CESifo WORKING PAPERS

10197
2022

December 2022

Covid-19 Full-Dose Vaccination across Uninsured Populations: Evidence across Counties in the United States

Rajeev K. Goel, Michael A. Nelson

CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editor: Clemens Fuest
https://www.cesifo.org/en/wp
An electronic version of the paper may be downloaded
· from the SSRN website: www.SSRN.com
· from the RePEc website: www.RePEc.org
· from the CESifo website: https://www.cesifo.org/en/wp

CESifo *Working Paper No. 10197*

Covid-19 Full-Dose Vaccination across Uninsured Populations: Evidence across Counties in the United States

Abstract

This paper studies the propensities of the U.S. population to seek a full dose of vaccinations against the COVID-19 pandemic. Beyond the consideration of vaccine dissemination at the disaggregated or the local level, the main focus of this study is on determining whether a lack of health insurance significantly impacted vaccination propensities. If it is indeed the case that a lack of health insurance mattered, this would be informative for policymakers since they tried to address this aspect in the vaccine rollout by subsidizing and offering vaccines at a zero price. Our results show that the uninsured were less likely to be fully vaccinated against the pandemic and this finding holds across different modeling formulations. However, there were differences in the responses of the different population subgroups. The findings with respect to the vaccination propensities of the unvaccinated are noteworthy, especially significant given the fact the COVID-19 vaccines were made available free of cost to the public in the United States, irrespective of their insurance status. A policy lesson from these results is that perhaps a better outreach to communities of the uninsured to inform them about the costs and availability of the coronavirus vaccines would have been better. Interestingly, new covid cases did not significantly impact decisions to fully vaccinate, while greater prosperity made full vaccination more likely. We did not find robust evidence of the elderly having a greater propensity to be fully vaccinated. Finally, accounting for the political dimension, counties housing the seats of the state government had greater full vaccination rates, ceteris paribus.

JEL-Codes: I180, I130, I110, H750, G220.

Keywords: Covid-19, vaccination, pandemic, insurance, elderly, county, United States.

*Rajeev K. Goel**
Department of Economics
Illinois State University
USA – Normal, IL 61790-4200
rkgoel@ilstu.edu

Michael A. Nelson
Department of Economics
University of Akron / OH / USA
nelson2@uakron.edu

*corresponding author

Goel thanks the Katie School of Insurance for support.

1. Introduction

Consideration of vaccinations at the county level would capture the effectiveness of government outreach at the local level, better account for local socio-economic differences, and examine the effectiveness of the decentralization of health services in fighting the pandemic. Given the federalist structure of the U.S. government, individual states have substantial autonomy in the way they structure and deliver public services, including health services. Furthermore, the structure and competitiveness of the private sector complementary players (e.g., nursing homes, pharmacies, etc.) varies across regions, impacting the supply side of vaccine delivery.

The COVID-19 vaccines were approved for distribution to the population at different times and this might have prompted some individuals to wait to be vaccinated for their “preferred” vaccine.[1] These issues are less of a concern in our analysis, given its later date when a number of vaccines were available concurrently in most nations of the world.

To ensure equitable distribution of the vaccines and effectively control the pandemic (Shen et al. (2020)), the U.S. government decided to make the COVID-19 vaccines available free of cost to the population, irrespective of the health insurance coverage one had.[2] Yet, the paperwork/disclosures required might a barrier to some without health insurance because of their perception that there may be hidden costs.[3] For example, a 2021 Kaiser Family Foundation poll found that nearly one-third of those who had not been vaccinated expressed concerns that they might have to pay an out-of-pocket cost to get the vaccine shot.[4] Individuals without health insurance might also generally have fewer interactions with health professionals and less information about health requirements, including pandemic vaccination recommendations (Goel and Nelson (2021a)). Furthermore, a person’s decision to obtain health insurance (or any insurance for that matter), is tied to risk attitudes (Carson et al. (2018), Ku (2021), Werner (2016)). Attitudes towards risk have, of course, broader implications, impacting individuals’ decisions to seek health insurance (Schmidt and Deichert (1992), Werner (2016); also see Cebula (2006) and Ku (2022)). These attitudes towards not obtaining insurance might be further impacted when there is a presence/perception of insurance fraud (Goel (2014)).[5] Even before the

---

[1] https://www.who.int/emergencies/diseases/novel-coronavirus-2019/covid-19-vaccines/advice; https://commission.europa.eu/strategy-and-policy/coronavirus-response/safe-covid-19-vaccines-europeans_en https://www.cdc.gov/coronavirus/2019-ncov/vaccines/stay-up-to-date.html?s_cid=11747:fully%20vaccinated%20guidelines:sem.ga:p:RG:GM:gen:PTN:FY22

[2] Beyond the urgency to control the pandemic, the public provision of health care is driven in part by its public good nature (Karsten (1995)).

[3] When scheduling a vaccine appointment healthcare organizations may ask the individual for information about their health care coverage, either with private insurance companies or via Medicaid/Medicare. The latter fully cover the cost of the vaccine and a majority of private insurance plans cover COVID-19 vaccines (https://www.verywellhealth.com/how-will-my-health-insurance-cover-a-covid-19-vaccine-5090168e). For individuals lacking insurance, healthcare providers can seek reimbursement through the COVID-19 Uninsured Program (https://www.hrsa.gov/provider-relief/about/covid-uninsured-claim or the COVID-19 Coverage Assistance Fund (https://www.hrsa.gov/provider-relief/about/covid-19-coverage-assistance).
Even with all this government machinery, vaccine hesitancy among sections of the population might prevent them from seeking vaccines (Goel et al. (2022); Karpman et al. (2021)).

[4] https://www.kff.org/coronavirus-covid-19/poll-finding/kff-covid-19-vaccine-monitor-april-2021/
See, also, Kliff (2021).

[5] The relatively recent introduction of technology, especially information technology, might have significantly impacted the insurance markets, with not all effects being positive (Neale et al. (2020); and Rothschild and Stiglitz (1976) for a related seminal theoretical piece).

current pandemic, health insurance coverage in the United States had been on a decline over time (Kronick and Gilmer (1999), Schmidt and Deichert (1992); also see Hoffman and Paradise (2008)).

In addition to all this, some counties house the seats of state government, and government outreach likely is better there - due to greater media scrutiny and relatively greater realization of the citizen's needs by the lawmakers and bureaucrats (Goel and Nelson (2021a,b)).

Given the nature of the current pandemic, immunity against the virus is contingent upon one getting the full course (i.e., two doses after a set minimum interval in the case of most vaccines), and bottlenecks (both on the demand side or the supply side) could prevent someone from not getting the full dose. In this study, we focus on the full dose of the vaccine delivery (without the booster shots), as that accomplishes the (minimum) goal of the health authorities.

This paper tries to explain the propensities of the U.S. population to seek a full dose of vaccinations against the COVID-19 pandemic. Beyond the consideration of vaccine dissemination at the disaggregated or the local level, the main focus of this study is on determining whether a lack of health insurance significantly impacted vaccination propensities. If it is indeed the case that a lack of health insurance mattered, this would be informative for policymakers since they tried to address this aspect in the vaccine rollout by subsidizing and offering vaccines at a zero price.

Key questions addressed in this research are:

- What socio-economic factors drive the full-dose COVID-19 vaccinations across counties in the United States?
- Does a lack of health insurance significantly impact vaccination propensities (even when vaccinations are underwritten by the government)?
- How do vaccination propensities differ across different population subgroups of the uninsured?
- Are vaccination rates in counties hosting state capitals better than other counties?

Our results show that the uninsured were less likely to be fully vaccinated against the pandemic and this finding holds across alternative formulations. However, there were differences in the responses of the different population subgroups. The findings with respect to the vaccination propensities of the unvaccinated are noteworthy, especially significant given the fact the COVID-19 vaccines were made available free of cost to the public in the United States, irrespective of their insurance status. Interestingly, new covid cases did not significantly impact decisions to fully vaccinate, while greater prosperity made full vaccination more likely. We did not find robust evidence of the elderly having a greater propensity to be fully vaccinated. Finally, accounting for the political dimension, counties housing state governments had greater full vaccination rates, ceteris paribus.

Besides adding to the literature, the findings will have policy value, not just for more effectively combating the current pandemic but also to better prepare governments for a future pandemic.

The layout of the rest of the paper includes the background and the model in the next section, followed by data and estimation, results, and conclusions.

2. Background and the model

2.1 Background

The execution of COVID-19 vaccine delivery can be viewed from both the demand and the supply side of the vaccine market. On the supply side, first, there were issues with the invention and testing of the vaccines, followed by supply chain/storage issues with getting the vaccines delivered and administered where they were needed. An underlying current, also on the supply side, was the composition of health markets, both in the public and the private sector. Besides vaccine access, these factors would impact the vaccine price. Thankfully, the United States government chose to subsidize COVID-19 vaccines, with the vaccines being free to all, irrespective of whether one had health insurance or not.

On the demand side, cost, access, personal attributes (race, gender, age, etc.), and risk attitudes (shaping hesitancy towards inoculations in general and/or in the case of COVID-19) would matter.

Beyond the current vaccinations and the pandemic, a broader aspect is a person’s access to health insurance. Insurance cost is an obviously important element, but risk attitudes crucially dictate whether and how much insurance someone buys. Whereas the presence of health insurance and vaccine costs are not an issue with respect to COVID-19 vaccines in the United States, folks with health insurance would likely have better health information (about access to/need for vaccines) ceteris paribus. Plus, the fact that they chose to get some form of health insurance signifies some level of aversion toward risk.

In a broader interdisciplinary context, a few studies have considered vaccination rates across counties in the United States. However, these studies look at the initial phases of the pandemic and are thus unable to address the full dose vaccination rates that we do here. For instance, Brown et al. (2021) used the COVID-19 Community Vulnerability Index to study the associations between vulnerability and county-level COVID-19 vaccination across 2415 counties through May 25th, 2021. They found that housing type, transportation, household composition, and disability were associated with the largest vaccination disparity (also see Hughes et al. (2021) for evidence on the initial phases of vaccination rates across counties). Puranik et al. (2021) found that the aggregate county-level vaccination rate through March 1, 2021, was associated with a decline in COVID-19 incidence, with regional differences across counties in the United States. Another county-level study, using earlier data, is due to Donadio et al. (2021) who look at vaccination rates across U.S. counties through June 2021. They consider different demographic and environmental factors affecting them, but do not consider the effects of economic prosperity, and state capital, nor address complete vaccine doses. Significantly, the differences across the subgroups of the uninsured considered in our work are missing from earlier studies.

Goel and Nelson (2021b) used broader state-level data for the United States to examine the drivers of the administration and delivery efficiency of coronavirus vaccines. Their results showed that state-economic prosperity and rural population aided vaccine administration and delivery efficiency. Delivery efficiency improved in states with more nursing homes per capita, in states with more COVID-19 deaths, and with more health workers.

This study primarily considers the determinants of the full dose of vaccinations, with the main research questions outlined in the Introduction.

2.2 The model

The general format of our estimated equation, using data at the county level in the United States (see Table 1 and Section 3.1 for details) is

FullDOSE = (*CovidCASES*, Economic Prosperity$_j$, *ELDERLY*, *UNINSURED*, Demographic factor$_m$, *StateCAPITAL*, Uninsured populations$_k$) …(1)

j = *INCOME*, *PovertyRT*

m = *RACE, lowEDUCATION*

k = *Uninsured_fem, Uninsured_married, Uninsured_black, Uninsured_highsch, Uninsured_noEnglish*

The dependent variable is the percent of the U.S. population (at the county level) that received the full dose (no booster) of COVID-19 vaccinations (*FullDOSE*). As of April 1, 2022, a little over half the U.S. population had received the full dose of the COVID-19 vaccines (not including booster shots).[6]

An obvious, and important, determinant of vaccinations is the number of covid cases (*CovidCASES*), in this case at the county level. More cases impact the perceptions and urgency toward preventing the spread of the virus. This would increase the supply/access and increase the propensity of (some) individuals to get vaccinated.

Economic prosperity (measured alternately via *INCOME* and *PovertyRT*) accounts for affordability, and more prosperous states would have a better infrastructure to deliver the vaccines. Even though vaccines are offered free of cost in the United States, greater prosperity would tie to information and transportation access for individuals seeking vaccines.

The level of (low) education (*lowEDUCATION*) is included to account for a person's ability to better evaluate the risks of vaccines and to be informed about vaccine access (especially, when access was limited right after the vaccines were approved for public distribution). In the initial days, vaccinations for certain groups, the elderly and frontline workers, were prioritized for vaccines. Accordingly, we include the share of the elderly in the population (*ELDERLY*).[7] We also account for race by including the population share of the black population (*RACE*).

The main focus is on the propensity of the uninsured to be fully vaccinated. In general, a person's economic status, risk attitudes, and personal attributes (age, race, etc.) might shape individuals' propensities to vaccinate. In a private health insurance market, like in the United States, some individuals with preexisting health conditions might be denied (or priced out) health

---

[6] Obviously, this number would increase over time. However, we had to pick a date for the analysis, plus, we picked a date when the peak of the pandemic had subsided in the United States and vaccines had been widely available across the nation for quite some time (allowing many/most individuals access to both doses of the related vaccines).

[7] Compared to other adults, some of the elderly might have given medical decision-making rights to others. In that case, the elderly person's own attitudes toward vaccines might matter less.

insurance (some of this has changed with the recent Affordable Care Act). These attitudes could also indirectly be impacted by access to information, which the government could have a role in. In our sample, about 12 percent of the U.S. population lacked health insurance.

In order to examine the propensities of different groups of the uninsured to seek health insurance, we consider five dimensions, each measured by group size relative to their share of the total non-elderly population: (i). uninsured females (*Uninsured_fem*), (ii), uninsured and married (*Uninsured_married),* (iii). individuals identifying themselves as Black or African-American and uninsured (*Uninsured_black),* (iv). uninsured with less than high school education (*Uninsured_highsch*), and (v). uninsured and have non-English speaking adults in the household (*Uninsured_noEnglish*). If it turns out that these different subgroups of the uninsured have different propensities to get fully vaccinated, then health policies or pandemic containment policies may be fine-tuned accordingly.

To account for the political aspects in vaccine delivery, we include a dummy variable, *StateCAPITAL*, that identifies counties housing the seats of state governments. As argued about, these counties likely face greater scrutiny and focus, resulting in better vaccination outcomes.[8] About 16 percent of sample counties housed seats of state capitals (realize that some state capitals might encompass more than one county).

3. Data and estimation

2.1 Data

A county in the United States comprises the unit of analysis in this research. As of the time of this writing, there were 3,142 counties in the US. Of this total, 19 counties were excluded in the analysis below, either due to a lack of data on the vaccine completion or the insurance status of the counties' population, leaving a total of 3,123 counties in our data set.[9]

The data sources used in this paper are all widely used in the literature and available in the public domain. Complete details about the variables used, including summary statistics, definitions, and data sources are in Table 1. Table 2 presents the correlations between the main variables in the analysis. The correlation between *FullDOSE* and *UNINSURED* is -0.3 and statistically significant, while that between *CovidCASES* and *UNINSURED* is nearly zero.

2.2 Estimation

Estimation is carried out using Ordinary Least Squares for ease of interpretation of the results. Hypothesis testing is conducted using state-level clustered standard errors to account for possible correlation of the model residuals within counties of a given state. It is important to acknowledge that the dependent variable value, *FullDOSE,* lies within the [0, 1] interval when expressed as a fraction. An OLS regression in this case may suffer from similar problems to linear probability models involving binary response dependent variables. In particular, predicted probabilities can lie outside the [0, 1] interval and linear relationships with the independent variables in the model

[8] Additionally, the recording of vaccines administered might also be better in such counties, ceteris paribus.
[9] Eight of the excluded counties were in California, four in Hawaii, three in Alaska and Massachusetts, and one in South Dakota.

are assumed. To address this, we conduct robustness tests below, following Papke and Wooldridge (1996) and Wooldridge (2010), by fitting a fractional response model using the quasi-likelihood estimator, under the assumption that the distribution of the conditional mean of the response variable follows a logistic functional form. The results section follows.

4. Results

4.1 Baseline models

Table 3 reports results from the baseline models, considering *PovertyRT* and *INCOME* as alternative aspects of economic prosperity.

The results show that a greater share of the uninsured lowered full vaccination rates across U.S. counties. The resulting coefficient on *UNINSURED* is negative and statistically significant in all four models (two with *INCOME* and *PovertyRT* each) in Table 3. This result is consistent with the uninsured being relatively less informed (because of their limited interactions with health professionals) about the need and availability of COVID-19 vaccines, even when the vaccines were available free of cost to the U.S. population., irrespective of their health insurance status. These results also tie attitudes toward risk and misunderstanding of the price of the vaccine discussed above. The results with regard to the uninsured are consistent with earlier findings of Donadio et al. (2021), although that study did not consider sub-populations of the uninsured.

Importantly, the estimated magnitudes of the impact implied by the parameter estimates on the *UNINSURED* variable are substantial. For example, using either Model 1.1 or Model 1.3 results, a one standard deviation increase in the percentage of the population that is uninsured (5.86% - see Table 1) translates into an approximately 10 percent lower share of the population with complete COVID-19 vaccinations, holding other factors constant. This constitutes nearly one-standard deviation of the *FullDOSE* variable in our data set. In Models 1.2 and 1.4, the corresponding drop in vaccination rates would be around 7 to 8 percent.

On the other hand, the number of new covid cases (*CovidCASES*), capturing the spread of the pandemic did not have a significant impact on full vaccination rates. It is likely the case that the spread of the pandemic was more significant in impacting a person's decision to seek vaccines (vaccine initiation (Roghani and Panahi (2021)), and once they received the first dose, many folks went on to complete the mandated full dose program, irrespective of the pandemic spread in their vicinity.

Consistent with intuition, greater economic prosperity enabled full vaccination - both through better information and better access. The negative sign on low education is also consistent with intuition - related to access to and understanding of health-related information with the less educated that reduces their willingness to be vaccinated. Finally, the impact of *RACE* was insignificant, as was the case for the *ELDERLY* in most cases. Holding other factors constant, African Americans were no less like to become vaccinated than other segments of the population, at least by the April 2022 date considered in this analysis. The results with respect elderly are in lie with Goel and Nelson's (2021b) earlier findings about the behavior of the elderly across U.S. states. That study, however, did not consider full vaccination doses.

4.2 Considering nonlinear effects

In Table 4, we examine possible nonlinearities in the relation between *FullDOSE* and *UNINSURED* and *CovidCASES*, by alternatively taking the squared values of the latter two variables.

The results show that the uninsured do exhibit a U-shaped relation with full vaccination doses - the squared term of *UNINSURED* is positive and statistically significant and this holds whether *INCOME* or *PovertyRT* is used as a control.

On the other hand, no presence of nonlinear effects is found with respect to *CovidCASES*, with both the *CovidCASES* and $CovidCASES^2$ coefficients being statistically insignificant. The study of possible nonlinear effects deserves more attention in the related research.

The results for the other variables largely support what was reported in Table 3.

4.3 Political considerations and population subgroups of the uninsured

In Table 5 expanded models that take into account political considerations and possible differences in uninsured population subgroups in seeking COVID-19 vaccinations are reported. In Model 3.1, *StateCAPITAL* is added to the baseline Model 1.4 reported earlier. The consideration of state capitals accounts for the political dimension to the vaccine rollout and administration and is an added novel feature of our analysis.

Interestingly, counties housing state capitals performed better in their ability to fully vaccinate their populations. This might be due to both demand-side and supply-side factors: there might be a better/more timely supply of vaccines to these counties and residents of these counties might be better informed of the vaccine availability, ceteris paribus. In terms of magnitude, the parameter estimate for the capital variable (*StateCAPITAL*) reported in Model 3.1 indicates the vaccination rates are nearly 10 percent higher in counties where the state capital is located, other things being equal.

Table 5 also delves further into the behavior of the uninsured by considering different socio-economic subgroups in terms of their propensities to fully vaccinate: *Uninsured_fem, Uninsured_married, Uninsured_black, Uninsured_highsch, Uninsured_noEnglish*. In our sample, females make up the largest group of uninsured, constituting about 5 percent of the total non-elderly population or a little less than one-half of all uninsured individuals, married individuals represent the second largest group of uninsured followed by those with less than a high school education. Uninsured Blacks made up about 1.5% of the total population or about 13% of all insured, followed by individuals living in households with no English-speaking adults. See Table 1 for additional details.

Results, using median income as the measure of county prosperity, are presented as Models 3.2 – 3.4 in Table 5. The share of married in the uninsured (*Uninsured_married*) showed lower propensities to fully vaccinate, between 1.5 and 2.0 lower complete vaccination rates, other things being equal. A possible explanation for the lower full vaccination by the married might be that married folks have a spousal support system and this might make them relatively less risk-averse (thus choosing to not vaccinate).

Interestingly, results for Model 3.4 show that households with no English-speaking households were more like to vaccinate (*Uninsured_noEnglish*] even if they lack health insurance The findings might be consistent with greater risk aversion or a better public outreach to these subgroups.

Results for the other group variables were not statistically significant at conventional levels. A possible contributing factor may be due to the underlying multicollinearity among some of the group variables.[10]

To conserve space, the results from Table 5 with *PovertyRT* as a control, instead of *INCOME,* are not reported here but are available upon request. Results regarding the population group variables are in line with what is reported above. The findings for the other control variables in the model are also similar with the exception that the *ELDERLY* variable, where the parameter estimate becomes negative and is generally statistically significant.

4.4 Using alternative estimation

We also did a replication of the baseline results from Table 3 by using fractional response estimation. Here we use the fraction of *FullDOSE,* rather than its percentage, as the dependent variable.

The results, available upon request, confirm earlier findings from the baseline models. In particular, all four coefficients on *UNINSURED* are negative and statistically significant, while those on *CovidCASES* remain insignificant. Furthermore, greater income increased vaccination rates, while greater high school graduation rates had the opposite effect.[11] The concluding section follows.

5. Conclusions

This paper tries to explain the propensities of the U.S. population to seek a full dose of vaccinations against the COVID-19 pandemic. Beyond the consideration of vaccine dissemination at the local level, the main focus of this study is on determining whether a lack of health insurance significantly impacted vaccination propensities. People with a lack of health insurance would likely be interacting with health providers less frequently than others and thus be less aware of the health mandates and recommendations. When they do contact health providers infrequently, it might be the case that certain latent preexisting conditions might make them ineligible for additional procedures, in this the coronavirus vaccines.

Using data on 3,123 U.S. counties, our results show that the uninsured were less likely to be fully vaccinated against the pandemic and this finding is robust. However, there were differences in the responses of the different population subgroups. The findings with respect to the vaccination propensities of the unvaccinated are noteworthy, especially significant given the fact the COVID-19 vaccines were made available free of cost to the public in the United States,

---

[10] For instance, the correlation between *Uninsured_fem* and *Uninsured_married* was 0.87. Additional details are available upon request.

[11] It is important to keep in mind that fractional response regressions assume a logit distribution. Hence the parameter estimates represent log-odds ratios and therefore are not directly comparable with the OLS parameter estimates presented in the remainder of the paper.

irrespective of their insurance status. A policy lesson from these results is that perhaps a better outreach to communities of the uninsured to inform them about the costs and availability of the coronavirus vaccines would have been better.

Interestingly, new covid cases did not significantly impact decisions to fully vaccinate, while greater prosperity made full vaccination more likely. We did not find robust evidence of the elderly population having a greater propensity to be fully vaccinated. Finally, accounting for the political dimension, counties housing the seats of the state government had greater full vaccination rates, ceteris paribus. These findings are useful not just for formulating more effective policies in the current pandemic but also in better preparing for future pandemics.

Key questions posed in the Introduction now have the following answers from our analysis:

- What socio-economic factors drive the full-dose COVID-19 vaccinations across counties in the United States?
  We find that economic prosperity and education status mattered, while race and the elderly were most insignificant in driving full vaccination rates. The spread of covid cases also did not matter. Once individuals initiate a COVID-19 vaccination program, they seem to be paying less attention to the overall spread of the pandemic.

- Does a lack of health insurance significantly impact vaccination propensities (even when vaccinations are underwritten by the government)?
  Yes, a lack of health insurance did lower vaccination rates across U.S. counties. The magnitude of the related effect is also found to be substantial. This suggests that policymakers need to do better outreach across uninsured communities to bolster COVID-19 vaccinations. Merely making the vaccines free of cost seems to not be enough.

- How do vaccination propensities differ across different population subgroups of the uninsured?
  Among the subgroups of the uninsured, marital status, a lack of English-speaking adults in the household, and education mattered, but not gender or race. The lack of gender and racial differences in full vaccine dose administration should be welcome news for lawmakers.

- Are vaccination rates in counties hosting state capitals better than other counties?
  Yes, vaccination rates for counties housing states capitals fared better in vaccinating their residents, ceteris paribus. Policymakers focusing only on the vaccination trends in the immediate counties the seats of government might be being myopic and making decisions on the basis of incomplete or biased information.

These findings can inform policies going forward. It is not just crucial in this context to increase health insurance coverage, but to target certain subgroups of the uninsured to increase their vaccination rates. It remains to be seen whether and how vaccination rates can be improved as the pandemic wanes to ward off threats from additional variants of the virus.

References

Brown, C.C., Young, S.G., Pro, G.C., 2021. COVID-19 vaccination rates vary by community vulnerability: A county-level analysis. Vaccines, 39(31), 4245-4249.

Carson, J., Dumm, R., Halek, M., Liebenberg, A., 2018. What factors portend changes in household relative risk aversion? Journal of Insurance Issues, 41(1), 1-21.

Cebula, R.J., 2006. A further analysis of determinants of health insurance coverage. International Advances in Economic Research, 12, 382-389.

Donadio, G., Choudhary, M., Lindemer, E., Pawlowski, C., Soundararajan, V., 2021. Counties with lower insurance coverage and housing problems are associated with both slower vaccine rollout and higher COVID-19 incidence. Vaccines, 9(9), 973, https://doi.org/10.3390/vaccines9090973

Goel, R.K., 2014. Insurance fraud and corruption in the United States. Applied Financial Economics, 24(4), 241-246.

Goel, R.K., Jones, J.R., Saunoris, J.W., 2022. Explaining vaccine hesitancy: A COVID-19 study of the United States. Managerial and Decision Economics, in press. https://doi.org/10.1002/mde.3732

Goel, R.K., Nelson, M.A., 2021a. COVID-19 internet vaccination information and vaccine administration: Evidence from the United States. Journal of Economics and Finance, 45(4), 716-734.

Goel, R.K., Nelson, M.A., 2021b. Drivers of COVID-19 vaccinations: Vaccine delivery and delivery efficiency in the United States. NETNOMICS: Economic Research and Electronic Networking, 22(1), 53-69.

Hoffman, C., Paradise, J., 2008. Health insurance and access to health care in the United States. Annals of the New York Academy of Sciences, 1136(1), 149-160. https://nyaspubs.onlinelibrary.wiley.com/doi/full/10.1196/annals.1425.007

Hughes, M.M., Wang, A., Grossman, M.K., et al. County-Level COVID-19 Vaccination Coverage and Social Vulnerability—United States, 14 December 2020–1 March 2021. MMWR. Morbidity and Mortality Weekly Report 2021, 70, 431-436. https://www.cdc.gov/mmwr/volumes/70/wr/mm7012e1.htm?s_cid=mm7012e1_w

Karpman, M., Kenney, G.M., Zuckerman, S., Gonzalez, D., Courtot, B., 2021. Confronting COVID-19 vaccine hesitancy among nonelderly adults: Findings from the December 2020 well-being and basic needs survey. Urban Institute, February, https://www.urban.org/sites/default/files/publication/103713/confronting-covid-19-vaccine-hesitancy-among-nonelderly-adults_0_0.pdf

Karsten, S.G., 1995. Health care: Private good vs. public good. The American Journal of Economics and Sociology, 54(2), 129-144.

Kliff, S., 2021. The Covid vaccine is free, but not everyone believes that. The New York Times, June 1, https://www.nytimes.com/2021/06/01/upshot/covid-vaccine-hesitancy-cost.html

Ku, L., 2022. The association of social factors and health insurance coverage with COVID-19 vaccinations and hesitancy, July 2021. Journal of General Internal Medicine, 37, 409-414.
Neale, F.R., Drake, P.P., Konstantopoulos, T., 2020. InsurTech and the disruption of the insurance industry. Journal of Insurance Issues, 43(2), 64-96.

Papke, L.E., Wooldridge, J.M., 1996. Econometric methods for fractional response variables with an application to 401(k) plan participation rates. Journal of Applied Econometrics, 11(6), 619-632.

Puranik, A., Venkatakrishnan, A.J., Pawlowski, C., Raghunathan, B., Ramudu, E., Lenehan, P., Agarwal, V., Jayaram, S., Choudhary, M., Soundararajan, V., 2021. Higher COVID-19 vaccination rates are linked to decreased county-level COVID-19 incidence across USA. British Medical Journal, medRxiv, 1-11. https://www.medrxiv.org/content/10.1101/2021.03.05.21252946v1

Roghani, A., Panahi, S., 2021. Higher COVID-19 vaccination rates among unemployed in the United States: State level study in the first 100 days of vaccine initiation. British Medical Journal, medRxiv, https://doi.org/10.1101/2021.04.17.21255668

Rothschild, M., Stiglitz, J., 1976. Equilibrium in competitive insurance markets: An essay on the economics of imperfect information. Quarterly Journal of Economics, 90(4), 629-649.

Schmidt, J.R., Deichert, J.A., 1992. Determinants of regional variation in the lack of health insurance coverage. Journal of Insurance Issues,15(1), 65-88.

Shen, A.K., Hughes IV, R., DeWald, E., Rosenbaum, S., Pisani, A., Orenstein, W., 2020. Ensuring equitable access to COVID-19 vaccines in the US: Current system challenges and opportunities. Health Affairs, 40(1), https://doi.org/10.1377/hlthaff.2020.01554

Werner, K., 2016. Insurance demand and heterogeneity in risk perception. Journal of Insurance Issues, 39(1), 69-91.

Wooldridge, J.M., 2010. Econometric Analysis of Cross Section and Panel Data (2nd ed.). Cambridge, MA: MIT Press.

Table 1
Variable definitions, summary statistics, and data sources

Variable	Mean (std. dev.)	Source
Percentage of the population with completed primary vaccine series as of April 1, 2022. [*FullDOSE*]	50.92 (12.02)	[1]
Percentage of uninsured population ages 0 – 64 that are likely to qualify for coverage through Qualified Health Plans in the Health Insurance Marketplace, 2019. [*UNINSURED*]	12.11 (5.86)	[2]
New COVID-19 cases per 100,000 population &-day total), average daily value for the month of March 2022. [*CovidCASES*]	97.28 (119.80)	[3]
Percentage of population (all ages) below the poverty level, 2019. [*PovertyRT*]	14.46 (5.78)	[4]
Median household income (in thousands), 2019. [*INCOME*]	55.67 (14.46)	[4]
Percentage of the population 65 years of age and older, 2019. [*ELDERLY*]	19.74 (4.77)	[5]
Percentage of population (all ages) Black or African American, 2019. [*RACE*]	9.41 (14.49)	[4]
Percentage of adults (25 and over) with only a high school diploma, 2018. [*lowEDUCATION*]	34.32 (7.18)	[6]
The county includes the state capital. [*StateCAPITAL*]	0.16 (0.12)	[7]
Percentage of uninsured females relative to the total non-elderly population, 2019. [*Uninsured_fem*]	5.07 (2.62)	[2]
Percentage of married and uninsured relative to the total non-elderly population, 2019. [*Uninsured_married*]	3.45 (1.92)	[2]
Percentage of uninsured individuals that identify themselves as Black, non-Latino, relative to the total non-elderly population, 2019. [*Uninsured_black*]	1.55 (2.46)	[2]
Percentage of individuals with less than a high school education relative to the total non-elderly population, 2019. [*Uninsured_highsch*]	2.44 (1.96)	[2]
Percentage of individuals that have no English-speaking adults in the household relative to the total non-elderly population, 2019. [*Uninsured_noEnglish*]	0.48 (0.76)	[2]

Notes: Statistics pertain to observations used in the first model that the variable appears.
Sources:
[1]. Centers for Disease Control and Prevention (https://data.cdc.gov/Vaccinations/COVID-19-Vaccinations-in-the-United-States-County/8xkx-amqh/data). (accessed November 2022)
[2]. Office of the Assistant Secretary for Planning and Evaluation, Department of Health and Human Services, "State, County, and Local Estimates of the Uninsured Population: Prevalence and Key Demographic Features." (March 11, 2021) (https://aspe.hhs.gov/reports/state-county-local-estimates-uninsured-population-prevalence-key-demographic-features). (accessed November 2022)
[3]. Centers for Disease Control and Prevention, "United States COVID-19 Community Levels by County," (https://data.cdc.gov/Public-Health-Surveillance/United-States-COVID-19-Community-Levels-by-County/3nnm-4jni). (accessed November 2022)
[4]. US Census Bureau, SAIPE State and County Estimates for 2019. (https://www.census.gov/data/datasets/2019/demo/saipe/2019-state-and-county.html). (accessed November 2022)

[5]. 2019 Census of Population, drawn from Centers for Disease Control and Prevention (https://data.cdc.gov/Vaccinations/COVID-19-Vaccinations-in-the-United-States-County/8xkx-amqh/data). (accessed November 2022)
[6]. https://federalism.sharepoint.com/:x:/s/website-data/EWX7JXjlVpJChFcdyqD5JTcB04Q4_bIGs_5rNpzLEww94Q?rtime=TgwQ9h_W2kg (accessed November 2022)
[7]. https://www.sporcle.com/games/Anne13/usstatecapitals_bycounty/results

Table 2
Correlation coefficients of key variables used in the analysis

	FullDOSE	*UINSURED*	*CovidCASES*	*POVERTY*	*INCOME*	*ELDERLY*	*RACE*	*lowEDUCATION*
FullDOSE	1.00							
UNINSURED	-0.33**	1.00						
CovidCASES	0.03	-0.01	1.00					
POVERTY	-0.22**	0.40**	0.05**	1.00				
INCOME	0.42**	-0.37**	-0.04**	-0.77**	1.00			
ELDERLY	-0.10**	-0.01	-0.03	-0.04**	-0.27**	1.00		
RACE	-0.02	0.18**	-0.13**	0.49**	-0.24**	-0.19**	1.00	
lowEDUCATION	-0.45**	0.13**	0.01	0.29**	-0.54**	0.25**	-0.00	1.00

Notes: Based on a sample of 3,123 counties used in the analysis below. Variable definitions are provided in Table 1.
*** denotes significance at the 5% level (or better).*

Table 3
Completion of primary vaccination series and uninsured county population: Baseline models

(Dependent variable: *FullDOSE*)

Model →	**[1.1]**	**[1.2]**	**[1.3]**	**[1.4]**
Uninsured population [*UNINSURED*]	**-0.578**** **(4.3)**	**-0.407**** **(4.4)**	**-0.560**** **(5.4)**	**-0.461**** **(4.9)**
New COVID cases [*CovidCASES*]	0.004 (0.8)	0.005 (1.2)	0.004 (0.9)	0.006 (1.2)
Population below poverty level [*PovertyRT*]	-0.239** (2.2)		-0.036 (0.3)	
Median household income [*INCOME*]		0.285** (6.6)		0.163** (2.9)
Population ≥ 65 years old [*ELDERLY*]	-0.260** (2.0)	-0.011 (0.1)	0.031 (0.2)	0.136 (1.0)
Black population [*RACE*]			0.038 (0.8)	0.071* (1.7)
High school diploma only [*lowEDUCATION*]			-0.684** (8.2)	-0.545** (5.6)
F-Statistic	8.61**	18.68**	28.10**	33.80**
R-squared	0.13	0.21	0.28	0.30
Observations (counties)	3,123	3,123	3,123	3,123

Notes: Variable definitions are provided in Table 1.
Constant term included in all models but not reported to conserve space.
The numbers in parentheses are t-statistics in absolute value based on state-level clustered standard errors.
** denotes statistical significance at the 10% level, and ** denotes significance at the 5% level (or better).*

Table 4
Completion of primary vaccination series and uninsured county population:
Non-linear relationships between vaccine completeness and key variables

(Dependent variable: *FullDOSE*)

Model →	**[2.1]**	**[2.2]**	**[2.3]**	**[2.4]**
Uninsured population [*UNINSURED*]	**-2.199**** **(7.3)**	**-1.967**** **(6.7)**	**-0.559**** **(5.4)**	**-0.458**** **(5.0)**
Uninsured population - sq [*UNINSURED*]^2	**0.055**** **(6.2)**	**0.049**** **(6.1)**		
New COVID cases [*CovidCASES*]	0.004 (0.7)	0.005 (1.0)	0.007 (0.9)	0.010 (1.4)
New COVID cases - sq [*CovidCASES*]^2			-0.000 (0.6)	-0.000 (1.1)
Population below poverty level [*PovertyRT*]	-0.027 (0.2)		-0.040 (0.3)	
Median household income [*INCOME*]		0.129** (2.4)		0.166** (3.0)
Population ≥ 65 years old [*ELDERLY*]	0.080 (0.6)	0.158 (1.2)	0.030 (0.2)	0.135 (1.0)
Black population [*RACE*]	0.064 (1.5)	0.088** (2.3)	0.039 (0.8)	0.074* (1.7)
High school diploma only *[lowEDUCATION*]	-0.647** (8.0)	-0.540** (5.9)	-0.682** (8.2)	-0.540** (5.7)
F-Statistic	38.26**	41.55**	25.08**	29.37**
R-squared	0.32	0.33	0.28	0.30
Observations (counties)	3,123	3,123	3,123	3,123

Notes: See Table 3.

Table 5
Completion of primary vaccination series and uninsured county population: State capital and characteristics of the uninsured

(Dependent variable: *FullDOSE*)

Model →	**[3.1]**	**[3.2]**	**[3.3]**	**[3.4]**
Uninsured population [*UNINSURED*]	**-0.397**** **(4.3)**			
Female uninsured [*Uninsured_fem*]		**0.175** **(0.5)**	**0.213** **(0.5)**	**-0.158** **(0.5)**
Married uninsured [*Uninsured_married*]		**-1.672**** **(4.8)**	**-1.518**** **(3.5)**	**-1.954**** **(5.3)**
Black uninsured [*Uninsured_black*]			**0.043** **(0.1)**	**0.091** **(0.4)**
< High school uninsured [*Uninsured_highsch*]			**-0.284** **(0.8)**	
No English uninsured [*Uninsured_noEnglish*]				**3.082**** **(3.7)**
State capital [*StateCAPITAL*]	**9.234**** **(9.5)**	**8.682**** **(9.1)**	**8.617**** **(8.6)**	**8.412**** **(8.3)**
New COVID cases [*CovidCASES*]	0.005 (1.2)	0.005 (1.5)	0.005 (1.4)	0.005 (1.1)
Median household income [*INCOME*]	0.282** (6.5)	0.287** (7.3)	0.285** (6.1)	0.265** (5.4)
Population ≥ 65 years old [*ELDERLY*]	0.010 (0.1)	0.042 (0.3)	0.036 (0.3)	0.092 (0.7)
F-Statistic	50.48**	45.00**	36.31**	51.08**
R-squared	0.22	0.24	0.24	0.26
Observations (counties)	3,123	3,123	3,123	3,123

Notes: See Table 3.