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 the 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; Cortés and Strahan, 2017).[1] The lending function of banks evolved from their earlier cash management function — 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 primary economic service that greases the wheels of the economy. However, very little is known empirically about the economic value of the cash management function of financial intermediaries.[2] This paper seeks to quantify the economic value of cash management and, in doing so, to provide insights into this under-investigated topic.

In this paper, we measure how cash management affects firm profitability. We do not question whether cash management has a positive effect on firms, despite the lack of empirical evidence, its near-ubiquitous use suggests that it does. Instead, our goal is to quantify the magnitude of its economic benefits as a stand-alone banking function. There are two major empirical challenges to measuring how cash management influences 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 provide no valid treated or control firms.

[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; Coval and Thakor, 2005). Related results in the literature include Petersen and Rajan (1994), Petersen and Rajan (2002), Brickley, Linck and Smith Jr. (2003), Berger, Miller, Petersen, Rajan and Stein (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, Dai, Ongena and Smith, 2003; Gitau, Nyangweso, Mwencha and Onchangwa, 2014; Njeru Mugambi Duncan, Njeru, Member and Tirimba, 2015).

Second, if firms have banking access, they generally can access both the lending and cash management functions. The benefits of cash management, in other words, are inseparable from the benefits of lending. Our unique empirical setting allows us to isolate the economic benefits of cash management and provide evidence on this open question in the literature.

We tackle these challenges using the marijuana industry in the United States as an experimental setting. The marijuana industry is economically large and rapidly growing, and yet firms face regulatory hurdles in obtaining basic financial services (Mace, Patel and Seegert, 2020).[3] Marijuana is legal in some states but illegal according to federal law.[4] Federal regulations prevent marijuana dispensaries from accessing federal resources. Thus 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 which introduces both safety and regulatory issues.

These bank regulations limit cash management services and shift the supply and demand for marijuana products in wholesale and retail markets. In the wholesale market, operating without cash management increases counterparty risks 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. Cash management services generate a stream of quasi-rents that increases 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

[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.

quality guarantee to customers in the retail market (Klein and Leffler, 1981; Shapiro, 1983). This means that dispensaries create a "clientele effect" that allows them to sell at a price premium and, at the same time, retail customers assign a lower marginal value to the products sold at dispensaries without cash management (Buchak, Matvos, Piskorski and Seru, 2018).

We develop a model that links reputational capital, clientele effects, and administrative costs to supply and demand in the wholesale and retail markets. Consistent with predictions from our model, we find that dispensaries with cash management (1) charge higher retail prices, (2) pay lower wholesale prices, and (3) buy and sell higher quantities. As a result of these differences in prices and quantities, dispensaries with cash management have higher profitability. 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.

We combine three novel datasets to get a detailed view of the day-to-day operations of marijuana dispensaries and a big-picture perspective on how the industry generates profits. The first dataset contains administrative records from the *Washington State Liquor and Cannabis Board* (*WSLCB*), which includes the universe of 62 million transactions at marijuana dispensaries from 2014 to the beginning of 2017. We use the wholesale and retail prices at the product (strain) level to calculate product-level profitability as the difference between retail and wholesale prices multiplied by quantity. The second dataset comes from a comprehensive survey we conducted on marijuana business managers and includes data about a dispensary's finances, such as whether they have cash management services and about the individuals who run marijuana dispensaries. We gather bank and credit union branch locations from the *FDIC* and the *National Credit Union Administration* (*NCUA*) data.

We identify a quasi-experimental setting in which cash management services were randomly assigned to some marijuana dispensaries and not others. In the state of Washington,

two credit unions, with 21 branches spread across the state, decided to offer cash management services to a very limited number of marijuana dispensaries. The state used a lottery system to allocate licenses to sell recreational marijuana. At the time, these credit unions accepted deposits and provided cash management services to marijuana dispensaries but could not lend them money.[5] These features of banking in the marijuana industry allow us to separate the economic value of cash management from the value of lending.[6]

We use an instrumental variables (IV) strategy based on physical proximity to these credit unions to estimate the causal effects of cash management on dispensaries. Research shows that shorter distances between firms and financial institutions allow banks to gather soft information, which increases the likelihood of forming a banking relationship.[7] Distance should be particularly important in the marijuana industry, where regulatory hurdles require financial institutions to gather detailed information, perform on-site visits, and file thousands of Suspicious Activity Reports (SARs) merely to hold cash balances. 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 these credit unions have a 28 percentage point higher probability of having cash management services. In contrast, a placebo analysis shows that proximity to a bank or alternative credit union does not predict access to cash management. Evidence from our

[5]For more information about current developments in banking laws that govern marijuana-related businesses (MRBs) see: 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 want bank loans but are unable to get them.

[7]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), Gilje (2017), Nguyen (2019), and Berger (2021).

survey data shows that manager 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 profitability results.[8]

We find that dispensaries with cash management pay slightly lower wholesale prices, charge slightly higher retail prices, and sell slightly more quantity in a way that leads them to earn meaningfully more than dispensaries without cash management. Dispensaries with cash management receive a 7.3% discount on their wholesale price for the same product (strain), which amounts to a $0.51 discount (the average wholesale prices for dispensaries with and without cash management; $6.42 and $6.93). Dispensaries with cash management also charge $1.00 more for the same product (strain), an 8.3% price hike ($13.04 and $12.04). Finally, dispensaries with cash management sell 1.29 grams more per transaction than dispensaries without cash management (8.09 grams and 6.8 grams) and sell a higher quality product.[9] When combined, these effects suggest that dispensaries with cash management earn $21.06 more per transaction than dispensaries without cash management ($55.81 and $34.75).

We use placebo tests, sensitivity analyses, and alternative empirical methods to investigate alternative explanations. We bolster our results using OLS, a differences-in-differences design, and different instrumental variables. We find entry and exit decisions had a limited impact on our findings. Entry was gradual and strictly limited by the lottery and licensing process, and there were only two exits over our sample period.

We calculate that the economic value of cash management is roughly $17,700,000 in the

[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, in which 1,174 applicants were vying for 334 licenses. In addition, credit unions announced their decision to work with marijuana firms before any sales occurred, meaning that credit unions could not have selected dispensaries based on their profitability or to know where the final slate of dispensaries would locate.

[9]For context, when customers purchase pre-rolled marijuana cigarettes (called "joints"), they are typically sold in 1-gram increments such that customers buy about 8 joints rather than 7 joints.

marijuana industry in Washington state over 31 months spanning 2014 to 2017. This amounts to about 1.8% of total industry sales over our time period. We find that $5,973,076 of the economic value comes from the wholesale market, and the remaining $11,710,372 comes from the retail market. Hence, regulations that limit cash management services produce economic costs that lead to substantial loss of economic value.

A natural concern is that the banking needs of marijuana-related firms are vastly different from 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 unique 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 IT support), and currency issuance (providing legal currency to complete transactions). The benefits of the warehousing function for marijuana firms are quite similar for typical firms in most industries and our model shows that these benefits will exist regardless of whether national banks, credit unions, or fintech provide these functions.

The setting allows us to study 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 were not willing to risk working with marijuana businesses. Local credit unions invented customized, small-scale models for providing them with financial services, and fintech firms developed technology that allowed credit unions to scale up their 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, Piacentino and Thakor (2018) by demonstrating substantial economic value of cash management for marijuana dispensaries. Our results complement and extend current research

into 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 the payments, clearing, and settlement services and we complement these findings by calculating the value of warehousing and documenting recent fintech innovations for these services. We add to research on financial exclusion by showing that it negatively affects firms.[11] Finally, our results give a unique insight into the future of the banking industry. We find that local financial institutions and fintech played complementary roles and assumed 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 important institutional background about the marijuana industry. Section II introduces a graphical framework of the mechanisms through which cash management should affect marijuana dispensaries. Section III describes our data and Section IV presents our empirical method. Section V reports our empirical results and Section VI discusses their robustness. 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. Appendix D provides an in-depth review of the institutional details in the marijuana industry.

[10] See, for example, Baumol (1952); Miller and Orr (1966); Frost (1970); Daellenbach (1974); Gitman, Moses and White (1979); Vickson (1985); Berger, Dai, Ongena and Smith (2003); Gitau, Nyangweso, Mwencha and Onchangwa (2014)

[11] (See, for example, Karlan, Ratan and Zinman (2014); Agarwal, Alok, Ghosh, Ghosh, Piskorski and Seru (2017); Brown, Cookson and Heimer (2019); Stein and Yannelis (2019); Brune, Chyn and Kerwin (2021))

A. *Banking Institutions*

Distance and bank size and scope have traditionally played an important role in banking relationships by aiding in information gathering and decision-making.[12] Evidence shows that physical proximity has been an important determinant of lending relationships (Petersen and Rajan, 1994, 2002; Rajan, Seru and Vig, 2015; Nguyen, 2019; Berger, 2021). Proximity to borrowers gives banks a comparative advantage in gathering and using soft information.[13]

While this evidence pertains primarily to lending relationships, the insights from these studies are relevant to cash management relationships in general (Donaldson et al., 2018). Specifically, when banks accept deposits, banking regulations require them to verify the business/account holder, determine the source of funds, and file suspicious activity reports (SARs) for "abnormal" transactions. Hence, record-keeping and due diligence efforts are important components of a cash management relationship (Office of the Comptroller of the Currency, 2002).

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 medical 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 (US Drug Enforcement Administration, 2022). As a result, the US government prohibits marijuana production and consumption.

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

[13]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), Gilje (2017).

Individual states, however, have the right to set their laws regarding marijuana.[14] In 2012, individual states started legalizing recreational marijuana for adults 21 years of age and older. As of 2022, 19 states and Washington DC have legalized recreational marijuana.

Following state-level marijuana legalization, the rules about whether financial institutions could work with the marijuana industry were ambiguous. FDIC-insured financial institutions are subject to federal law, for example, FIN-2014-G001 (February 14, 2014), and require specific directions from federal regulators before interacting with marijuana firms.

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 (FIN-2014-G001, February 14, 2014). The guidelines suggest banks should "know their clients" to ensure they are not engaged in illegal activities 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 the Colorado Bankers Association urged its members officially to avoid serving marijuana businesses (Colorado Bankers Association, 2022). Even with this guidance the fact remains, accepting cash from marijuana firms is money laundering under federal law.

C. Banking in the Marijuana Industry: In Practice

As of May 2022, access to cash management is an ongoing, daily struggle for marijuana retailers. Due to the current legal status of marijuana in the US, less than 4% of all banks and credit unions are willing to provide banking services to marijuana firms (Gurien, 2021). Congress has failed to pass concrete laws to encourage banking and most financial institutions continue to wait on the sidelines. Appendix D provides a list of banking legislation related to marijuana.

[14] 10th Amendment of the Constitution.

Most dispensaries have struggled to obtain financial services due to these regulatory ambiguities. In Table I, we reveal that only 49% of dispensaries have access to a business bank account, 30% do not use any financial services, and 18% use personal accounts. This data comes from our survey, which we explain in full detail in Section C. Of dispensaries that use banks, only 12% have accounts with national banks. Survey participants responded that they use personal bank accounts but that banks frequently close these accounts when they discover that the account is related to a marijuana business. Numerous anecdotes, discussed in Appendix D, corroborate these responses.

[Insert Table I]

One effect of limited financial services is that financial transactions in the marijuana industry are mostly in cash. Table II shows that in our survey, 49% of dispensaries report that they only accept cash, 40% also accept checks, and only 3% accept credit cards. Even dispensaries with bank accounts have limited payment processing options due to banking regulations. As the size of the marijuana industry increases rapidly, cash management is becoming a greater concern (Weed, May 7, 2018b). 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 managers of marijuana dispensaries in our survey worry about the safety and efficiency of an all-cash business (Weed, May 7, 2018b). Table II reports that in our survey, 30% of dispensaries 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 and participants suspect an average loss from theft of $618 per month. Even normal business activities, such as payroll, are more costly when transacted in cash. For example, many dispensaries must pay employees in cash. Dispensaries bear the risk of holding payroll in cash and then, payday shifts the risk onto employees. In response to these costs, dispensaries are willing to pay large fees to financial institutions for their services. In 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 community have increased as a result (Espino and Mirnateghi, 2022). At the time, local financial institutions faced pressure to provide banking solutions. Table I reports that 69% of the dispensaries with cash management services obtained them through a community or regional credit union. In contrast, only 11% of dispensaries reported working with a national bank.

D. Banking Solutions: Salal and Numerica

By April of 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 features of cash management, which in practical terms meant that firms could use depository services. However, taking these deposits was technically money laundering and they needed to carefully develop processes for managing these accounts to ensure that they were compliant with federal guidance.

They used 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. They invented a customized, small-scale model for providing financial services to marijuana businesses. Their solutions evolved over time but were labor-intensive, hyper-localized, and emphasized due diligence, strict compliance, and constant contact with state regulators. For example, the account application process took between seven and ten days and required on-site visits. Account opening procedures included reviewing the applicant's business license documentation, criminal background checks, funding and financial scrutiny, and public records from the *Washington State Liquor and Cannabis Board* (*WSLCB*). These accounts required a daunting array of additional monitoring, reporting, and special services, which we describe in detail in Appendix D. By October of 2014, Salal had received 200 requests for accounts. Despite the intense demand, Salal and Numerica needed to limit the number of new accounts to keep up with reporting

requirements.

We use these characteristics of the banking sector to design our empirical tests that measure how cash management influences marijuana firms.

II. Conceptual Framework

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. The following discussion provides a graphical framework of the mechanisms through which cash management can create value by lowering friction in the market. This framework produces four key predictions (two for the wholesale market and two for the retail market). The second part of this section reports institutional details about this market that illustrate how frictions arise in the absence of cash management. We use this framework to estimate the economic value of cash management in Section C. We provide formal derivations of these markets in Appendix E and an in-depth discussion of institutional details in Appendix D.

A. Framework of cash management

We depict supply and demand in the wholesale market in Figure 1. 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).[15] Frictions in this market are due to regulations that limit access to cash management. We model these frictions as an increase in the marginal cost and,

[15]The assumption of perfectly elastic supply may be rationalized if suppliers can costlessly switch selling to dispensaries with and without cash management. In Appendix E, we provide an in-depth discussion of these assumptions, which are typical in the literature (Mace et al., 2020), including their implications and how to loosen them.

thus, an upward shift in the supply curve from "Supply with CM" to "Supply without CM." Section B, below, identifies potential sources of these frictions.

Several predictions about the wholesale market come from this framework. First, dispensaries with cash management pay lower wholesale prices than dispensaries without cash management. In Figure 1, the supply curve without frictions intersects with the demand curve at a lower price than the supply curve with frictions. Second, dispensaries with cash management buy more quantity than dispensaries without cash management. In Figure 1, the supply curve without frictions intersects with the demand curve at a higher quantity than the implied quantity with frictions.

[Insert Figure 1]

We depict the retail market in Figure 2. 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).[16] This market also has 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, 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]

Several predictions about the retail market come from this framework. First, 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

[16]The assumption of perfectly elastic demand may be rationalized if customers can costlessly reallocate buying from dispensaries with and without cash management. Appendix E describes the model without this assumption.

curve is higher than the demand for dispensaries without cash management. As seen in Figure 2, this higher demand leads to the intersection of their demand and supply curves to be at a higher retail price than the intersection of the demand and supply curves for dispensaries without cash management. Second, dispensaries with cash management sell more quantity than dispensaries without cash management. As seen in Figure 2, the higher demand for dispensaries with cash management leads to the intersection of their demand and supply curves being 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 the 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 the development of licensed transporters that charge 1% to 1.5% of the value of cash-in-transit to cover insurance. Moreover, suppliers must count the cash payment – often in small currency denominations – and safely store the cash.[17] 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 avoid the costs and risks of cash transactions. Dispensaries with cash management are able to develop a loyal customer base in the retail market through the clientele effect, which allows dispensaries to have stable demand and accurate estimates for wholesale purchases. These dispensaries build reputational capital in

[17]It takes 2 - 3 hours to count and verify $20,000 in $20 bills using a counting machine.

the wholesale market, and wholesalers provide discounts and high-quality products to these dispensaries.

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, there is uncertainty about product quality that cannot be resolved 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; Shapiro, 1983). Briefly, 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 in which firms with cash management invest even more in reputational capital. This reputational capital then leads to clientele effects.

In our setting, the clientele effect likely drives most of the higher retail prices for several reasons. Most directly, customers report that they are willing to pay higher prices for the clientele effect.[18] Customer reviews posted to "Yelp" reveal that customers expect consistency, quality, and safety in the dispensary's products and build close relationships with their budtenders.[19] Finally, because cash management creates an incentive to invest in reputational capital in the wholesale market, these dispensaries are able to buy consistently

[18]This clientele effect is consistent with a recent study of grocery stores, which found that the clientele effect 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 advice and selection of products (Brasler, 2014). Specifically, this 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.

[19]We constructed a dataset 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 our survey data.

high-quality products in the wholesale market. This has ripple effects on the retail side of the business. Dispensaries are able to provide predictable product quality and safety and improve a customer's experience by hiring good budtenders and offering a fully-stocked, wide range of products.

Although transaction processing and warehousing functions make business management more convenient and safe, dispensaries without cash management could design "in-house" models that mimic many functions of cash management in the retail market. Likewise, dispensaries without cash management could invest in a high-quality shopping experience. Hence, the clientele effect provides a quality guarantee in the retail market that increases the marginal value to customers and increases their demand relative to dispensaries without cash management.

III. Data

We combine three novel datasets 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 a dataset based on our hand-collected surveys of marijuana business owners. We provide descriptive statistics at the end of this section.

A. Washington State Liquor and Cannabis Board (WSLCB)

States that have legalized recreational marijuana for adult use legislate extensive data reporting requirements.[20] In Washington state, firms are required to report germination, harvest, production, and final retail sale data for each marijuana plant. Firms record the

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

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) and 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 with penalties and inventory destruction to ensure that marijuana dispensaries comply with the regulations and that they disclose this information accurately in the tracking system.

This dataset contains the universe of marijuana dispensaries and includes 62 million retail transactions from July 2014 to February 2017. Because data are tracked at the transaction level, they allow us to construct transaction-level variables. We define transaction-level profitability as: $\textit{Profitability} = (\text{retail price} - \text{wholesale price}) \times \text{quantity}$.

Profitability measures product-level profits rather than firm-level profits. It is a function of only the product that the firm sells less what it paid for the product and does not include labor costs, building costs, or other fixed costs. It does not account for the overall efficiency of the firm.[21]

In the administrative dataset, 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 dataset includes information about the *strains* of marijuana, which can be thought of like wine varietals, such as a cabernet sauvignon. *Strains* include Pineapple Kush, Super Lemon Haze, and Snoops Blue Dream and the average dispensary

[21]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, and 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 they are similar across all other aspects. They both charge a retail price of \$15 per gram, sell 10,000 grams, have overhead of \$100,000, and additional revenue of \$300,000 (from selling t-shirts and accessories). The profitability of these two firms is \$70,000 for Firm 1 and \$50,000 for Firm 2 (a 29% difference). In contrast, the profits of these two firms is given by (retail price–wholesale price) $\times$ quantity + other revenue − overhead = \$270,000 for Firm 1 and \$250,000 for Firm 2 (a 7% difference).

sold 262 different strains. 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, many dispensaries and *sales* are spread across the entire state.[22]

[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 report. 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 of 2014, two independent credit unions (Salal and Numerica) elected to work with marijuana dispensaries following the passage of initiative 502.[23] We refer to these credit unions as 502 credit unions and combined, they have 21 branches. Figure 4 maps all credit union locations and shows that 502 and non 502 credit unions are evenly spaced throughout 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. Table CI provides summary statistics of data from the *National Credit Union Call Reports*. In terms

[22]These retail establishments are located in 152 cities or towns within Washington. The percentage of dispensaries in these cities is roughly similar to their percentage of the population of Washington. For example, Seattle accounts for 9% of Washington's population and has 13% of the state's dispensaries.

[23]Initiative 502 legalized marijuana-related products for adults over 21 in small amounts, and retained that marijuana in large amounts, by persons under 21, or the growing of unlicensed marijuana was illegal under state law.

of assets, deposits, and net income, 502 and non 502 credit unions look similar. The 502 credit unions have higher total loans and leases, and liabilities. These financial strengths may make 502 credit unions more willing to risk working with marijuana dispensaries. Both 502 and non 502 credit unions have similar bank outreach in terms of number of members, number of branches, and plans to expand branching networks. Proprietary data show that they also have similar FICO scores, number of car loans and other lending measures.[24]

C. *Banking, Entrepreneurship, Regulation, and Taxes Study*

The third dataset comes from a survey we conducted as part of the *Banking, Entrepreneurship, Regulation, and Taxes* (*BERT*) Study. The survey covers the period from July 10, 2016, to October 31, 2016. We contacted all dispensaries in Colorado, Oregon, and Washington through 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 through several additional waves with a shorter targeted survey. All participants were compensated $50.

After all waves of the survey, the full survey response rate was 21%. This is similar to recent surveys of businesses, although we applied a more intensive recruitment strategy. For example, Graham and Harvey (2001) obtained 16% and Trahan and Gitman (1995) 12%; however, these surveys focused on the CFOs and business executives of large firms.

The administrative data include 314 organizations and 354 locations, after restricting the data to businesses that have sales (Mace et al., 2020). Most organizations have only one location and were restricted by law to having no more than three. We supplement the *BERT* study with additional waves of a shorter survey to capture some responses from all 314 organizations. Specifically, we have a response from all of the organizations on whether they have access to cash management. The *BERT* study has demographic information, including education level and whether their parents ran a business (*parent run company*),

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

for 238 of the organizations (76%) and 264 locations (75%). We assign manager/owner answers from the organization to all locations. We also assume that organizations that report having access to cash management continue to have access throughout the sample and those that report to not having access do not obtain access. This assumption is a limitation of a one time survey and likely adds measurement error. This measurement error likely biases the ordinary least squares estimates toward zero, which is why we focus on instrumental variable evidence (Hausman, Newey, Ichimura and Powell, 1991; Bound, Brown and Mathiowetz, 2001; Schennach, 2007). Appendix D provides a comparison between the instrumental variable and ordinary least squares estimates.

D. Descriptive Statistics

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

[Insert Table III]

The results in Panel A show that there are economically and statistically meaningful differences in operation-specific variables between dispensaries within 1 mile of a 502 credit union (column (2)) and dispensaries between 1 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 1 mile of a 502 credit union than those located 1 to 10 miles away.

Panel B reports owner/manager characteristics such as a manager's educational attainment and whether the owner had a parent who ran a company (*parent run company*), which likely predict a dispensary operator's business acumen. Our results show that these characteristics are economically similar and not statistically different for dispensaries in column

(2) compared to (3).[25] This evidence suggests a limited role for alternative explanations for our results based on the strategic choice of location.

In Panel C, we summarize the average distances between dispensaries, non 502 credit unions, banks, and other dispensaries. Dispensaries in columns (2) and (3) have similar distances to these establishments. Specifically, we find the average difference in 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 for the possibility that dispensaries, non 502 credit unions, 502 credit unions, and banks locate near economic opportunities by comparing *profitability* of dispensaries near economic opportunities with and without 502 credit unions. In addition, we include the distance to the nearest bank as an indirect control for local economic opportunities. We also conduct placebo tests using distance to a bank, rather than 502 credit union, as a placebo instrument (see Table CIX and Figure 7).

IV. Instrumental Variable Design

Our goal is to measure the causal effects of cash management on dispensary *profitability*. Ideally, we would have an experimental setting where cash management is assigned randomly to some dispensaries and not to others, thereby reducing concerns that dispensaries with cash management differ from dispensaries without cash management. In the absence of a truly random experiment, we use an instrumental variable (IV) approach to circumvent 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 in the causal identification literature (Card, 1995; Currie and Moretti, 2003;

[25] We find 55% of owners/managers had a parent 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).

Cameron and Taber, 2004). In the marijuana banking setting, distance is likely a particularly strong instrument due to the extra layers of monitoring, including quarterly site visits from bank personnel, which strengthen the relationship between distance, information asymmetry, and cash management (e.g., Berger et al. (2005)). Our statistical tests discussed below, corroborate these insights 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 variable that equals one for marijuana dispensaries that have access to cash management, based on our survey responses, and zero, otherwise. *Distance to 502 Credit Union* is the distance measure, measured in one of two ways. First, we use a discrete measure of distance, where f(*Distance to 502 Credit Union*) is an indicator function that equals one if a marijuana dispensary is within one mile of a 502 credit union and zero otherwise. Second, we use a continuous measure, the *log distance to the nearest 502 credit union*. The results are not sensitive to the definitions that we use to construct these measures or to using different mile thresholds for the discrete measure, which we discuss in Subsection B.

In the second stage equation, equation (2), *log(profitability)* is the dependent variable of interest. It is measured at the dispensary-strain level at the 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 a one-mile distance (*competitors*). The specification includes week (α_t) and city (α_j) fixed effects and standard errors clustered at the dispensary level. The focal point is the average of β_1 among 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:

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

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

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 reports 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 *cash management* decreases monotonically as the discrete measure increases from within 1 mile to within 3 miles (columns (1)–(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 the nearest 502 credit union*) decreases the probability of its access to *cash management* by one percentage point. The F-statistic for most of these specifications is above the cutoff for a strong instrumental variable (Bound, Jaeger and Baker, 1995; Stock, Wright and Yogo, 2002). As a precaution, we run several placebo tests using distance to *other* financial institutions, banks, and non 502 credit unions. We find no evidence that distance to these alternative financial institutions predicts access to *cash management* (see Table CIV and Appendix B 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; (1) monotonicity and (2) an exclusion restriction. We briefly discuss these in

turn leaving a larger discussion for Appendix B.

The monotonicity assumption in our setting requires that for all marijuana dispensaries, being closer to a 502 credit union does not decrease their probability of having access to cash management. This assumption appears particularly likely to hold in our setting, where only two credit unions work with dispensaries, and the relationship between dispensary and credit union entails physical costs. We also find 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 CII).

Our exclusion restriction is that distance affects marijuana dispensary profits only through its impact on access to cash management. The exclusion restriction appears especially 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 other. In particular, marijuana dispensaries made location decisions when they applied for a license (December 2013). This step occurred before any credit union had elected to offer banking services to the marijuana industry making it impossible for dispensaries to choose locations based on credit unions that would work with them. A random subset of these dispensaries would ultimately receive a license. In May 2014, lottery winners were announced but did not start business until July 2014. Two credit unions announced their intention to work with the marijuana industry by June 2014. This decision occurred well before any dispensary was open for business making it impossible for credit unions to make this decision based on a dispensary's *profitability*. Due to this timing, it is likely that credit unions did not know where the dispensaries would locate, but this knowledge would not be a violation of the exclusion restriction—only if they knew the *profitability*, 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. Said differently,

even if there was a profitable dispensary near one of their branches, there is no guarantee there would be profitable dispensaries around their other branches. Moreover, Figure 4 shows that 502 credit unions are spread throughout Washington state, further reducing the concern that these credit unions only locate in the most lucrative areas. These institutional details make it likely that distance between a marijuana dispensary and a 502 credit union is exogenous. In Appendix C we discuss a series of tests that check alternative mechanisms and other potential threats to validity.[26]

[Insert Figure 5]

V. Results

We report our estimates of the impact of cash management on profitability in Section A. We explore alternative explanations and sensitivity of our results in Section B and conclude with an investigation of the mechanisms driving the results in Section C. More tests are provided in Appendix C.

A. The Impact of Cash Management on Profitability

A.1. Graphical Evidence: Distance and Profitability

In Figure 6, we present reduced-form evidence of our IV strategy by mapping 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*

[26]In particular, we show that (1) 502 credit unions are not located in more prosperous counties than non 502 credit unions (see Table CIII) and (2) savvy business owners (as proxied by whether they had a parent run a company and educational attainment) are unable to strategically locate near 502 credit unions (see Panel B of Table III and Table CVI).

union (dashed line), and *distance to 502 credit union* (solid line)—where distance is predictive of access to *cash management* (see Subsection B). Working backward from a distance of ten miles, the figure shows that the lines are all parallel and flat in terms of *profitability*, meaning that *profitability* is similar across all financial institutions at these distances. Starting at three miles, log *profitability* increases as the *distance to a 502 credit union* declines. For dispensaries within one mile of a 502 credit union, *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 instrumental variable, no control variables, and only fixed effects 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) and drive the results. To control for this, we include city fixed effects in the model reported in column (3) and find a slightly higher effect of 52.8%.[27] 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,

[27]We also estimate the model excluding Seattle and Spokane and find similar results. See Appendix C.

we include a control for the *distance to the nearest bank* (columns 4-8) and for the number of other dispensaries (*competition*) to control for competition (columns 5-8).[28]

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) reports that estimates in this subset are very similar to the full sample, 51.7%.

[Insert Table V]

Our *profitability* measure does not include labor costs and other fixed costs such as rent and utilities; therefore, it should not be compared with profits. In addition, bank fees, cash storage, and secure cash transportation expenses do not affect our estimates. Hence, *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 and controls for local economic conditions (i.e., *distance to a bank*) and competition from other local dispensaries (*competition*). 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 a 502 credit union*).

Standard errors are clustered at the dispensary level. However, in this setting, there is not an ideal level of clustering, and there are good arguments for clustering at other levels, such as the week and city level. See Appendix C for a larger discussion. We address this ambiguity by estimating our main effects using standard errors clustered at alternative, and perhaps equally viable, 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, including two-way clustering at the week and dispensary level (see Figure C1) and different aggregation frequencies (see Figure 8).

[28]We explore further questions about economic activity in Appendix C, with, for example, a differences-in-differences model and other splits by geographies in Appendices A and B.

In column (8), we report the results of a dispensary-level analysis, rather than a strain-level analysis. We aggregate the data to the dispensary-week level and include city and week fixed effects and the distance to the nearest bank and competition controls. Dispensary *profitability* is 23.8% higher when a dispensary has *cash management*. Our results show that cash management has a large impact on dispensary *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 market and their 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 unions* and *distance to banks* 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. Appendix C reports estimates of placebo tests in which we find that the distance between a dispensary and non 502 credit unions or banks does not impact product *profitability*.

These estimates help to rule out alternative explanations in which the *distance to a 502 credit union* impacts product *profitability* due to 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 also report eleven additional specifications in Figure 8 to explore the sensitivity of our estimates to the myriad modeling alternatives in our main specification. Our baseline estimate excludes marijuana dispensaries that are farther than 10 miles from a 502 credit union. We expand that restriction to 15 miles, reduce the restriction to 5 miles, or have no restriction. We explore the effects of the sample period on the estimates by only including transactions during the period from 2015 to 2017. We use an alternative control variable for

competition. We replace the baseline instrumental variable (an indicator for being within 1 mile of a 502 credit union) with indicators for being within 2 or 3 miles of a 502 credit union or the continuous measure *log distance to a 502 credit union*. We assess the sensitivity of our results to the level of aggregation in our data, such as monthly or daily aggregation, rather than weekly. In all of these specifications, the estimates remain similar and statistically significant. As expected, confidence intervals change as models become more or less restrictive. We provide additional discussion and tests in Appendix C.

C. Mechanisms

In this analysis, we 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.[29]

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 more quantity (*sales*). In addition to these dependent variables, we also 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, this reflects the prices required to create reputational capital in the wholesale market and the clientele effect 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* fixed effects reveals how differences in a dispensary's product offerings (e.g. variety, quality, uniqueness) drive prices and sales for dispensaries with and without cash management. We may expect differences in product bundles if part of the effect of cash man-

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

agement is that it allows dispensaries to build reputational capital with suppliers (wholesale market) and cater to customers with different demands for quality assurance (retail market).

First, consider the difference in *wholesale prices* with *strain* fixed effects, reported 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). Using 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 such that suppliers sell at a discounted price to high-quality dispensaries (i.e., dispensaries with cash management) (see Figure 1).

[Insert Table VI]

Second, consider the difference in *retail prices* with *strain* fixed effects, reported 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. Customers pay an average retail price of $13.04 at these dispensaries and $12.04 in a dispensary 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 the clientele effect, which that has been shown to be valuable in other markets (Buchak et al., 2018). For example, hiring better budtenders who have more time to spend with customers explaining the product—a main comment in Yelp reviews. See Section II for a detailed discussion of these costs and benefits.

Third, consider the difference in quantities sold (*sales*) with *strain* fixed effects, reported in column (6) of Table VI. Dispensaries with *cash management* sell 19.0% more for the same product (*strain*) as dispensaries without cash management. This difference suggests

that dispensaries with *cash management* sell 1.29 more grams per transaction; the difference between 8.09 grams and 6.8 grams.

We use the estimates in Table VI to quantify the contribution of each factor to the total increase in *profitability* through a series of back-of-the-envelope calculations. Specifically, we find dispensaries with *cash management* earn \$8.09 more per transaction because they are able to charge higher retail prices; \$8.09 = (\$13.04 - \$12.04)×8.09. Lower *wholesale prices* lead to an additional \$4.13 for dispensaries with *cash management*; \$4.13 = (\$6.93 - \$6.42)×8.09. Selling more quantity leads dispensaries with *cash management* to earn \$6.59 more per transaction; \$6.59 = (\$12.04 - \$6.93)×(8.09 - 6.8). Finally, we find selling a higher quality bundle of goods leads to \$2.25 greater earnings.[30] We find that dispensaries with *cash management* sell 9% more *strains* (column (7) of Table VI) and sell higher quality product as noted by higher *wholesale prices* and *retail prices* (columns (1)–(4) of Table VI). Together, we find that dispensaries with cash management earn \$21.06 more per transaction than dispensaries without cash management. Appendix E combines the framework from Section II and our estimates of the differences in prices and quantities to calculate the economic value of cash management.

We find the total economic value of cash management is \$17,683,448 in the marijuana industry from 2014 to 2017 by scaling the transaction values by the total number of observations. The total value consists of \$5,973,076 from the wholesale market and \$11,710,372 from the retail market. This amounts to about 1.8% of total industry sales during our sample period across our whole sample if all dispensaries had cash management.[31] These estimates

[30]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 the profitability at dispensaries without cash management is \$34.75. The difference between dispensaries with and without cash management is \$21.06. We also find the profitability of the undiversified bundle of products at dispensaries with cash management is \$53.56.

[31]The marijuana industry in Washington state generated close to \$1 billion in sales from June 2014 to January 2017 (Pellicciotti, 2022).

come from combining the framework from Section II and our estimates of the differences in prices and quantities. The derivation of this is in Appendix E.

VI. Discussion

In this section, we discuss the alternative empirical approaches that we have used to explore 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 Appendices B and C, 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 a manager's business acumen, that affect both access to cash management and business success, bias a simple OLS analysis. A detailed discussion in Appendix Section D reports that the OLS estimates are consistent with our IV results but the difference between these estimates suggests that confounding factors bias the OLS results.

In addition, we use a differences-in-differences analysis to document whether unobserved differences in neighborhoods explain our results. In this analysis, reported in Appendix A, we use discrete measures of distance to proxy for access to cash management in an OLS setting. We explore how factors such as urban and rural geographies and "main street" agglomeration affect our IV results. The estimates bolster our instrumental variable findings suggesting that *profitability* is greater only for those dispensaries close to a 502 credit union and highlight the strength of using distance as an exogenous variable.

Finally, Appendix B reports regression estimates based on a county-level instrumental variable that uses a credit union's banking market to define access to cash management. The instrumental variable measures whether a dispensary is located in a county with a 502

credit union. 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 document 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.

These findings allow us, through our rich data, to rule out many alternative explanations for our results. In addition, the similarity in results across methods and instrumental variables 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 diminish the effects that action on the extensive margin would have on marginal *profitability*.[32]

We examine the entry and exit decisions throughout our sample and find that entry was gradual from 2014 to 2017 and there were only 2 exits over that period. Specifically, 321 of the licenses were granted and retail dispensary storefronts were opened. The number of new entries was spread evenly throughout the full time-series, which suggests that compliance with the time-consuming and onerous licensing process determined entry, rather than changes in product market competition. We also report in Appendix D that new entry is not correlated with proximity to a credit union or *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 market.

[32]See Appendix D for more information.

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. Cash management services help dispensaries build reputational capital and allow dispensaries to cater to different clientele. We show these costs shift supply and demand in the wholesale and retail markets. The value of having cash management services comes from receiving lower wholesale prices, charging higher retail prices, and selling more quantity than firms without these services.

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

We find that dispensaries with cash management (1) charge higher retail prices ($1 more per gram), (2) pay lower wholesale prices ($0.51 per gram), and (3) buy and sell higher quantities (19%), consistent with predictions from our model. Combined effects suggest that dispensaries with cash management earn $21.06 more per transaction than dispensaries without cash management ($55.81 and $34.75), a 40% increase in profitability.

Although our results are rooted in the heavily-regulated, cash-intensive marijuana industry, the fundamental benefits (storage, security, verification, and issuance of currency) of warehousing extend beyond our unique 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 shows that the benefits from warehousing will exist regardless of whether national banks, credit unions, or fintech provide these warehouse functions.

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Table I: **Cash Management in the Marijuana Industry**

This table shows survey responses from the *BERT* survey for firms in Washington state. The survey includes some answers from all 314 organizations that encompass all 354 locations. Note during our 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 shown in column (1), we have 314 answers to the question about bank type. For the second question that provided information on disaggregated bank account shown in columns (2)–(7), we have 203 organizations. The survey questions are in Appendix C.

		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: **Transactions and Cash Management in the Marijuana Industry**

The survey includes some answers from all 314 organizations that encompass all 354 locations. Note during our period, owners were restricted to the number of dispensaries they could own (typically three). For any given question, however, we have fewer observations. We denote the number of owner/manager observations after the question below. Survey questions are in Appendix C.

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
Non-bank financial institution	$1,059
Other	$437

Table III: **Descriptive Statistics**

We summarize our combined datasets in this table. In Panel A, we report operation specific variables from the administrative Washington data and location data from the *NCUA*. In Panel B, we report owner/manager variables from the *BERT* survey for firms in Washington state only. From this survey, we have data on 314 owner/managers in Washington that own a total of 354 dispensaries. During our period, owners were restricted to the number of dispensaries they could own (typically three). For demographic information, we have answers from 238 organizations with 264 locations. Finally, we report in Panel C location specific variables combining data from the state of Washington, the *NCUA*, and the *FDIC*. In column (4) we report differences between columns (2) and (3) and *, **, and *** indicate significance at the 10%, 5%, and 1% levels, 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/manager 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	Mean	32.65	0.59	4.00	-3.42
credit union	Std. Dev.	33.73	0.27	2.40	(13.48)
Miles to non502	Mean	3.25	1.05	1.12	-0.06
credit union	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 marijuana dispensary level. The sample is a combination of survey data and administrative data from Washington state (see Section III). The dependent variable, Cash management$_{i,t}$, is an indicator variable 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, measured in one of two ways. First, we use a discrete measure of distance, where f(Distance to 502 Credit Union) is an indicator function that equals one if a dispensary is within one mile of a 502 credit union and zero otherwise. Second, we use a continuous measure, the log distance to a 502 credit union. Standard errors are in parentheses and *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

$$\text{Cash management}_{i,t} = \delta_0 + \delta_1 \text{f(Distance to 502 Credit Union)}_i + \delta X_{i,t} + \alpha_t + \alpha_j + \varepsilon_{i,t}$$

	Discrete measures			Continuous Measure
	(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 the 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-Square	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 the effects of cash management on the profitability of marijuana dispensaries using an instrumental variable (IV) specification. An observation is a *strain* in a dispensary in a given week for columns (1)–(7). An observation in column (8) is a dispensary week. The IV specification uses *distance to a 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 a 502 credit union* as an instrument in column (7) and in all other columns 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 (columns 1–8), week fixed effects α_t (columns 2–8), city fixed effects α_j (columns 3–8), a control for *distance to the nearest bank* as a proxy for local economic opportunities (columns 4–8), and a control for the number of dispensaries (*competitors*) within one mile (columns 5–8). In column (6), we report an estimate in the subset of transactions from generic *strains*. The sample consists of observations from 2014–2017 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% levels. The results of the following IV regression are in the table:

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

	Profitability by Dispensary and Strain and Week							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)
Week fixed effects		✓	✓	✓	✓	✓	✓	✓
City fixed effects			✓	✓	✓	✓	✓	✓
Distance to bank controls				✓	✓	✓	✓	✓
Competition controls					✓	✓	✓	✓
Generic strain subset						✓		
Instrument: indicator	✓	✓	✓	✓	✓	✓		✓
Instrument: continuous							✓	
Strain fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
F-statistic	34.670	52.967	35.031	21.662	23.375	20.563	34.642	19.417
Adj. R-Square	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 the effects of *cash management* on prices and quantities using an instrumental variable (IV) specification. The IV specification uses *distance to a 502 credit union* as an instrument for whether a dispensary has access to cash management through a financial institution. We report estimates with week fixed effects α_t, city fixed effects α_j, a control for *distance to the nearest bank* as a proxy for local economic opportunities, and a control for the number of dispensaries (*competitors*) within one mile in all columns. In even columns, we include strain fixed effects α_s. This table reports how access to cash management changes *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 2014–2017 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% levels.
The results of the following IV regression are in the table:

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

	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 bank controls	✓	✓	✓	✓	✓	✓	✓
Competition controls	✓	✓	✓	✓	✓	✓	✓
F-statistic	28.150	20.469	103.243	40.353	92.766	45.823	19.228
Adj. R-Square	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**

This figure 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 shifts the supply curve upward (Supply without CM).

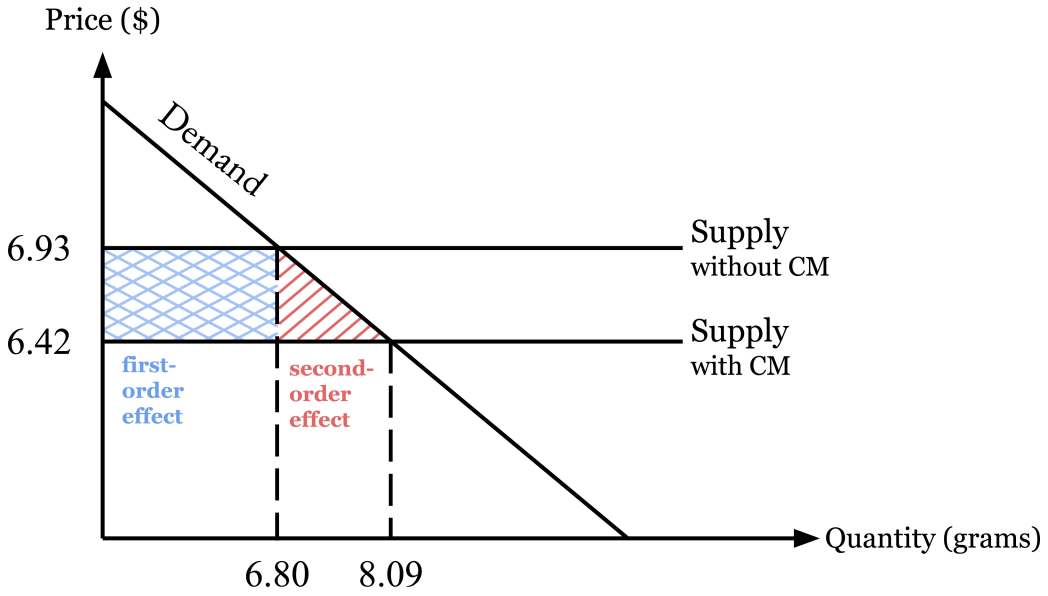


Figure 2: **Value of Cash Management – Retail Market**

This figure 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 shifts the demand curve downward (Demand without CM).

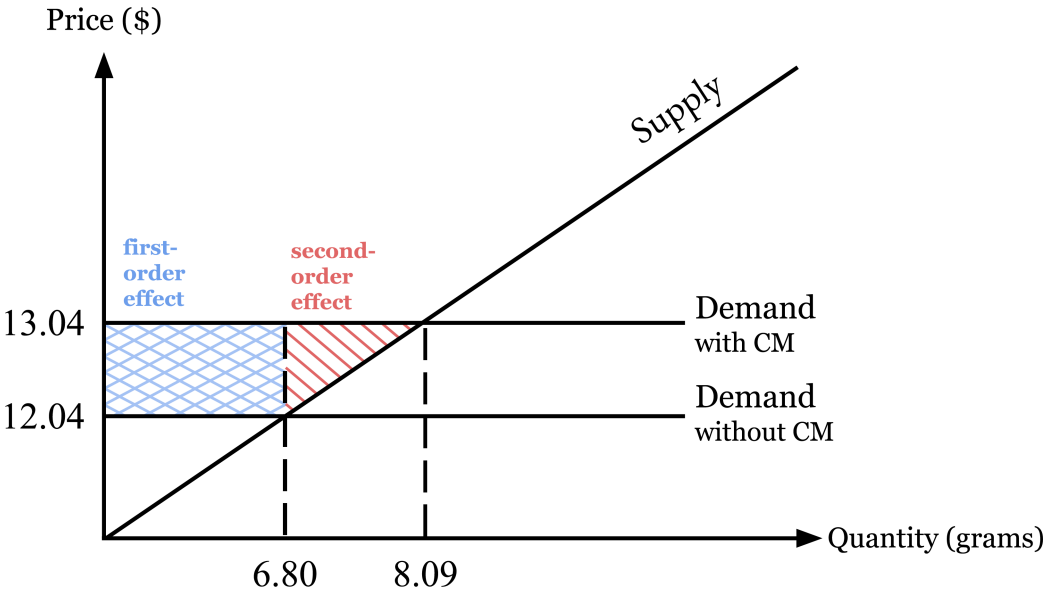


Figure 3: **Marijuana Dispensaries in Washington**

This figure shows the location of marijuana dispensaries across counties in Washington state. These retail establishments are located in 152 cities or towns within Washington 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* and the darkest represents counties with the most *sales*. Dots represent a marijuana dispensary. The data to construct the map are from the *Washington State Liquor and Cannabis Board*.

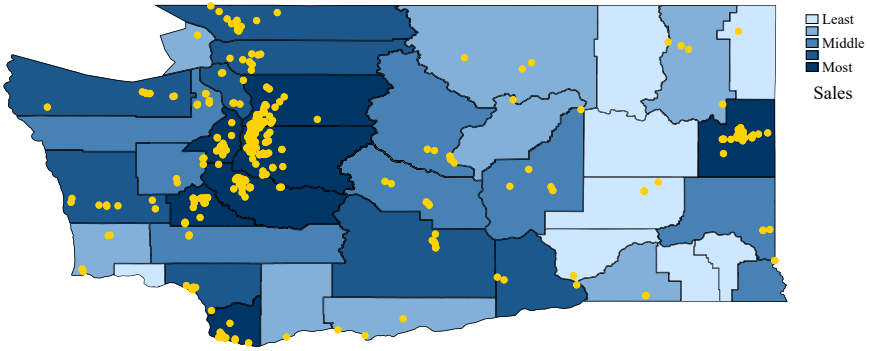


Figure 4: **Marijuana Profit by County and Location of Credit Unions**

This figure shows the location of credit unions across counties in Washington state. Credit unions that work with marijuana dispensaries are denoted by dark dots and lighter dots denote 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*. We use data from the *Washington State Liquor and Cannabis Board* and the *National Credit Union Administration* to create this map.

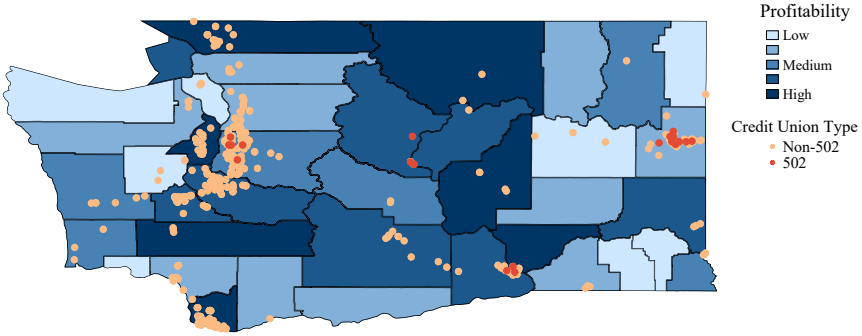


Figure 5: **Timeline of Events**

This figure presents the time series of events that are related to the legalization of recreational marijuana in Washington state.

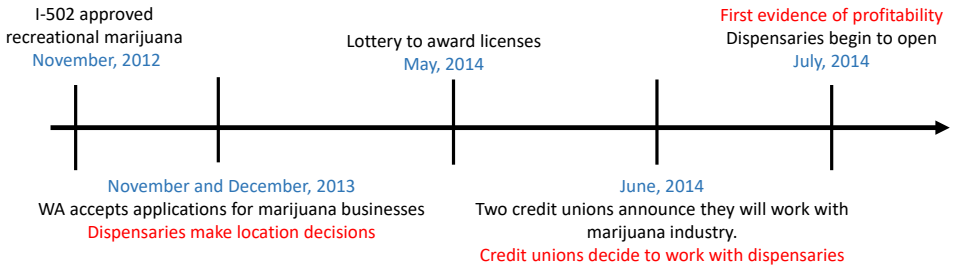


Figure 6: **Log Profitability and Distance to Financial Institutions**

This figure is a graph of the log of *profitability* at a dispensary by *strain* (on the vertical axis) by the dispensary's distance to a financial institution (on the horizontal axis). We depict *distance to a 502 credit union* as a solid line, *distance to a non 502 credit union* as a dashed line, and *distance to a bank* as 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.

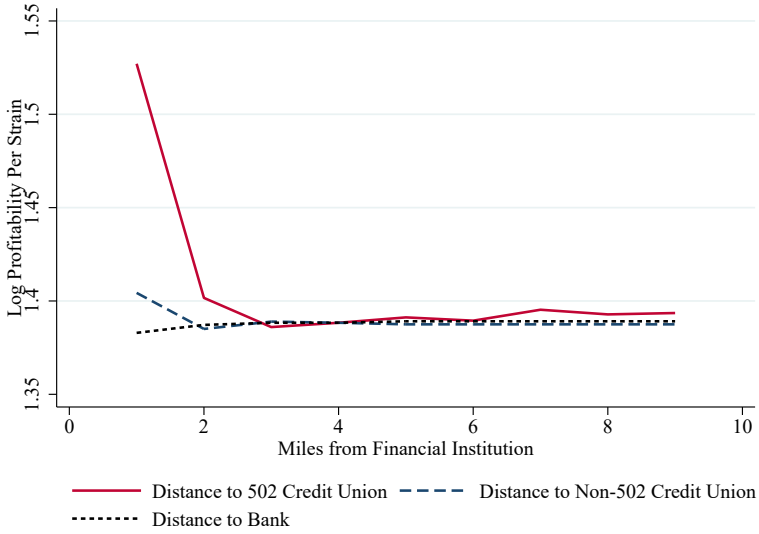


Figure 7: **Placebo Tests of Profitability and Banking Services**

This figure reports the coefficients from our placebo test of log *profitability* using *distance to non 502 credit unions* or *distance to banks* as alternative instrumental variables. We provide three sets of estimates. The first set uses *distance to non 502 credit unions* ("credit union"). The second and third sets use *distance to banks* in two different samples. The second set uses the same sample as our main results ("Bank (credit union sample)"), restricting to within 10 miles of a 502 credit union. The third set uses a different restriction ("Bank"); within 10 miles of a bank. Within each set, 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.

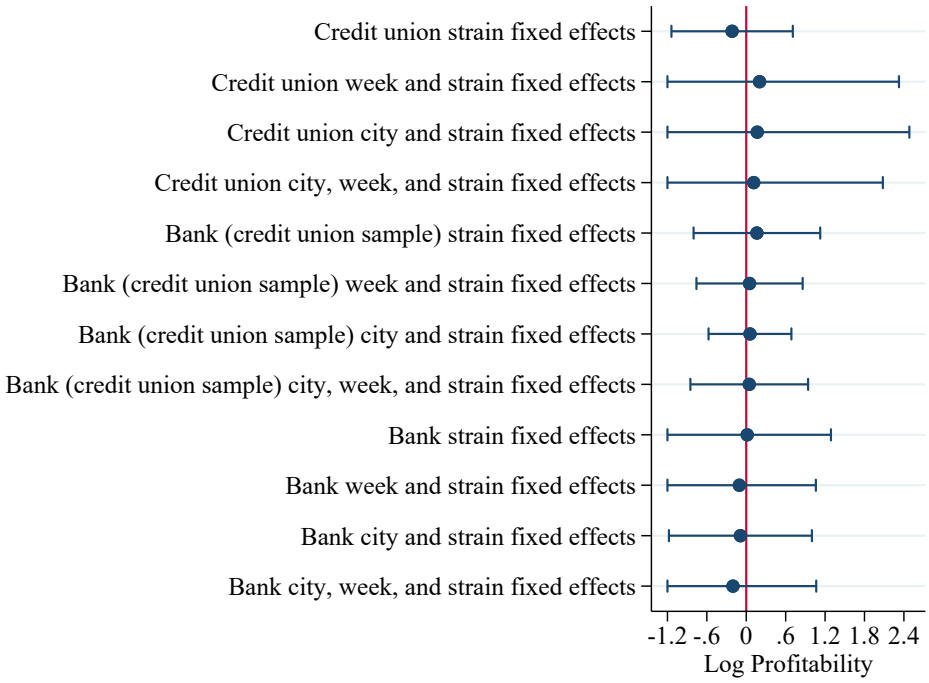
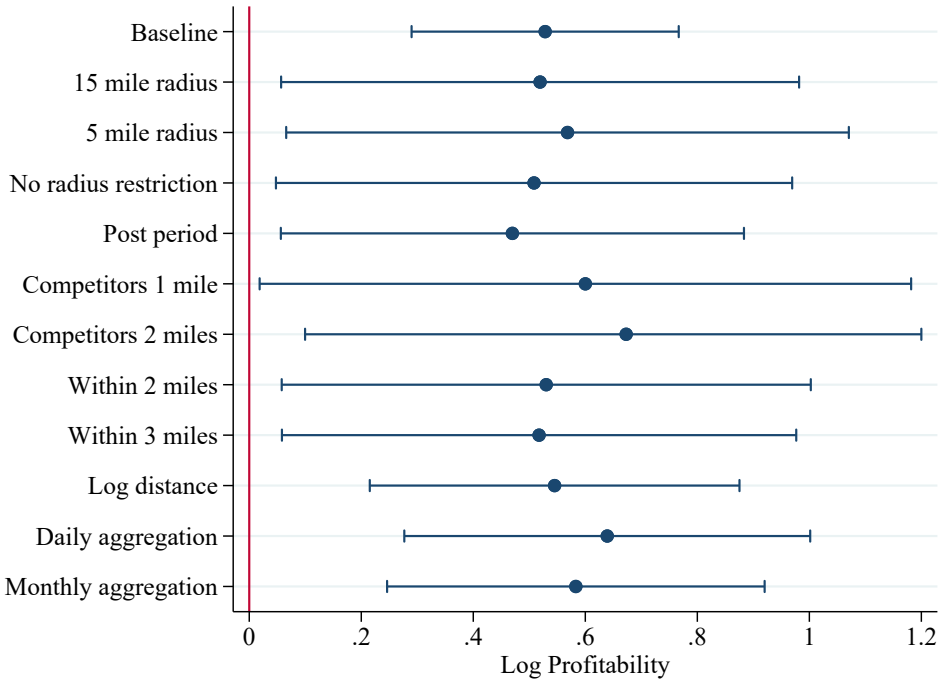


Figure 8: **Sensitivity Tests of Profitability and Cash Management**

This figure reports the coefficients for a series of sensitivity tests of how *profitability* changes with access to *cash management* with 95% confidence intervals. Standard errors are clustered at the dispensary level.



INTERNET APPENDIX for "Half Banked: The Economic Impact of Cash Management in the Marijuana Industry"

A. Data Appendix

A. *Washington State Liquor and Cannabis Board (WSLCB)*

The State of Washington has extensive data requirements and these requirements generate the administrative data that we use in this study. The data is collected through a system created by BioTrackTHC. This company provides technology that tracks cannabis from "Seed-to-Sale," with contracts in Delaware, New Mexico, Illinois, New York, Hawaii, and for our purposes notably Washington.

The administrative data provide a unique look at business operations. At the wholesale level, suppliers record characteristics of each plant, including weight, and test results for the primary psychoactive ingredients tetrahydrocannabinol (THC), tetrahydrocannabinolic acid (THC-A), and cannabidiol (CBD). They then seal the product into packages of specific weights (e.g., 1 gram) and sell a retail lot to dispensaries, where each lot is considered identical and given its own retail lot identification number.

At a retail level, each transaction is recorded, including data on price, wholesale price, volume (weight), and strain (product type). Because most firms operate in cash due to a lack of financial services, most retail firms choose prices such that the tax-inclusive price is a round number, for example, $15.00 per gram (Hansen et al., 2017). These pricing decisions lower the transaction costs of using cash.

Average prices dropped substantially after retail marijuana was first legalized and cross-sectional price dispersion decreased as well. Prices tend to be about 5% lower when dispensaries have competition within one mile of store location. As competition falls, prices increase (Mace et al., 2020).

B. *Banking, Entrepreneurship, Regulation, and Taxes (BERT) Study*

As part of the *BERT* study, we included a survey module specifically about access to financial services. Building on existing surveys of individuals and small businesses, we developed an initial set of questions to include in the survey (Fairlie (2013); US Bureau of Labor Statistics (December 5, 2018); Ballou and DesRoches (2009)). The questions cover a range of topics from personal details about the business owner, such as education and occupation of parents, and technical details of the business, such as whether the business uses banking services and what type of banking institution it works with. We incorporated feedback from experienced academics and marketing experts into the survey over several iterations.

We then piloted the survey through in-person interviews with small businesses in different industries to ensure participants and researchers had similar interpretations of the questions and to minimize biases induced by the survey. Participants took an average of 40 minutes to complete the survey. Participation entailed visiting a website and answering survey questions. Participants were compensated $50 and entered to win a $500 reward, which was given away randomly to two participants. To determine if participant fatigue

affected the quality of answers, we implemented two versions of the survey with different ordering of the nondemographic sections. We find no evidence that the quality of response rate differs depending on the ordering of the questions.

We contacted all retail cannabis dispensaries, medical and recreational, in Colorado, Washington, and Oregon through several waves of contact.[33] First, we mailed letters that contained information and instructions on how to take the survey with an enclosed $2 bill as a free gift to increase participation. Second, we called all businesses. If their given phone number did not work we used internet searches to find updated numbers. Third, we partnered with several industry groups that emailed their members information about the survey. Fourth, we sent another wave of letters. Fifth, we had a research assistant physically visit businesses for two months. Finally, we did an additional round of phone calls.

After all waves of the survey, the full survey response rate was 21% and our sample contains 325 firms of 1,548 firms across Colorado, Oregon, and Washington. This response rate is similar to recent surveys of businesses. For example, Graham and Harvey (2001) obtained 16% and Trahan and Gitman (1995) 12%—though these surveys focused on CFOs and business executives of large firms.

Our goal was to have owners or managers fill out the survey. One of the first questions asks the participant whether they are an owner, manager, both, or neither. In our sample we have 65% of respondents were either an owner or owner and manager and 31% of respondents were managers and the remaining responses were filled out by someone else such as an accountant or office manager.

To supplement the survey evidence, we followed up with businesses in Washington that had not replied to answer a short survey about their access to banking services. We started with whether or not the firm had access to a bank account and through several waves were able to get an answer from 354 firm locations. We have responses from 264 firm locations on whether the owner/manager had a parent run a firm and their educational attainment, a 75% response rate.

C. Survey Questions

Survey Questions

What type of bank account does [your business] use? Please mark all that apply.

- Business bank account
- Owner's personal bank account
- No bank account
- Other

If [your business] does bank, which best describes [your business]'s banking? (Please mark all that apply).

[33]The *BERT* study information can be found at eccles.link/bert.

- Community credit union
- Regional credit union
- Community bank
- Regional bank
- National bank
- Other

How much does [your business] pay per month, in dollars, to use all financial services? These are defined as a checking account, savings account, money market account, and access to loans from a Bank or credit union, a Non-bank financial institution (finance companies, insurance companies, brokerage or mutual fund companies, leasing companies, mortgage banks, private equity, etc.), or Other (friends, family, other companies, other individuals, etc.).

- Bank or credit union
- Non-bank financial institution
- Other

What forms of payment do you accept? (Please mark all that apply).

- Cash
- Check
- Debit cards
- Credit cards

Do you pay for a security company that transports cash and/or product? If yes how much per month, in dollars, do you pay to your security company?

What is the highest level of education you have?

- Less than 9th grade
- Some Highschool but no diploma
- Highschool graduate (diploma or equivalent diploma GED)
- Technical, trade, or vocational degree

- Some college, but no degree
- Associate's degree
- Bachelor's degree
- Some graduate school but no degree
- Master's degree
- Professional school or doctorate

Did either of your parents ever own or run a company?

- Yes
- No

B. Methods Appendix

This appendix provides additional discussion of our instrumental variable approach. In particular, it discusses instrument relevance, the monotonicity assumption, and the exclusion restriction. In addition, it presents a comparison with ordinary least squares and discusses the trade-off between internal and external validity in our setting.

A. Instrument Relevance

Table IV presents evidence that distance to a 502 credit union is related to access to cash management. We also provide several placebo tests that investigate whether other amenities correlated with distance to 502 credit unions could explain the increase in cash management reported in Table IV. Specifically, we test whether distance to *other* financial institutions, banks, and non 502 credit unions, is associated with an increase in access to cash management. Table CIV reports that distance to these other financial institutions does not predict access to cash management, using the specification in equation (1) and Table IV. None of the estimates are statistically significant, and the sign often suggests that dispensaries close to these financial institutions are less likely to have access to cash management. For example, the results in column (1) show that dispensaries within one mile of a bank are 7% less likely to have access to cash management. In contrast, dispensaries within one mile of a 502 credit union are 28% more likely to have access to cash management (see Table IV).

B. *Monotonicity Assumption*

We cannot verify the monotonicity assumption directly because we do not observe the same dispensary at different distances from a 502 credit union. However, we can provide indirect evidence. Specifically, we estimate the first-stage regression from equation (1) in sub-samples of the data based on observable pre-determined characteristics, educational attainment, and whether a parent ran a company. Consistent with the monotonicity assumption, we find that estimates are consistently positive and sizable (see Table CII).

C. *Exclusion Restriction*

This subsection provides a series of tests that check alternative mechanisms and other potential threats to validity. First, dispensary outcomes could be affected by mechanisms other than access to cash management that are also related to distance. For example, if 502 credit unions are located in areas that are better for business, then this could conflate our estimates. To investigate this, we compare summary statistics of the county locations where 502 credit unions locate compared to counties where non 502 credit unions locate. Table CIII shows that in terms of employment opportunities, personal income, population, wages, GDP, and labor force, these counties do not differ statistically or economically. This evidence suggests that 502 credit unions are not located in better counties than non 502 credit unions, which could otherwise conflate our estimates.

Second, our exclusion restriction could also be violated if better owner/managers located their marijuana dispensary near 502 credit unions, and it was their skill, rather than access to cash management, that caused differential firm outcomes. To test this, we use evidence from our survey on the educational attainment and whether the owner/manager had a parent that ran a company as proxies for skill. Panel B of Table III reports that characteristics of the owner/manager are similar for dispensaries within 1 mile of a 502 credit union (column (2) and between 1 and 10 miles (column (3)).[34] We also find that owner/manager characteristics do not predict the distance to a 502 credit union (see Table CVI). Although these owner/manager characteristics do not differ based on distance, they are predictive of access to cash management. One of the most informative differences to examine is whether the owner had experience running a marijuana dispensary in the past. Because it was not possible to own a marijuana dispensary prior to our study, owners will not have this type of experience. Instead we use the response to whether the owner had a parent who ran a company as an alternative predictor for how sophisticated the dispensary operator will be. Table CV shows that owner/managers that had a parent who ran a company are 24% more likely to have cash management, reported in column (1).[35] This evidence suggests that our

[34]Panel C of Table III shows similarities in other distance characteristics between dispensaries within 1 mile and between 1 mile and 10 miles of a 502 credit union. For example, distance to a competitor or non 502 credit union is similar and not statistically significant. Distance to a bank branch is statistically significant, but the difference is 0.3 miles, which is not economically significant.

[35]Similarly if the owner/manager has a college degree the likelihood that a dispensary has cash manage-

proxies for smart business owners are predictive of cash management but that they were unable to strategically locate near 502 credit unions.

We conclude from these analyses that a dispensary's distance from a 502 credit union predicts access to cash management. Moreover, the impact of distance on profitability is unlikely to be driven by mechanisms other than cash management.

D. Comparison with ordinary least squares

We use an instrumental variable approach to address the strong possibility that several potential confounding factors could bias the estimates from an ordinary least squares (OLS) regression. There are many factors that determine the propensity of an owner/manager to seek out a bank account that are also likely correlated with business success. The correlation could be positive if owner/managers with more business education are both more likely to obtain a bank account and to run a more profitable business. The correlation could be negative if owner/managers with other businesses have less need for a bank account or use other types of banking (fintech) and their experience helps them run a more profitable business. These correlations could confound the ordinary least squares estimates because they would include not only the effect of cash management but also all of the factors that affect both profitability and the propensity to obtain a bank account.

In addition, it is very likely that measurement error is a concern in our setting. The measurement of whether a dispensary has a bank account or not is based on survey evidence. Measurement error drives the OLS estimates to be biased toward zero. In contrast, an IV approach would be consistent. The typical solution for this bias is to use a validation dataset, repeated measurements, or an IV approach (Hausman et al., 1991; Bound et al., 2001; Schennach, 2007). We use an IV approach because neither a validation dataset or repeated measurements is available.

To gauge the seriousness of these issues in our analysis, we compare our results using the IV to results using an OLS specification. Predicting the relationship between the OLS and IV results depends on the sources of measurement error and confounding factors in the setting. Measurement error should drive the OLS coefficient towards zero. At the same time, correlations with confounding factors may drive positive estimated effects in the IV specification, for example, and negative estimated effects in the OLS specification. Alternatively, the difference could be due to differences in the local average treatment effect, which the IV estimates, and the average treatment effect, which the OLS estimates. There are many, and sometimes contradictory, rules of thumb governing how IV estimates and OLS estimates should be related. The range of expectations for differences between OLS and IV estimates varies from relatively small differences, to large, orders of magnitude differences, to differences that switch the signs of the coefficient estimates (Giroud, Mueller, Stomper and Westerkamp, 2012; Berger et al., 2005; Becker, 2007).

Panel A of Table BI replicates our IV analysis from Table V using OLS regression. The comparison has several implications. First, the OLS estimates support the IV evidence

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ment is higher, reported in Table CV, column (2). Column (4) shows that the log distance to a 502 credit union is still predictive of cash management after we control for these other characteristics.

that cash management positively affects profitability. Second, the difference between the OLS and IV estimates is consistent with the hypothesis that confounding factors and/or measurement error bias the OLS results. As discussed above, both are likely—in which case the IV estimates are consistent and the OLS are not.

Panel B of Table BI replicates our IV analysis of the mechanisms driving profitability from Table VI. These OLS estimates support the IV results that *cash management* drives *profitability* through lower *wholesale prices*, higher *retail prices*, and more *sales*.

E. Internal and External Validity

This paper contributes to a first wave of empirical evidence on the importance of the cash management function of banks. To give theory its best chance, we made several decisions to provide high internal validity (List, 2020). For example, we focused on collecting the data on all marijuana dispensaries in a state rather than expanding to other states or industries. We follow the suggestion by List (2020) and discuss selection, attrition, naturalness, and scaling noting that for empirical studies in the first wave "external validity serves as an 'extra credit' component" (List, 2020, p. 43). This discussion provides transparency to the strengths and weaknesses of our study in terms of external validity and motivates future work that can provide a second wave of empirical evidence.

We collected data from the universe of marijuana dispensaries in Washington state through a combination of freedom of information act requests and purpose built surveys. The study, therefore, has high internal validity as it consists of the entire population. The treated group, dispensaries with cash management, may not be representative for many reasons, which is why we use an instrumental variable approach based on location to a 502 credit union. These 502 credit unions are located throughout the state and are similar to non 502 credit unions and banks in terms of observable characteristics. Dispensaries close to and far from 502 credit unions also have similar observable characteristics.

A strength of our data is the lack of attrition and compliance concerns. Dispensaries are required to report the detailed data that we use to state regulators for monitoring purposes. Firms are subject to audits with large potential fines or loss of license. The data collected is not used to calculate tax liability and therefore there are limited advantages for a dispensary to misreport. Our one-time survey has a high response rate. We paid people $50 to complete the survey and followed up with several waves including waves with limited questions.

A strength of our setting is that cash management is a need that all businesses face and we study our research question in the field and at scale in Washington state. One of the first systems businesses put into place is cash management. We find that cash management leads to higher profits through lower wholesale prices, higher retail prices, and more sales. Despite these benefits, regulations still differ across states within the marijuana industry. The evidence from Washington likely would scale to other states and contexts. For example, our evidence suggests that there may be benefits to encouraging cash management in other industries and locations, such as developing countries (Brune et al., 2021) and banking deserts within developed countries that are more likely to be found in areas with higher African American and Hispanic populations (Kashian, Tao and Perez-Valdez, 2015; Dahl and Franke, 2017).

Table BI: **Comparison of Models**

This table reports the ordinary least squares (OLS) estimates that correspond to Tables V and VI. An observation is a strain in a dispensary in a given week. Panel A reports the OLS estimates from Table V and Panel B reports the OLS estimates from Table VI. The sample consists of observations from 2015–2017 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 in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

Panel A: OLS: Profitability	Profitability by Dispensary and Strain and Week							Dispensary Profits
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cash management	0.087*	0.076*	0.062	0.061	0.061	0.057	0.061	0.073***
	(0.050)	(0.043)	(0.044)	(0.046)	(0.046)	(0.048)	(0.046)	(0.021)
Week fixed effects		✓	✓	✓	✓	✓	✓	✓
City fixed effects			✓	✓	✓	✓	✓	✓
Distance to bank controls				✓	✓	✓	✓	✓
Competition controls					✓	✓	✓	✓
Generic strain subset						✓		
Instrument: indicator	✓	✓	✓	✓	✓	✓		✓
Instrument: continuous							✓	
Strain fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Adj. R-Square	0.095	0.176	0.204	0.204	0.204	0.156	0.204	0.349
Observations	1,512,183	1,512,183	1,512,183	1,512,183	1,512,183	730,522	1,512,183	6,599

Panel B: OLS: Mechanisms	Wholesale price		Retail price		Sales (weight)		# Strains
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cash management	-0.036	-0.038	0.017	0.019	0.090	0.052	-0.054
	(0.030)	(0.024)	(0.035)	(0.028)	(0.091)	(0.079)	(0.135)
Strain fixed effects		✓		✓		✓	
Week fixed effects	✓	✓	✓	✓	✓	✓	✓
City fixed effects	✓	✓	✓	✓	✓	✓	✓
Distance to bank controls	✓	✓	✓	✓	✓	✓	✓
Competition controls	✓	✓	✓	✓	✓	✓	✓
Adj. R-Square	0.019	0.087	0.044	0.109	0.032	0.086	0.257
Observations	1,568,225	1,540,175	1,571,862	1,543,751	1,586,562	1,543,778	1,586,150

C. Supplementary Results Appendix

In this appendix we provide several complementary analyses. First, we use a differences-in-differences empirical design to highlight the strength of using distance as an exogenous variable that allows us to control for many unobserved differences in neighborhoods. Second, we use a different, though related, instrumental variable. Specifically, we use an instrument that measures whether a marijuana firm is within a county with a 502 credit union. Third, we present a detailed discussion of our robustness tests.

A. Differences-in-Differences

We explore the robustness of our main analysis to a differences-in-differences framework. This analysis employs discrete measures of distance to proxy for access to cash management in an OLS setting. We examine the full sample and subsamples of the data to validate our findings in the IV setting.

The differences-in-differences analysis compares dispensary-financial institution pairs within discrete distances. Financial institutions can be either 502 credit unions or all other financial institutions (banks and non 502 credit unions). Dispensaries and financial institutions form pairs if they are located within specific distances of one another. Dispensary-finance pairs can be within 0-1 mile or 1-2 miles of each other. We exclude dispensary-finance pairs that are greater than 2 miles apart. The differences-in-differences specification compares the profitability of dispensary-502 credit union pairs within 1 mile to dispensary-financial institution pairs within 1 mile (first difference). These pairs are then compared to dispensary-finance pairs that are within 1-2 miles of each other (second difference).

Our differences-in-differences specification is:

$$\begin{aligned} log(\text{profitability}) = \beta_0 &+ \beta_1 \mathbb{I}(\text{Within 1 mile of a 502 credit union}) \\ &+ \beta_2 \mathbb{I}(\text{Within 1 mile of a financial institution}) \\ &+ \beta_3 \mathbb{I}(\text{Within 2 miles of a 502 credit union}) + \varepsilon_i, \end{aligned} \tag{C.1}$$

where β_1 measures the effect of *cash management* on the profitability of dispensaries within *1 mile of a 502 credit union*, β_2 and β_3 control for the effects of being *within 1 mile of a non 502 financial institution* and being *within 2 miles of a 502 credit union*. The omitted category is comprised of dispensaries that are within 2 miles of a non 502 credit union (β_0).

We also run a variant of this analysis comparing dispensary-financial institution pairs within 1-2 miles to dispensary-financial institution pairs that are within 2-3 miles of each other. This analysis excludes dispensary-financial institution pairs with distances less than 1 mile or with distances greater than 3 miles. Because the likelihood of having cash management decreases the farther away a dispensary is, we expect the effect of being between 1-2 miles (compared to 2-3 miles) to be smaller than the effect of being 0-1 miles (compared to 1-2 miles).

In Table CVII, we report the results of this analysis. The coefficient of interest is β_1 which measures the effect of close proximity to a 502 credit union (a proxy for cash management) on dispensary profitability. Columns (1), (3), (5), and (7) report results measuring the

effects of a 0-1 mile distance compared to a 1-2 mile distance. Columns (2), (4), (6), and (8) report results measuring the effects of a 1-2 mile distance compared to a 2-3 mile distance. The specifications control for β_2 and β_3, that is, the "nuisance parameters"[36], denoted by "Within X miles of a financial institution" and "Within X+1 miles of a financial institution" in the table. Specifications include week fixed effects and standard errors clustered at the dispensary level, reported in parentheses.

In columns (1) and (2), we report the results using the full sample, which includes observations for all valid firm-financial institution pairs. Column (1) shows that dispensaries *within 1 mile of a 502 credit union* experience *profitability* that is 19.7% higher than dispensaries that are *1-2 miles from a non 502 credit union*. Consistent with our expectations, the effect is smaller when comparing dispensaries between 1-2 miles to those 2-3 miles; reported in column (2).

There is potential heterogeneity in the effects of distance on firm-financial institution pairs. For example, a full sample analysis ignores the possibility that pairs may locate in areas that are very different economically. Some pairs may be located in areas near other public resources whereas others may be located in rural communities. Estimated treatment effects may be confounded by these differences and make for noisy comparisons.

We address these concerns first by examining a subset of dispensary-finance pairs within 5 miles of a 502 credit union. Said differently, in addition to being within 2 miles of a financial institution, this subsample requires the dispensary to also be within 5 miles of a 502 credit union. This test aims to address the potential that areas with 502 credit unions are distinct from areas without 502 credit unions by requiring that all dispensaries are within a short distance of 502 credit unions. The estimates in columns (3) and (4) are similar to those in columns (1) and (2), which alleviates some concern about potential confounding factors. Specifically, the coefficient in column (1) is 0.197 and the coefficient in column (3) is 0.192.

In a separate analysis, we exclude dispensary-financial institution pairs that overlap with dispensary-502-credit union pairs, thereby omitting areas with a high density of financial establishments. The purpose of this test is to exclude the "main street" effects in which the benefits of a 502 credit union might reflect benefits of other nearby financial institutions or business activity. In this setting, a dispensary-502 credit union pair between 0-2 miles cannot overlap with a dispensary-non 502 financial institution pair between 0-2 miles. The restrictions are similar for the 1-3 mile radius analysis reported in column (6). The estimate in column (5) is similar to the estimate in column (1), which again alleviates some concern of confounding factors.

In a final set of analyses, we focus exclusively on credit unions as the relevant financial institutions in our study. We focus only on credit unions to define "financial institutions" to test whether credit unions locate in different areas than banks. Column (7) reports results using the *0-1 mile distance from a credit union* and column (8) reports results using the *1-2 mile distance from a credit union*. The similarity of these estimates again alleviates some concern of confounding factors.

Overall, these results support the findings from our instrumental variables analysis. The effects decline as the distance between a dispensary and a 502 credit union increases, consistent with distance being correlated with access to cash management. Subsample analyses

[36] Cameron and Trivedi (2005)

reveal that these results are robust to potential confounding factors including the effects of local economic conditions, "main street" benefits, and alternative definitions of financial institutions.

B. County Instrumental Variable

In this section, we use counties with a 502 credit union as an instrumental variable. Many credit unions explicitly state in their charters that their goal is to serve members of a given community (and often that is a county). Our focal instrument is distance from a 502 credit union. Whether a firm is in a county with a 502 credit union is positively correlated with distance. To the extent that 502 credit unions restrict accounts to firms within the county where they operate, the instrument will provide additional validation of our main findings. Otherwise, this instrument will increase noise in our distance instrument.

The estimates in Table CVIII provide complementary evidence to our main specifications. Specifically, firms are 8.4% more likely to have a bank account if they are in a *county with a 502 credit union* (column (1)). In columns (2)–(4), we report that *profitability* is similarly higher for firms with *cash management* using the county-level instrument. Similarly, columns (5)–(7) report estimates from a differences-in-differences specification and show that *profitability* is higher in *counties with 502 credit unions*. These results support the findings of our main analysis.

C. Alternative Explanations and Sensitivity of the Results

C.1. Placebo tests

We use a series of placebo tests to investigate alternative explanations. We use distance to non 502 credit unions and banks as placebo instrumental variables. We have previously shown that distance to these other financial institutions does not predict cash management (see Subsection B). Estimates from these placebo tests capture unobserved characteristics associated with distance and profitability that could conflate our estimates.

We find that the distance between a marijuana dispensary and non 502 credit unions or banks does not impact product profitability. Specifically, we report estimates in Figure 7 that repeat estimates from Table V with no fixed effects, week fixed effects, city fixed effects, and week and city fixed effects using (1) distance to a non 502 credit union, (2) banks (in the credit union sample), and (3) banks (within 10-miles of a bank) as the instrument. All of the coefficients reported in Figure 7 are small and statistically insignificant and sometimes negative.[37] These estimates help to rule out alternative explanations in which the distance to a 502 credit union impacts product profitability due to the types of locations where financial institutions are found (such as shopping areas) rather than through cash management.

[Insert Figure 7]

[37] These estimates are also reported in Table CIX.

C.2. Sensitivity of the Results

We also consider the sensitivity of our estimates to the myriad modeling alternatives in our main specification. In Figure 8, we plot our coefficients with 95% confidence intervals for eleven additional specifications that all include week and city fixed effects.

[Insert Figure 8]

The first estimate is our baseline estimate that excludes marijuana dispensaries that are farther than 10 miles from a 502 credit union. This restriction is to ensure that marijuana dispensaries close or far from a 502 credit union are similar. In the following three specifications, we expand that restriction to 15 miles, reduce the restriction to 5 miles, or have no restriction. The point estimates of these specifications remain similar to the baseline estimates and are statistically significant.

We also explore the effects of the sample period on the estimates. The main regressions include all transactions from 2014 to 2017. The fifth specification in Figure 8 only includes transactions in a post-period that occurred from 2015 to 2017. The estimates remain similar, and the standard errors shrink, most likely due to a reduction in volatility in the nascent marijuana industry.

Figure 8 also shows the results of altering our control variable for competition. The sixth and seventh specifications include controls for the number of competitors within one and two miles. The regression coefficients are larger in these specifications, and economically and statistically comparable.

We also consider our choice of instrumental variable. In the eighth through tenth specifications, we replace the baseline instrumental variable (an indicator for being within 1 mile of a 502 credit union) with indicators for being within 2 or 3 miles of a 502 credit union or the continuous measure log distance to a 502 credit union. In all of these specifications, the estimates remain similar and statistically significant. As expected, though, the confidence interval is larger when we use the IV within two and three miles because it adds noise to our first-stage regression.

We also assess the sensitivity of our results to the level of aggregation in our data. In our main regression specifications, we use a weekly level of aggregation. Alternatively, we could use monthly or daily aggregation. We report these models in the last two rows of Figure 8 and they both yield similar point estimates, and the estimates are statistically significant. The confidence interval is larger when we use the daily aggregation, likely because it includes additional noise from daily fluctuations.

In Table CX, we report several additional sensitivity results. Columns (1) and (2) replicate columns (1) and (5) from Table V. Columns (3) and (4) exclude transactions in 2014. Columns (5) and (6) exclude transactions from Seattle and columns (7) and (8) exclude transactions from Spokane. Across all specifications, the baseline estimates are similar.

D. Standard Errors

There are several recent survey works that provide new insights into the level at which an analysis should cluster its standard errors. One view is that there is correlation between all observations within a group (Hansen, 2007; Cameron and Miller, 2015). The advice in

this literature is to cluster at higher levels, "including the point at which there is concern about having too few clusters," (Cameron and Miller; 2015, p.333). In light of this, a reasonable choice would be to cluster at the city level (rather than a lower level like ZIP code or dispensary).

The other view is that clustering is a design problem (Abadie, Athey, Imbens and Wooldridge, 2017). This view argues that, "contrary to common wisdom, correlations between residuals within clusters are neither necessary, nor sufficient, for cluster adjustments to matter," (Abadie, Athey, Imbens, and Wooldridge; 2017 p. 2). The authors show that clustering is not necessary if you include fixed effects at the level of clusters and there is no heterogeneity in treatment effects. In this view, clustering is justified based on whether sampling or assignment of treatment varies with group. Neither of these is true in our setting because we have the full universe of firms and transactions, not a sample. Therefore, Abadie, Athey, Imben, and Wooldridge (2017) p. 2 suggest, "one should *not* adjust the standard errors for clustering, irrespective of whether such an adjustment would change the standard errors." Therefore, this view would suggest not clustering standard errors.

Finally, there is a view that standard errors, as typically interpreted, are irrelevant when a study has the full universe and not a sample—as is the case in our context. In this case, the suggestion would be report standard errors without clustering as a measure of variation—but not sampling error.

Table CI: **Summary Statistics: Credit Unions**

This table reports summary statistics for credit unions separated by whether or not they offer *cash management* services to the marijuana industry. Columns (1) and (2) present means (standard deviations) for credit unions that are non 502 credit unions and 502 credit unions, respectively. 502 credit unions are the subset of credit unions that elected to provide cash management services to marijuana dispensaries. The table reports financial statement information including *total loans and leases*, *total assets*, *accounts payable and other liabilities*, *total shares and deposits*, and *net income*. The table also reports credit union characteristics such as the *number of members*, the *number of branches*, and *future plans to expand*. All variables are reported in logs. Column (3) reports the differences-in-means and the p-value of the t-test adjusted for clustering at the credit union level (reported in parentheses).

Differences in Means	Non 502 Credit Unions	502 Credit Unions	Difference
	(1)	(2)	(3)
Total Loans and Leases	19.069	20.090	1.021
	(1.485)	(1.007)	(0.082)
Total Assets	19.543	20.370	0.826
	(1.452)	(0.911)	(0.123)
Account Payable and other Liabilities	15.116	16.051	0.935
	(1.566)	(0.539)	(0.018)
Total Shares and Deposits	19.412	20.203	0.791
	(1.448)	(0.871)	(0.126)
Net Income	4.546	5.725	1.179
	(6.503)	(8.096)	(0.785)
Number of Current Members	10.286	10.981	0.695
	(1.319)	(0.795)	(0.140)
Number of credit union branches	2.076	2.368	0.292
	(0.785)	(0.815)	(0.508)
Does CU plan to expand or add branches in next 12 months	0.201	0.347	0.146
	(0.319)	(0.490)	(0.573)

Table CII: **Sub-sample First Stage Estimates—Monotonicity Assumption**

This table shows how the probability of using cash management services changes with proximity to a 502 credit union across observable characteristics. Observations are at the marijuana dispensary level. The sample is a combination of survey data and administrative data from the state of Washington (see Section III). The dependent variable, *Cash management*$_{i,t}$, is an indicator variable equal to one if in the survey the firm indicated that it used cash management services and zero otherwise. *f(Distance to 502 Credit Union)*$_i$ is an indicator variable equal to one if the distance to the nearest 502 credit union is within 1 mile and zero otherwise. Standard errors appear in parentheses and *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

$$\textit{Cash management}_{i,t} = \delta_0 + \delta_1 \textit{f(Distance to 502 Credit Union)}_i + \delta X_{i,t} + \alpha_t + \alpha_j + \varepsilon_{i,t}$$

	Probability of Using Cash Management Services			
	(1)	(2)	(3)	(4)
Distance to 502 credit union	0.164	0.236	0.154	0.222*
	(0.149)	(0.164)	(0.201)	(0.133)
Constant	0.419***	0.653***	0.346***	0.578***
	(0.041)	(0.048)	(0.043)	(0.040)
High school or Assoc. degree	✓			
College, Prof, or Doct.		✓		
Parent did not run company			✓	
Parent did run company				✓
F-statistic	1.217	2.087	0.585	2.800
Adj. R-Square	0.001	0.010	-0.003	0.011
Observations	160	104	133	162

Table CIII: **Balance Test between Counties With and Without 502 Credit Unions**

The table reports summary statistics for the counties in which marijuana dispensaries are located as of February 2017. The sample consists of counties in which 502 credit unions operate and counties in which 502 credit unions do not operate. Column (1) reports the means of variables for the counties without 502 credit unions and column (2) reports the means for the set of counties with 502 credit unions. Column (3) reports the difference in means between columns (1) and (2) and the p-value of the t-statistic of these differences, with standard errors clustered by dispensary. Variables include the *total employment* in the county, *total personal income*, *personal income per capita*, *population size*, *wages*, *personal income of business owners*, *county GDP*, *size of the labor force*, and the *total employed and unemployed populations*.

	(1)	(2)	(3)
Credit Union Availability:	Without 502 Credit Unions	With 502 Credit Unions	Difference
Total Employment	10.967	11.576	0.608
	(0.977)	(1.647)	(0.377)
Personal Income (Thousands)	15.392	15.921	0.529
	(1.027)	(1.689)	(0.454)
Population	11.701	12.160	0.459
	(0.946)	(1.452)	(0.453)
Personal Income(Per Capita)	10.599	10.631	0.032
	(0.113)	(0.200)	(0.698)
Wages and Salaries	14.413	15.146	0.732
	(1.114)	(1.920)	(0.361)
Personal Income (Proprietors)	12.802	13.366	0.565
	(1.033)	(1.800)	(0.450)
County GDP	15.318	16.065	0.747
	(1.067)	(1.789)	(0.319)
Labor Force	10.897	10.304	-0.593
	(0.990)	(1.799)	(0.426)
Employed Population	10.821	10.234	-0.587
	(0.996)	(1.790)	(0.429)
Unemployed Population	8.273	8.750	0.477
	(0.937)	(1.349)	(0.406)

Table CIV: **Distance to Nearest Bank or Non 502 Credit Union and Cash Management**

This table shows how the probability of using cash management services changes with proximity to a bank or a non 502 credit union that does not work with the marijuana industry. Observations are at the marijuana dispensary level. The sample is a combination of survey data and administrative data from the state of Washington (see Section III). The dependent variable, *Cash management*$_{i,t}$, is an indicator variable equal to one if in the survey the firm indicated that it used cash management services and zero otherwise. The variable of interest is the coefficient on *f(Distance to non 502 Credit Union)*$_i$, which denotes either the discrete measures within 1, 2, or 3 miles of a bank or non 502 credit union (non 502 CU) or the continuous measure log distance to a bank or non 502 CU. Standard errors appear in parentheses and *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

$$\textit{Cash management}_{i,t} = \delta_0 + \delta_1 \textit{f(Distance to non 502 Credit Union)}_i + \delta X_{i,t} + \alpha_t + \alpha_j + \varepsilon_{i,t}$$

	Probability of Using Cash Management Services							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Within 1 mile of bank	-0.074							
	(0.059)							
Within 1 mile of non 502 CU		-0.032						
		(0.147)						
Within 2 miles of bank			-0.051					
			(0.074)					
Within 2 miles of non 502 CU				0.060				
				(0.097)				
Within 3 miles of bank					0.004			
					(0.088)			
Within 3 miles of non 502 CU						0.089		
						(0.079)		
Proximity to nearest bank							0.016	
							(0.021)	
Proximity to nearest non 502 CU								-0.032
								(0.062)
Constant	0.584***	0.532***	0.574***	0.526***	0.528***	0.519***	0.569***	0.629***
	(0.050)	(0.027)	(0.068)	(0.028)	(0.083)	(0.028)	(0.030)	(0.056)
F-statistic	1.597	0.048	0.471	0.384	0.002	1.277	7.331	0.266
Adj. R-Square	0.002	-0.003	-0.002	-0.002	-0.003	0.001	0.018	-0.009
Observations	354	354	354	354	354	354	354	354

Table CV: **Cash management and Observable Manager Characteristics**

This table shows how cash management relates to observable dispensary manager characteristics. $Cash\ management_{i,t}$ is a function of manager characteristics and the $f(Distance\ to\ 502\ Credit\ Union)_i$. The manager characteristics include whether or not a manager's parent ran their own firm and a manager's educational attainment. *Log distance to 502 credit union* measures the distance between the manager's dispensary and a 502 credit union. Columns (1)–(3) report results using manager characteristics only. Column (4) includes manager characteristics and the log distance to a 502 credit union. Standard errors appear in parentheses and *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

$$Cash\ management_{i,t}, = \delta_0 + \delta_1 f(Distance\ to\ 502\ Credit\ Union)_i + \delta X_{i,t} + \alpha_t + \alpha_j + \varepsilon_{i,t}$$

	Probability of Using Cash Management Services			
	(1)	(2)	(3)	(4)
Log distance to 502 credit union				-0.086***
				(0.021)
Parent ran company	0.240***		0.246***	0.232***
	(0.060)		(0.057)	(0.055)
High school graduate		0.072	0.039	0.074
		(0.144)	(0.139)	(0.135)
Assoc. or technical degree		-0.105	-0.161	-0.109
		(0.140)	(0.136)	(0.132)
College degree		0.350**	0.302**	0.305**
		(0.142)	(0.138)	(0.134)
Professional or doctorate		-0.062	-0.108	-0.059
		(0.152)	(0.148)	(0.144)
Constant	0.391***	0.462***	0.367***	0.354***
	(0.045)	(0.130)	(0.128)	(0.124)
Adj. R-Square	0.053	0.119	0.176	0.224
Observations	264	264	264	264

Table CVI: Distance to a 502 Credit Union and Observable Manager Characteristics

This table shows how distance to a 502 credit union relates to other observable dispensary manager characteristics. The manager characteristics include whether or not a manager's parent ran their own firm (*parent ran company*) and a manager's educational attainment. *Log distance to 502 credit union* measures the distance between the manager's dispensary and a 502 credit union. Columns (1)–(3) report results using manager characteristics. Standard errors appear in parentheses and *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

$$Log(Distance)_i = \beta_0 + X\beta + \varepsilon_i$$

	Distance to 502 Credit Union		
	(1)	(2)	(3)
Parent ran company	-0.144		-0.165
	(0.164)		(0.164)
High school graduate		0.388	0.410
		(0.401)	(0.402)
Assoc. or technical degree		0.568	0.606
		(0.390)	(0.392)
College degree		0.003	0.035
		(0.397)	(0.398)
Professional or doctorate		0.533	0.564
		(0.426)	(0.427)
Constant	0.216*	-0.213	-0.149
	(0.123)	(0.364)	(0.369)
Adj. R-Square	0.001	0.018	0.018
Observations	264	264	264

Table CVII: **Differences-in-Differences: Dispensary Profitability**

This table reports the effects of cash management on dispensary profitability in a differences-in-differences framework. The dependent variable, log(*profitability*) is the log of dispensary profitability. The variable of interest is the coefficient on $\mathbb{I}$(Within X mile of a 502 credit union), which denotes dispensary-502 credit union pairs within X miles. X is the miles between a dispensary-finance pair, where X is either 1 mile or 2 miles. 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% levels, respectively.
The results of the following differences-in-differences regression are in the table:

$$\begin{aligned} log(\text{profitability}) = \beta_0 &+ \beta_1 \mathbb{I}(\text{Within X mile of a 502 credit union}) \\ &+ \beta_2 \mathbb{I}(\text{Within X mile of a financial institution}) \\ &+ \beta_3 \mathbb{I}(\text{Within X+1 miles of a 502 credit union}) + \alpha_t + \alpha_s + \varepsilon_i, \end{aligned}$$

			Within 5 mi of 502 credit union		No overlap		Only Credit unions	
Within	1 mile	2 miles	1 mile	2 miles	1 mile	2 miles	1 mile	2 miles
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Within 1 mile	0.197**		0.192**		0.102***		0.198**	
	(0.082)		(0.079)		(0.033)		(0.082)	
Between 1 and 2 miles of a 502 credit union		0.031		0.141**		0.257***		0.258*
		(0.034)		(0.025)		(0.025)		(0.139)
Constant	1.552***	1.482***	1.623***	1.634***	1.464***	1.693***	1.547***	1.462***
	(0.035)	(0.059)	(0.068)	(0.010)	(0.034)	(0.015)	(0.042)	(0.037)
Within X miles of a financial institution	✓	✓	✓	✓	✓	✓	✓	✓
Within X + 1 miles of a 502 credit union	✓	✓	✓	✓	✓	✓	✓	✓
Week fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Strain fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Adj. R-Square	0.167	0.214	0.196	0.386	0.210	0.273	0.170	0.210
Observations	3,454,849	668,732	1,164,766	20,477	3,454,849	668,732	2,938,416	1,059,302

Table CVIII: **Estimates using County with 502 Credit Union as an Instrument**

This table reports tests of the effects of cash management on the profitability of marijuana dispensaries using counties with a 502 credit union as an instrument for cash management. An observation is a *strain* in a dispensary in a given week. In column (1), we report the first stage of the two stage least squares using whether a firm is in a *county with a 502 credit union* (502 CU) to predict cash management. In columns (2)–(4), we report the second stage estimates adding week fixed effects and controls for number of *competitors* within 1 mile and miles to the nearest bank in columns (3) and (4). In columns (5)–(7), we report our differences-in-differences specification adding week fixed effects and controls for number of competitors within 1 mile in columns (6) and (7). The dependent variable is aggregated to the dispensary week level from transaction-level data. Standard errors are clustered at the dispensary level and are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels. The results of the following instrumental variables regression and differences-in-differences specification are in the table:

$$\begin{aligned}
\textit{Cash management}_{i,t}, &= \delta_0 + \delta_1 f(\textit{County with 502 Credit Union})_i + \delta X_{i,t} + \alpha_t + \alpha_s + \varepsilon_{i,t} \\
\textit{log(Profitability)}_{i,t} &= \beta_0 + \beta_1 \textit{Cash management}_{i,t}, + \beta X_{i,t} + \alpha_t + \alpha_s + u_{i,t} \\
\textit{log(Profitability)}_{i,t} &= \beta_0 + \beta_1 f(\textit{County with 502 Credit Union})_i + \beta X_{i,t} + \alpha_t + \alpha_s + u_{i,t}.
\end{aligned}$$

	First-stage	IV			Differences-in-Differences		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
County with 502 CU	0.084***				0.036***	0.038***	0.045***
	(0.001)				(0.006)	(0.006)	(0.006)
Cash management		0.423***	0.442***	0.408***			
		(0.067)	(0.068)	(0.051)			
Strain fixed effects	✓	✓	✓	✓	✓	✓	✓
Week fixed effects	✓		✓	✓		✓	✓
Controls				✓			✓
Adj. R-Square	0.081	-0.081	-0.090	-0.073	0.160	0.160	0.163
Observations	3,870,036	3,805,535	3,805,535	3,805,535	3,805,535	3,805,535	3,805,535

Table CIX: **Placebo Tests using Non 502 Credit Unions and Banks**

This table reports placebo tests of the effects of cash management on the profitability of marijuana dispensaries. An observation is a *strain* in a dispensary in a given week. In the specifications for the results in columns (1) and (2), we use as an instrument an indicator variable equal to one for dispensaries within one mile of a non 502 credit union and zero otherwise. Columns (3)–(6) use as an instrument an indicator variable equal to one for dispensaries within one mile of a bank and zero otherwise. Non 502 credit unions and banks did not provide cash management services to dispensaries, making them an ideal placebo test. Week fixed effects, α_t, city fixed effects α_j, and strain fixed effects α_s are included in the specifications for the results in columns (2), (4), and (6). The sample in columns (1)–(4) consists of observations from 2014–2017 within 10 miles of a non 502 credit union and within 10 miles of a bank in the specifications for the results in columns (5) and (6). The dependent variable is aggregated to the dispensary week level from transaction-level data. Standard errors are clustered at the dispensary level and are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels.
The results of the following instrumental variables regression are in the table:

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

	Non 502 Credit union		Bank (credit union sample)		Bank	
	(1)	(2)	(3)	(4)	(5)	(6)
Cash management	-0.215	-3.001	0.478	0.271	-1.892	-0.407
	(0.466)	(224.151)	(1.246)	(0.202)	(6.762)	(0.665)
Week fixed effects		✓		✓		✓
City fixed effects		✓		✓		✓
Strain fixed effects		✓		✓		✓
Adj. R-Square	0.040	0.063	0.016	0.055	0.030	0.053
Observations	1,512,183	1,512,183	1,512,183	1,512,183	3,790,160	3,790,160

Table CX: **Sensitivity of results**

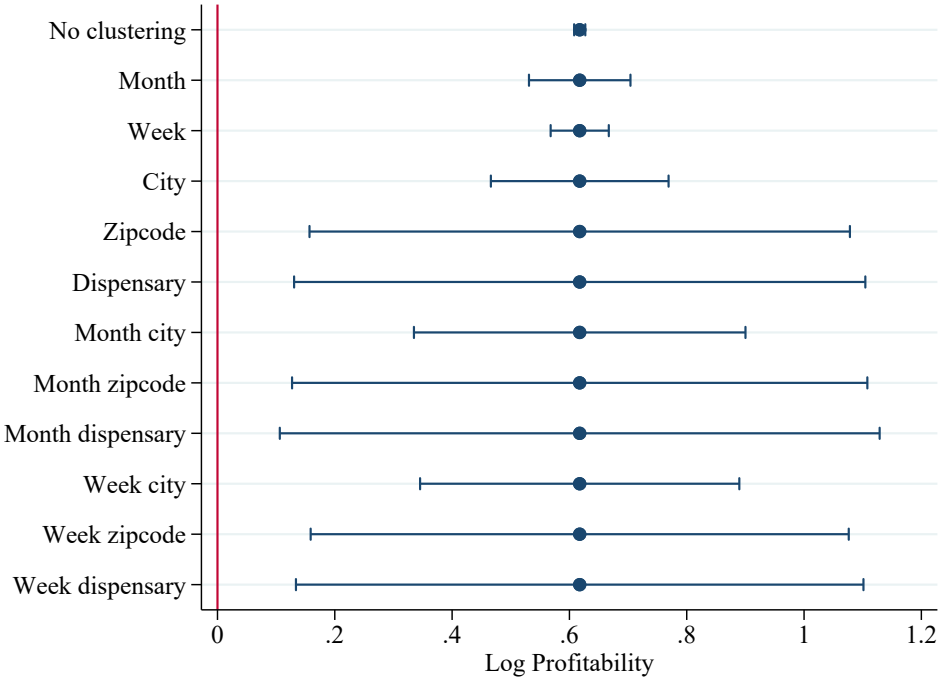
This table reports robustness tests of our main results (reported in Table 5). Results in columns (1) and (2) replicate columns (1) and (5) from Table 5 for the baseline case. We run these specifications on three additional subsets of the data; excluding 2014 (columns (3) and (4)), excluding Seattle (columns (5) and (6)), and excluding Spokane (columns (7) and (8)). An observation is a strain in a dispensary in a given week. The instrumental variable specification uses distance to a 502 credit union as an instrument for whether a dispensary has cash management. We use an indicator variable equal to one if a dispensary is within one mile of a 502 credit union and zero otherwise as an instrument. Week fixed effects α_t and city fixed effects α_j are included in the model for the results in even columns. The even columns also include controls for distance to a bank and number of competitors. All columns include strain fixed effects. Standard errors clustered at the dispensary level are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels.
The results of the following instrumental variables regression are in the table:

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

	Baseline		Excluding 2014		Excluding Seattle		Excluding Spokane	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cash management	0.378*	0.485*	0.380*	0.481*	0.308	0.595	0.463**	0.422*
	(0.203)	(0.246)	(0.201)	(0.245)	(0.243)	(0.475)	(0.181)	(0.227)
Week fixed effects		✓		✓		✓		✓
City fixed effects		✓		✓		✓		✓
Distance to bank controls		✓		✓		✓		✓
Competition controls		✓		✓		✓		✓
Instrument: indicator	✓	✓	✓	✓	✓	✓	✓	✓
Strain fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
F-statistic	34.670	23.375	35.551	23.220	26.165	21.184	34.171	22.172
Adj. R-Square	0.035	0.053	0.037	0.053	0.012	0.054	0.055	0.034
Observations	1,512,183	1,512,183	1,500,903	1,500,903	827,270	827,270	1,285,009	1,285,009

Figure C1: **Sensitivity Tests of Profitability and Banking Services**

This figure reports the coefficients for a series of sensitivity tests of the level of clustered standard errors for our baseline estimates with 95% confidence intervals.



D. Institutional Details Appendix

A. *Definition of Cash Management*

Banks serve two primary functions: lending and cash management. Within the role of cash management there is a payment processing function that helps streamline payments and a warehousing function in which banks provide storage, guarantee, and issuance of funds.

Firms use payment processing to avoid costs and risks of cash transportation and transactions. They can use warehousing to store large deposits. Banks "verify" funds by certifying that the currency is not counterfeit and guarantee that the account holder has assets to use for payments. Banks also distribute funds. They can disburse cash in convenient currency denominations and, for marijuana businesses, can provide cash that does not have a marijuana odor.

In our setting, cash management evolved as follows. Initially, cash management was limited to depository services. In 2014, Salal and Numerica began offering depository services with limited features: check writing, wire payments, and automated deposits. These accounts also offered armored transport when businesses had large amounts of cash to deposit or deliver and dedicated account managers. Deposits of cash and checks were required to be made in person during the branch's daytime hours. Numerica limited total deposits per firm to $5 million and deposits of all marijuana accounts combined could not exceed 5% of Numerica's total deposits. Numerica required that account holders live in a community where it also had a branch. The accounts did not have: debit cards, online bill pay, mobile banking, night deposits, credit cards, courtesy pay, remote deposit capture, and shared branching (Ragusa, 2014; Fairley, 2014). As of 2021, marijuana credit union accounts include debit cards, savings and money market accounts, certificates of deposit, online banking, and accounts for dispensary employees (Curren, 2018).

In 2022, banking options continue to be quite limited even as 19 states have legalized recreational marijuana. Credit unions are working with fintech firms to lower the administrative costs of serving marijuana dispensaries. Fintech has created new products to make the application process and compliance requirements less onerous. For example, Salal joined with fintech provider Shield Compliance which offers products that accelerate new member onboarding and automate compliance tasks such as daily monitoring and reporting.

B. *Credit Unions and Marijuana Businesses*

Costs of operating without cash management

When firms operate solely in cash, especially in a highly regulated industry, they must verify that cash is not counterfeit and that it comes from a legal source. They need a safe way to store and transport the cash and they must accept investments from outside investors in cash. These are implicit functions of bank accounts, but the marijuana setting highlights the economic costs of going without them.

Operating in cash makes businesses and employees targets of crime. Owners need to pay for supplies, salaries, taxes, and rents in thousands of bills. Owners also need to safely store

the cash. One business owner hid his cash in three different vaults buried on a 200-acre parcel and used a handmade map with landmarks to guide him to the vaults (Davis, 2017).

There are risks of transporting cash – even cash from legal retail marijuana. Firms hire armored vehicles to deliver monthly tax payments, and the Department of Revenue has a bulletproof room in which tax payments are made. Business owners discreetly transport cash in duffel bags, paper bags, and fast food containers (Brown, 2019). Laws are murky about whether transporting marijuana-related money across state lines is legal. In 2021, cash from marijuana dispensaries was being transported from Missouri, where recreational marijuana use is legal, through Kansas, where recreational marijuana is not. The cash was seized when it crossed the state line into Kansas.

Finally, attracting outside investment is difficult in an all-cash environment. Dispensaries often use boot strapped funds, friends and family, and some private investors. From the investor's perspective, delivering cash investments is risky due to challenges with record keeping, traceability, and theft (Kovaleski, 2014).

The dangers of conducting business in an all-cash environment are ongoing, ten years later. There were 77 armed robberies and 3 deaths related to cannabis by June of 2022 in Washington state (Espino and Mirnateghi, 2022).

Risks of working with marijuana businesses

When credit unions work with marijuana businesses they take legal and financial risk. Managing cash from marijuana firms is money laundering under federal law. Institutions and employees who knowingly engage in money laundering face federal prosecution. In addition, there are onerous financial penalties. The penalty for money laundering is two times the amount of cash involved in the offense. For example, processing $250,000 in cash could result in a fine of $500,000. The federal guidance for financial institutions is ambiguous and can be revoked at any time, meaning that financial institutions need to be prepared to shut down accounts and possibly pay penalties at a moment's notice. This poses liquidity risk. If marijuana deposits account for a large portion of a bank's portfolio and the government revokes the FinCEN guidance, banks would need to return the deposits immediately. Finally, financial institutions are taking reputational risk. They need to avoid working with marijuana businesses that would create scandals and make headlines.

Why credit unions work with marijuana businesses

Credit unions in Washington state cited public safety and potential profits as the primary drivers of the decision to work with marijuana firms. Communities were concerned about the potential crime associated with a large, cash-only business. They anticipated a large amount of cash on the streets and feared home invasions and violent crimes that had occurred in other states that legalized marijuana without access to banking. By definition, credit unions are community oriented and Numerica and Salal credit unions saw themselves as serving an important need in the community. Specifically, Numerica's mission statement is that it will "enhance lives and build communities." The leadership felt that it was in the best interest of the communities they served to take cash off the streets and securely store it in financial institutions (Espino and Mirnateghi, 2022).

In the longer term, credit unions stood to benefit financially from this new industry. Credit unions sensed that the legalized, recreational marijuana would be a multi million-dollar industry. This was an opportunity to innovate, experiment, and ultimately influence and lead the banking industry into the marijuana business. In 2014, Salal estimated that 80% of the future value of the credit union could be driven by marijuana related banking. In the early years, credit unions set fees to cover costs and leave a small profit for the credit union. The initial breakdown was roughly 75% of annual fees paid for personnel and 25% covered overhead, out-of-pocket costs, and compensation for risk. Credit unions eventually used deposits to fund loan activity within the organization, but had strict rules in place to limit the liquidity impact of unexpected changes in marijuana regulations (Matthews, 2022).

Officials in Washington state provided much needed support to financial institutions that were interested in working with marijuana businesses. In addition to public safety, regulators in Washington state wanted to facilitate revenue collections. Bank accounts keep businesses from entering the underground economy instead of paying taxes – which is a major benefit of legalizing marijuana. Department of Financial Institutions (DFI) director Scott Jarvis spent more than one year working with federal regulators to develop specific guidelines to help businesses and bankers figure out how to bank as close to legally as possible.

Supply of credit unions accounts

Most marijuana dispensaries did not get credit union accounts because supply was limited. First, credit unions wanted to develop processes for managing these accounts and therefore limited the number of accounts that they would open. By October of 2014, Salal had received 200 requests for accounts and had opened 12.

In the first year, Numerica would only work with marijuana businesses operating in municipalities where it had a branch. In addition, Numerica limited the number of accounts by self-imposing a rule that marijuana-business accounts could not exceed 5% of total deposits at the credit union. As the credit unions learned good practices for maintaining these accounts, they expanded access. By 2019 Salal had 300 marijuana-related accounts.

On the demand side, account application fees were expensive – $1,000 according to interviews – and dispensary owners had to go through a rigorous application process and agree to onerous conditions and high fees to maintain the account. In addition, there was a very likely chance that the accounts would be terminated instantly if legislation changed or regulators chose different enforcement strategies.

Managing marijuana business accounts

Credit unions developed highly customized solutions to banking with marijuana-related businesses. The account application process took seven to ten days and included on-site visits and a review of business license documentation, criminal background checks, funding and financial scrutiny, and public records from the Liquor and Cannabis Board of Washington state. Lynn Ciani, chief risk officer of Numerica Credit Union, referred to this process as "know your client" on steroids. Numerica had four, full-time account managers dedicated to these accounts who performed due diligence and onboarding. In addition, the "Canna-Committee", which included the chief risk officer, the lead marijuana account manager,

corporate counsel, a member of the legal compliance team, a branch representative, and the senior vice president of enterprise risk management, reviewed each account. Approved accounts remained separated from regular credit union accounts. Salal credit union employed a team of six marijuana account managers, assigned a personal account manager to each account, and hired armored trucks to transport cash (Payne, 2019; Morgan, 2022).

Marijuana bank accounts require on-going, special services. Credit unions must file Suspicious Activity Reports (SARs) each quarter for all marijuana accounts and Currency Transaction Reports (CTRs) for currency transactions over $10,000 per day. They must continuously monitor noteworthy events, changes, and issues that the Liquor and Cannabis Board reports, and follow legislative and judicial actions, and any other publicly-available information that may affect their marijuana business clients (FIN-2014-G001, February 14, 2014).

Official data reveal that these services were and continue to be relevant. An examination of 170,975 marijuana-related suspicious activity reports (SARs) shows that 20,000 have been "termination SARs" meaning that the financial institutions terminated 20,000 marijuana-related accounts from 2014 to 2021. The remainder of the SARs are "limited" or "priority" SARs which report marijuana activity but note that the transaction is not abnormal or concerning. Financial institutions are required to file these reports quarterly for each account and the remaining SARs are part of ongoing account management required of credit unions that provide banking to marijuana businesses.

Fees

The account fees paid by marijuana dispensaries reflect the costs of these customized solutions. Anecdotes from the time report that the account application fees were $1,000, nonrefundable, and came without a guarantee or even a signal of approval. Salal Credit Union charged a minimum monthly fee of $350, but tacked on additional fees for the number and type of transactions and the cost of armored vehicles to transport cash. The co-founder of Evergreen Market suggested that his business was paying several thousand dollars per month in bank fees (Groover, 2014; Barcott, 2015).

In contrast, a "Basic Business Checking" product with Numerica, includes debit cards, online bill pay, mobile banking, night deposits (deposits do not need to be made in person), credit cards, courtesy pay, remote deposit capture (cell phone check deposits based on a picture of the check), financial services products, and shared-network banking (Numerica, 2023). Businesses pay no monthly fee with a $5,000 daily balance. Of the 10 most-used business checking accounts in the U.S. in 2022, 6 charged $0 and 4 charged between $10 and $16 in monthly fees (Kriss and Sheehy, 2023).

Lottery for Marijuana Licenses

The state used a lottery system to determine who would be able to apply for a license to sell recreational marijuana. There were 1,174 applicants vying for 334 licenses and the lottery was held in May of 2014. The lottery results did not guarantee that the winner would obtain a retail license and qualifying for a license was an arduous process with many pitfalls for applicants. Regulators needed to review the applicant's operations and financial plans and

conduct background checks. Startup costs could range from $50,000 to $400,000. Applicants were required to build out their stores, which included infrastructure such as paved parking lots and cameras, and pass a final inspection. Applicants could fail the licensing process if their location was too close to specific types of venues. For example, a proposed store was disqualified because it was too close to a public park, but further inspection revealed that the venue was a private RV park and the licensing process moved forward. Another potential store owner was left in limbo because a day-care center moved nearby after he applied for a license. If an applicant failed, the state moved to the next lottery number drawn in the initial lottery. State officials started issuing store licenses by early July.

Numerica and Salal credit unions announced that they would work with marijuana businesses soon after FinCEN guidance about banking with marijuana businesses was released on February 14, 2014, well before the May lottery. Despite the uncertainties in the lottery and approval process, credit unions heard from at least 1,000 potential applicants expressing interest and asking questions.

C. Alternatives to cash management

In terms of alternatives, accessing banking services under false pretenses ("underground banking") is time-intensive and risky. To stay underground, transactions must be small (Carlyon, 2019). As one dispensary owner noted, "it's a daily activity if you're a 502 business to make your deposits without blowing up the bank." He makes multiple deposits over many days before he can write a check to the IRS (Kiley, 2014). Small money orders, prepaid debit cards, and department store credit cards with low spending limits are also options. Despite these efforts, most accounts get shut down and money orders and debit cards get canceled. For example, Kristi Kelly, owner of Good Meds, has had 23 bank accounts canceled. Owners have been blacklisted by banks and have lost accounts due to the marijuana odor of cash deposits (Richtel, 2015).

For dispensaries that want to patch together legal cash management solutions there are a growing array of options. Dispensary owners that want to provide customers with payment solutions to make shopping easy provide on-site ATMs. Dispensaries also have developed "cashless ATM" transactions in which customers can use a debit card for purchases but the transaction appears as an ATM withdrawal on the customer's bank statement. Customers paid fees for these services of up to 20% of the transaction price. Although initially touted as a "convenient and cost-effective way to transact legitimate cannabis purchases", banks and transaction processors eventually cracked down on these transactions, labeling them as a form of money laundering. Other innovations include ZaZZZ, a marijuana vending machine which operates inside dispensaries and accepts cash and Bitcoin (Scott, 2015). "Smart safes" are an in-store option that helps dispensaries manage large amounts of cash. These safes are bolted to the floor, connected to the internet, monitored by security cameras, and able to collect cash, count currency, and check for counterfeits.

The need for banking alternatives in the marijuana industry has led to an explosion of fintech solutions that can replace many of the traditional banking functions. Fintech has developed new forms of customer payment options. Canpay and Aeropay are payment apps that allow customers to use debit and credit cards (Mullen, 2022). "FinCann" offers a product that competes with cashless ATMs (Fincann, 2023). Smart Safes and hybrid ATMs

resolve physical, in-branch transactions (Paybotic, 2023). Customers can preload PayQwick cards or use the app to make purchases. In addition, PayQwick is a nonbank financial institution that gives business owners access to an online payment platform to pay vendors, landlords, and employees (PayQwick, 2023). Dama Financial gives businesses access to online banking and cash courier services (Dama, 2023).

Fintech may be able to provide some of the warehousing functions by easing bookkeeping, verification, and validation of currency. Banking-as-a-service (BaaS) providers have emerged with products and services to help financial institutions and fintech firms work with dispensaries. Hypur collects all relevant business data, provides a software platform that audits a company's licenses, tax returns, financial statements, and state records, and makes it possible for banks to conform to Treasury Department regulations (Hypur, 2023). It can integrate into point-of-sale providers, e-commerce platforms, and data analytics software and allows businesses to connect their checking account to a digital payment option. Shield Compliance is a compliance management platform that includes "Shield Assure", which automates compliance tasks such as daily monitoring and reporting and "Shield Engage", which manages new member onboarding (Shield, 2023). Wurk helps marijuana firms meet various operating requirements of local and U.S. laws and manage HR functions (Wurk, 2023). "Link to Banking" and "Kind Financial" have partnered to help marijuana businesses and financial institutions follow anti-laundering and other regulatory guidelines.[38]

D. Wholesale and Retail Market Transactions

Wholesale Market: Dispensary - Supplier Relationship

Through interviews with processors and dispensaries we learned that transactions in the wholesale market with dispensaries without cash management services are more costly than with dispensaries with cash management services because of the need to verify, validate, and securely transport cash. We call these, and other additional costs, "administrative" costs.

In the wholesale market, suppliers sell marijuana to dispensaries at wholesale prices and transactions consist of large quantities of marijuana and cash being exchanged. Without cash management services, the cash transfer becomes more complicated. First, suppliers must coordinate transportation for cash collections (Koch, 2019). They hire licensed transporters and pay 1% to 1.5% of the value of cash-in-transit just to insure the cash.

Second, cash payments must be counted, verified as legal tender, and safely stored. Firms typically hire at least one or two employees dedicated to bookkeeping (counting cash and managing cash flows), security (armored guards and IT software), and issuance (converting cash into convenient denominations and obtaining money orders). In interviews, employees say a large amount of their time is spent dealing with cash including, applying scented laundry spray on the money to remove the marijuana odor, sorting money into piles to be vacuum sealed, and continually counting and verifying the amount of cash on hand. That, of course, makes firms extremely vulnerable to misappropriation of funds and employee theft; as much as 90% of monetary and product loss in the cannabis industry has been attributed

[38] https://mjbizdaily.com/industry-snapshot-banking-related-services/

to employee theft (Kaufman, 2020). Moreover, supplier contracts typically allow between 14 and 30 days for payment in full and suppliers bear the risk that dispensaries without bank accounts will be robbed and unable to pay.

Legal restrictions in Washington state prevent dispensaries and processors from forming a vertically integrated supply chain. Hence, dispensaries must work closely with suppliers to develop long-term, stable relationships (Rensburg, 2016). Suppliers offer a variety of products and variation in quality. Suppliers can create, package, and brand products and can offer novelty (Guth, 2022). These features are important to customers, sometimes more than the price per gram. Good relationships with suppliers mean that dispensaries can access similar product offerings and consistent product availability which are a function of drought, harvest, and shelf life (Rensburg, 2016).

Cash management can help dispensaries form relationships with suppliers by avoiding the costs of all-cash transactions. Some suppliers will not work with dispensaries without cash management. For example, Hawthorne growers, will not accept cash, money orders, traveler's check, or cashier's checks. They accept company check, personal check, credit card, ACH, or wire transfer and want to review financial statements and other financial information that they request before making payment agreements (Hawthorne, 2023). Suppliers may reward dispensaries for using non-cash payments by extending payment due dates to 30 days, rather than 14 days after billing (LeafLink, 2023). Common deal terms will include the number of high-quality products, price-volume discounts, and payment terms (Rensburg, 2016).

Suppliers rely on accurate estimates of product volumes from dispensaries in order to create enough product for the market (Carlson, 2021). Dispensaries with cash management form a loyal customer base and can have more accurate estimates of demand compared to dispensaries without cash management. Having a consistent supply chain, with predictable product quality and safety, improves the reputation of the dispensary and supplier (Guth, 2022). Ultimately, the quality and consistency of products and services holds the dispensary and supplier relationship together (Staff, 2022).

Retail Market: Dispensary - Customer Relationship

In the retail market, customers want in-stock inventory, greater product variety, and affordable pricing at dispensaries (Rensburg, 2016). The quality advantage that the dispensary gets in the wholesale market predicts that dispensaries with cash management services will have more resources to provide a high quality shopping experience to customers. Higher quality creates a "clientele effect" that allows firms to charge higher prices for the same product. In a hand-collected dataset of customer reviews from Yelp from 2014 to 2017, we find that budtenders make or break a customer's experience with the dispensary. Repeat customers build close relationships with their budtender and expect consistency, quality, and safety in the dispensary's products. They are willing to pay higher prices for these benefits. Customers frequently say they are willing to drive longer distances for higher quality employee interactions. We also find that dispensaries with cash management receive better Yelp reviews, based on over 2,000 Yelp reviews that we collected.

Anecdotal evidence from customers and dispensaries in Washington state at the time of our analysis suggests that payment processing was not the main driver of value. In our survey data we found that payment types (credit cards, debit cards, cryptocurrency)

do not differ by whether a dispensary has cash management services or not. Credit card transactions are exceedingly rare because they are illegal whether the dispensary has cash management services or not. Other payment solutions, such as "cashless ATMs" also have some amount of legal uncertainty that does not differ based on whether a dispensary has cash management services. Moreover, customers, rather than dispensaries, were paying the transaction fees either at the ATMs inside of the store or when they use the "cashless ATM" option. The "cashless" ATM option charged a fee of $3 for every $15 purchased and these fees were assessed separately on the receipt - appearing as an ATM fee. Finally, a 2021 survey conducted by Hypur reports that 70% of cannabis customers will choose a dispensary with no convenience fees over one with convenience fees.

Through industry reports and customer reviews on the "Yelp" website, we find that dispensaries without cash management must commit significant resources of time and money to build an "in-house" solution. Solutions are labor- and time-intensive due to cash payments LeafLink (2023). Most cannabis businesses need at least one or two employees exclusively dedicated to counting cash, making money drops, and obtaining money orders and cashier's checks. Payment in cash requires the payer to wait as money runs through counting and counterfeit-detection machines (Weed, 2018a). In an all-cash environment, delegating payment authority is risky and, typically the owner, makes all of the payments, which can limit the scale of the business (Staff, 2022).

E. Competition and the Benefits of Cash Management

Profits and losses drive entry and exit in a frictionless product market, but there are regulatory and logistical frictions in the marijuana industry that limit new entry. The lottery for licenses and the extensive regulatory approvals required for licensed dispensaries to start doing business create frictions that substantially diminish the effects that action on the extensive margin would have on marginal profitability. We examine the entry and exit decisions throughout our sample. Entry was gradual from 2014 to 2017. There were 2 exits over the sample period and by January of 2017, 321 of the licenses were granted and storefronts were opened. The timing of the gradual entry suggests that compliance with the licensing process determined entry, rather than changes in product market competition. We also report in Table DI that new entry is not correlated with proximity to a credit union or profitability following entry.

Rather than competition arising from new entrants, in our model competition arises when more and more firms are able to garner the clientele effect with customers, through access to cash management. As firms are able to access cash management, the magnitude and statistical significance of our results should eventually disappear. However, this does not mean that the positive effect of cash management attenuates. Cash management will continue to generate the value that we measure, but any measurable treatment effect will disappear because all businesses will have access to the technology. Instead, the setting reaches an equilibrium in which all firms have access to cash management, as in most industries, and we no longer have a counterfactual to measure the effect.

F. External Validity

The administrative and quality costs that we find matter in the marijuana business are not unique to the marijuana industry. Specifically, the cash warehousing value applies in all industries. Moreover, we argue that warehousing is central to the growth in fintech and banking rather than an outmoded function. Consider digital warehousing, for example. Bookkeeping, for example, counting currency, tracking cash flows, and recording transactions, is essential as are safe storage (cyber security) and currency issuance (providing legal currency to complete transactions). Cryptocurrency and fintech solutions that redefine the banking industry will need to incorporate these lessons to ensure a well-functioning banking system.

In addition, the setting allows us to study how credit unions, local and national banks, and fintech services respond to uncertainty, risk, and new growth opportunities. Local credit unions used 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. They invented a customized, small-scale model for providing financial services to marijuana businesses. Their solutions evolved over time, but were labor-intensive, hyper-localized and emphasized due diligence, strict compliance, and constant contact with state regulators (Payne, 2019).

In contrast, large banks did not want to undertake the risks associated with marijuana businesses. National banks would need to learn the local regulations and laws and develop compliance protocols that they could communicate to a central authority. Moreover, national institutions had alternative investment opportunities outside of these communities.

This gap in solutions allowed fintech businesses to develop a niche in the banking market. They used the local expertise gathered by credit unions to build standardized products, such as compliance and onboarding products, that allowed financial institutions to scale up their account offerings. These fintech products are able to use hard information about marijuana firms, like traditional national banks use, but can process the information to comply with idiosyncratic, local laws.

In this experiment, fintech and local banks played complementary roles. Credit unions addressed the uncertainties of working with local marijuana businesses. Fintech found a niche in the banking market by developing technology that allowed credit unions to expand these relationships. Our findings provide a unique window into the benefits fintech is providing through cash management across industries.

G. Legislation

The Bank Secrecy Act (BSA) is a 45 year old federal statute that outlaws money laundering. FinCEN enforces the Act and issued guidance in 2014 for marijuana-related businesses and bank accounts. There is no formal act or law that protects financial institutions. Legislatures have tried and failed to pass laws to facilitate banking access since 2014.

Marijuana Business Access to Banking Act and related bills include:

- 2014: Rohrabacher-Farr Amendment which prohibits the use of Department of Justice federal funds to interfere with the implementation of state-level marijuana laws.

- 2015: HR 2076/S2076 died in committee.
- 2015: The courts required further clarification of the Rohrabacher-Farr Amendment to manage lawsuits.
- 2016: The courts required even more clarification of the Rohrabacher-Farr Amendment to manage lawsuits.
- 2018: U.S. Senator Cory Gardner initiated a failed attempt to pass the STATES Act that would enable banks, credit card networks, credit unions, and other financial institutions to enter the cannabis sector.
- 2018: Attorney General Jeff Sessions rescinded key guidance outlined in the "Cole Memo" detailing the principles of responsibly providing financial services to the marijuana industry.
- 2019: Legislature introduced the "SAFE Banking Act." The Act would help financial institutions to provide legal banking to marijuana related businesses (MRB).
- 2020: The MORE Act, which proposes to decriminalize marijuana at the federal level, passed the House but failed in the Senate.
- 2021: SAFE Banking Act has not passed yet.
- 2022: MORE Act passes the House again and advances to the Senate.
- 2022: SAFE Banking Act passes House and advances to the Senate.

Table DI: **Dispensary Entry**

This table reports results from a regression of *dispensary entry* on *distance to 502 credit unions*, future *profitability*, and survival (*continued operating*). An observation is a dispensary in a given week. Week fixed effects α_t, are included in the model. Standard errors clustered at the dispensary level are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels.

	Dispensary Entry
	(1)
Mi to 502 credit union	0.001*
	(1.74)
Profits (t+1)	-0.011
	(-0.32)
Profits (t+2)	-0.035
	(-0.82)
Profits (t+3)	0.021
	(0.61)
Profits (t+4)	-0.000
	(-0.01)
Continued operating	0.006
	(1.08)
R-squared	0.062
Number of Observations	7,315
Week FE	Yes

Table DII: **Yelp evidence**

This table investigates whether dispensaries with *cash management* receive better, more, or a different mix of reviews on *Yelp*. An observation is a dispensary. Columns (1) and (2) report estimates with *average score* as the dependent variable. Columns (3) and (4) report estimates with *total reviews* as the dependent variable. Columns (5) and (6) report estimates with the *fraction local reviewer* as the dependent variable. Columns (1), (3), and (5) report specifications in levels and columns (2), (4), and (6) report specifications in logs. *, **, and *** denote significance at the 10%, 5%, and 1% levels.
The results of the following OLS regression are in the table:

$$\text{Yelp}_i = \delta_0 + \delta_1 \text{Cash management}_i + u_{i,t}.$$

	Average Score		Total Reviews		Local fraction	
	Level	Log	Level	Log	Level	Log
	(1)	(2)	(3)	(4)	(5)	(6)
Cash management	0.260*	0.074*	2.270	-0.113	-0.016	-0.034
	(0.155)	(0.041)	(3.955)	(0.229)	(0.046)	(0.071)
City fixed effects	✓	✓	✓	✓	✓	✓
Adj. R-Square	0.081	0.061	0.062	0.221	0.142	0.210
Observations	103	103	103	103	103	103

Table DIII: **Survey evidence: Cash management and Payment Processing**

This table reports results from an analysis of the effects of *cash management* on payment processing at dispensaries. The data are from the *BERT* survey of marijuana businesses. Payment types include *credit card* and *debit cards*. Standard errors are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels.
The results of the following OLS regression are in the table:

$$\text{Payment}_i = \delta_0 + \delta_1 \text{Cash management} + u_{i,t}.$$

	Credit card	Debit card
	(1)	(2)
Cash management	-0.018	-0.055
	(0.029)	(0.050)
Adj. R-Square	0.0016	0.0051
Observations	254	254

E. Value of Cash Management Appendix

We consider a standard regulation model to provide a framework for developing predictions about cash management. We first present our framework with general supply and demand functions in the wholesale and retail markets, which we depict in Figures 1 and 2.

Next, we demonstrate how we can use this framework to calculate a back-of-the-envelope estimate of the value of cash management. In particular, we calculate the change in value from eliminating the regulation that makes banking in the marijuana industry difficult. We can calculate this change using observations from dispensaries with and without cash management services in wholesale and retail markets.

Finally, we provide a discussion of several extensions to our model. In particular, we discuss how our estimates would change if we loosen the assumptions of our model. In our framework, we follow the literature and make the simplifying assumption of perfectly elastic supply in the wholesale market and perfectly elastic demand in the retail market to focus on dispensaries; see Mace et al. (2020) for a discussion of this assumption in the marijuana industry. We show that if this assumption is violated, then our value estimates are lower bounds of the true effect. With our data, we calculate the first-order effect without additional assumptions on the supply and demand curves. We calculate the second-order effect with an additional assumption of linear supply and demand, which is approximate for small changes and can be relaxed (Kang and Vasserman, 2022).

A. *Framework*

In Figure 1, we graph supply and demand in the wholesale marijuana market assuming that supply is perfectly elastic. We model regulation that limits cash management as creating a friction $\theta_w > 0$ for firms that cannot access cash management. This friction could be due to a lack of reputation capital that firms with cash management have or due to administrative and information costs (see Appendix D for more details). Supply and demand in this market are given by,

$$P_w^S = C + \theta_w \tag{E.1}$$
$$P_w^D = A - Bq_w, \tag{E.2}$$

where w denotes wholesale, S and D denote supply and demand, q_w is wholesale quantity, and A, B, and C are supply and demand parameters. The market clearing price and quantities are

$$P_w = C + \theta_w \tag{E.3}$$
$$q_w = (1/B)(A - C - \theta_w). \tag{E.4}$$

The equilibrium price and quantities demonstrate that dispensaries without cash management ($\theta_w > 0$) face higher wholesale prices and buy smaller quantities than dispensaries with cash management ($\theta_w = 0$); the first two predictions outlined in Section II.

In Figure 2, we graph supply and demand in the retail marijuana market assuming that demand is perfectly elastic. We model regulation that limits cash management as creating

a friction $\theta_r > 0$ for firms that cannot access cash management. This friction could be due to a lack of reputation capital. In the retail market this reduces a firm's ability to create a "clientele effect." Supply and demand in this market are given by,

$$P_r^S = \chi + \gamma q_r \tag{E.5}$$

$$P_r^D = \alpha, \tag{E.6}$$

where r denotes retail, S and D denote supply and demand, q_r is retail quantity, P_r is retail price, and α, χ, and γ are supply and demand parameters. The market clearing price and quantities are

$$P_r = \alpha - \theta_r \tag{E.7}$$

$$q_r = (1/\gamma)(\alpha - \chi - \theta_r). \tag{E.8}$$

The equilibrium price and quantities demonstrate that dispensaries without cash management ($\theta_r > 0$) sell their product for a lower price and sell less than dispensaries with cash management ($\theta_r = 0$); the two predictions from the retail market in Section II.

B. Economic Value

Regulations, such as limiting access to cash management, create costs that shift supply and demand—much like a tax. Unlike a tax, however, there is no tax revenue. The value to the economy of eliminating the regulation has a first-order and a second-order effect, unlike a tax, which only has a second-order effect.

The economic value generated by the marijuana industry declines due to frictions in accessing cash management resulting in higher wholesale prices and lower quantities sold. This value can be decomposed into a first-order and second-order effect. The first-order effect is given by the blue cross-hatch rectangle in Figure 1 with height equal to the difference in wholesale prices charged to dispensaries with and without cash management and base equal to the quantity sold to dispensaries without cash management. This is the effect on the inframarginal transactions—which still take place but produce less value to the market. The calculation of this effect does not require any additional assumptions on the demand curve, though it does depend on the assumption of perfectly elastic supply. The second-order effect is given by the red diagonal-hatch triangle in Figure 1 with height equal to the difference in wholesale prices charged to dispensaries with and without the regulation and base equal to the difference in the quantities sold to dispensaries with and without the regulation. This is the effect on marginal transactions—which no longer occur because of the frictions in the wholesale market. The calculation of the second-order effect as a triangle requires an assumption of linearity in the demand curve in this range. This assumption seems reasonable but could be loosened; see Kang and Vasserman (2022). The economic value in the marijuana industry from cash management is given by the sum of the first- and second-order effects across all transactions (the first and second terms below)

$$\begin{aligned} \textit{Economic value wholesale market} &= \Delta P_w \times q_w(\theta_w > 0) + \frac{1}{2}\Delta P_w \Delta q_w \\ &= (6.93 - 6.42) \times 6.8 + \frac{1}{2}(6.93 - 6.42) \times (8.09 - 6.80) \\ &= \$3.80 \end{aligned} \tag{E.9}$$

$$\begin{aligned} \textit{Economic value retail market} &= \Delta P_r \times q_r(\theta_r > 0) + \frac{1}{2}\Delta P_r \Delta q_r \\ &= (13.04 - 12.04) \times 6.80 + \frac{1}{2}(13.04 - 12.04) \times (8.09 - 6.80) \\ &= \$7.45 \end{aligned} \tag{E.10}$$

All of the numbers required to compute this economic value are reported in the paper. Specifically, the average wholesale price for dispensaries with and without cash management and quantity sold by dispensaries without cash management are \$6.93, \$6.42, and 6.8 grams. The value of the first-order effect of cash management per dispensary, per week, per strain is (\$6.93 - \$6.42)×6.8 = \$3.47. In our sample, we have 1,571,862 dispensary-strain-week observations; which implies the first-order value of having cash management for all dispensaries is \$5,454,361 from 2014 to the first month of 2017.

The second-order (or marginal) effect calculation uses four numbers; the wholesale price charged to dispensaries with and without cash management and the quantity sold to dispensaries with and without cash management. These numbers are \$6.93, \$6.42, 6.8 grams, and 8.09 grams, respectively. The value of the second-order effect of cash management per dispensary, per week, per strain, is $(1/2) \times (\$6.93 - \$6.42) \times (8.09 - 6.8) = \$0.33$. In our sample, the second-order effect for all dispensaries if they all had cash management is $\$0.33 \times 1,571,862 = \$518,714$. The total value of cash management in the wholesale market is \$5,973,076.

The calculation of the economic value of cash management in the retail market is similar to the wholesale market. In the retail market, we assume that customers are perfectly elastic while dispensaries are not. This assumption is reasonable if customers can costlessly switch between dispensaries. This implies that demand is flat and the supply curve is upward sloping as depicted in Figure 2. The value of cash management in the retail market is modeled as an increase in the demand curve. Its value incorporates the benefits from providing high-quality products, in other words, the clientele effect, which commands premium pricing to guarantee quality and higher demand for the high-quality product.[39] We calculate the economic value of cash management in the retail market by combining our framework and the estimates of retail prices in dispensaries with and without cash management of \$13.04 and \$12.04,

[39]Cash management benefits customers primarily through reputational capital in the supply chain by allowing dispensaries to provide product quantity, quality, and consistency.

respectively. The first-order effect is $(\$13.04 - \$12.04) \times 6.8 = \$6.80$ and the second-order effect is $(1/2) \times (\$13.04 - \$12.04) \times (8.09 - 6.8) = \$0.65$. In our sample, the first-order effect is \$10,688,662, and the second-order effect is \$1,021,710. These numbers imply the total value of cash management in the retail market (first and second-order effects) is \$11,710,372.

C. Extensions

We conclude this section by considering several extensions of the previous back-of-the-envelope calculation of the value of cash management. First, we note that our calculation of the total economic value considers the value if all dispensaries had access to cash management by scaling by all observations. We could calculate the value currently in the market for cash management dispensaries by scaling the effect by only the observations from dispensaries with cash management. In practice, this calculation would produce values equal to about half of the value provided above. Second, we note that the value of cash management we calculate would still exist if all dispensaries had access to cash management. Dispensaries with and without cash management allow us to calculate this value as the difference in prices and quantities. The value would not disappear if all dispensaries had access. The allocation of benefits from eliminating the restrictions on banking depends on how elastic wholesalers, dispensaries, and customers are. Third, there may be an interaction effect between cash management and other banking services, such as lending, that our calculation does not include. In this case, our estimates are likely a lower bound because we do not capture these interaction benefits.

Fourth, we note our estimates are a lower bound if supply in the wholesale market and demand in the retail market are not perfectly elastic. Consider the case where supply is not perfectly elastic in the wholesale market, given in Figure E1. When supply is not perfectly elastic some of the cost of the regulation is borne by wholesalers—but we do not see this effect. The difference in wholesale price between firms with and without cash management only gives the effect borne by the dispensaries. In this case, if 20% of the cost of the regulation is borne by the wholesalers, then our estimates are too low by 20%. See Mace et al. (2020) for an extended discussion of the elasticities of supply and demand in the marijuana industry. Finally, if supply and demand are not linear, our second-order effect calculations will be misspecified. When demand in the wholesale market is concave, our second-order effect calculation is an upper bound, and the reverse when demand is convex; see Kang and Vasserman (2022) for a discussion of how to bound these effects.

Figure E1: **Value of Cash Management – Wholesale Market With Inelastic Supply**

This figure depicts the wholesale market with inelastic supply.
This figure depicts the wholesale market in which suppliers have imperfectly elastic supply (upward sloping lines) and dispensaries have imperfectly elastic demand (downward sloping line). Quantity (in grams) is on the horizontal axis and Price is on the vertical axis. Some of the cost of operating without cash management is borne by wholesalers (Supply without CM)