table 2 results because the MOS does not report full-time equivalents for providers at patients' sources of care. Thus, this gap could be driven by both shorter workweeks and greater amounts of time spent with patients, and there appears to be evidence for both factors. Buerhaus et al. (2015), reporting on data from the 2012 National Survey of Primary Care Nurse Practitioners and Physicians, find that primary care physicians see an average of 89 patients per week, while NPs see an average of 67. The same study finds that primary care physicians work an average of 45 hours per week, compared to 37 hours among NPs. In a 2010 literature review, Naylor and Kurtzman report that the body of evidence indicates NPs have higher consultation times. Swan et al. (2015) report that 3 of 4 studies included in their review found longer consultation times among NPs, with average differences ranging from 3.0-4.3 minutes per patient.

Separately comparing results from other studies that examine either only NP or only physician work characteristics appears to yield directionally similar findings, although differences in methodology and study population may color such comparisons. For instance, Bae and Champion (2016), find from the 2012 National Sample Survey of Nurse Practitioners that NPs on average work 39 hours and see 61 patients per week. White and Twiddy (2017), find from the 2015 American Association of Family Practitioners Practice Profile Survey that family physicians on average work 47 hours and see 80 patients per week. The findings of Morgan, Everett, and Hing (2014) are an exception to this pattern, as they find no differences between NP and physician consultation times or weekly visit volumes. However, they use data from Community Health Centers and note that visit times in those settings are often determined by the clinic. On the whole, evidence appears to indicate that differences in workweeks and consultation times, as well as patients' confusing of NPs with physicians, may explain the apparent gap in the second and third rows of Table 2.

Turning to the frequencies shown in Table 3, there is wide variation in the count of MEPS-defined Priority Conditions. Approximately three-quarters of patients have at least one condition, and over half have two or more. Table 3 also shows that females are overrepresented in the sample even after weighting. This is because females in the 2015-2016 MEPS-HC sample are more likely to have a usual source of care and at least one office-based visit, and therefore a larger number of females meet the criteria for inclusion in this analysis. Another notable disparity is that between the unweighted and weighted percentages of blacks and Hispanics, which reflects the MEPS' oversampling of minorities.

Table 4. Descriptive Statistics by Provider Type Seen.

Variable	>=50% Annual NP Visits			<50% Annual NP Visits		
	Mean	**Mean - Weighted**	**Median**	**Mean**	**Mean - Weighted**	**Median**
Office-based expenditures	1,107	1,090	494	1,715	1,893	747
% NP visits	72.7	73.0	66.7	2.9	3.2	0.0
% NPs & PAs at usual care source	38.6	37.5	37.5	27.2	26.5	25.0
% Full scope exposure	17.6	16.48	16.09	17.15	16.52	7.77
Family income	60,623	75,877	42,224	64,908	79,717	48,000
PCS	47.4	48.2	52.1	45.1	46.1	49.2
MCS	49.0	49.1	52.8	49.5	50.6	52.8
% Months with insurance	89.6	91.0	100.0	92.0	94.5	100.0
N		715			9,322	

Statistics are computed on MEPS Household Component data from 2015-2016 (see Section 2.1 for sample restrictions). NP – nurse practitioner. PA – physician assistant. PCS – 12-item Short-Form Health Survey physical component score. MCS – 12-item Short-Form Health Survey mental component score. % NP visits is patient's annual # of office-based visits to NPs divided by the total of NP and physician office-based visits, multiplied by 100. Patient usual source of care is identified by the patient via survey. % NPs & PAs at source is percentage of physician and non-physician providers. Scope of practice exposure is calculated by census region, based on states' population size and whether states allowed full NP scope of practice during the study period (see Section 2.4 for details).

Table 5. Frequencies by Provider Type Seen.

	% NP Visits >=50		% NP Visits <50	
	Unweighted %	**Weighted %**	**Unweighted %**	**Weighted %**
Medical Condition Count				
0	32.0	32.8	23.6	23.4
1	22.4	24.8	20.1	20.5
2	18.0	19.0	18.4	18.4
3	11.9	10.9	15.6	15.5
4+	15.7	12.5	22.3	22.2
Age				
18-39	34.3	33.7	23.7	22.6
40-59	36.4	38.3	36.0	34.8
60-79	23.8	23.4	31.9	33.8
80+	5.6	4.7	8.4	8.8
Gender				
Female	67.8	66.2	61.0	58.0
Male	32.2	33.8	39.0	42.0
Race/Ethnicity				
White non-Hispanic	64.2	79.0	48.6	69.7
Black	12.7	6.0	19.3	11.5
Hispanic	15.7	7.6	24.0	11.5
Other	7.4	7.4	8.2	7.3
Education				
Bachelor's	16.2	18.2	14.9	18.7
Graduate/professional	8.3	13.0	9.6	13.2
High school or associate's	49.5	47.6	47.6	48.1
Less than high school	18.6	14.2	21.3	13.0
Other	7.4	7.0	6.6	7.1
Family Size				
Less than 4	76.5	75.7	73.7	78.9
4 or more	23.5	24.3	26.3	21.1
Travel Time to Usual Source of Care				
60 minutes or less	98.7	99.1	98.5	98.5
61-120 minutes	1.1	0.8	1.3	1.2
Over 120 minutes	0.1	0.1	0.2	0.3
N	715		9,322	

N=10,037. Frequencies are computed on MEPS Household Component data from 2015-2016 (see Section 2.1 for sample restrictions). % NP visits is patient's annual # of office-based visits to NPs divided by the total of NP and physician office-based visits, multiplied by 100. Medical condition count is count of MEPS-defined Priority Conditions (see Section 2.4 for list). Patient usual source of care is identified by the patient via survey.

Tables 4 and 5 highlight the issue of bias caused by differences in NP and physician case mix. The tables show descriptives broken out by whether the majority of a patient's annual visits were to an NP. Patients who see NPs a majority of the time appear to be younger, have fewer Priority Conditions, and have lower expenditures. The difference in expenditures is particularly stark, with NP patients having 35.5% lower mean expenditure than physician patients. NP patients also have slightly higher mean PCS and slightly lower MCS, but those differences are difficult to interpret since PCS and MCS are summary scores computed from a variety of health-related survey questions. In terms of demographics, NP patients in the sample are more likely to be white and female. Also noteworthy is that mean exposure to full NP scope of practice is only marginally higher among NP patients, but as explained in Section 2.4 the measure of exposure is extremely coarse.

4.2 Model Results

Table 6 contains results from the OLS and 2SLS models shown in Section 3 as Equations (1)-(3). The coefficients for the OLS and the second stage of the 2SLS model are exponentiated for easier interpretation. The results indicate that seeing NPs more often is associated with lower expenditures. Unfortunately, however, under the commonly used cutoff of an F-statistic of ten, the instrument appears to be weak. As discussed in Section 3, this means it is not clear that the 2SLS model is producing an estimate that is closer to the true causal effect than the OLS estimate.

From the first stage of the 2SLS model, an increase of one point in the percentage of NPs/PAs at the respondent's usual source of care is associated with an increase of .13

points in the percentage of visits to NPs. In general, while some are statistically significant, most of the first stage estimated effects are small. Notably, outside of a slight positive association with PCS, there is largely insufficient evidence to conclude that the health status measures are associated with a greater tendency to see NPs. There is, however, a pattern of slightly fewer NP visits among older individuals. Blacks and Hispanics are also marginally less likely to see NPs, as are males.

From the OLS model, an increase of one point in the percentage of visits to NPs is associated with a statistically significant decrease in expenditures of .24%. An additional percentage point in exposure to full NP scope of practice is estimated to increase expenditures by .51%, but since exposure can only be calculated by census region this effect should be interpreted with extreme caution. Estimates for the controls are mostly intuitive. Having a larger number of MEPS Priority Conditions is associated with substantially increased expenditures; individuals with four or more are estimated to have 140% of the expenditures of those with none. Individuals who are healthier by the other physical health measure, PCS, are also estimated to have lower expenditures. MCS, however, is found to have no significant effect. Surprisingly, none of the age coefficients are statistically significant either; age was expected to be correlated with unobserved health and therefore to have a positive effect on expenditures, but the estimates are not significant after accounting for the health measures and other factors in the model. This may be partly explained by lower reimbursement rates for individuals 65 years and older on Medicare (Lopez et al. 2020), as compared to younger individuals less likely to have public insurance. The results for the indicators for travel time are perhaps unintuitive,

Table 6. Model Results.

Variable	OLS Exp. Coeff.	OLS Std. Err.	2SLS 2nd Stage Exp. Coeff.	2SLS 2nd Stage Std. Err.	2SLS 1st Stage Coeff.	2SLS 1st Stage Std. Err.
Instrument (% NP or PA at usual care source)	—	—	—	—	0.1348***	0.0171
% NP visits	0.9976***	0.0009	0.9887*	0.006	—	—
% Full scope	1.0051***	0.001	1.0049***	0.0012	-0.0169	0.0269
1 med condition	1.3832***	0.0750	1.3928***	0.0799	0.6983	1.0938
2 med conditions	1.4771***	0.0959	1.4904***	0.1031	0.8639	1.2769
3 med conditions	1.8482***	0.1322	1.8448***	0.1384	-0.2426	1.2565
4+ med conditions	2.4022***	0.1584	2.4058***	0.166	-0.0774	1.2475
PCS	0.9894***	0.0014	0.9899***	0.0015	0.0556**	0.0248
MCS	1.0009	0.0013	1.0003	0.0014	-0.0526*	0.0269
Age 40-59	0.9927	0.0427	0.9785	0.0423	-1.4954	1.0712
Age 60-79	1.0746	0.0582	1.0382	0.0628	-3.2788***	1.1932
Age 80+	1.132	0.0953	1.0762	0.0957	-4.7913***	1.3801
% months with insurance	1.0067***	0.0008	1.0065***	0.0008	-0.0219	0.0193
Family inc. (thous)	1.0015***	0.0003	1.0014***	0.0004	-0.0056	0.0052
Male	0.7362***	0.0237	0.7221***	0.0236	-2.1687***	0.7014
Black	0.6528***	0.0303	0.6210***	0.0371	-5.1119***	0.7882
Hispanic	0.8168***	0.0386	0.7769***	0.0465	-5.5709***	1.1085
Other race	0.6553***	0.0467	0.6427***	0.0486	-1.9157	1.7284
HS or assoc.	1.3006***	0.0697	1.2849***	0.0702	-1.0897	1.5326
Bachelors	1.7119***	0.107	1.6851***	0.1077	-1.1894	1.454
Grad. or prof.	1.7431***	0.1237	1.7208***	0.1271	-0.9857	1.6163
Other educ.	1.3957***	0.1118	1.3775***	0.1129	-1.18	1.7435
Family size 4+	0.7778***	0.0333	0.7711***	0.0333	-0.8658	0.8994
Travel time 1-2 hrs.	1.3515**	0.1592	1.3557**	0.1652	0.999	1.9025

Variable	OLS Exp. Coeff.	OLS Std. Err.	2SLS 2nd Stage Exp. Coeff.	2SLS 2nd Stage Std. Err.	2SLS 1st Stage Coeff.	2SLS 1st Stage Std. Err.
Travel time 2+ hrs.	0.3647***	0.0712	0.3405***	0.0726	-8.8001***	2.9614
Constant	350.92***	44.31	412.67***	64.20	12.86***	2.73
R^2	0.193		0.172		0.043	
N	10,037		10,037		10,037	
F	78.4		68.9		6.9	

* p<.1, ** p<.05, *** p<.01. Estimating equations shown as Equations (1)-(3) in Section 3.1 Coefficients for the OLS and 2nd stage of the 2SLS models are exponentiated. Models are estimated using MEPS Household Component data from 2015-2016 (see Section 2.1 for sample restrictions). NP – nurse practitioner. PA – physician assistant. PCS – 12-item Short-Form Health Survey physical component score. MCS – 12-item Short-Form Health Survey mental component score. % NP visits is patient's annual # of office-based visits to NPs divided by the total of NP and physician office-based visits, multiplied by 100. Patient usual source of care is identified by the patient via survey. % NPs & PAs at source is percentage of physician and non-physician providers. Scope of practice exposure is calculated by census region, based on states' population size and whether states allowed full NP scope of practice during the study period (see Section 2.4 for details). Medical condition count is count of MEPS-defined Priority Conditions (see Section 2.4 for list). Travel time is time to usual source of care from household.

although only about 20 observations fall into the category for 2 or more hours. It is not clear whether it takes them so long to reach their usual source of care because they live in a remote area or they have a preference for a specific provider who works far away.

The estimates for the controls from the 2SLS model are largely similar to those from the OLS model. The estimated effect of seeing NPs more often is actually lower than that from OLS, with an increase of one percentage point in that variable being associated with a decrease of 1.13% in expenditures. This is not consistent with the hypothesis that the instrumental variable would reduce downward bias caused by unobserved health differences between NP and physician patients, but as noted above the instrument does appear to be weak.

In addition to the issues of bias discussed in Section 3, the influence of outliers in the data is a concern for the results. This is especially so given the heavily skewed dependent variable. Unfortunately, use of Stata's survey commands to account for the complex MEPS sampling scheme severely limits the set of model diagnostic tools that can be used, including those for detecting outliers. To identify potentially influential observations, I obtain dfbetas for an OLS model estimated without accounting for the MEPS sampling scheme. This statistic is calculated for every observation, and it measures how the estimated coefficient of interest changes when a given observation is deleted. I consider any observation with dfbeta greater in absolute value than the commonly used cutoff of 2/sqrt(n), where n is the sample size, to be a potential outlier. I then examine what changes, if any, removing some of these observations causes in the effect of the percentage of visits to NPs estimated by the models that do account for the sampling scheme. Given the large sample size, no single observation when removed by itself substantially changes the estimate. Most observations identified as potentially influencing the slope downward are cases of patients who saw NPs a significant portion of the time and had low expenditures. The presence of such individuals is to be expected. There are also two observations for which no NPs were seen and expenditures were very high (in excess of $15,000). The removal of these two observations, along with potentially downward-influencing observations with expenditures less than $50, still does not result in a positive estimate for the effect of seeing NPs. The point estimate remains negative, although it is no longer statistically significant in either the OLS or the 2SLS models (results shown in Appendix D).

Table 7. Results from OLS Model with NP & Health Interaction.

Variable	Coefficient	95% CI
% NP visits	0.0017	(-0.0014, 0.0047)
Med condition x % NP visits		
1	-0.0079***	(-0.0119, -0.0039)
2	-0.0055**	(-0.0104, -0.0006)
3	-0.002	(-0.0065, 0.0024)
4+	-0.0056**	(-0.0111, -0.0001)
1 med condition	0.4004***	(0.2862, 0.5146)
2 med conditions	0.4439***	(0.3068, 0.5811)
3 med conditions	0.6413***	(0.4986, 0.7841)
4+ med conditions	0.9295***	(0.7958, 1.0633)
% Full scope	0.0051***	(0.0030, 0.0071)
PCS	-0.0107***	(-0.0134, -0.0079)
MCS	0.0008	(-0.0019, 0.0034)
Age 40-59	-0.0064	(-0.0915, 0.0786)
Age 60-79	0.0702	(-0.0369, 0.1774)
Age 80+	0.1237	(-0.0422, 0.2896)
% months with insurance	0.0066***	(0.0050, 0.0082)
Family inc. (thous)	0.0015***	(0.0008, 0.0022)
Male	-0.3104***	(-0.3744, -0.2464)
Black	-0.4296***	(-0.5210, -0.3382)
Hispanic	-0.2049***	(-0.2982, -0.1116)
Other race	-0.4188***	(-0.5595, -0.2780)
HS or assoc.	0.2607***	(0.1547, 0.3667)
Bachelors	0.5361***	(0.4114, 0.6609)
Grad. or prof.	0.5496***	(0.4097, 0.6895)
Other educ.	0.3354***	(0.1760, 0.4948)
Family size 4+	-0.2516***	(-0.3352, -0.1680)
Travel time 1-2 hrs.	0.3018**	(0.0721, 0.5315)
Travel time 2+ hrs.	-1.0046***	(-1.3664, -0.6428)
Constant	5.8345***	(5.5852, 6.0837)

R^2 = .195. N = 10,037. * p<.1, ** p<.05, *** p<.01. Estimating equation shown as Equation (4) in Section 3.1. Model is estimated using MEPS Household Component data from 2015-2016 (see Section

2.1 for sample restrictions). NP – nurse practitioner. PA – physician assistant. PCS – 12-item Short-Form Health Survey physical component score. MCS – 12-item Short-Form Health Survey mental component score. % NP visits is patient's annual # of office-based visits to NPs divided by the total of NP and physician office-based visits, multiplied by 100. Patient usual source of care is identified by the patient via survey. % NPs & PAs at source is percentage of physician and non-physician providers. Scope of practice exposure is calculated by census region, based on states' population size and whether states allowed full NP scope of practice during the study period (see Section 2.4 for details). Medical condition count is count of MEPS-defined Priority Conditions (see Section 2.4 for list). Travel time is time to usual source of care from household.

It may be that the care of relatively healthy patients is handled in a similar way by NPs and physicians, and any differences in practice patterns only manifest themselves with more medically complex patients. Or, to the extent that practice patterns do diverge when seeing healthier patients, the impact is small since the patient has a low underlying propensity for medical spending. Thus, if NP practice patterns actually lead to increases in expenditures, one might expect those increases to be greater among less healthy patients. Further, if NPs are less likely to see these patients in the first place, this effect may be covered up by a large number of healthier patients influencing the estimated effect shown in Table 6. As discussed in Section 4.1, it does appear from descriptive results that NP patients tend to have substantially lower medical spending, to be younger, and to have fewer MEPS Priority Conditions. From the first stage results of the 2SLS model, the medical condition count does not have a statistically significant effect on the share of NP visits, but higher PCS is associated with more NP visits, as is lesser age.

To address the possibility of an interactive effect, I estimate OLS models that interact the percentage of visits to NPs with PCS and with the count of medical conditions, allowing the effect of seeing an NP to differ depending on observed patient health. The interaction with PCS is not statistically significant, but as shown in Table 7,

Table 8. Model Results – Observations with Imputed Expenditure Excluded.

	OLS		2SLS 2nd Stage		2SLS 1st Stage	
Variable	Exp. Coeff.	Std. Err.	Exp. Coeff.	Std. Err.	Exp. Coeff.	Std. Err.
% NP or PA at usual care source	—	—	—	—	0.2046***	0.0372
% NP visits	0.9973**	0.0011	0.9932	0.007	—	—
% Full scope	1.0051**	0.0021	1.0047**	0.002	-0.0588	0.0414
1 med condition	1.1071	0.0995	1.1238	0.1188	3.9347*	2.1219
2 med conditions	1.1827	0.1322	1.1899	0.1423	1.3101	2.5657
3 med conditions	1.4680***	0.1681	1.4545***	0.1661	-1.5233	2.6281
4+ med conditions	1.4790***	0.2056	1.4680***	0.2063	-1.5148	2.3775
PCS	0.9908***	0.0024	0.9907***	0.0024	-0.0303	0.0752
MCS	1.0045*	0.0024	1.0045*	0.0025	0.0017	0.0601
Age 40-59	1.1374	0.094	1.1328	0.0948	-0.7104	1.706
Age 60-79	1.2420**	0.1083	1.2192**	0.117	-3.7262	2.3817
Age 80+	1.107	0.1798	1.0875	0.1819	-3.2825	2.8889
% months with insurance	1.0037***	0.0011	1.0036***	0.0011	-0.0405	0.0329
Family inc. (thous)	1.0016***	0.0005	1.0016***	0.0005	0.0008	0.0084
Male	0.8033***	0.0472	0.7979***	0.0521	-1.4128	2.0013
Black	0.6449***	0.0445	0.6243***	0.0552	-6.9703***	1.4416
Hispanic	0.7534***	0.0645	0.7344***	0.0714	-6.5627***	2.0023
Other race	0.7134***	0.081	0.7053***	0.0823	-2.6634	2.7657
HS or assoc.	1.2181**	0.1144	1.2186**	0.115	0.4963	2.0603
Bachelors	1.7659***	0.2224	1.7429***	0.2269	-2.6902	1.8071
Grad. or prof.	1.3836**	0.1972	1.3701**	0.2004	-0.9908	2.1634
Other educ.	1.3529**	0.1876	1.3616**	0.1891	2.1458	3.1213
Family size 4+	0.9584	0.0656	0.9472	0.0601	-2.218	1.6919
Travel time 1-2 hrs.	1.4907	0.3797	1.4892	0.3726	1.7959	3.4505
Travel time 2+ hrs.	0.5770***	0.0759	0.5569***	0.0795	-9.9533***	2.5672
Constant	196.32***	31.51	214.95***	44.18	13.59***	4.64
R^2	0.133		0.125		0.067	
N	2,680		2,680		2,680	
F	15.06		13.74		4.74	

* p<.1, ** p<.05, *** p<.01. Coefficients for the OLS and 2nd stage of the 2SLS models are exponentiated. Models are estimated using MEPS Household Component data from 2015-2016 (see Section 2.1 for sample

restrictions). NP – nurse practitioner. PA – physician assistant. PCS – 12-item Short-Form Health Survey physical component score. MCS – 12-item Short-Form Health Survey mental component score. % NP visits is patient's annual # of office-based visits to NPs divided by the total of NP and physician office-based visits, multiplied by 100. Patient usual source of care is identified by the patient via survey. % NPs & PAs at source is percentage of physician and non-physician providers. Scope of practice exposure is calculated by census region, based on states' population size and whether states allowed full NP scope of practice during the study period (see Section 2.4 for details). Medical condition count is count of MEPS-defined Priority Conditions (see Section 2.4 for list). Travel time is time to usual source of care from household.

some of the interaction terms with the medical condition count are significant. However, the results do not display a pattern reflective of an increasingly positive effect of seeing NPs as the number of medical conditions rises; the 95% confidence intervals included in Table 7 demonstrate that there is not enough precision in the estimates to infer such a pattern. It is worth noting, however, that one may observe differences in outcomes other than medical expenditures, even among healthier patients. For instance, there is evidence of NPs achieving greater patient satisfaction and higher consultation times (Naylor and Kurtzman 2010, Jennings et al. 2015, Swan et al. 2015).

As a final robustness check, Table 8 shows results from the main model estimated while excluding observations that have partially or fully imputed expenditure. This reduces the sample size by 73.3%, down from 10,037 to 2,680. Despite this enormous loss, the OLS estimate of the main effect remains mostly the same. From Table 8, an increase of one point in the percentage of visits to NPs is associated with a decrease of .27% in expenditures, compared to .24% from the main results in Table 6. There is greater change in the 2SLS estimate, moving from an associated decrease of 1.13% to a decrease of .68% with imputed data removed. However, the effect from the main results is only weakly statistically significant, and it is not significant with imputed expenditures excluded.

Section 5 Discussion

Relative to physicians, NPs have advantages in terms of lower labor costs and faster training, and they thus represent an opportunity for improving access to healthcare and containing costs. However, there has been pushback to the idea of independently practicing NPs, particularly among physician groups. These physician groups point to the shorter duration of NP educational programs relative to physician training as a risk for NP-managed patients. This view contrasts with extensive evidence in the literature that NPs achieve patient satisfaction and health outcomes that are as strong as, and in some cases stronger than, those of physicians (Naylor and Kurtzman 2010; Newhouse et al. 2011; Jennings et al. 2015). However, there is less evidence, particularly at the national level, on whether or how NP practice patterns affect patient medical expenditures. This paper uses data from the nationally representative Medical Expenditure Panel Survey (MEPS) in an effort to contribute such evidence.

My results are consistent with NP practice patterns having either no relationship or a negative association with expenditures. Estimated effects from both an OLS model and a 2SLS model using the proportion of providers who are NPs or PAs at the respondent's usual source of care as the instrument are negative, with the former being statistically significant and the latter being weakly so. A variable measuring the respondent's exposure to full NP scope of practice state law is estimated to have a substantial positive expenditure effect, but the limited geographic information available in the data mean that exposure can only be calculated by census region. A lack of distinct values and conflation with geography is thus of particular concern for this estimated effect.

Differences in study population and methodology make direct comparisons of this paper's findings to those of prior studies difficult. The most comparable study is perhaps Perloff et al. (2016), but there are still major differences in population, the source of data, and available controls. Perloff et al. use Medicare claims data and assign patients to NPs or physicians based on the proportion of each patient's paid amounts associated with a given provider, with a minimum threshold of 30% required for attribution. With no adjustment for the lower reimbursement rate for independently practicing NPs (the most comparable estimate since this paper does not make the adjustment), they find a 29% expenditure reduction for NP patients. The magnitude of this estimate would seem to be greater than that from either model in this study, with the OLS estimate suggesting an increase of 30 points in the percentage of visits to NPs is associated with an expenditure decrease of about 7%. However, the direction of this paper's estimate is consistent with both that of Perloff et al. and studies of NP-staffed retail clinics, though the latter are limited to a particular care setting in Minnesota (Mehrotra et al. 2009).

The analysis in this paper has a number of important limitations. The estimates are likely biased by unobserved health differences between NP and physician patients. NP patients are likely to be healthier on average than physician patients when they walk in the office door for care, and therefore expenditure differences between physician and NP patients cannot be solely attributed to differences between physician and NP practice patterns. Put in terms of the model estimates presented in this paper, propensity to see an NP for care is expected to be negatively correlated with the number and severity of health problems, and health problems to be positively correlated with medical expenditures. Therefore, the estimated effect of seeing an NP on expenditures is expected to be biased downward. Conflation with patient preferences, geography, and other unobservables is also of concern. Unfortunately, the instrument meant to partially address this bias appears to be weak. A regression of the instrument on the controls included in the main OLS and 2SLS models shows a weakly statistically significant association of the instrument with MCS, which may raise doubt about the instrument's exogeneity with respect to unobserved health factors. However, the observed health measures were found not to have a jointly significant association with the instrument.

The expenditures of patients who saw independently practicing NPs are also affected by the lower reimbursement rate received by NPs who bill independently, but to the extent that this differential is likely to exist going forward, it is a built-in advantage to the utilization of independently practicing NPs. If more states continue to expand NP scope of practice law and grant NPs independence, the reimbursement differential may have a greater impact going forward. The survey data used in this paper are also self-reported and thus prone to measurement error. This issue is evident in the discrepancy between the sample mean percentage of visits to NPs and the mean percentage of NPs/PAs at patients' usual sources of care, as well in the implausibly high number of annual office-based visits reported by some respondents. A number of variables used, including expenditures, had some missing values that were imputed by AHRQ. Excluding observations with imputed expenditures does not result in substantial changes to the main effect estimated by OLS. There is greater change in the 2SLS estimate, but this effect lacks statistical significance both with and without imputed values included. Finally, this analysis is limited to those with a usual source of care and at least one office-based visit to an NP or a physician. These individuals may tend to have greater health complications and they may be less likely to fall within NP scope of practice as a result. Generalizability is thus an issue if NP practice patterns have different effects for individuals who do not regularly see a provider. Nonresponse is also a concern with survey data, though weights constructed by AHRQ are meant to alleviate this.

Two possible extensions of this analysis could address some limitations. First, more detailed health status information could be obtained from the publicly available MEPS Medical Conditions files, which contain International Classification of Diseases (ICD) codes (AHRQ 2018b). This could potentially enable the construction of a more nuanced control for medical conditions than was used in this analysis. The inclusion of such a control may reduce the degree of correlation between the main effect of interest and the error term, and in turn reduce the degree of bias. However, the switch to the tenth generation of ICD in 2016, as well as a restriction to only three digits in the ICD codes, would complicate this. Second, researchers can apply for access to restricted geographic data from the MEPS. This would allow the data to be merged with information from the Area Health Resource Files (AHRF). The AHRF are available from the Health Resources and Services Administration, and they contain information on provider numbers down to the county level. Access to such information would strengthen the analysis in a number of ways. It would enable a 2SLS model with the percentage of providers in the respondent's county who are NPs as the instrument, which is likely less endogenous than the instrument used in this paper. Since the AHRF provider counts distinguish between NPs and PAs, it would also remove dilution from PAs being lumped in with NPs for the provider counts used to construct the instrument in this analysis. Because of the structure of the 2SLS model, this dilution does not imply that the estimated effect of visits to NPs is blurred with the effect of seeing PAs. However, removing PAs from the count may strengthen the correlation of the instrument with the independent variable of interest and therefore reduce the degree of bias in the estimate. Finally, the AHRF provider counts would enable the use of a much larger sample since participation in the Medical Organizations Survey would no longer be required.

In summary, the results of this analysis suggest that NP care, relative to physician care, is associated with either reduced or similar levels of patient expenditure. These findings are consistent with the limited prior evidence on expenditures that is available. The results may be explained by the extensive evidence in the literature that NPs provide high quality care and achieve strong patient health outcomes. However, the limitations discussed above are a barrier to causal inference, and I cannot rule out the possibility that they are a driver of the results.

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Appendix

A. Model Results Using Lagged Version of Scope of Practice Exposure

Table A1. Model Results with 1-Year Lagged Version of Scope of Practice Exposure.

	OLS		2SLS 2nd Stage		2SLS 1st Stage	
Variable	Exp. Coeff.	Std. Err.	Exp. Coeff.	Std. Err.	Coeff.	Std. Err.
Instrument (% NP or PA at usual care source)	—	—	—	—	0.1348***	0.0171
% NP visits	0.9976***	0.0009	0.9889*	0.0060	—	—
% Full scope – 1 year lag	1.0053***	0.0010	1.0051***	0.0011	-0.0152	0.0258
1 med condition	1.3844***	0.0750	1.3938***	0.0799	0.6963	1.0937
2 med conditions	1.4781***	0.0959	1.4911***	0.1029	0.8622	1.2766
3 med conditions	1.8499***	0.1322	1.8466***	0.1383	-0.2426	1.2567
4+ med conditions	2.4065***	0.1585	2.4100***	0.1659	-0.0781	1.2473
PCS	0.9894***	0.0014	0.9899***	0.0015	0.0556**	0.0248
MCS	1.0009	0.0013	1.0004	0.0014	-0.0526*	0.0269
Age 40-59	0.9911	0.0427	0.9772	0.0423	-1.4917	1.0713
Age 60-79	1.073	0.0581	1.0373	0.0626	-3.2764***	1.1939
Age 80+	1.1287	0.0952	1.0741	0.0956	-4.7829***	1.3811
% months with insurance	1.0067***	0.0008	1.0065***	0.0008	-0.0219	0.0193
Family inc. (thous)	1.0015***	0.0003	1.0014***	0.0004	-0.0056	0.0052
Male	0.7363***	0.0237	0.7225***	0.0236	-2.1686***	0.7012
Black	0.6543***	0.0303	0.6230***	0.0371	-5.1053***	0.7916
Hispanic	0.8135***	0.0383	0.7744***	0.0462	-5.5717***	1.1063
Other race	0.6526***	0.0464	0.6402***	0.0483	-1.9182	1.7306
HS or assoc.	1.3010***	0.0697	1.2856***	0.0702	-1.0895	1.5327
Bachelors	1.7104***	0.1068	1.6842***	0.1076	-1.1853	1.4541
Grad. or prof.	1.7426***	0.1237	1.7207***	0.1271	-0.9832	1.6162

Variable	OLS Exp. Coeff.	OLS Std. Err.	2SLS 2nd Stage Exp. Coeff.	2SLS 2nd Stage Std. Err.	2SLS 1st Stage Coeff.	2SLS 1st Stage Std. Err.
Other educ.	1.3948***	0.1118	1.3770***	0.1129	-1.1727	1.7440
Family size 4+	0.7775***	0.0332	0.7710***	0.0332	-0.8640	0.8994
Travel time 1-2 hrs.	1.3509**	0.1599	1.3550**	0.1658	0.9921	1.8997
Travel time 2+ hrs.	0.3681***	0.0709	0.3440***	0.0723	-8.8253***	2.9700
Constant	353.89***	44.58	414.77***	64.27	12.80***	2.73
R^2	0.193		0.173		0.043	
N	10,037		10,037		10,037	
F	78.6		69.2		6.8	

* p<.1, ** p<.05, *** p<.01. Coefficients for the OLS and 2nd stage of the 2SLS models are exponentiated. Models are estimated using MEPS Household Component data from 2015-2016 (see Section 2.1 for sample restrictions). NP – nurse practitioner. PA – physician assistant. PCS – 12-item Short-Form Health Survey physical component score. MCS – 12-item Short-Form Health Survey mental component score. % NP visits is patient's annual # of office-based visits to NPs divided by the total of NP and physician office-based visits, multiplied by 100. Patient usual source of care is identified by the patient via survey. % NPs & PAs at source is percentage of physician and non-physician providers. Scope of practice exposure is calculated by census region, based on states' population size and whether states allowed full NP scope of practice during the study period (see Section 2.4 for details). Medical condition count is count of MEPS-defined Priority Conditions (see Section 2.4 for list). Travel time is time to usual source of care from household.

Table A2. Model Results with 5-Year Lagged Version of Scope of Practice Exposure.

Variable	OLS		2SLS 2nd Stage		2SLS 1st Stage	
	Exp. Coeff.	Std. Err.	Exp. Coeff.	Std. Err.	Coeff.	Std. Err.
Instrument (% NP or PA at usual care source)	—	—	—	—	0.1348***	0.0171
% NP visits	0.9976***	0.0009	0.9889*	0.0060	—	—
% Full scope – 5 year lag	1.0056***	0.0010	1.0054***	0.0011	-0.0153	0.0268
1 med condition	1.3849***	0.0751	1.3943***	0.0799	0.6956	1.0940
2 med conditions	1.4774***	0.0958	1.4904***	0.1028	0.8636	1.2770
3 med conditions	1.8474***	0.1320	1.8442***	0.1380	-0.2378	1.2585
4+ med conditions	2.4065***	0.1583	2.4100***	0.1656	-0.0763	1.2486
PCS	0.9894***	0.0014	0.9899***	0.0015	0.0556**	0.0248
MCS	1.0009	0.0013	1.0004	0.0014	-0.0527*	0.0269
Age 40-59	0.9901	0.0426	0.9763	0.0422	-1.4895	1.0719
Age 60-79	1.0719	0.0579	1.0363	0.0625	-3.2744***	1.1947
Age 80+	1.1254	0.0950	1.0711	0.0953	-4.7752***	1.3819
% months with insurance	1.0067***	0.0008	1.0065***	0.0008	-0.0219	0.0193
Family inc. (thous)	1.0014***	0.0003	1.0014***	0.0004	-0.0056	0.0052
Male	0.7365***	0.0237	0.7226***	0.0236	-2.1689***	0.7011
Black	0.6518***	0.0301	0.6208***	0.0370	-5.0896***	0.7919
Hispanic	0.8084***	0.0382	0.7698***	0.0461	-5.5601***	1.1134
Other race	0.6493***	0.0460	0.6370***	0.0479	-1.9101	1.7393
HS or assoc.	1.3015***	0.0701	1.2861***	0.0705	-1.0900	1.5325
Bachelors	1.7093***	0.1071	1.6832***	0.1077	-1.1830	1.4537
Grad. or prof.	1.7412***	0.1239	1.7195***	0.1271	-0.9804	1.6161
Other educ.	1.3967***	0.1122	1.3789***	0.1132	-1.1745	1.7429
Family size 4+	0.7779***	0.0332	0.7713***	0.0332	-0.8650	0.9000
Travel time 1-2 hrs.	1.3490**	0.1601	1.3531**	0.1662	0.9930	1.9006

Variable	OLS Exp. Coeff.	OLS Std. Err.	2SLS 2nd Stage Exp. Coeff.	2SLS 2nd Stage Std. Err.	2SLS 1st Stage Coeff.	2SLS 1st Stage Std. Err.
Travel time 2+ hrs.	0.3698***	0.0710	0.3455***	0.0724	-8.8353***	2.9743
Constant	359.78***	45.11	421.29***	64.96	12.74***	2.71
R^2	0.193		0.174		0.043	
N	10,037		10,037		10,037	
F	78.8		69.4		6.7	

* p<.1, ** p<.05, *** p<.01. Coefficients for the OLS and 2nd stage of the 2SLS models are exponentiated. Models are estimated using MEPS Household Component data from 2015-2016 (see Section 2.1 for sample restrictions). NP – nurse practitioner. PA – physician assistant. PCS – 12-item Short-Form Health Survey physical component score. MCS – 12-item Short-Form Health Survey mental component score. % NP visits is patient's annual # of office-based visits to NPs divided by the total of NP and physician office-based visits, multiplied by 100. Patient usual source of care is identified by the patient via survey. % NPs & PAs at source is percentage of physician and non-physician providers. Scope of practice exposure is calculated by census region, based on states' population size and whether states allowed full NP scope of practice during the study period (see Section 2.4 for details). Medical condition count is count of MEPS-defined Priority Conditions (see Section 2.4 for list). Travel time is time to usual source of care from household.

B. Regression of Instrument on Health Measures and Other Controls

Estimating equation:

$$PctNpPaUsc = \phi_0 + \phi_1 MedCon1 + \phi_2 MedCon2 + \phi_3 MedCon3 + \phi_4 MedCon4Plus + \phi_5 PCS + \phi_6 MCS + \Phi\Pi + \xi \quad (6)$$

The vector Π contains the full set of controls used in the main OLS and 2SLS models and shown in the table below.

Table B1. Regression of Instrument on Health Factors and Other Controls.

Variable	Coeff.	Std. Err.
1 med condition	0.5589	1.1304
2 med conditions	1.0375	1.3188
3 med conditions	0.2742	1.6057
4+ med conditions	1.8198	1.3850
PCS	0.0070	0.0261
MCS	-0.0485*	0.0282
% Full Scope	-0.0569*	0.0313
Family inc. (thous.)	-0.0245***	0.0069
% months with insurance	-0.0297*	0.0154
Age 40-59	-0.8970	0.9610
Age 60-79	-4.4231***	1.1213
Age 80+	-6.6951***	1.5357
Male	-0.0737	0.5539
Black	-3.7781***	1.1605
Hispanic	-0.4450	1.2160
Other Race	-2.0726	1.6312
HS or Assoc	-2.0057*	1.0975
Bachelors	-4.3324***	1.3342
Grad. or prof.	-3.4201**	1.4864
Other educ.	-2.1928	1.6442
Family size 4+	-0.7983	0.9092
Travel time 1-2 hrs.	-4.8033*	2.6222
Travel time 2+ hrs.	8.0165**	3.2009
Constant	39.9942***	2.3484
R^2 = .025 N = 10,037	* p<.1, ** p<.05, *** p<.01	

Instrument is % of providers at patient's self-identified usual source of care who are NPs or PAs. Model estimated using MEPS Household Component data from 2015-2016 (see Section 2.1 for sample restrictions). PCS – 12-item Short-Form Health Survey physical component score. MCS – 12-item Short-Form Health Survey mental component score. Scope of practice exposure is calculated by census region, based on states' population size and whether states allowed full NP scope of practice during the study period (see Section 2.4 for details). Medical condition count is count of MEPS-defined Priority Conditions (see Section 2.4 for list). Travel time is time to usual source of care from household.

F-test for joint significance of health factors:

H_0: $\phi_1 = \phi_2 = \phi_3 = \phi_4 = \phi_5 = \phi_6 = 0$

H_a: H_0 is false

F-stat: 1.26

p-value: 0.279

C. z-test of Two Proportions for Percent NP Visits and Percent NP/PA Providers at Care Source

$p \equiv$ Pooled sample proportion

$\mathrm{p_v} \equiv$ Sample proportion, visits to NPs

$p_p \equiv$ Sample proportion, providers at care source who are NPs/PAs

$SE \equiv$ Standard error

n ≡ Sample size, $n = n_v = n_p = 10{,}037$

$$p = \frac{p_v n_v + p_p n_p}{n_v + n_p} = \frac{10037 p_v + .281 \times 10037}{10037 + 10037} = \frac{p_v + .281}{2}$$

$$SE = \sqrt{p(1-p)\left(1/n_p + 1/n_v\right)}$$

$$= \sqrt{\left(\frac{p_v + .281}{2}\right)\left(1 - \frac{p_v + .281}{2}\right)\left(\frac{1}{10037} + \frac{1}{10037}\right)}$$

$$= \sqrt{\left(\frac{p_v + .281}{2}\right)\left(\frac{2 - p_v - .281}{2}\right)\left(\frac{2}{10037}\right)}$$

$$= \sqrt{\left(\frac{1}{20074}\right)(p_v + .281)(2 - p_v - .281)}$$

$$= \sqrt{\left(\frac{1}{20074}\right)\big(2(p_v + .281) - p_v(p_v + .281) - .281(p_v + .281)\big)}$$

$$= \sqrt{\frac{1}{20074}(2p_v + .562 - p_v^2 - .281p_v - .281p_v - .079)}$$

$$= \sqrt{\frac{1}{20074}(-p_v^2 + 1.438p_v + .483)}$$

$$z = \frac{p_v - p_p}{SE}$$

$$= \frac{p_v - .281}{\sqrt{\frac{1}{20074}(-p_v^2 + 1.438p_v + .483)}}$$

To achieve significance at the 5% level with a two-tailed test, we set $z = -1.960$:

$$-1.960 = \frac{p_v - .281}{\sqrt{\frac{1}{20074}(-p_v^2 + 1.438p_v + .483)}}$$

$$\Rightarrow \; p_v = .2687$$

D. Model Results with Potential Downward-Influencing Outliers Excluded.

Table D1. Model Results—Potential Downward-Influencing Outliers Excluded.

	OLS		2SLS 2nd Stage		2SLS 1st Stage	
Variable	Exp. Coeff.	Std. Err.	Exp. Coeff.	Std. Err.	Coeff.	Std. Err.
Instrument (% NP or PA at usual care source)	—	—	—	—	0.1269***	0.0165
% NP visits	0.9987	0.0008	0.9905	0.0063	—	—
% Full scope	1.0049***	0.0010	1.0048***	0.0011	-0.0112	0.0266
1 med condition	1.3771***	0.0737	1.3849***	0.0779	0.6154	1.1045
2 med conditions	1.4664***	0.0934	1.4801***	0.1003	0.9847	1.3059
3 med conditions	1.8308***	0.1294	1.8312***	0.1348	-0.0103	1.2724
4+ med conditions	2.3968***	0.1541	2.4020***	0.1617	0.0283	1.2371
PCS	0.9894***	0.0014	0.9899***	0.0015	0.0544**	0.0236
MCS	1.0007	0.0013	1.0003	0.0013	-0.0453*	0.0253
Age 40-59	0.9969	0.0423	0.9833	0.0421	-1.5506	1.0610
Age 60-79	1.0756	0.0574	1.0425	0.0623	-3.2279***	1.1652
Age 80+	1.1531*	0.0954	1.0981	0.0975	-5.0685***	1.3544
% months with insurance	1.0065***	0.0008	1.0064***	0.0008	-0.0106	0.0176
Family inc. (thous)	1.0015***	0.0003	1.0014***	0.0004	-0.0064	0.0052
Male	0.7381***	0.0234	0.7246***	0.0237	-2.2252***	0.6806
Black	0.6600***	0.0305	0.6299***	0.0382	-5.1637***	0.7647
Hispanic	0.8189***	0.0388	0.7831***	0.0468	-5.3625***	1.0713
Other race	0.6580***	0.0471	0.6456***	0.0486	-2.0432	1.6752
HS or assoc.	1.3001***	0.0690	1.2870***	0.0708	-0.9797	1.3846
Bachelors	1.7046***	0.1077	1.6832***	0.1092	-0.9846	1.3194
Grad. or prof.	1.7308***	0.1252	1.7148***	0.1287	-0.7068	1.4912
Other educ.	1.3900***	0.1133	1.3759***	0.1149	-0.9646	1.6335
Family size 4+	0.7723***	0.0336	0.7673***	0.0332	-0.6995	0.8948

Variable	OLS		2SLS 2nd Stage		2SLS 1st Stage	
	Exp. Coeff.	Std. Err.	Exp. Coeff.	Std. Err.	Coeff.	Std. Err.
Travel time 1-2 hrs.	1.3462**	0.1574	1.3510**	0.1627	1.0388	1.9213
Travel time 2+ hrs.	0.3654***	0.0704	0.3433***	0.0719	-8.5907***	2.9526
Constant	359.08***	44.46	410.92***	61.96	11.30***	2.41
R^2	0.192		0.174		0.040	
N	10,014		10,014		10,014	
F	75.6		68.5		7.0	

* p<.1, ** p<.05, *** p<.01. Excludes observations identified as influencing the main effect (% NP visits) downward and having annual expenditures less than $50 or greater than $15,000. Coefficients for the OLS and 2nd stage of the 2SLS models are exponentiated. Models are estimated using MEPS Household Component data from 2015-2016 (see Section 2.1 for sample restrictions). NP – nurse practitioner. PA – physician assistant. PCS – 12-item Short-Form Health Survey physical component score. MCS – 12-item Short-Form Health Survey mental component score. % NP visits is patient's annual # of office-based visits to NPs divided by the total of NP and physician office-based visits, multiplied by 100. Patient usual source of care is identified by the patient via survey. % NPs & PAs at source is percentage of physician and non-physician providers. Scope of practice exposure is calculated by census region, based on states' population size and whether states allowed full NP scope of practice during the study period (see Section 2.4 for details). Medical condition count is count of MEPS-defined Priority Conditions (see Section 2.4 for list). Travel time is time to usual source of care from household.