How did COVID-19 vaccination rates affect economic recovery across U.S. states?

Reichman University | Tiomkin School of Economics

Seminar Policy Paper

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1. Abstract

This paper assesses the impact of COVID-19 vaccination rates on economic activity across U.S. states, utilizing weekly panel data from early 2021 to mid-2021. Causal effects are identified through an instrumental variables approach, where vaccination rates are instrumented by the interaction of pharmacists per capita per state and state-level vaccine allocations. Our findings demonstrate that higher vaccination rates provide a modest but statistically significant stimulus to the economy. Specifically, a 1 percentage point increase in a state's vaccination rates leads to a 0.15 percentage point increase in consumer spending relative to the January 2020 baseline, a 0.0006 percentage point increase in workplace mobility, and a 0.0044 percentage point reduction in unemployment insurance claims as a share of the 2019 labor force. While modest at the individual state level, these effects scale up to substantial economic gains nationally, underscoring the importance of vaccination campaigns as both a public health and economic policy tool.

2. Introduction

The COVID-19 pandemic triggered one of the most severe economic downturns in modern U.S. history. To curb the spread of the virus and prevent hospitals from becoming overwhelmed, states imposed stay-at-home orders, restricted gatherings, and temporarily closed nonessential businesses. While these measures were crucial for safeguarding public health, they brought economic activity to a near standstill. In the second quarter of 2020, real gross domestic product (GDP) fell at an annualized rate of 31.7%, and the national unemployment rate surged to 14.7% in April—levels not seen since the Great Depression (Bureau of Economic Analysis, 2020; Bureau of Labor Statistics, 2020).

The approval of effective vaccines in late 2020 marked a potential turning point. Widespread vaccination promised to reduce infections and severe health outcomes, enabling a safer return to work and leisure while restoring consumer and business confidence. However, states differed significantly in their approach to vaccination campaigns. Some state governments adopted stricter mandates and actively promoted vaccines, while others took a more relaxed stance. This uneven response hindered the collective progress toward herd immunity that federal authorities were aiming for (Tito & Edwards, 2024). Between June and November 2021 alone, over 692,000 preventable COVID-19 hospitalizations occurred among unvaccinated adults, costing the U.S. economy more than $13.8 billion (Farrenkopf, 2022).

By the end of 2021, these disparities were evident in vaccination rates. States like Vermont and Rhode Island had fully vaccinated over 75% of their populations, whereas states such as Mississippi and Wyoming lagged below 55% (Centers for Disease Control and Prevention, 2021). This variation raises a critical question: did states with higher vaccination rates experience stronger economic recoveries? This paper examines the period from January through June 2021, which coincides with the initial rollout and ramp-up of COVID-19 vaccinations across the United States. This timeframe captures the crucial early phase of the vaccination campaign, when policy differences between states and logistical challenges were most pronounced, and before the emergence of significant vaccine-resistant variants later in the year. Alaska is excluded from our analysis due to incomplete and inconsistent data on pharmacist density and vaccine allocations, which would otherwise bias the estimates.

Our research examines how vaccination rates shaped economic activity across U.S. states using weekly panel data from early 2021 to mid-2021, by instrumenting vaccination rates with the interaction of pharmacists per capita per state and state-level vaccine allocations, to prevent endogeneity through reverse causality. Reverse causality is a primary concern because greater economic activity could itself drive higher vaccination rates rather than the reverse. For example, heightened consumer spending due to a large state event might spur vaccination efforts in anticipation, leading to a misattribution of economic activity to vaccines. Using our instrumental variable approach, we focus on three key outcome variables: spending, measured by credit card purchases; workplace mobility, measured as time spent in offices; and unemployment insurance claims, representing the proportion of people filing to receive benefits.

Relative to Hansen and Mano (2023), who find stronger effects at the county level, our state-level estimates are more modest. This is likely because county-level analyses capture more granular heterogeneity and localized shocks, whereas state-level analysis aggregates across diverse local conditions and policies, diluting the estimated effects. Nevertheless, our findings demonstrate that vaccination campaigns contributed meaningfully to economic recovery even at the broader state level, highlighting their policy relevance.

3. Literature Review

Hansen and Mano (2023) provide a seminal empirical analysis quantifying the economic effects of COVID-19 vaccinations in the United States. Their study utilizes weekly county-level data from late 2020 to mid-2021, focusing on high-frequency measures of economic activity: credit/debit card spending, initial unemployment claims, and workplace mobility. A key methodological contribution is their instrumental variable (IV) approach to establish causality, where county-level vaccination rates are instrumented by the interaction of pre-determined pharmacy densities (pharmacies per square mile) and weekly state-level vaccine allocations. Their findings indicate that vaccinations provided a substantial economic stimulus. They report that a one percentage point increase in initiated vaccination rates led to a 1.3 percentage point increase in consumer spending (relative to January 2020 averages), a 0.09 percentage point decrease in initial unemployment claims (as a share of the 2019 labor force), and an increase in workplace mobility. Our present research builds directly upon this methodology, adapting their instrumental variable strategy and focusing on a state-level analysis to capture broader policy and environmental influences.

Tito and Edwards (2024) uniquely examine the economic impact of COVID-19 vaccine lotteries, a specific policy designed to incentivize vaccination. Their analysis, using hand-collected lottery introduction data and daily state-level measures like retail spending and mobility, focuses on the exogenous variation introduced by the unexpected lottery announcements. They found that lotteries significantly boosted retail spending by 3.4% five days post-announcement, and contributed 0.4 percentage points to U.S. GDP growth in 2021,but had no meaningful effects on other activities like restaurant spending or employment. Notably, they also reference Hansen and Mano (2023) and contend that their lottery-based identification offers a more exogenous source of variation. They suggest that Hansen and Mano's (2023) instrumental variable strategy, while valuable for assessing direct vaccination impacts, might be susceptible to endogenous factors like demand shocks influencing vaccine reallocation or urban density effects, potentially biasing results upwards. Thus, while Tito and Edwards (2024) explore incentives for vaccination, our research focuses on the economic effects once individuals are vaccinated, collectively underscoring the diverse economic benefits of pandemic vaccination efforts.

Luong et al. (2024) contribute a broader, global perspective by assessing the economy-wide impacts of COVID-19 vaccinations using a Computable General Equilibrium

(CGE) model based on the Global Trade Analysis Project (GTAP) database. Their macro-level analysis emphasizes the crucial role of vaccination in driving economic recovery, primarily through increased labor participation and productivity. The study simulates various vaccination scenarios, demonstrating that higher vaccination rates are associated with substantial increases in GDP growth rates. For instance, their model predicted that a 75% vaccination rate for the U.S. would result in a $502.46 billion (3.08%) increase in real GDP, with further increases if 100% of the population were vaccinated. They attribute these gains largely to increased consumer spending (which accounts for a significant portion of GDP) and advances in work mobility, as the labor force returns to work physically or remotely. While their methodology and global scope differ from our state-level regression, their findings reinforce the fundamental premise that vaccination campaigns serve as a potent tool for economic resurgence by boosting confidence, restoring labor market functionality, and stimulating demand.

4. Data

Our research constructs a weekly panel dataset covering 49 of the 50 U.S. states, spanning January 11, 2021, to June 6, 2021, resulting in a maximum of 1,078 observations (49 states × 22 weeks). The initial 24 weeks of data are adjusted by excluding the first two weeks to align with the two-week lagged component of the instrumental variable, with weeks three and four adopting those lagged values. The descriptive statistics for the variables are presented in this table, and each variable is described in more detail below:

Descriptive Statistics

Variable	Mean	Standard Deviation	N
Vaccination Rates	32.28	16.90	1078
Credit/Debit Card Spending	0.10	0.07	1078
Workplace Mobility	−0.24	0.06	1078
Unemployment Insurance Claims	0.36	0.31	1078
Pharmacists per 100k People	106.64	23.32	49
Two-week Lagged Allocated Doses per Capita	0.02	0.00	1078

Vaccination Rates: These are measured daily as a percentage of the state population and are collected from the Centers for Disease Control and Prevention (CDC) and compiled by Mathiue et al. (2021). This data is aggregated to weekly averages.

Credit/Debit Card Spending: Daily credit/debit card spending, seasonally adjusted as a fractional change relative to the daily average during January 4–31, 2020. This daily data is collapsed to weekly state-level averages, covering spending across all merchant category codes. Spending data is provided by Affinity Solutions and compiled in the Opportunity Insights Economic Tracker by Chetty et al. (2020).

Workplace Mobility: State-level workplace mobility data is sourced from Google and compiled by Chetty et al. (2020) in the Opportunity Insights Economic Tracker. Using GPS technology, Google can measure the time people spend in offices. This measure is compared to its median value for weekdays in the period of January 3–February 6, 2020, creating an index representing changes relative to the pre-pandemic baseline.

Initial Unemployment Insurance Claims: These are measured as a percentage of the 2019 state labor force at a weekly frequency. This data is also obtained via the Opportunity Insights Economic Tracker, which relies on information from individual state agencies Chetty et al. (2020).

Pharmacists per 100,000 People: The number of pharmacists per 100,000 people is drawn from the Area Health Resources Files (AHRF) compiled by the Health Resources and Services Administration (2025). It is measured per state and in 2019, a year before the onset of the pandemic. Data for Alaska does not exist, which explains the sample of 49 and not 50.

Allocated Vaccine Doses per Capita: This component accounts for the supply-side variation in vaccine availability at the state level. It represents the state-level vaccine allocation data, normalized by the state population, collected weekly from the CDC (2021). This includes both Pfizer and Moderna vaccines. Consistent with its exclusion from the pharmacists per capita data, Alaska exhibited inconsistent data entries across multiple weeks, forming a recurrent pattern of data limitations for this state.

5. Methodology

As previously mentioned, the empirical framework of our research draws heavily on the pioneering work of Hansen and Mano (2023), who provide a robust foundation for assessing the economic impact of COVID-19 vaccinations in the United States, expressed as:

$$y_{c,t+h} = \beta^h \widehat{v_{c,t}} + \tau_{s,t}^h + \tau_c^h + \epsilon_{c,t+h} \qquad \text{(Second Stage)}$$

$$v_{c,t} = \gamma z_{c,t-2} + \delta_{s,t} + \delta_c + \xi_{c,t} \qquad \text{(First Stage)}$$

$$z_{c,t-2} = \frac{\text{\#pharmacies}_c}{\text{area}_c} \times \frac{\text{vaccine allocations}_{s,t-2}}{\text{population}_s} \equiv p_c \times \omega_{s,t-2} \qquad \text{(Instrument)}$$

Building upon this framework, our research adapts the methodology to a state-level analysis. The model simplifies the work by getting rid of sample intraperiod regressions after every week h. As a result, the fixed effects for time are not needed and the terms $\tau_{s,t}^h$ and $\delta_{s,t}$ are omitted. This reflects our continuous sampling of our panel data. We are left with the following 2SLS equations:

$$y_{s,t} = \beta \widehat{v_{s,t}} + \tau_s + \epsilon_{s,t} \qquad \text{(Second Stage)}$$

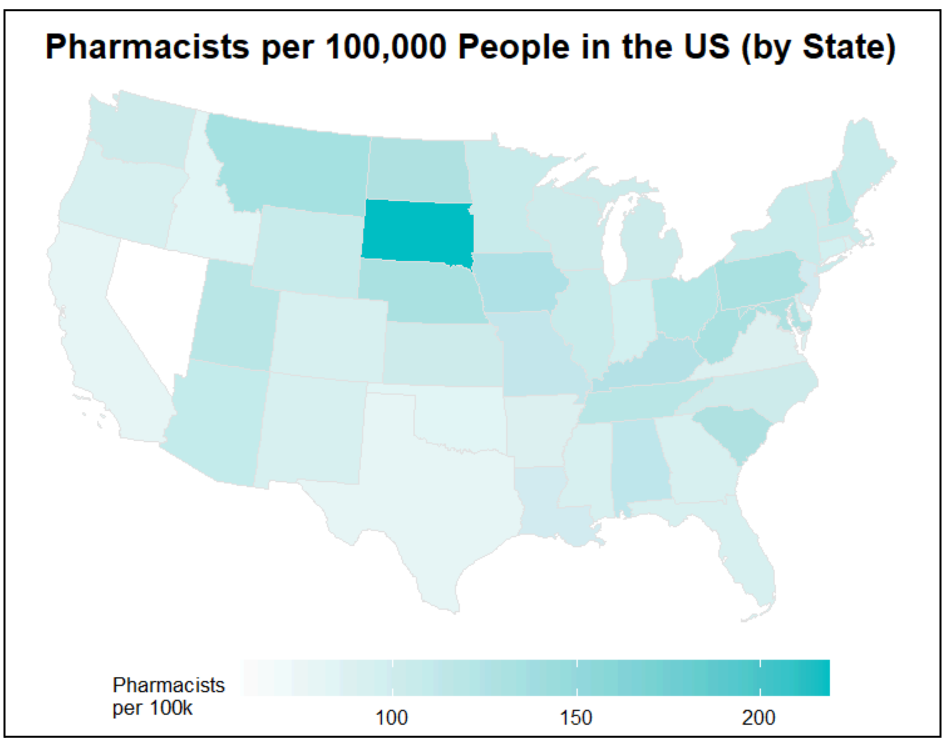
$$v_{s,t} = \gamma z_{s,t-2} + \delta_s + \xi_{s,t} \qquad \text{(First Stage)}$$

$$z_{s,t-2} = pharmacistsper100k_s \times \frac{state\ vaccine\ allocations_{s,t-2}}{state\ population_s} = p_s \times va_{s,t-2}$$

(Instrument)

where $y_{s,t}$ denotes state-level economic outcomes (spending, mobility, or unemployment insurance claims), $v_{s,t}$ is the vaccination rate, $\widehat{v_{s,t}}$ is the instrumented rate, τ_s represents state fixed effects, and $z_{s,t-2}$ is the instrument, defined as the interaction of pharmacists per capita per state and two-week lagged vaccine allocations per capita. This adjustment shifts the focus from county-specific variation to statewide patterns.

Implementing their exact instrumentation was not possible since obtaining per state pharmacy density data required access to private online databases. However, our choice of instrument represents a theoretically sound substitute. While Hansen and Mano rely on county-level pharmacy density, which varies spatially within states, our adaptation uses pharmacists per capita at the state level, a pre-determined measure of healthcare capacity from 2019, interacted with state-specific vaccine allocations (the same as Hansen and Mano). The interaction term exploits variation in healthcare infrastructure and allocation timing, providing an exogenous shock akin to Hansen and Mano's strategy. We include a two-week lag, following Hansen and Mano, to reflect the typical delay between allocation and administration. This improves the instrument's temporal validity. This graph illustrates how the number of pharmacists per 100,000 people is a fixed, time-invariant, geographical data point, making it a suitable theoretical substitute:



For the instrument to be valid and yield valid causal estimates, it must satisfy two conditions: relevance, indicated by a strong correlation with vaccination rates in the first stage, and the exclusion restriction, ensuring its effect on economic outcomes occurs solely through vaccination. The first-stage regression results to test for relevance are:

```
Dependent Var.:                              Vaccination Rates

Pharmacists per 100k X Vaccine Allocations  26.26*** (1.431)
Fixed-Effects:                               -----------------
State                                                      Yes
________________________________________    _________________
S.E.: Clustered                                      by: State
Observations                                             1,078
R2                                                     0.78883
Adj. R2                                                0.77877
F-test                                                  179.31
RMSE                                                    7.7614
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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

The first-stage regression results demonstrate that our instrument strongly predicts vaccination rates. The coefficient on the instrument is 26.26 ($p < 0.01$) with a clustered standard error of 1.431, indicating that states with higher pharmacist density and greater vaccine allocations achieved substantially higher vaccination rates. The model achieves an R^2 of 0.789 and an adjusted R^2 of 0.779, while the F-test statistic of 179.31 far exceeds the conventional threshold of 10 for weak instruments, confirming that our instrument satisfies the relevance condition and provides sufficient identifying variation for causal inference.

To assess the exclusion restriction's plausibility, which dictates that the instrument must affect economic outcomes solely through its influence on vaccination rates and not through any direct alternative channel, we examine the pre-vaccination relationship between pharmacists per capita and an economic activity outcome variable like spending:

```
Dependent Var.:                        Spending

Intercept              0.1097*** (0.0099)
Pharmacists per 100k -8.07e-5 (9.05e-5)
____________________ __________________
S.E. type                           IID
Observations                      1,078
R2                              0.00074
Adj. R2                        -0.00019
F-test                          0.79561
RMSE                            0.06852
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

The estimated coefficient for pharmacists per capita was -.0000807 with a p-value above .1. This statistically insignificant relationship between pharmacist density and spending before the vaccination campaign supports the assumption that the instrument's influence on economic activity is indeed mediated solely through vaccination rates. The identifying assumption holds that differences in the impact of vaccine allocations across states, driven by pharmacist availability, affect economic outcomes only via vaccination uptake. This approach, while not directly testable, aligns with theoretical expectations and empirical evidence, reinforcing the instrument's validity for our state-level analysis.

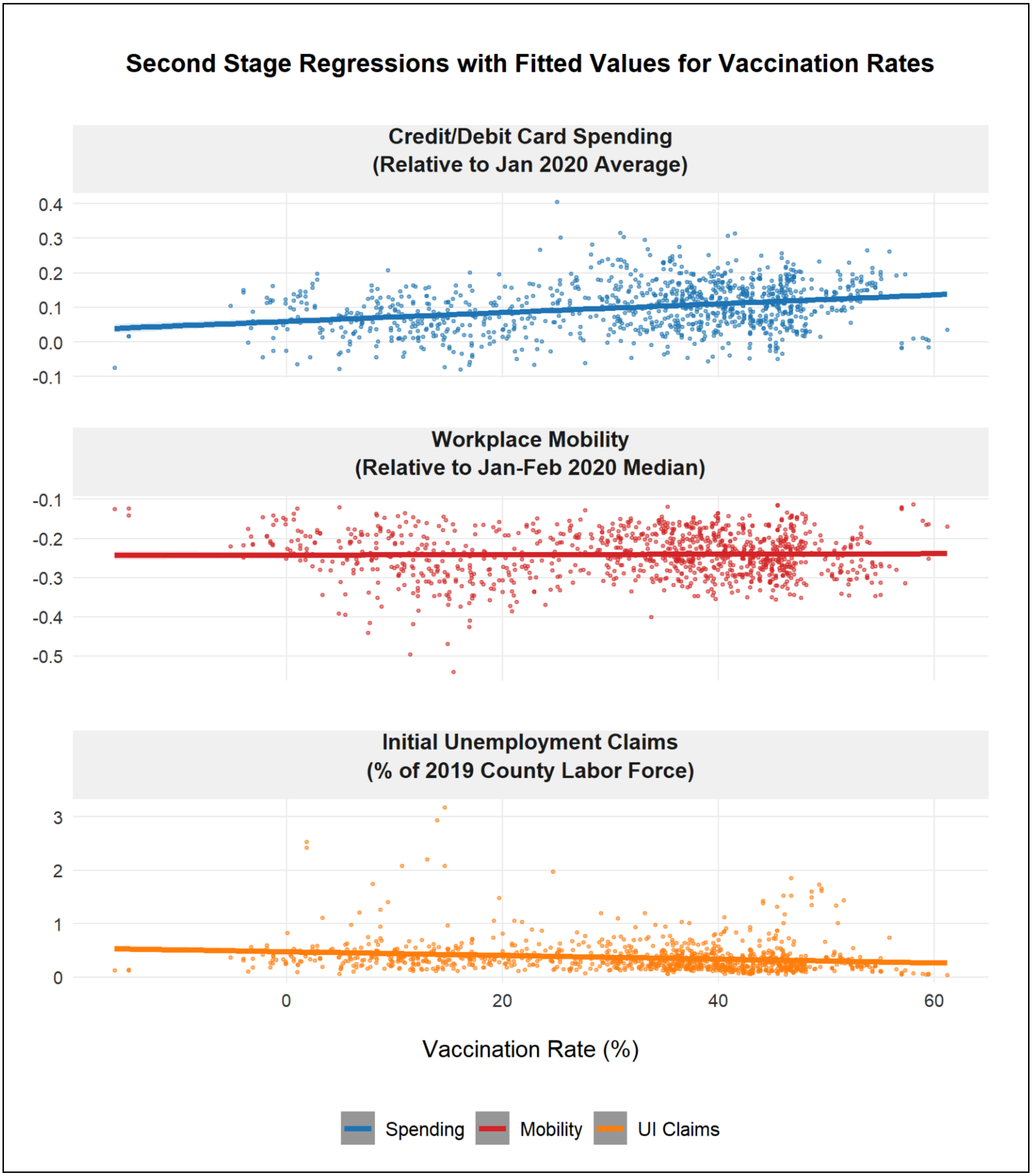
6. Results

The second-stage results reveal three economically meaningful causal relationships between vaccination rates and state-level economic activity. For consumer spending, we find that a one percentage point increase in vaccination rates leads to a 0.15 percentage point increase in credit card spending relative to the January 2020 baseline ($p < 0.01$). This effect suggests that vaccinations generated significant consumer confidence, enabling individuals to resume normal spending patterns. Similarly, workplace mobility responds positively to vaccination, with a one percentage point increase in vaccination rates causing a 0.0006 percentage point increase in time spent in offices compared to pre-pandemic levels ($p < 0.01$). This finding indicates that vaccinations facilitated the return to in-person work arrangements, supporting economic productivity through restored workplace interactions and collaboration. The labor market effects are captured through unemployment insurance claims, where we observe that a one percentage point increase in vaccination rates leads to a 0.0044 percentage point decrease in unemployment insurance claims as a share of the 2019 labor force ($p < 0.05$). This statistically significant reduction suggests that vaccinations enabled businesses to resume operations more fully, creating employment opportunities, thus reducing reliance on unemployment benefits. Below is the output table followed by a graph that illustrates the three regressions:

Effect of vaccination rates on economic activity at the state level, instrumented regressions

Dependent Var.:	Spending	Mobility	UI Claims
Instrumented Vaccination Rates	0.0015*** (0.0001)	0.0006*** (0.0001)	-0.0044** (0.0013)
Fixed-Effects:	------------------	------------------	------------------
factor(State)	Yes	Yes	Yes
S.E.: Clustered	by: State)	by: State)	by: State)
Observations	1,078	1,078	1,078
R2	0.80435	0.68129	0.54794
Adj. R2	0.79503	0.66610	0.52639
F-test	197.34	102.61	58.181
RMSE	0.03032	0.03275	0.20661

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


Second Stage Regressions with Fitted Values for Vaccination Rates
Credit/Debit Card Spending
(Relative to Jan 2020 Average)
0.4
0.3
0.2
0.1
0.0
-0.1
Workplace Mobility
(Relative to Jan-Feb 2020 Median)
-0.1
-0.2
-0.3
-0.4
-0.5
Initial Unemployment Claims
(% of 2019 County Labor Force)
3
2
1
0
0
20
40
60
Vaccination Rate (%)
Spending
Mobility
UI Claims

To validate our instrumental variables approach, we compare these results with uninstrumented regressions using actual vaccination rates, revealing several patterns that strengthen confidence in our causal identification strategy:

Effect of vaccination rates on economic activity at the state level, uninstrumented regressions

Dependent Var.:	Spending	Mobility	UI Claims
Uninstrumented Real Vaccination Rates	0.0011*** (8.29e-5)	0.0005*** (8.54e-5)	-0.0040*** (0.0010)
Fixed-Effects:	-------------------	-------------------	-------------------
factor(State)	Yes	Yes	Yes
S.E.: Clustered	by: State)	by: State)	by: State)
Observations	1,078	1,078	1,078
R2	0.77990	0.68005	0.54949
Adj. R2	0.76940	0.66480	0.52802
F-test	170.08	102.02	58.547
RMSE	0.03216	0.03281	0.20625

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

The uninstrumented coefficients are consistently smaller in magnitude across all three outcomes: 0.11 percentage points for spending compared to 0.15 percentage points in the instrumented specification (a 36% increase), 0.0005 percentage points for mobility compared to 0.0006 percentage points (a 20% increase), and -0.0040 percentage points for unemployment claims compared to -0.0044 percentage points (a 10% increase). These systematic differences in coefficient magnitudes suggest that our uninstrumented estimates suffered from downward endogeneity bias, likely due to reverse causality where states with weaker economic conditions may have struggled to achieve higher vaccination rates. The precision of our estimates, as measured by root mean squared error (RMSE), provides additional validation of our methodological approach. The instrumented models exhibit RMSE values of 0.030 for spending, 0.033 for mobility, and 0.207 for unemployment claims, compared to 0.032, 0.033, and 0.206 in the uninstrumented specifications. The minimal differences in RMSE values demonstrate that our instrument effectively corrects for endogeneity bias without substantially compromising estimation precision.

7. Conclusion

Our research offers compelling evidence that COVID-19 vaccination rates significantly shaped economic recovery across U.S. states between early 2021 and mid-2021. Through an instrumental variables approach, we determined that a one percentage point increase in vaccination rates resulted in a 0.15% rise in consumer spending relative to the January 2020 baseline, a 0.0006% increase in workplace mobility, and a 0.0044% reduction in unemployment insurance claims as a share of the 2019 labor force. These findings, though modest in comparison to Hansen and Mano's (2023) county-level results, emphasize the wider economic stimulus provided by vaccinations, particularly at the state level, where state government policy regarding vaccination participation reveals critical influences. The economic significance of our findings becomes more pronounced when considered at scale. We conjecture that even a modest, statistically significant impact at the state level translates into considerable economic value when scaled across the entire nation. Future investigations could enhance our understanding by examining heterogeneous treatment effects across different types of states, exploring whether vaccination impacts vary based on economic structure, population density, or pre-existing health infrastructure. Additionally, incorporating controls for pandemic severity, policy stringency indices, or federal fiscal interventions could help isolate the vaccination effect more precisely and provide more nuanced guidance for targeted interventions. Such research extensions would be particularly valuable for developing optimal allocation strategies for future vaccine rollouts, ensuring that public health investments maximize both health and economic returns across diverse state contexts.

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