Inframarginal Externalities: COVID-19, Vaccines, and Universal Mandates

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SARS-CoV-2 (commonly called COVID-19) vaccine mandates are in place or being debated across the world. Standard neoclassical economics argues that the marginal social benefit from vaccination exceeds the marginal private benefit; everyone vaccinated against a given infectious disease protects themselves and protects others by not transmitting the disease. Consequently, private levels of vaccination will be lower than the socially optimal levels due to underconsumption/free-rider problems, requiring mandates to overcome the problem. We that the economic argument for mandates is less compelling for COVID-19. First, most of the benefits of the COVID-19 vaccine are internalized, vaccinated individuals are protected from the worst effects of the disease and may even exclude others from the benefits of the vaccine by transmitting the infection. Therefore, the externality may be inframarginal or policy irrelevant. Even when all the benefits are not internalized to the individual, the externalities are mainly local, even in a global pandemic, therefore requiring local institutional (private and civil society) arrangements to boost vaccine rates. We find that the economic case for universal vaccine mandates, based on externality and free-riding, is weak in the case of the COVID-19 vaccines, and that economists and politicians must justify such vaccine mandates on some other basis.

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Gostin, Salmon, and Larson 2021). Even prior to the Covid pandemic, a large majority of economists argued that the benefits of mandated vaccines outweighed the cost, for example, in the case of measles (IGM Forum, 2015). Policymakers seem to agree. In the US, federal, state, and city-wise mandates for Covid-19 vaccines are in force.[4] Of the six federal mandates, three remain in effect after being challenged in the US Supreme Court.[5] These vaccine mandates apply to health care workers,[6] military personnel[7] and some categories of non-citizens traveling to the US, subject to certain exceptions.[8] In addition to federal mandates, 20 states[9] and 25 cities[10] have mandated the vaccines for different categories of workers with or without the alternative option to recurrent testing.

In November 2021, the Biden Administration announced (White House, 2021) that the

Economists recommending government interventions to increase vaccine uptake root their policy solutions in the free-rider problem associated with vaccines. Typically, everyone vaccinated against a given infectious disease protects themselves but protects others, though the extent of the protection to oneself and others may vary depending on the type of disease and vaccine. If vaccines also protect others, the marginal social benefit from vaccination is greater than the marginal private benefit, creating the dual problem of underconsumption and free-riding by individuals. For both efficiency reasons (people will under consume because they do not internalize all the benefits of the vaccine) and distributive reasons (poor and vulnerable members of society should not be left out), economists typically suggest a government intervention to correct this problem, usually in the form of a subsidy, and if that is insufficient, mandates. The standard economic argument in favor of vaccine mandates for various infectious diseases is that they help overcome the free-rider problem (Stiglitz, 1998; Buttenheim and Asch 2013; Gostin, Salmon, and Larson, 2021).

As different kinds of government intervention to increase vaccination rates are debated, it is important to understand the nature of the externality posed by the vaccine. We put forward a simple argument in this paper: the standard economic justification for universal mandates, which is grounded in arguments of externalities and free-riding, is not compelling in the case of the COVID-19 vaccine due to the efficacy and other characteristics of the vaccine. Any call for mandates must be rooted in other justifications.

Our argument is as follows. An externality does not automatically imply free-riding. Most of the benefits for the vaccines developed to battle COVID-19 are internalized. This is because vaccinated individuals primarily protect themselves from the most severe consequences of the infection, and not others.

not account for. When any individual gets vaccinated against an infectious disease, this typically reduces (or eliminates) their chance of getting the disease. But it may also reduce the chance of others getting the disease, as the vaccine recipient is less likely to transmit the disease. Therefore, the social benefit from a dose of a vaccine is higher than the private benefit.

Though an individual benefits through protection from infection, getting vaccinated is not costless to the individual. The costs are usually internalized, even if the vaccine is subsidized or at zero price. There are logistical costs of getting vaccinated as well as costs related to pain or side effects (if any) from the vaccine. These costs are nontrivial to the individual, is seen in vaccine adoption when they are delivered through drops (polio) versus injections (measles).

vaccines different from other vaccines that are currently mandated. The next section discusses the nature of the Covid-19 eternality in detail.

While this framing of externalities has critics (Cowen 1985, p. 58), it succinctly frames the collective-action problem a society faces in the case of vaccines. The Pigouvian solution is a subsidy and/or a mandate for getting vaccinated. This is considered the optimal policy response (for example, Francis 2004, and Goodkin-Gold, Kremer, Snyder, and Williams 2020). Stiglitz (1998) argues that vaccine mandates are a potential solution to the free-rider problem because they urge people to assume collective responsibility in preventing and eliminating infectious diseases.

Therefore, we can think about the problem through either lens since externalities and or free-riding are considered "two sides of the same coin" (Cowen, 2002). The positive externality provided by vaccinated individuals, in sufficient numbers, can lead to free-riding by unvaccinated individuals. However, this rationale breaks down if the positive benefits are excludable due to technology or institutional instruments. Even in cases where benefits are not completely internalized and are excludable, there may be cases where there is no free-riding. Not all vaccines are highly effective, at 95% rates, or may not be durable, and effects may wear off over time. COVID-19 vaccines fall in this category.

Though vaccine externalities are ubiquitous, the evidence for a free-rid(n t)2 (hi)-I(hi)-It (e)1 (r)0 Tw 11.01 0

infectious agent." The "herd immunity threshold" is different for different infectious diseases. These thresholds are predicted mathematically using a transmissibility estimate called the reproductive number (or R_0), but they also depend on the efficacy of the vaccination/natural immunity, the durability of the protection, asymptomatic infections/occult transmission, population heterogeneity, and new mutations of the virus. COVID-19 vaccines have low efficacy and durability compared to, say, the MMRV vaccine, where protection through the vaccine or natural immunity post-infection tends to be lifelong. The argument, therefore, is that to reach the herd immunity threshold required higher rates of vaccination, justifying mandates with few exceptions.

But due to the same factors, Giurgea and Morens (2022) argue that in the case of COVID-19, herd immunity is neither easy to estimate nor reach through interventions because susceptibility to infection increases with increasing time since vaccination. Herd immunity estimates for COVID-19 must account for partial vaccine efficacy, waning immunity, heterogenous population, dynamic, mutating virus, etc. they conclude that "current vaccine strategies may be able to slow down COVID-19 spread and are likely to alleviate the burden that waves of severe cases can inflict on limited health care resources, but they are unlikely to lead to COVID-19 eradication." Therefore, universal vaccine mandates to reach herd immunity thresholds to serve as a non-excludable and non-rival public good do not apply to COVID-19 vaccines.

III. Is the positive externality from COVID-19 vaccines inframarginal?

Not every externality generates a free-rider problem. More generally, if most of the benefits are internalized, free-riding is less of a problem than commonly acknowledged. We argue that the current vaccines for COVID-19 do not pose a free-rider problem, especially against some variants. While unvaccinated people are by far at the highest risk for catching and spreading Covid-19, fully vaccinated persons can develop symptomatic or asymptomatic infections with COVID-19. And though the risk of transmission is much lower (half by some estimates; see Eyre et al. 2020), fully vaccinated individuals can transmit the infection to both vaccinated and unvaccinated individuals.

Scobie et al. (2021) study 13 U.S. jurisdictions from April 4–July 17, 2021, when the Delta variant COVID-19 infection was predominant, found that age-standardized rates of reported cases were much higher among persons not fully vaccinated (112.3 per 100,000) than those fully

incentives to maintain a beautiful front yard (personal enjoyment, increase in the value of the property, viewers' approbation, etc.) are sufficiently high for most homeowners. The optimal amount of the good gets produced and consumed; that is, an externality exists, but it is inframarginal and not Pareto relevant (Buchanan and Stubblebine 1962).[13]

That an externality is inframarginal depends on various factors like technology, local context, institutional arrangements that may exclude participation, and is subjective to the individual, since some individuals may desire very high marginal private benefits.

However, individuals in the general population have strong private incentives to vaccinate themselves against COVID-19. First, vaccination will protect them from the worst effects of the disease. Vaccinated individuals are likely to have mild infections or remain asymptomatic. Second, it will help them engage in social activities that were either not possible or too costly because of the transmission risk. Third, it will allow them to participate gain entry in social groups and clubs that require participants to be vaccinated; for example, they can work at a grocery store or, fly on an airplane, or attend a sports game.

With COVID-19, the impact of infection is not uniform across all individuals and groups. Those with comorbidities, especially heart disease, hypertension, or diabetes, are affected more severely.[14] For the Alpha and Delta variant, hospitalizations and fatalities are higher among individuals over sixty-five.[15] For individuals in this age group or with comorbidities or other health conditions, getting vaccinated is likely privately and socially optimal. It is similar for individuals in occupations that face a much higher risk of contracting the virus, such as Uber drivers or checkout clerks. There are individuals who also encounter more people, thereby passing on the benefits of their vaccination to others. But the private incentives to get vaccinated may be sufficiently high that the benefit to others is not relevant on the margin. If this is the case, the economic case for universal vaccine mandates is weaker than commonly acknowledged because the externality may be inframarginal and that undermines that the case for interventions to solve a free-rider problem.

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[13] Buchanan and Stubblebine distinguish between inframarginal and irrelevant externalities, a distinction that turns on whether one considers only marginal changes or allows for discrete changes of people's actions. That is an important theoretical distinction but not important for the applications in this paper.

[14] "People with certain medical conditions", Centers for Disease Control and Prevention. Available at: https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html (Accessed: March 25, 2022).

[15] "Risk for COVID-19 infection, hospitalization, and death by age group," Centers for Disease Control and Prevention. Available at: https://www.cdc.gov/coronavirus/2019-ncov/covid-data/investigations-discovery/hospitalization-death-by-age.html (Accessed: March 25, 2022).

IV. Internalizing Local Externalities and Institutional Responses

If the benefits are of a vaccine are not immediately internalized, and there are some coordination and information problems that prevent full Coasean bargaining, they can be solved through a variety of institutional arrangements. Consider a well-maintained front yard again. This generates a positive externality for the neighbors, not just because it is a beautiful sight but also because it increases their real estate values by increasing their curb appeal (Johnson, Tidwell, and Villupuram, 2020). Because not all the benefits are internalized and because yard maintenance has a cost, standard theory predicts under maintenance or underinvestment in front yards and curb appeal. But private solutions to the problem exist. One is for a single private entity to internalize the externality (Demsetz 1967, p. 348). This is typically a private developer or a closed group such as a homeowners' association that has rules about how the yard is to be maintained and collec5 (t)2 v (e)1 ((e ((e)7 (c(61s)-1 2)-1 (l)-1 (e)7 (c)-3 (

the job. For instance, some hospital wards and nursing homes make flu shots mandatory, and sex workers in the adult-entertainment industry must be vaccinated against hepatitis. There is a voluntary element to these interactions—an individual can always look for another job—but they are mandatory conditional upon working at the particular firm. Another way to think about this is that they are mandatory in the short run, when it may be difficult to find another job, but voluntary in the long run, when exit is possible. Second, the mandate is not universal. Third, there may be reasons other than free-riding for the mandate, most notably employer liability in case of an outbreak.

For privately provisioned goods that are consumed collectively—such as airline travel—the mandates may extend beyond employees. Before the existence of a COVID-19 vaccine, some airlines mandated mask-wearing and proof of a negative test result to travel with them. For international travel, some of these requirements were based on other countries' immigration mandates. But airlines also formulated their own rules for protecting passengers.

A private firm can incentivize vaccination, especially for employees. This is typically done by giving employees time off or having vaccine drives at the workplace, with monetary incentives or bonuses for getting vaccinated. During flu season, several employers incentivize vaccination by providing free vaccines at the workplace and giving employees paid time off to get the vaccine. Even with private firms mandating vaccines or providing incentives, the issue of transaction costs arises. Firms or other associations trying to internalize the externality caused by high interaction in close proximity face limitations. Consider the case of a grocery store, such as Trader Joe's. If the owners wish to internalize the externality, they have to deal with two types of groups in close physical proximity: employees and customers. They could mandate that everyone in the store get vaccinated. That would be a blunt policy that might not even be optimal for the purpose of internalizing externalities. For employees, the grocery store owners could provide free or subsidized

They impose an externality on the store every day they work. They also spend more time in the store than customers do, a relevant consideration for infectious diseases. Moreover, there are likely bigger gains in the relationship between the owners and an employee than between the owners and a customer. All else equal, we would expect Trader Joe's to incentivize vaccination of employees to a greater extent than they would do the same for customers. And in fact, in January 2021, several retail stores, such as Trader Joe's and Dollar General, announced they would pay workers to get vaccines (Miller, 2021). In February, Kroger announced it would pay employ6 (ai)(pl)-1 (oy6 runc)-(a)7 (e)1 (s)-1 (,)3 ( )10 (s)-
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Take swimming pools, gyms, and exercise studios. They place people in close proximity while exercising and while in common areas and changing rooms. Let us stipulate that conditional upon believing that Covid-19 is an infectious disease with serious health consequences, patrons are likely to join only if all members take certain precautions. In the absence of a vaccine, this means the club will enforce mask mandates and social-distancing rules. Once a vaccine becomes available, if members have a strong preference for having the group be vaccinated, then the club can mandate vaccines as a condition for inclusion. The transaction costs grocery stores face in checking vaccine records for all their customers may be prohibitively high. But clubs have already solved that problem and only need to add one more requirement for inclusion in addition to their other requirements.

Clubs also have incentives to not over-exclude and to cater to the preferences of their clientele. If the patrons are young and healthy and willing to risk some exposure to infection, the clubs may use other kinds of mechanisms to accommodate them. For instance, these clubs may offer certain hours of operation for those who are vaccinated and the other hours for anyone, allowing patrons to take the appropriate level of exposure to infection risk. In fact, before the availability of a vaccine, many gyms and exercise studios had hours when masks were mandated and hours when no masks were required. Wearing a mask while working out intensely may be a high cost for some patrons, especially those who are young and likely to be asymptomatic or mildly symptomatic. Therefore, clubs have strong incentives to impose mandates that align well with the preferences of their patrons.

While we have laid out a few specific incentive mechanisms that we expect to see in response to a pandemic, we have seen an even wider variety of attempts by different groups to encourage vaccination. These groups recognize that vaccines have relevant externalities and want to incentivize others to change their actions.

For example, Kroger offered a lottery of 1 million USD and free groceries for a year; The Greenhouse offered pre-rolled marijuana joints under the “Pot for shots” campaign (Elassar, 2021); Krispy Kreme (Dickler, 2021), Chagrin Cinemas, and Samuel Adams (Tyko, 2021) gave out free donuts, popcorn, and beer respectively. NFL announced that it would not extend the season to accommodate a COVID-19 outbreak among unvaccinated players leading to forfeiting of games (Patra, 2021).

None of the examples imply that social or nongovernmental mechanisms will reach an optimal allocation. Instead, our argument is simply that social mechanisms turn social benefits into private benefits, allowing people to internalize externalities in creative ways. If a free marijuana joint

pushes a young person to get vaccinated, they do not need a Pigouvian subsidy/mandate. In fact, the subsidy would be wasteful to the extent it is funded by distortionary taxes somewhere else.

V. What Type of Policy Response?

We do not mean to imply that there is not an economic argument in supporting vaccines through government policy. We originally mentioned the supply side. On the demand side, policy should, first, not get in the way. Certain state and private actions can prevent private incentives from arising to make the externality inframarginal. At the time of writing, two vaccines, one created by Moderna and the other by Pfizer, have been approved by the US Food and Drug Administration for emergency use. Other vaccines, most notably AstraZeneca's, which has been adopted by several countries outside the United States, are still pending approval in the United States. Long delays in approving vaccines or approving vaccines only for emergency use after a long delay create uncertainty and fosters mistrust. If fewer people trust the vaccine-approval process, then theeapp[t)2 (hr)eh (y)1(e)1

When private arrangements or the transaction cost-reducing policies above are not sufficient, there is still the question of what level the mandate should occur. It is not enough to point to the fact that one person's vaccination decision has a tiny impact on other people all over the world. In practice, we need to look at both the relative and absolute magnitudes of the externalities.

For an analogy, consider the problem of littering. Littering is an externality. When Armen throws a McDonald's cup out his window on the way home, that cup has a chance (however small) of ending up in the farthest reaches of the ocean and thus being an externality on every other person on the earth. Given it has a positive chance of occurring, it is a global negative externality, strictly speaking. What should be the appropriate policy response to littering? There can be social pressures against littering in response. There are private solutions by providing trash cans. While there may be a role for some international agreements, it seems implausible that the bulk of the effort should be at the national or international scale.

Public goods and externalities are "two sides of the same coin." We know from Tiebout sorting those local public goods can sometimes be dealt with through local policy. The sorting allows the local community to internalize the externality, not at the individual level but at the appropriately defined local level. More than a theoretical possibility, there is evidence that cities internalize local externalities (Shoag and Veuger 2018). The general principle is that the policy response may be dealt with at the level which experiences the bulk of the externality. Garbage thrown within someone's house can be dealt with at the household level. Garbage thrown on the street can be dealt with at the neighborhood/city level.

We can apply this logic to vaccine mandates. If most of the benefits are local in nature, the appropriate policy response would be at the local level. Again, if this is the case, the economic case for universal vaccine mandates is weaker than commonly acknowledged.

There is another kind of collective problem that we have not considered so far. Every society has a limited amount of hospital capacity, and no society develops infrastructure to treat most of the population at the same time, as it would be prohibitively costly. However, during a pandemic, a lot of people get sick at the same time, adding stress to the limited hospital infrastructure. Some aspects of the healthcare infrastructure are not elastic in the short run, and this kind of stress on the health infrastructure may result in poor quality care or, worse, a collapse of the system. This is the reason, in the absence of a vaccine, many countries mandated shutdowns and lockdowns so that the healthcare infrastructure does not collapse. Some believe that stress on the (often state provisioned or subsidized) healthcare system is a negative externality on the entire

society, and therefore vaccines should be mandated. Once again, given the presence of a vaccine, the private benefits from vaccination are very high. Therefore, in places where the vaccine supply and availability are not the problems, the proportion of unvaccinated, however large, is the relevant group that can overwhelm the healthcare infrastructure. In societies with high state capacity, this is not a problem, as the healthcare infrastructure is relatively robust. This can become a problem in areas with low state capacity and merit a vaccine mandate. However, we should caution that a society with low state capacity will also find it very difficult to enforce a universal vaccine mandate, and the intended result – 100% vaccination - may not be achieved. Furthermore, if recovering from Covid-19 provides similar protection as the vaccine (which depends on the variant; see Shane 2021) then,

the vaccine. As people learn more about the vaccines, if the experimental trials capture the costs and benefits, we expect more people to get the vaccine. The sort of side payments or Coasean bargains that we discuss above can speed up this process.

In the case of the COVID-19 vaccines, there are distinct subsets of people who are unlikely to be persuaded by the mechanisms that we have highlighted so far. One group believes there is no infectious disease, and that COVID-19 is a conspiracy (see Ullah et al. 2021). Therefore, they do not consider the vaccine a desirable good because there is no negative externality from the infectious disease that needs to be overcome. Some believe that the vaccines contain mechanisms that allow government surveillance through microchips (see Berry et al. 2021). For these individuals, the vaccine is not a good but a private and social bad. More than just not getting vaccinated, these people will actively inhibit other people from getting vaccinated. For these groups, the question of underconsumption and optimal consumption is moot. For example, in January 2021, protesters forced a temporary shutdown of a vaccination site at Dodgers Stadium (Gerber and Khan, 2021).

These are not people who would receive a vaccination if it was subsidized and provided at a price of zero. And they are not free-riding on other vaccinated individuals in the absence of a mandate. Unlike the examples in previous sections, transaction costs are not the reason that these people are not ple bad ice Stkpeopl not tracc6 (hI1 (e)1pl)-(not)2 (t)2 (hut)(nd o)10 (pt)2 (i)-1 (m)1 (a)-pol ple bcnd

Second, even when the effects are not completely internalized, the external benefits are more

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