Pharmacy School Cost and Opioid Dispensing: A Hidden Connection?*

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Abstract

The opioid epidemic continues to be a major public health concern in the United States, but little is known about the role of pharmacists. Using large-scale data from pharmacists' online job profiles linked with data on opioid dispensing at the pharmacies where they work after graduation, we investigate how the financial burden of pharmacy education influences their career choices and subsequent dispensing behaviors. We compare opioid dispensing quantities across pharmacists working in the same county but trained at institutions with different tuition costs. First, we show that pharmacies dispensing more opioids tend to provide higher wages. Second, we find that even among pharmacies in the same county, pharmacists from higher-tuition institutions are more likely to work at pharmacies with higher opioid dispensing. Lastly, we demonstrate that the positive association between pharmacy education costs and opioid dispensing is stronger among pharmacists who are in their first two years post-graduation, male pharmacists, and those working in areas with more severe prescription opioid use. Overall, our findings suggest that pharmacists from institutions with higher tuition, who likely face greater student debt, may be more inclined to work at pharmacies that dispense larger quantities of opioids due to financial concerns.

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1 Introduction

The United States continues to face a prolonged and devastating opioid epidemic that has lasted for over two decades. Between 1999 and 2020, fatal drug overdoses increased by 445 percent, claiming more than one million lives (National Institute on Drug Abuse, 2024). The rise in overdose deaths is largely driven by opioid-involved overdoses, which account for 75 percent of these fatalities (Compton et al., 2021). Previous research has examined the factors contributing to this crisis, with extensive focus on pharmaceutical manufacturers, physicians, and insurers as key drivers of the epidemic.[1] However, despite their critical position as gatekeepers in the dispensing of prescription medications, relatively little attention has been paid to the involvement of pharmacies and pharmacists.

Emerging evidence suggests that pharmacies and pharmacists have contributed to fueling the epidemic. Over the past decade, multiple lawsuits have been filed against major pharmacy chains, including Walgreens, CVS, and Walmart. These lawsuits claimed that pharmacies had played a key role, primarily through improper dispensing and failure to monitor suspicious opioid orders. Although there is growing attention on the causes of these improper opioid dispensing practices, there is still limited understanding of the factors determining pharmacists' dispensing behavior.

In this paper, we examine whether financial motivations among pharmacists contribute to their opioid dispensing practices. Specifically, we investigate whether pharmacists who graduated from pharmacy schools with higher education costs are more likely to work in pharmacies that dispense greater quantities of opioids after graduation. We hypothesize that the financial pressure of repaying student debt may drive pharmacists to seek employment at pharmacies with higher opioid dispensing, where the financial rewards are potentially greater.

Recent evidence highlights the plausibility of this hypothesis by uncovering systemic factors that influence pharmacists' dispensing practices. Internal documents from the pharmaceutical industry, which have become available through litigation between 1997 and 2020, suggest that some pharmacies prioritized profits over patient safety (Yakubi et al., 2022; Caleb Alexander et al.,

[1] Manufacturers have invested heavily in advertising, using targeted campaigns to promote the widespread use of opioids and influence prescribing practices (Van Zee, 2009; Nguyen et al., 2019; Alpert et al., 2022b). Prescribers have contributed by issuing high volumes of opioid prescriptions, often influenced by aggressive marketing and limited recognition of addiction risks (Schnell, 2017; Eichmeyer and Zhang, 2022; Alpert et al., 2022a). Insurers have also contributed to the crisis by providing generous coverage for opioids, which substantially lowered out-of-pocket costs for patients and increased their accessibility (Zhou et al., 2016; Pacula and Powell, 2018).

2022; Chiu et al., 2023). For example, incident reports by Walgreens pharmacists reveal that managers pressured them to fill more opioid prescriptions, even when there were warning signs of misuse or diversion. These reports also suggest that higher opioid sales are associated with increased compensation for managers, whose salaries are linked to prescription volume (Chiu et al., 2023). Moreover, pharmacists who refused to fill opioid prescriptions in good faith often faced a negative work environment created by their managers. Overall, this evidence suggests that higher opioid sales may contribute to both negative work environments and increased compensation for pharmacists. If pharmacies provide financial benefits—such as higher wages or bonuses—based on their opioid dispensing, this may influence pharmacists' career decisions and dispensing behavior, particularly among those facing greater financial pressure.

However, investigating the link between educational costs for pharmacists and opioid dispensing behavior is empirically challenging, mainly due to data limitations. Conducting such an analysis would require comprehensive information on a pharmacist's education, tuition costs, post-graduation employment, and the opioid dispensing patterns of the pharmacies where they work, which are typically unavailable in the U.S.

We address this data challenge by constructing a novel dataset that links worker-level online job profiles to both education cost data and pharmacy-level opioid dispensing data. Our data are from three primary sources. First, Lightcast provides detailed job and education information by compiling longitudinal job histories from online career platforms, capturing both worker and job-level characteristics. Using this dataset, we identify the schools each pharmacist graduated from and the pharmacies where they are employed after graduation. Second, the College Scorecard offers data on higher education institutions, including tuition, fees, and completion rates, which we use to estimate the expected college costs for each pharmacist. Lastly, data from the Drug Enforcement Administration (DEA) provide detailed information on opioid dispensing at the pharmacy level over time.[2] By linking these datasets, we capture pharmacists' education, associated tuition costs, and their subsequent employment and opioid dispensing practices at the pharmacies where they work. Our sample consists of pharmacists from the Lightcast job profile data who were employed at opioid-dispensing pharmacies at any point between 2006 and 2019, representing approximately ten percent

[2] We focus primarily on oxycodone in our baseline analysis and conduct a supplemental analysis on hydrocodone, as the DEA pharmacy-level database only includes information on these drugs. Note that oxycodone and hydrocodone account for the majority of legal opioid distributions to retail pharmacies (Griffith et al., 2021).

of pharmacists working in health and personal care retail settings across the U.S.

We begin by presenting a simple two-period theoretical framework to model a pharmacist's decision-making process, emphasizing the trade-off between wages earned and the disutility arising from higher opioid dispensing. The framework leads to two key predictions. First, pharmacists with higher student debt are more likely to work at high-opioid-dispensing pharmacies early in their careers, as these positions tend to offer higher wages. Second, as the debt is repaid over time, the influence of financial constraints diminishes, reducing the likelihood of employment at high-opioid-dispensing pharmacies later in their careers.

We empirically test our key assumption that pharmacies with higher levels of opioid dispensing tend to offer higher wages to pharmacists. To examine this relationship, we construct a separate dataset that links pharmacy-level opioid dispensing to offered wages using the Lightcast Online Job Posting Database. Using this dataset, we find a positive correlation between opioid dispensing and average wages at the pharmacy level, showing that a one standard deviation (63 percent) increase in oxycodone dispensing is associated with a 2.4 percent increase in wages. This positive correlation supports the idea that pharmacists with greater education costs may be incentivized to work at pharmacies with higher opioid dispensing due to the financial incentive of higher wages.

We then turn to empirically testing the first prediction of our theoretical framework—that higher pharmacy school costs are associated with greater opioid dispensing at the pharmacies where pharmacists work after graduation—using two complementary approaches: (1) estimating the association while controlling for detailed individual, school, pharmacy, and geographic characteristics, and (2) conducting supplemental causal analysis that exploits plausibly exogenous variation in tuition costs.

In the association analysis, we use the approach suggested by Schnell and Currie (2018).[3] We control for a rich set of individual, college, pharmacy, and county characteristics to address concerns that differences in dispensing might reflect selection rather than an effect of tuition. These controls include proxies for individual ability that may correlate with college characteristics, such as the average SAT score and admission rate of the college attended, as well as measures of the pharmacist's observed skill levels. In an alternative specification, we further include county fixed effects for both

[3] Schnell and Currie (2018) employs a similar approach to study the impact of medical school rankings on opioid prescribing.

the pharmacy school and the employing pharmacy to account for geographic factors influencing education costs and dispensing practices.

Our supplemental causal analysis leverages variation that is plausibly unrelated to individual preferences or abilities. Specifically, we exploit budget shocks to public universities, as suggested by Deming and Walters (2017), in which state funding cuts led institutions to raise tuition and fees (Delaney and Marcotte, 2024). We use these shocks as an instrument in a two-stage least squares (2SLS) framework to estimate the effect of college costs on opioid dispensing. This strategy addresses a key concern that our estimated association could reflect unobserved confounding factors—such as differences in student ability, career preferences, or local labor market conditions—rather than a causal effect of tuition.

Using these approaches, we find a consistent and strong positive relationship between college costs and opioid dispensing over the course of a pharmacist's career. In our baseline sample, which is divided into seven tuition categories, pharmacists from the highest-tuition colleges work in pharmacies that dispense roughly 3 times more opioids than those employing graduates from the lowest-tuition colleges. Our elasticity estimates reinforce this pattern: a 1 percent increase in expected tuition and fees is associated with a 1.35 percent increase in opioid dispensing. This association remains robust after controlling for pharmacist skills, local opioid exposure, and other relevant factors, and is confirmed across a range of alternative specifications. Estimates from our 2SLS analysis point to a similarly positive and statistically significant effect, consistent with a causal interpretation of the relationship between higher tuition costs and greater opioid dispensing. The magnitude of the 2SLS estimates is comparable to, or slightly larger than, the corresponding OLS estimates.

We also find notable heterogeneity in the relationship between college costs and opioid dispensing. The association is stronger in regions with higher prescription-opioid use and among male pharmacists, while graduates of highly ranked schools show weaker effects, potentially reflecting unobserved advantages or institutional norms. The pattern holds within both chain and independent pharmacies, indicating it is not driven solely by differences between these business models. Finally, we find little evidence that economic conditions at the time of graduation affect the relationship.

Building on these findings, we next empirically test the second prediction of our theoretical framework—that the relationship between tuition costs and opioid dispensing is strongest early in a pharmacist's career and diminishes over time—using two approaches. First, we show that the positive association is most pronounced in the first two years after graduation, consistent with the idea that recent graduates facing higher debt may be more likely to seek employment at high-opioid-dispensing pharmacies for financial reasons. Second, our turnover analysis indicates that among pharmacists with high college costs, a 100 percent increase in opioid dispensing is associated with a 3.5 percentage point increase in overall job turnover and a 2.1 percentage point increase in transitions to low-opioid-dispensing pharmacies. In contrast, no significant relationship is observed among those with lower education costs. Overall, our results suggest that the association between tuition costs and opioid dispensing weakens over the course of a pharmacist's career. This pattern may reflect factors such as growing ethical considerations and increased awareness of the disutility associated with opioid dispensing, which could outweigh financial motivations as student debts are gradually repaid.

Our study contributes to the extensive literature on the causes and consequences of the opioid crisis, which has explored the roles of supply-side opioid policies (e.g., Alpert et al., 2018; Evans et al., 2019), physicians (e.g., Schnell, 2017; Eichmeyer and Zhang, 2022; Alpert et al., 2022a), manufacturers (e.g., Van Zee, 2009; Nguyen et al., 2019; Alpert et al., 2022b), and insurers (e.g., Zhou et al., 2016; Pacula and Powell, 2018) in fueling the epidemic.[4] For example, Schnell and Currie (2018) find that physicians who trained at top-ranked medical schools prescribe substantially fewer opioids than those from lower-ranked schools, suggesting that physician education may have a causal effect on prescribing behavior. Despite the critical role that pharmacists play as the final gatekeepers of opioid distribution, surprisingly little is known about how their educational background and financial pressures from college costs influence their opioid dispensing practices.[5] In this paper, we address this gap by examining the role of pharmacists in

[4] A comprehensive review of this literature is provided in Maclean et al. (2020).

[5] A small but growing literature highlights the role of pharmacies in the opioid crisis. For example, Janssen and Zhang (2023) show that independent pharmacies dispense more opioids than chain pharmacies, driven by competitive pressures and financial incentives associated with ownership. Similarly, Churchill and Burton (2024) find that "pill mill" laws, implemented to address opioid overprescription, led to reductions in retail pharmacy sales and employment, driven largely by the closure of independent pharmacies. Our findings suggest that pharmacists' education costs are a key factor contributing to improper opioid dispensing at pharmacies. Notably, we observe this evidence not only among independent pharmacies but also among chain pharmacies. This aligns with claims from recent lawsuits filed against major pharmacy chains, alleging improper dispensing practices and failure to monitor suspicious opioid orders, as discussed in detail in Section 2.

the opioid crisis, focusing on how pharmacy education costs may influence their workplace choices and dispensing behaviors. Another strand of recent papers reports the relationship between the opioid crisis and consumer, corporate, and public finance (Cornaggia et al., 2022; Boubaker et al., 2023; Jansen, 2023). We add to this literature by identifying a new financial channel—pharmacists' education costs and associated financial burdens—that plays a role in the opioid crisis.

Our paper also contributes to a broader literature investigating the effects of education debt on human capital investment and career decisions. Using policy changes in financial aid in universities, Rothstein and Rouse (2011) find that more student debt induces college graduates to pursue higher-salary jobs but reduces the probability of choosing low-paid public jobs. Using a similar context, Zhang (2013) shows that more college debt lowers graduate school attendance. A few other studies investigate how debt from college costs affects the career choice of medical students, who pay the highest tuition and fees among fields of study in the U.S. Rohlfing et al. (2014) surveyed medical students and report a strong association between debt level and the choice of their specialties.[6] Nicholson et al. (2015) surveyed dentists and find that dentists with higher initial debt are more likely to enter private practice, which offers higher salaries than public ones. Our study adds to this literature by exploring how education costs influence pharmacists' career trajectories.

Our research is also related to the literature on the trade-off between wages and non-pecuniary job disamenities. According to the theory of equalizing differences, wages should compensate for non-wage job disamenities such as job insecurity, health risks, and performance pressure (Rosen, 1986). A strand of papers reports compensation differentials caused by non-wage workplace characteristics in various contexts (French and Dunlap, 1998; Villanueva, 2007; Wissmann, 2022; Nagler et al., 2023). However, some studies point out the difficulty in estimating the effects of job disamenities on compensating differentials because of endogenous matching and incomplete compensation information (Duncan and Holmlund, 1983; Eriksson and Kristensen, 2014; Lavetti, 2023). This is the first paper to suggest the existence of pharmacists' willingness-to-pay (WTP) to avoid high levels of opioid dispensing and evidence for sorting into high-opioid-dispensing

[6] Prior studies also show that an increase in college costs affects graduation timing and satisfaction among students. Garibaldi et al. (2012) find that increasing continuation tuition by 1,000 euros reduces the probability of late graduation by at least 6.1 percentage points. Velez et al. (2019) find that a 1,000-pound increase in tuition fees for UK full-time degree students in 1998 led to higher student debt and lower satisfaction, particularly among disabled students and those without family support. It also resulted in increased term-time employment for the latter group.

pharmacies based on pharmacists' potential valuation of this disamenity. In particular, our paper takes advantage of a relatively homogeneous workplace setting of pharmacies with similar firm sizes, tasks, skill requirements, and working conditions.

Lastly, our study is part of the growing literature that leverages data from online job profiles, which are increasingly used in studies on the labor market for their rich worker-level details (Conzelmann et al., 2023; Berry et al., 2024; Curtis et al., 2024; Dorn et al., 2024; Gortmaker et al., 2024; Evsyukova et al., 2025). For instance, Berry et al. (2024) and Evsyukova et al. (2025) use the connection of workers with different demographics to investigate discrimination in the labor market. Curtis et al. (2024) and Dorn et al. (2024) analyze self-reported skills in online job profiles and reveal that this skill information effectively reflects trends in labor demand, earnings variation, and human capital accumulation. In addition, Conzelmann et al. (2023) use data on individual education and job history from online job profiles to characterize the labor markets that are unique to different colleges. Our paper uses online job profile data to link workplace characteristics with college characteristics at the pharmacist level, allowing us to investigate the lasting impact of college costs on career decisions among pharmacists.

Our paper has important policy implications. First, the role of pharmacists in the opioid crisis has long been a black box, but our findings shed light on a key mechanism: pharmacists facing financial constraints due to high college costs are more likely to sort into pharmacies with higher opioid dispensing rates. This is particularly concerning as it has the potential to alter their opioid dispensing behavior over the long term. Second, our findings suggest that alleviating financial pressure among pharmacists may be one potential approach to addressing aspects of the opioid epidemic. Efforts to reduce the financial burden of pharmacy education or to examine systemic factors that incentivize higher opioid dispensing may help mitigate risky dispensing practices.

2 Background

2.1 The Role of Pharmacists in the Opioid Epidemic

Prescription opioids are dispensed through pharmacies, making pharmacists gatekeepers in preventing and addressing opioid misuse and overdose (Vadiei et al., 2022; Kosobuski et al., 2022). Pharmacists can identify individuals at risk of opioid use disorder or overdose and provide necessary consultations (Vadiei et al., 2022). Furthermore, nearly 90 percent of Americans live within two miles of a community pharmacy, allowing pharmacists to reach a broad population (Qato et al., 2017).

2.2 Factors Contributing to Improper Opioid Dispensing Practices

One of the key challenges to fulfilling the critical role as gatekeepers is systemic factors in pharmacy practices. Using pharmaceutical industry documents released in litigation between 1997 and 2020, Chiu et al. (2023) conducted an observational, retrospective content analysis to assess the opioid dispensing practices of a retail community pharmacy chain, Walgreens.[7] The study identified four key factors contributing to improper opioid dispensing: (1) store-level procedures, (2) management pressure, (3) distribution center activities, and (4) pharmaceutical company sponsorship.[8] Management pressure was the most frequently mentioned factor, appearing in ten out of the 21 documents reviewed in the study.

The documents reviewed by Chiu et al. (2023) suggest that Walgreens management applied pressure on both store-level and firm-level employees, which contributed to improper opioid dispensing practices. Internal reports from the Walgreens employee hotline between 2010 and 2018 highlight numerous conflicts between pharmacists and their supervisors regarding opioid prescriptions. Pharmacists often expressed concerns about being overruled by managers when they refused to fill certain prescriptions due to red flags. Managers often prioritized customer satisfaction and productivity metrics over professional judgment, pressuring pharmacists to approve prescriptions. This created a work environment where pharmacists felt their autonomy was limited, contributing to improper opioid dispensing.

In addition, incident reports reveal that Walgreens' incentive structures, including performance metrics and bonus schemes, influenced these practices. Managers were rewarded based on the number of opioid prescriptions filled, which encouraged them to pressure pharmacists to approve

[7] Investigating the practices of retail chain pharmacies has historically been challenging due to restricted access to internal decision-making processes (Bero, 2003). Recent studies on the opioid crisis have addressed this challenge by investigating internal documents that became available through litigation (Yakubi et al., 2022; Caleb Alexander et al., 2022).

[8] Issues included unresolved red flags at the store level, pressure on pharmacists to fill more opioid prescriptions, and distribution centers' failure to monitor high-volume orders (Chiu et al., 2023).

more opioid prescriptions, regardless of red flags or errors. At the firm level, Walgreens management expressed concern about stores with lower opioid sales, even suggesting investigations into why these stores were not filling more prescriptions. This emphasis on sales, coupled with bonus systems tied to prescription volumes, created a culture where dispensing opioids was prioritized over patient safety.

Financial incentives for opioid dispensing and improper dispensing practices are not exclusive to chain pharmacies. Janssen and Zhang (2023) highlight that independent pharmacies have even stronger financial incentives to dispense more opioids than chain pharmacies. The study also shows that increased competition pressure is linked to higher rates of opioid dispensing. In Section 6.2, we examine how the association between education costs and opioid dispensing differs between independent and chain pharmacies.

2.3 Association Between Opioid Dispensing and Pharmacist Compensation

Anecdotal evidence documenting financial incentives for pharmacies and their managers in opioid dispensing, discussed in Section 2.2, raises questions about whether opioid dispensing are associated with the compensation of pharmacists employed at those pharmacies. If this link exists, it may more directly influence pharmacists' behavior and career paths.

We examine this relationship by using linked data on offered wages from Lightcast online job postings and opioid dispensing records from the DEA at the pharmacy level.[9] We run an ordinary least squares regression of offered wages on opioid dispensing, controlling for a wide range of covariates.[10]

Our regression analysis reveals a positive relationship between pharmacy-level oxycodone dispensing and the wages offered for pharmacist positions. Specifically, a doubling of oxycodone dispensing is associated with a 3.8 percent increase in offered wages, which is equivalent to a 2.4 percent increase in offered salaries in response to a one standard deviation increase in oxycodone

[9]Lightcast Job Posting Database covers the near universe of online job advertisements in the U.S. from 2007 and 2010–2019. We link the job posting data with opioid dispensing data from the DEA's Automation of Reports and Consolidated Orders System (ARCOS) at the pharmacy level.

[10]The regression is based on 1,378 observations at the pharmacist position-by-year level. The dependent variable is the inverse hyperbolic sine transformation of the offered wage. We include fixed effects for state and year and controls for job characteristics such as employment type (full-time vs. part-time), internship status, required years of education, required years of experience, and specific skill requirements (general, cognitive, social, IT, software, engineering, sales, administrative, manufacturing, and business skills).

dispensing.

3 Theoretical Framework

In this section, we present a simple two-period occupation choice model to illustrate the intuition behind our empirical tests. Assume that a pharmacist chooses from a continuum of job options with wage w and the level of opioid dispensing s in each period. Period utility U derives from consumption c and non-pecuniary job amenity x and satisfies the following properties: $U_c > 0$, $U_x > 0$, $U_{cc} < 0$, and $U_{xx} < 0$. The job amenity is a function of the level of opioid dispensing, and higher opioid dispensing implies lower job amenities and utility ($x'(s) < 0$). In other words, a pharmacist gets disutility from dispensing opioids, which is consistent with the anecdotal evidence discussed in Section 2.2. At the same time, higher opioid dispensing implies higher wages ($w'(s) > 0$), an assumption supported by the analysis discussed in Section 2.3. Let D denote the debt from the student loan when a pharmacist graduates from pharmacy school. We assume that the pharmacist should repay the debt in the first period, considering the pre-determined repayment schedule of student loans. Then, we can formally express a pharmacist's utility maximization problem subject to her budget constraint as follows:

$$\begin{aligned} &\max_{(c_i, s_i)} U(c_1, x(s_1)) + U(c_2, x(s_1)) \\ &\text{s.t. } c_1 = w(s_1) - D \;\&\; c_2 = w(s_2), \end{aligned} \tag{1}$$

where U is additively separable ($U_{cx} = 0$) and, the Inada conditions hold for both arguments.

The model abstracts many vital aspects of the labor market of pharmacists but provides practical guidance for our research purpose. However, a few data limitations restrict our ability to directly test the model predictions: First, we are unable to observe an individual pharmacist's debt level from student loans. Second, we cannot identify when a pharmacist completes her student loan repayment. Given these data limitations, we test the following two viable hypotheses derived from the model predictions.

Prediction 1. There is a positive correlation between the cost of the pharmacy school a pharmacist attended and the opioid dispensing levels at the pharmacies where they work after graduation.

The first-order condition of the maximization problem for the first period can be expressed as:

$$w'(s_1) = -\frac{U_s(w(s_1) - D, x(s_1))}{U_c(w(s_1) - D, x(s_1))}. \tag{2}$$

This equation suggests that when the debt D is higher, the pharmacist's marginal utility of consumption increases, which leads to a higher wage $w(s_1)$ and opioid dispensing level s_1 in the first period. Because pharmacy school costs are often directly linked to debt burden, this condition implies that pharmacists graduating from higher-cost institutions are more likely to work in positions with higher wages $w(s_1)$, which are associated with higher levels of opioid dispensing s_1.

Empirical Testing for Prediction 1. We empirically test the first hypothesis by investigating the effect of college-level tuition and fees on the level of opioid dispensing from the pharmacies where the pharmacists work post-graduation, controlling for a wide range of individual, pharmacy, and college-level controls. We discuss our empirical strategies and potential threats to our identification in Section 5. In Section 6.4, we supplement this analysis with a 2SLS framework that uses state budget shocks to public universities as an instrument, addressing potential confounding. Because we cannot determine the exact timing of a pharmacist's student loan repayment, we are unable to exclude the period after full repayment in this analysis. However, we examine the heterogeneity in the relationship between college costs and opioid dispensing across years of experience, as debt levels are likely higher among those earlier in their careers, as discussed later in this section and in Section 6.

Prediction 2. The positive association between pharmacy school costs and opioid dispensing declines over the course of a pharmacist's career.

The first-order condition for the second period,

$$w'(s_2) = -\frac{U_s(w(s_2), x(s_2))}{U_c(w(s_2), x(s_2))}, \tag{3}$$

shows that opioid dispensing s_2 in the second period does not depend on the initial student debt ($ds_2/dD = 0$), as the pharmacist fully repays the debt in the first period. This suggests that the impact of college costs (and associated debt) on opioid dispensing decreases over time, resulting in a weaker correlation between college costs and opioid dispensing in later periods as pharmacists experience reduced financial constraints from their student loans.

In addition, the comparison of the first-order conditions for the two periods implies that a pharmacist chooses a higher wage in the first period than in the second period if she has a positive debt from a student loan ($w(s_1) > w(s_2)$). Since the wage is an increasing function of opioid dispensing, it follows that the level of opioid dispensing decreases in the second period ($s_1 > s_2$). Thus, the model suggests that as student loans are repaid, a pharmacist tends to seek employment at pharmacies with lower levels of opioid dispensing.

The first-order conditions also imply $\frac{d(s_1-s_2)}{dD} > 0$, suggesting that as the initial debt D increases, the difference between opioid dispensing levels in the first period s_1 and the second period s_2 broadens. This is because higher debt D in the first period increases the pharmacist's incentive to choose a higher-wage, higher-opioid-dispensing pharmacy to address financial pressures at that time. This suggests that pharmacists with higher college costs are likely to exhibit a more pronounced pattern of transitioning to pharmacies with lower opioid dispensing as they repay their debt.

Empirical Testing for Prediction 2. We empirically test this prediction using two approaches. First, we investigate whether the effect of college costs on pharmacy-level opioid dispensing is larger for pharmacists early in their careers. Second, we explore within-individual job transitions to test whether pharmacists are likely to move to pharmacies with lower levels of opioid dispensing as their careers progress, and whether this pattern is more pronounced among those with higher college costs. We provide more details on this analysis and discuss the results in Section 6.

4 Data

To examine the relationship between opioid dispensing and college cost, we use three primary data sources: (1) Lightcast Job Profile Data (formerly Burning Glass Technologies); (2) College Scorecard; (3) Automation of Reports and Consolidated Orders System (ARCOS). This section describes each of these data sources and the construction of our sample.

To collect job and education information on pharmacists in the U.S., we rely on the Lightcast Job Profile Database ("Lightcast" henceforth), which contains the longitudinal job history of more than 130 million workers in the U.S. Lightcast collects professional profiles from online career platforms such as LinkedIn and Indeed, where individuals share information about their employment, skills, and education. Lightcast uses machine-learning algorithms to unify duplicate profiles to create one unique master profile corresponding to one person. Based on the job profiles, the Lightcast database reports worker-level characteristics, such as gender, degree, field of study, experience year, and skill sets, and job-level characteristics, such as job title, employer name, occupation, industry, start and end dates, and location.

The dataset covers the workers currently in the U.S. or working in the U.S. for their most recent jobs. We use the profiles of workers who report "pharmacist" as their occupation (SOC code 29-1051) and have education information. Based on the pharmacists' job histories, we construct pharmacist-pharmacy-year panel data for 2006–2019. For each pharmacist, we identify the primary college degree if the field of study of the degree is a pharmacy-related major or if the college title includes "pharmacy school."[11]

We also employ the College Scorecard provided by the U.S. Department of Education to capture college costs and other college characteristics. The College Scorecard includes detailed information on the cost and value of 4,000 higher education institutions nationwide. Among other factors, we use tuition and fees, cost of attendance, admission rates, and percentages completed within 4, 6, and 8 years. Our primary measure of college costs is the total expected tuition and fees required to complete a diploma. Specifically, we calculate the probability of earning a diploma in a given year (4, 6, or 8 years) based on the completion rate for that year, conditional on program completion, and sum up the product of the probability of earning a diploma in a given year and the corresponding year's tuition and fees.[12] We use tuition and fees as the primary measure of college costs, as it is the most consistently reported cost measure available in our dataset. In our sample, the average total expected tuition and fees to complete a diploma amount to $82,042 in 2010 dollars.

As a robustness check, we use the average attendance cost, which includes tuition and fees, books and supplies, and living expenses. The correlation between tuition and fees and the average cost of attendance is 0.96, conditional on both being observed. Though these college-level cost measures are not specific to pharmacy schools, we use them as proxies for the costs of attending pharmacy

[11]For pharmacists with missing field of study information, we define the last graduate degree as their primary college degree, considering that pharmacy schools offer graduate degrees in the U.S.

[12]For each college-year (c, t), we define Expected Cost$_{ct}$ $=$ Annual Cost$_{ct}$ $\times$ $(4 \times Prob(\text{graduation in 4 years})_{ct} + 6 \times Prob(\text{graduation in 4–6 years})_{ct} + 8 \times Prob(\text{graduation in 6–8 years})_{ct})$.

schools under the assumption that college-level and department-level costs are highly correlated. Although tuition and fees at the college-department-year level are not available, we find that a dollar increase in the college-level annual tuition and fees is associated with a 0.452 dollar increase in the median student loan debt at the college-major level using the Field of Study Survey of College Scorecard (See Appendix Figure A1). In a similar logic, our analysis controls for college-level characteristics, such as college type, the average SAT score, the average admission rate, and the racial and gender composition of students, as proxies for the characteristics of pharmacy schools. We link College Scorecard and Lightcast via Office of Postsecondary Education Identifier (OPE ID) for institutions and keep the matched sample.

Our data on opioid dispensing in retail pharmacies are from the DEA's Automation of Reports and Consolidated Orders System (ARCOS). This database tracks all legal transactions of certain controlled substances from their manufacture through commercial distribution channels to their point of sale or distribution at the dispensing or retail level, including hospitals, retail pharmacies, practitioners, mid-level practitioners, and teaching institutions. We use transaction records where retail pharmacies acted as buyers during the period from 2006 to 2019. We use annual oxycodone transactions measured in morphine milligram equivalents (MME) as our main measure of pharmacy-level opioid dispensing.[13] We focus on oxycodone dispensing since the DEA's pharmacy-level database includes data only on oxycodone and hydrocodone. We also check the robustness of the results using hydrocodone dispensing. Note that oxycodone and hydrocodone account for the majority of legal opioid distributions to retail pharmacies and are among the most widely abused prescription opioids (Griffith et al., 2021; Cai et al., 2010).

We link ARCOS data with the sample matched between Lightcast and College Scorecard at the pharmacy level using a fuzzy matching algorithm based on the pharmacy name and location. Specifically, we use fuzzy matching of pharmacy names between Lightcast and ARCOS within each county to link records referring to the same pharmacy. To construct our analysis sample, we first identify all pharmacies that appear at least once in the DEA's ARCOS data as having dispensed oxycodone or hydrocodone during the study period. We then define our sample as all pharmacists in the Lightcast Job Profile data who worked at any of these pharmacies at least once. For each

[13] Morphine milligram equivalents (MME) represent the amount of morphine, in milligrams, equivalent to a given opioid dose. For example, 6.6 mg of oxycodone is equivalent to 10 mg of oral morphine.

pharmacist meeting this criterion, we extract their complete job history from Lightcast and compile all pharmacies at which they were employed during the sample period, regardless of whether those pharmacies dispensed opioids in every year. This procedure yields a pharmacist-by-pharmacy-by-year panel that captures the full set of workplaces associated with pharmacists who have ever been employed at a pharmacy with recorded opioid dispensing.[14,15]

Table 1 presents the summary statistics of our matched sample with the full information. We classify pharmacists into two groups (low or high) based on their college-level expected tuition and fees, and report the characteristics of these groups, as well as those of the overall sample. Our sample includes 14,192 pharmacists and 69,972 pharmacist-by-pharmacy-by-year observations, which cover about 10% of pharmacists working in health and personal care retailers.[16] As shown in Panel A, about 40% of the sample pharmacists are women, meaning that female pharmacists are underrepresented in our sample.[17] Panel B reports the large variation in the cost of attending college across two groups, while there is not much difference in academic level and student composition. Most importantly, in Panel C, we observe the positive gradient of pharmacy-level oxycodone dispensing across college cost levels.

5 Empirical Strategy

We investigate whether higher college costs induce graduates from pharmacy schools to dispense more opioids during their careers (or, more realistically, to get a job at pharmacies that dispense more

[14]About 98.7% of pharmacist-by-year observations involve a single pharmacy. Therefore, in the majority of cases, pharmacist-by-pharmacy-by-year observations are equivalent to pharmacist-by-year observations.

[15]There are two cases in which a pharmacy records zero oxycodone dispensing in a given year. First, some pharmacies that appear in ARCOS as having dispensed opioids at least once may have zero dispensing in certain years. Second, some pharmacies in Lightcast cannot be matched to ARCOS. These unmatched pharmacies may be true non-dispensers, or they may reflect matching issues—such as minor name discrepancies—that introduce measurement error. Because we cannot distinguish between true zeros and zeros arising from matching error, we treat both cases as zero-dispensing observations. About 24% of pharmacist-by-pharmacy-by-year observations in our sample have zero oxycodone dispensing, and roughly 16 percentage points of this 24% arise from unmatched pharmacies. To address this concern, we conduct a robustness check excluding all zero-dispensing observations, as reported in Appendix Table A2.

[16]U.S. Bureau of Labor Statistics reports that the number of pharmacists working in the industry of health and personal care retailers is 134,050 as of 2023. For more information, see: `https://www.bls.gov/oes/2023/may/oes291051.htm`.

[17]For instance, women accounted for 63% of pharmacy degree recipients in 2020 (Draugalis et al., 2022). This under-representation is partly because our sample includes pharmacists who graduated before the share of women in the pharmaceutical profession sharply increased and partly because males are more likely to use online job platforms. For instance, 56.2% of LinkedIn users are male, while 43.6% are female as of 2024, according to Expandi.

opioids). To identify this relationship, we estimate regressions of the following form:

$$\text{IHS}(y_{ispt}) = \alpha + \sum_{k=2}^{7} \beta_k \mathbf{1}(\text{Rank}_s = k) + X_i'\gamma + Z_s'\eta + R_p'\delta + \theta_t + \varepsilon_{ispt}, \tag{4}$$

where IHS(y_{ispt}) is the inverse hyperbolic sine (IHS) transformation of opioid dispensing at the pharmacy p where pharmacist i, who graduated from pharmacy school s, works in year t.[18] $\mathbf{1}(\text{Rank}_s = k)$ is a binary variable representing whether the expected tuition and fees of college s, where pharmacist i graduated, fall into group k. Colleges are grouped into seven categories (septiles) from lowest ($k = 1$) to highest ($k = 7$) expected tuition and fees, and the lowest tuition group is the reference category.[19] Using this vector of indicators allows the effect of college costs to be nonlinear. It also allows us to check if particular groups drive the association between college costs and opioid dispensing. So, β_k coefficients capture the percentage difference in opioid dispensing for each group compared to the group with the lowest tuition level.

X_i is a vector of individual-level characteristics such as gender, graduation year fixed effects, and the number of degrees (Bachelor's, Master's, and Doctoral). Z_s is a vector of college-level characteristics such as college type (public, profit private, and non-profit private), the average SAT score, the average admission rate, the racial and gender composition of enrolled students, and characteristics of the county where the college is located (the shares of female, White, Black, Hispanic, and Asian populations and the IHS of median income for the period 2006–2010). R_p includes pharmacy type (chain and independent) and characteristics of the county where the pharmacy is located, which include the same set of county-level characteristics as those for the college's location. θ_t is the year fixed effects to rule out a mechanical association driven by increasing opioid use over time. We cluster the observations at the college level, considering that the tuition and fees vary across colleges.

Alternatively, we use the IHS transformation of expected college tuition and fees instead of the vector of indicators to measure the elasticity of opioid dispensing to college costs, which takes the

[18]The IHS transformation (IHS(y) = arsinh$(y) = \ln(y + \sqrt{y^2 + 1})$) is used to include observations with zero opioid dispensing. As the IHS transformation approximates the natural logarithm, we interpret the estimated coefficients in the same way as those from a standard log-transformed outcome variable.

[19]College Scorecard misses college cost information for some years, even for the same college. We construct time-invariant cost measures for each college to minimize missing observations without losing generality. Specifically, we first deflate observed college costs to the level of 2010. Then, we regress the deflated college costs on college and year fixed effects. We classify colleges into subgroups based on the college fixed effects.

following form:

$$\text{IHS}(y_{ispt}) = \alpha + \beta\text{IHS}(\text{Expected Tuition}_s) + X_i'\gamma + Z_s'\eta + R_p'\delta + \theta_t + \varepsilon_{ispt}, \tag{5}$$

where all other variables are defined as in equation (4).

One could argue that our covariates for counties where the pharmacy and college are located fail to capture some crucial observable or unobservable geographic characteristics that affect opioid dispensing and college costs simultaneously. To mitigate this concern, we also report the regression results from an alternative specification where we replace the county-level covariates in equation (4) with fixed effects for both the college county ($\xi_{county(s)}$) and the pharmacy county ($\phi_{county(p)}$) as follows:

$$\text{IHS}(y_{ispt}) = \alpha + \sum_{k=2}^{7} \beta_k \mathbf{1}(\text{Rank}_s = k) + X_i'\gamma + Z_s'\eta + R_p'\delta + \theta_t + \xi_{county(s)} + \phi_{county(p)} + \varepsilon_{ispt}. \tag{6}$$

However, a positive association between college costs and opioid dispensing from our specifications does not necessarily reflect a causal effect of college costs. There are two key threats:

1. Pharmacists who have a low repulsion against opioid misuse ex ante may have systematically chosen colleges with high tuition and fees for other reasons. Then, the association between college costs and opioid dispensing will reflect sorting across pharmacy schools at the time of college admission.

2. Pharmacists who graduated from colleges with high costs may be systematically more likely to join pharmacies that encounter patients with a greater need for opioids because of reasons other than high college costs. Then, the association between college costs and opioid dispensing could be at least partly driven by other sorting mechanisms.

While we do not have the data necessary to test whether pharmacists select pharmacy schools based on school characteristics correlated with their views on opioid dispensing, we control for the potentially correlated school characteristics. As explained earlier in this section, our regressions control for college characteristics that may influence a college applicant's decision, such as the average SAT score, the average admission rate, and the racial and gender composition of enrolled students.

We conduct three additional analyses to rule out sorting mechanisms across pharmacies unrelated to college costs. First, we examine whether the results of the heterogeneity analyses are consistent with the context of sorting mechanisms driven by college costs. Specifically, we examine how the association between college costs and opioid dispensing differs across regions more or less exposed to local prescription opioid use.[20] If the relationship between college costs and opioid dispensing reflects a causal effect, we would expect this relationship to be stronger in areas that are more exposed to local opioid use, given the larger variation in opioid dispensing across pharmacies in these areas. In addition, we investigate whether the association between college costs and opioid dispensing differs based on other observable characteristics, such as gender and the business cycle.

Second, we test the robustness of our results by additionally controlling for the factors that could potentially affect pharmacists' sorting across pharmacies with different levels of opioid dispensing. These include their skill sets (the number of certificates and the number of skills in each category) reported in the online profiles as well as the opioid exposure levels of local communities where their college and pharmacy are located. The former reflects a pharmacist's ability or understanding of the potential risks associated with opioid misuse. The latter controls for the geographic variation in opioid use that could mechanically generate the association between college costs and opioid dispensing. Alternatively, we test the robustness of our results by including fixed effects for both the college county and the pharmacy county in equation (6), as discussed earlier in this section.

Finally, we complement these analyses with an instrumental variables approach in Section 6.4 that leverages state budget shocks to public universities to provide additional evidence on the causal link between college costs and opioid dispensing. This strategy provides an external source of variation and strengthens our ability to rule out confounding explanations.

[20]The literature demonstrates that local opioid prescription rates are strongly associated with opioid misuse and mortality (Alpert et al., 2018; Evans et al., 2019, 2022).

6 Results

6.1 Opioid Dispensing Gradient Across College Costs

We begin by investigating the impact of college costs that a pharmacist incurred for her education on opioid dispensing at the pharmacy where she works after graduation. Figure 1 shows the differences in the IHS of pharmacy-level annual oxycodone dispensing among pharmacists from different college cost groups, relative to those from the group with the lowest college costs. College cost groups are categorized based on total expected tuition and fees in panels (a) and (b) and based on annual tuition and fees in panels (c) and (d). As described in Section 5, we classify the observations into seven college cost bins (the lowest in Group 1 and the highest in Group 7).

In each panel, we control for individual characteristics (gender, number of degrees, and graduation year), college characteristics (college type, the average SAT score, the average admission rate, and the racial and gender composition of enrolled students), pharmacy type, and year fixed effects. To address potential confounding effects from geographic variations, we also control for characteristics of the counties where the pharmacy and college are located in panels (a) and (c), as in our baseline specification (equation (4)). These county characteristics include the shares of female, White, Black, Hispanic, and Asian populations and the IHS of median income for the period 2006–2010.

Panel (a) of Figure 1 shows that a higher expected tuition cost in college is associated with greater opioid dispensing over a pharmacist's career. Pharmacists from colleges with the highest tuition costs (Group 7) dispense about three times more oxycodone during their careers compared to those who graduated from colleges with the lowest tuition costs (Group 1). Considering that the expected tuition cost for the lowest group is \$45,439 and that for the highest group is \$135,212 in the value of 2010, opioid dispensing increases twofold for every \$29,924 increase in college tuition and fees, holding all else constant. The figure also shows that oxycodone dispensing monotonically increases as the college tuition level increases, indicating that a particular subgroup of pharmacists does not drive the positive association. Panel (b) shows the parallel results after controlling for county fixed effects rather than county-level demographic characteristics.

Turning to the results for pharmacists who graduated from colleges without available tuition and fee information—representing about 8% of our sample—Figure 1 shows that their opioid dispensing is not statistically different from that of pharmacists who graduated from the lowest-cost colleges. Though we cannot explicitly identify the level of tuition and fees for those colleges because of data limitations, we can infer that the costs of these colleges may be low on average, as approximately 64 percent are public institutions specializing in health sciences and only 0.4 percent are private for-profit institutions.

To capture the quantitative association between college costs and opioid dispensing, we report the estimated elasticity of oxycodone dispensing to tuition and fees in Table 2. Column (1) reports the positive elasticity of oxycodone dispensing to the expected tuition and fees, which is visualized in panel (a) of Figure 1. A 1 percent increase in the expected tuition and fees is associated with about a 1.351 percent increase in oxycodone dispensing during the pharmacist's career after controlling for the baseline covariates. The elasticity to annual tuition and fees is similar (1.581), as shown in column (5).

As discussed in Section 5, the striking positive association between college costs and opioid dispensing does not necessarily indicate the causal effect of the financial burden of college costs on opioid dispensing during a pharmacist's career. The other mechanisms resulting in sorting to pharmacy schools or pharmacies could mechanically generate the association. To address these concerns, we control for additional factors, capturing other mechanisms in the subsequent columns of Table 2.

First, in columns (2) and (6), we add a pharmacist's skill set (the number of certificates, general skills, software skills, cognitive skills, and social skills) reported in the profile data as proxies for his or her ability.[21] If there are skill premiums in the labor market of pharmacists and if higher education costs reflect better training for those skills, then their sorting based on skill levels could result in a positive association between college costs and opioid dispensing, considering the strong positive relationship between opioid dispensing and wages. However, our results do not support this explanation. Controlling the IHSs of the skill measures does not reduce the elasticities; instead, the regression estimates slightly increase. This increase likely stems from the negative association between pharmacist skills and oxycodone dispensing, a relationship explored in more detail below. Since higher college costs are positively correlated with better skills—which may encourage greater caution or reluctance in dispensing opioids—the effect of college costs on

[21] We also take the inverse hyperbolic sine transformation to take into account zero numbers of skills in the data.

opioid dispensing becomes more pronounced when these skills are accounted for.

We find that some types of pharmacists' skills have a statistically significant negative association with oxycodone dispensing. A 1 percent increase in the number of a pharmacist's cognitive and social skills is correlated with a 0.175 percent and 0.143 percent decrease in oxycodone dispensing, respectively. The negative association between these skill levels and opioid dispensing suggests that pharmacists with high cognitive and social skills may take opioid dispensing levels into account when they make workplace choices because of two primary explanations. First, the skill measures may be positively associated with a pharmacist's awareness of the consequences of opioid abuse and potential moral concerns. If this is the case, the observed negative association may reflect disutility from dispensing high levels of opioids among more-skilled pharmacists. Second, if pharmacists select pharmacies solely based on wage levels, we would expect a positive association between the skill measures and oxycodone dispensing, given the strong positive relationship between wage levels and opioid dispensing. However, the lack of such a pattern suggests that high-skilled pharmacists may prioritize non-pecuniary factors, such as ethical considerations, over financial incentives when making career decisions.

Second, in columns (3) and (7), we additionally control for the local exposure to the opioid crisis around a pharmacist's college and workplace. The literature points out that there has been a substantial geographic variation in the number of opioid prescriptions and that local opioid prescriptions predict opioid abuse and mortality (Alpert et al., 2018; Evans et al., 2019; Powell and Pacula, 2021). If colleges with higher costs are concentrated in the areas that are more exposed to the opioid crisis or if graduates from those colleges are more likely to work in the more exposed areas, then our estimates may capture the mechanical relationship between college costs and opioid dispensing. To test this possibility, we control for the normalized opioid prescriptions per capita in the counties where a pharmacist's college and workplace are located. Columns (3) and (7) present that local opioid prescriptions have no statistically significant correlation with pharmacy-level opioid dispensing. The positive association between college costs and opioid dispensing also does not change after these additional covariates are controlled.

Third, in columns (4) and (8), we replace these county-level opioid exposures with fixed effects for both the college county and the pharmacy county, as specified in our alternative specification (equation (6)). These fixed effects can control for many other time-invariant unobservable heterogeneity across locations, as well as local exposure to the opioid crisis. These results indicate that local characteristics do not spuriously generate the positive association between the expected tuition and fees and opioid dispensing, though the point estimate decreases by 25.5% to 0.98.

Our findings have important implications for understanding the role of pharmacists in the opioid crisis. The positive association we observe between college costs and opioid dispensing suggests that pharmacists, at least indirectly, influence the distribution of opioids. If a pharmacist owns a pharmacy, the findings imply that they could overlook patient red flags to increase opioid sales, increase pharmacy revenue, and accelerate student debt repayment. Alternatively, if the pharmacist is employed at a high-paying pharmacy with high levels of opioid dispensing, they may feel pressure to meet the pharmacy's sales expectations to maintain their salary, potentially ignoring warning signs of opioid abuse.

6.2 Heterogeneity in Opioid Sale Gradient

In this section, we explore heterogeneity in the association between college costs and opioid dispensing across various dimensions, including geography, gender, business cycle, pharmacy type, and school ranking. The purpose of this exercise is twofold. First, we examine whether the heterogeneous patterns support the mechanism of pharmacists' sorting into pharmacies with different levels of opioid dispensing due to the financial burden of college costs. Second, we discuss the policy implications derived from the results of our heterogeneity analysis.

Figure 2 reports the non-parametric relationship between the expected tuition and fee and opioid dispensing across the subgroups of pharmacists from the estimation of equation (4). First, given the substantial geographic variation in opioid prescriptions and abuse reported in the literature, we would expect pharmacists' sorting to be more pronounced in the regions more exposed to the opioid crisis. Panel (a) reports the association separately for counties with above-median opioid prescriptions per capita (high-exposure areas) and counties with below-median prescriptions (low-exposure areas). The results support our hypothesis, showing that the positive association between college costs and opioid dispensing is stronger among pharmacists working in high-exposure areas. We also observe a positive association in low-exposed areas, though it is largely driven by a few top college cost groups.

Second, panel (b) reports heterogeneity in the association between college costs and opioid dispensing by gender. Drawing on the long-standing literature on gender differences in risk attitudes (Powell and Ansic, 1997; Eckel and Grossman, 2008; Croson and Gneezy, 2009), we hypothesize that female pharmacists may be more conservative in dispensing opioids because they are more concerned about their health and legal consequences compared to male pharmacists. Although there is no clear evidence for pharmacists, a meta-analysis on prescribing practices by gender concludes that female physicians are more likely to engage in conservative drug prescribing and to reduce the incidence of adverse drug events than male physicians (Mishra et al., 2020). Panel (b) suggests that this pattern is also observed among pharmacists, showing that the positive association between college costs and oxycodone dispensing is much more prominent among male pharmacists than among female pharmacists.

Third, we examine heterogeneity by business cycle, which could influence how college costs impact pharmacists' workplace decisions. Specifically, we explore how the dispensing gradient differs between pharmacists who graduated during economic busts and those who graduated during economic booms. The literature on college graduate outcomes across business cycles suggests that individuals graduating during economic downturns face fewer job opportunities and greater financial constraints (Kahn, 2010; Oreopoulos et al., 2012; von Wachter, 2020). Thus, if the variation in financial debt from college costs among pharmacists is substantially greater during economic downturns, one might expect a steeper gradient for pharmacists who graduated during these periods. However, as shown in panel (c), we do not find clear evidence to support this hypothesis.

Lastly, panel (d) presents an analysis of heterogeneity based on pharmacy type, distinguishing between independent and chain pharmacies. While Janssen and Zhang (2023) suggest that independent pharmacies may be more inclined to distribute opioids due to competitive pressures and financial constraints, recent investigations into lawsuits against chain pharmacies, including Walgreens and CVS, revealed that chain pharmacies have also contributed to the opioid crisis through improper management of opioid dispensing. As discussed in Section 2, Walgreens managers were found to pressure pharmacists to fill prescriptions quickly, even in cases with red flags, to prioritize prescription volume and meet dispensing targets (Chiu et al., 2023). Therefore, we would expect pharmacists in both independent and chain pharmacies to exhibit a positive relationship between college costs and opioid dispensing. Panel (d) supports this expectation by showing comparable gradients for both types of pharmacies, though the estimates for chain pharmacies are associated with wider confidence intervals. Taken together, these findings suggest that the observed relationship is not solely attributable to differences between chain and independent pharmacies, but is also evident within each pharmacy category.

To investigate whether the quality of education affects how college costs influence opioid dispensing behavior, we investigate heterogeneity by pharmacy school ranking. Schnell and Currie (2018) find evidence suggesting that quality education in high-ranked medical schools may reduce opioid prescribing among physicians. Similarly, pharmacists who completed their training at high-ranked pharmacy schools may be less likely to engage in risky opioid dispensing than those from lower-ranked schools, ceteris paribus. We use the widely recognized *U.S. News and World Report* (USNWR) ranking and estimate the elasticity of opioid dispensing with respect to college costs for high-ranked (1–30), middle-ranked (31–70), and low-ranked (70+) schools. The results are reported in panel (a) of Figure 3.[22]

Panel (a) of Figure 3 indicates that the association between college costs and opioid dispensing is weaker among pharmacists who graduated from high-ranked schools in terms of the USNWR ranking than those from lower-ranked schools, suggesting that school quality may help mitigate the impact of college costs on opioid dispensing. However, this heterogeneity does not necessarily result from the education quality or curriculum of high-ranked schools and may reflect unobservable characteristics of pharmacists who graduated from these schools. For instance, pharmacists from high-ranked schools may have advantages in earning a high income, independent of dispensing more opioids.

In Appendix Figure A4, we also compare results using alternative pharmacy school rankings. Specifically, we employ three ranking measures: (1) the USNWR ranking, (2) an education ranking, and (3) a research ranking, with the latter two constructed by Lebovitz et al. (2022). While the USNWR ranking reflects a wide range of pharmacy schools' education, research, and finance factors, the rankings by Lebovitz et al. (2022) separate the quality in education and research factors.

Using the alternative rankings in panels (b) and (c), we observe smaller, statistically

[22]This classification is to maintain a sufficient number of observations for each group, and the results are robust to alternative methods of grouping.

insignificant effects among high education-rank and high research-rank schools. These results are generally consistent with those in panel (a). Overall, these findings provide suggestive evidence that improvements in pharmacy education could play a role in reducing risky opioid dispensing resulting from the financial burden of college costs.

6.3 Sensitivity Analysis

We also check the robustness of the relationship between college costs and opioid dispensing using alternative specifications and variable choices. First, one may be concerned that the clear monotonic relationship in Figure 1 could depend on the specific number of subgroups. Appendix Figure A2 indicates this is not the case, showing that the monotonic relationship holds with five and ten subgroups.

Second, we also use hydrocodone instead of oxycodone as an alternative measure of opioid dispensing in Appendix Figure A3 and Appendix Table A1. While oxycodone is the most commonly prescribed opioid, as shown in Table 1, hydrocodone is also among the most frequently prescribed and abused opioids (Cicero et al., 2013; Beheshti, 2023). The results indicate that hydrocodone dispensing is also positively correlated with college costs across all specifications used in our baseline analyses for oxycodone dispensing.

Third, our results may be affected by the transformation applied to the outcome variable, specifically the IHS transformation. As mentioned in Section 5, we use the IHS because it allows the inclusion of zero dispensing observations while maintaining an interpretation similar to the logarithmic form. To assess the sensitivity of our results to excluding zero observations, we compare estimates based on the IHS and log transformations in Appendix Table A2. Column (1) reports the baseline estimate using the IHS transformation of oxycodone dispensing, while column (3) presents the corresponding estimate based on the log transformation. With the log transformation, the coefficient is smaller but remains positive and statistically significant.

Similarly, we test the sensitivity of our results using a more restricted sample that excludes not only zero observations but also pharmacists who worked at pharmacies with zero oxycodone sales in any year of the sample period. The results are presented in columns (2) and (4). In this case, the IHS and log transformations yield identical results because there are no zero observations. The estimates in columns (2) and (4) remain positive and significant but are slightly smaller than in column (3).

The finding that excluding zero-dispensing observations leads to smaller coefficients suggests that much of the estimated relationship reflects pharmacists' decisions to work at pharmacies that recorded zero oxycodone dispensing compared with those that dispensed any oxycodone. At the same time, our results indicate that a strong positive association between pharmacy school cost and opioid dispensing persists even among pharmacists employed at pharmacies with positive oxycodone dispensing. Overall, this exercise suggests that our results are driven by both the intensive margin (variation among pharmacies with positive dispensing) and the extensive margin (variation across pharmacies that do and do not dispense oxycodone in a given year).

6.4 Causal Analysis

The results so far indicate a strong association between tuition and fees and oxycodone dispensing among pharmacists; however, they do not demonstrate a causal relationship. Even with extensive controls for individual characteristics, college quality, pharmacy attributes, and geographic factors, selection on unobservables remains a fundamental concern.

To support a causal interpretation of our results, we employ an instrumental variable approach using college budget shocks following Deming and Walters (2017). Public universities' revenue is influenced by state government appropriations, which can vary across states and over time depending on the government's financial situation and support for higher education. Within a given state and year, universities' budgets are more or less sensitive to fluctuations in state funding depending on their historical reliance on state appropriations. When universities face budget cuts from the state government, they can respond by increasing tuition fees. Moreover, universities that depend heavily on state funding may be particularly responsive to these budget cuts. If the response to budget cuts is substantial enough (relevance condition) and affects a pharmacist's future opioid dispensing solely through financial constraints (exclusion condition), then our budget shock serves as a valid instrument for college tuition and fees. For this analysis, we focus specifically on pharmacists who graduated from public universities and accurately reported their graduation year between 2000 and 2019.

Following Deming and Walters (2017), we use university-level financial information from the Integrated Postsecondary Education Data System (IPEDS) and state legislative appropriations data from Grapevine to construct the following budget shock instrumental variable (IV):

$$Z_{it} = \left(\frac{\text{Approp}_{i.2000}}{\text{Revenue}_{i.2000}}\right) \times \left(\frac{\text{State Approp}_{s(i)t}}{\text{College Pop}_{s(i)t}}\right) \tag{7}$$

where subscript i and t denote university and academic year and $s(i)$ represents the state where the university i locate in. The first term on the left-hand side reflects university i's financial dependence on state appropriations in the base year of 2000, while the second term indicates the state's total appropriations per college-age population (ages 20-24) within the state.[23] By measuring financial dependence in the base year, we exclude budget changes driven by the university's own responses, such as selectivity, appeal, or other funding sources. Since a student goes through multiple academic years before graduating, we use three different measures for the instrument: (1) budget shock four years prior to graduation, (2) the average budget shock over the four years leading up to graduation, and (3) the average budget shock during the six years before graduation. We use the IHS of tuition and fees for the relevant years as the variables being instrumented in our analysis.

Panel A of Table 3 presents the results of the first-stage estimation. Columns (1), (3), and (5) display estimates that account for the covariates in the baseline model. Columns (2), (4), and (6) also include the log of university revenue for the corresponding academic years. This additional control helps eliminate potential omitted variable bias related to the university's financial status. The results indicate that all the IV measures show significant explanatory power concerning the tuition and fees, which aligns with the findings reported by Delaney and Marcotte (2024).

Panel B illustrates the elasticity of oxycodone dispensing to tuition and fees for this narrowed sample, based on the OLS regressions. The estimates are more than twice as large as those found in the baseline results presented in Table 2. Part of this increase may arise mechanically because the variance in tuition and fees among public universities is smaller than in the full sample, which can inflate the estimated slope coefficient given a similar covariance between tuition and dispensing outcomes. Another plausible explanation is that pharmacists who attend public universities tend to be more financially constrained and thus more sensitive to tuition changes. For these individuals, higher tuition is more likely to translate into greater debt pressure and a stronger incentive to seek higher-paying positions, which are often associated with greater opioid dispensing.

[23] The age-group population data is sourced from the Survey of Epidemiology and End Results (SEER).

The 2SLS estimates reported in Panel C indicate that an exogenous increase in tuition and fees incurred by pharmacists during their college years leads to an increase in opioid dispensing after graduation. For instance, column (4) indicates that a one percentage point increase in the four-year average tuition and fees results in approximately a 4.2% rise in opioid dispensing throughout their careers. Given that the baseline OLS estimates for the full sample are considerably lower than those for graduates of public universities, the overall causal effect for the full sample is likely smaller than the 2SLS estimates reported in this table.

6.5 Job Turnover of Pharmacists

So far, we have demonstrated that pharmacists choose their workplaces after graduation in a way that creates a strong positive relationship between college costs and opioid dispensing. We also provide evidence indicating that pharmacies that dispense more opioids tend to offer higher average salaries. Taken together, these findings raise the question of whether pharmacists under financial pressure make workplace choices solely based on wage levels or if opioid dispensing levels also influence their decisions over time. As discussed in our theoretical framework in Section 3, opioid dispensing may directly impact workplace choices if pharmacists experience disutility from filling opioid prescriptions. To explore this possibility, we empirically test several hypotheses related to pharmacists' job turnover.

First, we investigate whether pharmacy-level oxycodone dispensing influences pharmacists' job turnover decisions, as shown in Table 4. Pharmacists may initially choose their workplace primarily based on wage levels. However, if they later face moral conflict or emotional distress while filling opioid prescriptions despite recognizing warning signs in individuals who may misuse them, or if they face managerial pressure to meet opioid sales targets—thereby opioid dispensing increases non-pecuniary job disamenities—they may become more inclined to seek employment at pharmacies with lower levels of opioid distribution. As financial pressure decreases over time with the repayment of student debt, this transition may become more likely.[24] In contrast, if pharmacists are motivated solely by wage levels, they would have little incentive to transition to lower-opioid-dispensing pharmacies, which are likely to offer lower compensation.

[24] In our theoretical framework in Section 3, this occurs when the marginal disutility of debt is outweighed by the marginal disutility of selling opioids.

Column (1) in panel A of Table 4 shows the results from the regression of 100 times an indicator for job turnover on the IHS of oxycodone dispensing, controlling for the full set of covariates. Our estimates indicate that a 100 percent increase in oxycodone dispensing is associated with a 3.5 percentage point increase in the probability of job turnover. This relationship is large in magnitude, given that the average annual job turnover rate is 2.86 percent. In the following columns, we examine whether pharmacists transition to low-opioid pharmacies (those with opioid dispensing levels below the median) or high-opioid pharmacies (those with opioid dispensing levels at or above the median). If pharmacists' job transitions are motivated by the disutility associated with dispensing opioids, they would be more likely to move to low-opioid pharmacies. In column (2), the outcome represents 100 times an indicator for job transitions to pharmacies with oxycodone dispensing below the median, while column (3) indicates 100 times an indicator for transitions to pharmacies with oxycodone dispensing at or above the median. Our findings reveal that a 100 percent increase in oxycodone dispensing is associated with a 2.1 percentage point increase in the likelihood of pharmacists moving to low-opioid pharmacies. In contrast, there is no statistically significant relationship between oxycodone dispensing and transitions to high-opioid pharmacies. Importantly, these results cannot be solely attributed to mean reversion, as our definition of a transition to a low-opioid pharmacy relies on the current opioid dispensing levels of the pharmacies rather than a direct comparison between the pharmacist's previous and current workplaces.[25]

In Panels B and C of Table 4, we examine how job turnover patterns vary among pharmacists with different college cost levels. Panel B focuses on pharmacists who incurred college costs lower than the median, indicating that the relationship between their turnover rate and oxycodone dispensing levels is not statistically significant. In contrast, Panel C reveals a strong positive association between job turnover and opioid dispensing for pharmacists who faced college costs at or above the median. Specifically, a 100 percent increase in opioid dispensing corresponds to a 4.3 percentage point increase in the overall turnover rate and a 3.1 percentage point increase in the rate of job turnover to pharmacies with low opioid dispensing. This suggests that among pharmacists with high college costs, higher opioid dispensing is associated with a greater likelihood of

[25] For example, if a pharmacist moves from one high-opioid pharmacy (e.g., in the 90th percentile) to another high-opioid pharmacy (e.g., in the 80th percentile), it would not be categorized as a transition to a low-opioid pharmacy.

transitions to pharmacies with lower opioid volumes. Overall, these findings suggest that involvement in opioid dispensing may create disutility for pharmacists, leading them to seek employment at pharmacies with reduced opioid activity.

Our findings, indicating that pharmacists with higher education costs transition to low-opioid pharmacies over time, suggest that the association between college costs and opioid dispensing may weaken as pharmacists' careers progress. We also test this hypothesis by examining heterogeneity by pharmacists' years of experience. Panel (b) of Figure 3 presents the elasticity of opioid dispensing in relation to college costs across different experience years. We categorize the observations into five subgroups based on experience levels: 1-2 years, 3-4 years, 5-6 years, 7-8 years, and more than 9 years. The figure illustrates the decline in elasticity as experience increases, suggesting that the positive correlation between college costs and opioid dispensing is primarily driven by pharmacists early in their careers. If pharmacists with high college costs made workplace choices based solely on wage levels instead of opioid dispensing levels throughout their careers, this decline would not be observed.

7 Discussion

In this section, we discuss several key empirical limitations of our study and their implications for interpreting the results. These considerations include constraints in how fully we can reflect the mechanisms suggested by our theoretical framework, limitations in our data sources and sample coverage, and challenges in measuring opioid dispensing behavior.

Pharmacist Sample Limitations. An important limitation of our analysis stems from observing only a subset of pharmacists through the Lightcast data while measuring opioid dispensing at the pharmacy level. Since Lightcast captures approximately 10% of pharmacists based on their online professional profiles, we do not observe all pharmacists working at each pharmacy in our sample.

Our analysis implicitly relies on two key assumptions. First, we assume that the observed pharmacists in our data are representative of all pharmacists at their workplace, particularly regarding their educational backgrounds and associated tuition costs. This assumption does not appear overly strong, as the widespread adoption of LinkedIn and similar platforms among healthcare professionals suggests that the pharmacists we observe are unlikely to differ systematically from their unobserved colleagues in ways correlated with education costs.

Second, we assume that pharmacists within the same pharmacy contribute roughly equally to the total opioid dispensing volume. This assumption aligns with standard pharmacy operations, where pharmacists within the same pharmacy are not specifically allocated to opioid dispensing duties; rather, all licensed pharmacists participate in the verification and dispensing of controlled substances as part of their standard clinical responsibilities (Chui et al., 2014; Drug Enforcement Administration, 2022). State regulations require pharmacist oversight for all controlled substance prescriptions, and pharmacies utilize various scheduling and rotation systems to manage workload and maintain accuracy, but the assignment of opioid prescriptions is not typically restricted to particular staff members. While some variation may exist due to employment status or seniority, the core dispensing tasks are generally shared across the pharmacy team to ensure workflow efficiency and compliance with legal requirements for pharmacist supervision.

Future research with pharmacist-level dispensing data would provide more definitive evidence on individual behavioral responses to education-related financial pressures. Nevertheless, from a policy perspective, pharmacy-level patterns remain highly relevant, as these represent the actual points of opioid distribution to patients.

Measurement Limitations. Another key limitation of our analysis is that total opioid dispensing may not precisely capture inappropriate or misuse-prone distribution. Three considerations support using total volume as a proxy for the workplace conditions that create pharmacist disutility and influence their workplace choices.

First, during our study period, prescription opioids were widely misused. According to the 2019 NSDUH, prescription opioids were the most commonly misused prescription drugs among people aged 12 or older. Of the 16.3 million people who misused prescription psychotherapeutic drugs in the past year, 9.7 million misused prescription pain relievers (SAMHSA, 2020). This high prevalence suggests that overall dispensing levels reflected not only the volume of medications handled but also the extent to which pharmacists were exposed to the risks associated with patients' potential misuse of these drugs.

Second, the institutional pressures documented in high-volume settings created moral distress that went beyond specific patient interactions. Internal pharmacy documents show that pharmacists experienced ethical strain when pressured to prioritize volume over professional judgment, even when individual prescriptions appeared legitimate (Chiu et al., 2023). This suggests that the overall scale of opioid dispensing, rather than just isolated red-flag prescriptions, likely contributed to stressful working conditions for pharmacists.

Third, between 2006 and 2019, the risks of prescription opioids became increasingly clear to healthcare professionals. As awareness of the opioid crisis grew, pharmacists in high-volume settings reported greater concern about their role in fueling addiction and overdose deaths (Bell et al., 2023; Chiu et al., 2023). This concern was tied to overall dispensing volume rather than only obvious cases of inappropriate prescribing, as regulations and legal scrutiny held pharmacists accountable for the total amount of controlled substances they dispensed (Qato et al., 2022). Rising professional liability may have made lower-volume workplaces more appealing, especially as financial pressures lessened.

Future research could improve on this study by incorporating finer measures of inappropriate prescribing or qualitative insights from pharmacists. Still, total dispensing volume is a useful proxy for workplace pressures and liability risks and helps show how dispensing environments shape pharmacists' decisions.

Pharmacy Data Limitations. An important conceptual gap remains between the predictions of our theoretical framework and the constraints of our empirical environment. The model implies that pharmacists facing higher education costs (and thus stronger financial incentives) would choose to work at pharmacies with higher opioid dispensing, holding all else equal across pharmacies. Empirically, however, we observe only a limited set of pharmacy-level characteristics. Although we control for broad factors such as pharmacy type and local demographics, it is difficult to obtain consistent, nationwide, time-varying data on many other operational or managerial features of pharmacies, especially small independent ones. As a result, opioid dispensing is one of the few pharmacy-level measures that can be accurately captured at scale. These data constraints mean that we cannot fully rule out the possibility that unobserved pharmacy attributes correlated with both opioid dispensing and pharmacists' workplace choices contribute to the observed relationship.

Nevertheless, even with these limitations, our study offers several important contributions. First, we provide the first systematic evidence of a strong and robust correlation between pharmacy school costs and the opioid dispensing intensity of pharmacists' workplaces. Consistent with this, the background section highlights that opioid dispensing is likely an important career-relevant job attribute for pharmacists, influenced by managerial pressure, workplace norms, and financial incentives. Second, although we cannot fully rule out the role of other pharmacy characteristics, the patterns we document align with the idea that pharmacists facing greater financial pressure are more likely to choose to work at higher-dispensing pharmacies, which tend to offer stronger financial incentives but may also carry greater risks of improper dispensing practices. In turn, this suggests that, whatever the underlying reason for their sorting into high-dispensing pharmacies, financially motivated pharmacists may be more likely to contribute—directly or indirectly—to workplace environments in which profit considerations are prioritized over patient safety. Taken together, these findings provide suggestive but important evidence that the financial burden of pharmacy education may have downstream consequences for opioid distribution and the broader culture of community pharmacies.

8 Conclusion

The United States continues to battle an opioid epidemic. While prior research has largely focused on manufacturers, physicians, and insurers as drivers of the crisis, relatively little attention has been paid to pharmacists and the factors driving inappropriate opioid dispensing, despite their critical role in dispensing medications.

Using a unique dataset that links individual-level online job profiles with pharmacy-level opioid distribution data, this paper investigates how financial burdens from college costs influence pharmacists' workplace choices and opioid dispensing behaviors throughout their careers. Our analysis reveals a strong positive relationship between college costs and opioid dispensing in pharmacies where pharmacists work after graduation, with the effect most pronounced during the early years of their careers when financial constraints from student loans are at their peak. These findings suggest that economic factors, such as education costs, may indirectly influence pharmacists' professional decisions and their contribution to the opioid epidemic.

The findings of this paper contribute to a deeper understanding of the role pharmacists play in the opioid crisis and the factors influencing their decisions. By examining the intersection of education costs, workplace decisions, and opioid dispensing, this paper provides a new perspective for policymakers to develop strategies to combat the opioid crisis. Our study has important policy implications. Reducing the financial burden of pharmacy education could help mitigate the sorting of pharmacists into high-opioid-dispensing environments driven by economic pressures. Policies such as tuition reduction, targeted loan forgiveness programs for healthcare professionals, or incentives for pharmacists to work in underserved, low-opioid-dispensing settings may help address the financial factors that contribute to risky dispensing practices. Moreover, enhanced monitoring of systemic factors in pharmacies, including dispensing practices and wage structures, could help address a culture prioritizing sales over patient safety and discourage financial incentives tied to controlled substance sales.

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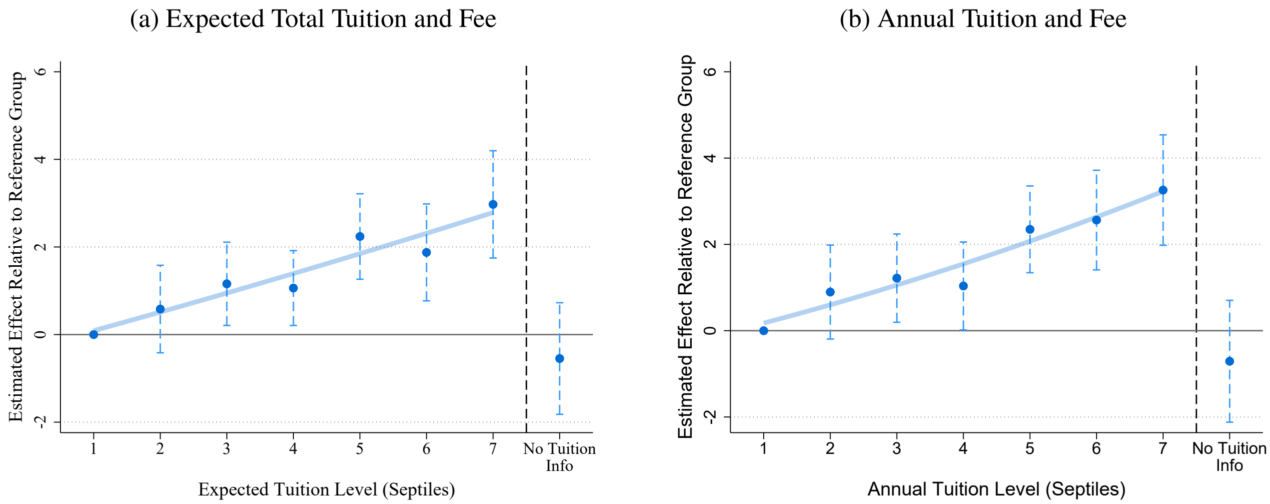
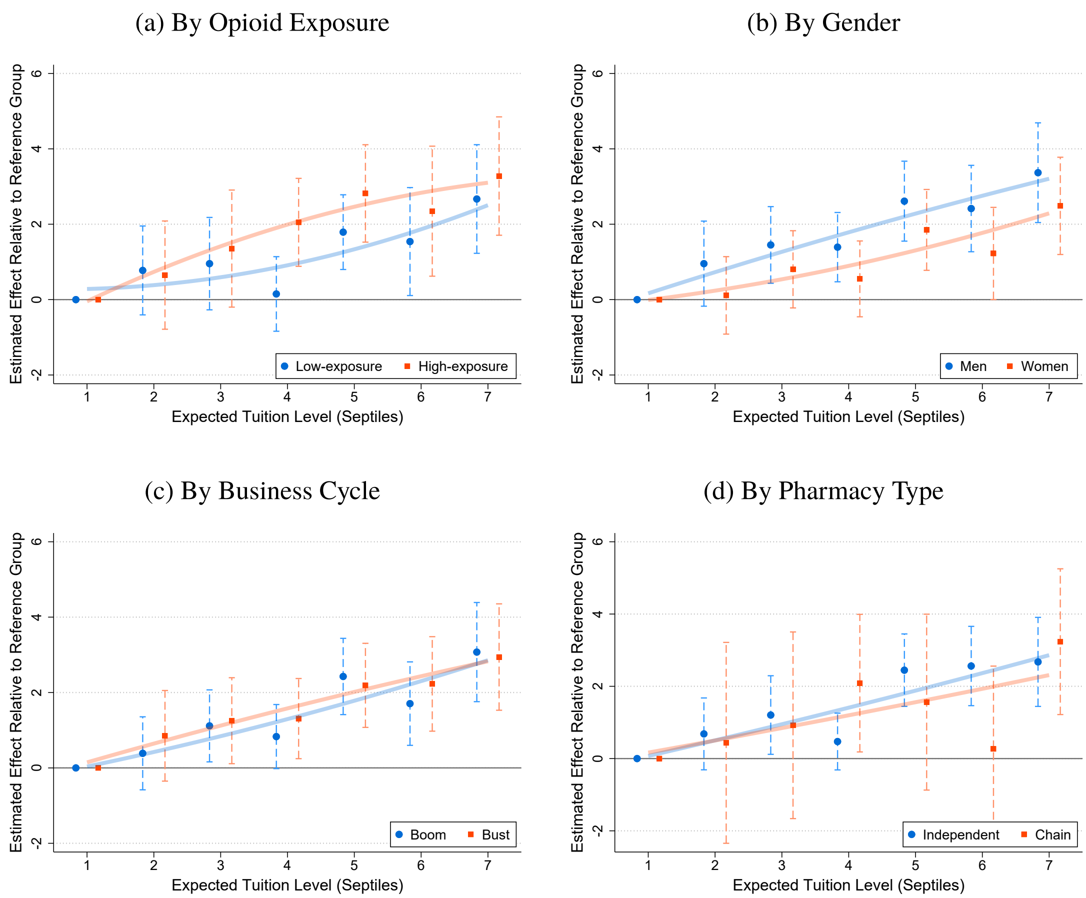
9 Figures and Tables

Figure 1: Association Between Pharmacy School Costs and Oxycodone Dispensing



Notes: This figure shows the association between the IHS of pharmacy-level oxycodone dispensing and pharmacist-level tuition levels. In Panel (a), the estimated effect relative to the reference group is plotted across septiles of total expected tuition and fees. Panel (b) displays a similar pattern, using annual tuition and fees. In each panel, control variables include individual characteristics (gender, number of degrees, and graduation year), college characteristics (college type, the average SAT score, the average admission rate, and the racial and gender composition of enrolled students), characteristics of counties where the pharmacy and college are located (the shares of female, White, Black, Hispanic, and Asian populations and the IHS of median income for the period 2006–2010), pharmacy type, and year fixed effects. The observations are clustered at the college level.

Figure 2: Heterogeneity in the Association Between Pharmacy School Costs and Oxycodone Dispensing

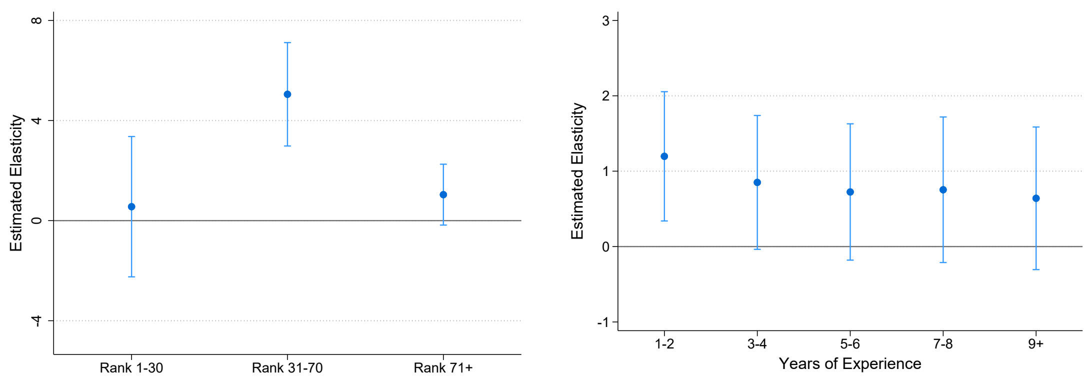


Notes: This figure shows the association between pharmacy-level oxycodone dispensing and pharmacist-level tuition levels across subgroups of pharmacists. The estimated effect relative to the reference group is plotted across septiles of total expected tuition and fees. Panel (a) reports the estimates for pharmacists in counties with below-median opioid prescriptions (blue dots) and pharmacists in counties with above-median opioid prescriptions (orange dots). Panel (b) reports the estimates for male pharmacists (blue dots) and female pharmacists (orange dots). Panel (c) reports the estimates for pharmacists who graduated in years with below-median employment rates (blue dots) and pharmacists who graduated in years with above-median employment rates (orange dots). Panel (d) reports the estimates for pharmacists working for independent pharmacies (blue dots) and pharmacists working for chain pharmacies (orange dots). In the regressions, control variables include individual characteristics (gender, number of degrees, and graduation year), college characteristics (college type, the average SAT score, the average admission rate, and the racial and gender composition of enrolled students), pharmacy type, characteristics of counties where the pharmacy and college are located (the shares of female, White, Black, Hispanic, and Asian populations and the IHS of median income for the period 2006–2010), and year fixed effects. The observations are clustered at the college level.

Figure 3: Elasticity of Oxycodone Dispensing to Pharmacy School Costs by School Rank and Years of Experience

(a) By School Rank (USNWR)

(b) By Pharmacists' Years of Experience



Notes: The figure presents the elasticity of oxycodone dispensing with respect to pharmacy school costs by school rank and pharmacists' years of experience. Panel (a) reports estimates by U.S. News & World Report (USNWR) school rank, and panel (b) reports estimates by years of professional experience. Each point represents an estimated elasticity from a separate regression, and vertical bars indicate the corresponding 95% confidence intervals. In the regressions, control variables include individual characteristics (gender, number of degrees, and graduation year), college characteristics (college type, the average SAT score, the average admission rate, and the racial and gender composition of enrolled students), pharmacy type, characteristics of counties where the pharmacy is located (the shares of female, White, Black, Hispanic, and Asian populations and the IHS of median income for the period 2006–2010), and year fixed effects. The observations are clustered at the college level.

Table 1: Summary Statistics

		Tuition Fee Level	
	Overall	Low	High
Number of Pharmacists	14192	6889	7303
Pharmacist-pharmacy-year Obs.	69972	35298	34674
A. Pharmacist Characteristics			
Female	0.40 (0.49)	0.41 (0.49)	0.39 (0.49)
Year of Graduation	2001.39 (12.40)	2001.08 (12.40)	2001.71 (12.38)
Certificates	0.60 (1.13)	0.59 (1.12)	0.61 (1.13)
General Skills	2.16 (3.25)	2.07 (3.19)	2.25 (3.32)
Cognitive Skills	1.21 (2.16)	1.14 (2.08)	1.27 (2.24)
Social Skills	5.91 (6.42)	5.74 (6.32)	6.09 (6.52)
Software Skills	0.58 (1.45)	0.53 (1.43)	0.63 (1.46)
B. College Characteristics			
Public College	0.64 (0.48)	0.97 (0.17)	0.31 (0.46)
Private Non-profit College	0.35 (0.48)	0.01 (0.10)	0.69 (0.46)
Annual Tuition and Fees	18746.1 (7244.4)	13152.1 (2475.9)	24440.8 (5948.3)
Exp. Tuition and Fees	82031.3 (29989.1)	58990.0 (10128.6)	105487.1 (24896.0)
Annual Cost of Attendance	28575.0 (10857.3)	20296.7 (2644.2)	36925.6 (9532.9)
SAT Score	1159.79 (92.51)	1147.98 (99.35)	1171.18 (83.85)
Admission Rate	0.69 (0.14)	0.70 (0.16)	0.67 (0.12)
Completion within 4 Years	0.49 (0.13)	0.44 (0.14)	0.54 (0.10)
Share of White Students	0.54 (0.17)	0.57 (0.16)	0.51 (0.18)
Share of Black Students	0.10 (0.14)	0.10 (0.14)	0.10 (0.13)
Share of Hispanic Students	0.08 (0.07)	0.08 (0.07)	0.07 (0.07)
Share of Female Students	0.55 (0.08)	0.53 (0.07)	0.57 (0.08)
C. Pharmacy Characteristics			
Retail Pharmacy	0.69 (0.46)	0.67 (0.47)	0.71 (0.45)
Oxycodone Dispensing (Million MME)	2.19 (5.77)	2.13 (5.63)	2.26 (5.92)
Hydrocodone Dispensing (Million MME)	0.70 (1.82)	0.77 (1.83)	0.63 (1.81)

Notes: This table presents the summary statistics of individual-, college-, and pharmacy-level characteristics of the pharmacists in our sample. Panel A presents the statistics of individual characteristics collected from the Lightast Job Profile Database. Panel B presents the statistics of college characteristics reported in the College Scorecard. Panel C presents the statistics of pharmacy characteristics from the DEA's Automation of Reports and Consolidated Orders System (ARCOS).

Table 2: Association Between Pharmacy School Costs and Oxycodone Dispensing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	IHS(Oxycodone)							
IHS(Exp. Tuition Fee)	1.351***	1.365***	1.317***	0.980**				
	(0.476)	(0.471)	(0.478)	(0.405)				
IHS(Ann. Tuition Fee)					1.581***	1.602***	1.525***	1.777***
					(0.576)	(0.571)	(0.581)	(0.586)
IHS(Certificates)		-0.092	-0.096	0.093		-0.095	-0.099	0.094
		(0.087)	(0.088)	(0.066)		(0.087)	(0.088)	(0.066)
IHS(General Skills)		0.160*	0.157*	0.098*		0.159*	0.157*	0.099*
		(0.088)	(0.088)	(0.053)		(0.088)	(0.088)	(0.053)
IHS(Software Skills)		-0.184	-0.185	-0.057		-0.185	-0.186*	-0.056
		(0.113)	(0.113)	(0.076)		(0.113)	(0.113)	(0.076)
IHS(Cognitive Skills)		-0.175**	-0.171**	-0.180***		-0.175**	-0.171**	-0.182***
		(0.079)	(0.078)	(0.060)		(0.079)	(0.078)	(0.060)
IHS(Social Skills)		-0.143***	-0.149***	-0.059		-0.141***	-0.148***	-0.058
		(0.053)	(0.053)	(0.043)		(0.053)	(0.053)	(0.043)
Opioid Rx (College)			0.705				0.688	
			(0.434)				(0.449)	
Opioid Rx (Pharmacy)			-0.052				-0.062	
			(0.287)				(0.288)	
Observations	69,419	69,419	69,072	68,979	69,425	69,425	69,078	68,985
Baseline Controls	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Skill Controls	N	Y	Y	Y	N	Y	Y	Y
Local Opioid Controls	N	N	Y	N	N	N	Y	N
Location FEs	N	N	N	Y	N	N	N	Y

Notes: This table reports the elasticity of pharmacy-level oxycodone dispensing to pharmacist-level expected tuition and fees in columns (1)–(4) and to annual tuition and fees in columns (5)–(8). The baseline controls in columns (1) and (5) include individual characteristics (gender, number of degrees, and graduation year), college characteristics (college type, the average SAT score, the average admission rate, and the racial and gender composition of enrolled students), pharmacy type, characteristics of counties where the pharmacy and college are located (the shares of female, White, Black, Hispanic, and Asian populations and the IHS of median income for the period 2006–2010), and year fixed effects. Columns (2) and (6) additionally control a pharmacist's skill set (the IHSs of certificates, general skills, cognitive skills, social skills, and software skills). Columns (3) and (7) add the total opioid prescriptions in the counties of college and workplace as covariates. Columns (4) and (8) add the fixed effects for both the college county and the pharmacy county instead of local opioid prescriptions. The observations are clustered at the college level.

Table 3: 2SLS Analysis of the Effect of Pharmacy School Costs on Oxycodone Dispensing

Panel A: First-stage Regressions						
	(1)	(2)	(3)	(4)	(5)	(6)
	IHS(Tuition): T-4		IHS(Tuition): T-4 to T-1		IHS(Tuition): T-6 to T-1	
Budget Shock: T-4	-0.235***	-0.196***				
	(0.039)	(0.039)				
Budget Shock: T-4 to T-1			-0.243***	-0.205***		
			(0.040)	(0.040)		
Budget Shock: T-6 to T-1					-0.226***	-0.188***
					(0.038)	(0.038)
Panel B: OLS Regressions						
	(1)	(2)	(3)	(4)	(5)	(6)
	IHS(Oxycodone)		IHS(Oxycodone)		IHS(Oxycodone)	
IHS(Tuition): T-4	2.526***	2.844***				
	(0.863)	(0.876)				
IHS(Tuition): T-4 to T-1			3.143***	3.370***		
			(0.865)	(0.933)		
IHS(Tuition): T-6 to T-1					3.214***	3.498***
					(0.893)	(0.978)
Panel C: 2SLS Regressions						
	(1)	(2)	(3)	(4)	(5)	(6)
	IHS(Oxycodone)		IHS(Oxycodone)		IHS(Oxycodone)	
IHS(Tuition): T-4	3.056*	3.815*				
	(1.604)	(1.947)				
IHS(Tuition): T-4 to T-1			3.660**	4.226**		
			(1.621)	(2.024)		
IHS(Tuition): T-6 to T-1					3.564**	4.159*
					(1.676)	(2.123)
First F-stat	36.239	25.156	37.363	25.929	36.044	24.482
Observations	19,386	19,386	15,634	15,634	15,634	15,634
Baseline Controls	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Skill Controls	Y	Y	Y	Y	Y	Y
Local Opioid Controls	Y	Y	Y	Y	Y	Y
Revenue Controls	N	Y	N	Y	N	Y

Notes: This table presents estimates from the 2SLS analysis of the effect of pharmacist-level expected tuition and fees on pharmacy-level oxycodone dispensing. Each panel reports the estimates from the first-stage regression (Panel A), the OLS estimates (Panel B), and the 2SLS estimates (Panel C). T denotes the year of graduation, and we use the budget shock and tuition for $T-4$, $T-4$ through $T-1$, and $T-6$ through $T-1$. The baseline controls include individual characteristics (gender, number of degrees, and graduation year), college characteristics (college type, the average SAT score, the average admission rate, and the racial and gender composition of enrolled students), pharmacy type, characteristics of counties where the pharmacy and college are located (the shares of female, White, Black, Hispanic, and Asian populations and the IHS of median income for the period 2006–2010), and year fixed effects. The log of college revenue for corresponding years is additionally controlled in columns (2), (4), and (6).

Table 4: Association Between Oxycodone Dispensing and Job Turnover

	(1) Turnover	(2) Turnover to Low Opioid	(3) Turnover to High Opioid
Panel A: Overall Sample			
IHS(Oxycodone)	0.035**	0.021*	0.014
	(0.015)	(0.012)	(0.010)
Observations	63,045	63,045	63,045
Mean	2.873	1.467	1.406
Panel B: Pharmacists with Low College Costs			
IHS(Oxycodone)	0.026	0.011	0.015
	(0.026)	(0.018)	(0.015)
Observations	30,325	30,325	30,325
Mean	2.873	1.467	1.406
Panel C: Pharmacists with High College Costs			
IHS(Oxycodone)	0.043**	0.031**	0.012
	(0.017)	(0.015)	(0.013)
Observations	32,720	32,720	32,720
Mean	2.873	1.467	1.406
Baseline Controls	Y	Y	Y
Year FE	Y	Y	Y
Skill Controls	Y	Y	Y
Local Opioid Controls	Y	Y	Y

Notes: This table reports the association between the IHS of pharmacy-level oxycodone dispensing and pharmacist-level job turnover. The outcome variables are the dummies for overall turnover (column 1), turnover to a pharmacy with below-median oxycodone dispensing (column 2), and turnover to a pharmacy with above-median oxycodone dispensing (column 3). The samples are all pharmacists (panel A), pharmacists who paid below-median expected tuition and fees (panel B), and pharmacists who paid above-median expected tuition and fees (panel C). The baseline controls include individual characteristics (gender, number of degrees, and graduation year), college characteristics (college type, the average SAT score, the average admission rate, and the racial and gender composition of enrolled students), pharmacy type, characteristics of counties where the pharmacy and college are located (the shares of female, White, Black, Hispanic, and Asian populations and the IHS of median income for the period 2006–2010), and year fixed effects.

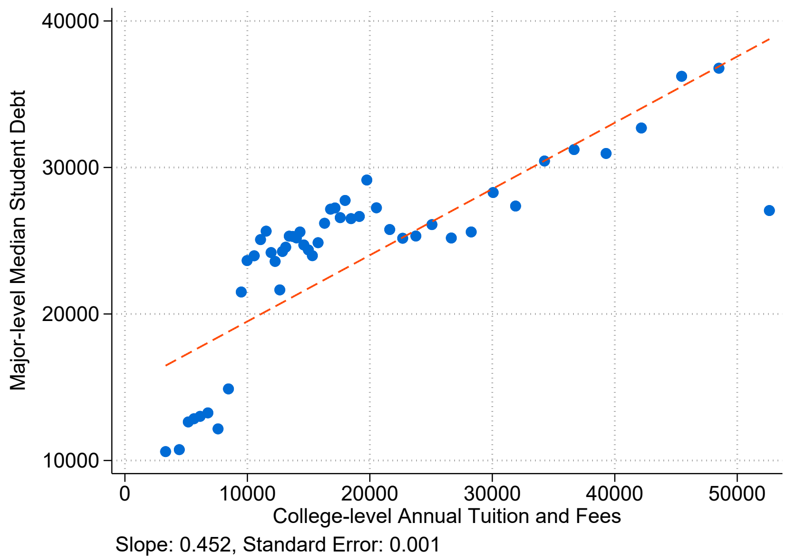
For Online Publication

"Pharmacy School Cost and Opioid Dispensing:
A Hidden Connection?"

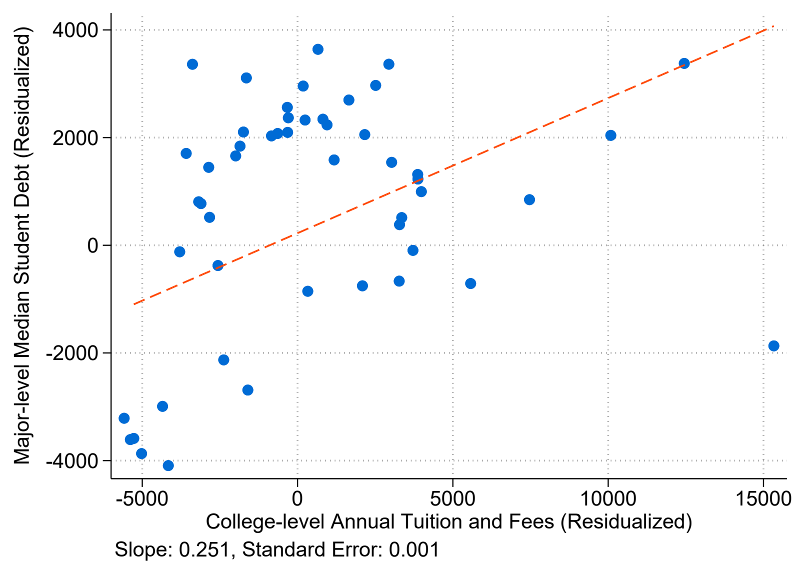
Kim, Kim, and Park (2025)

Figure A1: Association Between College-level Tuition and Fees and Major-level Student Debt

(a) Raw Dollar Values



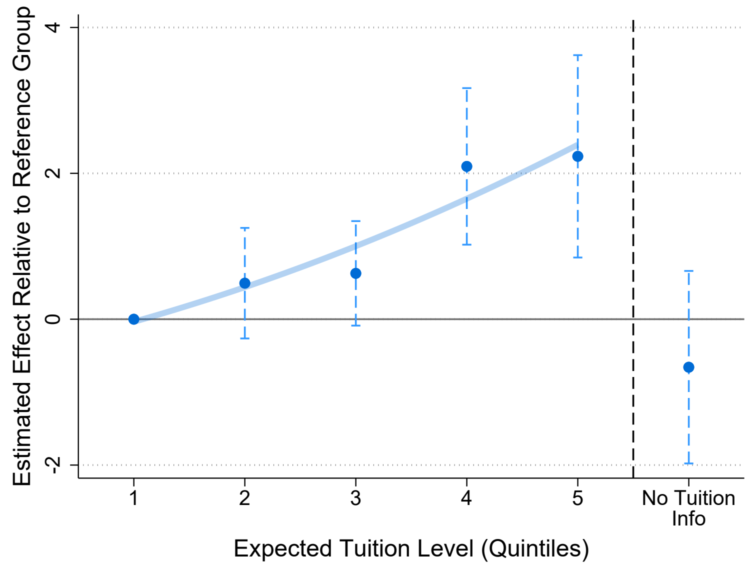
(b) Residualized Dollar Values



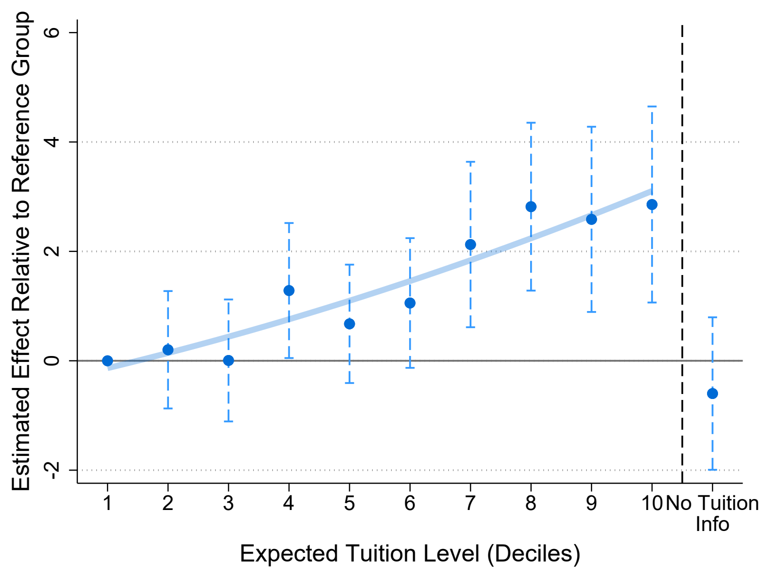
Notes: This figure shows the association between college-level average tuition and fees and major-level median student debts. The major-level student debts are federal borrowers' median cumulative federal loan debt from the College Scorecard Field of Study Survey for 2014-2018. The federal loan debt includes only loan disbursement amounts and does not capture any accrued interest. Panel (a) reports the association in raw dollar values and Panel (b) reports the association after controlling for college type, campus type (main campus or not), year fixed effects, and field of study fixed effects (CIP code). The observations are at college-major-year level and are clustered at the college level to estimate the slopes.

Figure A2: Association Between Pharmacy School Costs and Oxycodone Dispensing by Alternative Tuition Groupings

(a) By Quintiles



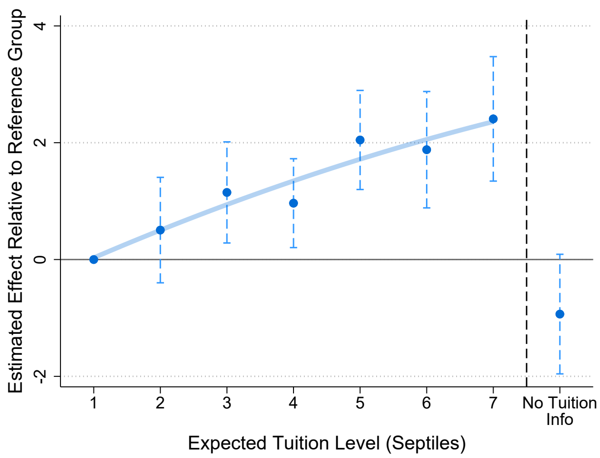
(b) By Deciles



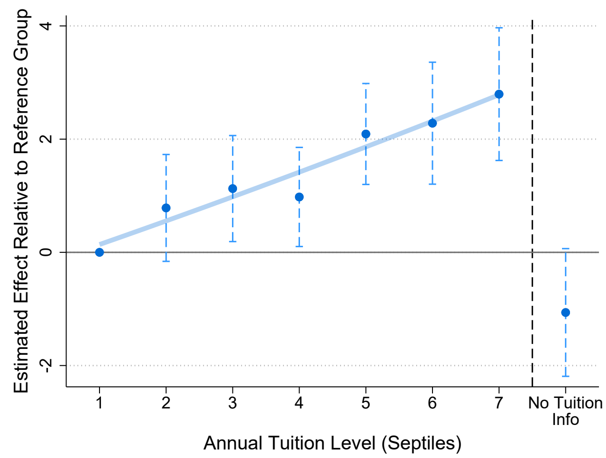
Notes: This figure shows the association between pharmacy-level oxycodone dispensing and pharmacist-level tuition levels across subgroups of pharmacists. Panels report the estimates by quintiles (panel a) and deciles (panel b). In the regressions, control variables include individual characteristics (gender, number of degrees, and graduation year), college characteristics (college type, the average SAT score, the average admission rate, and the racial and gender composition of enrolled students), pharmacy type, characteristics of counties where the pharmacy and college are located (the shares of female, White, Black, Hispanic, and Asian populations and the IHS of median income for the period 2006–2010), and year fixed effects. The observations are clustered at the college level.

Figure A3: Association Between Pharmacy School Costs and Hydrocodone Dispensing

(a) By Expected Tuition and Fee

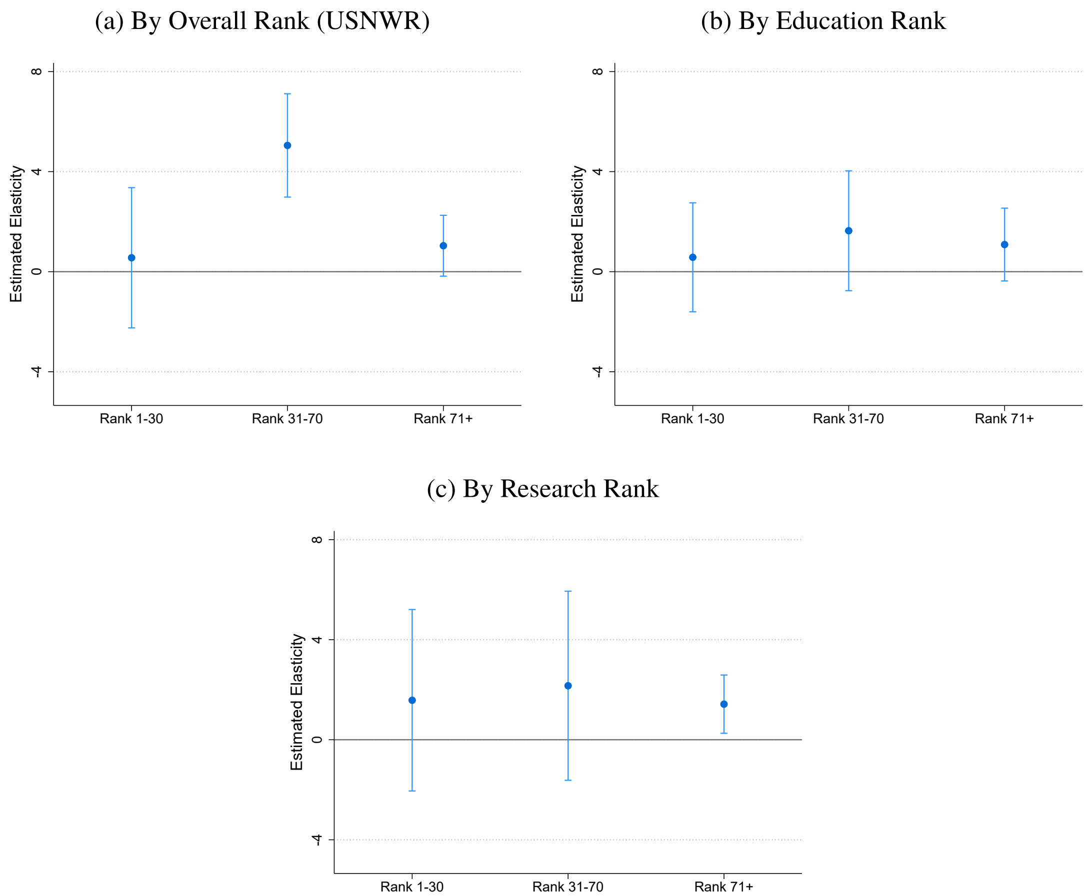


(b) By Annual Tuition and Fee



Notes: This figure shows the association between the IHS of pharmacy-level hydrocodone dispensing and pharmacist-level tuition levels. In Panel (a), the estimated effect relative to the reference group is plotted across septiles of total expected tuition and fees. Panel (b) displays a similar pattern, using annual tuition and fees. In each panel, control variables include individual characteristics (gender, number of degrees, and graduation year), college characteristics (college type, the average SAT score, the average admission rate, and the racial and gender composition of enrolled students), characteristics of counties where the pharmacy and college are located (the shares of female, White, Black, Hispanic, and Asian populations and the IHS of median income for the period 2006–2010), pharmacy type, and year fixed effects. The observations are clustered at the college level.

Figure A4: Elasticity of Oxycodone Dispensing to Pharmacy School Costs by Type of School Ranking



Notes: The figure presents the elasticity of oxycodone dispensing with respect to pharmacy school costs across different types of school rankings. Panel (a) reports estimates by the U.S. News & World Report (USNWR) ranking, while panels (b) and (c) report estimates by education and research rankings constructed by Lebovitz et al. (2022). Each point represents an estimated elasticity from a separate regression, and vertical bars indicate the corresponding 95% confidence intervals. In the regressions, control variables include individual characteristics (gender, number of degrees, and graduation year), college characteristics (college type, the average SAT score, the average admission rate, and the racial and gender composition of enrolled students), pharmacy type, characteristics of counties where the pharmacy is located (the shares of female, White, Black, Hispanic, and Asian populations and the IHS of median income for the period 2006–2010), and year fixed effects. The observations are clustered at the college level.

Table A1: Association Between Pharmacy School Costs and Hydrocodone Dispensing

	(1)	(2)	(3)	(4)	(5)	(6)
	IHS(Hydrocodone)					
IHS(Exp. Tuition Fee)	1.180***	1.193***	1.151**			
	(0.452)	(0.447)	(0.451)			
IHS(Annual Tuition Fee)				1.407***	1.428***	1.350**
				(0.534)	(0.528)	(0.533)
Observations	69,419	69,419	69,072	69,425	69,425	69,078
Baseline Controls	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Skill Controls	N	Y	Y	N	Y	Y
Local Opioid Controls	N	N	Y	N	N	Y

Notes: This table reports the elasticity of pharmacy-level hydrocodone dispensing to the expected tuition and fees in columns (1) to (3) and to the annual tuition and fees in columns (4) to (6). The baseline controls in columns (1) and (4) include individual characteristics (gender, number of degrees, and graduation year), college characteristics (college type, the average SAT score, the average admission rate, and the racial and gender composition of enrolled students), pharmacy type, characteristics of counties where the pharmacy and college are located (the shares of female, White, Black, Hispanic, and Asian populations and the IHS of median income for the period 2006–2010), and year fixed effects. Columns (2) and (5) additionally control for a pharmacist's skill set (the IHSs of certificates, general skills, cognitive skills, social skills, and software skills). Columns (3) and (6) add the total opioid prescriptions in the counties of college and workplace as covariates. The observations are clustered at the college level.

Table A2: Robustness of IHS Transformation

	(1)	(2)	(3)	(4)
	IHS(Oxycodone)		Log(Oxycodone)	
IHS(Exp. Tuition Fee)	0.980**	0.370**	0.448**	0.370**
	(0.405)	(0.188)	(0.176)	(0.188)
Observations	68,979	43,711	52,480	43,711
Full Controls	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Sample	Full	Never-zero Pharm.	Full	Never-zero Pharm.

Notes: This table reports the elasticity of pharmacy-level oxycodone dispensing to the expected tuition and fees using the IHS transformation in columns (1) and (2) and using the log transformation in columns (3) and (4). Columns (2) and (4) exclude pharmacists who worked at pharmacies with zero oxycodone sales at least once during the sample period. In the regressions, control variables include individual characteristics (gender, number of degrees, and graduation year), individual skill set (the IHSs of certificates, general skills, cognitive skills, social skills, and software skills), college characteristics (college type, the average SAT score, the average admission rate, and the racial and gender composition of enrolled students), pharmacy type, characteristics of counties where the pharmacy and college are located (the shares of female, White, Black, Hispanic, and Asian populations and the IHS of median income for the period 2006–2010), the fixed effects for both the college county and the pharmacy county, and year fixed effects. The observations are clustered at the college level.