Public Health Interventions, Economic Activity, and Firm Value: Evidence from COVID-19 Vaccinations

John M. Bizjak, Swaminathan L. Kalpathy, Vassil T. Mihov, and Jue Ren *

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* All authors are from the School of Business, Texas Christian University, Fort Worth, TX, 76129, USA. Please address correspondence to Swaminathan Kalpathy: s.kalpathy@tcu.edu, M.J. Neeley School of Business, Texas Christian University, Box 298530, Fort Worth, TX 76129, phone: (817) 257-7533.

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Abstract

We examine how the introduction of COVID-19 vaccinations affects business activity and firm performance in the US. A ten percent increase in vaccination rates results in a 6.6 percent increase in establishment customer visits. Difference-in-differences analysis shows that the effects are causal. Studying both the ex-ante market anticipation at the vaccine announcement and the ex-post realization in terms of establishment foot traffic once vaccines are introduced, we find that the benefits are concentrated among firms that perform poorly at the onset of COVID-19, firms that rely less on online sales, and firms that are of non-essential nature. Increased vaccination rates ultimately result in higher firm sales and earnings, and impact strategic decisions to expand stores. The main channels of increased store visits are increased vaccination rates of customers, relaxation of local restrictions in response to rising vaccination rates, and increased employment rates at the establishments. There are limits, however, to the effect of vaccinations on business activity. The benefits of increased vaccinations on business activity are diminished during the "delta" variant surge in COVID infections in the summer of 2021. Overall, we show that vaccinations create private benefits to firms and their shareholders, in addition to their intended public health benefits.

1. Introduction

The onset of COVID-19 had a significant negative effect on public health and on business activity in the US. Starting in late February of 2020, there was a substantial contraction in GDP, increase in unemployment, and a precipitous decline in aggregate stock returns. Goolsbee and Syverson (2021) and Bizjak, Kalpathy, Mihov, and Ren (2022) document that foot traffic to retail establishments declined between 60 and 70 percent during the early onset of the pandemic in March and April of 2020. Collectively, this evidence reflects the adverse consequences of COVID-19 on the US economy.

Recognizing the importance of vaccinations in combating the spread of the virus and the severity of its consequences on public heath, there was a concerted effort by entities both in the government and the private sector to rapidly develop an effective vaccine against the virus. When results from successful Phase 3 clinical trials of the COVID-19 vaccine were first announced by Pfizer-BioNTech on November 9, 2020 (and soon after by Moderna), they were greeted with optimism and elicited a positive market-wide response in expectations of revived business activity (Acharya, Johnson, Sundaresan, and Zheng, 2021). Subsequent approvals through Emergency Use Authorizations (EUA) allowed the formal administration of the vaccines.[1]

Goolsbee and Syverson (2021) document that the crippling effect of COVID-19 on the economy is first order, reflecting people's fear of the virus. Stay-at-home measures and other government policies only have a limited effect on reducing establishment visits. Since the vaccination for COVID-19 reflects a reversal of the initial adverse shock, and the aforementioned discussion relating to the optimism that was associated with the introduction of vaccines, we expect

[1] The authorization dates are December 11, 2020 for Pfizer-BioNTech, December 18, 2020 for Moderna, and February 27, 2021 for Johnson and Johnson. https://www.fda.gov/emergency-preparedness-and-response/mcm-legal-regulatory-and-policy-framework/emergency-use-authorization

that the vaccines would alleviate people's fear of the virus and boost economic activity. Accordingly, we predict that economic activity will be increasing in vaccination rates.

Nonetheless, vaccines were not unilaterally embraced. There were opposing viewpoints on COVID-19 vaccines at many levels. On the individual level, evidence from surveys and academic research points to an ideological divide on the decision of an individual to get vaccinated. (Agarwal, Dugas, Ramaprasad, and Gao, 2021; Kaiser Family Foundation surveys, 2021). There was also a divide in the business community on this issue. Many firms required their employees to get vaccinated before they could work in-person.[2] On the other hand, there were many others that were opposed to such requirements. A poll conducted by Willis Towers Watson reported that more than a third of the large companies included in the survey were not intending to impose such vaccine requirements for their employees.[3] At the government level, the Federal mandate of private employers requiring their employees to get vaccinated was blocked by the US Supreme Court. At the local level, states differed in their policies relating to vaccines mostly along political ideology. While some states imposed vaccine mandates (for example, for state employees, frontline and health care workers, teachers and school staff), others passed legislation or executive orders banning such mandates.[4] Further, some states kept local restrictions in place even after the introduction of vaccinations, which could dampen the effect of vaccinations on business activity.

From an epidemiological standpoint, the scientific community had proposed a target vaccination rate of 70% in order to achieve herd immunity.[5] Nonetheless, a report by McKinsey identified several challenges in achieving this target, including low adoption rates of vaccination

[2] https://www.nbcnews.com/business/business-news/here-are-companies-mandating-vaccines-all-or-some-employees-n1275808
[3] https://www.nytimes.com/2022/01/31/business/texas-florida-vaccine-mandate.html
[4] https://www.aarp.org/politics-society/government-elections/info-2020/coronavirus-state-restrictions.html
[5] https://www.who.int/news/item/23-12-2021-achieving-70-covid-19-immunization-coverage-by-mid-2022#:~:text=%5B4%5D%20These%20targets%20were%20then,population%20coverage%20by%20mid%2D2022.

in the US in the past, uncertainty about the adoption of vaccination and concerns about the safety and side effects, a lack of unanimity among medical professionals in recommending vaccines, and mis- and dis-information on the topic of vaccinations.[6]

Given these challenges, it is unclear how vaccine rates in the US would evolve over time, whether herd immunity can be achieved, and at what rates of vaccination the economic benefits accrue. The differential attitudes relating to vaccines make it unclear how big of an effect vaccine rates ultimately might have on overall business activity. This alternative viewpoint serves as the null hypothesis as to why vaccines may not have a significant effect on economic activity.

Several studies document the medical efficacy of vaccines in reducing hospitalizations and deaths[7]. We present evidence on the effect of vaccines on business activity. We study how COVID-19 vaccinations, in addition to their intended public health benefits in containing the spread of the virus and mitigating its impact on the infected, create firm value through expanded economic activity. We examine how vaccinations rates impact economic activity in business establishments. We measure weekly vaccination rates using Center for Disease Control and Prevention (CDC) data at the county level.[8] Our primary measure of economic activity is the weekly foot traffic to retail establishments obtained from *SafeGraph*. The foot traffic data offers several advantages in studying the impact of vaccinations on economic activity. First, by using establishment fixed effects for our main tests, we are able to account for many confounding factors that could be present if economic activity is aggregated at county, state or higher level. Second, for some of our tests, we are able to measure the geographical source of customer visits on a granular level (Census

[6] https://www.mckinsey.com/industries/life-sciences/our-insights/covid-19-vaccines-meet-100-million-uncertain-americans

[7] Harris, 2022; Vilches, Moghadas, Sah, Fitzpatrick, Shoukat, Pandey, Galvani, 2022; Watson, Barnsley, Toor, Hogan, Winskill, Ghani, 2022.

[8] We define vaccination rates as the total number of fully vaccinated individuals (two doses of Pfizer-BioNTech or Moderna or one dose of Johnson and Johnson vaccines) divided by the county's population. Our results are robust when we use the first dose only.

Block Group, CBG) which allows us to connect vaccination rates of customers to visits more tightly.[9] Third, unlike firm financial or aggregate economic data typically available at a quarterly or annual frequency, the weekly establishment visits capture the economic effects in almost real time providing a cleaner and more direct inference less subject to confounding effects.

We find that foot traffic increases significantly following the introduction of vaccinations in the US. A ten percent increase in vaccination rates results in a 6.6 percent increase in establishment visits, on average. Our evidence suggests that this effect is causal in nature. We show that the primary channels that positively influence store visits are increased vaccination rates of customers, the relaxing of local government restrictions in response to rising vaccination rates, and higher employment in the establishments. We note that these channels are not mutually exclusive, and they reflect both demand-side as well as supply-side effects that drive up business activity.

The increase in visits translates into higher sales and earnings at the firm level. We also show that firms adjust their policies relating to expansion in response to the new environment. Firms experience a higher sensitivity in establishment visits to vaccinations rates when there is a greater initial loss of foot traffic at the onset of COVID-19, when firms are in non-essential industries, and when firms have a sharp decline in financial performance during the last three quarters of 2020.

We examine the stock market reaction to the initial announcement of successful vaccine trials, and find that higher abnormal returns for firms which had greater initial loss of foot traffic during the initial onset of the pandemic and among firms that witnessed the sharpest decline in financial performance.

[9] Our primary tests rely on county-level vaccination rates. Given the heterogeneity in vaccination rates within a county, we also use more granular data from California using ZIP code level vaccination rates to validate our primary results.

We recognize that the vaccination choice is endogenous and directly related to an individual's disposition toward the virus and social distancing measures. Individuals with *laissez faire* attitudes towards the pandemic are less likely to stay at home (and more likely to attend business establishments) while also less likely to get vaccinated (as cited earlier). On the contrary, individuals exercising abundant caution might have avoided visiting stores despite being fully vaccinated. Therefore, any tests using observed vaccination rates potentially bias downward the effect of vaccines on business activity. In addition to using establishment and establishment and time fixed effects, our identification strategy also relies on a difference-in-differences approach by comparing US states that border Canadian provinces which introduced vaccinations with a notable lag relative to the US. We find a greater increase in traffic to an establishment in a US state compared to an establishment of the same brand in a bordering province in Canada during a period when there is increased vaccination in the US compared to Canada.

We also examine the limitations of the influence of vaccines on business activity. The surge in COVID-19 cases arising from the "delta" variant in summer of 2021 presents an external shock that demonstrates that vaccines have limits in terms of their medical efficacy. Insofar as customers' shopping behavior responds to the safety of the environment, overall, we find a diminished effect of vaccination rates on foot traffic during this period. Foot traffic increases are lower in retail establishments that are essential in nature, and among establishments that have higher online sales. Further, we show that the effect of vaccination rates on business activity are non-linear with higher benefits achieved at lower levels of vaccination which diminish at higher vaccination rates. In a quadratic specification, we estimate that the economic benefits are maximized when cumulative vaccination rates reach around 37%. In a cubic specification we observe a local maximum at 27% vaccination rates, after which the effect plateaus. This is much lower than the scientifically proposed level of 70% required to achieve herd immunity. An important insight from our paper is that the rate of vaccination required from a public health standpoint differs significantly from that required to achieve economic benefits.

Our paper is most closely related to the following studies. Acharya, et al. (2021) examine the ex-ante anticipatory effect of COVID-19 vaccine development on asset prices and show that financial markets anticipate increased economic activity with vaccine introduction. Our paper, on the other hand, documents the ex-post realization of benefits of vaccine introduction using customer behavior. Goolsbee and Syverson (2021) and Bizjak et al. (2022) study consumer behavior during the initial phase of the COVID-19 pandemic and document a sharp decline in economic activity. Kim, Parker, and Schoar (2020) show that both revenues of small businesses and the consumption spending of their owners decline by roughly 40% at the COVID-19 onset. In contrast, our paper examines a period of reversal in customer attitudes with vaccine introduction resulting in economic growth. Additional contemporaneous studies (Deb, Furceri, Jiménez, Kothari, Ostry, Tawk (2021), Hansen and Mano (2021), Gagnon, Kamin, and Kearns (2022)) examine how vaccines impact the economy by using aggregate data at the county or national level. Our study uses granular data at the establishment level and weekly frequency to understand the causal effect on business activity and the channels that drive it. Our difference-in-differences analysis using cross-border comparison (US versus Canada) further establishes the causal nature of vaccinations on economic output. Finally, by studying a major government intervention that has economy-wide implications, our paper is related to a large literature in the banking setting, especially during the financial crises, that examines how these interventions affect shareholder welfare in addition to their societal impact. One of the major takeaways from our study is that vaccinations create private economic benefits to firms and their shareholders by boosting economic activity, in addition to their intended public health benefits.

2. Empirical Design and Data

2.1. Identifying Assumptions

A key econometric issue in our empirical analysis is establishing causality in the effect of vaccines on economic activity. For example, as Bizjak et al. (2022) note, there was a high degree of politization of the virus and the business responses to containing its transmission. Similarly, Agarwal, Dugas, Ramaprasad, and Gao (2021) and Kaiser Family Foundation surveys (2021) document that political partisanship is one of the strongest predictors of the decision to get vaccinated. In light of this evidence, individuals with *laissez faire* attitudes towards the pandemic are more likely to attend business establishments while also less like to get vaccinated. Alternatively, individuals exercising an abundance of caution are likely to stay home even after getting vaccinated. This could cause the cross-sectional coefficients of the effect of the vaccination rate on business activity to be downward biased. We address this issue in two main ways. One, we use cross-sectional identification using an establishment (or establishment and time) fixed effect specification.[10] In other words, we account for many latent factors that drive establishment traffic that are time-invariant in nature, while allowing foot traffic and vaccinations rates to vary week by week. We estimate the following baseline panel regression specification:

$$LNVISITS_{i,t} = \alpha + \beta_1 VRATE_{i,t} + X_i + Y_i + \varepsilon_{i,t} \tag{1}$$

[10] Additional specifications include the use of firm control characteristics, industry, state, county or firm fixed effects.

where $LNVISTS_{i,t}$ is the logarithm of the visits to establishment *i* during week t, X_i stands for the lagged firm-level or demographic control variables, Y_i refers to the industry, state, county, establishment or time fixed effects.

An additional identification strategy we adopt to address causation uses the staggered introduction of vaccines in the US relative to vaccine introductions in Canada. Canada and the US demonstrated significantly different vaccination rates between late December of 2020 (the beginning of vaccination in the US) through May of 2021 (Figure 2, Panel A). Exploiting the difference in vaccination rates between the two countries to address causality, we perform a difference-in-differences (DiD) analysis comparing US states and Canadian border provinces after vaccines were introduced in the US but not yet in Canada. We account explicitly for whether the states and provinces are contiguous to each other, and only include establishments belonging to firms or brands that operate in both countries in those states and provinces. This analysis relies on the assumption of parallel trends in these contiguous states and provinces before the introduction of the vaccines. The US border states and Canadian border provinces are similar in industrial development, commerce, political system, culture (especially accounting for state and provinces bordering each other), climate, and other factors that may jointly affect store visits. Furthermore, Canada effectively closed its border with the US during our sample period, thus the visits on each side of the border reflects strictly local traffic. We estimate a regression specification of the following form:

$$LNVISITS_{i,t} = \alpha + \beta_1 US_i + \beta_2 Post + \beta_3 US_i * Post + Y_i + \varepsilon_{i,t} \qquad (2)$$

where $LNVISITS_{i,t}$ is the natural logarithm of weekly visits to an establishment *i* during week *t;* *US* is an indicator variable equal to 1 if the establishment *i* is in a US border state, and 0 if in a

Canadian border province; *Post* is an indicator variable taking the value of 1 during March 1, 2021-April 26, 2021, and 0 during the period June 1, 2020-December 7, 2020; and Y_i stands for brand, contiguousness, or brand-contiguousness fixed effects.

2.2 Data and summary statistics

We use the *SafeGraph* database to collect data on establishment-level foot traffic. *SafeGraph* identifies physical visits to millions of points-of-interests (POIs) by collecting GPS data from mobile phone applications and provides detailed information on visits and (anonymized) visitors to establishments. The establishments cover thousands of distinct brands, including public and private companies in industries such as such as restaurants, grocery stores, retail stores, hotels, banks, movie theaters, etc.

We identify brand establishments and link them to their parent firms. We calculate the number of the visits each week (*VISITS*) in each establishment. Bizjak et al. (2022) show that firm characteristics help explain changes in store traffic, in addition to other variables. Therefore, we add firm controls measured as of 2019 for all of our observations (2020-2021), except when we use firm/brand fixed effects or establishment fixed effects, where these controls are not needed. Firm characteristics are obtained from Compustat and CRSP.

We use several sources for vaccination rates. First, we use weekly data at the county level from the Center for Disease Control (CDC) for all US states. Since data for Texas is not included in the CDC data, we obtain the data from the Texas Department of State Health Services (DSHS). For our DiD analysis, we obtain Canadian vaccination data from the Public Health Agency of Canada. Finally, for some of our tests we obtain data on vaccinations and local policies from the California Department of Public Health. Throughout the analyses, we use the percentage fully vaccinated individuals as our explanatory variable.

We obtain demographic data from *SafeGraph* Open Census. We obtain from the New York Times county-level data on COVID-19 cases and county-level 2020 Presidential election voting results.

Our final sample consist of 327,259 establishments owned by 249 public firms operating in 2,770 counties during the period December 28, 2020-June 28, 2021. Table 1 presents the summary statistics for our sample. The average number of visits to an establishment in a week is 100.6 with a median of 63. The average vaccination rate during the period in a county is 16.6% with a median of 11.9%.

In Figure 1, we plot the distribution of cumulative vaccination rates per capita across time in the US, and the natural logarithm of visits in our sample. As we observe in the figure, visits to establishments exhibit a notable increase in the beginning of 2021 which coincides in time with the introduction of vaccinations.

3. Results

3.1 Vaccination rates and store visits

Table 2 reports our baseline regression results. We regress *LNVISITS*, the dependent variable, on vaccination rates, control variables, and different types of fixed effects. In model 1, we include state and industry fixed effects; in model 2 we include an exhaustive set of firm and demographic control variables as well as state and industry fixed effects; in model 3 we include firm controls and county and industry fixed effects (county fixed effects fully absorb the demographic characteristics). In model 4, we include establishment fixed effects. The establishment fixed effects fully absorb all observable and unobservable time-invariant factors that influence foot traffic. In this specification, which is the tightest of all the models, we compare week-by-week foot traffic as a function of vaccination rates for the same store. Across the first four models, we observe that a 10 percent increase in vaccination rates is associated with 5.2 to 6.6 percent increase in foot traffic. Given the average weekly change in visits of 5.6 percent in our sample, the point estimates we obtain are economically quite meaningful. In model 5, we include time (monthly) fixed effects in addition to establishment fixed effects. The coefficient estimate is much lower, indicating that a 10 percent increase in vaccination rates is associated with 1.4 percent increase in foot traffic. The time fixed effects estimate an average effect at each point in time and assume that the same average effect for all establishments (and by extension, all counties in which they operate) which is a strong an assumption. The time fixed effects also remove the time-series variation in vaccination rates, and the test becomes a cross-sectional comparison of two counties, for example Dallas County versus Los Angeles County at a given point in time, which is a weaker inference compared to model 4.

In unreported robustness tests, we obtain similar results when we use percentage change in visits relative to a pre-COVID benchmark; when we use a period starting in mid-April 2021, when there is a "critical mass" of vaccinations in the US based on an inflection point in the distribution of cumulative vaccinations; when we exclude politically polarizing firms (based on survey, or their political donations); when we exclude politically polarized counties (based on 2020 Presidential voting results); when we use the first dose of COVID-19 vaccines.

3.2. Difference-in-differences analysis

We use the staggered nature of the introduction of vaccinations in the US (the treated group) relative to Canada (the untreated group) to perform a DiD analysis. As Figure 2 shows, there is a distinct lag between the introduction of the vaccines in the two countries. We identify as pre-vaccinations the period from June 2020 to December 7, 2020, before vaccinations were administered. We define as post-vaccinations the period starting in March 1, 2021 and ending in the last week of April, 2021, during which period the US ramped up vaccinations significantly, but Canada did not yet. We exclude the Canadian province of Yukon, which had vaccination rates similar to the US bordering states. We exclude the period January 1 to February 28, during which the difference in vaccination rates between the bordering states and provinces was quite small. As of March 1, the difference in vaccination rates was greater than 5%. We note that Canada had much lower vaccination rates (as opposed to being strictly “untreated”), and the US had higher vaccination rates (as opposed to being fully “treated”). This set up allows us to draw inferences of the effect of vaccine introduction on foot traffic, as the two countries generally have similar economic and political systems, and the same retail stores. This set up also ensures that the control group (Canada) remains “untreated” since Canada had closed its border with the US. Our identification is strong because we account for the change in traffic (pre- vs. post) for establishments of the same brand, but across different vaccination regimes. We include US state and Canadian provinces that are on the border in order to account for latent cultural, social, political, climatic, and other factors based on shared geography. In other words, we compare, for example, a store in Seattle with one in Vancouver of the same brand as opposed to comparing a store in Miami with one in Montreal.

We present the results in Table 3. In model 1, we include fixed effects for brand and contiguousness simultaneously; in other words, we compare the traffic for stores of the same brand in a US state to the traffic of stores of the same brand in an adjacent Canadian border province. In the model 2, we include brand fixed effects and contiguousness fixed effects independently. In model 3, we include brand fixed effects only. We find that the coefficient associated with the post period in the US is positive and significant, indicating higher visits in US border states relative to contiguous Canadian border provinces by 38 percent after the introduction of vaccinations in the

US, across all three models. Figure 3 presents the DiD weekly coefficient plot, along with the 95% confidence intervals. We observe a sharp increase in the coefficient (indicating higher visits in the treated group, US), starting in March of 2021. The average coefficient in the pre-period is 9.5 percent indicating a higher traffic in the US relative to Canada pre-vaccinations. Importantly, for the DiD assumptions of parallel trends, we do not observe any trends in the coefficients in the pre-period. The coefficient increases sharply in the post-period with an average of 43.4 percent.

3.3 Channels affecting store traffic

In this subsection, we provide additional analysis on how increased vaccination rates translate into store traffic. Specifically, we examine the following channels: 1) increased vaccination rates among customers (which we study by using visits by senior citizens, more granular evidence at the ZIP code level from California, and by comparing the effect on visits by vaccinated versus unvaccinated individuals); 2) the effect of vaccination rates on relaxation of local restrictions (also from California); and 3) the effect of vaccinations on increased employment at the retail establishments.

3.3.1 Visits by seniors

Early eligibility criteria gave priority for vaccination to seniors (along with individual with certain medical conditions). We obtain the age distribution for the Census Block Group (CBG) in which each establishment is located (in models 1 and 2), as well as that the primary CBG from which customers come from (in models 3 and 4). We define *HIGH_AGE* as an indicator variable equal to 1 if the CBG is in the top quintile of age, 0 otherwise. In Table 4, we interact *HIGH_AGE* with *VRATE* to examine the incremental effect of individuals that are more likely to be vaccinated on store traffic. We note that store traffic is decreasing in *HIGH_AGE*, indicating that, on average, older individuals are less likely to shop in person. The interaction variable is positively related to store traffic, suggesting that the effect of vaccination rates on store traffic is amplified when the traffic is driven by senior customers who are more likely to be vaccinated.

3.3.2 ZIP code evidence from California

We employ the disclosure of vaccination rates on ZIP code level by the state of California. There is a high level of heterogeneity in vaccination within a county. However, ZIP codes reflect a higher homogeneity in demographics and attitudes towards vaccination. This allows us to proxy for the vaccination status of the individuals going to the store more precisely.[11] In Table 5, we repeat our Table 2 models 4 and 5 (establishment or establishment and time fixed effects) with vaccination rates measured at the ZIP code level. In Table 5 models 1 and 2, we measure the vaccination rate at the store ZIP code, while in models 3 and 4 we measure it from the ZIP code from which the majority of the customer traffic comes from. We continue to find economically large and statistically significant coefficients of vaccination rates on traffic. This analysis provides more direct evidence that the increased store traffic is driven by customer that are vaccinated visiting the store.

We obtain additional evidence based on the source of traffic to the stores by examining ZIP codes with the high and low vaccination rates in California. For each establishment in each week, *SafeGraph* provides the number of visitors from various CBGs. We classify each customer CBG into the top or bottom quintile based on its vaccination rate measured at the corresponding ZIP code. Next, we calculate the ratio of number of visitors coming from the highest or the lowest quintile to total store visitors for each establishment in each week (*PCT_VISITOR*). In Table 6, we regress *PCT_VISITOR* on the store ZIP code *VRATE* separately for the lowest (in models 1 and

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[11] We ensure that the inferences that we draw from California data can be generalized. In Internet Appendix (IA) Table 1, we replicate our results from Table 2 for California and compare them to the rest of the country. Generally, the coefficients are of similar magnitude, and we are unable to reject that they are statistically different pairwise, with the exception of those in models 5.

2) and the highest (in models 3 and 4) quintiles. We observe that as the vaccination rate for the store area goes up, a greater fraction of customers come from highly vaccinated areas, and a lower fraction from low vaccinated areas. This finding is consistent with the idea that the store traffic is driven by vaccinated individuals, and is inconsistent with the alternative idea that unvaccinated customers may go out more and contribute to traffic as vaccination rates increase in an area.

3.3.3 Lifting of local restrictions

California instituted a color-coded rank system for counties with four tiers ranging from 1 (purple) having the most stringent restrictions to 4 (yellow) having minimal restrictions, with the status updated weekly.[12] In Table 7, we show that the vaccination rate is positively associated with higher tier (fewer restrictions) for a county. In terms of economic significance, a 10 percent increase in vaccination rates corresponds to an improvement in the county status (and the associated lifting of restrictions) by more than one half a tier. We obtain similar results when we examine changes in tier status. The evidence points to another channel through which vaccination rates can drive up traffic, by removing or relaxing government restrictions on businesses.

3.3.4 Labor market effects

The last channel that we examine is how vaccination rates can boost business activity by increased employment. *SafeGraph* provides a variable related to foot traffic that likely indicates the presence of an employee measured by the "dwell time" that an individual spends at a store at prolonged intervals of time. In Table 8, we regress natural logarithm of number of store employees (*LN_EMP*) on *VRATE*, on weekly basis. A ten percent increase in vaccination rate is associated with around 2.7% increase in employment at the establishment. This provides another mechanism

[12] https://emd.saccounty.gov/EMD-COVID-19-Information/Documents/California-Color-Coded-Tier-System--en.pdf

through which vaccination rates can enhance business activity by increased labor market participation.

3.4 Cross-sectional analysis of the effect of vaccinations on foot traffic

While COVID had a devastating effect on business activity, not all businesses fared equally. For some, the effect was much worse, and some actually benefited from the effect of the pandemic (Goolsbee and Syverson, 2021). In this subsection, we examine the differential effects of the introduction of vaccinations across establishment and firm characteristic.

In Table 9, we examine the effect of vaccinations on establishment or firms that were particularly negatively affected by COVID comparted to those that were not. In Table 9, Panel A, models 1 and 2, we define an indicator variable equal to 1 if the establishment was in the highest quintile of decrease in visits in March 2020, or 0 otherwise. We interact that variable with *VRAT*E, and show that the establishment who lost greater traffic benefit the most from increase in vaccination rates.[13]

We also examine the essential or non-essential nature of the establishment business. Using data from CDC we classify establishments as essential or non-essential.[14] In models 3 and 4, we interact the non-essential dummy with *VRATE*, and observe much higher incremental effect of vaccination on foot traffic for non-essential businesses.

We use data from *SafeGraph* to determine the percentage of sales that come from online orders on establishment level. We classify establishments with low level of online sales (*LOW_ONLINE*) as those in the lowest quintile. In models 5 and 6, we interact *LOW_ONLINE* with *VRATE* and find higher differential effect for businesses with low percentage of online sales.

[13] We find similar results if we aggregate the initial drop in visits at the firm level.
[14] https://www.cdc.gov/vaccines/covid-19/categories-essential-workers.html

In Table 9, Panel B, we examine the effect of vaccinations on or firms that were particularly adversely affected by COVID-19 compared to those that were not. We use several measures of performance to examine this adverse effect – sales, earnings, free cash flow, and stock returns over the last three quarters of 2020. We classify if a firm is in the lowest quintile in each of these four characteristics, and interact its poor performance status with *VRATE*. Across all eight models we observe firms that had the worst performance across these categories benefited the most in terms of increase in foot traffic as it relates to vaccinations.

3.5 Firm-level effects of vaccinations

Our findings so far indicate that vaccination rates positively influence establishment level foot traffic. In this subsection, we investigate the impact at the firm level. In Table 10, panel A, we regress the natural logarithm of a firm's quarterly sales for the first two quarters of 2021 (in models 1-4), and the natural logarithm of a firm's quarterly EPS[15] (earnings per share) obtained from COMPUSTAT, on the natural logarithm of store visits (*LNVISITS*). We calculate the sum of the weekly visits to all establishments of the same firm to obtain the firm-level visits for the first two quarters of 2021. In models 5 through 8, we drop *ROA* (which measures prior profitability). We observe that a 10 percent increase in foot traffic results anywhere between 3.6 and 4.9 percent increase in a firm's quarterly sales, and a 0.25 to 0.47 percent in quarterly EPS, indicating that increased customer visits arising from vaccinations ultimately result in significant economic benefits as observed in higher revenues and profitability for companies.[16]

[15] We add a constant equal to the minimum EPS observation to ensure that there are no negative values resulting in loss of observations when taking the logarithm. As an alternative approach, we calculate the percentile rank of all variables and rerun the same regression. We obtain similar results.

[16] We also conducted the same tests with quarterly net income and find similar results, not reported for brevity. A 10 percent increase in foot traffic results anywhere between 0.68 to 1.11 percent increase in net income.

In panel B, we study how vaccines influence corporate decision to expand or close stores. Specifically, we calculate the number of stores for each firm in each county per month. We compare this to the total number of stores in the period between June, 2020 and November, 2020 prior to vaccinations. We estimate a multinomial logit model with the following outcomes: no change (the normalized alternative); increase in number of stores; decrease in number of stores. Results indicate that vaccination rates positively influence the likelihood of store openings and negatively influence the likelihood of store closures. Overall, we find that firms incorporate the new business environment post-vaccination in their strategic decisions relating to store expansion or contraction.

One potential channel through which vaccination rates can increase business activity is by removal of restrictive measures by the firms themselves through their store policies (e.g., relaxing social distancing measures, removing limits of number of customers at a time, lifting of mask requirements). While we do not have available data to examine this channel directly, the evidence presented in this subsection does not rule out the possibility of firms taking into consideration the changing environment after vaccines are introduced. The store expansion and the labor market increased participation point to supply-side channels that drive up business activity, in addition to the demand-side channel arising from customer vaccinations.

3.6 Market response to vaccine announcement

We examine the stock market reaction to the initial announcement of successful vaccine trials. On November 9, 2020, Pfizer-BioNTech announced successful phase 3 trials for their COVID-19 vaccine. In Table 11, we report regressions of cumulative abnormal stock returns (*CAR*) on firm characteristics. *CARs* are calculated using a market adjusted model, in Panel A, and relative to the Fama-French model, in Panel B. We use the CRSP value-weighted index as the market portfolio. The estimation period is 252 trading days ending 30 trading days before the event. We cumulate the CARs over days (0,1) relative to the event.

Overall, we observe greater positive market response for firms of non-essential nature, those that experience greater initial drop of foot traffic, or perform poorly during the last three quarters of 2020 based on sales, earnings, free cash flows, or risk-adjusted stock returns. These results reflect the ex-ante anticipation of increased business activity, particularly for the firms hit the hardest by COVID-19. The market's anticipation is validated by the ex-post realization reflected in higher foot traffic to the establishment of firms of similar characteristics as shown earlier.

3.7 Limits to the effect of vaccinations on business activity

We examine the limitations of the influence of vaccines on business activity. As already shown in our cross-sectional tests, the introduction vaccination benefits different firms differently. While firms that did poorly during the onset of the pandemic benefit more, firms that were of essential nature, had higher percentage of online sales, or otherwise performed well do not benefit as much.

To shed light into other dimensions of the vaccine limitation on business activity, we examine a period (the "delta" surge in summer of 2021) where vaccines were not nearly as effective in terms of their medical efficacy towards the new variant. Insofar as customers' shopping behavior responds to the safety of the environment, we study the effect of vaccination rates on foot traffic during this period. In Table 12, we define an indicator variable, *DELTA_VARIANT*, equal to one during July-September, 2021 (the delta variant surge), 0 otherwise. We interact the variable with *VRATE*. The interacted variable is negative and significant, indicating a lower impact of vaccination rates on customer traffic during the delta surge.

Further, we show that the effect of vaccination rates on business activity is non-linear, with higher benefits achieved at lower levels of vaccination, and with the benefits diminishing at higher vaccination rates. In an unreported quadratic specification for *VRATE*, we estimate that the economic benefits are maximized when cumulative vaccination rate reaches 37%. In a cubic specification, we observe a local maximum even earlier, at 27% vaccination rate, after which the effect plateaus. These findings indicate that the benefits accrue faster at relatively lower levels of vaccination rate, after which the benefit diminishes. We note that the average vaccination rate at the end of our sample is in the mid-30s (35.5) percent. As vaccination rates evolve further, it remains to be seen how the effect may change at higher levels of vaccination, and at what level the benefits plateau.

4. Conclusion

In this paper, we study how COVID-19 vaccines impact business activity. Using granular data on store level foot traffic, and county or ZIP code level vaccination rates, we show that customer foot traffic is increasing in vaccination rates with significant economic effects both at the establishment level as well as at the corporate level in terms of increased firm sales, earnings, and positive announcement stock returns. Our evidence suggests that this effect is causal in nature. We also find that firms incorporate the new business environment post-vaccination in their strategic decisions to expand or close stores.

We document three primary channels that influence the effect of vaccinations on increased business activity: traffic driven by vaccinated individuals, lifting of local government restrictions in response to higher vaccination rates, and higher employment rates at the establishments as a function of vaccination rates. These channels are not necessarily mutually exclusive, reflecting both demand-side as well as supply-side factors that influence increased economic activity.

We examine both the ex-ante market anticipation at the vaccine announcement and the ex-post realization in terms of customer foot traffic once vaccines are introduced. The benefits we document are not uniform across all firms or establishments. The benefits are concentrated among firms that perform poorly at the onset of COVID-19, firms that rely less on online sales, and firms that are of non-essential nature. Nonetheless, there are limitations on the positive effect of vaccinations on business activity. The effect is reduced during the “delta” variant surge in COVID infections in the summer of 2021, among retail establishments that are essential in nature, and among establishments with higher levels of online sales.

By studying a major government intervention that has economy-wide implications, our paper sheds light on the effects of public health policies on a firm’s business activity. One of the key takeaways from our study is that vaccinations create private economic benefits to firms and their shareholders by boosting economic activity, in addition to their societal impact on public health.

Appendix - Variable Definitions

CAR	Cumulative abnormal return based on either market-adjusted returns or the Fama-French factors
CASH	*Compustat* item CH/*Compustat* item AT
DEBT	*Compustat* item DLTT+ *Compustat* item DLC)/ *Compustat* item AT
FCF	(*Compustat* item IB-*Compustat* item TXT+*Compustat* item DP-*Compustat* item CAPX)/*Compustat* item AT
HIGH DROP	Equal to 1 if the establishment was in the highest quintile of decrease in visits in March 2020, and 0 otherwise
LOW ONLINE SALE	Equal to 1 if the establishments were in the lowest quintile of online sales in November 2020, and 0 otherwise
MKTBOOK	[*Compustat* item AT + (*Compustat* item CSHO**Compustat* item PRCC_F) − *Compustat* item CEQ]/ *Compustat* item AT
NI	*Compustat* item NI
NON-ESSENTIAL	Equals 1 if an industry is defined as essential-work industry by Center for Disease Control and Prevention, and 0 otherwise https://www.cdc.gov/vaccines/covid-19/categories-essential-workers.html
PBLACK	The share of the Black population measured at the county level. We aggregate census block group (CBG) data from *SafeGraph Open Census* at the county level
PLATINO	The share of the Latino population measured at the county level. We aggregate CBG data from *SafeGraph Open Census* at the county level
RETURNS	Cumulative abnormal return based on market-adjusted returns for the period between April, 2020 and November, 2020
ROA	*Compustat* item EBITDA/ *Compustat* item AT
SALES	*Compustat* item SALE
TRUMP_BIDEN_2020	Trump share of the presidential 2020 vote at the county level.
VISITS	Weekly visits to stores
VRATE	Ratio of fully vaccinated (second dose for Pfizer-BioNTech or Moderna, single dose of Johnson and Johnson) individuals to the population of the county, measured every week

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Figure 1. Store visits and vaccination rates in the US across time

The figure presents, for each week in our sample, the mean of the natural logarithm of weekly store visits for our sample, obtain from *SafeGraph*, measured on the left vertical axis, and the percentage of individuals fully vaccinated in the US as percent of a county's population, measured on the right vertical axis.

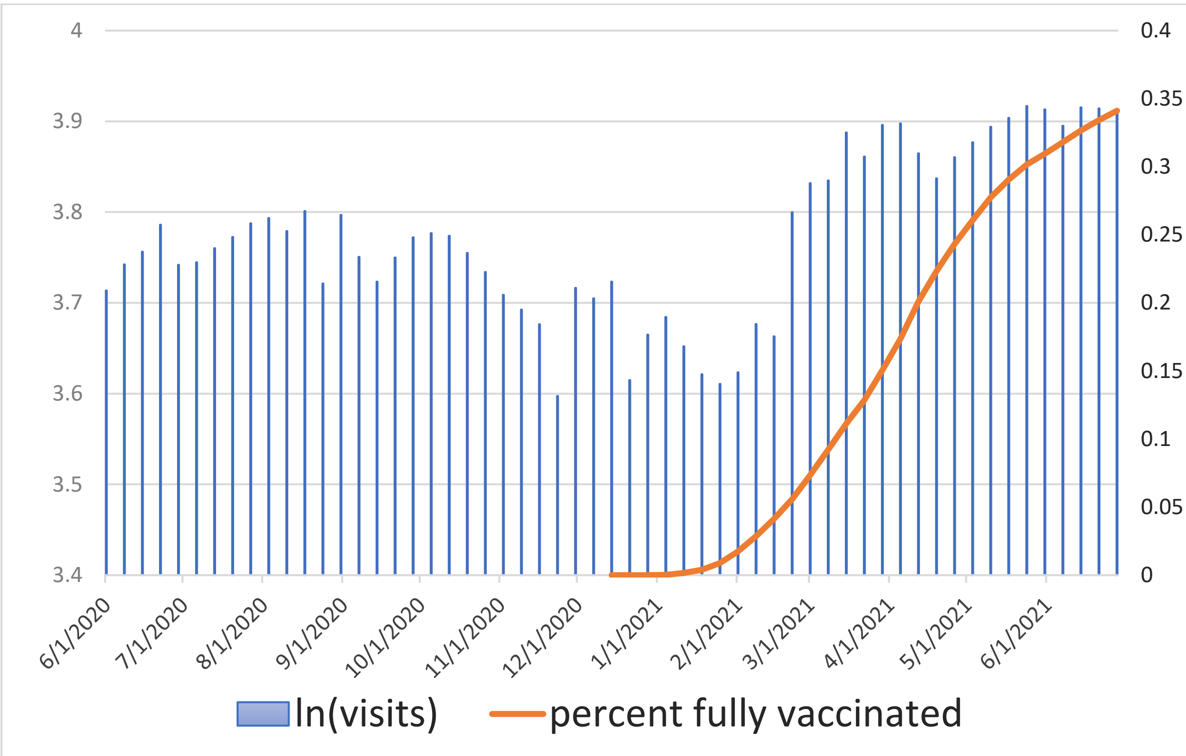
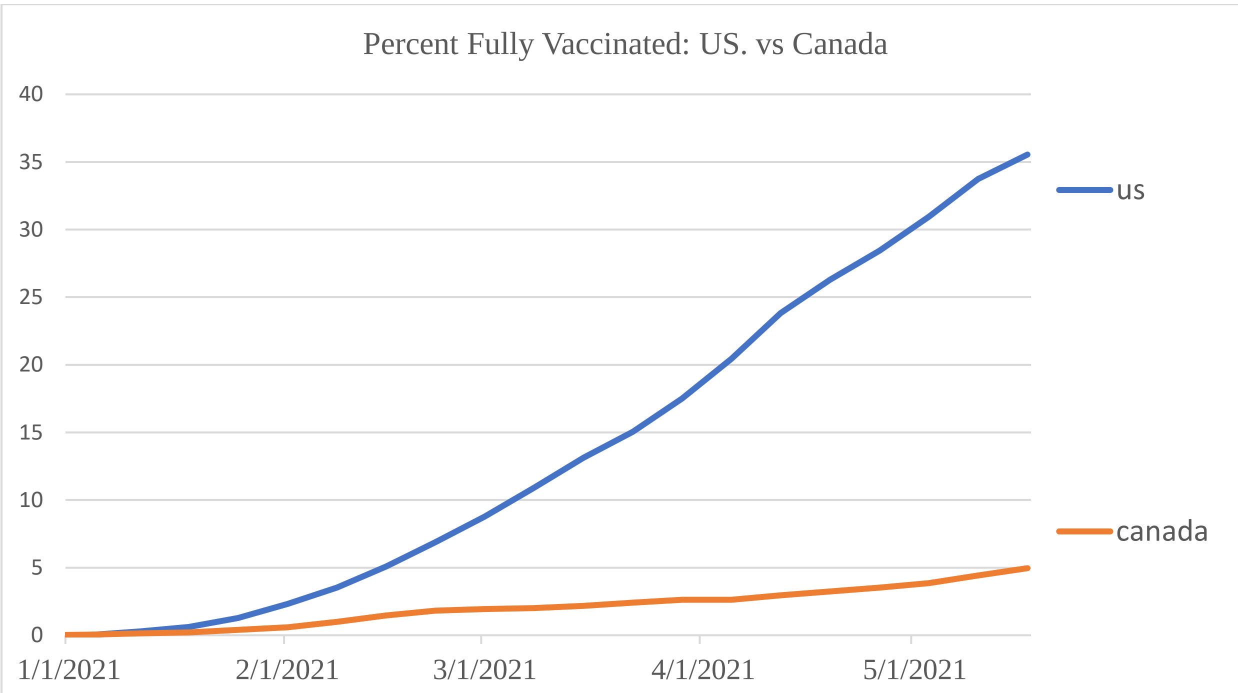


Figure 2. Vaccination rates in the US and Canada

The figure presents the percentage fully vaccinated individuals in the US and Canada from the January 1, 2020 through May, 17, 2021, in Panel A. The vaccination rate data is based on the US states and Canadian provinces on the US-Canada border, shown in Panel B. Source for the figure in panel B is DOI: 10.1007/978-3-540-46266-8_9

Panel A: Vaccination rates



Panel B: States and provinces on the US-Canada border

Figure 3. Difference-in-Differences coefficient time plot

The figure displays the weekly coefficients from our Difference-in-Differences (DiD) analysis on the comparison between the US (the treated group) and Canada (the untreated group) along with their 95% confidence intervals. The pre-vaccination period is June 1-December 7, 2020. The post-vaccination period is March 1 – April 26, 2021. The figure also displays the average coefficient in the pre-period (9.53%) and the average coefficient for the post-period (43.36%).

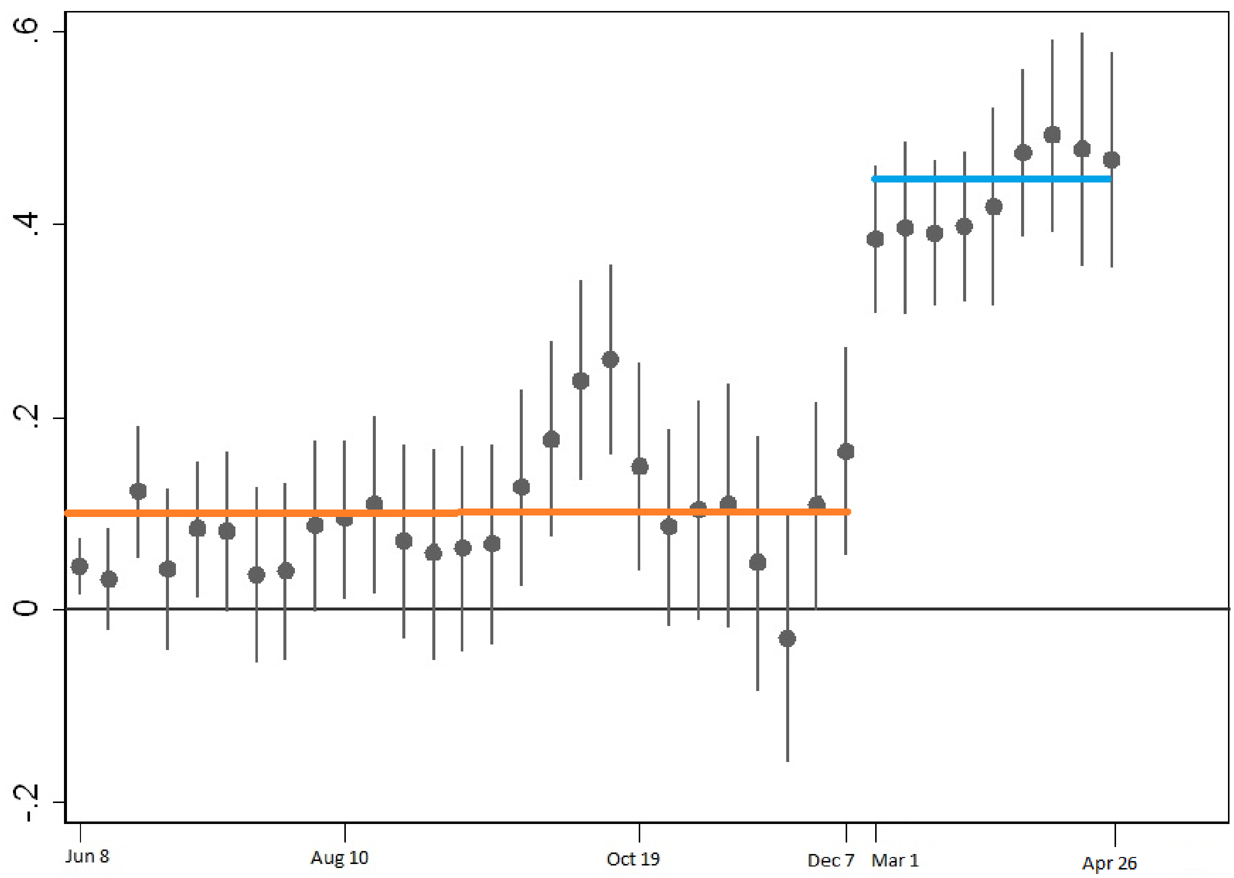


Table 1. Descriptive Statistics

This table presents descriptive statistics across establishment-week observations for a sample of 327,259 establishments owned by 249 firms for the period December 28, 2020-June 28, 2021, with available firm-level data, and *SafeGraph* data on store visits. *VISITS* are calculated at the establishment level on a weekly basis, *VRATE* is calculated at the county level measured at weekly frequency. Demographic characteristics are on the county level, and firm characteristics are as of the year preceding COVID, i.e., 2019. Variable definitions are provided in Appendix.

Variable	N	MEAN	SD	P25	P50	P75
VISITS	8,287,701	100.579	119.210	26	63	126
VRATE	8,287,701	0.166	0.160	0.017	0.119	0.293
SALES (in $ mil.)	8,287,701	61,302	96,113	4,627	16,039	72,148
DEBT	8,287,701	0.539	0.250	0.352	0.512	0.666
MKTBOOK	8,287,701	2.861	2.482	1.286	1.739	3.765
ROA	8,287,701	0.162	0.101	0.101	0.124	0.204
CASH	8,287,701	0.059	0.064	0.018	0.036	0.080
PBLACK	8,287,701	0.139	0.144	0.030	0.086	0.202
PLATINO	8,287,701	0.134	0.137	0.039	0.082	0.185
TRUMP_BIDEN_2020	8,287,701	0.482	0.165	0.369	0.461	0.605

Table 2. Vaccination Rates and Store Visits

The table presents regression of the natural logarithm of weekly store visits at establishment level, *LNVISTS,* on county-level weekly cumulative vaccination rates, *VRATE*, and control variables for the period December 28, 2020-June 28, 2021. We report coefficient estimates with standard errors in parentheses. Variable definitions are provided in Appendix. Standard errors are clustered at county level. We use ∗∗∗, ∗∗, and ∗ to indicate statistical significance at the 1, 5, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*
VRATE	0.5183***	0.5728***	0.6199***	0.6598***	0.1392***
	(0.0145)	(0.0127)	(0.0115)	(0.0118)	(0.0186)
LNSALES		0.2722***	0.2754***		
		(0.0036)	(0.0035)		
DEBT		0.0670***	0.0604***		
		(0.0218)	(0.0206)		
MKTBOOK		-0.0817***	-0.0785***		
		(0.0036)	(0.0036)		
ROA		-0.4407***	-0.4989***		
		(0.0603)	(0.0584)		
CASH		2.0508***	2.0055***		
		(0.1089)	(0.1074)		
PBLACK		0.2242***			
		(0.0822)			
PLATINO		0.1963			
		(0.1258)			
TRUMP_BIDEN_2020		0.8758***			
		(0.0841)			
Observations	8,287,701	8,287,701	8,287,701	8,287,701	8,287,701
Adjusted R-squared	0.3166	0.3762	0.3963	0.9377	0.9404
State FE, Industry FE	YES	YES			
County FE, Industry FE			YES		
Store FE				YES	
Store FE, Time FE					YES

Table 3. Difference-in-Differences Analysis: US versus Canada

The table displays the results from a DiD analysis comparing visits in the US (the threated group) vs Canada (the untreated group) following the introduction of vaccinations in the US. We identify the pre-vaccination period as June 1, 2020 to December 7, 2020, before vaccinations started being administered. We define as post-vaccinations the period from March 1, 2021 to April 26, 2021. We report coefficient estimates with standard errors in parentheses. Variable definitions are provided in the appendix. Standard errors are clustered at county level. We use ∗∗∗, ∗∗, and ∗ to indicate statistical significance at the 1, 5, and 10% levels, respectively.

	(1)	(2)	(3)
VARIABLES	*LNVISITS*	*LNVISITS*	*LNVISITS*
*US*POST*	0.3838***	0.3829***	0.3826***
	(0.0272)	(0.0272)	(0.0272)
US	1.3448***	1.3360***	1.3160***
	(0.0646)	(0.0573)	(0.0638)
POST	-0.2715***	-0.2709***	-0.2705***
	(0.0268)	(0.0267)	(0.0267)
Observations	2,831,391	2,831,391	2,831,391
Adjusted R-squared	0.5865	0.5747	0.5723
Brand - Contiguous FE	YES		
Brand FE, Contiguous FE		YES	
Brand FE			YES

Table 4. Channels of the Vaccination Effect on Store Visits: Seniors

The table presents regression of the natural logarithm of weekly store visits at establishment level (*LNVISTS*) on county-level vaccination rates (*VRATE*), and interacted variable indicating high age of the store census block group (CBG) in models (1) and (2) or customer CBG in models (3) and (4), and control variables for the period December 28, 2020-June 28, 2021. We report coefficient estimates with standard errors in parentheses. Variable definitions are provided in Appendix. Standard errors are clustered at county level. We use ∗∗∗, ∗∗, and ∗ to indicate statistical significance at the 1, 5, and 10% levels, respectively.

	Store CBG		Customer CBG	
	(1)	(2)	(3)	(4)
VARIABLES	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*
*VRATE*HIGH_AGE*	0.0624***	0.0505***	0.0819***	0.0678***
	(0.0162)	(0.0139)	(0.0172)	(0.0159)
HIGH_AGE	-0.0396***	0.0022	-0.1486***	-0.0974***
	(0.0074)	(0.0070)	(0.0094)	(0.0091)
VRATE	0.5600***	0.6090***	0.5721***	0.6208***
	(0.0131)	(0.0113)	(0.0124)	(0.0111)
LNSALES	0.2722***	0.2754***	0.2628***	0.2663***
	(0.0036)	(0.0035)	(0.0039)	(0.0038)
DEBT	0.0667***	0.0606***	0.2656***	0.2534***
	(0.0218)	(0.0206)	(0.0217)	(0.0208)
MKTBOOK	-0.0818***	-0.0785***	-0.0668***	-0.0647***
	(0.0036)	(0.0036)	(0.0032)	(0.0032)
ROA	-0.4406***	-0.4989***	-0.8288***	-0.8682***
	(0.0604)	(0.0584)	(0.0550)	(0.0539)
CASH	2.0515***	2.0049***	1.7290***	1.7116***
	(0.1089)	(0.1075)	(0.1147)	(0.1144)
PBLACK	0.2263***		0.2771***	
	(0.0819)		(0.0741)	
PLATINO	0.1874		0.1517	
	(0.1251)		(0.1185)	
TRUMP_BIDEN_2020	0.8872***		1.0010***	
	(0.0839)		(0.0757)	
Observations	8,287,701	8,287,701	7,862,956	7,862,956
Adjusted R-squared	0.3763	0.3963	0.3718	0.3902
State FE, Industry FE	YES		YES	
County FE, Industry FE		YES		YES

Table 5. Channels of the Vaccination Effect: California Zip Code Level Evidence

The table presents regression of the natural logarithm of weekly store visits at establishment level (*LNVISTS*) on ZIP code level vaccination rates (*VRATE*) in California. In models (1) and (2), the vaccination rate is from the store ZIP code. In models (3) and (4) the vaccination rate is from ZIP code from which the majority of the customer traffic comes from. We report coefficient estimates with standard errors in parentheses. Variable definitions are provided in Appendix. Standard errors are clustered at county level. We use ∗∗∗, ∗∗, and ∗ to indicate statistical significance at the 1, 5, and 10% levels, respectively.

	Store ZIP Code		Customer ZIP Code	
	(1)	(2)	(3)	(3)
VARIABLES	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*
VRATE	0.4939***	0.2644***	0.5084***	0.2617***
	(0.0148)	(0.0303)	(0.0156)	(0.0321)
CONSTANT	3.6160***	3.6723***	3.5985***	3.6578***
	(0.0036)	(0.0074)	(0.0037)	(0.0077)
Observations	793,384	793,384	755,947	755,947
Adjusted R-squared	0.9392	0.9409	0.9327	0.9348
Store FE	YES		YES	
Store FE, Time FE		YES		YES

Table 6. Channels of the Vaccination Effect: Source of Traffic by Customer Vaccination Rate

For each establishment in each week, *SafeGraph* provides the number of visitors from various CBGs. We classify each customer CBG into the top or bottom quintile based on its vaccination rate measured at the corresponding ZIP code in California. Next, we calculate the ratio of number of visitors coming from the highest or the lowest quintile to total store visitors for each establishment in each week (*PCT_VISITOR*). We regress *PCT_VISITOR* on the store ZIP code *VRATE* separately for the lowest (in models 1 and 2) and the highest (in models 3 and 4) quintiles. We report coefficient estimates with standard errors in parentheses. Variable definitions are provided in Appendix. Standard errors are clustered at county level. We use ∗∗∗, ∗∗, and ∗ to indicate statistical significance at the 1, 5, and 10% levels, respectively.

	Lowest Quantile Vaccination Rate		Highest Quantile Vaccination Rate	
	(1)	(2)	(3)	(4)
VARIABLES	*PCT_VISITOR*	*PCT_VISITOR*	*PCT_VISITOR*	*PCT_VISITOR*
VRATE	-2.0645***	-0.7776***	0.0721***	0.2017***
	(0.0561)	(0.0812)	(0.0188)	(0.0534)
Observations	691,643	691,643	691,643	691,643
Adjusted R-squared	0.7761	0.8585	0.1298	0.1769
Store FE	YES		YES	
Store FE, Time FE		YES		YES

Table 7. Channels of the Vaccination Effect: Vaccination Rates and Lifting of Restrictions

The table presents regressions of the California county rank on vaccinations rates and control variables. The rank represents a color-coded tier system for counties with four tiers ranging from 1 (purple) having the most stringent restrictions to 4 (yellow) having minimal restrictions updated weekly. *ΔCASES* is the change in the number of COVID-19 cases in a county compared to the previous week. We report coefficient estimates with standard errors in parentheses. Variable definitions are provided in Appendix. Standard errors are clustered at county level. We use ∗∗∗, ∗∗, and ∗ to indicate statistical significance at the 1, 5, and 10% levels, respectively.

VARIABLES	(1) *RANK*	(2) *RANK*	(3) *RANK*
VRATE	5.7107***	5.2656***	5.7353***
	(0.2192)	(0.2369)	(0.2177)
ΔCASES		-65.5418***	
		(9.5118)	
PBLACK	-0.3982	-0.3043	
	(1.1329)	(1.1727)	
PLATINO	0.2712	0.3420*	
	(0.1784)	(0.1833)	
TRUMP_BIDEN_2020	0.3508	0.3403	
	(0.3198)	(0.3282)	
Observations	1,250	1,250	1,250
Adjusted R-squared	0.7660	0.7779	0.8057
County FE	NO	NO	YES

Table 8. Channels of Vaccination Effect: Employment

The table presents regression of the natural logarithm of weekly number of employees at establishment level (*LN_EMP*) on county-level vaccination rates (*VRATE*) and control variables for the period December 28, 2020-June 28, 2021. The number of employees is obtained from *SafeGraph* data. We report coefficient estimates with standard errors in parentheses. Variable definitions are provided in Appendix. Standard errors are clustered at county level. We use ∗∗∗, ∗∗, and ∗ to indicate statistical significance at the 1, 5, and 10% levels, respectively.

VARIABLES	(1) *LN_EMP*	(2) *LN_EMP*	(3) *LN_EMP*	(4) *LN_EMP*
VRATE	0.2140***	0.2405***	0.2728***	0.0472***
	(0.0090)	(0.0081)	(0.0088)	(0.0155)
LNSALES	0.1378***	0.1380***		
	(0.0022)	(0.0022)		
DEBT	-0.1128***	-0.1164***		
	(0.0175)	(0.0172)		
MKTBOOK	-0.0080***	-0.0070***		
	(0.0023)	(0.0023)		
ROA	-0.2062***	-0.2062***		
	(0.0517)	(0.0516)		
CASH	0.1978***	0.1346**		
	(0.0651)	(0.0650)		
PBLACK	-0.0503			
	(0.0466)			
PLATINO	0.1435*			
	(0.0743)			
TRUMP_BIDEN_2020	0.1155***			
	(0.0365)			
Observations	5,751,675	5,751,674	5,742,733	5,742,733
Adjusted R-squared	0.2284	0.2410	0.7374	0.7378
State FE, Industry FE	YES			
County FE, Industry FE		YES		
Store FE			YES	
Store FE, Time FE				YES

Table 9. Cross-sectional Analyses: Role of Establishment and Firm Characteristics

The table presents regression of the natural logarithm of weekly store visits at establishment level, *LNVISITS*, on county-level vaccination rates, *VRATE*, and interacted variables. In Panel A, the interacted variables indicate high drop in establishment visits at the onset of COVID-19 in models (1) and (2), non-essential nature of business in models (3) and (4), or low-online percentage of establishment sales in models (5) and (6). We report coefficient estimates with standard errors in parentheses. In Panel B, the interacted variables indicate high decrease in sales in models (1) and (2), high decrease in net income in models (3) and (4), high decrease in free cash flows in models (5) and (6), and poor risk-adjusted returns in models (7) and (8), all measured over the last three quarters of 2020 on firm level. The interacted variables indicate that the change in the firm characteristic falls in the bottom quintile. We report coefficient estimates with standard errors in parentheses. Variable definitions are provided in Appendix. Standard errors are clustered at county level. We use ∗∗∗, ∗∗, and ∗ to indicate statistical significance at the 1, 5, and 10% levels, respectively.

Panel A: Establishment Characteristics

	High Drop in Visits		Non-essential Business		Low Online Sales	
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*
*VRATE*Variable*	0.1276***	0.1854***	0.2086***	0.2241***	0.0890***	0.0682***
	(0.0185)	(0.0171)	(0.0113)	(0.0112)	(0.0091)	(0.0099)
VRATE	0.6310***	0.0758***	0.6024***	0.0760***	0.5802***	0.1130***
	(0.0120)	(0.0169)	(0.0106)	(0.0180)	(0.0134)	(0.0187)
Observations	8,267,278	8,267,278	7,694,900	7,694,900	5,564,371	5,564,371
Adjusted R-squared	0.9374	0.9401	0.9387	0.9411	0.9410	0.9445
Store FE	YES		YES		YES	
Store FE, Time FE		YES		YES		YES

Table 9, Panel B: Firm Characteristics

	LOW SALES		*LOW NI*		*LOW FCF*		*LOW RETURNS*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*
*VRATE*Variable*	0.3903***	0.4126***	0.3463***	0.3770***	0.3176***	0.3183***	0.1333***	0.1230***
	(0.0111)	(0.0106)	(0.0144)	(0.0141)	(0.0116)	(0.0111)	(0.0195)	(0.0189)
VRATE	0.4818***	-0.1215***	0.5213***	-0.1027***	0.4986***	-0.0748***	0.5286***	0.0400
	(0.0122)	(0.0166)	(0.0125)	(0.0187)	(0.0110)	(0.0211)	(0.0184)	(0.0266)
Observations	4,706,483	4,706,483	4,551,406	4,551,406	3,698,661	3,698,661	2,861,013	2,861,013
Adjusted R-squared	0.9371	0.9402	0.9297	0.9330	0.9295	0.9327	0.9480	0.9505
Store FE	YES		YES		YES		YES	
Store FE, Time FE		YES		YES		YES		YES

Table 10. Vaccination Rates and Firm-level Effects

Panel A presents regressions of the natural logarithm of a firm's quarterly sales or EPS (earnings per share) for the first two quarters of 2021, obtained from COMPUSTAT, on the natural logarithm of store visits (*LNVISITS*). In panel B, we present the results from a multinomial logit model with the following outcomes: no change (the normalized alternative); increase in number of stores; decrease in number of stores as a function of *LNVISITS*. We report coefficient estimates with standard errors in parentheses. Variable definitions are provided in Appendix. We report coefficient estimates with robust standard errors in parentheses. We use ∗∗∗, ∗∗, and ∗ to indicate statistical significance at the 1, 5, and 10% levels, respectively.

Panel A: Effect of Store Visits on Firm Quarterly Sales and Earnings Per Share

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	*LN_SALES*	*LN_SALES*	*LN_SALES*	*LN_SALES*	*LN_EPS*	*LN_EPS*	*LN_EPS*	*LN_EPS*
LNVISIT	0.3590***	0.4903***	0.3819***	0.4877***	0.0277***	0.0468***	0.0248***	0.0426***
	-0.038	-0.0315	-0.0379	-0.0323	(0.0072)	(0.0081)	(0.0074)	(0.0081)
DEBT			-1.6203***	0.1196			-0.1079	-0.1171
			-0.3742	-0.301			(0.0733)	(0.0757)
MKTBOOK			-0.1696***	-0.0786*			0.0242***	0.0295***
			-0.0579	-0.0442			(0.0084)	(0.0083)
ROA			3.2220**	1.5423				
			-1.2645	-0.952				
CASH			-2.7540***	0.1283			-0.1862	-0.0284
			-1.0013	-0.8779			(0.1964)	(0.2221)
Observations	471	470	471	470	470	469	470	469
Adjusted R-squared	0.1578	0.6455	0.2208	0.6453	0.0283	0.2510	0.0411	0.2730
Industry FE	NO	YES	NO	YES	NO	YES	NO	YES

Table 10, Panel B: Probability of Increase or Decrease in the Number of Stores (Multinomial Logit)

	(1)		(2)		(3)		(4)	
VARIABLES	*DECREASE*	*INCREASE*	*DECREASE*	*INCREASE*	*DECREASE*	*INCREASE*	*DECREASE*	*INCREASE*
VRATE	-0.8526***	2.5454***	-0.9274***	2.6415***	-1.0692***	2.2607***	-1.1617***	2.3266***
	(0.0449)	(0.0686)	(0.0466)	(0.0703)	(0.0451)	(0.0684)	(0.0470)	(0.0700)
LNSALES					0.0292***	0.2229***		
					(0.0060)	(0.0105)		
DEBT					1.1598***	0.0770		
					(0.0428)	(0.0850)		
MKTBOOK					-0.0441***	0.2142***		
					(0.0063)	(0.0078)		
ROA					3.8854***	-0.9359***		
					(0.1253)	(0.2127)		
CASH					-0.3033***	-2.1238***		
					(0.1139)	(0.2446)		
PBLACK					-0.7889***	-0.6953***	-0.8391***	-0.8177***
					(0.0793)	(0.1377)	(0.0826)	(0.1393)
PLATINO					1.6034***	1.8727***	1.8616***	2.0521***
					(0.0736)	(0.1237)	(0.0777)	(0.1271)
TRUMP_BIDEN_2020					-4.5043***	-3.4029***	-5.1426***	-3.8968***
					(0.0651)	(0.1107)	(0.0694)	(0.1133)
Observations	564,458		564,458		564,458		564,458	
Pseudo R-squared	0.173		0.267		0.216		0.304	
State FE, Firm FE			YES				YES	
State FE, Industry FE	YES				YES			

Table 11. Market Response to Vaccine Announcements

The table presents regressions of cumulative abnormal stock returns (*CAR*) on firm characteristics. *CARs* are calculated using a market adjusted model, in Panel A, and relative to the Fama-French model, in Panel B, using value-weighted (VW) *CRSP* index as the market portfolio, with estimation period of 252 trading days ending 30 trading days before the event. The event date is the announcement of Pfizer-BioNTech of successful phase 3 clinical trials on November 9, 2020. The CARs are calculated during days (0,1) relative to the event. We report coefficient estimates with robust standard errors in parentheses. Variable definitions are provided in Appendix. We use ***, **, and * to indicate statistical significance at the 1, 5, and 10% levels, respectively.

Panel A: Market-Adjusted CARs	Non-essential		High Drop		Low Net Income		Low Sales		Low Returns		Low FCF	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLE	0.0484***	0.0404	0.0791***	0.0589***	0.1208***	0.0750***	0.1150***	0.0788***	0.0161	-0.0174	0.0923***	0.0550***
	(0.0156)	(0.0287)	(0.0181)	(0.0180)	(0.0153)	(0.0165)	(0.0158)	(0.0148)	(0.0164)	(0.0173)	(0.0149)	(0.0183)
LNSALES	-0.0031	0.0036	-0.0035	0.0023	-0.0035	0.0009	-0.0024	0.0018	-0.0056*	0.0050	-0.0054*	0.0020
	(0.0036)	(0.0040)	(0.0034)	(0.0037)	(0.0031)	(0.0035)	(0.0030)	(0.0035)	(0.0033)	(0.0037)	(0.0032)	(0.0038)
DEBT	0.0682*	0.0279	0.0538*	0.0250	0.0595**	0.0314	0.0660**	0.0337	0.0581*	0.0103	0.0639**	0.0251
	(0.0348)	(0.0325)	(0.0303)	(0.0304)	(0.0301)	(0.0303)	(0.0291)	(0.0291)	(0.0331)	(0.0307)	(0.0307)	(0.0305)
MKTBOOK	-0.0164***	-0.0163***	-0.0171***	-0.0133***	-0.0183***	-0.0151***	-0.0148***	-0.0136***	-0.0178***	-0.0157***	-0.0193***	-0.0167***
	(0.0043)	(0.0044)	(0.0043)	(0.0039)	(0.0048)	(0.0046)	(0.0038)	(0.0039)	(0.0041)	(0.0044)	(0.0049)	(0.0050)
ROA	0.0290	0.0139	0.0870	0.0138	0.1062	0.0441	0.0944	0.0553	0.0751	0.0333	0.0871	0.0405
	(0.1105)	(0.1043)	(0.1023)	(0.0997)	(0.1034)	(0.1072)	(0.0947)	(0.0981)	(0.1054)	(0.1058)	(0.1061)	(0.1087)
CASH	0.0569	0.0456	0.0985	0.0115	0.0962	0.0732	0.0513	0.0231	0.0849	0.0026	0.0978	0.0676
	(0.0726)	(0.0782)	(0.0734)	(0.0832)	(0.0674)	(0.0793)	(0.0569)	(0.0720)	(0.0694)	(0.0784)	(0.0690)	(0.0799)
Observations	235	229	245	239	245	239	245	239	245	239	245	239
Adj. R-squared	0.0950	0.4114	0.1440	0.4389	0.2768	0.4633	0.2589	0.4782	0.0539	0.4003	0.1770	0.4324
Industry FE	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

	Non-essential		High Drop		Low Net Income		Low Sales		Low Returns		Low FCF	
Panel B: FF CARs	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLE	-0.0007	0.0117	0.0341**	0.0247*	0.0832***	0.0620***	0.0636***	0.0404***	0.0630***	0.0278	0.0658***	0.0510***
	(0.0135)	(0.0241)	(0.0155)	(0.0144)	(0.0139)	(0.0141)	(0.0150)	(0.0133)	(0.0113)	(0.0169)	(0.0133)	(0.0157)
Observations	235	229	245	239	245	239	245	239	245	239	245	239
Adj. R-squared	-0.0043	0.2922	0.0205	0.3014	0.1473	0.3572	0.0881	0.3219	0.0514	0.2989	0.0864	0.3342
Industry FE	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

Table 12. Vaccination Limitations: Delta Variant Surge

The table presents regression of the natural logarithm of weekly store visits at establishment level (*LNVISITS*) on county-level vaccination rates (*VRATE*), and interacted variable indicating the period of the "delta" variant surge (July 1, 20201 to September 30, 2021). We report coefficient estimates with standard errors in parentheses. Variable definitions are provided in Appendix. Standard errors are clustered at county-week level. We use ∗∗∗, ∗∗, and ∗ to indicate statistical significance at the 1, 5, and 10% levels, respectively.

VARIABLES	(1) *LNVISITS*	(2) *LNVISITS*
*VRATE*DELTA_VARIANT*	-0.4565***	-0.0405***
	(0.0223)	(0.0139)
VRATE	0.6362***	0.1277***
	(0.0114)	(0.0180)
DELTA_VARIANT	0.1266***	
	(0.0087)	
Observations	12,528,024	12,528,024
Adjusted R-squared	0.9296	0.9313
Store FE	YES	
Store FE, Time FE		YES

Internet Appendix (IA) Table 1. The Effect of Vaccination Rates on Store Visits: US versus California

The table replicates our benchmark regressions from Table 2 for US excluding California and California itself. We report coefficient estimates with standard errors in parentheses. Variable definitions are provided in Appendix. Standard errors are clustered at county level. We use ***, **, and * to indicate statistical significance at the 1, 5, and 10% levels, respectively.

	EXCLUDING CALIFORNIA					CALIFORNIA				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
VARIABLES	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*	*LNVISITS*
VRATE	0.5387***	0.5780***	0.6247***	0.6635***	0.1253***	0.3863***	0.5806***	0.5893***	0.6353***	0.2429***
	(0.0143)	(0.0134)	(0.0126)	(0.0130)	(0.0195)	(0.0669)	(0.0251)	(0.0272)	(0.0285)	(0.0516)
LNSALES		0.2814***	0.2843***				0.2203***	0.2213***		
		(0.0033)	(0.0032)				(0.0057)	(0.0055)		
DEBT		0.0344	0.0285				0.3681***	0.3577***		
		(0.0214)	(0.0200)				(0.0537)	(0.0510)		
MKTBOOK		-0.0867***	-0.0832***				-0.0554***	-0.0554***		
		(0.0043)	(0.0043)				(0.0045)	(0.0044)		
ROA		-0.3281***	-0.3958***				-1.1834***	-1.1601***		
		(0.0589)	(0.0586)				(0.1560)	(0.1563)		
CASH		2.0603***	2.0197***				2.0880***	2.0486***		
		(0.1187)	(0.1168)				(0.2363)	(0.2327)		
PBLACK		0.0926					2.7510***			
		(0.0846)					(0.5228)			
PLATINO		0.0391					0.1433			
		(0.1113)					(0.1224)			
TRUMP_BIDEN_2020		0.7201***					2.0596***			
		(0.0873)					(0.2026)			
Observations	7,406,902	7,406,902	7,406,902	7,406,902	7,406,902	880,799	880,799	880,799	880,241	880,241
Adj. R-squared	0.3181	0.3780	0.3984	0.9379	0.9407	0.3060	0.3740	0.3801	0.9343	0.9365
State FE, Industry FE	YES	YES				YES	YES			
County FE, Industry FE			YES					YES		
Store FE				YES					YES	
Store FE, Time FE					YES					YES