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Essays on the collective action dilemma of vaccination

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Abstract

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Vaccines famously possess positive externalities that make them susceptible to the collective action dilemma: when I get vaccinated, I protect not only myself, but also those who I might otherwise have infected. Thus, some people will have an incentive to free ride on the immunity of others. In a population of rational agents, the critical level of vaccination uptake required for herd immunity will therefore be difficult to attain in the long run, which poses difficulties for disease eradication.

In this doctoral dissertation, I explore different implications of the collective action dilemma of vaccination, and different ways of ameliorating it. First: given that coercion or force could solve the dilemma, and democracies may be less likely to engage in policies that violate the physical integrity of citizens, democracies may also be at a disadvantage compared to non-democracies when securing herd immunity. In essay I, I show that this is, empirically, indeed the case. Barring the use of extensive coercion therefore necessitates other solutions.

In essay II, I highlight the exception to individual rationality found in other-regarding motivations such as altruism. Our moral psychology has likely evolved to take other's welfare into account, but the extent of our prosocial motivations vary: a wider form of altruism that encompasses not just family or friends, but strangers, is likely to give way to a more narrow form when humans pair-bond and have children. This dynamic is shown to apply to the sentiments underlying vaccination behavior as well: appeals to the welfare of society of getting vaccinated have positive effects on vaccination propensity, but this effect disappears in people with families and children. On this demographic, appeals to the welfare of close loved ones instead appears to have large effects.

In essay III, I investigate whether the prosocial motivations underlying vaccination behavior are liable to be affected by motivation crowding - that is, whether they are crowded out when introducing economic incentives to get vaccinated. I find that on average, economic incentives do not have adverse effects, but for a small minority of highly prosocially motivated people, they might.

Keywords: vaccines, collective action, democracy, rationality, altruism

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To Dr. Salk

List of essays

This thesis is based on the following essays.

- I Ahlskog, Rafael. Democracy and vaccination uptake - a complex friendship. *Working Paper, Department of Government, Uppsala University.*
- II Ahlskog, Rafael. When is blood thicker than water? Variations of other-regard in the vaccination decision. *Working Paper, Department of Government, Uppsala University.*
- III Ahlskog, Rafael. Money for nothing? Motivation crowding and economic rationality in the vaccination decision. *Working Paper, Department of Government, Uppsala University.*

Thank you

Our beloved Carl Sagan once said that “science is a way of thinking, much more than it is a body of knowledge.” Like any good scientist would, I consequently approached writing these acknowledgements as an analytical problem deserving of just as much scrutiny as any of the ones contained in the rest of this thesis.

My initial line of attack was to construct some form of simple taxonomy of *ideal types* of people I would wish to thank. Having failed in such an endeavor (much due to the almost universally cross-cutting category “friends”), I instead tried a more multi-dimensional approach. Being a political scientist, I assumed that the go-to workhorse of the 2×2 matrix (the “fyrfältare”) would be a good framework to depart from. Upon realizing that this, too, would be a structure too weak to bear the complex ties I wished to capture, the entire enterprise was abandoned. However fallible, some things may be best left to unaided human intuition. This, my dear friends, colleagues, and fellow humans, comes straight from the heart.

The Department of Government in Uppsala is an exceptional research environment. Those words may for some evoke images of very smart people drinking too much coffee, saying complicated things and writing obscure formulas on whiteboards. While that description is undeniably true, the department is also the kind of genuinely warm place that provides fertile soil for a truly inspiring, free exchange of ideas. I am quite convinced that it’s hard to find this type of heterogeneity of both subjects and methods, housed within the same walls, anywhere else. This culture of openness, interdisciplinarity and friendly skepticism is something I feel honored to have been part of. For that, I would like to extend my gratitude to all of you; staff and student alike, who make up the bustling environment at our department. Thank you.

A few people, however, deserve special mention. First, of course, my supervisors. I think it’s fair to say that Sven Oskarsson and Kåre Vernby, these two blazingly intelligent yet graceful and compassionate men, have had good reason to worry about where I, or this project, was heading a lot of the time. Going off on tangents (both academically and geographically speaking), being impossible

to schedule early meetings with, rarely sending drafts in good time – for all these things and more, I extend my apologies, as well as my eternal gratitude for putting up with me. I have always felt very strongly that you have my back. From the bottom of my heart, thank you.

Second, where would I be without you, my fantastic – and may I say, gorgeous – cohort? Karin Leijon, Marcus Wangel and Nadja Grees, I could not have asked for better co-travellers along the road. You will achieve great things. We have some splendid parties ahead of us!

Third, the people one would superficially refer to as fellow PhD candidates, but who in reality are *so* much more than that. Pär, I would likely be in a different department if it weren't for you. You have been more important during these years than you can imagine. Ewelina, your razor sharp intellect has been crucial to me, both as an aspiring researcher, but also as a human being. You are amazing. Ariel, thank you for all of our stimulating discussions and for having more of a backbone than just about any other person I've ever met. Michal, please never stop being a force of nature. Also, needless to say, Femman-inhabitants: thank you for the supportive work atmosphere, and for the countless lunch/coffee/Kreativa Femman breaks.

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Helena, Kristina, Ragnvald, Jimmi, Erika, Ewelina, Hanna, Åland, Anders, the Luna staff and the rest of my Flogsta family – you are, and always will be, my light. Carl and Albert, thank you for the inspiration.

Finally, my family, who are still confused about how I ended up here. Mom, thank you for always making sure I take some rest now and then. Dad, thank you for keeping the house warm and feeding the cat in my absence. My wise, compassionate and patient grandmothers – Kerstin and Gertrud – thank you. Cornelia, thank you for paving your own way and being an example for all of us. Jonas and Ana, thank you for being a few steps ahead in the academic rat race and showing me that it's possible to navigate. Dante, stay sharp. Minoo, I look forward to getting to know you.

Without further ado, here is my thesis.

Rafael,
Berkeley, December 15, 2016

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Introduction

As the late Elinor Ostrom pointed out in her famous presidential address to the American Political Science Association, solving collective action dilemmas is often considered the core justification for the existence of the state and therefore lies at the very heart of political science (Ostrom, 1998).

From the roots of political theory in Aristotle, via Hobbes, to modern characterizations of the collective action dilemma by scholars like Mancur Olson (1965) and Garrett Hardin (1968), the clash between the interests of individual actors and the groups, both formal and informal, that they constitute has been at the core of our discipline. Wars and arms races (Majeski, 1984), environmental policies (Barrett & Dannenberg, 2012), organization of fishing, foresting and farming (Ostrom, 1990), corruption and rent seeking among politicians (Persson et al, 2012) and taxation policies (Gottlieb, 1985) are all examples of some of the many areas where collective action dilemmas may complicate, hamper or even prevent fair and efficient outcomes.

Another such problem, as others have pointed out, and as I shall argue more extensively later in this introduction, is that of achieving sufficient vaccination coverage. Vaccinations not only give immunity to disease to the person taking the shot, but also indirectly protecting all those other people who the vaccinated person would otherwise have infected. They therefore constitute a typical example of a public good, giving rise to a market failure, a tragedy of the commons, a collective action problem – whatever one wishes to call it. On Ostrom’s account, political scientists *could* therefore have something to say about this crucial public good. Here, I will argue that we *should*.¹

¹Some may question whether this problem is really *political science* proper. If the allusion to the collective action dilemma does not convince the reader, consider another view on what separates the discipline from others: that political science is simply the study of the state or of government. On the one hand, as Ostrom argued, the collective action dilemma is why we *need* governments to begin with. On the other hand, vaccination is a legitimate field of study in the context of comparative politics, since vaccination policy varies widely between states. Additionally, from a normative standpoint, how such policy should look

So do we? When it comes to politics and health more generally, there is an emerging literature that political scientists have engaged with on the relationship between regime type and population health. Using aggregate measures such as infant mortality, maternal mortality and life expectancy, this strand of research seems to be converging on the conclusion that citizens in democracies are healthier and live longer (Ghobarah, Huth & Russett, 2004; Lake & Baum, 2001; Wigley & Akkoyunlu-Wigley, 2011a), that this is a historical (cumulative) phenomenon rather than an instantaneous effect (Gerring, Thacker & Alvaro, 2012) and that it cannot be exclusively explained by distributive mechanisms (Wigley & Akkoyunlu-Wigley, 2011a). It has also been suggested that even within democracies, the choice of electoral system may have health effects – proportional systems appear to have an edge over majoritarian ones (Wigley & Akkoyunlu-Wigley, 2011b).

A tangential literature in the study of the evolutionary underpinnings of political behavior (Petersen, 2015; Peterson & Aarøe, 2015), pertaining to infectious disease, is on *disgust sensitivity* and how it relates to individual political traits. The basic emotion of disgust likely evolved as a guide to our “behavioral immune system,” and in essence makes us avoid disease carrying materials and people (Tybur et al, 2013). Several authors have argued that individual variation in disgust sensitivity acts as an input in political attitude formation. For example, high disgust sensitivity has been linked to xenophobic attitudes (Faulkner et al, 2006), possibly mediated by social dominance orientation (Green et al, 2010). It has also been suggested that it is as a driver of social conservatism (Terrizzi et al, 2013) and that this relationship is mediated by sexual morals and mating strategies (Tybur et al, 2015; though others have argued that disgust sensitivity is a predictor of protectionist attitudes *independently* of ideology – see Kam & Estes, 2016). Further, Aarøe et al (2016) argue that disgust sensitivity is connected to social trust more generally.

The more specific field of vaccinations, however, has drawn quite limited attention from political scientists – perhaps because it superficially appears outside of our domain.² There are some ex-

to achieve its goals requires empirical input on how individuals respond to incentive structures and other dimensions of policy design.

²It is important to point out that there is a substantial body of research *not*

ceptions. As a striking example, attempting to correct misperceptions about vaccine side-effects has been shown to have the opposite effect of reinforcing them, for both childhood immunizations and flu vaccines (Nyhan et al, 2014; Nyhan & Reifler, 2015). Such research on motivated reasoning, confirmation bias, and the frequent failure of information as a policy tool (Taber & Lodge, 2006; Nyhan & Reifler, 2010) further underscores that interventions connected to vaccination policy shouldn't be the exclusive domain of the medical profession.

Among related questions that perhaps lie closer to the mainstream of the discipline, it has been found that social capital, generalized trust and institutional trust in healthcare is positively associated with vaccination intent (Rönnerstrand, 2013; 2014). Rönnerstrand (2015) also found that willingness to *unconditionally* vaccinate altruistically was higher among high-trusting individuals, while low-trusting individuals require reciprocal cooperation of others to vaccinate altruistically. These results show that both contextual and individual-level factors that are central issues in political science can further our understanding of vaccination behavior.

On the policy formation side, some researchers have also looked at how pandemic response has varied between countries (specifically during the A/H1N1 pandemic of 2009), and the roles of politicians versus experts and the sovereignty of the bureaucratic apparatus involved in managing vaccination campaigns. Baekkeskov (2016) and Baekkeskov & Öberg (2016) found that the design of the vaccination campaigns in Sweden, Denmark and Holland were mainly driven by the opinion of biomedical professionals rather than political considerations. This stands in stark contrast to responses to other types of natural disasters in that the logic of political survival is overridden in the particular case of pandemics by a strong tradition of medical expertise (Baekkeskov & Rubin, 2014).

Research of a more comparative nature has looked at cross-national variation in vaccination uptake as a function of political determinants, and has produced contradictory results. Conventional wisdom is that democracies produce public goods better than non-democracies (Bueno de Mesquita et al, 2003; Deacon

produced by political scientists on related matters. These lines of research are outlined in the individual essays in this compilation.

& Saha, 2006; Deacon, 2009),³ which is confirmed with regards to vaccinations by both Bueno de Mesquita et al (2003) and Lake & Baum (2001). Gauri & Khalegian (2002), however, find that democracies tend to have *lower* uptake except in the poorest subset of countries. These older studies are affected by a number of methodological problems that cloud any definite conclusions regarding regime effects. Some of these problems are addressed in paper I in this compilation.

One may ask, given the often pressing problems that our discipline generally engages with – questions of war and peace, democracy or violent repression, integration or ethnic conflict – is this particular problem really worth directing any significant amount of attention to? In the public mind, the famous alleged statement by United States Surgeon General William Stewart, in 1969, that it was now “time to close the book on infectious disease, and declare the war on pestilence won” may still ring quite true.⁴

A plethora of arguments can be furthered as to why such a view is dangerously mistaken. To begin with, epidemics have historically had major impacts on both political and economic trajectories of nations, and frequently more dramatic consequences than even war or genocide. The Spanish flu pandemic of 1918–1919 killed somewhere between 50–100 million people, arguably making it a more effective killer than both of the World Wars combined. It has been estimated that if a pandemic of the same magnitude were to hit today, the global economy would shrink by more than 12% (McKibbin & Sidorenko, 2006) – as a point of comparison, the 2009 financial crisis caused a contraction of about 1.5%.

The problem of infectious diseases is not just of historical interest but is rather of major, and likely drastically increasing, importance. Despite vast progress in medical science during the last century, infectious diseases are still (as of 2012) the second largest

³Although this has been challenged by Truex (2016), who argues that such conclusions are very sensitive to precise model specifications.

⁴Whether Stewart actually said this or not has been subject to debate, and a primary source for this alleged quote has proven elusive to find, but it nonetheless represents a type of attitude that antibiotics, vaccines and disease surveillance systems has largely rendered infectious diseases a problem of the past, which was quite prevalent even in the medical profession at least up until the HIV epidemic took serious foothold in the West. See Spellberg (2008) for a discussion of the quote in question.

cause of mortality in the world, responsible for no less than 23% of all deaths (WHO, n.d.).

With the advent of antibiotic resistance that is rapidly approaching pandemic proportions and climate change that threatens to expand the habitable zones for many diseases, our defense against substantial increases in mortality will depend heavily on the possibility of protecting ourselves before viruses and bacteria strike. When the next pandemic comes, well-functioning mass vaccination programs with high coverage may therefore be our most important barrier against a public health disaster.

Aim of this thesis

Being successful in the enterprise of safeguarding the efficiency and high uptake of our vaccination programs can never be an exclusively medical matter, however. Even if medical science can find safe and effective vaccines against every conceivable plague, we also need to understand how people act and make decisions about vaccines. Specifically, we need to find ways to overcome the collective action dilemma as it affects individual vaccination decisions. Yet, many social aspects of vaccination decisions remain chronically underresearched.

Such aspects include a more detailed description of how the collective action dilemma arises with this particular public good, how different political regime types may differ in their design of vaccination policy, what the roles of other-regarding preferences are in the individual decision process, and what role – good or bad – economic incentives can play; all of which are questions addressed in the included essays. This dissertation is thus intended as both an overarching contribution to the understanding of vaccination as a collective action dilemma, as well as a contribution to some of the ways in which we can help secure high uptake rates by solving it.

The questions brought up in both this introduction and the essays are:

- What makes vaccines public goods and how are they different from other public goods?
- What are the consequences of their public goods character for the universe of individual motivations that underlie the vaccination decision?

- When, and how, can those motivations be used to solve the collective action dilemma that results?

This introduction will proceed in the following steps. First, I will outline a short introduction to the history of vaccines and their impact on society and public health. I will then go on to explain why, exactly, vaccines pose a collective action dilemma, why a strictly rational choice approach to solving it may be insufficient, and thus why a wide range of political solutions are necessary to safeguard uptake and help in eradication efforts. Finally, my own contributions to this endeavor are presented and implications discussed.

A brief history of the vaccine

Once upon a time, there was smallpox. Smallpox, or *variola vera*, is one of the most enduring and deadly epidemic diseases that our species has confronted. The first symptoms are often confused with the influenza: fever, headaches and muscle pain. As the disease progresses, lesions start to develop in the mouth and throat, and eventually rashes and lesions cover the entire body. In some cases, lesions will start bleeding into the skin, causing it to become black (Fenner, 1988). The mortality rate varies between 1–45% depending on the virus strain (Behbehani, 1983), and survivors often have to live with severe scarring of the skin, deformed limbs due to bone marrow inflammations and not seldom blindness (Fenner, 1988). In the 20:th century alone, somewhere around half a billion people succumbed to this tiny killing machine (Koplow, 2004).

Smallpox no longer exists in human hosts. It was globally eradicated in a massive vaccination effort in the 1970's and now only remains as heavily guarded samples in a few select laboratories (Behbehani, 1983; Hammond, 2007). The story of the origin and success of the vaccine is intricately entwined with the fate of this virus, and they are thus necessarily told together.

The very word vaccine betrays the humble origin of this revolutionary medical technology. The british physician Edward Jenner, often considered the father of modern immunology, was born in 1749 in the small town of Berkeley, Gloucestershire (Riedel, 2005). At the time, variolation, that is the practice of infecting patients with just a trace amount of real smallpox to provoke a milder form of the disease, had already been common in Europe for decades, but it was highly risky: 1–2% of patients ended up getting serious enough cases of smallpox from the variolation that they died (Riedel, 2005). Although better than nothing, it was hardly a solution.

Jenner was aware of stories circulating among milkmaids in the area, that having been exposed to cowpox, another, relatively benign, virus of the orthopox family that is common among bovines, somehow seemed to protect them from the far more dangerous smallpox (Barquet & Domingo, 1997). Hypothesizing that the pus from ruptured cowpox lesions could confer the same protective effect as variolation, he proceeded by deliberately infecting a number

of patients with this pus, noting that the patients developed lesions of their own, and subsequently by trying – and crucially, failing – to make them ill by infecting them with smallpox (Riedel, 2005). They had become immune. Thus, the vaccine, from the latin *vaccinus* (meaning, approximately *derived from cow*), was born.

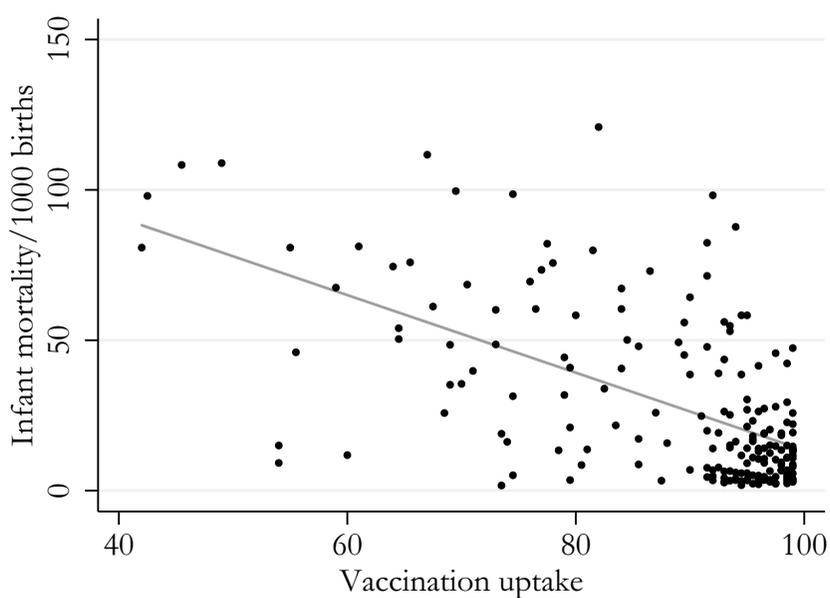
This first smallpox vaccine, of course, has been further developed and refined and moved far away from the realm of bovine infections. Modern vaccines cover a range of different pathogens, immunological mechanisms and routes of administration, but they all still have one thing in common with the original smallpox vaccine that Jenner developed: instead of treating an illness when it has already taken foothold in an organism, vaccines trigger it to develop its own immunity to the illness, so that it runs a lower risk of getting infected in the first place.

Today, standard vaccination practices in most parts of the world include comprehensive programs to immunize infants against at least measles, mumps, rubella, diphtheria, pertussis and tetanus (WHO, 2016a). Polio is close to being eradicated, but vaccinations against polio are used in areas where the disease is still endemic. Likewise, vaccines against tuberculosis are also used in countries with high levels of endemic TBC. In the last decade, vaccinations among teenage girls against certain strains of Human Papillomavirus (HPV) known to cause cervical cancer has been introduced in several countries. In adults, seasonal vaccination against influenza is common in the industrialized world (WHO et al, 2009).

Exactly how large the impact of vaccines on public health is can be difficult to disentangle considering the lack of a counterfactual. A few examples can be mentioned. Only since 2000, an estimated 17.1 million deaths were prevented globally by increases in measles vaccinations (WHO, 2015). When including all vaccines, the WHO estimates that roughly 2–3 million deaths are avoided every year, and 1.5 million further deaths per year could be avoided if vaccination targets were reached (WHO, 2016b). In the United States alone, vaccines prevent roughly 42,000 early deaths per year, and 20 million cases of disease (Zhou et al, 2014). The smallpox vaccine, needless to say, has likely saved lives in the hundreds of millions since becoming widely available.

Another way of assessing the possible impact of vaccination

Figure I.1: Bivariate relationship, vaccination uptake and infant mortality, 2010



Average uptake of DPT and measles vaccines as percentages on the horizontal axis (World Bank, 2015). Infant mortality per 1000 births on the vertical axis (UNESCO, 2015).

programs is to simply look at national level correlations between uptake and measures like infant mortality. Figure I.1 shows data on infant mortality and average diphtheria, pertussis, tetanus and measles uptake for the year 2010. This image shows a steep decline in infant mortality as we move to the right of the graph, but the relationship, needless to say, is likely heavily confounded. However, as shown in Appendix A, the relationship holds even when controlling for a whole host of possible confounders, taking time trends into account, and using only within-country variation. While admittedly a somewhat crude analysis, the most conservative estimate reveals a significant reduction in infant mortality that corresponds to more than ten deaths per 1000 births if a country with very low vaccination uptake were to reach herd immunity by means of vaccination. This difference is roughly equivalent to changing from the infant mortality rate on the Gaza Strip to the rate in the United States.

It should thus be clear that from a public health standpoint, the impact of vaccines, and therefore of vaccination policy, is substantial. Investigating the mechanisms underlying individual vaccination behavior as well as cross-country differences in vaccination policy is therefore a potentially important application of political science.

Vaccination as a collective action dilemma

The question now inevitably arises – if vaccines are so important for public health, and all that is required is that enough people get the shot, why is this not a simple problem of supply and logistics? After all, individual agents should *want* to avoid disease and therefore be highly motivated to get vaccines when they are available. From this perspective, it would appear that all we have to do is make sure that everyone has access. And yet, it took almost 200 years from the discovery of the vaccine, and immense efforts and coordination from the international community, to eradicate smallpox – not to mention that in theory easily eradicable diseases like measles and polio are *still* circulating. Why is this such a difficult problem to solve?

The fundamental problem is that immunity is a public good, and maintaining high vaccination uptake therefore poses a collective action dilemma. This places vaccination policy in the same diverse class of problems as climate policy, nuclear disarmament and online piracy. Understanding why disease eradication seems like such an elusive goal thus requires us to understand public goods and collective action dilemmas more generally.

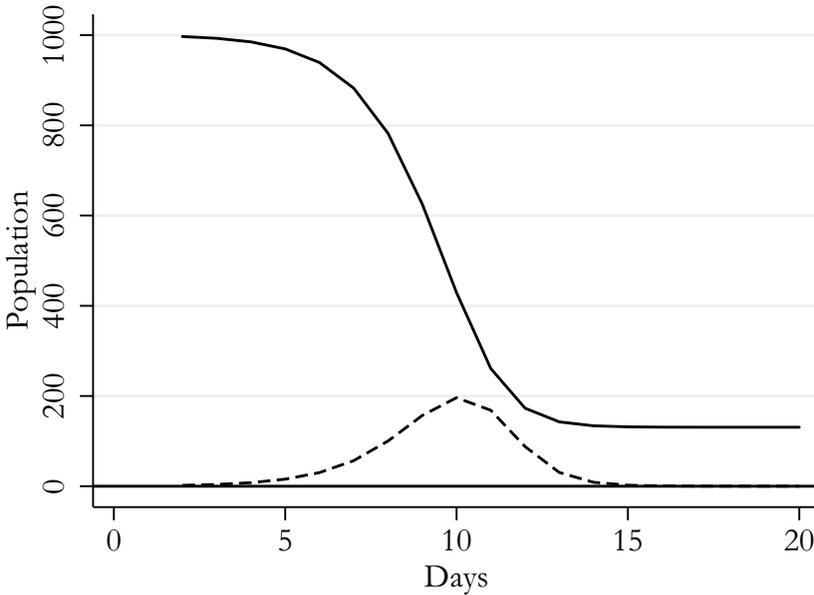
A public good is typically defined as a good that satisfies two criteria: non-rivalry and non-excludability. Non-rivalry means that consumption by one does not detract from the consumption of others, and non-excludability means that it is impossible or prohibitively expensive to exclude anyone from enjoying the benefits of the good. This leads to the existence of positive externalities: when consumed by one, the good is enjoyed by others. Typically, public goods are also divided into pure and impure ditto. Whereas pure public goods confer utility to the individual consumer only to the extent that the whole community benefits, an impure public good has a separate individual utility component as well.

To formalize this, one can set up a simple expression for the utility u of an individual i , as a function of the amount of effort e provided by the different members of the community:

$$u_i(e_1 + \dots + e_n) = b e_i + c \Sigma e - \delta(e_i). \quad (\text{I.1})$$

The parameters should be interpreted as follows: e_i is the effort put in by i , Σe is the sum of the effort put in by everyone in the

Figure I.2: SIR model



Typical SIR dynamics in a simulated population of 1000. Solid line represents susceptible people. Dashed line represents currently infected.

community, and $\delta(e_i)$ is the disutility of the effort put in by i . A positive coefficient c makes this a public good: some level of utility is obtained by i simply because others are putting in effort. A positive coefficient b , on the other hand, makes it an *impure* public good, since some amount of utility is private.

The problem arises when the term $\delta(e_i)$ is not zero. Since it is possible to obtain utility from the effort of others, and doing an effort oneself is a hassle, everyone has an individual incentive to freeride. This gives rise to the collective action dilemma: how do we find a way so that everyone in the community contributes, and we keep freeriding to a minimum? As we shall see, this problem afflicts vaccines as well.

To understand vaccines as social phenomena, and how their particular version of the collective action dilemma arises, we necessarily have to start out with an analysis of infectious disease dynamics. Traditional approaches to understanding the spread, as well as the societal effects, of infectious diseases have relied on a rather simple, but very powerful, framework of mathematical models called

compartmental models. Thanks to their simplicity, these models allow for elegant deductive derivations with profound theoretical implications. The models are based on a division of a population into a set of compartments with labels such as *susceptible* (S), *infected* (I) and *recovered* (R) (see for example Hethcote, 2000). Which specific compartments are necessary is determined by the characteristics of the particular infectious disease that is modeled.

With the aid of a number of simplifying assumptions about individual behavior, the flow of people between these compartments can be captured. For the simplest set of models, the necessary assumptions are, for example, that each infected person in turn infects a certain number of other people, on average (this constant is often referred to as the *basic reproduction number*, or R_0) and that matchings between infected and susceptible people are random over different social strata. In this manner, a few of the most important dynamics of the spread of the disease over time can be captured, such as the fact that the prevalence initially increases quite slowly, then rapidly catches up speed, reaches an epidemic apex and then gradually dies out. These dynamics are illustrated in figure I.2 for a simulated population of 1000.

A typical compartmental model (in this case, an *SIR*-model) with unity normalized population size has the following characteristics:

$$\frac{\partial s_t}{\partial t} = -\lambda s_i, \quad (\text{I.2})$$

$$\frac{\partial i_t}{\partial t} = \lambda s_i - \gamma i, \quad (\text{I.3})$$

$$\frac{\partial r_t}{\partial t} = \gamma i. \quad (\text{I.4})$$

The coefficients λ and γ denote the rate of transition into and out of infection, respectively. As can be read from the change in the infective compartment ($\partial i_t / \partial t$), the increase in infectives depend both on the amount of infectious people who can infect others (i_t) and the amount of susceptible people left to infect (s_t). The flow is unidirectional, so that $s \rightarrow i \rightarrow r$: once recovered, a person remains in the recovered compartment indefinitely and is as such effectively immune. An important analytical result is that the rate

of change of the compartment of infectives is equal to zero when $\lambda si - \gamma i = 0 \rightarrow s = \gamma/\lambda$ which can be shown to be equal to $1/R_0$.⁵ If the initially susceptible population is smaller than $1/R_0$, a disease *cannot* gain enough leverage to start an epidemic. This level of prior immunity, $1 - 1/R_0$, is commonly referred to as *herd immunity* (Fine et al, 2001).

An obvious problem with the traditional compartmental approaches concerns their static assumptions about human behavior. Economists have attempted to replace these assumptions with “proper” microfoundations, spawning a field of research known as *economic epidemiology* (Francis, 1997; Philipson, chapter 33 in Culyer & Newhouse, 2000). Rather than static assumptions, this field assumes that agents are aware of risks involved when an infectious disease is present in a population and adjust their behavior accordingly – by for example increasing social distance, consuming disinfectants or getting vaccinated (Geoffard & Philipson, 1996; Goldstein et al, 1996). Technically speaking, this can be expressed as λ being a function of disease prevalence (monotonously decreasing, such that $\lambda = f(i_t), \partial\lambda/\partial t \leq 0$). The result is that the force of infection is *prevalence elastic*, meaning that the system has a built-in negative feedback effect, limiting the spread of the disease as people alter their behavior. Economic epidemiology, therefore, generally predicts less dramatic epidemic patterns than more traditional approaches.

We can use these theoretical foundations to begin modeling an individual decision whether or not to get vaccinated. Taking the above outlined SIR-model as a starting point and adding a simple cost-benefit analysis, we get an epidemiologic game with the following characteristics: the risk of becoming infected, given a decision to abstain from getting vaccinated, is a negative function of the number of other people who chooses to get vaccinated (or $r(p)$, where p is the fraction of previously vaccinated and $\partial r/\partial p \leq 0$).⁶ As per the previous discussion, the risk effectively reaches zero

⁵To see that $R_0 = \lambda/\gamma$, consider that the average number of time periods spent in the infective compartment for an infected person necessarily amounts to $1/\gamma$. The number of contacts sufficient for transmission per infectious person, per period, is $\lambda i/i = \lambda$, giving a number of contacts sufficient for transmission per infectious person, for the duration of the infection, of $R_0 = \lambda/\gamma$.

⁶The functional form of $r(p)$ in an SIR-model can be shown to be $r(p) = 1 - \frac{1}{R_0(1-p)}$ (see Bauch & Earn, 2004).

when $p = 1 - 1/R_0$. The cost, or disutility, of getting infected is denoted δ_i and the expected disutility of getting vaccinated is denoted δ_v . Since the individual risk decreases in p , the marginal person getting vaccinated will fulfill the condition

$$r(p) = \frac{\delta_v}{\delta_i}. \quad (\text{I.5})$$

From this point on, any person facing the decision to get vaccinated will have a higher disutility from getting vaccinated than the expected disutility of not getting vaccinated, since the risk of getting infected is so low. It is important to note though that the risk at this equilibrium will never be zero, unless the perceived disutility of getting vaccinated is also zero. From this also follows that a higher relative disutility of getting vaccinated gives a higher equilibrium level of risk and a lower vaccination uptake in the population.

Why are these results important? On the one hand, the existence of a level of herd immunity that is necessarily lower than 100% also indicates the existence of free riding possibilities. If enough people are already vaccinated, the remaining unvaccinated population will still face a risk of becoming infected that is practically zero: they can free ride on the immunity of others. This also implies that the decision to get vaccinated involves a significant externality: not only are you protecting yourself, but also those who, in the counterfactual situation, you would have infected. So long as the relative disutility of getting vaccinated is even minutely above zero, the existence of this externality will lead to an equilibrium level of vaccine uptake that is below herd immunity. We therefore have at our hands a classic example of the collective action problem.

This has serious implications for the possibility of eradicating a disease: the rational decisions of free agents will fail in achieving high enough vaccination coverage. This is also what has traditionally been interpreted as the public goods character of vaccines: the effect of consuming them spill over to the community. In paper I in this compilation, I argue that there are also a number of important differences between most typical public goods and vaccines, and that these differences have implications for how we ought to understand them. The main difference is that there is a disutility

in getting vaccinated that is separate from the cost of simply purchasing it – it might involve the time required to get the shot, the pain of getting it, or the fear of side effects. This makes public investment in vaccines different from public investment in, say, a lighthouse or the military: people still have to get the shot.

To overcome the public goods problem of vaccines, economists have traditionally posited a number of standard tools for dealing with externalities, in the form of taxes and subsidies. In microeconomic terms, these tools should get individual rationality to harmonize with the socially optimal behavior (Brito et al, 1991; Geoffard & Philipson, 1997). A subsidy or some economic compensation, for example, would enter the equation as a lower cost, consequently increasing coverage. This would seem to solve the problem. But is this really all there is to it?

Implications of the public goods character of vaccines

Few people would seriously maintain the idea that everyone always behave like the rational egoists posited by traditional economic theory. While in some cases – in many product markets, for example – these axioms are a reasonable approximation, there are several additional perspectives one can add when it comes to understanding vaccination behavior. The public goods character of vaccines and the positive externality they impose alone opens up for many nuances regarding the underlying motivations for choosing to get vaccinated. While the individually rational response may be to free ride, the external effects makes potential room for various forms of other-regarding preferences as well as social and moral norms to manifest.

A fundamental human motivation is that of other-regard: that is, in technical terms, our utility functions encompass terms relating to the the utility levels of others around us. When these terms are positive (as opposed to negative feelings of spite or schadenfreude), it can give rise to altruistic behavior, which is the subject of paper II in this compilation.

The word altruism, first coined by Auguste Comte from the latin word for other, *alteri*, has been used in a multitude of ways. Definitions can differ over the origins (both ultimate and proximate) of altruism, its effects on the agent and the identity of the recipient. The discussion also tends to be confused by the inter-

changing use of concepts such as empathy or empathic concern, other-regard and prosociality. A full taxonomy would be outside of the scope of this introduction, but I will recount a few variations that have previously been used. In the following discussion, I will denote as the 'agent' the person who engages in altruistic behavior, and subject or recipient the person (or people) being the target of the altruistic behavior.

First, altruism can be defined solely in terms of motivation – if I care about the needs of others, I am an altruist, regardless of whether I act on those motivations or not. This, I think, is an unnecessary muddling up with the concept of other-regard. Here, I shall instead use the word other-regard to denote a *motivation* to increase the welfare of someone other than oneself.⁷

Second, altruism can be defined solely in terms of action. That is, if an action benefits someone else, it is in effect altruistic, regardless of its underlying motivation. This, as prominent altruism scholar C. Daniel Batson points out, includes a whole range of phenomena that one does not ordinarily conceive of as altruistic, including actions that accidentally, or as a by-product, benefit someone other than the agent (Batson, 2011). One example is the definition of altruism from evolutionary biology, where an allele (that is, a particular genetic variant) is seen as altruistic if it decreases the *relative* fitness of an organism, thereby increasing the fitness of others (Cosmides & Tooby, 1992). A horse with an allele for bad teeth, it has been said, is therefore altruistic from an evolutionary standpoint, since it grazes poorly and therefore leaves more grass for other horses.

Third, it is often claimed that an altruistic deed needs to impose a net cost on the agent (Elster, 2006). That is, if an action provides a net benefit to both the agent and the recipient, it cannot be altruistic. This, in my view, rests on the unfounded assumption that an action can only have one underlying motivation. On the contrary, I argue that an action can be motivated by both other-regarding and self-interested motivations, and it is the presence of an other-regarding motivation that makes an action altruistic, not

⁷Note that other-regarding preferences do not *necessarily* have to be positive – it is full well possible to have negative other-regarding preferences, that is, preferences to *decrease* the welfare of someone else. Spite, revenge or sadism might be examples. Here, I exclusively focus on positive other-regarding preferences.

the absence of self-interest. Even though these might be next to impossible to disentangle in real-life cases, it is an important distinction to be made. In other words, other-regard is a necessary and sufficient condition for an action to be considered altruistic. As an example, consider someone who wants to give money to charity. Given the opportunity, this person might give the money in a way that is visible to others, and therefore signals goodwill, but would give the money nonetheless. It is evident that both other-regard and self-interest (wanting the goodwill) motivates this charitable giving, and the giving is thus simultaneously other-regarding and self-interested.

A working definition of altruism that captures the relevant types of behavior thus includes both motivation and action. I define altruism as *a goal-directed, contextually appropriate action, in part or in full driven by other-regarding motivation*. It is goal-directed in the sense that benefits to others do not happen by accident, but are intended. It is contextually appropriate in the sense that care is taken to adapt the means to the recipient: helping a subject that does not wish to be helped is thus not altruistic. It is in part or in full driven by other-regarding motivation in the sense that the agent would be less likely to engage in the behavior if an other-regarding motivation was missing.

Altruism in the vaccination decision, then, could conceivably overcome the collective action dilemma by having agents internalize the externality of their decision. The failure of herd immunity caused by free riding is contingent on everyone acting exclusively in their atomistic self-interest. When they don't, but rather engage in some level of altruistic vaccination, the equilibrium uptake level increases. To see how this relates to eq. 1.5 above, it is easy to see that if δ_i (that, is the disutility of getting infected) were to increase by the disutility conferred on secondary infections (in essence, those you infect if you get sick), the equilibrium is also lower.

An alternative lens on other-regarding behavior is the literature on the *deservingness heuristic*, a psychological mechanism through which people (subconsciously) evaluate the appropriateness of given distributions of resources based on the perceived deservingness of the recipients (Petersen, 2015). Our sentiments on deservingness is likely an evolved consequence of reciprocal altruism, where re-

source sharing functioned as a form of insurance against random fluctuations in individual food availability – and crucially, would have required reciprocal effort in return for sharing (Trivers, 1971). Perceived deservingness, then, appears universally to be intimately connected to the effort put in by a prospective receiver of “aid,” with individuals who appear to shirk or free ride deemed undeserving of shared resources (Petersen et al, 2012).

Interestingly, the deservingness heuristic does *not* apply to judgments about illness: under ancestral conditions, infection or injury would have been a practically random event, and would thus not have been a signal of free riding. Consequently, it does not appear that this particular psychological mechanism affects decisions about resource sharing with sick individuals (Jensen & Petersen, 2016). This suggests that it also may not affect prosocial sentiments in the vaccination decision, since it effectively regards preventing illness.

In paper III in this compilation, I also investigate the possibility that the prosocial motivation potentially underlying vaccination behavior could make them vulnerable to a peculiar quirk of human psychology known as motivation crowding. When one motivation is added to encourage a particular behavior, it can sometimes replace, rather than add to, a previously existing motivation (Festré & Garrouste, 2015). This problem sometimes seems to arise when using monetary incentives to encourage a behavior that was already prosocially motivated, with the consequence that rather than *adding* an incentive and increasing the desirable behavior, prosocial motivation is crowded out and the behavior decreases. A striking example is a study that found that high-school children collecting money for charity put in substantially *less* effort when they received economic compensation (Gneezy & Rustichini, 2000b).

Incentivization schemes in vaccination policy could be liable to suffer from the same problem, provided that some level of other-regard in the vaccination decision does exist. Paper III documents that such motivations *do* in all likelihood drive some vaccination behavior, and tests whether motivation crowding occurs when economic incentives are added.

The existence of externalities in vaccination behavior also implies the possibility for another class of social mechanisms to become activated, namely different kinds of norms. A social norm,

to begin with, can be regarded as a mechanism where expected negative feedback from one's social environment causes one to abstain from a particular behavior, or vice versa (Elster, 1989). A behavior guarded by a pure social norm therefore also requires that the environment can observe the behavior, and is as such *externally* motivated. As a contrast, there may also be *moral* norms, that, rather than being reinforced by external feedback, are types of mechanisms where expected negative feedback in the form of feelings of guilt or anguish causes one to abstain from or engage in a behavior when the social environment is unable to observe it (Elster, 2006). Moral norms are by this logic exclusively *internal* mechanisms.

A form of hybrid between the two is a quasi-moral norm, where the direction of observation is the opposite of a social norm. In short, this means that a person may engage in an act (such as cooperating in a commons dilemma) when he or she can also observe others doing the same. This is sometimes referred to as conditional cooperation in the behavioral economics literature (Fischbacher et al, 2001). An example from Elster illustrates this: when water consumption needed to be drastically cut during a drought in Bogotá, authorities were faced with the problem that even though there were strong social norms to consume less water, there was no social feedback mechanism. Simply, private water consumption could not be monitored other than in the aggregate. To ameliorate this, a decision was taken to broadcast information on the TV news every day about how much the total water consumption had decreased. This way, everybody could see that there were in fact other people following the norm. Thus, a small group of unconditional cooperators incited others to join when the results became observable.

Norms regarding vaccination would likely fall under the quasi-moral umbrella. It is generally impossible for the wider surroundings to tell whether one has been vaccinated, unless asking directly and receiving an honest answer. This means that the establishment of social norms is complicated by the lack of a direct individual feedback mechanism. It *is*, however, possible for each and every one to observe the general level of cooperative behavior simply by learning about aggregate coverage rates. This makes the situation analogous to the Bogotá water supply.

Some evidence suggests that vaccination uptake is indeed sensi-

tive to this dynamic. Hershey et al (1994), for example, found that more subjects were willing to take a vaccine when informed that most others had taken it. If this logic generalizes, it could explain why there appears to be quite resilient vaccination cultures in certain countries (such as the Nordic), where historically high uptake establishes social norms that become self-reinforcing.

We have now seen that a number of possible deviations from individual rationality could ameliorate the collective action dilemma of vaccination, and that some mechanisms for solving it if individual rationality *were true* could conceivably do more damage than good. The empirical questions remain open, however. Do altruistic concerns or norms affect vaccination behavior, and if so, how? Is it possible that economic incentives undermine prosocial motivations to get vaccinated? And what are the implications of some of these mechanisms for the behavior of the state when instituting vaccination policy? I will now proceed to explain *how* I've tried to answer some of these questions.

Methodology

Given the multifaceted nature of collective action dilemmas generally, and particularly as it affects vaccines, a highly varied set of methodological approaches to study this problem are available. In this compilation, I have included papers which use two types of quantitative design, addressing two different levels of analysis. In this section, I will outline these levels of analysis and the accompanying methods I have used to investigate questions connected to them.

Dependent variables: individual versus aggregate level

The two levels of analysis of vaccination behavior that are addressed in this thesis are the individual level decision process, and the aggregate (country) level outcome from policy. This gives rise to different ways of measuring the dependent variable.

On the individual level, the studies included here measure willingness to accept a particular vaccine, or *vaccination propensity*, with a simple 1–5 Likert item ranging from “would definitely not get vaccinated” to “would definitely get vaccinated.” At the group level, this leads to means of vaccination propensity rather than actual uptake rates. On the one hand, this is not directly translatable to actual rates of vaccination in the sample – therefore, we cannot see exactly what the consequences would be for uptake other than indirectly. On the other hand, to the extent that a “longer” scale captures more nuanced true variation in vaccination propensity, a binary outcome variable would have required larger samples to achieve the same statistical power. The choice to not use a binary measure is therefore mainly a methodological choice based on maximization of power given the sample sizes that were feasible.

On the aggregate, or population level, data on actual vaccination uptake is used. In practice, this means the reported number of all infants receiving a particular vaccine as a fraction of all infants born, in a given year and country. I have chosen to use the uptake of two different reported vaccines: the measles vaccine, and the DPT (diphtheria, pertussis and tetanus) vaccine.

A fundamental difference between the two measures is that whereas the studies conducted at the individual level measure uptake in a situation where the respondent is called on to make a

judgement for him- or herself,⁸ the uptake data used at the country level is for childhood vaccines, and is thus essentially based on vaccination decisions taken by parents on behalf of someone else – namely their infant. Whether these two are considered essentially different or essentially the same type of decision hinges on to what extent a parent can be considered to act “as if” they were an enlightened and autonomous version of their infant. This can be debated, but it is not implausible to assume that parents are indeed mainly acting in what they perceive to be the best interests of their children, rather than in their own strict self-interest.

Methods, data and case selection

Papers II and III in this compilation are based on survey experiments, or more specifically, between-subjects vignette experiments conducted online. Generally speaking, survey experiments are just surveys where some item, the order of items, descriptions of items or particular phrasing of questions is randomized (Gaines, Kuklinski & Quirk, 2006). A vignette experiment, specifically, describes a hypothetical scenario to the respondent and follows up with questions about, for example, how the respondent would feel or act if this were to happen in real life. The experimental treatment typically consists of slight (or sometimes large) variations in the parameters of the scenario. The idea is to make it possible to experimentally compare respondent’s feelings and actions in different states of the world, where a field-experiment would be impossible to conduct.

The experiments conducted for this dissertation simulated a situation in which the respondent were to choose whether or not to get vaccinated in response to a new virus in circulation. While it could be feasible to conduct such a study in the field, it would require waiting for a situation where a novel virus was discovered and a vaccine was available – and would also lack several dimensions of proper causal control over, for example, individual risk.

Needless to say, the external validity of vignette experiments is heavily dependent on the realism of the scenario and to what extent the respondents themselves can accurately predict how they would feel if the scenario was not merely hypothetical. For example, Barabas & Jerit (2012) found, when comparing a set of survey

⁸It doesn’t have to be, but in these studies it is.

experiments with natural experiments, that effect sizes tend to be weaker in real-world settings. On the other hand, the internal validity is usually as good as can be, since we are dealing with an actual randomized experiment.

The data for papers II and III were gathered from two separate subject pools. On the one hand Amazon Mechanical Turk (MTurk) was used. MTurk is a pool of people who voluntarily sign up to do minor tasks online for compensation. It has become very popular in recent years as a recruitment pool for research. The question of how reliable data is, and the demographic characteristics of the samples, has been subjected to some scrutiny. For data reliability (as in absence of random noise), the evidence is mixed. Buhrmester et al (2011) found that reliability was at least as high as when using conventional survey methods. Rouse (2015) on the other hand, found that reliability was somewhat lower. Whether this represents a change in the character of the subject pool over time, the differing constructs measured, or something else, remains to be illuminated. Importantly, lower reliability does not introduce bias in a randomized experiment, but does lower power.

As for the demographic characteristics of the samples obtained, Berinsky et al (2012) found that they tend to be markedly more representative of the (US) population than traditional convenience samples, which typically often consist of college students. My MTurk data is from US respondents. In the sample of 1607 respondents that I obtained, men were overrepresented, and the median age was lower than that of the general population.

On the other hand, the Citizen Panel of Gothenburg university was used (Martinsson et al, 2014). The panel contains roughly 60000 Swedish respondents, out of which a total of 3330 respondents were sampled for papers II and III. Men were, as in the MTurk sample, overrepresented, but this sample was instead older, on average, than the general population. Like before, these surveys were conducted online, but unlike MTurk, respondents were not compensated.

Though randomized invitations to join the panel are sent out at regular intervals, it is essentially self-selected. The lack of compensation, therefore, likely attracts respondents with a higher level of interest in actually following the survey, rather than clicking through to get the reward. This is likely to lead to slightly higher

quality data, but also a subject pool with a higher level of civic interest than average (and also higher than the MTurk samples). Considering Rönnerstrands consistent finding (2015) that trust and social capital is positively associated with influenza vaccination uptake, this may lead to an inflated baseline estimate of vaccination propensity as compared to MTurk.

Experimental samples in this dissertation, as seen, therefore come from two populations, namely Sweden and the United States. Further the scenarios in the studies are based, either implicitly or explicitly, on influenza epidemics. This warrants some discussion about the likely influence of already prevailing norms regarding influenza vaccination in the two countries. In the United States, annual seasonal influenza vaccine uptake typically hovers around 40% for adults (CDC, n.d). In Sweden, these figures are only reached among the elderly, whereas among people under the age of 65 only around 2% get seasonal influenza vaccines (Folkhälsomyndigheten, 2016).

This striking difference is likely due to differing government recommendations in the two countries: whereas Sweden typically only recommends elderly and other risk groups to get the seasonal influenza vaccine, the Centers for Disease Control and Prevention in the US recommends everyone above the age of six months to get it. This is further illustrated by the fact that during the AH1N1 influenza pandemic of 2009, the Swedish recommendation was changed to cover the whole population rather than only the risk groups, consequently pushing the uptake to 60% (Cuesta et al, 2016).

Given the differing recommendations, an interesting possibility is that when reading the vignettes, Americans will have higher levels of pre-exposure to pushes to get vaccinated than Swedes do. This could inflate baseline vaccination propensity, but crucially could also *deflate* effect sizes among Americans. As we shall see in paper III, neither of these seem to apply: both baseline measurements and effect size for the comparable treatment are virtually identical. It thus appears that when presented with similar information, the underlying vaccination culture matters less.

When moving from the individual decision level and addressing the aggregate level of analysis, experiments are no longer feasible. Paper I therefore uses traditional cross-country aggregate level ob-

servational data. Data was gathered with the help of the Quality of Government database (Teorell et al, 2016) and comprise series of country-year observations for vaccination uptake, democracy score, GDP per capita and a number of control variables. As such, it provides fairly low internal, or causal validity, whereas the external validity (generalized to the determinants of vaccination uptake in nation states) has to be considered fairly high, since the object of study is in fact historical uptake rates.

The analysis is based on two separate strategies. First, I use a straight-forward correlational approach with multiple OLS regression. Models include fixed effects for countries and years, which gets rid of time effects and retains only within-country variation. I also complement this with an instrumental variables strategy proposed by Acemoglu et al (2014), that utilizes the fact that democratizations tend to occur in waves. Changes in democracy scores will therefore be correlated with changes in democracy scores in nearby countries, whereas changes in *foreign* democracy score should have no direct relationship with vaccination policy or vaccination uptake in any given country. Democracy scores for countries in the same region can therefore plausibly be used as an instrument. When using this instrument, I present both reduced form OLS estimates as well as 2SLS models. While the added instrumental variables analysis should not be considered a perfect causal inference strategy in this case, it is a form of robustness check for the simple correlational results.

Contributions

Paper I: Regime type and vaccination uptake

Conventional wisdom has it that democracies are better at safeguarding a number of qualities. Not only are they (almost tautologically) better than many alternative systems of government at providing freedom of expression, mobility and association, but they also appear to more efficiently provide solutions to public goods problems. This conventional wisdom has previously been applied to the public goods problem of vaccines as well.

In this paper I argue that vaccines have several unique characteristics that make traditional models of regime differences in public goods supply fail. States can pay up and stockpile vaccines all they want, but herd immunity is reached only if citizens also roll up their sleeves and get the shots. This stands in stark contrast to most other public goods where the collective action failure is simply one of financing, which could be fairly easily solved by a benevolent social planner by means of taxation and public provision.

Another difference is the existence of a *saturation point* – namely herd immunity. No level of consumption above this threshold is rationally attainable even when the good provided is entirely free of charge, since there is no benefit left in terms of disease risk reduction for the individual. With “normal” goods, a cost of zero would predict a level of consumption approaching infinity. The traditional models, that generally predict democracies to be more efficient at supplying public goods, assume normal goods and may therefore fall short in the case of vaccines.

Since the free riding problem is present *even* when vaccines are financed through taxation, and herd immunity is generally profitable for the state in societies with a reasonably high income level, this gives incumbents an incentive to institute certain levels of coercion in vaccination policy. However, we should have strong suspicions that democracies are less prone to implement such policies because of the very nature of the regime type – the importance of the philosophy of human rights to the development of western democracy makes respect for, at least, the physical integrity of citizens a concern that is more difficult to side-step.

This inevitably leads to the conclusion that even though democracies *may* have higher levels of public funding for vaccination pro-

grams, they will be less likely to try to maintain high uptake with coercive policies. Therefore, if coercive policy actually works in pushing uptake up (which we can plausibly expect it to), non-democracy should be associated with higher uptake in richer societies where taxable income is high enough to offset the cost of vaccines.

In this paper, I test this proposition using two types of analysis of country level panel data. First, I run simple panel OLS models with fixed country and year effects to capture the within-country variation. Second, I use a novel instrument (Acemoglu et al, 2014), namely regional lagged democracy. The instrument takes advantage of the fact that democratizations and reversals to autocracy tend to come in regional waves (as famously described by Samuel Huntington). Neither of these two approaches should be interpreted as allowing for causal inference in a strict sense. Both, however, produce similar and consistent results: democracy is associated with lower vaccination uptake in richer societies.

These results indicate that indeed, modernized democracies may be at a disadvantage when it comes to securing herd immunity. Put simply, democracies are highly likely to require some form of individual consent for vaccination. Coercive policies are unlikely to survive, and may additionally also be normatively unappealing. Since abolishing democracy for the sake of achieving marginally higher vaccination rates is clearly absurd, other means will have to be used. How then, can we secure sufficient vaccination uptake in these systems?

Paper II: Altruism in the vaccination decision

One possible answer to this question can be found in encouraging or stimulating our innate prosocial sentiments. As a species, we (or most individuals) have a certain set of moral traits that appear to be universal across cultures. These sentiments of caring for others can plausibly play a role in vaccination behavior and therefore possibly also in vaccination policy.

In this paper, I argue that in order to understand prosocial behavior more generally, we first have to understand the motivations that underlie it. I argue that, conceptually speaking, it is reasonable to separate other-regarding motivations into two distinct categories, namely narrow (or family/kin oriented) other-regard, and

wide (or purely altruistic) other-regard. These two types of motivation likely have different neural underpinnings and evolutionary origins. I also hypothesize that these motivations may fluctuate over the life-cycle, and specifically that wider other-regard may give way to narrow when humans enter pairbonding and have offspring.

This division has crucial implications for how prosociality may affect vaccination behavior. For example, people driven mainly by narrow other-regard will fail to internalize the benefit of herd immunity to certain risk groups unless there are such people in their own narrow circle, whereas those driven mainly by wide other-regard will have an easier time internalizing this benefit regardless.

To see how these motivations actually function in the vaccination decision, I utilize a vignette experiment conducted in cooperation with the Citizen Panel of Gothenburg university. The vignettes describe a scenario modeled on the 2009 A/H1N1 influenza pandemic (the so called *swine flu*), and the treatments consist of different appeals to the respondent to get vaccinated. The appeals are designed to stimulate narrow, wide or both types of other-regard, versus a control condition.

The results show that both types of appeals do increase the stated willingness of the respondents to get vaccinated in the given scenario, which can be interpreted as meaning that other-regard indeed *could* play a crucial role in maintaining high uptake. More importantly, narrow and wide appeals appear to affect different categories of respondents differently: individuals in settled family constellations (married or cohabiting and with children) respond strongly to narrow, but not to wide, appeals, whereas those with neither respond to wide, but not to narrow, appeals.

This means that, analogous to the logic mentioned above, even if people who have entered pairbonding are sensitive to some other-regarding appeals, the type of other-regard they respond to may not help much when safe-guarding herd immunity. Altruism may work for some, but is not the ultimate solution to the collective action dilemma of vaccination. This leads us, finally, to the mechanism proposed by economic epidemiologists: incentives.

Paper III: The role of economic incentives

Given the externalities of immunity and the possible existence of other-regarding motivations underlying vaccination behavior, the effects of economic incentives are less clear-cut than one might first intuit. There are a number of documented situations where a behavior driven by other-regard is adversely affected by the introduction of economic incentives. This phenomenon is often attributed to motivation crowding: one motivation to engage in a particular behavior replaces another. If the new motivation is not powerful enough, the end result is a *decrease* in the propensity for this behavior. Could this problem affect vaccines as well?

In this study, I hypothesize that the extent to which vaccines are affected should depend on two things. First, only people who are actually motivated by some level of other-regard should be affected. Second, since vaccines confer an individual benefit, this may already at the outset crowd out the effects of other-regarding motivations. Thus, individuals who stand to gain nothing themselves from getting vaccinated should be more likely to be affected.

To test these hypotheses, I use another set of survey experiments with a similar design as in the previous study. The samples are from the Citizen Panel (1328 Swedes), and from Amazon MTurk (1607 Americans). The treatments, rather than different appeals, are tweaks to the scenario involving various levels of stated monetary payoffs to getting vaccinated. I also varied the level of risk to the respondent from the described disease, so that some respondents would have no self-interested reason to take the vaccine apart from the possibility of monetary rewards.

The main results are clear: incentives have positive effects on vaccination propensity on average. This means that if there are any motivation crowding effects, they are drowned out by the incentivization effect. However, when one restricts the analysis to people who motivated their decision with a high level of other-regard, there seems to be some motivation crowding. This effect, further, was limited to the group where respondents had no individual risk of being adversely affected by the disease.

There thus seems to be some support for the initial hypotheses as well: when other-regard is high, and self-interested reasons for getting vaccinated are not present, motivation crowding could affect the individual vaccination decision.

Implications

What is to be learned from the studies in this compilation? When looking at the implications for the understanding of the collective action dilemma of vaccination, and by extension for vaccination policy, three main points should be highlighted.

First, force can solve the collective action dilemma of vaccination. This is a possible interpretation of the fact that democracies are at a disadvantage when measuring uptake rates. But if we think that coercive policies may not be the best option, what can we do?

One possible answer is the second point: we can rely to some extent on the social motivations of citizens – the fact that we *do* care about each other enough to at least consider the impact our vaccination behavior has on others. These motivations, unfortunately, are not the be-all and end-all solution, since the necessary prosocial motivation – care for a wider group of people than one’s own family or friends – appears to diminish when care for the latter is strengthened. Crucially though – in the case of influenza, for example – the age group disproportionately responsible for the spread of influenza (relatively young people with a large social contact network, who have not yet settled down and had a family) are likely the most responsive to arguments about the welfare of society.

Third, for those segments of the population that are unlikely to be very responsive to the necessary type of (wide) other-regard, economic incentives may provide the means to raise vaccination uptake. Motivation crowding in the vaccination decision, if it affects anyone, appears to be limited to those highly motivated by other-regard.

In summary, if we allow ourselves to derive general policy conclusions from this limited set of studies, I propose an institutional setup along the following lines:

1. General information campaigns should underscore the role of herd immunity and the importance for the wider society that individuals get vaccinated.
2. Monetary incentive schemes, if used, should be targeted at those who are least likely to be affected by the message above. One way of accomplishing this in practice is to direct incen-

tives to families with children, as this demographic group is easily distinguishable.

3. When directing foreign aid to public health programs, or when considering the comparative aspects of vaccination policy broadly, it may prove especially beneficial to pay extra attention to newly democratized countries in the middle-income spectrum – this subset of countries may be in particular need for points 1 and 2.

Needless to say, these lessons may also vary between different pathogens. In certain cases, it is not inconceivable that parents will be the *most* susceptible to pure information effects (such as with diseases that disproportionately affect children). In other cases, economic incentives will be useful across the board (such as with diseases that are transmissible by vectors like water, parasites or mosquitoes, rather than between people, since in these cases there is no other-regarding dimension to the decision).

It is also possible to fit the results into the puzzle of the existing political science literature on vaccination. To begin with, the route of stimulating other-regard provides a possible alternative to correcting misperceptions, when such are present. As mentioned, attempting to correct erroneous negative beliefs about vaccines often produce even stronger commitment to these beliefs (Nyhan et al, 2014). Rather than discussing the individual benefits and risks (and emphasizing the safety of vaccines), this is a way of reframing the individual decision problem to incorporate a different set of values. In effect, this *may* help circumvent the problem of commitment bias.

Further, the finding by Rönnerstrand (2013; 2014; 2015) that trust and social capital is positively related to vaccination intent is corroborated by auxiliary results in both essay II and essay III. When considering the differing effects of narrow and wide other-regard, Rönnerstrand's additional result (2015) that high-trusting individuals are more likely to unconditionally vaccinate altruistically also gives rise to additional questions on whether this applies to altruism driven by both types of other-regard or whether this effect applies to a more limited domain of prosocial attitudes. A plausible hypothesis to explore is that this interaction is mainly between trust and wide other-regard, where the impact of more

family-oriented other-regarding motivations are less likely to be affected by trust.

In order to move beyond the studies conducted in this dissertation, I also propose to continue with proper field experiments utilizing the treatments outlined in essays II and III – that is, try different other-regarding appeals, and different incentive schemes, and measure real-world vaccination behavior. While significantly more costly, this would test the external validity of the results obtained in these hypothetical survey experiments and provide ample testing ground for real vaccination policy.

There is also a whole host of other possible venues for investigating solutions to the collective action dilemma of vaccination. This introduction has mentioned a few, such as the establishment of social norms, but there is also a plethora of, for example, cognitive biases that have been left largely underexplored with regards to vaccination behavior. One such bias is omission bias, or the tendency to value negative outcomes as worse when they stem from an active decision, rather than from inaction. Some work has been done on this (see for example Ritov & Baron, 1990) and omission bias appears to indeed have negative effects on vaccination propensity, but the implications for policy remain unclear. It is, for example, conceivable that what is perceived as an active decision (vaccinating or abstaining) is a function of social norms. In a context where there are strong norms in favor of vaccinating, the logic of the decision may be transformed so that *abstaining* is instead regarded as the active decision. In such a situation, the effect of omission bias may flip and reinforce, rather than weaken, positive vaccination behavior.

It could also be worth exploring how vaccines are affected by hyperbolic discounting – that is, time-inconsistent preferences stemming from an over-valuation of either benefits or risks the closer they are in time. The possibility of finding how such biases affect the individual vaccination decision, and designing vaccination programs to avoid their negative impacts, is a potentially important future research area.

Another possible venue would be to explore how the vaccination decision is affected by disgust sensitivity. Previous literature suggests that on the one hand, high disgust sensitivity predicts lower generalized trust (Aarøe et al, 2016), and generalized

trust positively predicts vaccination propensity – especially altruistic vaccination intent (Rönnerstrand, 2013; 2014; 2015). The effect of disgust sensitivity on the individual motivations underlying the vaccination decision could therefore be quite paradoxical: it would likely affect the self-interested motivation positively, but the prosocial motivation negatively.

The wider theoretical lessons, when we leave vaccinations aside, can be separated into three main points. The first regards how we ought to go about analyzing differences in policy outcomes between political regime types. Paper I demonstrates that the specific characteristics of different public goods matter qualitatively for how we can expect democracies versus autocracies to handle provision and policy. In fact, where conventional models predict that aggregate public goods supply be higher in democracies, we should expect – and do indeed observe – the *opposite* when taking the particular characteristics of vaccines into account. There is no reason why this reversal could not affect other specific goods with similar characteristics.

One public good that shares at least one of the peculiar characteristics of vaccines – namely separation between solving the financing and getting the good – is national defense. The state can take in taxes to pay for a standing army, but will still somehow need people to staff that army. This vacuum is easily filled with different types of coercive policies (like conscription). This may provide yet another mechanism by which autocracies end up having larger militaries than democracies (Mulligan et al, 2004), despite defense being a public good.

Second, the effects of economic incentives on cooperation in public goods dilemmas is probably more complicated than either conventional microeconomic theory *or* motivation crowding theory would have it. When addressing the possibility of motivation crowding, it seems necessary to take into account the full range of human motivators: selfish versus other-regarding intrinsic motivations, as well as extrinsic ones. The central lesson is that when a public good also has a separate individual utility component, (that is, it is an *impure* public good), the individual utility has likely already crowded out other-regarding motivation at the outset. Further motivation crowding triggered by the introduction of economic incentives is therefore unlikely to happen. Motivation

crowding caused by money can be expected to afflict *pure* public goods exclusively.

Third, regarding the wider implications of the results on prosocial behavior, it appears that there are important differences in the *types* of prosocial motivations that people respond to over the life cycle. Specifically, pair-bonding and child rearing appears to replace wide other-regard with narrow – a different form of crowding out occurs. This could generalize to a more fundamental and evolutionarily grounded form of motivation crowding: capacity to care for the wider group triggers reciprocity and signals fitness, but once the opportunity to invest those cognitive resources directly in the survival of one's offspring, the other-regarding landscape shifts. The empathic circle shrinks.

This has potential implications for research on political behavior, where strong parochial tendencies tend to make themselves known. It could also provide an alternative version of the age-old cliché that if one is not a liberal at 20, one has no heart, and if one is not a conservative at 30, one has no brain. My theoretical model suggests that the narrow and wide forms of other-regard are driven by emotional vs. cognitive forms of empathy, respectively, and that it may therefore be vice versa: the young liberal may be the cerebral one, and the older conservative, having settled and reproduced, is driven by much more ancient sentiments.

The beginning of this introduction stated that the analysis of collective action dilemmas can be considered the core of political science. This dissertation has addressed one such example, namely vaccination and vaccination policy. It has also attempted to explore a few possible solutions to the dilemma. It is my hope that apart from the modest contributions I have made, the theoretical contributions contained in this dissertation also have the potential to ameliorate other important dilemmas that we face as a species.

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