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Lebesmuehlbacher, Thomas and Smith, Rhet A.

Xavier University, University fo Arkansas at Little Rock

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The Effect of Medical Cannabis Laws on Pharmaceutical Marketing to Physicians

Thomas Lebesmuehlbacher*
Xavier University

Rhet A. Smith†
University of Arkansas at Little Rock

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Abstract

Although cannabis is federally prohibited, a majority of U.S. states have implemented medical cannabis laws (MCLs). As more individuals consider the drug for medical treatment, they potentially substitute away from prescription drugs. Therefore, an MCL signals competitor entry. This paper exploits geographic and temporal variation in MCLs to examine the strategic response in direct-to-physician marketing by pharmaceutical firms as cannabis enters the market. We use office detailing records from 2014-2018 aggregated to the county level and find detailing increases by 7% in the quarter an MCL is proposed. The increase is temporary, however, and attenuates after MCL approval. We then incorporate physician-level cannabis recommendation data from Florida and find opioid detailing to cannabis-friendly doctors declines following MCL enactment. Although we find weak evidence of a similar decline in our primary analysis, the effects are muted at the aggregate level by the small percent of doctors that recommend cannabis.

JEL Codes: **I11, L21, D22, D78**

Keywords: **Cannabis, Medical Marijuana, Prescription Drugs, Competitor Entry, Detailing**

*Department of Economics, Williams College of Business, email: lebesmuehlbachert@xavier.edu.
†Department of Economics & Finance, email: rasmith5@ualr.edu.

1 Introduction

Cannabis is prohibited by the U.S. federal government as is it prone to abuse and considered to have no currently accepted medical use. However, a majority of U.S. states have passed laws legalizing cannabis for medical purposes. While these state laws directly contradict federal policies, the federal government in recent years has generally allowed legal markets to operate as long as state-level regulations are in place to prevent diversion, distribution to minors, drugged driving, and violence (Cole, 2013). Without the risk of federal prosecution, the legal marijuana market in the United States has grown to an estimated $11.3 billion in 2018 and is projected to continue to grow as more states enact laws liberalizing marijuana consumption (Grand View Research, 2019). At the time of this paper 33 states and the District of Columbia have enacted medical cannabis laws (MCLs).

Medical cannabis legalization reduces the nonpecuniary costs associated with cannabis and provides guidelines through which the drug may be acquired, possessed, distributed, and consumed. For doctors, they also provide a list of medical conditions that cannabis may be recommended to treat– conditions for which a significant prescription drug market already exists. Because the legalization of medical cannabis signals competitor entry with certainty, incumbent pharmaceutical companies may strategically alter marketing to preserve their market share. Facing cannabis legalization, incumbent options include: reducing the attractiveness of cannabis and hampering legalization efforts, limiting access to medical cannabis by hindering the process of dispensary openings, or by influencing physicians using advertising and direct contact marketing to discourage switching away from traditional prescription drugs. In this paper we examine the effect of medical cannabis legalization on direct-to-physician pharmaceutical marketing in the form of office-detailing.[1]

[1] Office detailing is the practice of pharmaceutical representatives providing doctors with food and other entertainment while marketing their drug.

Using records of pharmaceutical detailing from the Open Payments database for the years 2014-2018, we use a difference-in-differences approach to exploit the temporal and geographic variation in medical cannabis laws to study strategic changes in marketing by pharmaceutical companies leading up to and following cannabis legalization. We also use a self-constructed dataset of medical cannabis dispensaries at the county level to exploit within-state variation in access to cannabis to explore whether direct-to-physician marketing differs across areas that are more exposed to dispensaries. Specifically, we investigate whether the proposal of an MCL, the approval of an MCL, and the introduction of medical cannabis dispensaries have heterogeneous effects on direct-to-physician marketing. Using a model design that allows us to capture time-varying effects of medical cannabis legalization, we find detailing increases by $2.40 in the quarter an MCL is initially proposed or is under consideration. The roughly 7% relative increase is only evident for two quarters and is not distinguishable from zero for quarters after an MCL has been approved or implemented. Moreover, we do not find evidence to suggest pharmaceutical companies adjust direct-to-physician marketing in areas with greater access to medical cannabis (as measured by dispensary openings).

This paper contributes to the literature in multiple dimensions. First, we provide an empirical analysis of incumbent marketing behavior with impending competitor entry. Ellison and Ellison (2011) provide a similar framework modeling strategic investments by pharmaceutical incumbents as drug patents expire and generic substitutes prepare to enter.

Second, prescribing frequencies are positively related to office detailing (Hadland et al., 2018; Larkin et al., 2017; Nguyen, Bradford and Simon, 2019*b*; Perlis and Perlis, 2016; Spurling et al., 2010), and Alpert et al. (2019) argue that opioid marketing strategies in the 1990s had significant and highly persistent effects on the ongoing opioid epidemic. Recent studies exploit cannabis legalization to argue a substitutability between cannabis and traditional prescription drugs. For example, McMichael, Van

Horn and Viscusi (2020) find significant declines in opioids prescribed and patients receiving opioids following MCL enactment. Our paper connects these strands of literature. We provide weak evidence of a decline in county-level opioid detailing that emerges two years after an MCL is proposed. However, the effect is relatively small and otherwise not distinguishable from zero at this level of aggregation. We then explore this relationship at a more granular level using a novel dataset of physician-level medical cannabis certifications in Florida. We find a larger and more precisely estimated relative decline in opioid-related detailing to cannabis-friendly doctors following MCL enactment. However, due to an unclear direction of causality, doctor selection into treatment, and weak evidence of a negative effect at more aggregate level, we are cautious to suggest changes in opioid marketing as a channel through which MCLs may reduce opioid-related harms (Powell, Pacula and Jacobson, 2018).

Last, where research argues a small role for patient demand in explaining geographic variation in health care utilization (Baker, Bundorf and Kessler, 2014; Cutler et al., 2019; Finkelstein, Gentzkow and Williams, 2016; Fleming, 2019), we diverge from the literature and contend patient preferences are more significant in medical cannabis markets. The minimal response in opioid detailing at the aggregate level paired with a statistically significant negative relationship at the physician level reflects the small percent of doctors providing cannabis recommendations and the ability of pharmaceutical companies to adjust marketing away from cannabis doctors.

The rest of the paper proceeds as follows: in Section 2 we describe the evolving legal cannabis market in the United States and outline incumbent behavior when facing entry of competition from medical cannabis legalization. We discuss the data in Section 3 and detail our estimation strategy in Section 4. In Section 5, we provide the results, robustness checks, and a sub-analysis on Florida physicians. Section 6 concludes.

2 Background and Conceptual Framework

While U.S. prohibition on cannabis dates back to the 1930s, the Controlled Substances act of 1970 (CSA) established a structure and classification system through which the federal government regulates and restricts the distribution and possession of marijuana and other drugs. Under the CSA, all controlled substances (and analogues) are categorized into one of five schedules based upon the substance's abuse potential and medical usefulness.[2] The classification of cannabis as a schedule I drug criminalizes consumption and restricts access to the drug for medical research.[3]

Despite this restriction, there is a growing acceptance of the medical benefits of cannabis and its perceived efficacy to treat various ailments. A recent report from the National Academies of Sciences, Engineering, and Medicine (2017) examined over 10,000 cannabis-related scientific studies and found substantial evidence that cannabis is effective in treating symptoms such as chronic pain, chemotherapy-induced nausea, and spasticity.

Although the federal government has held firm on the prohibition of cannabis, a majority of U.S. states have implemented medical cannabis laws. California was the first state to legalize cannabis for medical use in 1996. Over the next decade, 10 other states would also adopt medical cannabis laws. While these early laws provided legal protection to consumers, they were vague regarding the distribution of the drug. The risk of federal prosecution deterred producer investment and the legal markets remained small over this time period.

The legal market changed dramatically in 2009 when the federal government issued a memorandum stating that federal funds would not be used to prosecute those

[2]Schedule I drugs have no medical value and a high potential for abuse. Substances listed in schedule II through schedule V categories all have some accepted medical benefit and varying levels of abuse potential.

[3]Stith and Vigil (2016) document the obstacles and limitations for studying the medical efficacy of cannabis due to its schedule I status.

in compliance with state medical marijuana laws (Ogden, 2009). Of the 33 U.S. states that have adopted medical cannabis laws, 20 enacted such policies after the 2009 Ogden Memorandum.[4] The geographic distribution of MCL-adopting states is described in Figure 1 (excluding Alaska and Hawaii). States that legalized medical cannabis before our sample period (always treated) include eight states in the geographic West (plus Alaska and Hawaii), seven states in the Northeast, and Michigan. Within our sample period, we observe variation in the timing MCL adoption across all regions of the United States. Five states implement MCLs between 2013 and 2014, five in 2016, one in 2017, and four additional states adopt an MCL in 2018.

All MCLs enacted after 2009 include provisions allowing for dispensaries. This feature is important for multiple reasons. First, dispensaries provide immediate access to cannabis. While cannabis can still be acquired by way of gray market transactions and home cultivation, these alternative methods of procurement are associated with additional costs such as search, quality concerns, safety aspects, or the onerous process of acquiring material needed to grow the drug. A dispensary eliminates these additional costs and Pacula et al. (2015) argue that legal and active dispensaries drive the increased consumption following medical cannabis legalization.

Second, licensed cannabis manufacturing and dispensing helps ensure greater consistency in the drug's components and that cannabis is provided to patients with physician approval (Williams et al., 2016). Similar to patients acquiring traditional prescription drugs from pharmacies, licensed marijuana dispensaries provide the same pharmacy-like services for individuals seeking medical cannabis. Thus, dispensaries circumvent the aforementioned costs associated with non-dispensary transactions making it less costly for an individual (or recommending physician) to substitute away from prescription drugs to cannabis.

[4]In addition to state-level growth of legal medical cannabis states, the number of patients and dispensaries also increased rapidly (Smart, 2015; Smith, 2020).

Last, from a conceptual standpoint, these late-adopting laws lay out a structure for timing and location of dispensary openings through which cannabis will enter a local market. Although the timing between legalization and dispensary opening varies by state, each market follows the same structure: (1) the proposal of an MCL, (2) law approval, and (3) implementation with physician approvals and dispensary openings.[5] From the incumbent pharmaceutical firm perspective, we have the opportunity to observe strategic anticipatory steps pharmaceutical companies take prior to cannabis legalization and examine how marketing behavior changes after cannabis entry.

If cannabis is a viable substitute for prescription drugs, then the process of medical cannabis legalization will be similar to that of generic drug entry upon patent expiration of a pioneer drug. Consistent with a substitution across drugs, Bradford and Bradford (2017, 2018) find prescription drug use falls following MCL enactment.[6] Because MCLs allow for an alternative, substitute form of treatment that could affect the market share and earnings of incumbent firms, a forward-looking profit-maximizing firm will behave strategically prior to legalization in response to the threat of this additional competition.

The most effective response for incumbent firms is entry deterrence through the continued prohibition of cannabis. In the U.S. medical cannabis market, however, this is only accomplished by influencing public opinion and preventing the legalization from occurring on a state-by-state basis.[7] If deterrence is not feasible, then incumbents

[5]The timing between law approval and a dispensary opening for each state is described in Table 1. We incorporate this timing when examining the time-varying response of office detailing to cannabis legalization.

[6]Some state MCLs specifically mention the approval of cannabis in place of drugs that may lead to dependence or other dangerous side effects (e.g. opioid painkillers). In addition, McMichael, Van Horn and Viscusi (2020) find declines in daily doses of opioids following medical marijuana legalization while survey-based analyses provide anecdotal evidence of a substitution from opioids to cannabis among medical marijuana patients (Corroon Jr., Mischley and Sexton, 2017).

[7]There are anecdotes of cannabis deterrence by pharmaceutical companies. Fang (2014) details monetary contributions from opioid manufacturers to organizations that opposed marijuana reform laws and advocated against re-scheduling marijuana from its schedule I classification in a 2014 proposal. Insys Therapeutics, a painkiller manufacturer, contributed $500,000 to an anti-marijuana campaign in Arizona prior to a vote to allow for recreational use (Ingraham, 2016).

will invest strategically prior to competitor entry to encourage inertia and dissuade switching from their product.

Inertia in prescribing is common, even for closely-related substitutes such as brand-name and generic prescription drugs (Kelton, Chang and Kreling, 2013; Kesselheim, Fischer and Avorn, 2006). The persistence stems from doctor uncertainty in treatment options due to heterogeneity in both patient illness and drug efficacy (Crawford and Shum, 2005). Treatment uncertainty is alleviated through learning and experience. Coscelli and Shum (2004) describe an environment where doctors learn about the effectiveness of alternative medicines either directly (through prescribing) or indirectly (from promotional activity). The learning process motivates the marketing strategies of pharmaceutical companies and sheds light on the importance of office detailing by health care companies.

Narayanan, Manchanda and Chintagunta (2005) argue that detailing is substantially more effective in learning about the efficacy of drugs than patient feedback and physician beliefs about treatment efficacy is the most important factor in explaining geographic variation in health care spending (Cutler et al., 2019). Pharmaceutical marketing reflects this relationship and companies invest heavily in direct-to-physician marketing. In 2016, approximately $20 billion was spent on pharmaceutical marketing directly to health care professionals (Schwartz and Woloshin, 2019).

For medical cannabis however, direct and indirect learning for doctors will be minimal to non-existent until legalization occurs. Strategically then, incumbent pharmaceutical companies have an incentive to temper learning for cannabis while expanding knowledge for their own products through promotions and detailing prior to medical cannabis legalization. Similar to Ellison and Ellison (2011), which exploits the lapse of patent protection for prescription drugs, we focus on changes in detailing dollars spent by pharmaceutical firms as states legalize medical cannabis.[8]

[8]Ellison and Ellison (2011) provide a framework for strategic investment prior to patent expiration

While there are a number of similarities between generic drug entry and cannabis legalization, there are also meaningful differences between the two events. These differences likely limit the impact of medical cannabis legalization on prescribing behaviors of physicians and the marketing strategies employed by pharmaceutical companies. The first dimension in which medical cannabis differs from alternative prescription drugs is the out-of-pocket costs. Insurance (public or private) does not cover medical cannabis and the out-of-pocket costs could limit the substitution among low income patients.[9]

Second, the schedule I classification of marijuana hinders the learning process and significantly limits access to cannabis for clinical trials (Stith and Vigil, 2016). The uncertainty of cannabis as an effective medical treatment implies a higher switching cost and a lower likelihood that doctors substitute away from traditional prescription drugs. Moreover, the contradicting state and federal laws and doctor concerns of federal prosecution affects doctors' willingness to "recommend" cannabis for treatment.[10,11] Therefore, the inertia in medical treatment, which is already present among brand and generic prescription drugs, is exacerbated for cannabis by federally prohibitive laws.

These mechanisms, however, do not take into consideration the changing perception of cannabis. Over the past 30 years, marijuana has evolved from its reputation as a "gateway" drug to being associated with medical treatment. Medical cannabis legalization is preceded by state-wide public debate that allows for learning to occur among prospective patients. The perceived riskiness of cannabis declines following MCL enactment indicating an outward shift in patient demand (Wen, Hockenberry and Druss,

that includes reducing marketing to make the market less appealing. However, the incentives for follower (generic) entry in their framework are not directly applicable to medical cannabis legalization.

[9]Bradford and Bradford (2018) argue these costs are similar to high co-payments associated with new FDA-approved drugs.

[10]Physicians cannot technically prescribe cannabis due to its Schedule I status. However, doctors sidestep this restriction by recommending the drug instead.

[11]Jeff Sessions, the U.S. Attorney General from February 2017 through November 2018, made multiple comments about repealing protections for the medical marijuana market and called for greater enforcement of the Controlled Substances Act.

2019).[12] In addition, patients can obtain a medical marijuana card without consulting their usual physician, thus avoiding the switching costs arising from their own doctor's risk aversion.

The importance of demand-side factors in the medical cannabis market is evident by the concentration of cannabis recommendations among doctors and by the resources available for patients to "doctor shop" for cannabis-friendly doctors.[13] Although survey results suggest most doctors are receptive to medical cannabis (Adler and Colbert, 2013; Sideris et al., 2018), the fraction of doctors using it in practice remains small. By the end of 2016, only 1 percent of Maryland's 16,000 doctors had registered with the state's medical marijuana program (Cohn and McDaniels, 2016). Similarly, the Florida Board of Medicine (2019) reported that 89 doctors were responsible for nearly 95,000 certifications in Florida in 2018 (out of 168,810 certifications).

Under these conditions, then, the response in direct-to-physician marketing to an MCL may be muted at aggregate levels due to more significant patient preferences and a small share of doctors that actively recommend cannabis. Regardless, the periods preceding medical cannabis legalization and those that follow are of interest because each will shed light on strategic behaviors of firms facing new competition.

3 Data

3.1 Medical Cannabis Laws and Dispensary Openings

Our identification relies on the variation in the implementation of medical cannabis laws. Although the MCL literature focuses on law enactment, the laws must first

[12] Anderson, Hansen and Rees (2013) show the price of high quality cannabis declines after an MCL is enacted suggesting a larger outward shift in supply and an unambiguous increase in cannabis consumption.

[13] The cost to locate or "shop" for cannabis-friendly doctors has been reduced by online postings, medical cannabis doctor registries, and dispensary-coordinated "patient drives" where consumers can meet a doctor and get the required recommendation needed to legally acquire medical cannabis.

be proposed and legally approved. Affected agents will likely respond to the initial announced proposal of an MCL. Residents will consider how the policy affects their lives, doctors will evaluate how their practice will be affected, and pharmaceutical firms will behave strategically facing the possible entry of an additional competitor. Therefore, the first aspect of medical cannabis legalization we examine is the proposal of an MCL by way of ballot or legislative initiative. These dates are collected from state websites, the National Organization for the Reform of Marijuana Laws (NORML), votesmart.org, and ballotpedia.org and are described in the first column of Table 1.

We also examine medical cannabis law approval and enactment dates. Medical cannabis legalization removes uncertainty that cannabis is entering the market and thus potentially affects office detailing differently than the initial proposal of an MCL. MCL enactment dates are obtained from Bradford and Bradford (2018) and updated through 2018 using ProCon.org (2019).[14]

Although MCLs conditionally legalize cannabis consumption for all adult residents with doctor approval, these laws do not ensure access to cannabis. Dispensary presence is an important characteristic of late-adopting MCL states, and there is significant within-state heterogeneity in dispensary access (Smith, 2020). Because dispensaries reduce nonpecuniary costs associated with cannabis and are associated with greater cannabis use (Freisthler and Gruenewald, 2014; Pacula et al., 2015), we also examine this dimension of medical cannabis legalization.

To avoid ambiguity and limit measurement error in dispensary presence, we follow Powell, Pacula and Jacobson (2018) and define dispensary presence as an active dispensary legally protected and regulated by a state MCL. While most dispensaries that opened during our sample period entered into a structured and legally protected market, this was not always the case. Many early dispensaries opened without explicit

[14]The timing of these laws are also cross-referenced with the dates listed in the online appendix of Powell, Pacula and Jacobson (2018). When sources conflict with one another, the earliest date is used.

legal protection and operated by exploiting loopholes within vaguely written MCLs.[15] By the beginning of our sample period, only Michigan, Montana, and Washington had dispensaries operating without explicit dispensary provisions included within their state cannabis law.[16] Michigan began issuing dispensary licenses in 2018 while Montana began registering providers in 2017. Legal sales began in Washington with the advent of recreational sales in July 2014.[17] The dates of MCL enactment and legal and active dispensary information are listed in the last two columns in Table 1. Because any resident medical cannabis patient can purchase from a dispensary, we examine the changes in office detailing following a legal dispensary opening at the state level. We also examine this relationship at the county level to account for within-state differences in competition and exposure to cannabis.

To allow for within-state variation in access to cannabis, we construct a dispensary dataset from a scraped directory of dispensaries registered on Weedmaps.com.[18] Weedmaps.com is an online platform where dispensaries can advertise freely and consumers can search for marijuana-related businesses and products. Business pages often include contact information, a list of products, corresponding prices, location, and hours of operation. Consumers, in turn, can provide reviews of their experience at these businesses. Because Weedmaps allows dispensaries to communicate information to customers regarding quality and location at no cost, the Weedmaps database likely includes most operating dispensaries.

Because the data do not include opening dates, this information is hand-collected

[15] Un-regulated quasi-dispensaries were more prevalent immediately following the 2009 Ogden Memorandum and either adapted to changes in regulations or shut down as states adopted measures to regulate the newly formed markets. See Smith (2020) for description of marijuana gray markets and quasi-dispensary operations.

[16] In our analysis of the impact of legal and active dispensaries on office detailing, an active dispensary without legal protections is considered untreated.

[17] Although Washington allowed for collective gardens prior to 2014, we use the date of legal recreational sales for "legal and active" dispensary activities for consistency across states. The results are quantitatively similar using either definition.

[18] The data were scraped from the Weedmaps.com directory in April 2019.

using the following steps. Each dispensary in the Weedmaps directory is assigned a numerical registration ID when they set up a business account. We group the dispensaries by their county and use the lowest Weedmaps registration ID within each county to identify the earliest registering dispensary in the area. We then consult business web pages and social media accounts, business license records, and local news sources to determine the opening date of these dispensaries. Last, keyword searches and media sources are used to confirm the dispensary with the lowest Weedmaps ID was actually the first in a given county.[19]

While the Weedmaps directory likely includes most active dispensaries, there are limitations to the data. Dispensaries may choose not to register with Weedmaps to avoid detection. However, because "legal and active" dispensaries are licensed and legally protected by state and local laws, the benefits from visibility and advertising on Weedmaps exceed the costs associated with the risk of criminal prosecution. We also supplement the Weedmaps data with state registries and tax revenue reports when available. Therefore, our "legal and active" definition of dispensaries limits the potential for measurement error in the dispensary variable and allows for consistency with related studies (e.g. see Powell, Pacula and Jacobson, 2018).

3.2 Promotions to Physicians

Records of office detailing are obtained from the U.S. Centers for Medicare and Medicaid Services (CMS) Open Payments database. The Open Payments data was established as part of the Affordable Care Act to provide greater transparency on the financial relationships between physicians and the health care companies whose products the physicians are prescribing. The data describe all detailing from health care

[19] California is omitted from the analysis it experiences unlicensed dispensary activities that cause disruptions in "treatment" at local levels. Cannabis proposal and legalization in California occurred well before our sample period and does not affect our identification strategy.

companies to a health care provider (e.g. pharmaceutical company to physicians) and includes the dollar amount, reason for payment (e.g. for which drug), and type of payment (e.g. meals, travel, presentation fees, etc.). Under the Physician Payments Sunshine Act, applicable manufacturers and group purchasing organizations (GPOs) are required to report payments and other transfers of value given to physicians and teaching hospitals.[20]

From the comprehensive list of financial interactions between health care companies and physicians, we focus on entertainment-related general purpose payments. All entries in teaching hospitals and those that are research- or ownership-related (e.g. royalties) are omitted. A small percent of the data (approximately 3.5% of drugs between 2013 and 2018) contain inaccurate or imprecise information regarding drug names. As such, we further restrict the sample to drugs whose NDC codes or names match information in the NDC registry. While the data contain state, zip code and street address information, the data do not include corresponding counties. We add this information by matching zip codes with county FIPS from the USPS Crosswalk.[21] Our final sample includes all known prescription-drug related detailing in the form of meals, travel, and general entertainment aggregated to the county-quarter-year level for a total of 58,585 observations spanning 2014 through 2018.

We examine, separately, changes in detailing for drugs in which cannabis could be considered a substitute. To identify prescription drugs that are substitutes in treatment for medical cannabis approved conditions, we use the list of Multum Tier 2 Drug Classes from Bradford and Bradford (2018). We link these drug classes to their individual prescription drugs using information from RxMix, a prescription drug library developed by the National Library of Medicine. Substitutes are defined as prescription drugs that

[20] Receiving physicians and teaching hospitals may review these reported payments and revise them before publication.

[21] Zip codes that overlap 2 counties get assigned to the county where the most businesses in the zip code are located.

are used to treat the same conditions as medical cannabis. This list of drugs includes both on- and off-label uses.[22]

As a subset of substitute drugs, previous literature argues a link between i) medical cannabis and opioid prescriptions and ii) office detailing and opioid prescriptions. To the extent that medical cannabis affects office detailing, it is reasonable to believe that there may be differences in the response of office detailing for opioids. We use NDC codes from the Open Payments data to create an indicator for marketing entries that involve prescription opioid drugs.

Last, we examine the impact of medical cannabis legalization on detailing across market structures. Pharmaceutical companies with a large market share (as measured by drug sales) may be less threatened by medical cannabis and, in turn, less likely to adjust their office detailing. Similarly, office detailing for specific drugs with a large sales volume may be less sensitive to competition from medical cannabis. Using data on product sales of major pharmaceutical companies from PharmaCompass, we create an indicator equal to one if a prescription drug reaches sales worth $1 billion in any year to identify blockbuster drugs, and another indicator equal to one for the company that created the drug. We use these indicators to test for differences in office detailing between i) small and large sized companies and ii) high and low volume prescription drugs.

The distribution of detailing is depicted in Figure 2. Non-drug related payments (e.g. gauze or syringes) are on average larger, though less frequent than drug-related detailing. A total of $11,930,354$ drug-related payments were made to MDs in non-MCL states at average value of $26 per payment.[23] MDs in states that implement an MCL during our sample period received more frequent detailing at a higher average

[22]The main source for off-label uses in RxMix come from Drug Bank, such as: https://www.drugbank.ca/drugs/DB00571.

[23]The term "payments" is used for brevity and it includes the various forms of detailing described earlier in this section.

dollar value than MDs in non-MCL states. Opioid-related office detailing makes up the smallest payments to most physicians with, on average, only $20. Further, the number of payments associated with opioids is relatively low, making up less than 1% of payments for most physician types. Substitute drug detailing follows a similar pattern to opioids and is less frequent and smaller on average than other detailing entries. Finally, detailing for non-blockbuster drugs and by non-big pharmaceutical companies (as previously defined) are larger in value than other types of detailing and occur more frequently in states that adopt an MCL during our sample period.

We complement medical cannabis data and Open Payments Data with county level information on sociodemographic characteristics from the U.S. Census Bureau, county level health care information from the Area Health Resource Files, and mandatory access prescription drug monitoring program laws from Buchmueller and Carey (2018), Nguyen, Bradford and Simon (2019*a*), and the Prescription Drug Abuse Policy System.

3.3 Patterns and Evolution of Medical Cannabis Laws and Office Detailing

Although medical cannabis was already legal in 18 of 33 states prior to our sample period, access to the drug in the form of a legal and active dispensary was only available in 7 states. Panel (a) in Figure 3 complements Table 1 and depicts the number of counties exposed to proposed medical cannabis legalization, the total counties in states that approve an MCL, and the number of counties with access to a legal and active dispensary. State- and county-level exposure to dispensaries are plotted separately to emphasize within-state variation in dispensaries and illustrate the importance to distinguish between cannabis access at each geographic level. While 796 counties had access to medical cannabis through a state-regulated dispensary in 2018Q1, only 283

counties had a dispensary operating within the county. Therefore, patients and local markets may not respond if a dispensary is not active locally.

To compare office detailing levels with exposure to medical cannabis, in Panel (b) in Figure 3 we plot the level of payments per doctor over time. For both MCL and non-MCL counties, we observe cyclical detailing that slightly declines in later periods. However, the difference between MCL and non-MCL counties is largely unchanged. A similar pattern emerges when we examine changes in cannabis access and office detailing within states. In Figure 4 we depict the expansion of legal access points to cannabis by comparing counties with dispensaries in 2014 to counties with dispensaries in 2018. However, when we map county-level detailing in Figure 5, we see no obvious differences in office detailing across MCL and non-MCL states. While states in the west generally have greater access to medical cannabis (as measured by an open and legal dispensary in a county), the geographic distribution of office detailing is mostly concentrated in eastern half of the United States (with the exception of California).

The summary statistics for county-level average detailing dollars spent per doctor, substitute-related payments per doctor and opioid-related detailing dollars spent per doctor are provided in Table 2. The outcomes are separated by whether a county is located in a state that ever enacts an MCL and whether the MCL is active for counties that do locate in a state that adopts an MCL. While the staggered timing of laws makes comparing county-level averages across groups over time difficult, we observe lower levels of payments per doctor in counties that have an MCL in effect. The pre-MCL counties and non-MCL counties are otherwise comparable in the average amount of detailing dollars per doctor per quarter-year.

4 Estimation Strategy

To estimate anticipatory and post-MCL effects on drug-related office detailing, we use an event study approach and exploit the temporal and geographic variation in MCLs.[24] Rather than impose an arbitrary duration of anticipation periods, we leverage the timing of an MCL *proposal* on office detailing. Relative to the other stages of medical cannabis legalization, the proposal stage is likely least affected by anticipation affects. Our baseline model allows for time-varying effects and takes the form:

$$D_{cst} = \sum_{\tau=0}^{8} \beta_{-\tau} MCL_{s,t-\tau} + \sum_{\tau=2}^{7} \beta_{+\tau} MCL_{s,t+\tau} + \mathbf{X}_{cst}^{'} \alpha + \gamma_c + \delta_t + \varepsilon_{cst}. \tag{1}$$

The dependent variable is the dollar value of office detailing per physician in county c in state s in quarter-year t.[25] The terms γ_c and δ_t represent county and quarter-year fixed effects. The vector $\mathbf{X}_{cst}$ includes state-level mandatory access prescription drug monitoring program laws, county-level health conditions, domestic migration data, and population demographic proportions. We also include county-level unemployment rates and average weekly wages to control for local time-varying macroeconomic conditions that may affect levels of detailing. The quarter immediately preceding bill introduction is normalized to zero and $\sum_{\tau=2}^{7} MCL_{s,t+\tau}$ represents the periods preceding the initial proposal of a medical cannabis law. Changes in detailing in the quarter of bill introduction ($t = 0$) and the quarters following are represented in $\sum_{\tau=0}^{8} MCL_{s,t-\tau}$. Any observed trends in the respective $\hat{\beta}_{+\tau}$ suggests differing trends in detailing across MCL and non-MCL observations prior to an MCL proposal and threatens the validity of the estimation strategy. Observations 7 or more quarters prior to bill introduction and 8 or

[24] Malani and Reif (2015) suggest the use of quasi-myopic model that controls for anticipation effects for S periods prior to treatment. One shortcoming of this approach, however, is researchers must assume there are no more than S periods of anticipation.

[25] The results are not sensitive to the natural log transformation of the dependent variable and are presented in Figure A1 in the Appendix.

more quarters post are grouped into respective "7+ quarters" and "8+ quarters" bins. Last, ε_{cst} is the mean zero error term.

We use a similar approach to equation (1) to examine the change in detailing in response to dispensary openings. Because dispensaries indicate direct competitor entry, pharmaceutical firms may respond differently to their presence. Here, we replace the lead and lagged variables relative to MCL proposal with a set of lead and lagged variables relative to a dispensary opening. We estimate separate specifications allowing for the dispensary treatment to vary at both the state- and county-level.

Last, we estimate traditional difference-in-differences (DD) models examining whether detailing varies by MCL characteristics. Our DD model includes county and quarter-year fixed effects and the same time-varying control variables as equation (1). It takes the form:

$$D_{cst} = \beta_1 MCL_{st} + \beta_2 Disp_{st} + \mathbf{X}_{cst}^{'}\alpha + \gamma_c + \delta_t + \varepsilon_{cst} \tag{2}$$

where MCL_{st} is a binary indicator variable equal to one if an MCL is implemented in state s in quarter-year t and equal to zero otherwise. Similarly, the $Disp_{st}$ variable is equal to one if an active and legally protected dispensary is operating within the state.

5 Results

5.1 Office Detailing and Medical Cannabis Legalization

The time-varying estimated effects relative to the initial proposal of an MCL and corresponding 95% confidence intervals are provided in Figure 6. Period 0 indicates the quarter in which legal medical cannabis is proposed in legislature or introduced on a ballot. The quarter prior to the MCL proposal period is omitted as the base period and is normalized to zero. The two graphs in Panel (a) describe the relationship between

medical cannabis legalization and per physician office detailing to all physicians and to medical doctors (MD) only.[26] The results are not sensitive to our sample of doctors used or how we scale the dependent variable and suggest office detailing increases during the semester in which legal medical cannabis is initially proposed and under consideration. We find office detailing increases by $2.40 per physician during the quarter an MCL is proposed. The increase is only temporary, however, as the effect attenuates and is not distinguishable from zero after 2 quarters.

Among the states that enact an MCL within our sample period, the mean duration between proposal date and law approval is 2 quarters while the median quarter duration is 1. Thus, the temporary increase in detailing followed by null results after 2 quarters suggest pharmaceutical marketing reacts to uncertainty and greater public discussion but is otherwise unresponsive to cannabis legalization.[27]

In Panel (b) in Figure 6, we examine separately the markets for which cannabis may be a substitute. Unlike overall detailing, we do not observe a temporary increase in substitute- or opioid-related detailing during the period an MCL is proposed. However, we find weak evidence of relative declines in substitute- and opioid-related detailing that becomes marginally significant during the second year of legalized medical cannabis. Although the decline in detailing is consistent with a reduced market share and a lower return on investment, the effects are relatively small and not distinguishable from zero at this level of observation until nearly a year after medical cannabis is legalized.

The relative declines in substitute and opioid-related detailing are more pronounced in Figure 7 when we omit detailing from large pharmaceutical companies (Panel (a)) and blockbuster drug detailing (Panel (b)). Likewise, the temporary increase in overall detailing immediately following an MCL proposal is evident in these

[26]Physician is broadly defined and includes those with a low propensity to recommend medical cannabis (such as chiropractors).

[27]Time-varying estimates relative to law approval and enactment indicate a similar up-tick in the period preceding quarter of "treatment." These results are provided in Figure A2 in the Appendix.

alternative samples suggesting our baseline results are not driven by large pharmaceutical companies or high value prescription drugs.

5.2 Office Detailing and Medical Cannabis Dispensaries

Cannabis dispensaries are essential in reducing non-pecuniary costs associated with medical cannabis and providing a safe and legal access point for consumers. Because dispensaries provide greater access to cannabis and a more tangible threat of competition, pharmaceutical companies may ignore the initial implementation of an MCL and instead adjust detailing in response to dispensary openings.

In Figure 8, we explore this dimension and examine the response in pharmaceutical detailing relative to dispensary openings at the state and county level. We do not find evidence of changes in detailing leading up to or following the opening of a dispensary at either level of dispensary exposure. However, dispensaries do not open unexpectedly and firms have likely anticipated their opening following MCL approval.[28]

To disentangle legalization effects from dispensary effects, we regress prescription drug-related detailing on MCLs *and* dispensaries using the difference-in-differences approach described in equation 2. The results are provided in Table 3. The coefficients on MCLs and dispensaries are not distinguishable from zero for any specification or sample. Comparing the magnitudes of the coefficients, detailing is less reactive to a dispensary opening than medical cannabis legalization. Although, the negative effect of an MCL on opioid-detailing in column (4) in Panel D is consistent with the previous results, they are not statistically significant at conventional levels (p-value=0.13). Thus, while detailing increases when an MCL is under consideration and both public discussion and uncertainty are highest, there is not strong evidence at the county

[28] We also examine the response in detailing for blockbuster drugs and more concentrated markets and do not find evidence of changes in detailing following a dispensary opening at the county or state level.

level of pharmaceutical companies reducing marketing to physicians following medical cannabis legalization and entry.

5.3 Falsification Tests

As falsification tests, we examine the effect of MCLs on medical device-related detailing and detailing to different types of doctors that are likely unaffected by medical cannabis legalization. Patients seeking medical attention from optometrists, dentists, and podiatrists will differ from patients seeking medical cannabis. Pharmaceutical marketing to these doctors should not respond to the approval of an MCL. The results for these four falsification tests are provided in Figure 9.

Unlike the previous results, detailing does not increase for any outcome in the quarters an MCL is proposed and under consideration ($t = 0, 1$). The relative decline in medical device detailing following MCL approval in the top left graph weakens our results on opioid-related detailing. We further explore this relationship and other types of detailing at a more granular level in the following subsection by examining post-MCL changes in detailing to doctors that recommend cannabis.

5.4 Market Concentration in Cannabis Recommendations and Detailing to Cannabis Doctors

Medical cannabis markets differ from traditional prescription drugs in that demand-side factors play a more significant role. A larger patient influence and physician risk aversion have led to greater market concentration in physicians that provide medical cannabis recommendations. Physician registries, cannabis-friendly websites, and dispensary sponsored patient drives that connect patients with cannabis doctors further condenses the cannabis recommendation market and likely conceals any response in pharmaceutical detailing following medical cannabis legalization at aggregate levels.

To examine the relationship at a more granular level, we use physician-level medical cannabis data from the Florida Board of Medicine and Board of Osteopathic Medicine's Physician Certification Pattern Review Panel Annual Report (2019). These data describe the number of cannabis recommendations made by each Florida doctor during the first 9 months of 2018.[29] We pair these data with entries from the open payments data to examine the relationship between prescription drug detailing and cannabis recommendations at the physician level.

In Panel A in Table 4, we compare detailing to Florida physicians by whether the physician recommends cannabis in 2018. The average value of detailing per physician is higher among doctors that recommend cannabis (hereafter referred to as cannabis doctors). In Panel B, we use our sample of cannabis doctors and compare the number of cannabis recommendations written by whether the doctor receives detailing. Approximately 87% of Florida cannabis doctors receive detailing in our sample period. However, the average number of certifications is higher among physicians that are not exposed to direct-to-physician marketing. This difference suggests a disproportionate share of large cannabis recommenders are physicians that pharmaceutical companies do not invest in marketing to. Moreover, these stylized facts are consistent with a concentrated market of cannabis-friendly physicians that doctors select into and patients can shop for.

To examine the relationship between detailing and cannabis recommendations, we estimate a difference-in-differences equation that takes the form

$$D_{ijct} = \beta_1 CannabisDr_i + \beta_2 CannabisDr_i \times MCL_{ct} + \mathbf{X}'_{ct}\alpha + \gamma_c + \delta_t + \phi_j + \varepsilon_{ijct} \quad (3)$$

[29] To recommend cannabis in Florida, a physician must complete a two hour course and exam. We assume physician certification and at least one recommendation as evidence the doctor perceives cannabis as a potential substitute to traditional prescription drugs. Patients can obtain certification for up to a 210 days before needing re-evaluation and recommendation renewal.

where D_{ijct} is the detailing dollars spent on physician i of doctor type j in county c in quarter year t.[30] In addition to the same set of time-varying control variables used in prior specifications, we include the natural log of the number of physicians receiving payments in a county as well as county, quarter-year, and doctor type fixed effects. Our sample includes all Florida doctors that receive detailing from 2014 through 2018. Doctors that recommend cannabis comprise our treatment group while doctors that do not recommend cannabis are included in our control group. Cannabis doctors are considered "untreated" for all observations prior to MCL approval and β_2 captures the change in detailing relative to non-cannabis doctors following MCL approval.

The estimated relationships are provided in Table 5. The results in columns (1) and (2) suggest overall prescription drug detailing to cannabis doctors increases following medical cannabis legalization. However, the coefficients in columns (3) and (4) indicate a relative decline in opioid detailing to cannabis doctors after MCL approval. Although different from the overall effects, pain management is the most common reason for seeking medical cannabis. Therefore, opioid markets are more exposed to competition and will likely respond differently than other prescription drug markets. Among doctors that recommend cannabis, the dollar value of opioid detailing declines by 33% to 42% following MCL approval in 2016. It is worth noting that selection into treatment likely introduces bias and contaminates the estimates. Still, the negative relationship is consistent with the positive correlation between detailing and prescriptions (Nguyen, Bradford and Simon, 2019*a*) and the negative effect of MCLs on prescribed opioids (McMichael, Van Horn and Viscusi, 2020). Moreover, the effects in columns (3) and (4) are significantly larger in magnitude than the county-level estimates suggesting the response in detailing to medical cannabis legalization is masked by the small percent of doctors that consider cannabis a substitute in practice.

[30] We also estimate the relationship using an unbalanced panel rather than repeated cross sections. The results are quantitatively similar and are available in the Appendix.

Finally, we examine the impact of an MCL on device-related detailing as a falsification test. The results in columns (5) and (6) in Table 5 are not distinguishable from zero. Although sample composition and level of observation are different, the results do not support the marginally significant county-level estimates previously detailed in Figure 9. Further, these null results do not jeopardize the negative relationship between medical cannabis legalization and opioid detailing to cannabis doctors that are described in columns (3) and (4).

6 Conclusion

The medical cannabis market is relatively new and rapidly evolving with each election cycle. The acceptance of cannabis as an alternative form of medical treatment suggests that medical cannabis legalization signals a competitor entry for a number of pharmaceutical markets. Therefore, incumbent pharmaceutical firms may behave strategically to preserve market share. We exploit the temporal and geographic variation in MCLs to examine the relationship between medical cannabis legalization and direct-to-physician marketing.

We find overall detailing increases during quarters when an MCL has been proposed and is under consideration. However, this increase is not driven specifically by drug markets in which cannabis is considered to be a substitute. Moreover, we do not find strong evidence to indicate changes in office detailing following medical cannabis legalization. We argue the lack of response in direct-to-physician marketing following cannabis legalization is due to a small, concentrated market of doctors willing to recommend cannabis. Moreover, the prescribing inertia for a large majority of doctors that do not recommend cannabis is exacerbated by the federal illegality of cannabis and the overall uncertainty in the treatment efficacy of the drug. At the aggregate level, then, there is no need for pharmaceutical companies to alter their marketing strategies if an

overwhelming majority of doctors do not view medical cannabis as a viable substitute.

To explore this relationship at a more granular level, we pair office detailing records with a novel dataset of physician-level cannabis certifications in the state of the Florida. We find relative declines in opioid detailing to cannabis-friendly doctors following MCL approval. Although the direction of causality and physician selection into treatment prevent us from identifying a causal relationship at the physician level, the decline in opioid detailing among Florida cannabis doctors provides evidence that pharmaceutical companies respond to medical cannabis as a competitor. This response will likely grow with the proliferation of medical cannabis.

Last, medical cannabis differs from traditional prescription drugs in that demand side factors and patient preferences are likely more important in medical cannabis markets. The resources available to facilitate doctor shopping and the ability of patients to bypass their usual physician to obtain medical cannabis approval reduces the role of provider in determining medical cannabis as treatment. The mitigated results at the aggregate level reflect these features that are unique to the medical cannabis market and should be considered when examining the implications of cannabis liberalizing policies.

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7 Figures

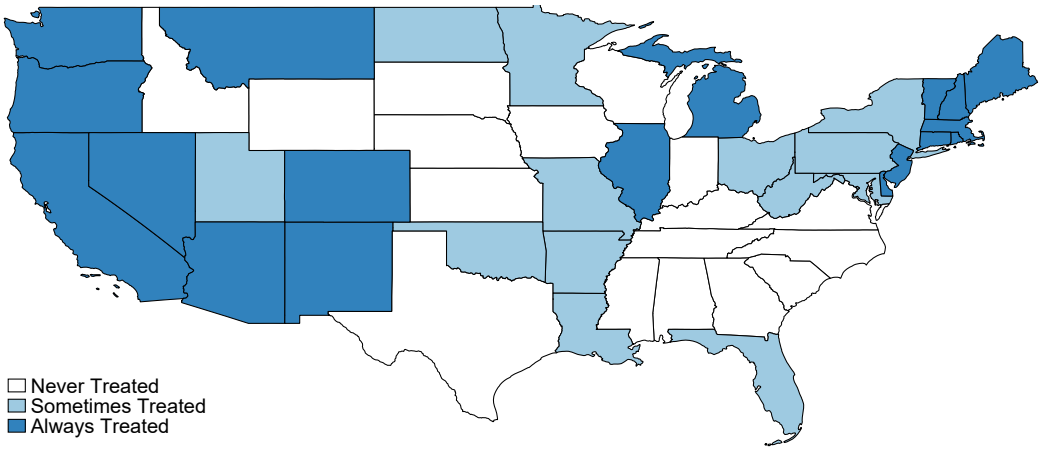
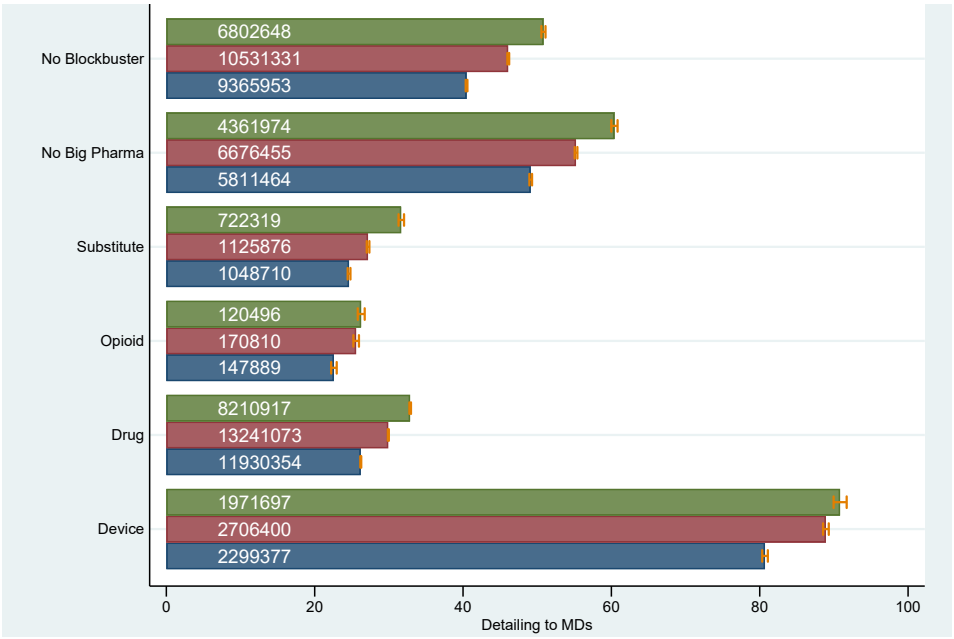
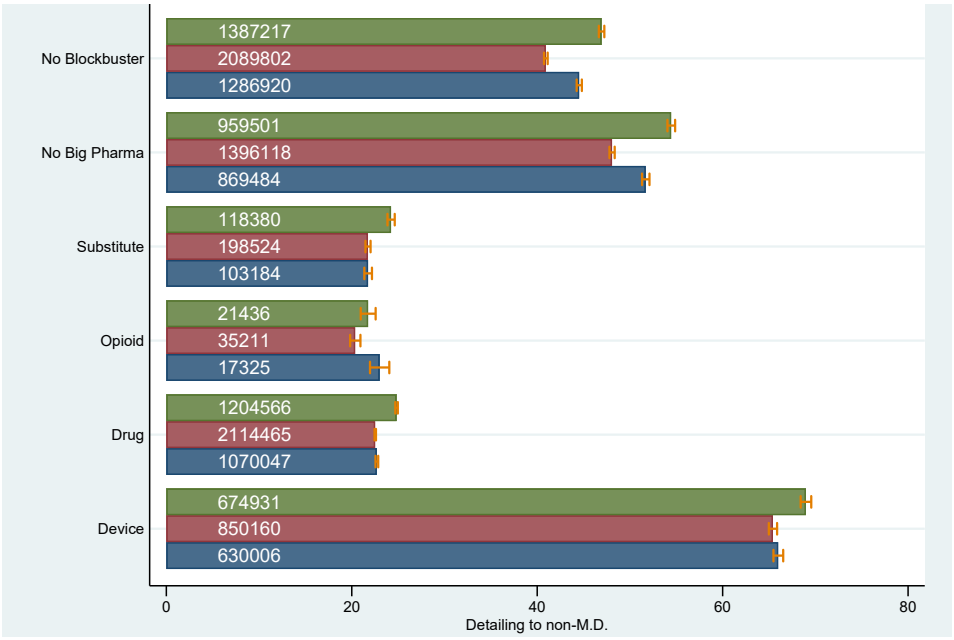


Figure 1: States with MCL 2014 - 2018

Medical Cannabis legalization dates are obtained from Bradford and Bradford (2018) and are update through 2018 using ProCon.org (2019). See Table 1 for legalization dates.



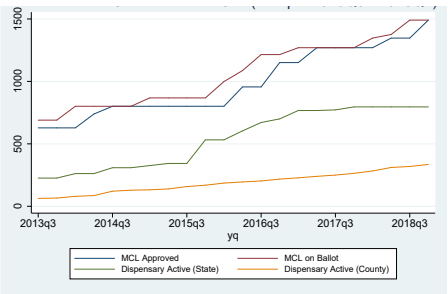
(a) Office Detailing to MDs



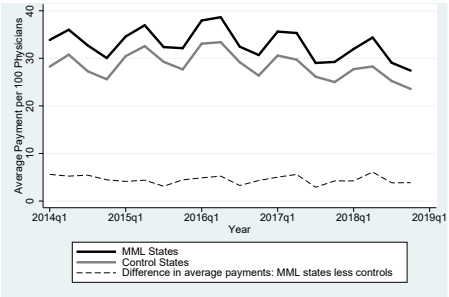
(b) Office Detailing to non-MDs

Figure 2: Office Detailing by Drug and Physician Type

The vertical axis describes the classifications of detailing while the horizontal axis describes the average dollar value of payments. The numbers within each bar indicate the number of individual payments observed in the Open Payments database from 2014 through 2018.



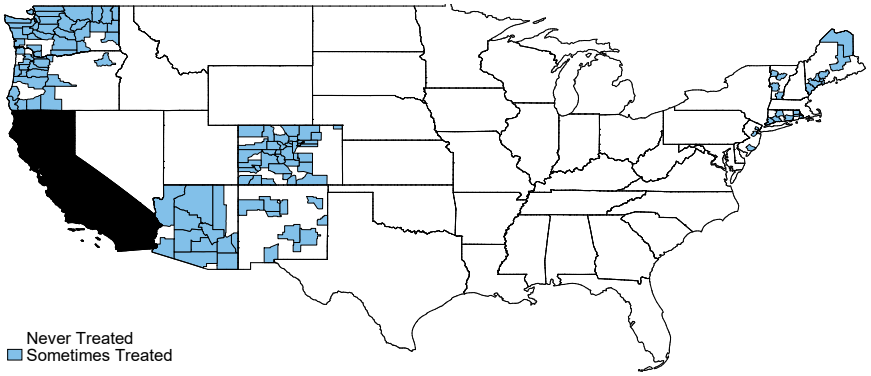
(a) Evolution of Counties with MCLs (2013Q3 - 2018Q4)



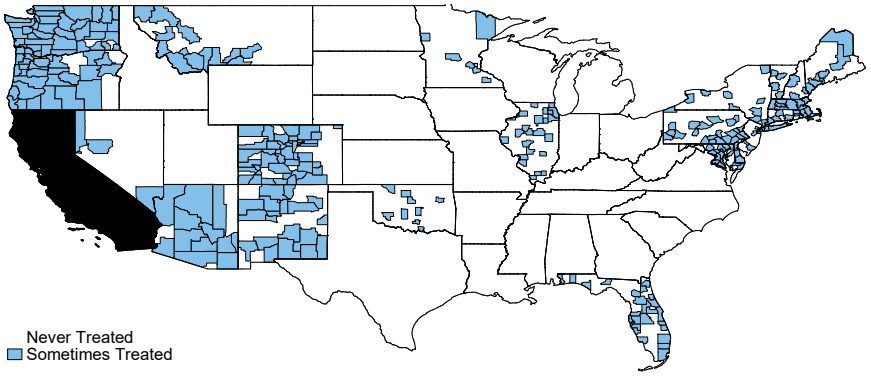
(b) Average Payments per Physicians (2014Q1 - 2018Q4)

Figure 3: Temporal Variation in Cannabis liberalization and Office Detailing

Panel (a) describes the number of counties exposed to each stage of medical cannabis legalization. Panel (b) compares the average dollar value of detailing per physician in MCL and non-MCL states.



(a) Counties with Dispensaries 2014



(b) Counties with Dispensaries 2018

Figure 4: Counties with Legal and Active Dispensaries: 2014 and 2018

Shaded counties indicate exposure to a legal and active dispensary during the calendar year. Dispensary information is obtained from dispensaries registered on weedmaps.com and the data used in Smith (2020).

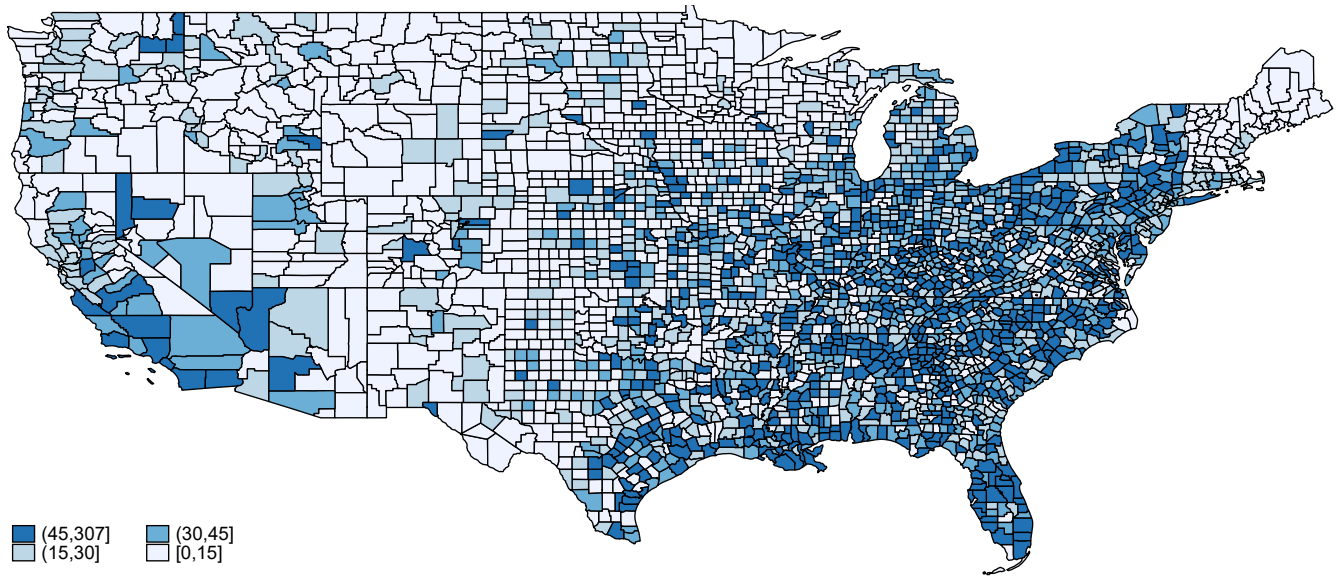
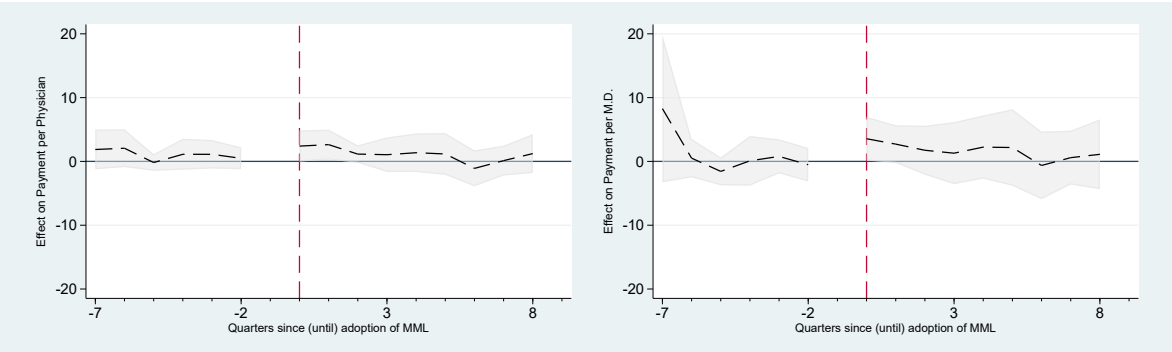
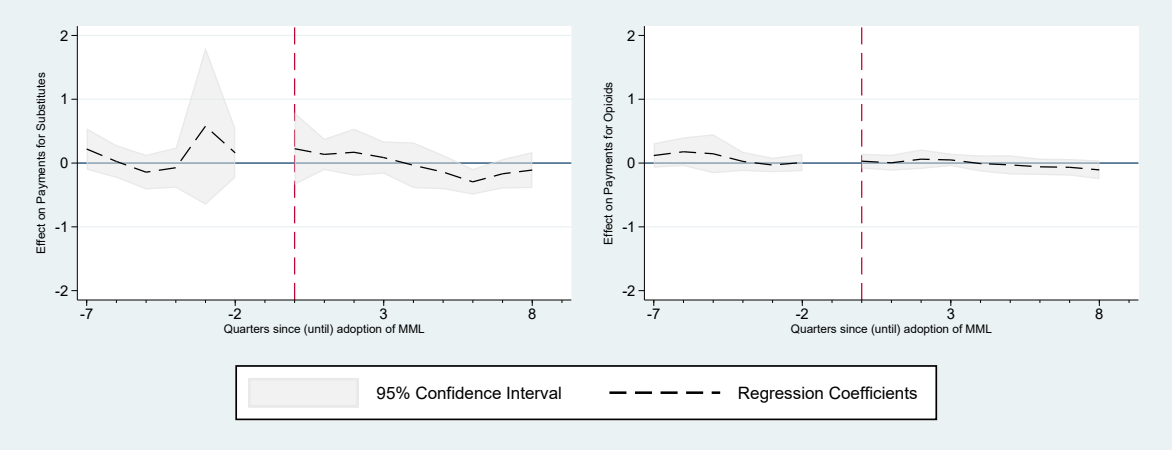


Figure 5: Average Payment per Physician: 2014 - 2018

The figure describes the average dollar value of detailing per physician by county from the Open Payments Database.



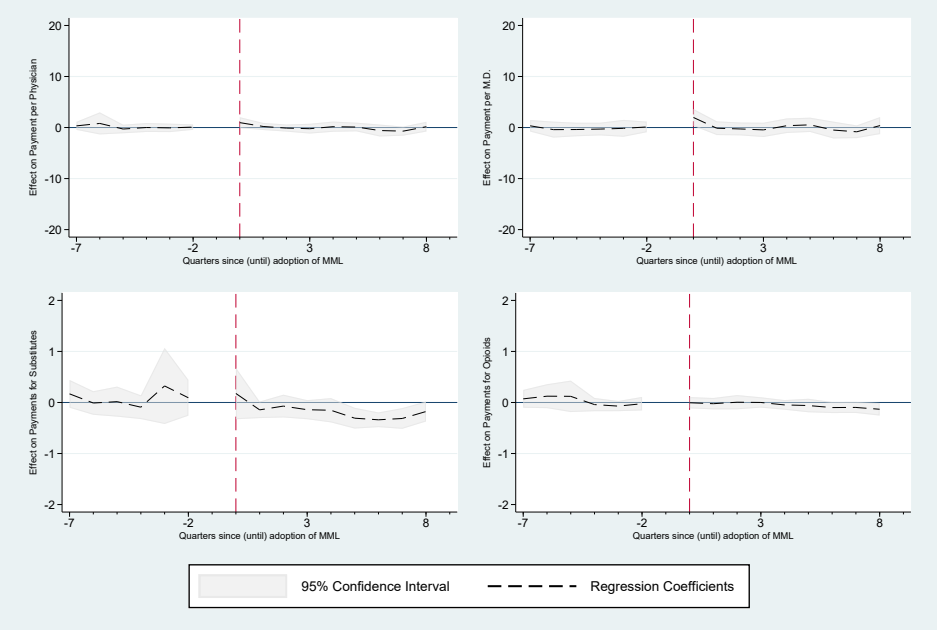
(a) Overall Detailing



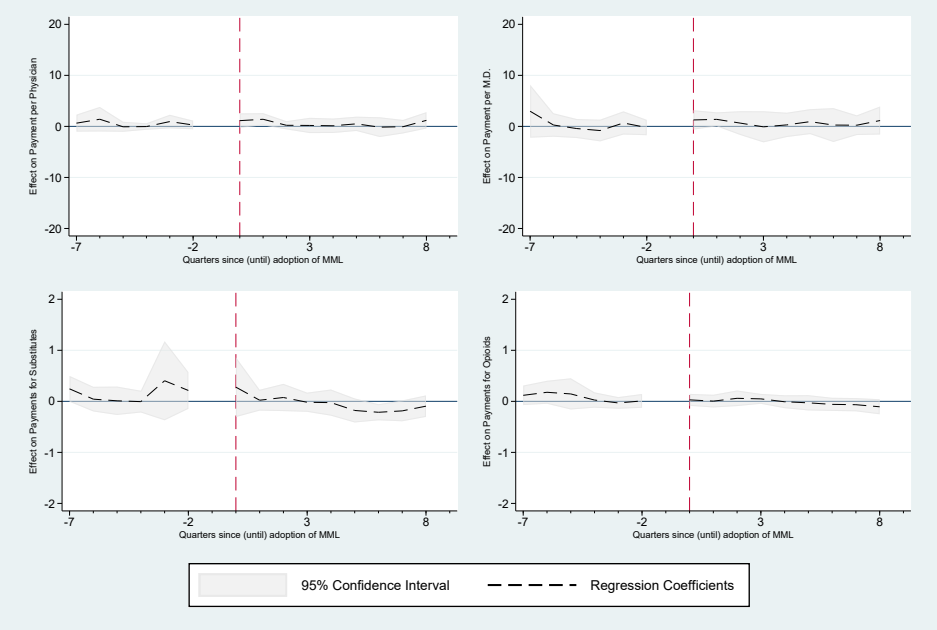
(b) Substitute and Opioid-related Detailing

Figure 6: Time-varying Effects of Medical Cannabis Legalization on Office Detailing

OLS estimated coefficients for each type of detailing are described. The period prior to law proposal is normalized to zero and the vertical line at period 0 indicates the quarter an MCL is proposed. The shaded region represents the 95% confidence interval at each point. Time-varying control variables and county and quarter-year fixed effects are included in each specification and standard errors are clustered at the state level.



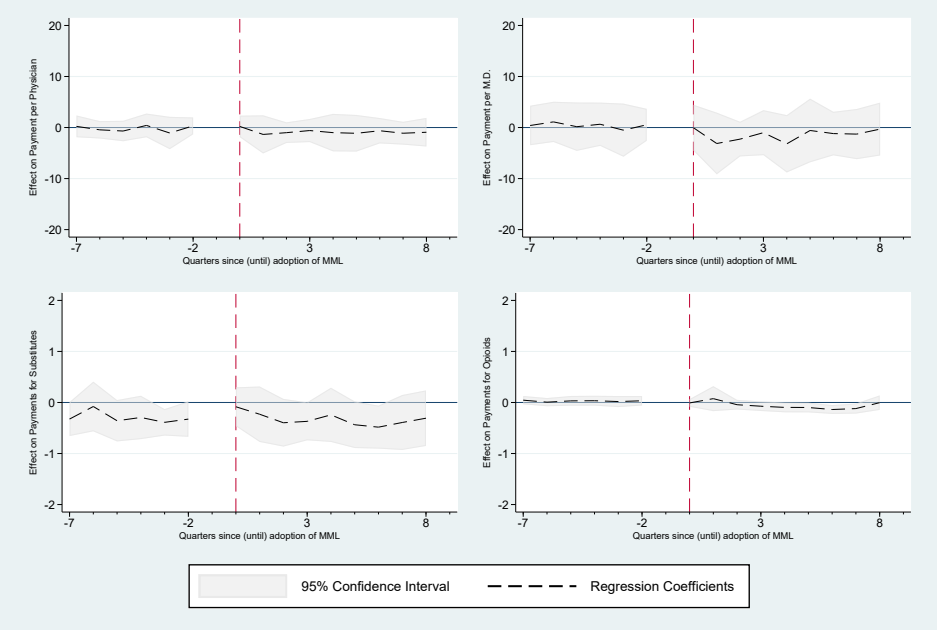
(a) No Big Pharma Companies



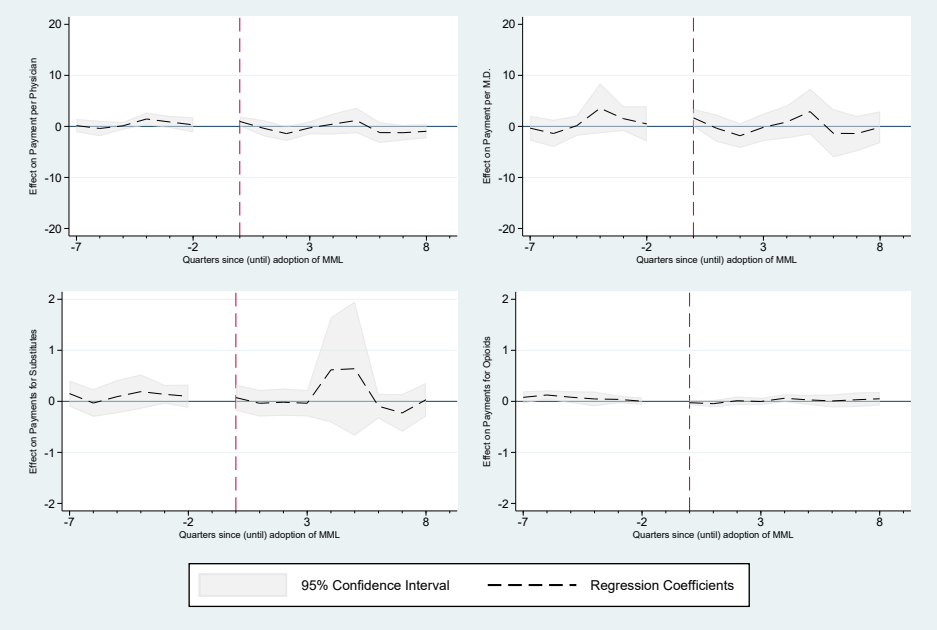
(b) No Blockbuster-related payments

Figure 7: Time-varying Effects of MCLs on Office Detailing by Market Structure

OLS estimated coefficients for each type of detailing are described. The period prior to law proposal is normalized to zero and the vertical line at period 0 indicates the quarter an MCL is proposed. The shaded region represents the 95% confidence interval at each point. Time-varying control variables and county and quarter-year fixed effects are included in each specification and standard errors are clustered at the state level.



(a) First dispensary in State



(b) First dispensary in County

Figure 8: Access to Medical Cannabis

OLS estimated coefficients for each type of detailing are described in each graph. The period prior to a dispensary opening is normalized to zero and the vertical line at period 0 indicates the quarter a legal dispensary is first active. The shaded region represents the 95% confidence interval at each point. Time-varying control variables and county and quarter-year fixed effects are included in each specification and standard errors are clustered at the state level.

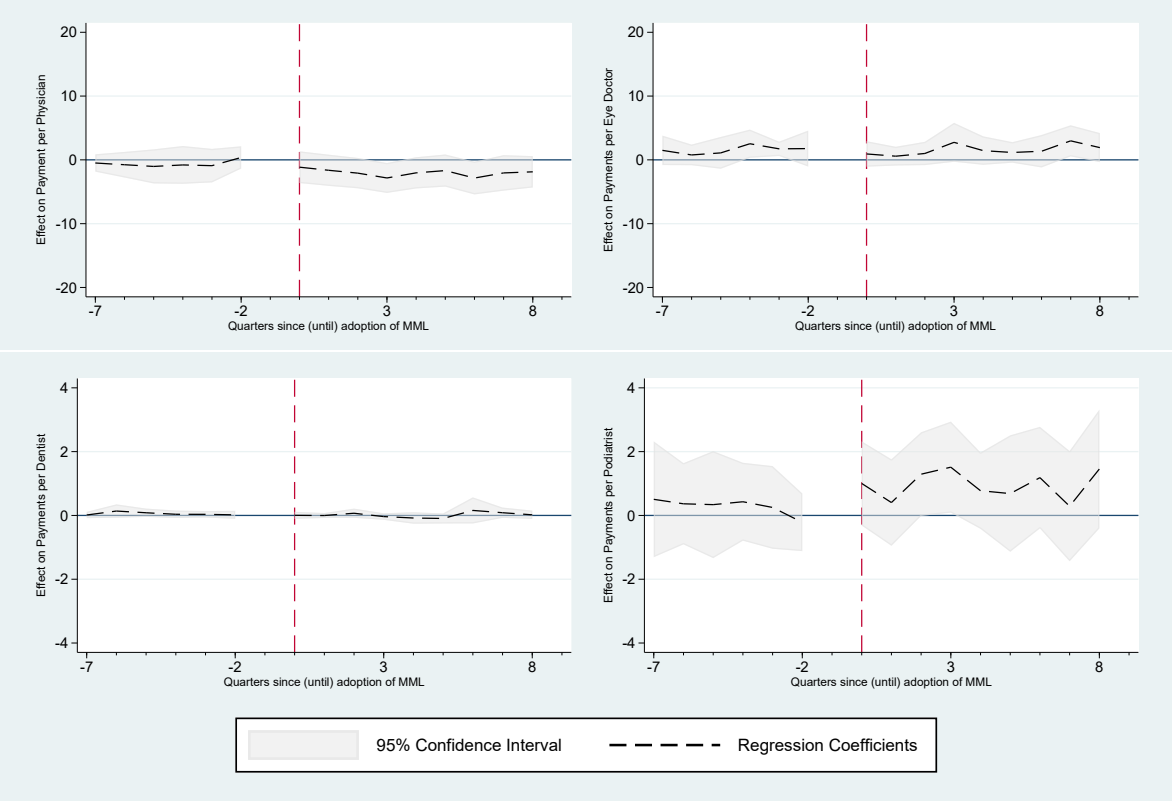


Figure 9: Time-varying Effects of MCLs on Unrelated Products and Doctors

As falsification tests, we estimate the time-varying coefficients for medical devices and detailing to optometrists, dentists, and podiatrists in each graph. The period prior to law proposal is normalized to zero and the vertical line at period 0 indicates the quarter an MCL is proposed. The shaded region represents the 95% confidence interval at each point. Time-varying control variables and county and quarter-year fixed effects are included in each specification and standard errors are clustered at the state level.

8 Tables

Table 1: Timing of State Medical Cannabis Laws

	Ballot / Legislation Date	Approval Date	Effective Date	Legal and Active Dispensary
Alaska	1998q2	1998q4	1999q1	2016q4
Arizona	2010q2	2010q4	2010q4	2012q4
Arkansas*	**2016q3**	**2016q4**	**2016q4**	**2019q2**
California	1996q2	1996q4	1996q4	2004q1
Colorado	1999q3	2000q4	2001q2	2010q2
Connecticut	2012q1	2012q2	2012q2	2014q3
Delaware	2011q1	2011q2	2011q3	2015q2
Florida†	**2016q1**	**2016q4**	**2017q1**	**2016q3**
Hawaii	1999q1	2000q2	2000q4	2017q3
Illinois	2013q1	2013q3	2014q1	2015q4
Louisiana*	2016q1	2017q2	2016q2	2019q3
Maine	1999q2	1999q4	1999q4	2011q1
Maryland	**2014q1**	**2014q2**	**2014q2**	**2017q4**
Massachusetts	2012q3	2012q4	2013q1	2015q2
Michigan‡	2008q1	2008q4	2008q4	2018q4
Minnesota	**2014q1**	**2014q2**	**2014q2**	**2015q3**
Missouri	2018q3	2018q4	2018q4	-
Montana	2004q2	2004q4	2004q4	2017q3
Nevada	1998q2	2000q4	2001q4	2015q1
New Hampshire	2013q1	2013q3	2013q3	2016q4
New Jersey	2008q1	2010q1	2010q3	2012q4
New Mexico	2007q1	2007q1	2007q3	2009q3
New York	**2013q1**	**2014q3**	**2014q3**	**2016q1**
North Dakota*	**2016q3**	**2016q4**	**2016q4**	**2019q1**
Ohio*	**2016q2**	**2016q2**	**2016q3**	**2019q1**
Oklahoma	**2018q1**	**2018q2**	**2018q2**	**2018q4**
Oregon	1998q3	1998q4	1999q4	2014q1
Pennsylvania	**2015q1**	**2016q2**	**2016q2**	**2018q1**
Rhode Island	2005q1	2006q1	2006q1	2013q2
Utah	**2018q2**	**2018q4**	**2018q4**	**2020q1**
Vermont	2003q1	2004q2	2007q2	2013q2
Washington	1998q1	1998q4	1998q4	2014q3
West Virginia	**2017q1**	2017q2	2019q3	-

Bold font indicates law enactment occurred within our sample period.
*- Dispensaries operating with state license provisions were not active within the sample period.
†- Dispensaries opened under the protection of right-to-try laws. We treat the interaction of MCL date and dispensary date (2017q1) as the first quarter of treatment.
‡- Although dispensaries had been operating for multiple years in gray markets and under emergency rules, the first state-licensed sale occurred in October 2018.

Table 2: Summary Statistics by Medical Cannabis Legalization Status

	Non-MCL Counties			Pre-MCL Counties			Post-MCL Counties		
Variable	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.
Overall (All Drs.)	31,070	31.56	34.60	9,136	33.12	36.79	18,379	24.16	26.41
Overall (MDs)	31,070	48.97	63.20	9,136	53.09	187.31	18,379	35.92	44.27
Substitute-Related	31,070	2.23	6.22	9,136	2.48	5.78	18,379	1.64	3.27
Opioid-Related	31,070	0.37	1.44	9,136	0.49	2.04	18,379	0.27	0.95

Observations consist of detailing entries from the Open Payments dataset from 2014 through 2018 that are aggregated to the county-quarter-year level and scaled by the number of doctors receiving payments in the county in a given quarter-year. Observations are separated by MCL status such that non-MCL counties are located in states that never adopt an MCL within the sample period, pre-MCL county observations are counties located in states that adopt an MCL prior to 2019 but have not yet approved their medical cannabis law, and post-MCL counties consist of observations of counties in states with an MCL.

Table 3: Effects of MCLs and Dispensaries on Office Detailing

	Panel A: All Physicians			Panel B: Medical Doctors		
	(1)	(2)	(3)	(4)	(5)	(6)
MCL	-0.488	-	-0.444	-1.375	-	-1.246
	(0.996)	-	(0.926)	(1.917)	-	(1.832)
State Disp.	-	-0.436	-0.379	-	-1.274	-1.114
	-	(0.811)	(0.713)	-	(1.382)	(1.287)
	Panel C: Substitutes			Panel D: Opioids		
MCL	-0.171	-	-0.170	-0.093	-	-0.088
	(0.156)	-	(0.161)	(0.063)	-	(0.066)
State Disp.	-	-0.025	-0.003	-	-0.057	-0.046
	-	(0.126)	(0.134)	-	(0.044)	(0.048)
Observations	58,585	58,585	58,585	58,585	58,585	58,585

Coefficients describe the impact of medical cannabis legalization on the type of detailing specified for each panel estimated using equation 2. All specifications include time and county fixed effects as well county-level time-varying characteristics such as county population, average weekly wages, unemployment rate, percent uninsured, obesity, health costs and demographic information. *MCL* indicates approval of a medical cannabis law and *State Disp.* indicates a legal and active dispensary at the state level. Standard errors are clustered at the state level.

Table 4: Mean Comparisons in Detailing for Florida Medical Cannabis Doctors

	Panel A: Sample of Florida Doctors Receiving Detailing			
	(1)	(2)	(3)	(4)
	Cannabis Doctors	Non-Cannabis Doctors	Difference	t-statistic
Detailing Dollars				
Total	126.57	82.94	-43.63	-25.60
Opioid-related	1.11	0.24	-0.86	-7.91
Observations	10,944	482,468		
	Panel B: Sample of Florida Medical Cannabis Doctors in 2018			
	Detailing Received	No Detailing Occurs	Difference	t-statistic
Cannabis Recommendations				
Total	159.01	279.59	120.59	2.55
Pain-related	46.47	58.38	11.91	0.96
Observations	923	142		

The sample in Panel A consists of all Florida doctors that receive prescription drug-related detailing in the Open Payments database and compares detailing dollars across whether they provide cannabis recommendations. Panel B compares the number of cannabis recommendations provided by Florida doctors between January 1 and September 30 2018 separated by whether the physicians received prescription drug-related detailing.

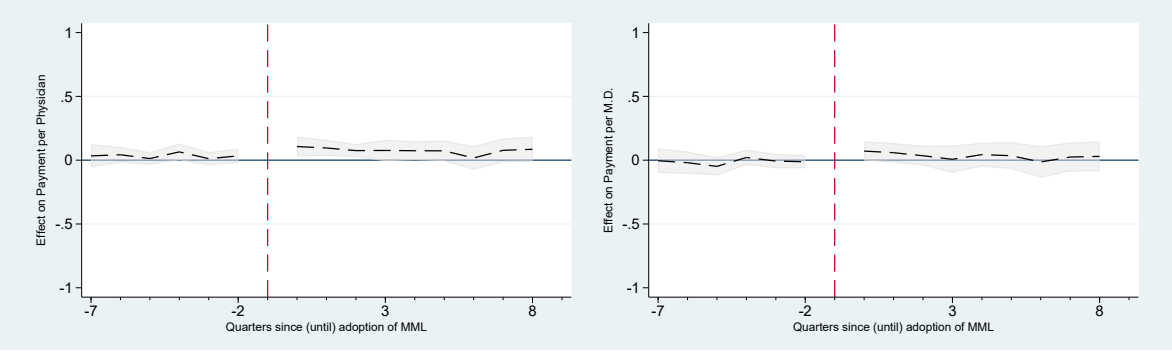
Table 5: Response in Detailing for Florida Medical Cannabis Doctors

	Overall		Opioid-Related		Device-Related	
	(1)	(2)	(3)	(4)	(5)	(6)
Cannabis Dr.	39.165***	39.168***	1.093***	1.093***	-18.489***	-18.488***
	(2.587)	(2.587)	(0.220)	(0.220)	(1.291)	(1.291)
Cannabis Dr.×MCL	5.991	10.146*	-0.595**	-0.459*	-1.322	0.042
	(4.320)	(5.794)	(0.238)	(0.268)	(2.190)	(2.695)
Cannabis Dr.× Disp.	-	-7.519	-	-0.247	-	-2.469
	-	(6.960)	-	(0.192)	-	(3.515)
Observations	574,909	574,909	574,909	574,909	574,909	574,909

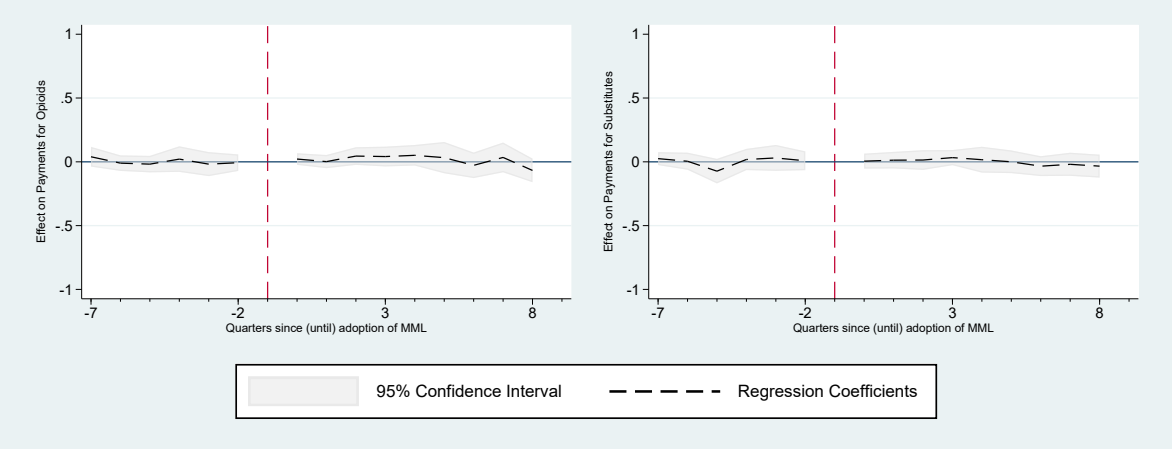
We regress physician-level detailing dollars on whether the physician recommends cannabis in 2018 (*Cannabis Dr.*), the detailing post MCL approval (*Cannabis Dr.×MCL*), and whether the physician is located in a county with an active cannabis dispensary (*Cannabis Dr.×Disp.*). Each specification includes a vector of county-level time-varying control variables, the natural log of the number of physicians receiving payments in a county, and county, quarter-year, and doctor type fixed effects. Robust standard errors are provided in parentheses, $^{***}p < 0.01$,** $p < 0.05$,* $p < 0.10$.

9 Appendix

We estimate the effect of medical cannabis legalization on the average dollars spent on office detailing per physician in a county per quarter-year. For consistency across specifications and samples, we estimate the response by examining relative changes in per doctor detailing levels. Because of the non-normal distribution of the dependent variable, in Figure A1 we also estimate the effect on the natural log of detailing per doctor. Although the percent changes are slightly larger in the period an MCL is proposed, the results are qualitatively similar to the estimated effects on detailing levels depicted in Figure 6.



(a) Physician Types



(b) Drug Types

Figure A1: Time-varying Effects of Medical Cannabis Legalization on Office Detailing

The dependent variable is the natural log of the detailing dollars per doctor in county c in quarter-year t. Detailing is categorized by doctor type in Panel A and drug type in Panel B. Each graph describes the OLS estimated coefficients for each category of detailing are described and the shaded region represents the 95% confidence interval at each point. The period prior to law proposal is normalized to zero and the vertical line at period 0 indicates the quarter an MCL is proposed. Time-varying control variables and county and quarter-year fixed effects are included in each specification and standard errors are clustered at the state level.

As a robustness test, we estimate the response in prescription drug-related office detailing relative to the approval of an MCL. This event removes uncertainty of whether legal cannabis will enter the market and likely reduces the public debate regarding legalization. Because the median duration between MCL proposal and approval within our sample period is one quarter, we allow for one period of anticipation effects and normalize the quarter two periods prior to approval to zero. This approach provides a better estimate of changes in detailing following confirmation that medical cannabis is entering the market.[31]

The results in Figure A2 are consistent with our estimates in Figure 6 that exploit the timing in MCL proposals. We find a statistically significant increase in overall detailing dollars spent per doctor in the quarter prior to approval that largely coincides with the period in which an MCL is proposed. Similar to the results in Figure 6 however, the effect on prescription drug detailing attenuates to zero after an MCL is approved.

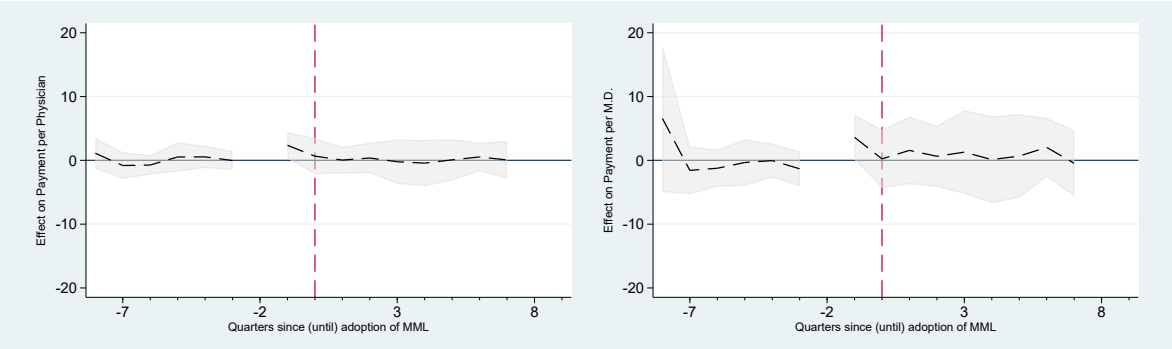
To examine the relationship between detailing and cannabis recommendations, we estimate a difference-in-differences equation that takes the form

$$D_{ict} = \beta_1 CannabisDr_i \times MCL_{ct} + \mathbf{X}_{ct}^{'}\alpha + \gamma_c + \delta_t + \phi_i + \varepsilon_{ict} \tag{4}$$

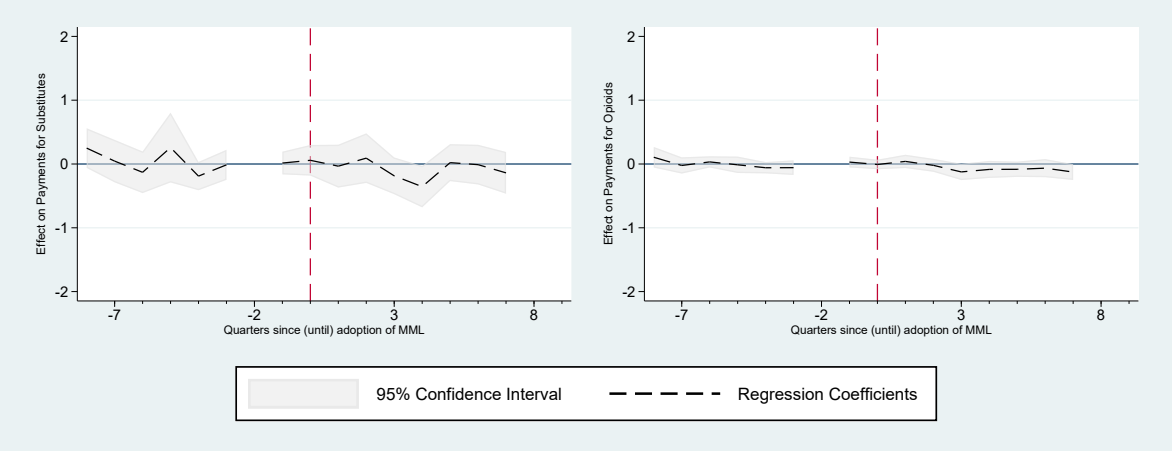
where D_{ict} is the detailing dollars spent on physician i of doctor type j in county c in quarter year t.[32] In addition to the same set of time-varying control variables used in prior specifications, we include the natural log of the number of physicians receiving payments in a county as well as county, quarter-year, and physician fixed effects. Our sample includes all Florida doctors that receive drug-related detailing from 2014 through 2018. Doctors that recommend cannabis comprise our treatment group while physicians that do not recommend cannabis are included our control group. Cannabis doctors are considered "untreated" for all observations prior to MCL approval and β_1 captures the change in detailing relative to non-cannabis doctors following MCL approval.

[31] The estimates are not sensitive to the choice of the excluded base period. The lone exception occurs if we omit the period immediately preceding the quarter of MCL approval ($t = -1$).

[32] We also estimate the relationship using repeated cross sections rather than an unbalanced panel. The results are quantitatively similar and are available in the Appendix.



(a) Physician Types



(b) Drug Types

Figure A2: Time-varying Effects of MCLs on Office Detailing by MCL Approval

OLS estimated coefficients for each type of detailing are described in each graph. The period two periods prior to law approval is normalized to zero and the vertical line at period 0 indicates the quarter an MCL is approved. The shaded region represents the 95% confidence interval at each point. Time-varying control variables and county and quarter-year fixed effects are included in each specification and standard errors are clustered at the state level.

Table A1: Post-MCL Effects on Detailing to Cannabis Doctors

	Overall		Substitute-Related		Opioid-Related	
	(1)	(2)	(3)	(4)	(5)	(6)
Cannabis Dr.	6.709	10.092**	-4.511	-4.069*	-0.575**	-0.414
×MCL	(4.657)	(4.864)	(2.791)	(2.456)	(0.272)	(0.294)
Cannabis Dr.		-6.981		-0.911		-0.334
×Dispensary		(5.686)		(2.745)		(0.248)
Observations	576,616	576,616	576,616	576,616	576,616	576,616

We regress physician-level detailing dollars on whether the physician recommends cannabis in 2018 interacted with observations post MCL approval (*Cannabis Dr.* x MCL) and whether the physician is located in a county with an active cannabis dispensary (*Cannabis Dr. x Dispensary*). Each specification includes a vector of county-level time-varying control variables, the natural log of the number of physicians receiving payments in a county, and county, quarter-year, and doctor fixed effects. Robust standard errors are provided in parentheses, $^{***}p < 0.01$,** $p < 0.05$,* $p < 0.10$.