Vaccine Refusal is Not Free Riding

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Introduction

Game theory attempts to model and predict human behavior by assuming that people act rationally. That is, given a list of potential outcomes based on their actions, they can rank their preference of the outcomes and they will take the actions that will lead to the best outcomes. They know their interests, and they act to promote their interests. When someone behaves in a way that appears irrational, game theorists will try to explain the apparent irrationality by other means, usually by showing either a) that the behavior is in fact rational, but in a non-obvious way, or b) that the available information can make the behavior rational given the limited information available to the actor.

As an example of approach (a), consider the Prisoner's Dilemma. In this classic thought experiment, Alice and Bob are arrested on suspicion that they committed burglary, but law enforcement only has enough evidence to pin them on a lesser charge of breaking and entering. The police come up with the following plan to elicit confessions from both Alice and Bob:

1. Separate Alice from Bob, not allowing them to communicate.
2. Tell Alice and Bob that law enforcement can secure a conviction with a one-year sentence for each of them, even if they both remain silent.
3. Offer Alice and Bob immunity if they testify to their accomplice's guilt, so that if Alice testifies, she will go free while Bob will receive a three-year sentence.
4. Tell Alice and Bob that if both testify, then law enforcement will be able to secure a two-year sentence for both.

The plan is summarized in the following table:

	Bob Stays Silent	Bob Testifies
Alice Stays Silent	Alice: 1 Bob: 1	Alice: 3 Bob: 0
Alice Testifies	Alice: 0 Bob: 3	Alice: 2 Bob: 2

At first glance, this may seem like a terrible plan. Clearly, both Alice and Bob will recognize that they are collectively better off if they both stay silent, so that's what will happen. The police have failed in their attempt to elicit confessions. If this case were to play out and both Alice and Bob testified, many people would say that they were stupid to fall for the trap the police had set. But what if neither Alice nor Bob cares about what makes them collectively better off?

If each person cares only about how many years they individually spend in prison, then we find that the best way for each of them to protect their own interests is to testify. Consider the situation from Alice's perspective. She does not know what Bob will do because the two are separated. Suppose Alice assumes that Bob will stay silent. In that case, she will get one year in prison if she stays silent, while she will walk free if she testifies against Bob. So, if Bob stays silent, Alice is better off testifying. This gives rise to a term that will make frequent appearances throughout this thesis. Alice is *free riding* by refusing to cooperate on a group project (in this case, staying silent in the face of police interrogation) while her accomplice, Bob, is making his fair contribution.

But what if Bob testifies? In that case, Alice will get three years if she stays silent, but only two years if she testifies. Again, she is better off if she testifies. Since Alice prefers to

testify regardless of what Bob does, she will always testify, and since the case is symmetrical, Bob will always testify as well. Although the scenario where both testify is the second worst case for each of them, and results in the highest total time in prison, it is what will always happen if Alice and Bob care only about their own prison terms and each takes the action that minimizes their prison sentence. Although this behavior may strike us as irrational, it is in fact the direct result of each actor considering their interests and attempting to maximize their benefits and minimize the harm that comes to them.

The other most common approach to explaining apparently irrational behavior is to appeal to a lack of information. Clearly, if a person does not have enough information to reliably predict the outcomes of their actions, they may behave in ways that would seem irrational if that lack of information were ignored. If Mike goes shopping for a bicycle and the one Mike chooses has an irreparable mechanical failure a few days after the purchase, we should not assume that Mike irrationally considered the costs and benefits of this bike as opposed to others. Instead, we may point out that Mike, being inexperienced in bicycle construction, maintenance, and repair, was unable to predict the failure before making the purchase. His behavior was not irrational, it was uninformed.

This thesis will focus on the implications of trying to explain vaccine refusal without appealing to imperfect information. In the first two sections, I will argue that the factors that influence vaccination decisions can lead to behavior characteristic of a Prisoner's Dilemma, but that this approach explains only a minuscule amount of vaccine refusal. The rest is the result of a lack of information. Laypeople are unfamiliar with the experiences, actions, and motives of those who promote vaccines and those who disparage them. The resulting uncertainty is usually resolved by trust in the scientific method and in the idea that governments and doctors aim to

promote public health. When that trust breaks down, we should expect some people to conclude that vaccines are unsafe and ineffective, being promoted by individuals with perverse incentives that get in the way of their supposed goal of promoting public health. These sections are reproduced with minor changes from a previous publication (Bradley & Navin, 2021).

I will then discuss the ethical and practical implications of my argument for policymakers aiming to increase vaccine uptake, particularly in the context of the COVID-19 pandemic. Finally, I will analyze the performance of a particular kind of vaccine policy informed by the Prisoner's Dilemma model of vaccine refusal, namely, the use of lottery-based incentives for vaccination by several U.S. states during the summer of 2021.

Vaccine Refusal is Not Free Riding

The Covid-19 pandemic has highlighted problems of non-compliance with public health guidelines. Some people refuse to wear masks in public, to engage in social distancing, or even to avoid large gatherings (Breslow 2020; Glanz et al. 2020; van Rooij et al. 2020). Of particular interest to us is that some have indicated an unwillingness to receive Covid-19 vaccines (Freeman et al. 2020; Lazarus et al. 2021). Refusal of Covid-19 vaccines would therefore seem to be another instance of the general phenomenon of *vaccine refusal*, which has recently contributed to outbreaks of previously well-controlled infections (Jacobson, St. Sauver, and Finney Rutten 2015; Phadke et al. 2016).

Researchers have sometimes characterized vaccine refusal as a free rider problem (Bauch, Bhattacharyya, and Ball 2010; Betsch, Böhm, and Korn 2013; Betsch et al. 2017; Buttenheim and Asch 2013; van den Hoven 2012; May and Silverman 2005; Schröder-Bäck et al. 2009; Siegal, Siegal, and Bonnie 2009). That is, they have claimed that vaccine refusers promote their individual interest by benefitting from the community's protection from infection without also contributing to the community's protection by becoming vaccinated themselves. Notably, this characterization of vaccine refusers applies only in cases in which the community already has protection against infection—that is, when a sufficiently large percentage of the population, having been vaccinated, is immune to the disease so that outbreaks are unlikely. Most countries possess herd immunity for many vaccine-preventable diseases, including, for example, polio (Global Polio Eradication Initiative n.d.). Though none yet have herd immunity against Covid-19, we may hope that ongoing vaccine distribution efforts will soon generate it.

The diagnosis of vaccine refusal as a kind of free riding is supposed to inform our understanding of the origins of vaccine refusal (*vaccine refusers rationally pursue their own interests*), the ethical analysis of vaccine refusal (*vaccine refusers make unfair use of herd immunity*), and potential policy responses (*vaccine refusers will vaccinate if one makes slight changes to their incentives*).

But, as I[1] shall argue, vaccine refusal is not a kind of free riding. First, a free rider model misrepresents the *subjective* motivations of most vaccine refusers. Vaccine refusers often doubt that vaccines provide benefits to individuals and communities, and often radically overstate the risks associated with vaccination. That is, vaccine refusers do not think they are using a valuable public good (herd immunity) or that they are refusing to make a reasonable contribution to that good since they think the expected costs of vaccination are very high. Second, a free rider model misstates the *objective* relationship between individual vaccination choices and one's ability to benefit from herd immunity. A free rider benefits from a public good that they could *also* be contributing to, but it is not possible to both *contribute* to herd immunity and to *benefit* from it. This is because the means by which a person contributes to herd immunity (individual immunity, usually generated through vaccination) makes it impossible for that same person to benefit from

[1] This and the following sections have been reproduced from a previously published paper (Bradley & Navin 2021). With my coauthor's permission, any use of the word "we" to refer to the two of us has been replaced with "I" for consistency with the rest of the thesis. Additionally, references to "community protection" have been changed to "herd immunity" for the same reason.

herd immunity.[2] Furthermore, the act of 'contributing' to herd immunity (by becoming vaccinated) is, by itself, individually rational, even when community immunization rates are high, because there is rarely an objective anticipated *cost* of vaccination for individuals. Free riding is individually rational, by definition, but refusing vaccines rarely is.

Vaccine Refusal as Free Riding

An individual is a free rider if they enjoy the benefits of a public good (that is, a good that is non-rivalrous and non-excludable) without also contributing to it, even though they could also contribute to the good, and even though the personal benefits they acquire from the public good would outweigh their personal costs of contribution (Olson 1965). Free riding creates a collective action problem: it is individually rational to free ride, but if enough people free ride, then no one can, since insufficient contribution undermines or destroys the good that they were attempting to enjoy. That is a collectively irrational outcome. In this way, free riding problems may take the shape of a Prisoner's Dilemma, wherein a social good can be created by cooperation, but each individual benefits from defecting (Hardin 1971).

Furthermore, some have argued that free riding is ethically wrong when the public good is sufficiently valuable and the costs of contribution are sufficiently low. On this kind of view,

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[2] An individual can (1) *intend* to contribute to herd immunity (by getting vaccinated) without *actually* contributing to herd immunity (if the vaccine does not give them immunity), and (2) continue to benefit from herd immunity But such a person does not *both* contribute to and benefit from herd immunity.

free riding is not only collectively irrational, but also individually unethical, because it is unfair to benefit from the contributions of others without making a reasonable contribution oneself (Cullity 1995).

If vaccine refusal were a kind of free riding, then (1) mass vaccination must create a public good, (2) it must be possible for individuals to contribute to that good and to benefit from it, though (3) it must be better for individuals not to contribute, but just to benefit from it. Furthermore, vaccine refusers would have an *intention* to free ride just in case they intended to enjoy the benefits of the public good that mass vaccination creates, but they did not intend to pay the (small) costs associated with contributing to that good.

Mass vaccination creates a public good. 'Community protection' (sometimes called 'herd immunity') exists when a community has a sufficiently high rate of individual immunity, such that outbreaks are highly unlikely and such that it is highly improbable that individuals who are not immune to infection will become infected (Anderson et al. 2018). The logic of free riding on herd immunity may seem straightforward: vaccination has expected costs for individuals, including time, money, and risks of side effects and adverse events. Community protection has many expected benefits for individuals, including decreased morbidity and mortality. The benefits an individual enjoys from herd immunity outweigh the individual costs associated with vaccination. However, someone who free rides on herd immunity enjoys the benefits of herd immunity without paying any costs associated with contributing to it.

Scholars writing about *empirical* issues in vaccine refusal have sometimes modeled vaccine refusal as a form of free riding (Bauch, Bhattacharyya, and Ball 2010; Betsch, Böhm, and Korn 2013; Betsch et al. 2017; Buttenheim and Asch 2013; van den Hoven 2012; Ibuka et al.

2014; May and Silverman 2005; Siegal, Siegal, and Bonnie 2009). The details of their models differ. For example, Bauch and colleagues (2010) show that free riding practices can develop quickly after the introduction of a vaccine that is universally and freely available but not mandatory. For another example, Ibuka and colleagues (2014) found that individuals were less likely to vaccinate in a simulation when the rate of vaccination was high in the previous round of the simulation. But the common thread that ties together 'free riding' models of vaccine refusal is that vaccine refusers pursue their rational self-interest in avoiding the costs associated with vaccination while benefiting from the vaccination behaviors of others.

People who have written about the *ethical* issues involved in vaccine refusal have also sometimes invoked the idea that refusers are free riders who make selfish and unfair use of others' contributions to herd immunity (Clarke, Giubilini, and Walker 2017; Dawson 2007; Giubilini, Douglas, and Savulescu 2017; Giubilini 2019; Hendrix et al. 2016; van den Hoven 2012; Navin 2016; Salmon and Siegel 2001). Some have argued that one goal of immunization policy is to fairly distribute the burden of achieving herd immunity while avoiding unfair free riding. For example, they have proposed that nonmedical exemptions to vaccine mandates only be granted to people who make an alternative contribution to public health—that is, contributions similar to those of some conscripted pacifists who are asked to provide alternative (for example, non-combatant) services to a war effort (Clarke, Giubilini, and Walker 2017; Giubilini, Douglas, and Savulescu 2017).

Why Not Free Riding?

Vaccine refusal is not a case of free riding. Vaccine refusers do not have the subjective beliefs and attitudes of free riders, and the objective costs and benefits associated with vaccine refusal are not consistent with free riding.

Beliefs and Attitudes

Vaccine refusers rarely possess the beliefs and attitudes towards vaccination and herd immunity that are consistent with them being *subjective* free riders. Someone *intends* to free ride when they recognize the benefits of a public good that they are enjoying and when they acknowledge that they are benefitting from that good without making a reasonable contribution to it. For example, in Prisoner's Dilemma models, a defector (who wishes to be a free rider) seeks to take advantage of the benefits of other people's cooperative behavior without themselves engaging in cooperative behavior. Vaccine refusers do not fit this profile. First, vaccine refusers often believe that vaccines are ineffective, that vaccines do not cultivate individual immunity to disease, and that herd immunity does not exist (Harmsen et al. 2013; Sobo 2016). Others are wholly unfamiliar with the concept of herd immunity (Quadri-Sheriff et al. 2012; Sobo 2016). Such vaccine refusers cannot be motivated by a desire to take advantage of others' cooperative behavior because they do not think other people's vaccination choices create a public good. There are some exceptions. For example, Dr. Bob Sears recommends that parents who refuse vaccines for their children do not "share their fears with their neighbors, because if too many people avoid the MMR [measles, mumps, and rubella vaccine], we'll likely see the disease increase significantly" (Sears 2007, 96–97). The clear implication is that parents of children in Sears' practice should want *other parents* to continue to vaccinate so that their own

children will be safe from disease. But it is rare to see vaccine refusers acknowledge that they are benefitting from other people's decisions to vaccinate. A more common view is that vaccines are ineffective, that they are collectively harmful, and that everyone would be better off if no one were vaccinated (Dubé et al. 2013; Harmsen et al. 2013; Sobo 2016).

Second, part of the idea of free riding is that it better promotes an individual's interests than contribution does, but that contributing to (and enjoying) a public good is better for the individual than non-contribution and non-enjoyment of the public good would be. This is because an individual's costs of contribution are outweighed by the benefits they receive from the public good. So, even though free riding on a public good is individually rational, contribution is also beneficial (though less so than free riding) compared to not enjoying the public good at all. In the case of modeling vaccine refusal as free riding, a free rider would better promote their own interests than would someone who were vaccinated, but a vaccinated person enjoying herd immunity would better promote their own interests than would someone who did not benefit from herd immunity at all. On such a view, an individual's expected costs of vaccination are more than compensated for by the benefits they receive from herd immunity.

But many vaccine refusers do not believe that the expected costs of vaccination are low. They reject the scientific consensus that vaccines usually have only mild side effects and that the risks of serious adverse events (for example, death or life-threatening illness) are very low (Smith 2015). Vaccine refusers commonly believe that vaccines often cause serious disorders (including autism), damage one's immune system, degrade one's genetic code, or place one's body under unacceptable forms of government surveillance or control (Dubé et al. 2013). Someone who intends to free ride aims to avoid paying a reasonable price for a public good. But many vaccine refusers think that vaccination is dangerous and that it would be unreasonable to

ask them to vaccinate. Such people conceive of vaccination choices as a matter of avoiding or acquiescing to significant harms, rather than as a matter of whether to contribute to a public good from which they benefit.

Costs and Benefits

Vaccine refusal also usually fails to meet *objective* criteria for free riding. First, vaccine refusers are not free riders on herd immunity, because it is not possible to both contribute to and benefit from herd immunity. A free rider benefits from a public good to which they could also contribute. When free riding is immoral, free riders *should* also contribute to the public goods from which they benefit. The way to contribute to herd immunity is to possess individual immunity, either through vaccination or by recovering from a disease. But people who possess individual immunity do not (and indeed, *cannot*) rely on herd immunity to protect themselves from the diseases against which they have individual immunity. They rely on *individual* immunity. Accordingly, someone who contributes to herd immunity cannot also benefit from it. Consequently, someone who does not contribute to herd immunity—for example, by refusing vaccines—is not a free rider.

Second, free riding is individually rational, but vaccine refusal is not. Vaccination almost always promotes the interests of the vaccinated individual, even at very high levels of herd immunity. Since the costs of vaccination are generally negligible—for example, serious complications are exceedingly rare (Spencer, Trondsen Pawlowski, and Thomas 2017)—it is almost always in a person's interest to vaccinate, even when herd immunity makes their odds of infection very low. Consider the fact that herd immunity against some vaccine-preventable infections requires very high levels of population-level immunity, such that even universal

vaccination with very effective vaccines may still leave someone vulnerable to exposure (and therefore make it rational to be vaccinated). For example, roughly 95% of the population needs to be individually immune to measles to eliminate outbreaks (Gay 2004; Moss and Strebel 2011), while only 95% of people fully vaccinated against measles have individual immunity (Demicheli et al. 2012), so that communities with less than 100% measles vaccine uptake remain at risk for measles outbreaks, and therefore individual vaccination against measles is almost always rational (Bester 2017). More importantly, it is very difficult to know one's risk of being exposed to a vaccine-preventable infection, even if reliable community-wide immunization rates are available. Outbreaks commonly appear in small geographically clustered groups of under-vaccinated persons (Omer et al. 2008; Phadke et al. 2016), and it can be all but impossible to identify and avoid such groups. In contrast, vaccination reliably generates individual immunity at negligible costs. Notably, attempts to model vaccine refusal as an instance of free riding sometimes presume that individuals can make reliable predictions about the proportion of immune individuals in the groups they interact with (for example, Betsch, Böhm, and Korn 2013). Yet, it seems highly unlikely that most vaccine refusers possess (or even *could* possess) such knowledge.

Free Riding and Policy Interventions

If policy responses to vaccine refusal are to be effective and ethically justified, then they should be based on an accurate understanding of vaccine refusal. The claim that vaccine refusers are free riders may lead to policy proposals that are ineffective or morally unjustified.

Incentives and Pro-Vaccine Interventions

There are a set of standard interventions for solving free riding problems (Buttenheim and Asch 2013). These include offering economic incentives for cooperation (or disincentives for defection), restricting defectors' access to other goods, invoking or creating social norms to pressure individuals to cooperate, or using state coercion. These enforcement mechanisms shift the relevant payoffs in ways that incentivize potential free riders to cooperate, instead of defect, by making it rational for would-be free riders to contribute (Buttenheim and Asch 2013).

If vaccine refusal were a free rider problem, then one way to encourage vaccination would be to slightly shift the perceived payoffs of potential vaccine refusers. Governments should be able to avoid vaccine refusal with small (or even trivial) amounts of incentives or disincentives. Recall that *actual* free riders acknowledge the value of the public good they enjoy but refuse to pay the small cost of contributing to that good when they can get away with not incurring the cost. A government could therefore overcome 'free rider vaccine refusal' if it increased the costs of vaccine refusal so that those costs were somewhat higher than the costs of vaccination. This means that placing small additional burdens on vaccine refusers should lead to overcoming vaccine refusal that results from subjective free riding.

The evidence is not consistent with the hypothesis that the behavior of most vaccine refusers can be changed by making small modifications to their incentives. For example, many countries have recently adopted or revised childhood vaccine mandates as a way of providing additional incentives for vaccination or of disincentivizing vaccine refusal. For example, Australia's federal government withholds state payments to parents who do not vaccinate their children ('No Jab, No Pay'), while their state governments prevent unvaccinated children from being enrolled in childcare ('No Jab, No Play') (Attwell et al. 2018). All US states require children to be vaccinated to enroll in school, and many states have recently made those enrollment mandates more difficult to escape, for example, by eliminating nonmedical exemptions or imposing burdensome administrative procedures (National Conference of State Legislatures 2021). Other political communities, like Italy, have decided to fine parents who do not vaccinate their children (Vaz et al. 2020).

These kinds of policy changes sometimes somewhat increase vaccination rates or decrease nonmedical exemption rates (Omer et al. 2012; Navin, Largent, and McCright 2020). That is not evidence that the parents who change their minds in the face of such changed payoffs are free riders—I have already presented evidence to motivate skepticism about that conclusion—but the number of parents who *do* change their behaviors clearly identifies a *ceiling* for the maximum number of *possible* free riders among vaccine refusers. Even if we supposed that *every* parent who changed their vaccination behavior in the face of changes in their incentive structure were a free rider, then the evidence suggests that perhaps around a third of parents could possibly be free riders—that is about the maximum number of vaccine refusers who seem willing to change their behavior in the face of substantial changes to their incentives. Notably, even quite serious penalties seem insufficient to change the behavior of many vaccine refusers.

For example, Delamater and colleagues (2019) found that eliminating nonmedical exemptions in California caused few parents to vaccinate their children. In fact, the positive results of that policy change were almost entirely a consequence of better administrative oversight and record-keeping or were offset by corresponding increases in medical exemptions or the enrollment of children not in compliance with immunization requirements. Many thousands of California parents allowed their children to be denied access to public or private schools, or to be prevented from participating in group homeschooling activities rather than be vaccinated. This is not the profile of a free rider.

Pro-vaccination policies that are likely to overcome free riding behavior, especially *subjective* free riding behavior, are unlikely to be as effective against someone who refuses vaccines because they believe vaccines are ineffective or dangerous. If someone does not think that herd immunity is valuable, or if they think vaccination is a grave risk to their health, then small changes to their incentive structure are unlikely to change their minds. Relying on a free rider model of the attitudes and motivations of vaccine refusers may therefore encourage unjustified optimism that vaccine refusal can be overcome with minimally invasive interventions.

Ethical Justifications for Pro-Vaccine Interventions

The mere fact that herd immunity is a public good does not, by itself, justify government coercion (Bernstein and Randall 2020), but the substantial individual and collective benefits of herd immunity strongly favor government efforts to promote vaccination (Brennan 2018; Flanigan 2014; Giubilini and Savulescu 2019; Giubilini 2019, 2020; Navin 2016; Pierik 2018). If vaccine refusal were *objectively* a form of free riding, then one weighty ethical reason for

societies to promote vaccination would be to promote *fairness* in the distributions of benefits and burdens associated with mass immunization. The people who benefit from herd immunity should be incentivized or even compelled to contribute to herd immunity, rather than be allowed to unfairly free ride on the socially productive contributions of others, if they can do so at a reasonable cost to themselves.

But vaccine refusers are not *objectively* free riders, even though some of them may *think* they are free riding, as in the case of Dr. Bob Sears' patients I discussed above. The goal of pro-vaccination policies, therefore, should not be to punish people for free riding, that is, to make sure that they 'pay' for the benefits that they enjoy from herd immunity. As I argued above, it is not possible both to contribute to and to benefit from herd immunity. Inasmuch as *fairness* plays a role in ethical arguments for pro-vaccination policies, it should be to make sure that there is a fair distribution of labor among the members of society who *have a duty to protect others from harm* (Giubilini, Douglas, and Savulescu 2018). That is, fairness in vaccination behavior is about doing one's part to help others. It is about being a *contributor* to herd immunity, rather than a *beneficiary* of it, whenever one is reasonably able to do so. But fairness with respect to vaccination is not about ensuring that one is paying for the public goods they are benefiting from: this is not possible.

Aside from the fact that vaccine refusal is not *objectively* a free rider problem, it also matters for an ethical analysis that vaccine refusers are rarely *subjectively* free riders. Vaccine refusers usually do not think they are acting unfairly. They do not believe they are taking advantage of a public good that they could also be contributing to. Instead, they think that (almost) *everyone* would be better off if they refused vaccines. So, inasmuch as vaccination policies aim to *punish* vaccine refusers for their unethical behavior, it would be incorrect to focus

on refusers' supposed intentions to free ride. Relatedly, inasmuch as vaccine advocates express anger at vaccine refusers for (what they believe to be) unfair free riding (Bernstein 2021), those moral emotions are not entirely apt. Vaccine refusers seem to be motivated by ordinary ideas about avoiding serious risks to their health based on false beliefs about the costs and benefits of vaccination and about the risks of vaccine-preventable infections. I acknowledge that vaccine refusers may sometimes be morally responsible for these false beliefs and that they may be acting unfairly, but their moral failure is not the straightforward unfairness of free riding.

Many people have endorsed pro-vaccination interventions or made ethical arguments about vaccine refusal that presume vaccine refusers are free riders. I have argued that vaccine refusal is not an instance of free riding and that few vaccine refusers believe themselves to be free riding. Accordingly, effective policy interventions and apt ethical judgments about vaccine refusal will need to rely on other explanations for why people sometimes refuse vaccines.

If those who study vaccine refusal want to introduce game-theoretic models to explain this phenomenon, then perhaps they should turn away from free rider models and consider embracing information problem models. The core dynamics of information problem game-theoretic models is that participants in the game are not fully aware of the 'rules' of the game, for example, who else is playing, what each participant's interests are, and what actions have been taken previously (Jones 1977). Participants must therefore make educated guesses about the best course of action, rather than calculate a deterministic result. Considering the prominent role those false beliefs play in the decisions of vaccine refusers, such models may present more accurate depictions of the objective and subjective attributes of vaccine refusal than free rider models do.

Case Study: Lottery Incentives for COVID-19 Vaccination[3]

Introduction

Although mass vaccination is a key goal for ending the COVID-19 pandemic, vaccination rates have remained low across the globe. In the Global South, low vaccination rates are caused primarily by a lack of access to vaccines. Here, however, I will focus on the United States, where the primary cause of low vaccination rates is the prevalence of vaccine refusal. Many policy tools have been suggested for addressing vaccine refusal, but here I will examine just one: lottery-based incentives for vaccination, as implemented by state governments in the United States. These programs involve the state establishing a prize that residents can enter to win, usually by uploading a picture of their vaccination record card to a state website. Incentive programs seek to reduce vaccine refusal by providing a counterbalance to the perceived costs of vaccination: if a person considers the sum of costs and benefits of vaccination to be negative, they will refuse, but if a benefit is added that makes the new sum positive, they will get vaccinated.

I will begin by explaining in detail some of the lottery programs that have been used to promote COVID-19 vaccination. Then, I will consider literature relating to the degree of success

[3] It is worth noting that herd immunity has not been achieved in the U.S. for COVID-19. However, a vaccine uptake rate less than the threshold for herd immunity may still give rise to free riding behavior (Betsch et al. 2013). The argument here contends that the proportion of vaccine refusers who can be characterized as free riders is too small for policies targeting free riding to be effective at increasing vaccine uptake.

that these programs have had in the context of COVID-19. Finally, I will interpret the theoretical and empirical findings surrounding lottery-based incentive programs and make a recommendation regarding the value of such programs. Although state-run lottery incentives for COVID-19 vaccination have already been completed, it is important to understand the value of such programs in general so that governments can apply the lessons of COVID-19 in the context of other vaccine-preventable diseases and future possible pandemics.

Vaccine Lotteries

There are many variations of the lottery-based incentive scheme for promoting COVID-19 vaccination, so this paper cannot examine them all in-depth. Nevertheless, it is useful to have a reference for the kinds of prizes that have been associated with these programs. In Ohio, a $1 million jackpot was offered. In Michigan, prizes included $1 million and $2 million jackpots, several drawings for $50,000, and scholarships worth $55,000. Maine tied their prize to the total vaccination rate, offering the prize winner $1 for every person vaccinated in the state before July 4, 2021. Other states offered smaller prizes, such as Alabama, which gave residents a chance at being allowed to drive their car on the Talladega Superspeedway when they got vaccinated. New Jersey gave residents a chance to win a dinner at the governor's mansion (Hassan & Kannappell, 2021).

These programs were prevalent during the spring and summer of 2021, shortly after the Pfizer-BioNTech, Johnson & Johnson, and Moderna vaccines were made available to all adults regardless of occupation or risk status. The first of these programs was Ohio's, which was announced May 12, 2021. As mentioned in the introduction, these programs have all ended and

the prizes have been awarded. Nevertheless, analyzing these programs can serve to inform future efforts to increase vaccine uptake for both known and future diseases.

Did it Work?

The previous discussion of why vaccine refusal is not free riding gives us reason to believe that incentive programs (including lottery programs in particular) that are small enough to fit in a state budget would be ineffective and inefficient solutions to vaccine refusal. Indeed, this analysis is borne out in data collected around the time that these programs were announced.

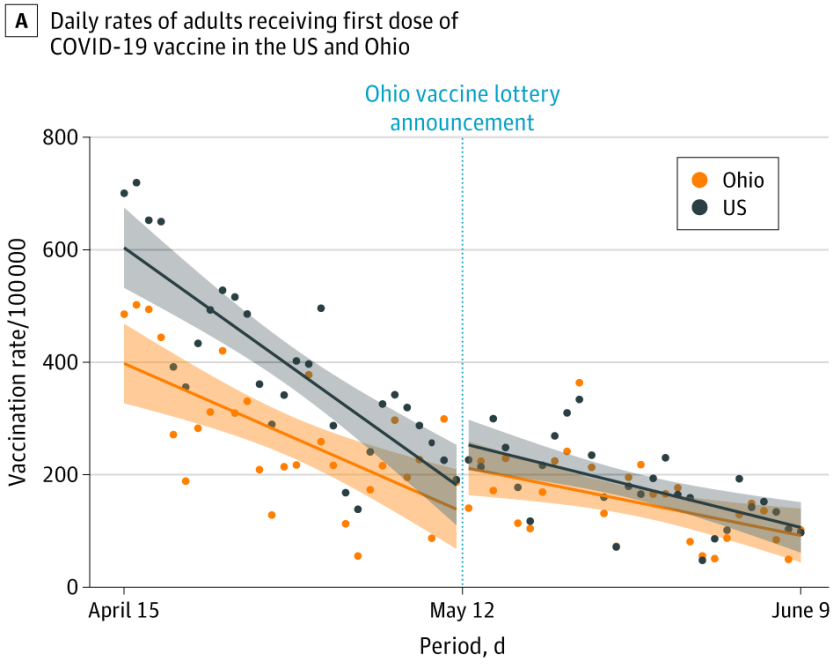

Figure 1. Chart from Walkey, Law, & Bosch, demonstrating that the slowing decrease in vaccination rates following May 12 was not unique to Ohio.

After Ohio became the first state to announce a lottery for COVID-19 vaccination on May 12, the state reported an initial slowing in the rate at which vaccination rates were decreasing, which seemed to indicate the program had succeeded. However, a study drawing on data from the Centers for Disease Control and Prevention, found that this slowing also correlated

with a slowing across the United States, which the authors attributed to the May 10 expansion of the Pfizer-BioNTech vaccine to people ages 12–15 (CDC, COVID data tracker, 2020; Walkey, Law, & Bosch, 2021). Moreover, the authors found that the decreasing vaccination rate slowed less in Ohio following the announcement of their lottery than it did in the United States overall in the same period. Another study looked at vaccination rates in all states, and similarly found that there was a small benefit to lottery-based incentives, if there was any (Dave, Friedson, & Hansen, 2021).

These studies suggest that lottery-based incentives for COVID-19 vaccination were ineffective in increasing vaccination rates. Furthermore, state vaccine lottery programs typically allowed for those who were vaccinated prior to the program's announcement to enter for the prize. Therefore, it was likely that the prizes being established would go to residents who were previously vaccinated while having little impact on the thoughts and behavior of those who were not previously vaccinated. Even an individual who received their vaccine shortly following the announcement of a vaccine lottery in their state may have done so at that time regardless of the lottery. Most likely, some people were convinced to receive a COVID-19 vaccine because of their state's lottery program, but the scale of the prizes issued appear to have consistently outweighed the increased vaccination rates they caused, making this policy inefficient as well as ineffective.

Conclusion

The use of lottery-based incentives to promote vaccination has failed in the context of COVID-19, and the theory presented here to explain this failure suggests that the results would be similar if these programs were mimicked for any other diseases. Because of this, I would caution against similar programs for other vaccine-preventable diseases. Moreover, the theory presented here does not distinguish between lottery-based incentives and incentives with certainty, which suggests that guaranteed incentives would have modest results, as did lottery-based programs. However, additional research is necessary to make such a determination with certainty, as more data would be required to see the effect of such programs and an examination of gambling psychology would be required to understand and predict any differences in results between lottery and certain incentives.

In addition to the ineffectiveness of lottery-based incentive programs for COVID-19 vaccination, I have argued that treating vaccine refusal as free riding leads to incorrect moral judgments about vaccine refusers. Vaccine refusal is not wrong as an unfair failure of reciprocity, because ardent vaccine refusers typically do not believe that vaccinated people have done them any favors worth repaying. Vaccine refusal is also not a failure of care for the vulnerable, because vaccine refusers typically do not believe that them getting vaccinated would be beneficial to immunocompromised people around them.

Instead, vaccine refusal is a failure of trust and information. Discussions of what is ethically wrong about vaccine refusal should focus on whether it is immoral to act on ill-informed beliefs that affect others. Public health policy should focus on educating the public and

fostering trust between individuals and their doctors, their government, and the scientists who develop and test vaccines.

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