Half Banked: The Economic Impact of Cash Management in the Marijuana Industry

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Abstract

We investigate the economic value of cash management. In the legal marijuana industry, where only half of businesses have access to cash management services from a financial institution, we examine dispensary profitability using administrative and survey data. Our results show that businesses with cash management charge higher retail prices (8.3%), pay lower wholesale prices (7.3%), and have higher sales volume (19%). Together these advantages create a 40% increase in profitability. These results support our model in which reputational capital and administrative costs drive profitability regardless of whether national banks, credit unions, or Fintech provide the cash management functions.

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Banks create value by serving two primary functions: lending and cash management. The empirical literature shows that bank lending generates broad and persistent economic value (Beck, Demirguc-Kunt, and Martinez Peria (2006), Becker (2007), Morse (2011), Adelino, Schoar, and Severino (2015), and Cortés and Strahan (2017)).[1] The lending function of banks evolved from their earlier cash management function, as banks were originally commodity warehouses (see Donaldson, Piacentino, and Thakor (2018)). This cash management function, whereby banks collect, verify, guarantee, and monitor a firm's cash position to ensure its financial stability, is a fundamental economic service that greases the wheels of the economy. Yet, little is known about the economic value of the cash management function of financial intermediaries, or about what aspects of cash management create value.[2]

In this paper, we shed light on the questions above by examining the effect of cash management on firm profitability. We do not ask whether cash management has a positive effect on firms – despite the lack of empirical evidence, its near-ubiquitous use suggests that it does. Instead, we seek to quantify the magnitude of its economic benefits as a standalone banking function. There are two major empirical challenges to capturing the effect of cash management on firm profitability. First, almost all firms have access to cash management; those few that do not are outliers. As a result, most settings related to our central question do not provide valid treated or control firms. Second, if firms have banking access, they generally have access to both the lending and the cash management functions. The benefits

[1] As part of the lending function, banks resolve information asymmetry and monitor borrowers, which creates economic value (e.g., Diamond and Dybvig (1983), Diamond (1984), Ramakrishnan and Thakor (1984), and Coval and Thakor (2005)). Related studies in the literature include Petersen and Rajan (1994), Petersen and Rajan (2002), Brickley, Linck, and Smith Jr. (2003), Berger et al. (2005), Cetorelli and Strahan (2006), Paravisini (2008), Rice and Strahan (2010), Butler and Cornaggia (2011), Gilje, Loutskina, and Strahan (2016), and Gilje (2017).

[2] Studies on cash management explore the economic costs and benefits of incremental variation within cash management programs (Frost (1970), Daellenbach (1974), Gitman, Moses, and White (1979), Vickson (1985), Berger et al. (2003), Gitau et al. (2014), and Duncan et al. (2015)).

of cash management, in other words, are inseparable from the benefits of lending. We address these challenges by using a unique empirical setting that allows us to isolate the economic benefits of cash management, namely, the marijuana industry in the United States.

The U.S. marijuana industry is economically large and rapidly growing.[3] Firms in this industry face regulatory hurdles, however, in obtaining basic financial services, due to the fact that marijuana is legal in some states but illegal under federal law (Mace, Patel, and Seegert (2020)).[4] In particular, federal regulations prevent marijuana dispensaries from accessing federal resources. These regulations imply that financial institutions, which are regulated by the Federal Deposit Insurance Corporation (FDIC), are laundering money when they provide banking services to the marijuana industry. Federal guidelines for banks about working with marijuana firms have been erratic, ambiguous, and onerous, and heavy penalties for violations have discouraged banks from serving the marijuana industry. As a result, a substantial fraction of marijuana dispensaries must conduct business on an all-cash basis.

These bank regulations that limit cash management services shift the supply and demand for marijuana products in wholesale and retail markets. In the wholesale market, operating without cash management increases both counterparty risk and administrative costs by forcing suppliers to securely transport, verify, and store cash – roles that financial institutions typically coordinate. Frictions in the wholesale market affect dispensaries in the retail market. In general, cash management services generate a stream of quasi-rents that increase the value of a firm's reputational capital. Firms can use cash management to build reputational capital, which allows them to command better terms in the wholesale market and offer an implicit quality guarantee to customers in the retail market (Klein and Leffler (1981) and Shapiro (1983)). In our context, this means that dispensaries with access to

[3]In 2021, the marijuana industry generated $559.5 million in annual tax revenues to Washington state.

[4]The District of Columbia and 19 states (Alaska, Arizona, California, Colorado, Connecticut, Illinois, Maine, Massachusetts, Michigan, Montana, New Jersey, New Mexico, New York, Nevada, Oregon, Rhode Island, Vermont, Virginia, and Washington) have legalized the adult use of recreational marijuana as of 2021.

cash management services can create a "clientele effect" that allows them to sell at a price premium relative to dispensaries without cash management, that is, retail customers assign a lower marginal value to products sold at dispensaries without cash management (Buchak et al. (2018)).

Motivated by the above insights, we develop a model that links reputational capital, clientele effects, and administrative costs to supply and demand in the wholesale and retail markets. The model predicts that dispensaries with cash management (i) charge higher retail prices, (ii) pay lower wholesale prices, and (iii) buy and sell higher quantities, which lead dispensaries with cash management to have higher profitability. The model further predicts that cash management creates economic value in the wholesale and retail markets by allowing dispensaries to reduce administrative costs and counterparty risk and to provide a quality guarantee to customers.

To test these predictions empirically, we identify a quasi-experimental setting in which cash management services were randomly assigned to some marijuana dispensaries and not others. Specifically, in Washington state, two credit unions – with a total of 21 branches across the state – decided to offer cash management services to a limited number of marijuana dispensaries. The state used a lottery system to allocate licenses to sell recreational marijuana. These credit unions could accept deposits and provide cash management services to marijuana dispensaries but could not lend them money.[5] These features of banking in the marijuana industry in Washington state allow us to separate the economic value of cash management from the value of lending.[6]

We combine three novel data sets to estimate the causal effects of cash management on

[5]For more information about developments in banking laws that govern marijuana-related businesses (MRBs), see the Secure and Fair Enforcement (SAFE) Banking Act of 2021. Most relevant to our study, the Act seeks to remove liability or asset forfeiture under federal law for providing a loan or other financial services to a legitimate cannabis-related business.

[6]Merz and Riepe (2021) document that 80% of marijuana firms in their sample would like access to bank loans.

the profitability of dispensaries. The first data set comprises administrative records from the Washington State Liquor and Cannabis Board (WSLCB), which cover the universe of 62 million transactions at marijuana dispensaries from July 2014 to February 2017. We use wholesale and retail prices at the product (i.e., strain) level to calculate product-level profitability as the difference between retail and wholesale prices multiplied by quantity. The second data set consists of bank and credit union branch locations, which we obtain from the FDIC and the National Credit Union Administration (NCUA). The third data set comes from a comprehensive survey of marijuana business managers/owners ("owners" hereafter) in several states that we conducted between July 10, 2016 and October 31, 2016. The survey provides information about a dispensary's finances, such as whether they have access to cash management services, as well as about the individuals who run marijuana dispensaries.

Using the above data, we use an instrumental variables (IV) strategy based on physical proximity to the participating credit unions to estimate the effects of cash management on firm profitability. Research shows that shorter distances between firms and financial institutions allow banks to collect soft information about firms, which facilitates the formation of banking relationships.[7] Distance should be particularly important in the marijuana industry, where regulations require financial institutions to gather detailed information, perform on-site visits, and file thousands of Suspicious Activity Reports (SARs) merely to hold cash balances. In short, physical proximity allows credit unions to verify that marijuana dispensaries generate cash through legal activity.

For our instrument to be valid, it must predict access to cash management and be uncorrelated with confounding factors such as a dispensary owner's skill. We find that dispensaries within one mile of a participating credit union have a 28 percentage point higher probability of having cash management services. In contrast, placebo analysis shows that proximity to

[7]Related literature includes Petersen and Rajan (1994, 2002), Brickley et al. (2003), Berger et al. (2005), Cetorelli and Strahan (2006), Paravisini (2008), Rice and Strahan (2010), Butler and Cornaggia (2011), Gilje et al. (2016), Gilje (2017), Nguyen (2019), and Berger (2022).

a bank or alternative credit union does not predict access to cash management. Evidence from our survey data further shows that owner characteristics, including educational attainment, experience, and exposure to entrepreneurship, are not correlated with the instrument, alleviating concerns that these factors, rather than cash management, drive our results.[8]

Consistent with our model predictions, we find that dispensaries with cash management pay lower wholesale prices, charge higher retail prices, and sell larger quantities. More specifically, we first find that dispensaries with cash management receive a $0.51, or 7.3% discount, on their wholesale price for a given product (i.e., strain) – the average wholesale price for dispensaries with and without cash management is $6.42 and $6.93, respectively. In addition, dispensaries with cash management charge $1.00 (= $13.04 - $12.04), or 8.3%, more for the same product. Dispensaries with cash management also sell 1.29 (= 8.09 - 6.8) grams more per transaction than dispensaries without cash management, that is, they sell a higher-quality product from the perspective of the retail customer.[9] Taken together, these effects lead dispensaries with cash management to earn $21.06 (= $55.81 - $34.75) more per transaction than dispensaries without cash management.

We conduct a battery of placebo tests, sensitivity analyses, and alternative empirical methods to test the robustness of our results. We find support for our results using ordinary least squares (OLS), a differences-in-differences design, and different instrumental variables. Moreover, we find that entry and exit decisions had little effect on our findings, as entry

[8]The timing of credit union announcements and the lottery for dispensary licenses made it nearly impossible for dispensaries and credit unions to co-locate strategically. First, dispensaries applied for a license based on a specific retail location. Licenses were allocated via lottery, with 1,174 applicants vying for 334 licenses. In addition, the two participating credit unions announced their decision to work with marijuana firms before any sales occurred, meaning that the credit unions could not have selected dispensaries based on their profitability or on knowledge of where the final slate of dispensaries would locate.

[9]When customers purchase pre-rolled marijuana cigarettes (called "joints"), they are typically sold in one-gram increments. Thus, customers of dispensaries with cash management buy about eight joints versus seven joints for customers of dispensaries without cash management.

was gradual and strictly controlled by the lottery and licensing process, and only two exits occurred over our sample period.

Turning to the economic value of cash management, we estimate that it is equal to $17,700,000 in the marijuana industry in Washington state over the 31 months spanning July 2014 to February 2017. This amounts to about 1.8% of total industry sales over the sample period. We find that $5,973,076 of the economic value comes from the wholesale market, while the remaining $11,710,372 comes from the retail market. These results suggest that regulations limiting cash management services lead to real economic costs and in turn to substantial loss of economic value.

A natural question to arise is whether the banking needs of marijuana-related firms differ materially from those of typical firms. While the marijuana industry is unique, the ongoing value of cash management comes from fundamental functions (i.e., transaction processing and warehousing) that extend beyond our setting and beyond the management of physical cash. For example, online banking, cryptocurrencies, and digital warehousing require bookkeeping (e.g., counting currency, tracking cash flows, and recording transactions), safe storage (cyber security and information technology support), and currency issuance (providing legal currency to complete transactions). The benefits of the warehousing function for marijuana firms are quite similar to those for firms in most industries, and our model suggests that these benefits hold regardless of whether national banks, credit unions, or fintech provide these functions.

Our setting allows us to shed light on how credit unions, local and national banks, and fintech services respond to uncertainty, risk, and new growth opportunities. The demand for cash management services is driving an explosion of innovation in the financial services sector, including fintech. We investigate a unique part of this demand in an industry that has limited access to traditional banking services. Traditional banks face regulatory hurdles to working with marijuana businesses. Local credit unions designed customized, small-scale solutions to provide these firms with financial services, and fintech firms developed technology

that allowed credit unions to scale up these business models.

Our paper fits in the intersection of banking, financial development, and economic outcomes. Our results provide early empirical evidence consistent with the model in Donaldson et al. (2018) by demonstrating substantial economic value of cash management for marijuana dispensaries. Our results complement and extend current research on cash management by studying the value of introducing, rather than intensifying, the use of cash management.[10] Thakor (2020) finds that fintech's greatest impact so far is in payments, clearing, and settlement services. We complement these findings by calculating the value of warehousing and documenting recent fintech innovations for these services. We also add to research on financial exclusion by showing that it negatively affects firm profitability.[11] Finally, our results provide insights relevant for the future of the banking industry. We show that local financial institutions and fintech played complementary roles to assume some of the functions that have traditionally been filled by large, national financial institutions.

The remainder of the paper is organized as follows. Section I provides institutional background about the marijuana industry. Section II introduces our model of the mechanisms through which cash management can create value for marijuana dispensaries. Section III describes our data and Section IV discusses our empirical design. Section V presents the empirical results. Section VI turns to robustness. Finally, Section VII concludes.

I. Background

This section describes the general functions of banking institutions, the legal status of banking in the marijuana industry, and how banking in the marijuana industry works. Section IV of the Internet Appendix provides an in-depth review of institutional details in the

[10]See, for example, Baumol (1952), Miller and Orr (1966), Frost (1970), Daellenbach (1974), Gitman et al. (1979), Vickson (1985), Berger et al. (2003), and Gitau et al. (2014).

[11]See, for example, Karlan, Ratan, and Zinman (2014), Agarwal et al. (2017), Brown, Cookson, and Heimer (2019), Stein and Yannelis (2020), and Brune, Chyn, and Kerwin (2021).

marijuana industry.[12]

A. *Banking Institutions*

Distance and bank size and scope have traditionally played an important role in banks' information gathering and decision-making.[13] Evidence shows that physical proximity is an important determinant of lending relationships (Petersen and Rajan (1994), Petersen and Rajan (2002), Rajan, Seru, and Vig (2015), Nguyen (2019), and Berger (2022)). Proximity to borrowers gives banks a comparative advantage in gathering and using soft information.[14]

While this evidence pertains primarily to lending relationships, insights from these studies are relevant to cash management relationships in general (Donaldson et al. (2018)). Specifically, when banks accept deposits, banking regulations require that they verify the business/account holder, determine the source of funds, and file SARs for "abnormal" transactions. Hence, record-keeping and due diligence efforts are important components of a cash management relationship.[15]

B. *Banking in the Marijuana Industry: Legal Status*

The Comprehensive Drug Abuse Prevention and Control Act of 1970 includes a schedule with five tiers of controlled substances based on characteristics such as acceptable medi-

[12]The Internet Appendix is available in the online version of this article on the *Journal of Finance* website.

[13]Banks gather both hard and soft information about potential borrowers. Hard information is easy to locate, record, and transmit through the banking system. Soft information is not easily recorded and is based mainly on perception and interpersonal interactions.

[14]Related results in the literature include Petersen and Rajan (1994), Petersen and Rajan (2002), Brickley et al. (2003), Berger et al. (2005), Cetorelli and Strahan (2006), Paravisini (2008), Rice and Strahan (2010), Butler and Cornaggia (2011), Gilje et al. (2016), and Gilje (2017).

[15]Office of the Comptroller of the Currency, 2002, Money laundering: A banker's guide to avoiding problems, https://www.occ.gov/publications-and-resources/publications/banker-education/files/pub-money-laundering-bankers-guide-avoiding-probs.pdf.

cal use, the potential for abuse, and general safety. Schedule I substances are defined as drugs with no currently accepted medical use and a high potential for abuse; examples include heroin, LSD, and marijuana.[16] As a result, the U.S. government prohibits marijuana production and consumption.

Individual states, however, have the right to set their laws regarding marijuana under the 10th Amendment of the U.S. Constitution. In 2012, individual states started legalizing recreational marijuana for adults 21 years of age and older. As of 2022, 19 states and Washington D.C. have legalized recreational marijuana.

Following state-level marijuana legalization, rules about whether financial institutions could work with the marijuana industry were ambiguous. FDIC-insured financial institutions are subject to federal law and require specific directions from federal regulators before interacting with marijuana firms.[17]

On August 29, 2013, the FDIC issued guidance on how financial institutions should interact with recreational marijuana dispensaries (Cole (2013)). Additional guidance came from the Financial Crimes Enforcement Network (FinCEN) to clarify Bank Secrecy Act (BSA) expectations.[18] The guidelines suggest that banks "know their clients" to ensure they are not engaged in illegal activities as outlined in the Cole memo (Cole (2013)). Unfortunately, this guidance includes the provision that all rules could be revoked at any time (Cole (2013)). Moreover, the Drug Enforcement Administration formally warned banks that marijuana remains illegal at the federal level, and the CEO and President of Colorado Bankers Association urged its members officially to avoid serving marijuana businesses.[19] Even with this

[16]U.S. Drug Enforcement Administration, 2022, Drug scheduling, https://www.dea.gov/drug-information/drug-scheduling.

[17]For example, see FIN-2014-G001, (2014), BSA expectations regarding marijuana-related businesses, Department of the Treasury; Financial Crimes Enforcement Network.

[18]FIN-2014-G001, (2014), BSA expectations regarding marijuana-related businesses, Department of the Treasury; Financial Crimes Enforcement Network.

[19]Colorado Bankers Association, 2022, Cannabis banking, https://www.coloradobankers.org/page/

guidance, the fact remains that accepting cash from marijuana firms is regarded as money laundering under federal law.

C. Banking in the Marijuana Industry: Practice

As of May 2023, access to cash management is an ongoing struggle for marijuana retailers. Due to the current legal status of marijuana in the United States, less than 4% of all banks and credit unions are willing to provide banking services to marijuana firms.[20] Congress has failed to pass concrete laws to encourage banking to this industry, and thus most financial institutions continue to wait on the sidelines. Section IV of the Internet Appendix provides a list of proposed banking regulations and policies related to marijuana.

Most dispensaries have struggled to obtain financial services due to these regulatory ambiguities. For example, based on responses of dispensary owners in Washington state between July 10, 2016 and October 31, 2016 (see Section III.C for more details about the survey) Table I shows that only 49% of dispensaries have access to a business bank account, 30% do not use any financial services, and 18% resort to using personal bank accounts. Of dispensaries that have business accounts, only 12% have accounts with national banks. And while some survey respondents indicate the use of personal bank accounts, we note that banks frequently close such accounts when they discover that the account is related to a marijuana business. Numerous anecdotes, discussed in Section IV of the Internet Appendix, corroborate these responses.

[Insert Table I]

One effect of limited financial services is that financial transactions in the marijuana industry are mostly cash transactions. Based again on our survey of dispensaries in Washington state, Table II shows that 49% accept cash only, 40% also accept checks, and only

60.

[20]Gurien, Nathan, 2021, How many banks work with cannabis? it's fewer than you think., https://fincann.com/blog/how-many-banks-work-cannabis-industry/.

3% accept credit cards. Even those dispensaries with bank accounts have limited payment processing options due to banking regulations. As the size of the marijuana industry is increasing rapidly, cash management is becoming a greater concern.[21] Indeed, Merz and Riepe (2021) show that marijuana dispensaries report that their major challenges are managing customer payments, making financial business transactions, and accessing financial capital.

The owners of marijuana dispensaries in our survey worry about the safety and efficiency of an all-cash business.[22] Table II further shows that among our survey dispensaries, 30% use a security company to transport their cash or product at an average cost of $348 a month. Cash is also more vulnerable to theft, with survey respondents suspecting an average loss from theft of $618 per month. Even normal business activities such as payroll are more costly when conducted in cash. For example, many dispensaries must pay employees in cash. Dispensaries bear the risk of holding payroll in cash, and on payday this risk shifts onto employees. In response to these costs, dispensaries are willing to pay large fees to financial institutions for their services – our survey respondents report paying monthly fees between $437 and $1,059 for access to cash management.

[Insert Table II]

Theft and crime in the communities in which dispensaries are located have increased as a result of the lack of cash management.[23] Local financial institutions have therefore faced pressure to provide banking solutions. Table I shows that 69% of the dispensaries with cash

[21]Weed, Julie, 2018, Washington state marijuana companies getting some, but not all banking services, *Forbes*, May 7, https://www.forbes.com/sites/julieweed/2018/05/07/washington-state-marijuana-companies-getting-some-but-not-all-banking-services/.

[22]Weed, Julie, 2018, Bags of cash and stealthy deliveries: How pot startups pay taxes, *Forbes*, May 18, https://www.nytimes.com/2018/05/18/business/smallbusiness/marijuana-companies-federal-taxes.html.

[23]Espino, Adan, and Maryam Mirnateghi, 2022, Armed robberies of cannabis retailers require immediate response, https://washingtonstatewire.com/oped-armed-robberies-of-cannabis-retailers-require-immediate-response/.

management services have obtained such services through a community or regional credit union. In contrast, only 11% of dispensaries report working with a national bank.

D. Banking Solutions: Salal and Numerica

By April 2014, two credit unions in Washington state – Salal and Numerica – announced that they would work with marijuana-related businesses due to public safety concerns. The accounts gave dispensaries access to limited cash management services, which in practical terms meant that these firms could use depository services. However, because taking such deposits was technically considered money laundering under federal law, these credit unions needed to develop careful processes for managing these accounts to ensure they were compliant with federal guidance.

Salal and Numerica relied on relationships with the local community of financial regulators, business leaders, legal experts, and state regulators to reduce uncertainty and limit the risks of working with recreational marijuana businesses. Together they designed a customized, small-scale framework for providing financial services to marijuana businesses. This solution, which evolved over time, was labor-intensive and hyper-local, emphasizing due diligence, strict compliance, and constant contact with state regulators. For example, the account application process took between seven and 10 days and required on-site visits. Account opening procedures included a review of the applicant's business license documentation, criminal background checks, funding and financial scrutiny, and a review of public records from the WSLCB. These accounts required a daunting increase in monitoring, reporting, and special services, which we detail in Section IV of the Internet Appendix. By October 2014, Salal had received 200 requests for accounts. Despite the intense demand, Salal and Numerica limited the number of new accounts to keep up with reporting requirements.

These characteristics of the banking sector in Washington state allow us to isolate the effect of cash management from bank lending and other confounding factors, and thus to empirically quantify the economic effect of cash management on the profitability of marijuana

firms.

II. Model

Our research question is twofold. First, we seek to estimate the economic impact of cash management on a firm's profitability. Second, we seek to understand what aspects of cash management create value. In this section we begin by introducing a model of the mechanisms through which cash management can create value by lowering market frictions. This model yields four key predictions, two for the wholesale market and two for the retail market. We next describe institutional details about the marijuana market that show how frictions arise in the absence of cash management. We use this model to estimate the economic value of cash management in Section V.C. The Internet Appendix provides formal derivations of these markets in Section V and an in-depth discussion of institutional details in Section IV.

A. Model of Cash Management

Figure 1 depicts supply and demand in the wholesale market. In this market, suppliers sell marijuana to dispensaries at wholesale prices, and transactions consist of large quantities of marijuana and cash being exchanged. We model suppliers as having perfectly elastic supply (horizontal lines) and dispensaries as having imperfectly elastic demand (downward-sloping line).[24] Frictions in this market arise due to regulations that limit access to cash management. We model these frictions as an increase in the marginal cost and thus as an upward shift in the supply curve from "Supply with CM" to "Supply without CM." Section II.B below identifies potential sources of these frictions.

This model generates two testable predictions about the wholesale market. The first

[24]The assumption of perfectly elastic supply may be rationalized if suppliers can costlessly switch between selling to dispensaries with and without cash management. In Section V of the Internet Appendix we provide an in-depth discussion of this assumption, which is common in the literature (Mace et al. (2020)), including its implications and how to loosen the assumption.

prediction is that dispensaries with cash management pay lower wholesale prices than dispensaries without cash management. In Figure 1, this can be seen as the supply curve without frictions intersecting the demand curve at a lower price than the supply curve with frictions. The second prediction is that dispensaries with cash management buy more quantity than dispensaries without cash management. In Figure 1, this is reflected as the supply curve without frictions intersecting the demand curve at a higher quantity than the implied quantity with frictions.

[Insert Figure 1]

Figure 2 depicts the retail market. In this market, customers buy marijuana from dispensaries at retail prices. We model customers as having perfectly elastic demand (horizontal lines) and dispensaries as having imperfectly elastic supply (upward-sloping line).[25] This market also faces frictions that arise from regulations that limit access to cash management. We model these frictions as lowering the willingness to pay for marijuana and thus as a downward shift in the demand curve from "Demand with CM" to "Demand without CM." These frictions could be due to a lack of reputational capital, sometimes referred to as a "clientele effect" (Buchak et al. (2018)), which we discuss in the next section.

[Insert Figure 2]

The model leads to two testable predictions about the retail market. The first prediction is that dispensaries with cash management charge higher retail prices than dispensaries without cash management. Dispensaries with cash management charge a higher retail price because their demand curve is higher than that for dispensaries without cash management. As can be seen in Figure 2, this higher demand leads the intersection of their demand and

[25]The assumption of perfectly elastic demand may be rationalized if customers can costlessly reallocate purchases from dispensaries with and without cash management. Section V of the Internet Appendix describes the model without this assumption.

supply curves to be at a higher retail price than the intersection of the demand and supply curves for dispensaries without cash management. The second prediction on the retail side is that dispensaries with cash management sell larger quantities than dispensaries without cash management. As can be seen in Figure 2, the higher demand for dispensaries with cash management leads the intersection of their demand and supply curves to be at a higher quantity than the intersection of the demand and supply curves for dispensaries without cash management.

B. Institutional Details about Cash Management

Figure 1 shows that suppliers charge lower wholesale prices and sell higher quantities to dispensaries with cash management. In the wholesale market, these effects are likely driven by both logistical considerations associated with cash transactions and uncertainty about the integrity of the dispensary-supplier relationship. Without cash management services, the physical transportation of cash increases risk, which has led to licensed transporters charging 1% to 1.5% of the value of cash-in-transit to cover insurance. Moreover, suppliers must count cash payments, which are often in small currency denominations, and safely store the cash.[26] Uncertainty arises in these relationships because suppliers bear the risk that dispensaries will be unable to pay or that they will pay with counterfeit currency. Lastly, suppliers must continually produce marijuana but face uncertainty about future demand.

Cash management resolves these concerns. Dispensaries with cash management can use credit unions and payment processing to mitigate the costs and risks of cash transactions. Moreover, dispensaries with cash management are able to develop a loyal customer base in the retail market through a clientele effect, which allows dispensaries to develop stable demand and accurate estimates for wholesale purchases. These dispensaries build reputational capital in the wholesale market, and wholesalers provide discounts and high-quality products to these dispensaries.

[26]It takes two to three hours to count and verify $20,000 in $20 bills using a counting machine.

Figure 2 depicts the retail market in which customers are willing to pay higher retail prices and demand higher quantities from dispensaries with cash management. Although the marijuana industry in Washington state is highly regulated, uncertainty about product quality cannot be resolved entirely before the customer purchases the product. When quality is unobservable and cannot be guaranteed, firms can offer an implicit quality guarantee through reputational capital (Klein and Leffler (1981) and Shapiro (1983)). Dispensaries that offer high-quality products can charge a premium price for their product to support the high-quality promise. Cash management services create quasi-rents that increase the value of the firm's reputational capital, creating a feedback loop whereby firms with cash management invest even more in reputational capital, which leads in turn to clientele effects.

In our setting, clientele effects likely drive most of the higher retail prices of dispensaries with cash management, for several reasons. Most directly, customers report that they are willing to pay higher prices for clientele effects.[27] Customer reviews posted to Yelp further reveal that customers expect consistency, quality, and safety in a dispensary's products and build close relationships with their budtenders.[28] In addition, because cash management creates an incentive to invest in reputational capital in the wholesale market, these dispensaries are able to buy consistently high-quality products in the wholesale market. This has ripple effects on the retail side of the business. Dispensaries are able to provide predictable

[27]This effect is consistent with a recent study of grocery stores that found that clientele effects allowed the Whole Foods grocery store chain to charge higher prices for the same products carried by competitors because customers valued aspects of the shopping experience at Whole Foods, such as interactions with store employees about the selection of products (See Brasler, 2014, Wine prices, https://www.checkbook.org/washington-area/wine-prices/). Specifically, the study found that Whole Foods was able to charge $14.99 for a bottle of Kim Crawford Marlborough Sauvignon Blanc while other grocery stores in the area charged between $11.79 and $12.97—a 15% markup.

[28]We constructed a data set of customer reviews from Yelp, an online business directory and review website. We compiled all reviews for marijuana dispensaries in Washington state from 2014 to 2017 – roughly 2,000 reviews – and matched the reviews to the dispensaries in our survey data.

product quality and safety, and can improve a customer's experience by hiring good budtenders and offering a fully stocked range of products. Hence, the clientele effect should provide a quality guarantee in the retail market that increases the marginal value to customers and increases demand for products from dispensaries with cash management relative to dispensaries without cash management.

III. Data

We combine three novel data sets for our empirical analysis. First, we use administrative records from the Washington State Liquor and Cannabis Board (WSLCB). Second, we compile data about financial institutions using data from the Federal Deposit Insurance Corporation (FDIC) and the National Credit Union Administration (NCUA). Third, we use data based on our hand-collected surveys of marijuana business owners. We discuss each of these data sets in turn. We then provide descriptive statistics at the end of this section.

A. Washington State Liquor and Cannabis Board

States that have legalized recreational marijuana for adult use have imposed extensive data reporting requirements.[29] In Washington state, firms are required to report germination, harvest, production, and final retail sales data for each marijuana plant. Firms record the strain, quantity (weight), retail price, and wholesale price for each transaction. Firms have a large incentive to accurately report this information because misreporting has minimal benefits (e.g., it does not determine tax liability) but large potential costs, as firms are subject to audit with the risk of losing their license. For example, Washington state uses random audits of dispensaries and suppliers, and employs penalties and inventory destruction in the event of misreporting, to ensure that marijuana dispensaries comply with the regulations

[29]States require in-depth disclosure from suppliers and dispensaries due in part to the Cole Memo (Cole (2013)). For more information on disclosure, see Hansen, Miller, and Weber (2017).

and disclose this information accurately in the tracking system.

The WSLCB data set covers the universe of marijuana dispensaries and includes 62 million retail transactions from July 2014 to February 2017. Because the data are tracked at the transaction level, we are able to construct transaction-level variables. We define transaction-level profitability as *Profitability* = (retail price − wholesale price) × quantity. We emphasize that *profitability* is a measure of product-level profits rather than firm-level profits and thus is a function only of the product that the firm sells less what it paid for the product. The measure does not include labor costs, building costs, or other fixed costs, and thus is not a measure of the overall efficiency of the firm.[30]

In the administrative data set, the average *retail price* is \$12.04 per gram and the average transaction size (*sales*) is 6.8 grams. For comparison, the average tobacco cigarette weighs one gram and costs \$0.31. The data set includes information about the strains of marijuana, which can be thought of as wine varietals, such as cabernet sauvignon. The average dispensary sold 262 different strains, including Pineapple Kush, Super Lemon Haze, and Snoops Blue Dream. Figure 3 shows dispensary locations in Washington state using their latitude and longitude. Each county is shaded depending on the amount of sales. This figure shows that while there is a large volume of sales in and around Seattle, dispensaries and sales are spread across the entire state.[31]

[30]To understand the difference, consider the following example. Suppose there are two marijuana dispensaries, Firm 1 and Firm 2. Firm 1 has access to cash management while Firm 2 does not. As a result, Firm 1's wholesale price is \$8 per gram and Firm 2's is \$10. For simplicity, suppose the two firms are similar across all other dimensions – they both charge a retail price of \$15 per gram, sell 10,000 grams, have overhead of \$100,000, and have additional revenue of \$300,000 (from selling t-shirts and accessories). The product-level profitability (= (retail price − wholesale price) × quantity) of these two firms is \$70,000 for Firm 1 and \$50,000 for Firm 2, a 29% difference. In contrast, the firm-level profit or efficiency (=(retail price–wholesale price) × quantity + other revenue − overhead) of the two firms is \$270,000 for Firm 1 and \$250,000 for Firm 2, a 7% difference.

[31]These retail establishments are located in 152 cities or towns within Washington state. The percentage of dispensaries in these cities is roughly similar to the percentage of the state's population. For example,

[Insert Figure 3]

B. Banking and Credit Union Data

We combine the administrative data with the geographic locations of branches and headquarters of credit unions and banks in Washington state from the NCUA and the FDIC Summary of Deposits. In total, there are 1,481 branches of financial institutions and 52 banks, and 40 credit unions headquartered in Washington with at least one branch. On average, banks have 20 branches and credit unions have 6.4 branches.

In June 2014, two independent credit unions – Salal and Numerica – elected to work with marijuana dispensaries following the passage of initiative 502.[32] We refer to these credit unions as 502 credit unions. Together these two credit unions have 21 branches. Figure 4 shows all credit union locations in the state. As can be seen, 502 and non-502 credit unions are evenly spaced across the state and in counties with high and low average dispensary profits.

[Insert Figure 4]

The characteristics of 502 credit unions and non-502 credit unions are similar along most dimensions. Table IA.II provides summary statistics based on NCUA Call Reports data. As can be seen, 502 and non-502 credit unions are similar in terms of assets, deposits, and net income. In addition, 502 and non-502 credit unions have similar bank outreach in terms of number of members, number of branches, and plans to expand branch networks, and proprietary data show that they have similar FICO scores, number of car loans, and other lending measures.[33] However, 502 credit unions have higher total loans and leases, as well as

Seattle accounts for 9% of Washington's population and 13% of the state's dispensaries.

[32]Initiative 502 legalized marijuana-related products for adults over 21 in small amounts, but stipulated that marijuana in large amounts, marijuana in the possession of persons under 21, and the growing of unlicensed marijuana remained illegal under state law.

[33]These data come from a financial database company that works with credit unions and banks.

higher liabilities. These differences may make 502 credit unions more willing to risk working with marijuana dispensaries.

C. Banking, Entrepreneurship, Regulation, and Taxes Study

Our third data set comes from a survey we conducted between July 10, 2016 to October 31, 2016, namely, the Banking, Entrepreneurship, Regulation, and Taxes (BERT) Study. We contacted all dispensaries in Colorado, Oregon, and Washington over several waves that included letters, phone calls, partnerships with industry groups, and a field team. Participants were asked to take an online survey that took an average of 40 minutes. We followed up with phone calls in several additional waves with a shorter targeted survey. All participants were compensated $50.

After all waves of the survey, the survey response rate was 21%. This response rate is a bit higher than in other recent surveys of businesses, likely because we applied a more intensive recruitment strategy. For example, Graham and Harvey (2001) obtained a response rate of 16% and Trahan and Gitman (1995) a response rate of 12% in surveys of CFOs and business executives of large firms.

The WSLCB administrative data include 314 organizations that own 354 dispensaries, after restricting attention to locations that have sales (Mace et al. (2020)). Most organizations in our sample have only one location; they were restricted by law to having no more than three. We supplemented the survey from the BERT study with additional waves of a shorter survey to ensure we captured responses from all 314 organizations in Washington state. Specifically, we obtain responses from all organizations in the state on whether they have access to cash management. The survey also elicited demographic information on the owners, including education level and whether their parents had run a business (*Parent run company*) as a proxy for exposure to entrepreneurship. We received responses to demographic questions from 238 organizations (76%), which corresponds to 264 dispensaries (75%). We assign responses to all locations of an organization. We also assume that orga-

nizations that report having access to cash management continue to have access throughout the sample period, while those that report not having access do not obtain access at any point in our sample period. This assumption is a limitation of a one-time survey and likely leads to measurement error. Because such measurement error is expected to bias OLS estimates toward zero, we focus on IV evidence in our main analysis (Hausman et al. (1991), Bound, Brown, and Mathiowetz (2001), and Schennach (2007)). Section II.D of the Internet Appendix reports OLS estimates and provides a comparison of estimates.

D. Descriptive Statistics

Table III presents descriptive statistics. Column (1) reports full-sample averages, column (2) reports averages for dispensaries located within one mile of a 502 credit union, column (3) reports averages for dispensaries located one to 10 miles from a 502 credit union, and column (4) reports differences and their statistical significance.

[Insert Table III]

Panel A shows economically and statistically meaningful differences in operation-specific variables between dispensaries within one mile of a 502 credit union (column (2)) and dispensaries between one and 10 miles of a 502 credit union (column (3)). In particular, retail prices, wholesale prices, profitability, and sales are all larger for dispensaries within one mile of a 502 credit union than for those located one to 10 miles away from a 502 credit union.

Panel B reports summary statistics for owner characteristics such as educational attainment and whether the owner's parent had run a company (*Parent run company*), which is a proxy for a dispensary operator's exposure to entrepreneurship. We find that these characteristics are economically and statistically similar for dispensaries in columns (2) and (3).[34]

[34]We find that 55% of owners had a parent who had run a company, which is comparable to other papers that find that over 50% of business owners had a self-employed family member before starting their business (Fairlie and Robb (2007)).

These results suggest a limited role for business acumen of the owner or the strategic choice of location to explain our results.

Panel C summarizes the average distances between dispensaries and 502 credit unions, non-502 credit unions, banks, and competitor dispensaries. Dispensaries in columns (2) and (3) have similar distances to the latter three types of establishments. Specifically, the average difference in the distance to a non-502 credit union (*Miles to non-502 credit union*), bank (*Miles to bank*), and competitor (*Miles to competitor*) is 0.6 miles, 0.3 miles, and 0.11 miles, respectively. Our empirical design allows us to capture the possibility that dispensaries, non-502 credit unions, 502 credit unions, and banks locate near economic opportunities by comparing the profitability of dispensaries near economic opportunities with and without 502 credit unions. We also include the distance to the nearest bank as an indirect control for local economic opportunities, and we conduct placebo tests using distance to a bank, rather than a 502 credit union, as a placebo instrument (see Table IA.X and Figure 7).

IV. Instrumental Variable Design

Our goal is to measure the causal effects of cash management on dispensary profitability. Ideally, we would examine an experimental setting in which cash management is assigned randomly to some dispensaries and not to others, mitigating concerns that dispensaries with cash management differ from dispensaries without cash management. In the absence of a truly random experiment, we use an IV approach to address this potential bias.

Our instrument is based on the distance between a marijuana dispensary and a 502 credit union, which for several institutional reasons is likely to be random. Distance is often used as an instrument for causal identification in the literature (Card (1995), Currie and Moretti (2003), and Cameron and Taber (2004)). In our setting of marijuana banking, distance is likely a particularly strong instrument due to the extra monitoring, including quarterly site visits from bank personnel, that strengthen the relationship between distance, information asymmetry, and cash management (e.g., Berger et al. (2005)). Our statistical tests discussed

below support this view and show that distance is a good predictor of cash management services in the marijuana industry.

A. Model

In the first-stage equation (equation (1)), the outcome variable, *Cash management*, is an indicator equal to one for marijuana dispensaries that have access to cash management based on our survey responses, and zero otherwise. The distance measure, *Distance to 502 credit union* is constructed in two ways. First, we use a discrete measure of distance, where f(*Distance to 502 credit union*) is an indicator equal to one if a marijuana dispensary is within one mile of a 502 credit union and zero otherwise. Second, we use a continuous measure, log(*Distance to nearest 502 credit union*). The results are not sensitive to the definitions that we use to construct these measures or to using different distance thresholds for the discrete measure, as we discuss in Section IV.B.

In the second-stage equation (equation (2)), log(*Profitability*) is the dependent variable. It is measured at the dispensary-strain level at a weekly frequency and is measured after the random assignment of access to cash management. We control for product market competition by including the presence of other dispensaries within one mile (*Competitors*). The specification includes week (α_t) and city (α_j) fixed effects, and standard errors are clustered at the dispensary level. The coefficient of interest is β_1, the average profitability across marijuana dispensaries that have cash management because they are close to a 502 credit union.

Our baseline IV model can be described by the following two-equation system:

$$\textit{Cash management}_{i,t} = \delta_0 + \delta_1 \text{f}(\textit{Distance to 502 credit union})_i + \delta X_{i,t} + \alpha_t + \alpha_j + \varepsilon_{i,t} \quad (1)$$

$$\log(\textit{Profitability}_{i,t}) = \beta_0 + \beta_1 \textit{Cash management}_{i,t} + \beta X_{i,t} + \alpha_t + \alpha_j + u_{i,t}. \quad (2)$$

B. *Instrument Relevance and Validity*

We find a strong correlation between cash management and a marijuana dispensary's distance to a 502 credit union, as modeled by equation (1). Table IV shows that marijuana dispensaries within one mile of a 502 credit union have a 28 percentage point higher probability of having cash management services than those farther than one mile (column (1)). The probability of having cash management decreases monotonically as the discrete measure increases from within one mile to within three miles (columns (1) to (3)). The results in column (4) suggest that a 10% increase in a marijuana dispensary's distance from a 502 credit union (log(*Distance to nearest 502 credit union*)) decreases the probability of access to cash management by one percentage point. The F-statistic for most of these specifications is above the cutoff for a strong instrument (Bound, Jaeger, and Baker (1995) and Stock, Wright, and Yogo (2002)). Notwithstanding, as a precaution we run several placebo tests using the distance to banks, non-502 credit unions, and other types of financial institutions. We find no evidence that distance to these alternative financial institutions predicts access to cash management (see Table IA.V and Section II of the Internet Appendix for a detailed discussion).

[Insert Table IV]

For distance to be a valid instrument, the assignment of distance must be uncorrelated with marijuana dispensary characteristics. This random assignment mechanism is sufficient for consistent estimation of the reduced-form effects of distance on access to cash management. Two further assumptions are necessary, however, to interpret the IV estimates as causal effects: (i) monotonicity and (ii) an exclusion restriction. We briefly discuss these in turn, leaving a more detailed discussion for Section II of the Internet Appendix.

The monotonicity assumption in our setting requires that being closer to a 502 credit union does not decrease dispensaries' probability of access to cash management. This assumption is likely to hold in our setting, as only two credit unions work with dispensaries

and the relationship between dispensary and credit union entails physical costs. We also find that the correlation between *Distance to the nearest 502 credit union* and *Cash management* is consistently positive and sizable in subsamples of the data based on pre-determined characteristics (see Table IA.III).

Our exclusion restriction is that distance affects marijuana dispensary profits only through its impact on access to cash management. The exclusion restriction is likely to hold in our setting because of the asynchronous timing of the location decisions by dispensaries and the decision to provide banking services to marijuana businesses by credit unions. Figure 5 depicts the timeline of these decisions and demonstrates that it would have been difficult for either group to make its decision strategically based on the decision of the other group. In particular, potential marijuana dispensaries made location decisions when they applied for a license (December 2013). This step occurred before any credit union elected to offer banking services to the marijuana industry, making it impossible for the potential dispensaries to choose locations based on credit unions that would work with them. Moreover, only a random subset of these dispensaries would ultimately receive a license. Lottery winners were announced in May 2014 but could not start transacting with customers until July 2014. Two credit unions announced their intention to work with the marijuana industry in June 2014. This decision occurred well before any dispensary was open for business, making it impossible for credit unions to make their decision based on a dispensary's profitability. Due to this timing, it is likely that credit unions did not know where licensed dispensaries would be located, but if they did have it this knowledge would not be a violation of the exclusion restriction—a violation would obtain only if they knew the profitability of dispensaries, which could not be known before July 2014 when dispensaries opened. It would also be difficult for credit unions to co-locate with profitable dispensaries due to the number of branches that they have. Put differently, even if a profitable dispensary was located near one of their branches, there was no guarantee that profitable dispensaries would be located near their other branches. Figure 4 further shows that the 502 credit unions are spread

throughout Washington state, reducing the concern that credit unions locate only in the most lucrative areas. These institutional details make it likely that the distance between a marijuana dispensary and a 502 credit union is exogenous. In Section III of the Internet Appendix we discuss a series of tests that we employ to check alternative mechanisms and other potential threats to validity.[35]

[Insert Figure 5]

V. Results

We report our estimates of the impact of cash management on profitability in Section V.A. We explore alternative explanations and the sensitivity of our results in Section V.B. We investigate mechanisms driving the results in Section V.C. Additional tests are reported in Section III of the Internet Appendix.

A. The Impact of Cash Management on Profitability

A.1. Graphical Evidence: Distance and Profitability

Figure 6 presents reduced-form evidence of our IV strategy by plotting the relationship between profitability and distance (Miles from Financial Institution) in the raw data. The figure reports the marijuana dispensary profitability of individual marijuana strains by distance to a financial institution – *Distance to bank* (dotted line), *Distance to non-502 credit union* (dashed line), and *Distance to 502 credit union* (solid line)—where distance is predictive of access to cash management (see Section IV.B). Working backward from a distance of 10 miles, the figure shows that the lines are all parallel and flat in terms of profitability,

[35]In particular, we show that (i) 502 credit unions are not located in more prosperous counties than non-502 credit unions (see Table IA.IV) and (ii) business owners with greater business acumen (as proxied by educational attainment and whether a parent had run a company) are unable to strategically locate near 502 credit unions (see Table III, Panel B and Table IA.VII).

meaning that profitability is similar across all financial institutions at these distances. Starting at three miles, log(*Profitability*) increases as the *Distance to 502 credit union* declines. For dispensaries within one mile of a 502 credit union, log(*Profitability*) is 10% higher than for dispensaries within one mile of banks or non-502 credit unions.

[Insert Figure 6]

A.2. Instrumental Variable Evidence: Cash Management and Profitability

We use our quasi-experimental IV setting to test for a causal relationship between access to cash management and marijuana dispensary profitability. In Table V, we show that product profitability (at the strain level) is higher at dispensaries with cash management. In column (1) we present our most parsimonious model, which includes the discrete measure of distance as the IV, no control variables, and fixed effects only for strain. In this model, we find that cash management increases product profitability by 37.8%. When we include week fixed effects in column (2), the precision of the estimate increases and the point estimate remains similar at 39.5%.

Our results are robust to a series of potential confounding factors. One concern might be that highly profitable dispensaries cluster in Seattle and Spokane (alongside the 502 credit unions), which drives the results. To control for this possibility, we include city fixed effects in the model reported in column (3) and find a slightly higher effect of 52.8%.[36] This estimate relies on within-city variation, meaning that the estimate is not a result of differences in profitability across cities. Another concern might be that highly profitable dispensaries cluster near areas with high economic activity that also include banks. To control for these local conditions, we control for *Distance to nearest bank* in columns (4) to (8). Finally, we control for the extent of competition using the number of other dispensaries (*Competitors*)

[36]We also estimate the model excluding Seattle and Spokane and find similar results. See Section III of the Internet Appendix.

in columns (5) to (8).[37]

In a related test, we restrict our sample to generic strains and house varietals to investigate whether brand quality may be an omitted variable related to micro-locations or clientele. Column (6) shows that the estimates for this subset are very similar to those for the full sample of 51.7%.

[Insert Table V]

As we mention in the introduction, our profitability measure does not include labor costs and other fixed costs such as rent and utilities, and hence it should not be compared with firm profits. Bank fees, cash storage, and secure cash transportation expenses also do not enter our estimates. Rather, profitability only captures cash flows from retail prices, wholesale prices, and sales quantities (grams).

We report our most saturated model in columns (5) and (7). These specifications include strain, week, and city fixed effects as well as controls for local economic conditions (i.e., *Distance to bank*) and competition from other local dispensaries (*Competitors*). The estimated effect of *Cash management* on *Profitability* is 48.5% using the indicator instrument (column (5)) and 45.6% using the continuous distance instrument (log(*Distance to 502 credit union*)).

Standard errors are clustered at the dispensary level. However, in this setting, there is no ideal level of clustering, and there are good arguments for clustering at other levels, such as the week and city level; see Section III of the Internet Appendix for a more detailed discussion. We address this ambiguity by estimating our main effects using standard errors clustered at alternative and perhaps equally valid levels. We also aggregate data at the daily, weekly, and monthly frequencies to explore how aggregation influences our results. Our estimates remain statistically significant using different levels of clustering, using two-way clustering at the week-dispensary level (see Figure IA.1), and using different aggregation frequencies (see Figure 8).

[37]In Section III of the Internet Appendix, we further explore questions about economic activity, with, for example, a differences-in-differences model and other splits by geography.

In column (8), we report results of dispensary-level, rather than strain-level, analysis. We aggregate the data to the dispensary-week level and include city and week fixed effects as well as controls for the distance to the nearest bank and competition. Dispensary profitability is 23.8% higher when a dispensary has access to cash management. Our results therefore show that cash management has a large impact on a dispensary's profitability. In the remainder of the paper, we examine how regulations that limit access to cash management shift supply and demand in the wholesale and retail markets and the implications for prices and quantities.

B. Alternative Explanations and Sensitivity

B.1. Placebo Tests

We use a series of placebo tests to investigate alternative explanations. We use *Distance to non-502 credit union* and *Distance to nearest bank* as placebo instruments. Estimates from these placebo tests are reported in Figure 7 and capture unobserved characteristics associated with distance and profitability that could conflate our estimates. Section III of the Internet Appendix reports estimates of placebo tests in which we find that the distance between a dispensary and a non-502 credit union or bank does not impact product profitability.

These estimates help to rule out alternative explanations whereby the effect of the distance to a 502 credit union on product profitability operates through the types of locations where financial institutions are found (such as shopping areas) rather than through cash management.

B.2. Sensitivity of the Results

We report results of 11 additional specifications in Figure 8 to explore the sensitivity of our estimates to the various modeling choices in our main specification. Our baseline estimate excludes marijuana dispensaries that are farther than 10 miles from a 502 credit union. In alternative specifications we expand that restriction to 15 miles, reduce the restriction to 5 miles, and eliminate the restriction. We next explore the effect of the choice of sample

period on the estimates by only including transactions from 2015 to 2017. We also use an alternative control for competition, and replace the baseline instrument (an indicator for being within one mile of a 502 credit union) with indicators for being within two or three miles of a 502 credit union or with the continuous measure log(*Distance to 502 credit union*). We further assess the sensitivity of our results to the level of aggregation in our data, considering monthly and daily aggregation rather than weekly. The estimates remain similar and statistically significant in all specifications. As expected, confidence intervals change as models become more or less restrictive. See Section III of the Internet Appendix for additional discussion and test results.

C. Mechanisms

We next use our IV model to examine how cash management affects the components of profitability: wholesale price, retail price, and sales volume. We estimate a series of regression specifications in which a marijuana dispensary's access to cash management is the primary explanatory variable.[38]

The predictions from our conceptual framework are that firms with access to cash management will pay lower wholesale prices, charge higher retail prices, and sell larger quantities (sales). In addition to these dependent variables, we consider whether cash management affects the number of strains sold. We report specifications with and without strain fixed effects to isolate product-level price variation across dispensaries from dispensary-level price variation across all products. In other words, we isolate the prices required to create reputational capital in the wholesale market and clientele effects in the retail market. The specifications with strain fixed effects show the pricing power of dispensaries with and without cash management for the same product. Comparing these results to specifications without strain

[38]As in our main analysis, standard errors are clustered at the dispensary level, and all specifications include week and city fixed effects. See Section III of the Internet Appendix for a discussion of standard errors.

fixed effects reveals how differences in a dispensary's product offerings (e.g. variety, quality, uniqueness) affect prices and sales for dispensaries with and without cash management. We expect differences in product bundles if cash management allows dispensaries to build reputational capital with suppliers (wholesale market) and to cater to customers with greater demand for quality assurance (retail market).

We first consider the difference in wholesale prices with strain fixed effects, which we report in Table VI, column (2). Dispensaries with cash management pay suppliers 7.3% less for the same strain compared to dispensaries without cash management (column (2)). Specifically, compared to the average wholesale price of $6.93 per gram (see Table III), dispensaries with cash management pay $6.42 per gram, or $0.51 less. This difference in wholesale price reflects the value of a dispensary's reputational capital in the wholesale market. As discussed in Section II, cash management reduces transaction costs and uncertainty, leading suppliers to sell at a discounted price to high-quality dispensaries, that is, dispensaries with cash management (see Figure 1).

[Insert Table VI]

We next consider the difference in retail prices with strain fixed effects, which we report in column (4) of Table VI. Dispensaries with cash management charge customers 8.3% more for the same product (strain) as dispensaries without cash management. Specifically, customers pay an average retail price of $13.04 at these dispensaries versus $12.04 in dispensaries without cash management – a difference of $1.00 – for the same product. This difference reflects the price premium necessary to ensure that the dispensary provides high-quality products. Cash management allows dispensaries to secure consistently high-quality products in the wholesale market through reputational capital. Carrying high-quality products has ripple effects in the retail market through a clientele effect, which that has been shown to be valuable in other markets (Buchak et al., 2018). For example, carrying high quality products can allow dispensaries to hire better budtenders who can spend more time with customers

discussing the product—a main benefit cited in Yelp reviews. See Section II for a detailed discussion of these costs and benefits.

Turning to the difference in quantities sold (sales) with strain fixed effects, reported in column (6) of Table VI, we find that dispensaries with cash management sell 19.0% more of the same product (strain) relative to dispensaries without cash management. This difference suggests that dispensaries with cash management sell 1.29 (= 8.09 - 6.8) more grams per transaction.

We use the estimates in Table VI to quantify the contribution of each factor to the total increase in profitability for dispensaries with cash management. We find that dispensaries with cash management earn \$8.09 (=(\$13.04 - \$12.04)×8.09) more per transaction as a result of being able to charge higher retail prices. Lower wholesale prices lead to an additional \$4.13 (= (\$6.93 - \$6.42)×8.09) for dispensaries with cash management, while selling large quantities leads dispensaries with cash management to earn \$6.59 (= (\$12.04 - \$6.93)×(8.09 - 6.8)) more per transaction. Finally, we find that selling a higher-quality bundle of goods leads to \$2.25 greater earnings.[39] In sum, we find that dispensaries with cash management sell 9% more strains (column (7) of Table VI) and sell higher-quality product as indicated by higher wholesale prices and retail prices (columns (1) to (4) of Table VI). Taken together, we find that dispensaries with cash management earn \$21.06 more per transaction than dispensaries without cash management.

Section V of the Internet Appendix combines the model from Section II and our estimates of the differences in prices and quantities to calculate the total economic value of cash management in the marijuana industry in Washington state over the July 2014 to January 2017 period if all dispensaries had access to cash management. We find that the total

[39]Without strain fixed effects, wholesale prices are 4.9% lower, retail prices are 10.7% higher, and sales are 21.7% higher. These estimates suggest profitability of \$55.81 (= (\$13.33 - \$6.59)×8.28). Similarly, we find profitability at dispensaries without cash management is \$34.75. The difference between dispensaries with and without cash management is \$21.06. We also find that the profitability of the undiversified bundle of products at dispensaries with cash management is \$53.56.

economic value of cash management is $17,683,448. We obtain this value by multiplying the transaction values by the total number of observations. This value, of which $5,973,076 comes from the wholesale market and $11,710,372 from the retail market, amounts to about 1.8% of total industry sales during our sample period across our full sample if all dispensaries had cash management.[40]

VI. Discussion

In this section, we discuss the alternative empirical approaches that we employ to test the robustness of our results, rule out alternative explanations, and deepen our understanding of the link between cash management and firm profitability.

A. Alternative Empirical Approaches

In Sections II and III of the Internet Appendix, we explore the robustness of our results using several different empirical approaches to assess how confounding factors alter the conclusions from our IV strategy. First, we assess how confounding factors, such as an owner's business acumen, that affect both access to cash management and business success affect a simple OLS analysis. A detailed discussion in Section II.D in the Internet Appendix shows that the OLS estimates are consistent with our IV results, but the difference between these estimates suggests that confounding factors bias the OLS results.

Next, we use a differences-in-differences analysis to test whether unobserved differences across neighborhoods can explain our results. In this analysis, which we report in Section III.A of the Internet Appendix, we use discrete measures of distance to proxy for access to cash management in an OLS setting. We explore how factors such as urban versus rural geographies and "main street" agglomeration affect our IV results. The estimates bolster

[40]The marijuana industry in Washington state generated close to $1 billion in sales from July 2014 to January 2017. See Pellicciotti, 2022, Washington marijuana revenues and health, https://www.tre.wa.gov/portfolio-item/washington-state-marijuana-revenues-and-health/.

our IV findings suggesting that profitability is higher only for those dispensaries close to a 502 credit union and highlight the strength of using distance as an exogenous variable.

Finally, Section III.B of the Internet Appendix reports regression estimates based on a county-level IV that uses a credit union's banking market to define access to cash management. In particular, the instrument measures whether a dispensary is located in a county with a 502 credit union. Under this definition, a dispensary has access to cash management if it is within a credit union's banking market rather than within a fixed, linear distance. We find that counties with and without 502 credit unions are indistinguishable in terms of observable demographic and economic characteristics. The results of this analysis complement our main results by confirming that profitability is higher in counties with a 502 credit union.

In sum, these findings allow us to rule out many alternative explanations for our results. In addition, the similarity in results across methods and instruments suggests that our estimates are not due to a particular set of identifying assumptions.

B. Extensive Margin

By increasing profitability, cash management may also affect the extensive margin by encouraging new entrants. Typically, profits and losses drive entry and exit in a frictionless product market. The marijuana industry, however, is far from frictionless.

The lottery for licenses and the extensive regulatory approvals required for licensed dispensaries to start doing business create frictions that substantially reduce the effects that action on the extensive margin would have on marginal profitability.[41]

We examine entry and exit decisions throughout our sample and find that entry was gradual over the 2014 to 2017 period, while there were only two exits over the same period. Specifically, 321 licenses were granted and retail dispensary storefronts opened. The number of entries was spread evenly throughout the time series, which suggests that compliance with

[41] See Section IV of the Internet Appendix for more information.

the time-consuming and onerous licensing process determined entry, rather than changes in product market competition. In Section IV of the Internet Appendix we further show that new entry is not correlated with proximity to a credit union or with profitability following entry. Due to these features of the market, we focus on the intensive-margin effects—changes in prices and quantities in the wholesale and retail markets.

VII. Conclusion

Cash management services provided by financial institutions produce substantial economic value for firms. These services include safe storage, verification, and guarantee of funds. When firms lack these services, they must find alternatives and provide internal warehousing of cash that adds costs to transactions and diverts resources from the core business. In the marijuana industry, cash management services help dispensaries build reputational capital and cater to clientele who value a premium experience. We show that these costs shift supply and demand in the wholesale and retail markets. The value of access to cash management services comes from paying lower wholesale prices, charging higher retail prices, and selling larger quantities than firms without these services.

Cash management services become an essential part of a firm's operation, much like water or electricity. However, the value of cash management is difficult to quantify because its ubiquitous adoption provides little variation to analyze. We focus on the legal marijuana industry over the 2014 to 2017 period to overcome the empirical challenges endemic to studying the value of cash management. Our empirical setting represents a unique point in time when the confluence of financial regulations, industry regulations, and an unprecedented level of tracking and traceability in a product market provide both rich data and plausibly random variation in the adoption of cash management services.

We find that dispensaries with cash management charge higher retail prices ($1 more per gram), pay lower wholesale prices ($0.51 per gram), and buy and sell larger quantities (19%), consistent with the predictions of our model. Taken together, these effects suggest that dis-

pensaries with cash management earn $21.06 more per transaction than dispensaries without cash management (= $55.81 - $34.75), which amounts to a 40% increase in profitability.

Although our results are rooted in the heavily-regulated, cash-intensive marijuana industry, the fundamental benefits of warehousing (storage, security, verification, and issuance of currency) extend beyond our setting and beyond the management of physical cash. Without warehousing, firms that use digital banking, cryptocurrencies, and fintech solutions must bear the costs of developing infrastructure to serve these functions. Our model suggests that the benefits of warehousing exist regardless of whether national banks, credit unions, or fintech provide these warehousing functions.

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TABLE I

Cash Management in the Marijuana Industry in Washington state

This table summarizes survey responses from the Banking, Entrepreneurship, Regulation, and Taxes (BERT) study for firms in Washington state. Survey responses come from all 314 organizations, which cover 354 locations. Note that during the survey period, owners were restricted to the number of dispensaries they could own (typically three). For any given question, however, we have fewer observations. For the first question, reported in column (1), we received responses from 314 organizations to the question about account type. For the second question, reported in columns (2) to (7), which elicited information on accounts disaggregated by bank type, we received responses from 203 organizations. The survey questions are reproduced in Section I.C of the Internet Appendix.

		Credit Union		Bank			
	All Types	Community	Regional	Community	Regional	National	Other
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Business	49%	30%	36%	5%	14%	12%	2%
Personal	18%	27%	26%	2%	9%	8%	5%
Other	3%						
No Acct.	30%						
Total		33%	36%	3%	14%	11%	3%

TABLE II

Financial Transactions in the Marijuana Industry in Washington state

This table summarizes survey responses from the Banking, Entrepreneurship, Regulation, and Taxes (BERT) study for firms in Washington state. Survey responses come from all 314 organizations, which cover 354 locations. Note that during the survey period, owners were restricted to the number of dispensaries they could own (a maximum of three). For any given question, however, we have fewer observations. We note the number of responses received for each question in parentheses. The survey questions are reproduced in Section I.C of the Internet Appendix.

What forms of payment do you accept? (Please mark all that apply). (N = 254)	
Cash Only	49%
Checks	40%
Debit Cards	14%
Credit Cards	3%
Do you pay for a security company that transports cash and/or product? (N = 260)	
Yes	30%
Dollars per month	$348
How much do you lose due to theft? (N = 247)	
Dollars per month	$618
How much does your business pay per month, in dollars, to use all financial services (N = 243)	
Bank or credit union	$748
Nonbank financial institution	$1,059
Other	$437

TABLE III
Descriptive Statistics

This table summarizes our three data sets. Panel A reports operation-specific variables from the Washington State Liquor and Cannabis Board (WSLCB) administrative data and the National Credit Union Association (NCUA) location data. Panel B reports summary statistics for owner-specific variables from the Banking, Entrepreneurship, Regulation, and Taxes (BERT) study for firms in Washington state only. This survey contains information on all 314 organizations in Washington, which together own a total of 354 dispensaries. During our sample period, owners were restricted to the number of dispensaries they could own (a maximum of three). With respect to demographic information, we obtain responses from 238 organizations that own 264 locations. Panel C reports summary statistics for location-specific variables that combine data from the WSLCB, NCUA, and Federal Deposit Insurance Corporation (FDIC). Column (4) reports differences between columns (2) and (3). *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

		Full sample	Within 1 mile of 502 credit union	Between 1 & 10 miles of 502 credit union	Difference (t-stat)
		(1)	(2)	(3)	(4)
Panel A: Operation-specific variables					
Retail price	Mean	12.04	12.81	12.09	0.71***
	Std. Dev.	3.90	4.21	3.61	(-6.95)
Wholesale price	Mean	6.93	7.31	7.08	0.23***
	Std. Dev.	1.74	1.78	1.63	(-5.32)
Profitability	Mean	67.00	67.48	65.63	1.85***
	Std. Dev.	20.36	18.98	19.29	(-3.83)
Number of strains	Mean	262.46	297.73	334.56	-36.83***
	Std. Dev.	203.17	210.95	217.23	(6.84)
Sales (grams)	Mean	6.80	7.44	7.07	0.38***
	Std. Dev.	4.00	3.99	3.78	(-3.81)
Observations		23,370	2,155	5,662	7,817
Panel B: Owner-specific variables					
Parent run company	Mean	0.55	0.71	0.55	0.16
	Std. Dev.	0.50	0.46	0.50	(1.39)
High school graduate	Mean	0.23	0.24	0.23	0.01
	Std. Dev.	0.42	0.44	0.43	(0.03)
Assoc. or tech. degree	Mean	0.33	0.33	0.31	0.02
	Std. Dev.	0.47	0.48	0.47	(0.17)
College degree	Mean	0.26	0.38	0.27	0.12
	Std. Dev.	0.44	0.50	0.45	(0.95)
Prof. or doct.	Mean	0.13	0.05	0.09	-0.05
	Std. Dev.	0.34	0.22	0.29	(0.77)
Locations		264	31	93	124
Panel C: Location-specific variables					
Miles to 502 credit union	Mean	32.65	0.59	4.00	-3.42
	Std. Dev.	33.73	0.27	2.40	(13.48)
Miles to non-502 credit union	Mean	3.25	1.05	1.12	-0.06
	Std. Dev.	7.14	1.15	0.72	(0.29)
Miles to bank	Mean	1.11	0.29	0.59	-0.30
	Std. Dev.	1.69	0.24	0.65	(3.71)
Miles to competitor	Mean	0.68	0.29	0.40	-0.11
	Std. Dev.	1.30	0.43	0.59	(1.07)
Locations		354	31	93	124

TABLE IV

Distance to Nearest 502 Credit Union and Cash Management

This table shows how the probability of using cash management services changes with proximity to a 502 credit union. Observations are at the dispensary level. The sample comes from a combination of survey data and administrative data from Washington state (see Section III). The dependent variable, *Cash management*$_{i,t}$, is an indicator equal to one if in the survey the firm indicated that it uses cash management services and zero otherwise. *Distance to 502 credit union* is the distance measure, which we construct in two ways. First, we use a discrete measure of distance, where f(*Distance to 502 credit union*) is an indicator that equals one if a dispensary is within one mile (two miles, three miles) of a 502 credit union and zero otherwise. Second, we use a continuous measure, log(*Distance to nearest 502 credit union*). Standard errors are in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. Results of the following regression are reported:

$$\textit{Cash management}_{i,t} = \delta_0 + \delta_1 \text{f}(\textit{Distance to 502 credit union})_i + \varepsilon_{i,t}$$

	Discrete measures of distance			Continuous measure of distance
	(1)	(2)	(3)	(4)
Within 1 mile of a 502 credit union	0.275***			
	(0.051)			
Within 2 miles of a 502 credit union		0.222***		
		(0.059)		
Within 3 miles of a 502 credit union			0.202***	
			(0.069)	
Log Distance to nearest 502 credit union				-0.099***
				(0.019)
Constant	0.390***	0.368***	0.365***	0.540***
	(0.037)	(0.050)	(0.062)	(0.026)
F-statistic	28.962	14.272	8.639	28.210
Adj. R^2	0.073	0.036	0.021	0.072
Observations	354	354	354	354

TABLE V

How Does Access to Cash Management Affect Profitability

This table reports results on the effects of cash management on the profitability of marijuana dispensaries using an instrumental variable (IV) specification. In columns (1) to (7) an observation is a strain in a given dispensary-week. In column (8), an observation is a dispensary-week. The IV specification uses *Distance to 502 credit union* as an instrument for whether a dispensary has access to cash management through a financial institution. We report estimates using the continuous measure log(*Distance to 502 credit union*) as an instrument in column (7), and in all other columns, we use an indicator variable equal to one if a dispensary is within one mile of a 502 credit union and zero otherwise. We report estimates with strain fixed effects α_s in columns (1) to (8), week fixed effects α_t in columns (2) to (8), city fixed effects α_j in columns (3) to (8), *Distance to nearest bank* as a control for local economic opportunities in columns (4) to (8), and a control for the number of dispensaries (*Competitors*) within one mile in columns (5) to (8). In column (6), we report estimates for the subset of transactions from generic strains. The sample consists of observations from 2014 to 2017 within 10 miles of a 502 credit union. Dependent variables are aggregated to the dispensary-strain-week level from transaction-level data. Standard errors clustered at the dispensary level are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level. Results of the following IV regression are reported:

$$\textit{Cash management}_{i,t} = \delta_0 + \delta_1 \text{f}(\textit{Distance to 502 credit union})_i + \delta X_{i,t} + \alpha_s + \alpha_t + \alpha_j + \varepsilon_{i,t}$$
$$\log(\textit{Profitability})_{i,t} = \beta_0 + \beta_1 \textit{Cash management}_{i,t} + \beta X_{i,t} + \alpha_s + \alpha_t + \alpha_j + u_{i,t}.$$

	Profitability at Dispensary-Strain-Week Level							Dispensary Profits
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cash management	0.378*	0.395**	0.528*	0.440**	0.485*	0.517*	0.456**	0.238**
	(0.203)	(0.172)	(0.282)	(0.213)	(0.246)	(0.296)	(0.224)	(0.093)
Strain fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Week fixed effects		✓	✓	✓	✓	✓	✓	✓
City fixed effects			✓	✓	✓	✓	✓	✓
Distance to nearest bank				✓	✓	✓	✓	✓
Competitors					✓	✓	✓	✓
Generic strain subset						✓		
Instrument: indicator	✓	✓	✓	✓	✓	✓		✓
Instrument: continuous							✓	
F-statistic	34.670	52.967	35.031	21.662	23.375	20.563	34.642	19.417
Adj. R^2	0.035	0.047	0.070	0.044	0.053	0.061	0.047	0.024
Observations	1,539,983	1,539,983	1,539,983	1,539,983	1,539,983	730,522	1,539,983	7,804

TABLE VI
Mechanisms: Prices and Quantities

This table reports results on the effects of cash management on prices and quantities using an instrumental variable (IV) specification. The IV specification uses *Distance to 502 credit union* as an instrument for whether a dispensary has access to cash management through a financial institution. Even columns report estimates with strain fixed effects α_s. All columns include week fixed effects α_t, city fixed effects α_j, *Distance to nearest bank* as a control for local economic opportunities, and a control for the number of dispensaries (*Competitors*) within one mile. This table reports how access to cash management affects wholesale prices (columns (1) and (2)), retail prices (columns (3) and (4)), sales in grams (columns (5) and (6)), and number of strains (column (7)). The sample consists of observations from 2014 to 2017 within 10 miles of a 502 credit union. Dependent variables are aggregated to the dispensary-week level from transaction-level data. Standard errors clustered at the dispensary level are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level. Results of the following IV regression are reported:

$$\textit{Cash management}_{i,t} = \delta_0 + \delta_1 \text{f}(\textit{Distance to 502 credit union})_i + \delta X_{i,t} + \alpha_s + \alpha_t + \alpha_j + \varepsilon_{i,t}$$
$$\log(Y)_{i,t} = \beta_0 + \beta_1 \textit{Cash management}_{i,t} + \beta X_{i,t} + \alpha_s + \alpha_t + \alpha_j + u_{i,t}.$$

	Wholesale price		Retail price		Sales (weight)		# Strains
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cash management	-0.049**	-0.073***	0.107***	0.083***	0.217***	0.190***	0.090*
	(0.021)	(0.021)	(0.013)	(0.011)	(0.014)	(0.016)	(0.049)
Strain fixed effects		✓		✓		✓	
Week fixed effects	✓	✓	✓	✓	✓	✓	✓
City fixed effects	✓	✓	✓	✓	✓	✓	✓
Distance to nearest bank	✓	✓	✓	✓	✓	✓	✓
Competitors	✓	✓	✓	✓	✓	✓	✓
F-statistic	28.150	20.469	103.243	40.353	92.766	45.823	19.228
Adj. R^2	0.003	0.004	0.005	0.007	0.001	0.004	0.006
Observations	1,568,225	1,540,175	1,571,862	1,543,751	1,586,562	1,543,778	1,586,150

Figure 1: Value of cash management – wholesale market.

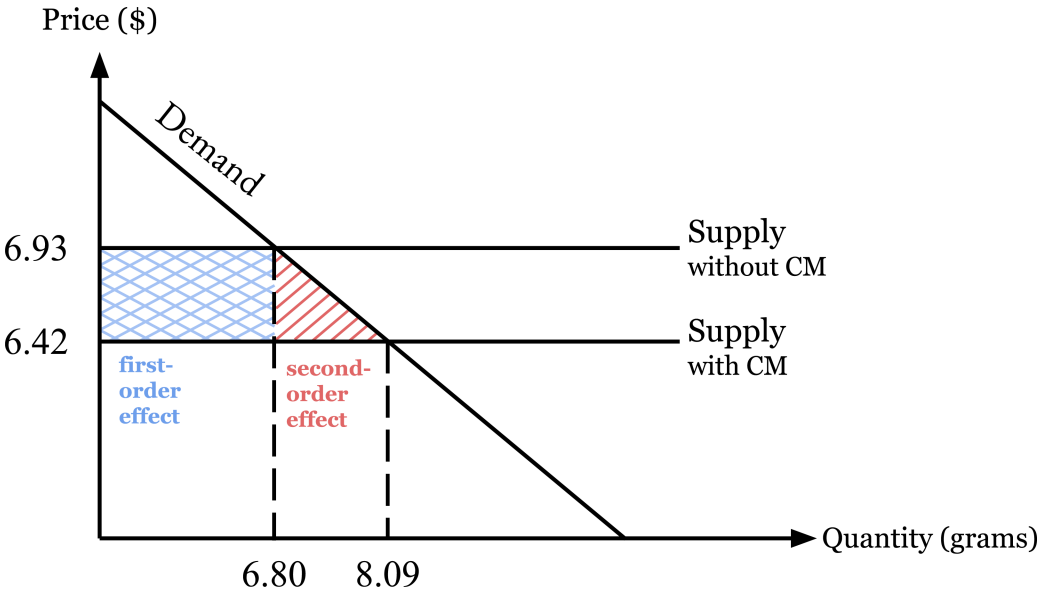


Figure 1 depicts the wholesale market, in which suppliers have perfectly elastic supply (horizontal lines) and dispensaries have imperfectly elastic demand (diagonal line). Quantity (in grams) is on the horizontal axis and price is on the vertical axis. Operating without cash management (CM) shifts the supply curve upward, from "Supply with CM" to "Supply without CM".

Figure 2: Value of cash management – retail market.

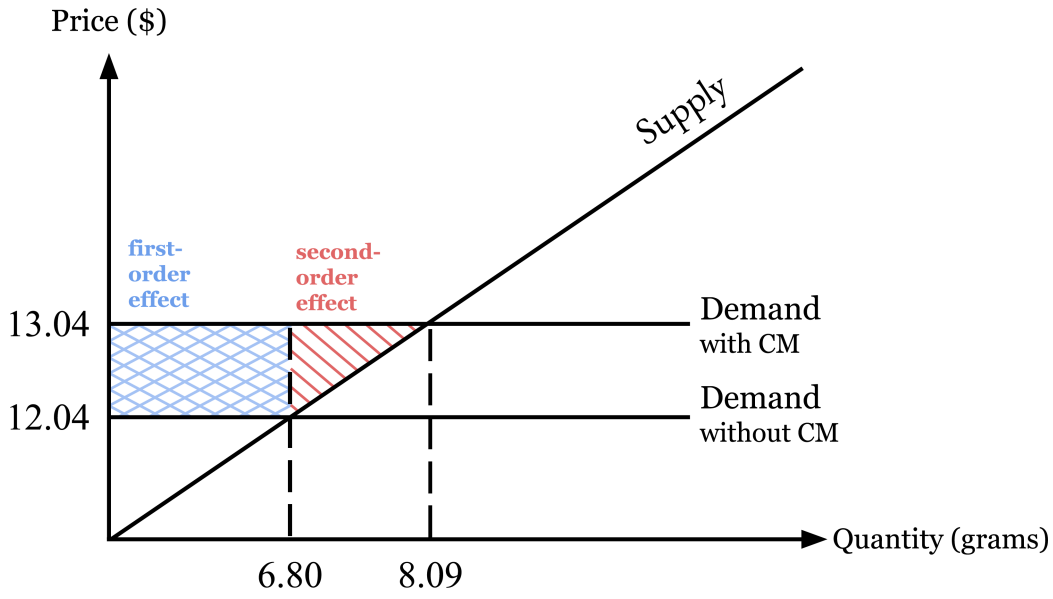


Figure 2 depicts the retail market, in which customers have perfectly elastic demand (horizontal lines) and dispensaries have imperfectly elastic supply (diagonal line). Quantity (in grams) is on the horizontal axis and price is on the vertical axis. Operating without cash management (CM) shifts the demand curve downward, from "Demand with CM" to "Demand without CM".

Figure 3: Marijuana dispensaries in Washington.

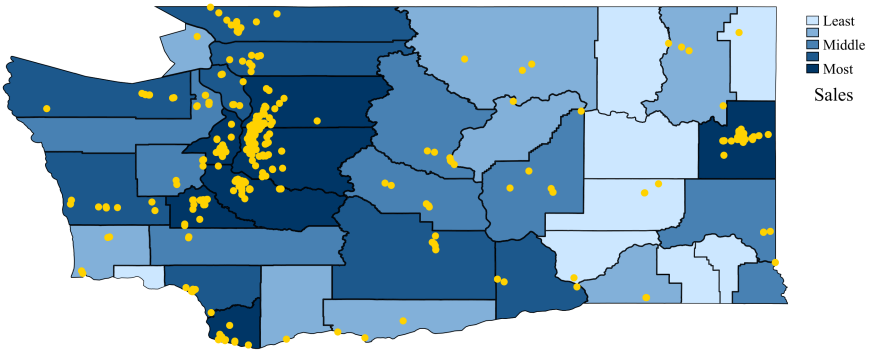


Figure 3 shows the locations of marijuana dispensaries across counties in Washington state. These retail establishments are located in 152 cities or towns within the state. Counties are shaded from light to dark based on county-level marijuana sales (in grams). The lightest shade represents counties with the least sales while the darkest shade represents counties with the most sales. Dots represent a marijuana dispensary. The data used to construct the map come from the Washington State Liquor and Cannabis Board.

Figure 4: Marijuana profit by county and location of credit unions.

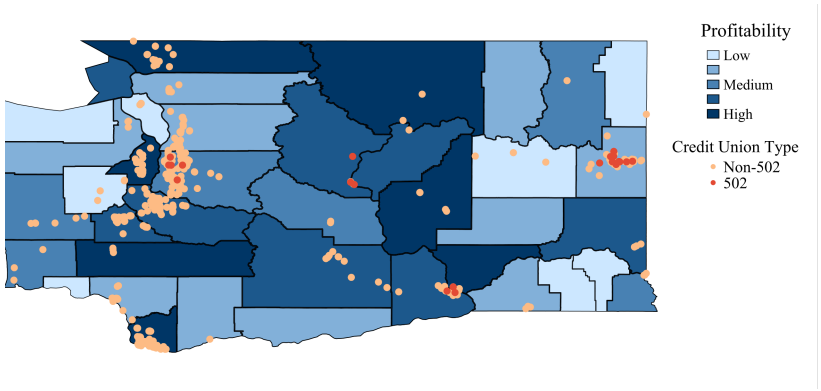


Figure 4 shows the locations of credit unions across counties in Washington state. Credit unions that work with marijuana dispensaries are denoted by dark dots, while lighter dots correspond to non-502 credit unions. Counties are shaded from light to dark based on county-level marijuana dispensary profitability. The lightest shade represents counties with the lowest profitability and the darkest represents counties with the highest profitability. The data used to construct this map come from the Washington State Liquor and Cannabis Board and the National Credit Union Administration.

Figure 5: Timeline of events.

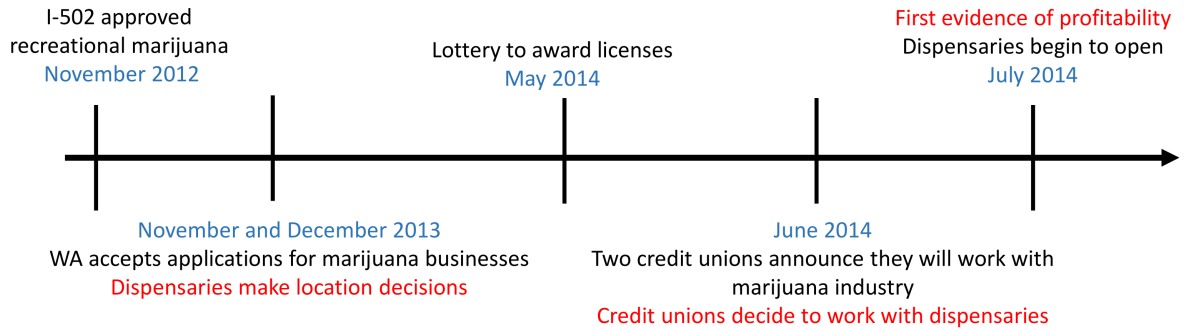


Figure 5 presents the time series of events related to the legalization of recreational marijuana in Washington state.

Figure 6: Log profitability and distance to financial institutions.

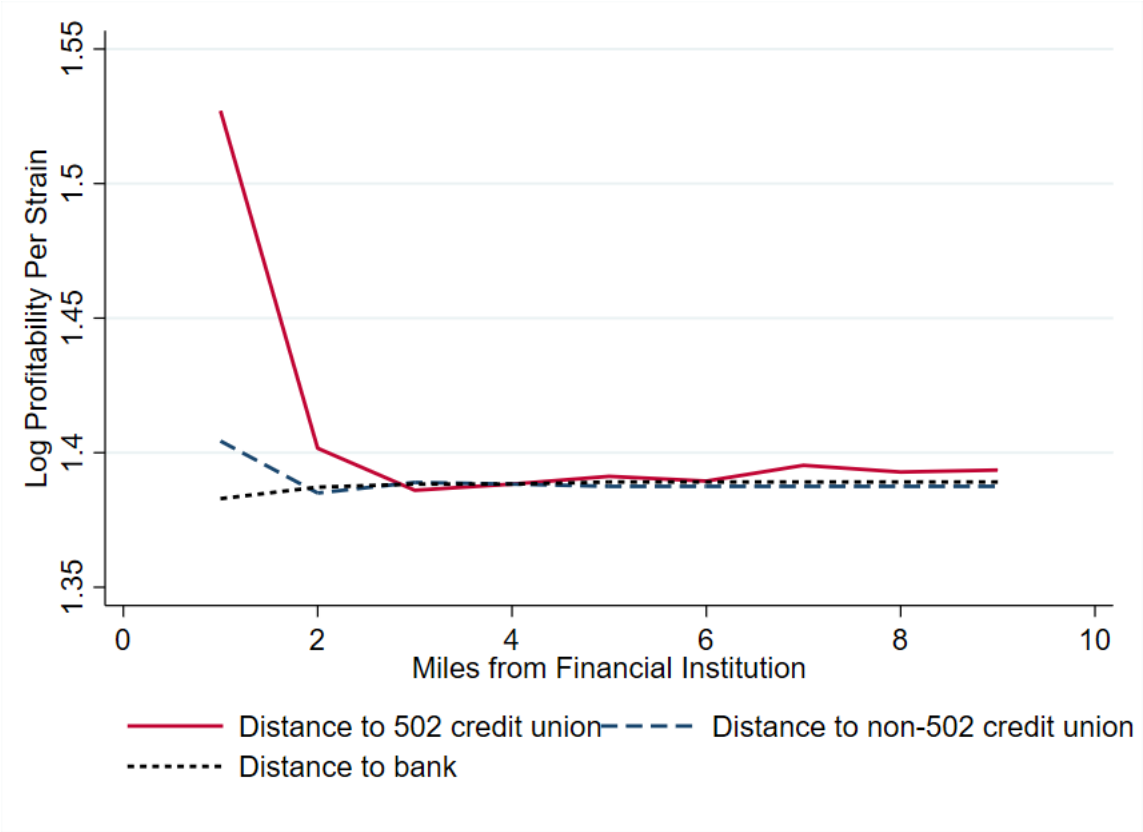


Figure 6 plots log(*Profitability*) at a dispensary by strain (vertical axis) by the dispensary's distance to a financial institution (horizontal axis). *Distance to 502 credit union* is depicted by a solid line, *Distance to non-502 credit union* by a dashed line, and *Distance to bank* by a dotted line. *Profitability* is measured at the transaction strain level as *Profitability* = (retail price - wholesale price) × quantity. Distance is calculated as straight-line distance. Credit unions that work with the marijuana industry are defined as 502 credit unions.

Figure 7: Placebo tests of profitability and banking services.

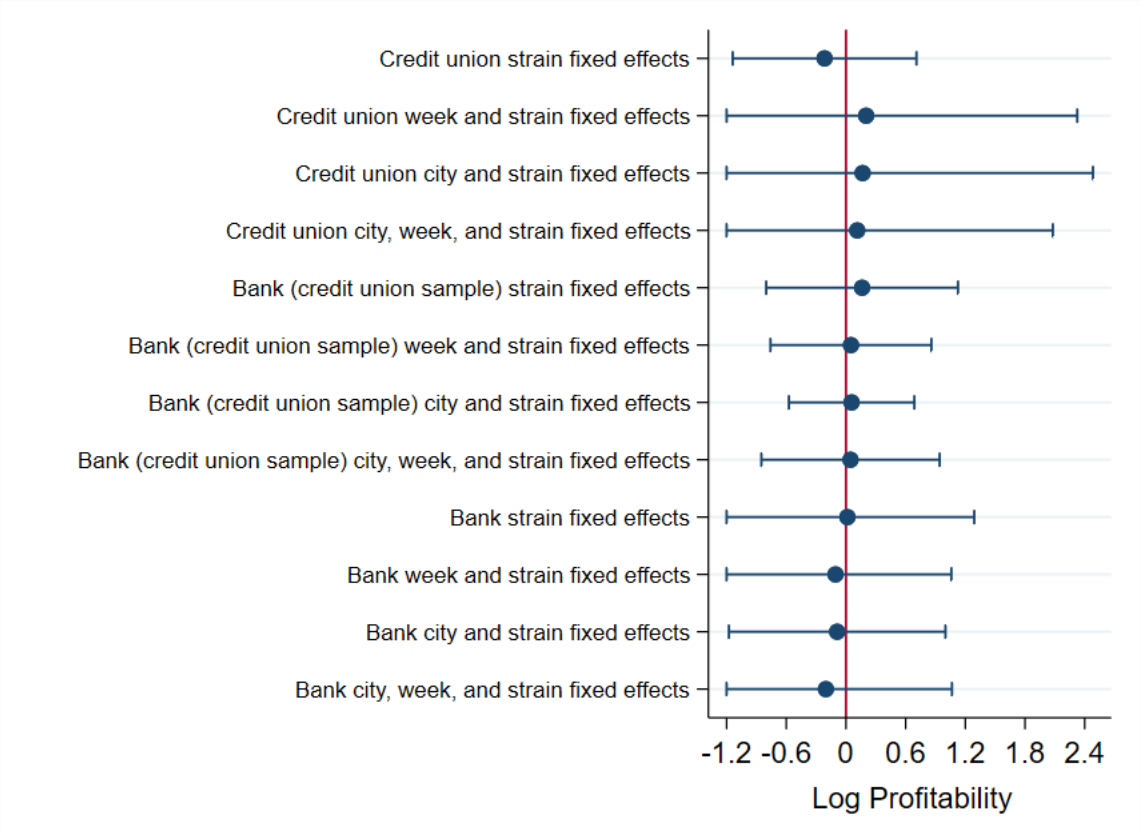


Figure 7 summarizes results of placebo tests of log(*Profitability*) using *Distance to non-502 credit union* or *Distance to nearest bank* as alternative instrumental variables. We provide three sets of estimates. The first uses *Distance to non-502 credit union* ("credit union"). The second and third sets of results use *Distance to nearest bank* in two different samples: the second set uses the same sample as our main results ("Bank (credit union sample)"), restricting attention to within 10 miles of a 502 credit union, while the third set uses a different restriction ("Bank"), that restricts attention to within 10 miles of a bank. For each set of tests, we report estimates with strain fixed effects, week and strain fixed effects, city and strain fixed effects, and city, week, and strain fixed effects. The bars represent 95% confidence intervals. Standard errors are clustered at the dispensary level.

Figure 8: Sensitivity tests of profitability and cash management.

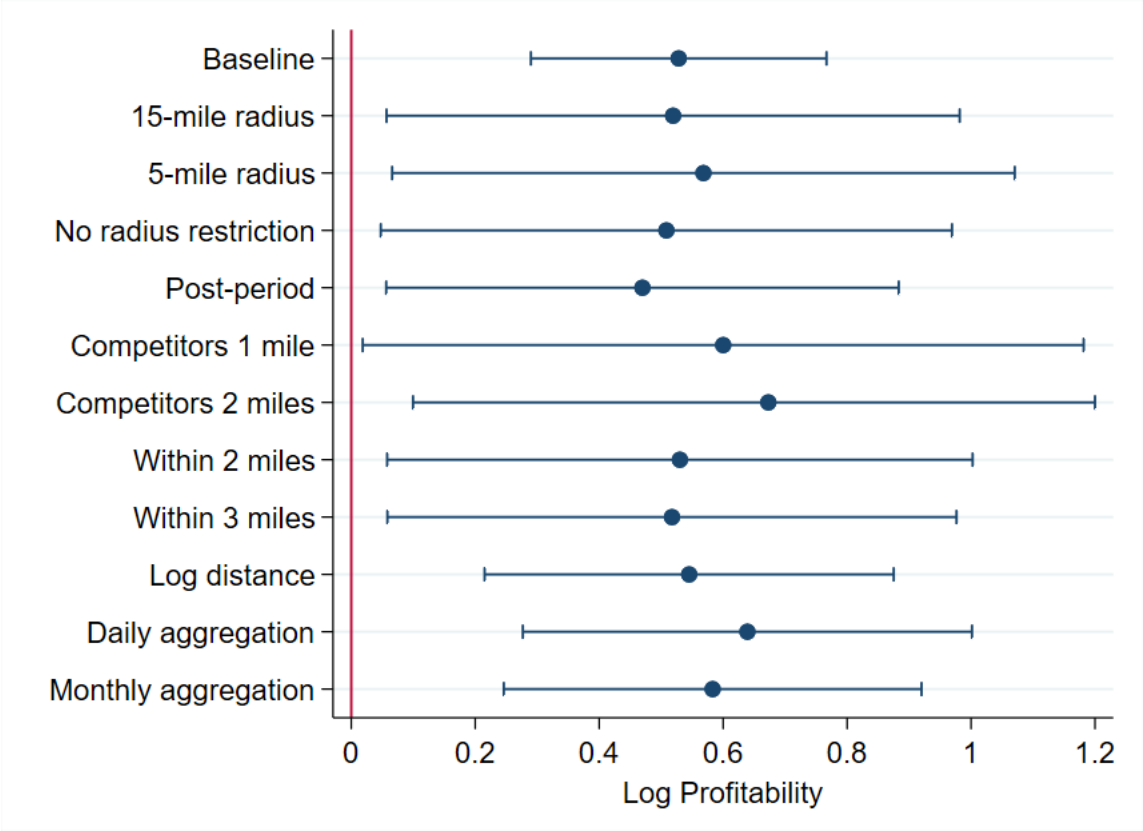


Figure 8 summarizes results of sensitivity tests of how *Profitability* changes with access to cash management along with 95% confidence intervals. Standard errors are clustered at the dispensary level.