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ADDRESSING THE OPIOID EPIDEMIC: IS THERE A ROLE FOR PHYSICIAN EDUCATION?

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Addressing the Opioid Epidemic: Is There a Role for Physician Education?
Molly Schnell and Janet Currie
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ABSTRACT

Using data on all opioid prescriptions written by physicians from 2006 to 2014, we uncover a striking relationship between opioid prescribing and medical school rank. Even within the same specialty and county of practice, physicians who completed their initial training at top medical schools write significantly fewer opioid prescriptions annually than physicians from lower ranked schools. Additional evidence suggests that some of this gradient represents a causal effect of education rather than patient selection across physicians or physician selection across medical schools. Altering physician education may therefore be a useful policy tool in fighting the current epidemic.

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I. Introduction

Between 2000 and 2014, drug overdoses involving opioids rose 200%, fueling widespread concern about an opioid epidemic and spurring calls for changes in public policy (Chen et al., 2014; Dart et al., 2015; Rudd et al., 2016). **A distinguishing feature of the current epidemic of drug abuse is that many overdoses and deaths can be attributed to legal opioids that were prescribed by a physician. The clinical use of opioids in the United States has quadrupled since 1999, contributing to the rise in drug overdoses, emergency room visits, and admissions for drug treatment. Despite significant efforts to restrict the prescribing of opioids over the past decade, prescription opioid abuse and drug overdoses due to prescription opioids have continued to rise (Health and Human Services, 2014; Meara et al., 2016).**

Recent evidence suggests that doctors play a key role in the opioid epidemic. While prescription drug monitoring programs (PDMPs)—prescription databases that allow physicians to check for signs of opioid abuse before prescribing—have little effect on average (Paulozzi et al., 2011; Reifler et al., 2012; Haegerich et al., 2014; Meara et al., 2016), research shows that they are more effective when states require physicians to consult them (Dowell et al., 2016; Buchmueller and Carey, 2017; Dave et al., 2017). Furthermore, among patients treated in the same emergency room, Barnett et al. (2017) demonstrate that those who happen to be treated by a physician with a higher propensity to prescribe opioids are more likely to be dependent on opioids 12 months later. Despite being the gatekeepers of the legal opioid supply, very little is known about why some physicians are more likely to prescribe opioids than others or about what role physician training can play in bringing the epidemic under control.

In this paper, we use comprehensive data on all opioid prescriptions written by doctors in the US between 2006 and 2014 to examine the relationship between opioid prescribing and training. In particular, we ask how the number of opioid prescriptions written yearly by individual physicians varies with a key feature of the school where they received their initial medical training: the rank of the medical school. As general practitioners (GPs) account for 48% of opioid prescriptions written by physicians in our sample, we examine the relationship between medical school rank and opioid prescriptions both across all physicians and separately for GPs.2

We find that where a doctor received his/her initial training matters in terms of predicting

how likely they are to prescribe opioids: physicians trained at the lowest ranked US medical schools prescribe nearly three times as many opioids per year as physicians trained at the top medical school. This striking inverse relationship reflects two factors: (1) physicians from lower ranked medical schools are more likely to write any opioid prescriptions; and (2) conditional on being an opioid prescriber, physicians for lower ranked medical schools write more opioid prescriptions on average. This prescribing gradient is particularly pronounced among GPs. Our results demonstrate that if all GPs prescribed like those from the top ranked school, we would have had 56.5% fewer opioid prescriptions and 8.5% fewer deaths over the period 2006 to 2014.

Differences in the propensity to prescribe opioids across medical schools need not reflect a causal effect of training. If physicians from lower ranked medical schools systematically see patients with a greater need for opioids, then at least part of the relationship between medical school rank and prescribing will reflect patient sorting across physicians. Furthermore, if people who have a higher probability of getting into selective medical schools are systematically less likely to write opioid prescriptions ex ante, then the prescribing gradient will also reflect selection into medical schools. While we cannot definitively quantify the role of training, we provide three additional sets of analyses that suggest that selection alone cannot account for the differences in prescribing habits that we observe across medical school ranks.

First, we demonstrate that the relationship between opioid prescriptions and medical school rank persists conditional on physician specialty and county of practice. It is therefore unlikely that differences in patient need across physicians can account for the entirety of the prescribing gradient. Second, we demonstrate that the prescribing gradient is flatter among physicians in specialties that receive specific training in the use of opioids after medical school. If physicians who go on to prescribe fewer opioids select into higher ranked medical schools (or if patients with a high need for opioids sort towards physicians from lower ranked schools), then the prescribing gradient should not be dependent on subsequent training in pain management. Finally, we demonstrate that the prescribing gradient is flatter in more recent cohorts. Since selectivity at top medical schools has been increasing over time, a story of selection would instead imply that the relationship should be stronger in more recent cohorts.

This paper contributes to a growing empirical literature on policies to address the opioid epidemic. In addition to the introduction of PDMPs, researchers have examined the impact of the introduction of abuse-deterrent opioids (Cicero and Ellis, 2012; Alpert et al., 2016; Evans et al., 2017), the strengthening of pain clinic laws (Kennedy-Hendricks et al., 2016; Meinhofer, 2016), and improvements in access to opioid antagonists such as naloxone (Mueller et al., 2015; Rees et al., 2017) on opioid abuse and related health outcomes. To the best of our knowledge, this is the first study to examine whether additional physician training is likely to have a significant role to play in addressing the opioid epidemic.

This paper further contributes to a large literature in health economics on the determinants of physician practice style. While a physician's network is known to influence how they practice (Coleman et al., 1957; Soumerai et al., 1998; Epstein and Nicholson, 2009; Lucas et al., 2010), the rank of a physician's initial medical school is one aspect of a physician's network that has received surprisingly little attention. A notable exception is Doyle et al. (2010), who demonstrate that patients randomly assigned to a doctor who attended a higher ranked medical school have less expensive stays but no difference in health outcomes compared to patients who instead see physicians from a lower ranked program.

Finally, we contribute to a literature on the impacts of selectivity in higher education on subsequent outcomes. While the literature on the effects of university rank highlights that at least some of the "effect" of going to a higher ranked school is the result of selection into schools rather than a consequence of any difference in the education received, the evidence suggests that there are economic returns to attending more selective institutions (Brewer et al., 1999; Dale and Krueger, 2002; Hoekstra, 2009; Hoxby, 2016). Our work demonstrates that the value-added of attending a selective medical school may include broader public health benefits resulting from differences in clinical practice as a result of the training received.

The paper proceeds as follows. Section II introduces the data. Section III asks how the number of annual opioid prescriptions written by individual physicians varies with the rank of the medical school where they were initially training. Section IV introduces three sets of empirical exercises that can be used to probe whether a causal effect of training contributes to the prescribing gradient that we observe. Section V provides the results from these ancillary analyses. Section VI discusses limitations of our study and provides a variety of robustness checks to help mitigate these concerns. Section VII provides a discussion and conclusions.

II. Data

To examine the relationship between opioid prescribing and training, we combine prescription data from QuintilesIMS with medical school rankings from US News and World Report and a new dataset documenting the countries of over 900 foreign medical schools. This data is supplemented with locations of teaching hospitals from the American Hospital Association's (AHA) annual surveys, county-level characteristics from the five-year pooled 2008-2012 American Community Survey (ACS), and county-level mortality from the US Mortality Files.

Our prescription data was purchased from QuintilesIMS, a public company specializing in pharmaceutical market intelligence. This dataset contains the number of prescriptions filled for opioid analgesics at US retail pharmacies in each year from 2006 to 2014 at the prescriber level. In addition to the number of prescriptions, the QuintilesIMS data contain information on each prescriber provided by the American Medical Association (AMA). In particular, we know each prescriber's specialty, current practice address as of 2014, the medical school where they obtained their first medical degree, and the year in which they graduated from medical school. We use ArcGIS to extract each provider's county of practice from their practice address. To create the sample of physicians used in the paper, we keep active physicians who graduated from medical school before 2006 and are not missing any information necessary for our analysis.6

Summary statistics for the annual, physician-level prescription measures that we use are provided in Table 1. We have nine observations for every physician in our sample—one for each year between 2006 and 2014. Table 1 shows that 2.16 billion opioid prescriptions were written between 2006 and 2014; 72.9% of these were written by the 742,297 physicians in our cleaned sample. Although GPs (here defined as physicians in general practice, family practice, and internal medicine) make up only 27.4% of our sample, they wrote 48.2% of all opioids prescribed by physicians between 2006 and 2014 (35.1% of all opioid prescriptions).
Table 1 shows a continuous increase in the number of opioid prescriptions from 2006 to 2012 and then a slight moderation. Nevertheless, in 2014 the average physician wrote 221.7

opioid prescriptions. This figure includes zeros—in 2014, 28.3% of physicians did not write any opioid prescriptions. Among physicians in general practice, these statistics are even more striking: only 16.2% of GPs wrote no opioid prescriptions in 2014 with opioid-prescribing GPs writing 480.3 prescriptions on average.

In order to rank medical schools, we use US News and World Report's "Best Medical Schools: Research Rankings." Although medical school rankings change from year to year, we construct a composite medical school rank to use in our analyses. In particular, we take the average of a school's non-missing rankings from 2010 to 2017 and then re-rank schools according to this average rank (assigning a rank of "1" to the school with the lowest average rank, "2" to the school with the next lowest average rank, and so on).[9] Refer to Table S1 for a list of these composite rankings. Figure 1 shows how our composite ranking compares to annual rankings from 2010 to 2017. There is a high correlation between the rankings of medical schools over time (pairwise correlation coefficients are all greater than 0.96 across annual rankings from 2010 to 2017).

There are 92 ranked medical schools and 55 unranked US medical schools in these data. We divide unranked schools by whether they grant the degree of medical doctor (MD) or doctor of osteopathic medicine (DO) (35 and 20 medical schools, respectively).

We group foreign medical schools based on the UN's "Classification of Countries by Major Area and Region of the World."[10] While the QuintilesIMS data does not provide information on the location of each medical school, we googled all medical schools with 10 or more opioid prescribers in the main sample and recorded the country of the school's primary campus (902 medical schools). Foreign medical schools with fewer than 10 opioid prescribers in the main sample are labeled as "Uncategorized" (695 medical schools). Refer to Figure S1 for the distribution of medical schools and physicians in our data across world regions.

In a robustness exercise we exclude physicians whose practice address is in the same zip code as a university-affiliated hospital. To obtain the zip codes of university-affiliated hospitals, we use the AHA's annual surveys from 2007 to 2013. We consider a zip code as containing a university-affiliated hospital if it contained a hospital that reported a university affiliation to the AMA in any year between 2007 and 2013. According to this measure, 9.4% of zip codes with any physicians in our data include a university-affiliated hospital.

The last piece of information necessary for our analysis are mortality rates. County-level deaths are measured using the US Vital Statistics Mortality Files. To measure “deaths involving drugs,” we include all deaths where either the underlying cause of death or a condition contributing to death indicates accidental poisoning by and exposure to drugs (ICD-10 codes X40-X44); intentional self-poisoning by exposure to drugs (ICD-10 codes X60-X64); poisoning by and exposure to drugs (ICD-10 codes Y10-Y14); and poisoning by, adverse effects of, or under dosing of drugs excluding anesthetics (ICD-10 codes T40, T42, T43). We further include deaths where drug dependence, excluding alcohol or tobacco, is indicated on the death certificate (ICD-10 codes F11-F16, F18, F19). Our results are robust to only including deaths where a drug overdose is listed as the cause of death.

Summary statistics for the annual, county-level mortality measures that we use are provided in Table 2. The table shows the clear upward trend in deaths due to drugs between 2006 and 2014 from 12.9 to 17.4 per 100,000—a trend that has received a great deal of recent attention (c.f. Case and Deaton, 2015).

III. Opioid Prescriptions and Medical School Rankings

We are interested in whether the propensity to prescribe opioids is associated with the rank of the medical school where a physician attained his/her initial medical education. We consider three outcomes: (1) the number of opioid prescriptions written annually by each physician including physician-years with no opioid prescriptions, (2) the number of opioid prescriptions excluding physician-years with no opioid prescriptions, and (3) an indicator denoting physician-years with at least one opioid prescription. As GPs account for nearly half of the opioid prescriptions written in the sample (Table 1), we look at all physicians as well as GPs separately. For ease of presentation, we present graphs summarizing the empirical findings as well as tables with regression output.

Figure 2 shows the average number of opioid prescriptions written yearly per physician by medical school rank, both among all physicians (Subfigure A) and among GPs (Subfigure B). We see that a higher medical school rank is associated with fewer opioid prescriptions: on average, physicians from the lowest ranked US medical schools write three times as many opioid prescriptions as physicians trained at Harvard Medical School, the top ranked school. While GPs trained at Harvard write an average of 180.2 opioid prescriptions per year, GPs from the lowest ranked US medical schools write an average of nearly 550 opioid prescriptions per year (Table S3).

This striking inverse relationship between the number of annual opioid prescriptions and medical school rank reflects two factors:

(1) physicians from higher ranked medical schools are less likely to write any opioid prescriptions; and (2) conditional on writing any opioid prescription, physicians from higher ranked medical schools write fewer opioid prescriptions on average. As shown in Figure 3 and Table S2, only 65% of physicians trained at Harvard Medical School wrote at least one opioid prescription in a given year between 2006 and 2014 compared to nearly 80% of physicians from the lowest ranked medical schools. Conditional on prescribing opioids, the behavior of physicians likewise varies with medical school rank: on average, opioid prescribers from the lowest ranked medical schools write over 160% more opioid prescriptions per year than opioid prescribers from Harvard (146.4 versus 381.6; see Table S2).

Turning to the results for physicians trained at unranked medical schools, we see from Figure 2 that foreign doctors have similar prescribing habits as physicians trained at mid-tier US schools, while MDs from unranked US schools are closer to the average for physicians from the lowest ranked schools. This is true both among all physicians (Subfigure A) and among GPs (Subfigure B). Comparing the prescribing habits of DOs to MDs, we see that DOs in general practice prescribe similarly to GPs trained at the lowest ranked US schools. However, at an average of over 400 opioid prescriptions annually per physician, DOs across all specialties write more opioid prescriptions per prescriber than MDs trained either domestically or abroad.

Figure 4 examines whether there are differences in prescribing practices across world regions of training, both for all physicians (Subfigure A) and for GPs (Subfigure B). Especially among GPs, physicians trained in most regions outside of the US prescribe similarly to physicians trained domestically at top schools. In fact, GPs trained in the Caribbean, Canada, and Mexico/ Central America are the only foreign-trained GPs who on average write more opioid prescriptions per year than GPs trained at the top 30 US schools. These differences suggest considerable variation in attitudes towards opioids across world regions which doctors bring with them to the US.

IV. Empirical Strategy

The striking inverse relationship between opioid prescribing and medical school rank documented in Section III begs the question of why such a relationship exists. It is possible that medical schools have differing approaches to the tradeoff between pain management and addiction and instill different beliefs among their graduates about the appropriate clinical use of opioids. However, a prescribing gradient across medical school rankings need not reflect a causal effect of training. There are two key threats to attributing the raw prescribing gradient to differences in training:

1. If physicians from lower ranked medical schools are systematically more likely to see patients with a greater need for opioids, then at least part of the relationship between medical school rank and prescribing will reflect patient sorting across physicians
2. If physicians who have a higher probability of getting into a higher ranked medical school have a lower propensity to prescribe opioids ex ante, then at least part of the relationship between medical school and prescribing will reflect physician sorting across medical schools

While we do not have the data necessary to test whether physicians select into medical schools based on their outlooks towards opioids (or, more realistically, whether physicians select into medical schools based on characteristics that are correlated with their outlooks towards opioids), we can examine whether physicians from lower ranked medical schools are more likely to encounter patients with a greater medical need for opioids. In particular, we can examine whether physicians from lower ranked medical schools are systematically more likely to practice in specialties and/or locations where patient need for opioids may be higher.

As shown in Table 3, there are differences in both the specialties and practice locations chosen across medical school rankings. While only 20% of doctors from the top 30 medical schools are in general practice, over 50% of DOs are GPs. Furthermore, while doctors from the top 30 schools tend to practice in places with greater population density, lower percentages of white inhabitants, and higher education levels (that is, in more urban settings), DOs practice in areas with low population density, a high percentage of white inhabitants, and the highest percentage of less educated residents. If, for example, GPs who practice in more rural settings see patients with a greater need for opioids, then the patterns documented in Figures 2-4 could reflect differences in the specialties and practice locations chosen across medical school rankings.

In the following section, we provide three sets of additional analyses that together provide evidence that neither patient sorting across physicians nor physician sorting across medical schools can account for all of the prescribing gradient that we observe. First, to control for differences in patient need, we replicate the analysis from Section III conditional on specialty and county of practice fixed effects. In particular, we estimate regressions of the following form:

$$(1)\ Y_{itc} = \beta Rank_i + \delta Specialty_i + \alpha_c + \gamma_t + e_{itc}$$

where Y_{itc} denotes the number of opioid prescriptions written by doctor i in year t in county c; $Specialty_i$, α_c, and γ_t denote specialty, county, and year fixed effects, respectively; and e_{itc} is an error term. In some specifications, county fixed effects are replaced with either exact practice address fixed effects or a vector of county characteristics. $Rank_i$ is a vector of indicators for medical school rank group. Harvard is the top ranked medical school, followed by schools ranked 2-5, 6-10, etc. Including this vector of indicators allows the effect of school rank to be non-linear. We further include separate indicators for unranked schools that grant MDs, unranked schools that grant DOs, and foreign schools. With the inclusion of county and specialty fixed effects, the parameters of interest—the vector β —are identified using variation in the number of prescriptions written by physicians within the same specialty who attended different medical school but who practice in the same county. Standard errors are clustered by physician.

While Equation (1) is useful for graphical analyses (the vector β can be plotted to visualize the prescribing gradient), we would like a parsimonious way to examine how the prescribing gradient changes when we include different controls. Hence, we also estimate equations similar to Equation (1) where we replace indicators for medical school rank bins with a quadratic in continuous medical school rank. That is, we estimate equations of the form:

$$(2)\ Y_{itc} = \beta_1 Rank_i + \beta_2 Rank_i^2 + \delta Specialty_i + \alpha_c + \gamma_t + e_{itc}$$

where $Rank_i$ is a continuous measure of medical school rank (graduates of Harvard receive a value of 1, graduates of Johns Hopkins receive a values of 2, etc.)[14] and all other variables are defined as in Equation (1). We include a quadratic in medical school rank because results from Equation (1) suggest that the relationship between medical school rank and annual opioid prescriptions is approximately quadratic. As there in no ordinal ranking for physicians who trained at unranked US medical schools or foreign institutions, we only include physicians who graduated from ranked US medical schools in these regressions. As before, standard errors are clustered by physician.

Next, instead of residualizing the number of prescriptions from specialty fixed effects, we examine whether the prescribing gradient is different across physicians in different specialties. If the prescribing gradient is driven entirely by patient sorting across physicians or physician selection into medical schools, then we would expect the prescribing gradient to be similar across specialties. If, however, there is a causal effect of training, then we would expect the prescribing gradient to be weaker in specialties that receive subsequent training in pain management.

To estimate the prescribing gradient across different specialties, we estimate Equations (1) and (2) separately for the top eight opioid-prescribing specialties.15 As shown in Table 4, the eight specialties with the most opioid prescriptions over our sample period are general practice, orthopaedic surgery, emergency medicine, pain medicine, physical medicine and rehabilitation, obstetrics and gynecology, anesthesiology, and general surgery. Of these specialties, those in pain medicine, physical medicine and rehabilitation, and anesthesiology have the most detailed subsequent training in the use of pain medicines.

Finally, we examine whether the prescribing gradient is different across graduation cohorts. While medical school rankings have been quite stable over time (Figure 1), the degree of selectivity at top schools has been increasing as the market for higher education has become national (and international) rather than being regionally segmented (Hoxby, 2009). Hence, if the effect of medical school rank is due to the selection of more qualified people into higher ranked schools, then we should see the effect of rank increase in more recent cohorts with increasing selectivity. Conversely, if the effect of rank is due to differences in training offered at different schools, and if training standards tend to diffuse downwards from the top schools over time, then the effect of rank should be less important in more recent cohorts. To examine whether the prescribing gradient is stronger in more selective cohorts, we estimate Equations (1) and (2) separately for four broad cohorts: those who graduated before 1975, between 1976 and 1985, between 1986 and 1995, and after 1996.

V. The Role of Training

We now implement the three sets of empirical exercises introduced in Section IV to investigate whether there is evidence that the prescribing gradient we uncover in Section III is driven—at least in part—by a causal effect of training.

a. Prescribing gradient conditional on specialty and practice location

Figure 5 provides coefficient estimates and 95% confidence intervals on indicators for medical school rank bins from estimation of Equation (1), both for all physicians (Subfigure A) and for GPs (Subfigure B). The figures are scaled so that the coefficients on the highest ranked medical school (Harvard) are set to zero, and all other schools are compared to it. A comparison of Figures 2 and 5 demonstrates that controlling for differences in specialties and practice locations moderates the relationship between medical school rank and opioid prescribing. However, even within the same specialty and county of practice, the relationship between medical school rank and opioid prescriptions remains highly statistically significant. This is particularly true among GPs, for whom the average number of opioid prescriptions written yearly per physician rises steeply with medical school rank until around the rank of 60, where the curve flattens out.

A comparison of specifications with and without controls is shown more formally in Table 5. Here, we provide results for variants of Equation (2) estimated on all physicians (Panel A) and using GPs alone (Panel B). Looking to the results for all physicians first, we see that a regression of annual opioid prescriptions on medical school rank yields a best fit line of y = 117.07 + 2.44x – 0.01x2 (column (1)). Controlling for specialty (column (2)), reduces the derivative of y with respect to x by about half, as does controlling for county-level demographics from the ACS (column (3)).[16] Comparing columns (3) and (4), we see that the estimates are very similar whether we control for observable differences across counties or for both observable and unobservable differences across counties using county fixed effects. Finally, column (5) shows estimates from a specification similar to that depicted in Figure 5 in that it includes both county and specialty fixed effects: here, the best fit line is given by $y = 111.57 + 0.64x - 0.003x2$. Taking into account differences in specialties and counties of practice across medical school rankings, doctors from the lowest ranked schools still write on average over 33 more opioid prescriptions per year than doctors from the highest ranked schools.

While the prescribing gradient among GPs is also attenuated when we control for specialty and county of practice, we see from the regression output in Panel B of Table 5 that a significant gradient persists among GPs practicing in the same county. Conditional on specialty and county of practice, GPs from the lowest ranked schools write on average over 70 more opioid prescriptions per year than GPs from the highest ranked schools (column (5)).

Turning to the coefficients on unranked medical schools in Figure 5, we see that among all physicians (Subfigure A), DOs write more prescriptions per prescriber than all other doctors even when we control for differences in specialties and practice locations. Furthermore, conditional on these controls, MDs trained at unranked US medical schools still prescribe similarly to physicians from the lowest third of ranked US medical schools, both among all physicians and among GPs. However, unlike in Figure 2, foreign-trained doctors actually write fewer opioid prescriptions than US-trained doctors once we control for specialty and county of practice.

The behavior of foreign-trained doctors is probed further in Figure 6. Here, we plot coefficient estimates from a regression similar to the specification outlined in Equation (1) except that the categories for ranked US schools are collapsed and indicators are added for world region of training for foreign doctors. Conditional on specialty and county characteristics, physicians trained in most regions outside of the US write significantly fewer opioid prescriptions per year on average than physicians trained domestically. The stark differences between physicians trained in various regions of the world suggest that differences in training are likely to be important.

It is possible that we are not fully controlling for medical need by controlling for physician specialty and county of practice. We can extend our analysis to compare the prescribing practices of physicians who practice in the exact same hospital or clinic by including practice address fixed effects in place of county fixed effects in Equations (1) and (2). The results of this exercise for all physicians and GPs are shown in Figure 7 and column (6) of Table 5. Even within the same practice, opioid prescribing increases with medical school rank, although the relationship is flatter than in a specification without these controls. This reduction in the relationship between medical school rank and prescribing practices within a given practice location indicates either that practices tend to hire doctors with similar propensities to prescribe opioids or that the opioid prescribing behavior of physicians is influenced by the institutions where they practice and/or the behavior of their colleagues.

b. Prescribing Gradient Across Specialties

We next ask whether there are differences in the prescribing gradient across the top eight opioid prescribing specialties (see Table 4 for opioid prescriptions by specialty). As discussed in Section IV, if differences in opioid prescribing across medical school ranks are in fact driven by differences in training, then we expect the rank of a physician's initial medical school to be a less important predictor of opioid prescribing behavior among specialties that receive subsequent training in the use of opioids.

Figure 8 shows that there is an inverse relationship between medical school rank and opioid prescribing in most of the top eight opioid-prescribing specialties, although the relationship is generally much flatter in other specialties than that observed for GPs. This can also be seen in Table 6, which provides estimates of Equation (2) for physicians in different specialties. For pain medicine, physical medicine and rehabilitation, and anesthesiology—the specialties where all practitioners could be expected to receive specific training in the use of opioids—we see virtually no relationship between initial medical school rank and opioid prescribing, as hypothesized above. This is true despite the fact that doctors who specialize in pain medicine, for example, prescribe many more opioids per physician than doctors in other specialties.

c. Prescribing Gradient Across Cohorts

Figure 9 and Table 7 turn to the question of cohort-level differences in the relationship between medical school rank and opioid prescribing. As discussed in Section IV, if the prescribing gradient is driven by physician selection into medical schools, then the gradient should be stronger in more recent cohorts due to the increasing selectivity at top medical schools.

The results show that the relationship between initial medical school rank and opioid prescribing, while significant in all cohorts, has become consistently flatter over time. For GPs who graduated from medical school before 1976 for instance, a regression of annual opioid prescriptions on a quadratic in continuous medical school rank with year, specialty, and county fixed effects (Equation (2)) yields a best fit line of $y = 354.40 + 3.55x – 0.03x2$ (column (2) of Panel B) compared to the best fit line of $y = 247.61 + 1.28x – 0.01x2$ for the cohort that graduated between 1996 and 2005 (column (5) of Panel B). This flattening gradient is inconsistent with the idea that the relationship between medical school rank and opioid prescribing is driven by selection into the top medical schools.

VI. Robustness

One limitation of these data is that they do not include information about the number of patients seen by each physician. If doctors trained at top schools are more likely to engage part-time in research or teaching and therefore see fewer patients than doctors from lower ranked medical schools, then a correlation between medical school rank and prescriptions could emerge because of differences in workloads. To investigate this possibility, we replicate our analysis excluding physicians who practice in a zip code containing a university-affiliated hospital. The results for all physicians and for GPs are shown in columns (2) and (4) of Table 8 and are remarkably consistent with those discussed above (reproduced in columns (1) and (3) of Table 8 for convenience of comparison).

A second limitation is that we do not know either the number or the strength of the pills included in each prescription. If physicians trained at top schools always write prescriptions for a month's supply of high-dose opioids, whereas physicians trained at lower ranked schools always write prescriptions for a few low-dose pills, then differences in the number of prescriptions could emerge without this association having any bearing on the overall provision of opioids. However, Table 9 shows that even when looking within a given county over time, there is a significant relationship between the number of opioid prescriptions and deaths involving drugs: on average, a 10% increase in opioid prescriptions annually is associated with a 1.5% increase in deaths involving drugs each year. This relationship suggests that differences in prescribing patterns are not fully offset by differences in the number or strength of pills prescribed, and thus it is meaningful to look at the number of prescriptions as an indicator of physician practice style.

A final limitation is that we only observe where each physician completed his or her initial medical training. Hence we cannot say how the rankings of institutions where physicians receive subsequent training are related to the propensity to prescribe opioids. However, the fact that physicians in specialties with significant further training in pain management have flatter relationships between opioid prescribing and initial medical school rank strongly suggests that the nature and type of further training is an important determinant of physician practice style.

VII. Discussion and Conclusions

This study offers several new facts about how doctor characteristics are related to their propensity to prescribe opioids. First, between 2006 and 2014, nearly half of all opioids prescribed by doctors were prescribed by GPs. This is true even though doctors in some specialties, like pain medicine, write many more prescriptions per practitioner. **Thus, it will be important to understand and modify the prescribing behavior of GPs if the opioid epidemic is to be successfully addressed.**

Second, there is a striking inverse relationship between the rank of a physician's medical school and his/her propensity to prescribe opioids. Previous research indicating that differences in practice style are largely set as early as the first year of medical practice (Epstein et al., 2016) suggests that the relationship between initial medical school rank and opioid prescribing behavior could reflect differences in training regarding the appropriate use of opioids across schools. An alternative hypothesis is that the estimated effect of medical school rank on the propensity to prescribe opioids reflects differences in either the types of patients seen by physicians who attend medical schools of higher and lower rank or the types of physicians who are selected into these schools.

While we cannot definitively rule out these alternatives, our ancillary results support the training hypothesis. In particular, the relationship between medical school rank and propensity to prescribe opioids persists even among specialists who attended different medical schools but practice in the exact same hospital or clinic—where patients can be assumed to be relatively homogenous in their need for opioids. Furthermore, the prescribing gradient is less pronounced in specialties in which physicians might be expected to receive specialized training in dealing with pain medications, such as pain medicine and anesthesiology. Finally, given the increasing competition to get into medical schools such as Harvard, the fact that the relationship between medical school rank and prescribing behavior has weakened over time (rather than strengthening) further suggests that the relationship reflects the more rapid diffusion of best practices in top schools rather than the selection of certain types of physicians.

We cannot know how training regarding opioids has differed across medical schools over time, although the evidence suggests that not all physicians receive the same training. A review of the curricula at all four medical schools in Massachusetts, for example, found that there was no standard in place to make sure that all students were taught safe and effective opioid prescribing practices before graduation (Antman et al., 2016). Recognizing that more comprehensive training will be needed to improve prescriber practices, in March 2016 the White House asked medical schools to pledge to include the Center for Disease Control's new opioid prescribing guidelines into their curriculum. Over 60 medical schools announced that they would update their curriculum by the fall of 2016, with 28% (43%) of ranked (unranked) US medical schools taking the pledge. If such training is effective in reducing opioid prescribing, then policy makers might consider offering stronger inducements for medical schools to incorporate these guidelines.

Taken together, our findings suggest that a doctor's initial training has a large impact on their attitudes towards opioid prescribing, especially for GPs. Since variations in opioid prescribing have contributed to deaths due to the current opioid epidemic, training aimed at reducing prescribing rates among the most liberal prescribers—who disproportionately come from the lowest ranked medical schools—could possibly have large public health benefits. Physician education therefore likely has a role to play in addressing the opioid epidemic.