The Vaccine Boost: Quantifying the Impact of the COVID-19 Vaccine Rollout on Measures of Activity

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Motivation

- Economic activity has shown improvement since the start of the COVID-19 vaccine rollout.
  - We identify the impact of vaccinations
- Focus on three dimensions of activity
  - Spending
  - Mobility
  - Employment

Data

We combine daily state-level data from various sources

- COVID-19 vaccinations by jurisdiction, Centers for Disease Control and Prevention.
- Spending: Fiserv and SafeGraph
- Mobility: Apple and INRIX
- Employment: Homebase
- Additional Information: NYT COVID-19 cases and deaths, HHS COVID-19 hospitalizations, Oxford Stringency Index, NOAA's National Climatic Data.

Impact of Vaccine on Economic Activity

Empirical Analysis

- Identification of vaccine effects through the implementation of vaccine lotteries
  - "Two-stage" analysis.
  - First stage (event study): impact of lottery announcements on vaccine uptake.
  - Looking at "second stage" impact on economic activity

Vaccine Lotteries and Vaccinations

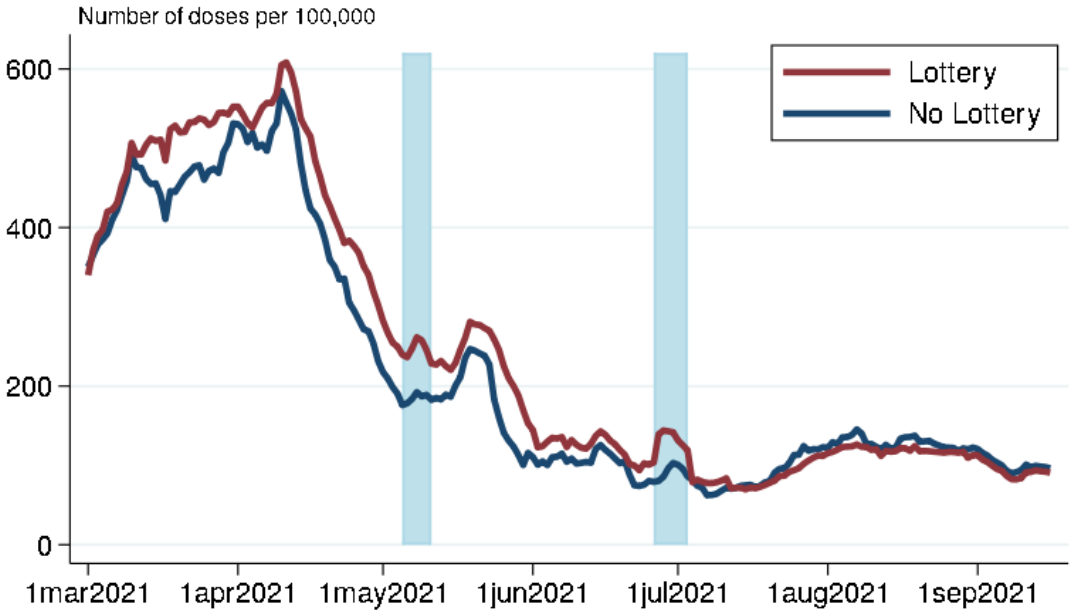
- First stage: Investigate the impact of vaccine lotteries on new vaccine administration
  - Data from 19 state lotteries (Summary)
  - Looking at the impact after the lottery announcement, comparing lottery adopters and non- or non-yet-adopters.

Previous Studies

Conditions for Identification

- Decision to implement lotteries uncorrelated with state-level economic conditions.
  - Identification relies on lottery announcements.
  - Vaccine lottery announcements were fairly unexpected.
    Like many of you, I first learned about this idea yesterday. At first blush, the concept does not appear to violate state law, though that will be dependent upon how it is designed. We will continue to review as additional details are made public. Just because a thing may be legally done does not mean it should be done. The wisdom and propriety of this expenditure is a question for the Governor and the General Assembly. Attorney General Dave Yost in response to Gov. DeWine's lottery announcement.
  - Specification includes a large set of controls, Mean Comparisons

Trends in Vaccine Administration



Source: CDC.
Notes: Average daily vaccine administration per 100,000 across groups of states that announced a vaccine lottery and those that offered no or other types of incentives around lottery implementations. Shaded areas denote deviations between the two trends.

- Two groups of states: lottery adopters vs. non-adopters
- Different trends in new vaccine administration, with slight changes in trends in early/mid-May and early July, highlighted in blue.
- Chart of trends does not account for differences in timing of adoption.

First Stage Empirical Specification

Dynamic difference-in-difference specification

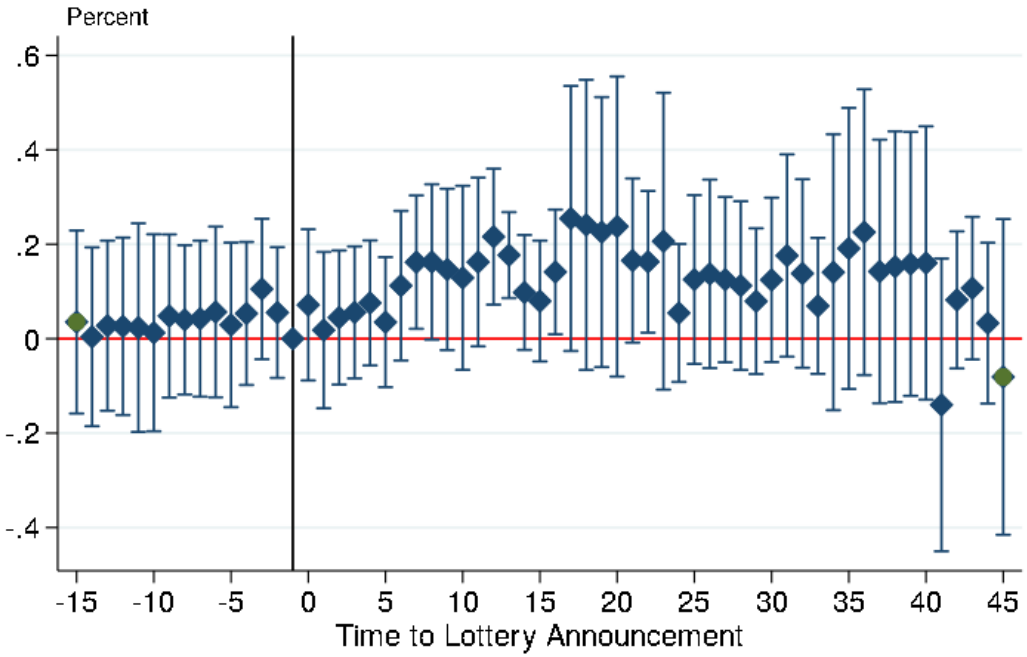
$$\text{New Adm.}_{st} = \delta_0 + \sum_{j=-15}^{45} \delta_{1,j} \text{Post Announc.}_{s,t-j} + \xi X_{st} + d_{sm} + d_t + u_{st}$$

- First-stage dependent variable: new vaccine administration for state s at time t
- Post Announc.$_{s,t-j}$ collects the leads and lags relative to the lottery announcement.
- $\delta_{1,j}$, $j \in \{-15, ..., 45\}$ identify the dynamic treatment effects under the assumption of conditional parallel trends of lottery adopters relative to the groups of not-yet adopters and never adopters

Empirical Specification: Additional Details

- Lotteries are adopted in different time periods across different states.
  - Dynamic specification that includes two-way (state- and day-) fixed effects to address bias due to this difference in adoption (Goodman-Bacon, 2021).
  - Results are roughly consistent comparing lottery adopters to the group of never adopters (Callaway and Sant'Anna, 2021), Comparison with Never Adopters.
- Controls: vaccine distribution, pandemic-related variables, Oxford stringency index, weather variables, other incentives for vaccination, time to extraction.

First Stage Results



Note: Point estimates of lottery announcement on new vaccine administration, controlling for new distribution; new cases, hospitalizations, and deaths; Oxford stringency index; heating and cooling degree days; time to extraction; presence of other incentives; state-month dummies; and day-fixed effects. Vertical bars denote 95 percent confidence interval.

- Significant increase within a few days after lottery announcement.
- Cumulative effect is significant. In particular, states that announced lotteries experienced a 3.5 percent increase in vaccinations a week after announcement and over the next 20 days relative to those that did not introduce or had not yet made an announcement. (Results)

Second Stage Specification

$$y_{st} = \beta_0 + \sum_{j=31}^{45} \beta_{1,j} \widehat{\text{New Adm.}}_{s,t-j} + \gamma X_{st} + d_{sm} + d_t + \varepsilon_{st},$$

- y_{st} denotes measures of spending, mobility, or employment.
- $\widehat{\text{New Adm.}}_{s,t-j}$ are predictions from the first stage.
- We exclude the first month post-vaccination to account for the time before receiving the second dose of vaccines, and we limit our analysis to 15 lags.

Second Stage Results

	(1)	(2)	(3)	(4)	(5)	(6)
	Spending		Mobility		Employment	
VARIABLES	Retail	Restaurant	INRIX	Apple	Hours	Open Businesses
New Adm.	23.770***	3.535	-41.412	-6.213	-1.822	-0.950
	(5.661)	(6.078)	(88.460)	(7.070)	(3.065)	(1.745)
Other Controls[1]	y	y	y	y	y	y
State-Month FE	y	y	y	y	y	y
Day FE	y	y	y	y	y	y
Obs.	1,127	1,127	94	1,127	1,127	1,127
R-squared	0.810	0.805	0.949	0.976	0.979	0.986
Number of States	50	50	20	50	50	50

Source: Fiserv, Inc., INRIX, Apple, Homebase, CDC and NOAA.

- Using lottery announcement as an instrument, we find a significant cumulative impact only on retail spending.
- Our effect suggest a daily boost to retail sales of about 1.6 percent per day for 15 days per percentage increase in vaccinations or a monthly rate of 27 percent.

Implications for GDP

- Our data imply that retail sales grew at almost 10 percent at an annual rate in 2021.
- Vaccine uptake explains about 15 percent of the average increase in retail sales.
- Retail spending accounts for about $1/3$ of GDP.
- **Result**: Vaccine Administration contributed, on average, $1/2$ pp to GDP growth in first three quarters of the year.

Summary of Implications

	2021
1. Retail Sales Growth[1]	9.98%
2. Retail Sales Contribution to GDP	3.38%
3. Vaccinations Impact	0.54%

Source: BEA, Census, and Fiserv, Inc.

[1] Retail sales growth prediction based on Fiserv data.

Notes: Estimates of vaccine rollout effects on GDP growth.

Conclusions and Next Steps

- Administration of COVID vaccines has boosted retail spending and, in turn, GDP.
- Cost-Benefit Analysis:
  - Robertson et al. (2021) estimate that the cost of marginal vaccination in lotteries was 55 USD
  - Boost to GDP from our analysis was 400 billion to GDP in 2021—or about 1500 USD per vaccination.

Lottery Summary

Table A1: State Lottery Summary

State	Announcement Date	Extraction Date (Last)
Arkansas	May 25	-
California	May 27	July 1
Colorado	May 25	July 6
Delaware	May 25	June 29
Illinois	June 17	August 16
Kentucky[1]	June 4	August 26
Louisiana	June 17	July 31
Maine	June 16	June 30
Maryland	May 20	July 3
Massachusetts	June 15	August 19
Michigan	July 1	August 3
Nevada	June 17	August 26
New Mexico	June 1	August 6
New York	May 20	June 11
North Carolina	June 10	August 1
Ohio	May 12	June 20
Oregon	May 21	June 27
Washington	June 3	July 13
West Virginia	June 1	August 1

[1] On May 10, Kentucky offered a coupon for a free lottery ticket ($225,000 maximum cash award to winner) to those ages 18+ who received a COVID-19 vaccine only at 180 Kroger and WalMart locations statewide.

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Lottery Adopters vs. Non-Adopters: Comparison

Characteristic	Adopter	Non-Adopter	P-Value
Aged between 16 and 24 (Share)	0.141	0.145	0.23
Aged between 25 and 64 (Share)	0.643	0.645	0.74
Aged 65 or more (Share)	0.216	0.210	0.37
White Non-Hispanic Share	0.691	0.726	0.44
Male Share	0.484	0.487	0.35
High School Graduates/Dropouts Share	0.414	0.400	0.24
Employed (Share)	0.577	0.610	0.01

Source: BLS Current Population Survey.

Notes: Reported p-values refer to two sided-testing hypothesis of a difference in means across the two groups.

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Comparison with Previous Studies

- Evidence on the impact of lotteries and monetary incentives is mixed.
  - Neil et al. (2021) suggests a small positive impact on vaccine administration in Ohio.
  - Dave et al. (2021) find no impact of lotteries on vaccine administration; their sample ends on July 1.
  - Evidence of a positive impact of guaranteed incentives in Sweden (P. Campos-Mercade at el., 2021) and in the U.S. in February (Dai et al., 2021), but not for the vaccine hesitant population (Chang et al., 2021)
- Our specification: state-level equation with an exhaustive set of controls.

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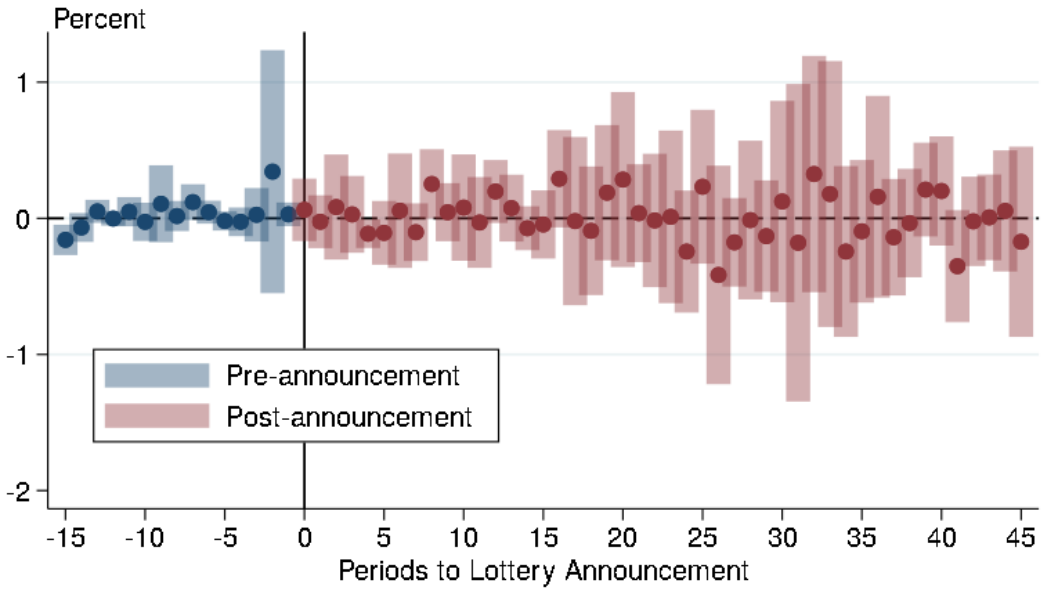
Lottery Adopters vs. Never Adopters



Note: Average treatment effect on the treated of lottery announcement on new vaccine administration relative to never adopters.

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Cumulative Effects of Lottery Announcements

	(1)	(2)	(3)	(4)
Variable		New Vaccine Adm.		
	Before		After	
	2 - 15 days	8-30 days	8-45 days	8-60 days
Cum Impact	0.559	3.565**	5.121**	3.545
	(1.114)	(1.624)	(2.326)	(2.686)
Other Controls[1]	y	y	y	y
State-Month FE	y	y	y	y
Day FE	y	y	y	y
Obs.	14,026	14,026	14,026	14,026
R-squared	0.580	0.580	0.580	0.580
Number of States	51	51	51	51

- No effect before announcement; impact on vaccination fades over time.

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