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Impact of State Incentives on COVID-19 Vaccination Uptake in the U.S.

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Abstract

What is the message? The authors assess how U.S. state government vaccination incentives (i.e., cash, lottery/sweepstakes, or other non-financial incentives) impacted vaccine hesitancy or reluctance. The findings indicate that the vaccine incentive programs demonstrated modest but insignificant effects on COVID-19 vaccination efforts.

What is the evidence? An analysis of Johns Hopkins University's state-level daily COVID-19 vaccination data, information on statewide incentives from the National Governors Association, and public datasets.

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Introduction

Since its detection in Wuhan city of China in late 2019, the infectious disease COVID-19 caused by the novel coronavirus (SARS-CoV-2) has spread worldwide [1]. The epidemic of one of the most contagious diseases in history took the lives of more than 6 million people and infected millions of others. As of July 7, 2022, 87 million people were infected in the United States, with a death toll of more than a million [2]. In addition, it had a disastrous impact on the world economy through the closure of industries, slump in economic activities or employment opportunities [3], disruption of human capital development (both education and health) [4], and shattering of people's economic welfare [5].

In an unprecedented effort to combat COVID-19, vaccines were rapidly developed. As the U.S. pushed towards fully reopening the economy, getting more people vaccinated had become a priority [6]. Since COVID-19 has brought lots of miseries, a solid willingness to vaccinate against it might be perceived. A few studies were done before the vaccine was circulated and found that people were willing to pay for the vaccine [7-9]. However, even if the COVID-19 vaccine is provided for free, vaccine hesitancy remains a harsh reality [10]. Mistrust in vaccine efficacy, fear of unanticipated side effects, and preferences for natural immunity – are a few reasons for such hesitancy [11]. Vaccination-pace in the U.S. slowed since mid-April 2021 when around 40% of the population got vaccinated [2,12]. Although declining over time, studies [13-16]. showed a high intention of vaccine uptake among U.S. adults. However, intent does not always necessarily translate into action.

The U.S. government had set a target to vaccinate 70% of adult Americans by the 4th of July 2021 [17] but missed its mark due to the low vaccine uptake. Since mid-April 2021, the slow pace of vaccination has motivated many U.S. states to announce incentives to attract vaccine-hesitant people. However, contradictory opinions on policies such as offering financial incentives to reduce vaccine hesitancy have seen mixed results in different contexts. Some studies have found incentives to be a good instrument in attracting hesitant people to take vaccines against some infectious diseases [20-25]. In contrast, others found it to be an ineffective tool or remained

inconclusive [26,27].

Some studies have argued in favor of providing incentives to lessen COVID-19 vaccine hesitancy resulting from uncertainties about the efficacy of vaccines [28,29]. A study found that financial incentives will not increase the likelihood of vaccination immediately after the vaccine becomes available as people may focus on vaccine efficacy [30]. Others have recommended large compensations, claiming low incentives could backfire as small incentives might not motivate skeptical individuals [31]. Chang et al. (2021) found financial incentives ineffective in an intervention of financial incentives among unvaccinated people in Contra Costa County of California [32]. However, Campos-Mercade et al. (2021) did another study that found monetary incentives effective in increasing COVID-19 vaccination rates in Sweden [33]. Recent studies in the U.S. suggest that a small cash incentive works better than a big lottery incentive to attract vaccine-hesitant people [34,35].

As part of their COVID-19 vaccination efforts, 26 U.S. states announced different types of incentives between April and July of 2021 [36]. One study conducted an early evaluation (April 15-June 9, 2021) of the impact of Ohio's Vax-a-million lottery incentive on COVID-19 vaccination uptake. Comparing Ohio's case with the rest of the U.S. states, they did not find any evidence of an association between incentive and vaccination rates in Ohio [34]. However, some synthetic control studies found positive effects of Ohio's lottery incentive [37-40]. Other studies found mixed or no effects of state lottery incentives [41-43]. As states adopt appropriate policies to ensure a smooth reopening, it is essential to generate evidence of whether these efforts were effective in combating vaccine hesitancy or not. This study aims to assess the impact of incentives on COVID-19 vaccine uptake and examine the effects of different types of incentives (financial and non-financial) on COVID-19 vaccination rates in the U.S.

Study Data and Methods

Data Sources

We used daily state-level data on the first dose of COVID-19 vaccination from April 19 through July 18, 2021, from Johns Hopkins University [44]. This period was chosen as all COVID-19 vaccination-related incentives were announced by states and remained effective. However, incentives in some states were announced for a certain period which subsequently expired during the study period. From the day of expiration of incentives, such states are excluded from the analysis. The analytical sample covered all 50 states plus Washington DC.

Our study focused on the state governor-announced public incentives accessible to residents across the state. We collected information on statewide incentives from the National Governors Association [36] and reviewed all announcements issued between April 19, 2021, and July 18, 2021. For other relevant state-level reopening policies, we used public datasets [45]. States differed by the type of incentives they offered, the process of signing up for the lotteries, etc. However, all states shared a common goal of improving vaccination coverage. According to the type of incentives announced, we categorized 26 states into those that announced financial incentives (17 states) and those that offered non-financial incentives (9 states). All Alabama, Idaho, and New York residents were not eligible to access the announced incentives. Therefore, along with the 24 states and Washington DC that never offered any incentives, Alabama, Idaho, and New York were part of the non-incentive providing or control group for our study, leaving 23 states to be considered in the incentive providing or treatment group. Details of the state incentives are summarized in Table 1 and the Supplement.

Table 1: State Characteristics

State	Incentive Announced	Incentives [a]	%Vaccinated [b]	Adoption [d]	Enrollment process [e]
California	5/27/2021	Financial	55.95	Early	Automatic
Colorado	5/25/2021	Financial	52.95	Early	Automatic
Maine	6/16/2021	Financial	65.23	Late	Registration
Massachusetts	6/15/2021	Financial	68.72	Late	Registration
Michigan	7/1/2021	Financial	51.50	Late	Registration
New Mexico	6/1/2021	Financial	57.87	Late	Registration
New York [f]	5/20/2021	Financial	52.79	Early	Automatic
Oregon	5/21/2021	Financial	52.02	Early	Automatic
Washington	6/3/2021	Financial	57.14	Late	Automatic
Illinois	6/17/2021	Financial	49.95	Early	Automatic
Kentucky	6/4/2021	Financial	46.81	Late	Registration
Louisiana	6/17/2021	Financial	37.51	Late	Registration
Maryland	5/20/2021	Financial	49.34	Early	Automatic
Nevada	6/17/2021	Financial	47.82	Late	Automatic
North Carolina	6/10/2021	Financial	44.07	Late	Automatic
Ohio	5/17/2021	Financial	43.16	Early	Registration
West Virginia	6/1/2021	Financial	44.15	Late	Registration
Connecticut	4/26/2021	Non-financial	55.19	Early	Automatic
Delaware	5/25/2021	Non-financial	53.11	Early	Automatic
Hawaii	06/04/2021	Non-financial	67.06	Late	Automatic
Minnesota	5/28/2021	Non-financial	53.95	Early	Automatic
New Jersey	5/3/2021	Non-financial	52.31	Early	Automatic
Alabama [f]	5/7/2021	Non-financial	33.38	Early	Automatic
Arkansas	5/25/2021	Non-financial	38.77	Early	Automatic
Idaho [f]	06/16/2021	Non-financial	38.69	Late	Automatic
Indiana	5/10/2021	Non-financial	38.11	Early	Automatic

Notes: States that offer financial incentives, either large or small, are categorized as providing financial incentives and states that offer incentives of non-financial nature are categorized as non-financial states. [b] % Vaccinated on the day of announcement of incentives. [c] Based on Cut off vaccination coverage of 50% on the date of announcement of incentives, states are categorized into high (>50%) and low (<50%) vaccination coverage; [d] Based on the month of the adoption of incentives, states are categorized as early adopters if they have adopted the

incentives in April or May, and late adopters if they have adopted the incentives in June or July; [e] *Based on the enrollment characteristic of incentives, states are categorized as automatic if those vaccinated are automatically enrolled or eligible to receive incentives, or categorized as registration if the states require those vaccinated to register and become eligible for incentives.* [f] *These states provided incentives that were not accessible to all state residents and were therefore categorized as control states in all analyses.*

Financial incentives

During the study period, 17 states had announced big or small financial incentives, ranging from lotteries with million-dollar cash prizes to small cash benefits such as coupons or gift cards, along with college scholarships and other awards. As a first state, Ohio announced a large financial incentive in the form of a lottery with a $1 million prize [46]. The most considerable financial incentives were announced by California, worth $116.5 million [47]. The Supplemental Material delivers a detailed description of the incentive programs for all treatment states.

Non-financial incentives

Nine states offered incentives that did not provide direct cash benefits but included various gift items which were non-financial. On April 26, 2021, Connecticut was the first state to offer non-financial incentives for COVID-19 vaccines in the form of free tickets, complimentary drinks, and food [48]. Elsewhere, non-financial incentives included vacations, freebies, discounts, airline tickets, travel packages, hunting, fishing licenses, park passes, driving on racetracks, paid leave, rifles and shotguns, marijuana joints, etc.

Outcome Measurement: Daily Vaccination Rate

Following other studies [49,50], we estimated the effects of incentives (any, financial and non-financial) on the daily state-level COVID-19 vaccination rates. To get the daily vaccination rate in percentage points, we calculated the difference in the natural log of cumulative COVID-19 first

dose vaccines on a given day minus the natural log of cumulative COVID-19 first dose vaccines on the previous day multiplied the difference by 100.

Statistical Analysis

To examine whether statewide incentives affected vaccination rates, we employed an event study, which allowed us to estimate the treatment effects in the context of a natural experiment. Providing state incentives can be considered a natural experiment as the states randomly announced providing such incentives, and the beneficiaries had no control over such decisions. The event study is similar to a differences-in-differences design, comparing the pre-post changes in COVID-19 vaccination rates in states with incentives versus changes in states that did not announce any such incentives. It is a critical assumption of the validity of an event study that there must be no differential pre-intervention trends among the treatment group. Our model analyzed if the pre-trend assumptions were upheld under testing or whether states issuing these incentives had differential pre-incentive trends in COVID-19 vaccination rates. In addition, we controlled for a wide range of relevant time-variant factors, including state reopening policies, such as withdrawal of mask mandates or state announced emergencies, state-level daily COVID-19 cases, and the daily number of doses shipped to the state. Time-invariant factors such as population density, education level, poverty rate, racial composition, etc., which might affect vaccination decisions, were controlled by including the state fixed effects along with month and day fixed effects.

We examined how the effects changed over five post-event periods: 1-3, 4-6, 7-9, 10-12, and 13 or more days. The reference period for estimating the incentive effects was 1-3 days before announcing the incentive. The model also tested for pre-incentive trends throughout 4-6, 7-9, 10-12, and 13 or more days before announcing the incentives. We include data from 7 days before the earliest announcement of state incentives, which was made in Connecticut on April 26. Therefore, the analytic sample included daily data on incentives and vaccination from April 19 through July 18 for all states. All models were weighted by the daily number of unvaccinated people in the state, estimated by least squares, with state-clustered and heteroscedasticity-robust standard errors.

As noted earlier, states differed by the type of announced statewide incentives. To understand the effects of heterogenous incentives (financial, non-financial) and characteristics of incentive-

providing states, we assessed different model specifications and sample choices based on the following criteria: percent of the population vaccinated, the timing of adoption of incentives, and the enrollment process. Based on the state vaccination rate on the day of the announcement of the incentives, we categorized states into two groups: low vaccination coverage (<50%) and high vaccination coverage (>50%). Based on the month of the adoption of incentives, we categorize states into – early adoption (in April and May) and late adoption (in June and July). States also varied by the process through which they enrolled eligible vaccinated residents into their incentive programs, and states were grouped based on – required registration or enrolled automatically. Separate models were constructed for these specifications and robustness checks (Supplemental Material).

Results

Effects of Incentives

Table 2 shows the estimates of the effect of state incentives (any, financial and non-financial) on the daily growth rate of COVID-19 vaccination obtained from the main regression models, using state-level data from April 19 through July 18, 2021. The effects are shown throughout five periods after the announcement of the incentives, relative to the reference period of three days before the announcement. We have also demonstrated the estimated differences in daily COVID-19 vaccination growth rates between states with and without incentives for four periods before the reference period.

Table 2: Event Study Estimates of States Providing Incentives on Covid-19 Vaccination Efforts with Alternative Treatment Variable Specifications.

	Any Incentives	Financial Incentives	Non-Financial Incentives
12 or More Days Before	-0.007 (0.092)	0.005 (0.106)	-0.087 (0.163)
10 to 12 Days Before	0.000 (0.101)	0.026 (0.106)	-0.207 (0.248)
7 to 9 Days Before	-0.014 (0.058)	-0.023 (0.065)	0.004 (0.199)
4 to 6 Days Before	-0.000 (0.079)	0.026 (0.080)	-0.198 (0.183)
1 to 3 Days After	-0.024 (0.064)	-0.009 (0.076)	-0.157 (0.140)
4 to 6 Days After	-0.053 (0.069)	-0.043 (0.080)	-0.172 (0.171)
7 to 9 Days After	0.025 (0.047)	0.065 (0.064)	-0.209 (0.149)
10 to 12 Days After	0.032 (0.054)	0.058 (0.063)	-0.156 (0.131)
12 or More Days After	-0.001 (0.045)	0.004 (0.059)	-0.083 (0.130)
N	4334	3752	2996

Notes: The table shows Incentive effects on daily vaccination rates among state residents from April 19 to July 18, 2021, using daily state-level vaccination data from Johns Hopkins University. The models adjust for state withdrawal of mask mandates or state emergencies, state-level daily COVID-19 cases, and the daily number of doses shipped to the state and include fixed effects for the day, month, and state. Standard errors are clustered by state and are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

We found no statistically significant increase in the daily vaccination rates after the announcement of incentives. However, a slight increase in daily COVID-19 vaccination rates was observed post-announcement, with positive effects remaining on days 7-12 after announcing the incentives. Specifically, the daily vaccination rate increased by 2.5 and 3.2 percentage points within 7-9 and 10-12 days after the announcement, respectively. In contrast, the pre-incentive trends in COVID-19 vaccination growth rates were small and insignificant, which validated our research design.

Similarly, findings show a statistically insignificant moderate increase in the daily vaccination rates after the announcement of the financial incentives, and the effects are positive from day four onwards. Specifically, the daily vaccination rate increased by 6.5, 5.8, and 0.4 percentage points within 7-9, 10-12, and 13 days after the announcement, respectively. In contrast, there was a decrease in the daily vaccination rates after announcing the non-financial incentives, for which the effects remained negative and statistically insignificant in all post-intervention periods.

Treatment heterogeneity and robustness checks

For all heterogeneous treatment specifications, robustness checks evaluated whether the results were impacted by adding controls for withdrawing state face mask mandates, withdrawing the state emergencies, the state-specific daily number of COVID-19 cases, number of doses shipped to the state daily, and excluding Alabama, Idaho, and New York from the analytic sample. The detailed description and results from these robustness checks are provided in the Supplement. For all heterogeneous treatment specifications, results were robust across these checks. Effects remained negative for incentives in states with high vaccination coverage and early incentive adoption. However, states with low vaccination coverage observed slight increases in the impact of incentives. The estimates remain moderate but statistically insignificant in most checks.

Discussion

Although at the time of this study, the national vaccination coverage reached around 56 percent of the total population [2], some states such as Mississippi, Alabama, and Louisiana were still

lagging far behind the coverage target [2]. [46][46, 45] Many states offered financial incentives while some others offered non-financial incentives to encourage more people to get vaccinated 44. This study examined the impact of such incentives on the daily growth of COVID-19 vaccination rates. To the best of our knowledge, this is the first study to evaluate the effect of state-announced incentives on COVID-19 vaccination rates, including all 50 U.S. states along with Washington DC, while considering heterogeneities within States and forms of incentives. We did not find a significant impact of incentives on vaccination rates. However, coefficients on post-intervention periods indicate that incentives have a slightly positive, though insignificant, effect on vaccination rates. Financial incentives perform better than non-financial incentives; low vaccination coverage (at the time of incentive announcement) states experience more impact on vaccination rates than high vaccination coverage states. These findings remain the same after controlling for state policies.

Vaccine hesitancy, despite millions of dollars worth of incentives, is a big concern for policymakers. A recent study shows vaccine hesitancy is higher in developed countries like the U.S. and Russia than in low- and middle-income countries [51]. Studies identified that fear of uncertain side-effects of vaccines or mistrust of vaccine efficacy influenced people's decision to take a vaccine, which indicates the risk-averse nature of the vaccine-hesitant people [11]. Lotteries typically do not attract risk-averse people since the lottery outcome itself is an uncertain event [34,35,52]. Our finding of better performance of financial incentives over non-financial incentives indicates that states need supplementary measures and financial incentives to boost COVID-19 vaccination coverage. Moreover, not all people who are less interested in the vaccine should be coined as vaccine-hesitant. Innovation-adoption theories reflect that adoption follows a typical pattern of making a choice slowly. So, apathy could have characterized their non-vaccination behavior as well [53].

Our finding that low-vaccination coverage states (at the time of incentive announcement) experience better daily vaccination rates than high-vaccination coverage states indicate that every state has a peak vaccine non-hesitant population. Therefore, it does not necessarily mean that announcing incentives at the stage of low coverage mitigates the vaccine hesitancy problem. It is essential to design more comprehensive strategies that address the reasons for non-commitment to vaccination. However, states were not successful in developing

comprehensive marketing strategies beyond these simple incentives[18]. So, the failure of an effect could be the failure of specific tactics used to implement an incentive or the broader failure of a lack of a strategy to reach unvaccinated populations[19].

Our study has some limitations. We cannot assess the individual-level effect of the COVID-19 vaccination efforts or measure the utilization of incentives in the community. At the time of analysis, we did not have data on county-level incentives or vaccination rates. In some control states, a few counties had announced such incentives [36]. These county-level incentives did not bias the intent-to-treat estimates of state-level incentives' effects as announced. Still, they added local-level heterogeneity not directly accounted for in the model. We could not stratify the sample by demographic characteristics such as age, gender, race, etc. This might be important as some incentives were targeted towards specific age groups, such as scholarships for young recipients. Another limitation may be that the effect of incentives on states with low base rates might reflect a recognition by states that they were in significant difficulty with vaccination. However, the signal that led to recognition by the governor could have also influenced people in the state to get vaccinated (or the initiation of other local programs within the state). Our framework could not address this possibility. Finally, we could not account for state-level hesitancy in taking COVID-19 vaccine doses, which might have impacted the vaccination rates. However, this is a comprehensive study of incentives on COVID-19 vaccination uptake that includes all U.S. states and considers the heterogeneity present across states. It contributes to the vaccine hesitancy and financial incentive literature in several aspects. We considered all states that offered financial, non-financial, or both treatment and compared those with those that never offered any incentives. Including all the states and several robustness checks increases the external validity of the results.

Conclusions

COVID-19 has impacted lives and livelihoods worldwide, and the United States is no exception. To develop herd immunity against the coronavirus, governments expected most of the population to have the vaccine. However, vaccine hesitancy is a harsh reality among people for some reason. As a result, some U.S. state governments announced different financial and non-financial incentives to encourage vaccine-hesitant populations to take the COVID-19 vaccine. Using Johns Hopkins University's state-level daily COVID-19 vaccination data from April 19

through July 18, 2021, this study presents evidence from a natural experiment on the effects of the 26 U.S. states' announced incentives (i.e., cash, lottery/sweepstakes, or other non-financial incentives) in 2021 to reduce vaccine hesitancy or reluctance. The research design is an event study assessing the changes in the daily state-level COVID-19 vaccination rates between April 19 and July 18. Any (financial and non-financial) incentives are associated with an increase in the daily COVID-19 vaccination rates by 2.5 and 3.2 percentage points in 7-9 and 10-12 days after the governors announced statewide incentives, but the effects were not statistically significant. Estimates suggest that state daily vaccination rates increased marginally due to the announcement of financial incentives but not for non-financial incentives. The findings of this impact evaluation study of the vaccine incentive program suggest modest but insignificant effects of statewide incentives on COVID-19 vaccination efforts.

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