Forum for Development Studies

ISSN: 0803-9410 (Print) 1891-1765 (Online) Journal homepage: https://www.tandfonline.com/loi/sfds20

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To cite this article: Alexander Cappelen , Ottar Mæstad & Bertil Tungodden (2010) Demand for Childhood Vaccination – Insights from Behavioral Economics, Forum for Development Studies, 37:3, 349-364, DOI: 10.1080/08039410.2010.507778

To link to this article: https://doi.org/10.1080/08039410.2010.507778

Forum for Development Studies
Vol. 37, No. 3, November 2010, 349–364

Routledge
Taylor & Francis Group

Demand for Childhood Vaccination – Insights from Behavioral Economics

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Childhood vaccination is a powerful tool for reducing morbidity and premature deaths, and vaccines are usually provided for free. Despite this, several low- and middle-income countries are lagging far behind in terms of their vaccination coverage. This article uses insights from behavioural economics to shed light on the mechanisms at work when people make decisions about childhood vaccination, thus explaining why demand for vaccination may be low. Some of the factors highlighted are the immediacy effect, loss aversion, overestimating and overweighting of small probabilities, and social preferences and trust. We conclude that these factors have important implications for how incentive mechanisms for vaccination should be designed, how vaccination decisions ought to be framed, who information campaigns should be conducted, as well as for the need to build trust in vaccine providers and health systems more generally.

Keywords: vaccination; behavioural economics

Introduction

Childhood vaccination is an immensely powerful tool for reducing morbidity and premature deaths. Following a global vaccination campaign, smallpox was declared eradicated in 1979. In 1974, the WHO initiated the Expanded Programme on Vaccination (EPI), a global effort to vaccinate all children against polio, measles, diphtheria, pertussis, tetanus and tuberculosis. Polio, which in 1988 was endemic in 125 countries and paralyzed an estimated 350,000 children every year, is currently endemic only in four countries and paralyses 2000 children annually (Jamison et al., 2006). By 2001, vaccination was averting 61 per cent of measles deaths, 69 per cent of tetanus deaths, 78 per cent of pertussis deaths, 94 per cent of diphtheria deaths and 98 per cent of polio deaths that would have occurred in the absence of vaccination (Brenzel et al., 2006). The original EPI vaccines together with vaccines against hepatitis B and Hib (a bacteria causing meningitis and pneumonia) currently prevent more than 2.5 million premature deaths annually (World Health Organization et al., 2009).

Despite these achievements, several countries – most of them low-income countries – are lagging behind in terms of their vaccination coverage (Figure 1). The main policy response to this challenge has been to improve the supply of vaccines,

ISSN 0803-9410 print/ISSN 1891-1765 online

DOI: 10.1080/08039410.2010.507778
http://www.informaworld.com

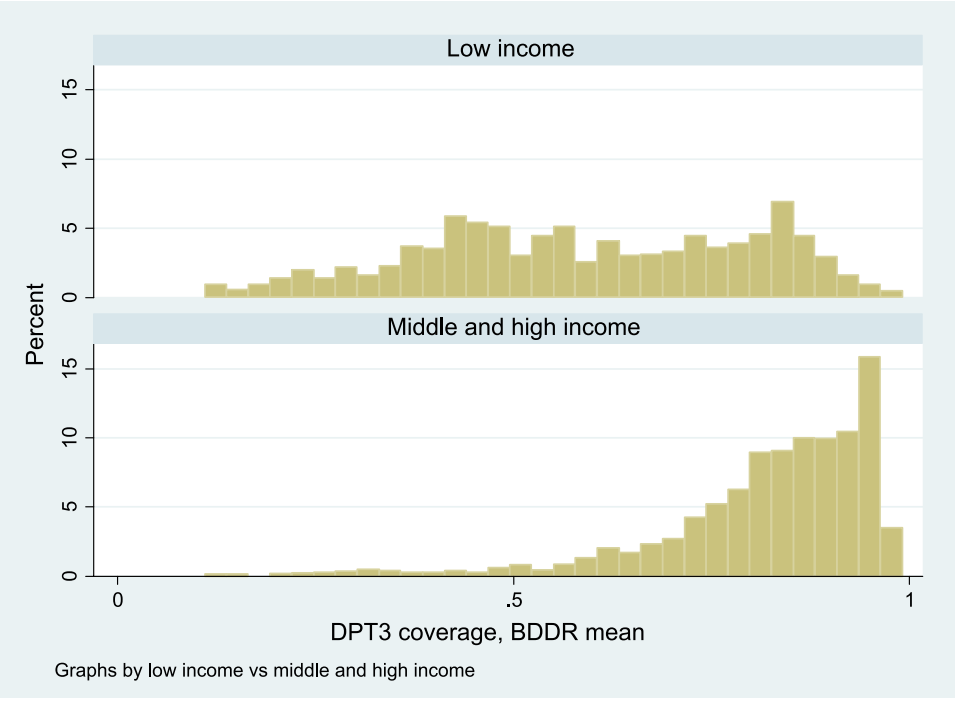

Figure 1. DPT3 coverage in 2006 by country income categories. Vaccination coverage data from Lim et al. (2009). Income categories from World Bank, 2006 classification (http://data.worldbank.org/about/country-classifications).

exemplified through the efforts of GAVI, the Global Alliance for Vaccines and Immunization. However, a number of observations point in the direction that demand side factors also need to be carefully considered and addressed in order to achieve high and stable vaccination coverage. One of them is the huge variation in vaccination coverage observed, especially among low- and middle-incomes countries. For instance, a very poor country like Malawi, with its severe shortage of health workers and infrastructure, has been able to achieve remarkably high vaccination coverage (>80 per cent DPT3 coverage), while in India, where income per capita is three times the level in Malawi, coverage is much lower (55 per cent DPT3 coverage; Malawi DHS, 2004; India NHFS, 2005–2006; WDI, 2009). It seems unlikely that such differences can all be explained by different levels of access to vaccines.

The decision to vaccinate is typically taken by the caretaker on behalf of the child. The 'conventional' assumption about vaccination demand is that caretakers make the choice that they believe is in the best interest of the child, considering also their own costs (efforts and expenditures) in taking the child to the vaccination station. According to this reasoning, once vaccines are made readily and freely available and caretakers are properly informed about the true benefits of vaccination, lack of demand will not be a constraint. However, the theory of decision-making underlying these conjectures seems unable to explain several characteristics of the demand for

vaccines, for instance that demand is sometimes absent even if vaccines are readily available and information about their benefits have been provided; that demand seems to respond strongly to small material side-benefits offered along with vaccination; that demand is very sensitive to (almost) irrelevant information; and that demand sometimes depends on the birth-order and the gender of the child.

We argue in this paper that the 'conventional' way of understanding demand for vaccination is too simplistic. The decision to vaccinate is a highly complex one. It involves large uncertainties both about benefits and side-effects; some of the probabilities involved are very low and therefore hard to comprehend; the main benefits are reaped at some uncertain future point in time; and agency issues arise both because the decision is not taken by the child itself and because some of the benefits of vaccination accrue to other people in the community through reduced transmission of disease.

Standard economic models of decision-making are known to have serious weaknesses in describing decisions that share one or several of these characteristics of the vaccination decision. A branch of economics called *behavioral economics* has taken these weaknesses seriously and incorporated insights from psychology and other disciplines, as well as from experiments done in the laboratory and in the field, into economic analysis.

This paper discusses how insights from behavioral economics can shed further light on the mechanisms at work when people make decisions about childhood vaccination. Some of the factors highlighted are the immediacy effect, loss aversion, overestimating and overweighting of small probabilities, and social preferences and trust. We conclude that each of these factors in their own way illuminates important mechanisms involved in decisions about childhood vaccination. Further research is needed in order to understand these mechanisms more precisely and also to derive more concrete policy implication.

Childhood vaccination and standard economic theory

Three important attributes of the decision about childhood vaccination are that it involves: (1) *uncertainty*; (2) *intertemporal considerations* – benefits and costs occur at different points in time; and (3) *externalities* – benefits and costs of vaccination accrue to others than the decision-maker. This section discusses the standard way of dealing with them within economics and some challenges to this approach.

Uncertainty

Vaccination clearly offers major benefits at the community level, but the benefits at the individual level are highly uncertain. First, there are large risks involved; at one extreme vaccination may prevent fatal illnesses; at the other extreme, there is some probability – though extremely low – of severe side effects, such as critical allergic reactions or even death. Second, the probabilities that any of these events will occur

are usually highly ambiguous; there is ambiguity about the probability of being exposed to disease that is preventable by the vaccine; about the probability that the vaccine actually will prevent disease in case of exposure; and about the probability of any side-effects. To understand how people make decisions under such extreme forms of uncertainty is a key to understanding vaccination demand.

There are clearly uncertainties involved also in the decision not to vaccinate; there is risk related to whether one will fall sick or not, and there is ambiguity about the probability of these events. The choice between vaccinating and not vaccinating can therefore be seen as a choice between two gambles.

Expected utility theory, dating back to the writings of Daniell Bernoulli in the early eighteenth century and developed further by von Neuman and Morgenstern (1944), is the standard framework in economics for analyzing decisions under uncertainty. The theory postulates that the goodness (or desirability) of a gamble can be judged by the sum of the probability-adjusted utility of all possible outcomes of the gamble. If we denote the utility in case the person falls sick as $u(sick)$ and the utility in case the person stays healthy as $u(healthy)$ and let p represent the probability of falling sick in case the person is not vaccinated, the goodness of the gamble '*not to vaccinate*' is postulated to be the expected utility $pu(sick) + (1-p)u(healthy)$.

Expected utility theory makes strong assumptions about people's ability to assess the utility of possible future states of the world, form probabilities about their occurrence, and process large amounts of information. Of particular interest in the context of vaccination are the assumptions that people are able to form reasonable probabilities over future states of the world, and that these probabilities are the only information used when people weigh different outcomes. In the case of vaccination, this requires that people are able to correctly infer probabilities about benefits and side-effects from small samples in their own surroundings, and also avoid being drawn towards assigning particular importance to critical outcomes.

Intertemporal considerations

Vaccination protects against future illness. The costs of vaccination occur immediately, while side-effects can arise both immediately and in the future. Since benefits and costs occur at different points in time, the decision-maker needs to make intertemporal considerations. Standard economic theory assumes that people discount future benefits and costs, and that they do the same level of discounting when comparing today and next month as comparing next month and the month thereafter. Typically, this is captured by assuming that people discount future gains and benefits at a constant rate. In other words, if the value of a benefit is x if received today and $x\delta$ if received in a month, the value will be $x\delta^2$ if received in two months (the discount factor δ is assumed to be smaller than 1). However, experimental evidence questions this framework, showing that people tend to pay particular importance to immediate benefits and costs. Hence, they discount much more heavily benefits that come with a month delay when comparing with the

present than when comparing two future events. In the case of vaccination, this may suggest that long-term gains are overturned by short-term considerations.

Externalities

The health benefits of childhood vaccination accrue not only to the decision-maker, which typically is the parent of the child. The most important benefits are experienced by the child, but there are also health benefits for members of the community who will be less exposed to communicable disease when more children are immunized. How does the decision-maker take these other-regarding considerations into account? Standard economic theory does not impose any structure on how decision-makers balance their self-interest against the interests of others, even though many applications in economics assume that decision-makers are guided by pure self-interest. Recent experimental research shows that this assumption is questionable, and that people typically tend to make a trade-off between self-interested and other-regarding considerations. This has important implications for how parents think of the vaccination decision in relation to the surrounding community. It suggests that parents take into account positive external effects on the broader community. Even though such experiments have not been done on interactions between parents and children, they do also make it pertinent to discuss the assumption – commonly made in the public health field – that caretakers behave like perfect altruists vis-à-vis their children.

Vaccination 'puzzles'

Some features of vaccination demand seem difficult to explain by a model of decision-making that entails maximization of expected utility. This section presents a few observations which may appear puzzling in light of this approach. We do not claim that these phenomena prove the approach wrong. Our ambition is merely to show that some phenomena become much easier to understand once we take seriously insights from behavioral economics, including evidence on how people take into account other-regarding considerations in their decisions.

Observation 1: Demand for vaccination is often absent even if vaccines are provided for free

How come only 44 per cent of the children in India are fully vaccinated when vaccines are provided for free in public health clinics? Is the explanation that, even at this low level of coverage, the *additional* personal benefits of vaccination is small? Evidence provided by GAVI suggests that this is not the case. Increased vaccination coverage over the past 10 years has resulted in 250 million more children being vaccinated and 5.4 million premature deaths averted (mostly from reduced incidents of hepatitis B and measles) (GAVI, 2010). This increase has mainly been taking place in countries with higher coverage rates than India, suggesting that the benefits in India should be

at least of the same magnitude. A rough estimate of the marginal benefits at the individual level would therefore be that vaccination reduces the probability of premature death by two per cent. Hence, the personal benefits of vaccination – even in a population where almost half the population is already vaccinated – seem unquestionable.

Two other explanations of the situation in India might be that, even though vaccines are free, they are inaccessible or difficult to obtain, or that people are just poorly informed about the benefits of vaccination. Recent evidence from a randomized controlled trial on vaccine demand in the district of Udaipur in Rajasthan (Banerjee et al., 2010) questions both these explanations.

Udaipur is a district with extremely low vaccination coverage. In the 134 villages (hamlets) included in the study, only six per cent of the children were fully vaccinated before the intervention. The researchers hypothesized that one reason for the low coverage was inadequate supply of vaccines, perhaps combined with poor information. They therefore set up a well-organized system of free immunization camps in 60 villages, with monthly immunization days. In addition, in each village, a social worker identified eligible children, informed mothers about the immunization camps, and educated them about the benefits of immunization.

After an intervention period of one and a half years, the results show that adequate supply of vaccines and education only increased the share of fully immunized children to 17 per cent. This example indicates that, in order to explain this puzzle, we have to broaden our view of what determines parents' demand for vaccination.

Observation 2: Small side-benefits seem to have a potentially huge impact on vaccine demand

In the same study, 30 of the villages with vaccination camps were randomly selected to receive a small material benefit along with the vaccination shots. Each vaccination shot was rewarded with one kilogram of lentils to the caretakers, representing a value of less than US$1. In addition, a fully vaccinated child was rewarded with a set of thalis (metal plates used for meals). These incentives resulted in a substantial increase in coverage; 38 per cent of the children in this intervention area were fully immunized, more than doubling the effect of the initial intervention.

In light of the huge personal benefits of vaccination, including the significant reduction in the probability of premature death, these material benefits seem highly insignificant. How come they still have such dramatic effects on vaccination coverage?

Observation 3: Almost irrelevant information sometimes strongly affects vaccine demand

Before and during the swine flu pandemic in 2009, health authorities constantly warned that there was a certain risk of death – even for people that did not belong to the groups with elevated risk for complications. The Norwegian population was for a

long time quite reluctant to vaccinate, and a poll during week 42 showed that only 21 per cent of the population wanted the vaccine. One week later, the figure had risen to 51 per cent and then remained at this level over the next couple of months (Synovate/Directorate of Health, 2010). The likely cause of the sudden increase in demand was the death of a 50-year-old man who did not belong to the main risk groups.

Did this single fatal incident add crucial information to the vaccination decision? Assuming that people trusted the information provided by the health authorities at the outset, this episode should only cause a negligible change in the updated beliefs of people. The deadly outcome only confirmed what the health authorities had already stated, that there was a certain risk of death also for people not belonging to the risk groups. Hence, the sudden change in vaccination demand seems to indicate that people process such information differently from what is typically assumed in economics.

Observation 4: Vaccine demand sometimes depends on birth-order and gender

There seems to be a tendency in several countries for vaccination coverage to be negatively associated with birth-order. In India, the share of children fully immunized ranges from 54.6 per cent for the first child to 18.5 per cent for children numbering six or more (India NHFS, 2005–2006). A similar, albeit less pronounced, pattern is reported in Malawi; full coverage declines from 72.2 per cent to 64.1, 62.8 and 58.3 per cent for birth orders 1, 2–3, 4–5 and 6+. Some of the differences might be explained by socio-economic factors, for example a low level of education, that both induce households to have many children and reduce the likelihood that they will vaccinate their children. Choi and Lee (2006), however, show on Indian data that the pattern is robust to the inclusion of a number of observable control variables, including wealth, caste and mother's education.

Vaccination coverage sometimes also differs across genders. Coverage in India is higher for boys than for girls; the difference is almost 5 per cent for BCG and measles vaccination, and somewhat less for the others. There also seems to be an interaction between gender and birth-order; if the two first children are girls, vaccination coverage for the third child is 36 per cent if it is a girl and 45 per cent if it is a boy (Corsi et al., 2009). These patterns are hard to reconcile with the assumption of parents being perfectly altruistic towards their children when making vaccination decisions.

Insights from behavioral economics

Behavioral economics relaxes the strong assumptions made by standard economic theory and aims to better capture the complexities of human reasoning and motivation. On some issues, behavioral economics have mainly drawn on insights and empirical results from biology, psychology and sociology and showed how they may improve our understanding of individual behavior in economic situations and also may guide policy design. In other cases, behavioral economics have provided new insights by the use of formal analysis and economic experiments.

In this section we survey some of these insights and discuss their relevance for the understanding of childhood vaccination, including the 'puzzles' discussed in the previous section. We assume that there is no conflict of interest between the parent and the child in the first three subsections, whereas we discuss this issue and the potential role of other-regarding preferences in the final subsection.

Immediacy effects

An important topic in behavioral economics is how agents trade off costs and benefits that occur at different points in time. Standard economic theory typically assumes that people discount future gains and benefits at a *constant* rate, but recent research, inspired by work of Elster (1979), among others, has convincingly shown that people assign particular importance to the present (Prelec and Loewenstein, 1991), and has also identified the neural underpinnings of such a preference (McClure at al., 2004).

An implication of the immediacy effect is that people will make relatively short-sighted decisions when some costs or benefits are immediate, but will make more far-sighted decisions if all costs and benefits are in the future. As a result, people will have a tendency to make choices that are inconsistent over time. In other words, they make choices today that are in disagreement with their future self (O'Donoghue and Rabin, 1999; Banerjee and Mullainathan, 2010).

To illustrate, consider a mother who is deciding whether to sign up her child for the monthly immunization day. When weighing the gains and losses, all of which are in the future, she decides to schedule her child for vaccination. However, when the immunization day arrives, the costs of attending immunization become immediate and as a result she may end up dropping visiting the health facility. This illustrates that the lack of demand for vaccination (Observation 1), as in the case of Udaipur, partly may reflect what is sometimes referred to as procrastination. Parents plan to vaccinate their child, but consistently defer this to a later time in the face of immediate costs.

The immediacy effect may also shed light on Observation 2, namely that small economic incentives might be effective in increasing vaccination coverage. This finding is hard to reconcile with standard economic theory, because it would imply an implausibly high (constant) discount rate. However, as soon as we realize that the discount rate people use in the present differs from the discount rate used when only future events are evaluated, the picture becomes easier to understand. The huge importance assigned to 1 kg of lentils relative to an increase in the probability of avoiding an illness does not necessarily reflect that the person in general is short-sighted, but derives from the lentils representing immediate gratification.

Framing and loss aversion

The way in which a decision problem is framed should not affect people's decisions, according to standard economic theory. However, following Tversky and Kahneman

(1981), hundreds of experiments have demonstrated that framing does affect people's decisions by shaping the reference point for evaluating alternative decisions. In particular, the framing may determine whether we think of some dimension of the choice problem as a loss or a gain, and this turns out to be crucial because people put more weight on avoiding losses than acquiring gains.

The 'Asian disease' problem, introduced by Tversky and Kahneman (1981), is the classical example of framing effects. They asked participants to imagine that the US was preparing for the outbreak of an unusual Asian disease, which was expected to kill 600 people. They were then presented with two alternative programs to combat the disease and were asked to choose one. One group of participants was given the choice between (A) saving 200 lives for sure, or (B) a one in three chance of saving all 600 and a two in three chance of saving no one. Another group was given the choice between (C) 400 people dying for sure, or (D) a two in three chance of 600 dying and a one in three chance of no one dying. Despite the fact that A and C, and B and D, are equivalent in terms of lives lost or at risk, most people choose A over B, but D over C. What can explain this behavior?

In the Asian disease problem the first group of participants was presented with a positive frame that presented the two alternatives as *gains* compared with the references point that all 600 die, while the second group was presented with a negative frame that measures the two alternatives as *losses* compared with the references point that everyone survives. The experiment thus illustrates that the reference point against which gains and losses are compared might affect people's decisions.

Why is the reference point important? One explanation is that people are loss averse, i.e. that they consider a loss to reduce their utility more than a similar gain would be able to increase utility. Thus, a person with loss aversion would consider the utility gain from increasing his income from US$900 to US$1000 as lower than the utility loss from reducing his income from US$1000 to US$900.

In the context of vaccination, what parents perceive as the reference point situation may be important for their decision to vaccinate. If the reference point is a situation without vaccination, the reduced probability of an illness due to vaccination will be viewed as a gain, while the possibility of side effects will be viewed as a loss. In order to choose to vaccinate, parents with loss aversion would then require the expected gain to be substantially higher than the expected cost. If, on the other hand, the reference point is to vaccinate, the reverse would be the case and we would expect that parents were *more* likely to vaccinate their children. One explanation for the low vaccination coverage in India could therefore be that vaccination requires an active choice from the parents, and that the reference point therefore is a situation without vaccination.

Overestimating and overweighing of small probabilities

According to expected utility theory, the utility of a risky distribution of outcomes is a probability-weighted average of the outcome utilities. Experimental evidence,

however, suggests that this theory works particularly badly when there is a small probability for a very good or a very bad outcome. This is partly because people tend to overestimate low probabilities and partly because they tend to overweigh low probability outcomes when they make decisions.

There is considerable evidence showing that people's subjective probabilities of rare events are consistently overestimated. Two striking examples are the tendency of people to overestimate the probabilities of the rarest causes of death (Lichtenstein et al., 1978), and the tendency of teens to greatly overestimate their risk of dying in the near future; teens in the US thought the probability was 18.6 per cent while the actual probability was 0.04 per cent (Fischhoff et al., 2000).

Overestimation of the probability of rare events can be explained by availability heuristics; rare events stand out as more special and are therefore more easily retrieved from memory (Tversky and Kahneman, 1974). Media coverage can help fuel this bias with widespread and extensive coverage of unusual events. As illustrated by Observation 3, this may sometimes increase the demand for vaccination, but it may also work in the opposite direction. For example, negative side-effects of vaccination, because they are rare, may get more attention than positive effects of vaccination, both in the news and in the community more generally, and this may contribute to overestimation of the likelihood of such events.

Another potential explanation of overestimation of small probabilities is *the law of small numbers*, which refers to the observation that people often believe that small samples exhibit large-sample statistical properties (Rabin, 2002). One example of such over-inference is seen in the stock market. Investors often believe that stocks that have performed well the last few years will continue to do so, even if there is little correlation between past and future performance. As a result, stocks with high past returns get overpriced and ultimately underperform (De Bondt and Thaler, 1985). In the context of vaccination, where bad news typically travel faster than good news, people who over-infer from a few observations might believe that recent occurrences of negative side effects from vaccination reflect an increase in the overall probability of side effects. As illustrated by Observation 3, however, this may also work in the opposite direction, when there is a small sample of observations highlighting the gains from vaccination.

People not only tend to overestimate low probabilities; they also tend to give too much weight to outcomes with low probabilities. The so-called prospect theory, developed by Kahneman and Tversky (1979), incorporates this aspect of decision-making by introducing a probability weighting function capturing that people place more weight on low probabilities than on medium or high probabilities. An illustration of overweighting is provided by Kahnema and Tversky (1992), who show that people value an increase in the probability of winning US$100 from zero to five per cent almost as much as they value the probability of an increase from five to 50 per cent. One explanation for this behavior is that people show *diminishing sensitivity* to outcomes further away from reference points. When considering risky prospects, there are two obvious

reference points, impossibility and certainty, and the distortion of probability captured by the probability weighting function reflects people's diminishing sensitivity to outcomes that are far away from both these reference points. In the context of vaccination, this may explain why people focus more on side-effects than on the increased probability for staying healthy. Choosing not to vaccinate a child ensures that there are no side-effects, and thus people are highly sensitive to the fact that vaccination moves one slightly away from this reference point. In contrast, the reduced likelihood of premature death may be seen as a move that takes place further away from both reference points, and thus people may be less sensitive to such changes.

Social preferences and trust

Laboratory experiments have documented that people are willing to sacrifice personal gains if doing so benefits others and in order to avoid large deviations from what they view as a fair distribution of resources (Camerer, 2003, Cappelen et al., 2007). The results from the so-called 'dictator game' are particularly convincing. In the dictator game participants are matched in pairs, and one of the two participants, the dictator, is given the task of distributing a sum of money given to both participants. Since the two participants in each pair have an equal entitlement to the money, a participant who is only motivated by moral considerations will split the money equally. In contrast, a participant who only cares about his own monetary reward will take everything for himself. The share given to the other participant in the dictator game can therefore be interpreted as a measure of how much weight a person attaches to moral considerations, or inversely, her level of selfishness.

The results from the dictator game, and other experiments of similar kind, show that people are clearly motivated by other-regarding considerations. In the context of vaccination, this implies that people, at least to some extent, take into account the positive external effects on the broader community. This may contribute to explaining the huge variation in vaccination coverage observed across low incomes countries, where we would expect that stronger social cohesion pulls in the direction of increased coverage. In fact, even small differences in social cohesion may lead to large differences in vaccination patterns, if parents mainly consider the decision of vaccination as a contribution to a public good. As shown in experiments on what is typically referred to as the public good game (Camerer, 2003), people tend to consider it fair to be conditional contributors; they contribute to a public good if others also do so. This may imply that, if a community is below a critical level of contributors, people find it fair not to contribute themselves. Hence, the community may go into a downward spiral that leads to a very low level of contribution to the public good. In contrast, in a society which is above the critical level, we may see the opposite dynamics, where people, inspired by others, find it fair that they themselves also contribute to the public good, that is, in the context of vaccination, to a community less exposed to communicable disease.

Social preferences, and beliefs about others' social preferences, are also essential in understanding people's willingness to trust others. Trust is important in many types of exchanges because the absence of trust in social interactions may severely hamper mutually beneficial exchanges (Fehr, 2009). Economists have emphasised that trust facilitates exchange by reducing the costs of transacting. If there is trust, more costly ways of creating confidence (e.g. legal contracts, threats about punishments) may be superfluous. Indeed, some types of beneficial exchange would never take place without trust, because the required level of assurance would be impossible to obtain through any type of contract.

The so-called 'trust game', first introduced by Berg et al. (1995), has been the standard tool to measure trust in behavioral economics. In the trust game participants are matched in pairs and given an endowment of money. One participant in each pair is then given the opportunity to send some or all of this endowment to the other participant. The amount sent is typically multiplied by a factor of three, implying that the received amount is three times the sent amount. The receiver finally has to decide what share of the received amount she wants to return to the sender. Clearly, belief in the other participant's willingness to return a fair share will influence the sender's decision of how much to send, and the sent amount is often viewed as a measure of trust. This experiment has been conducted numerous times with different groups and in different countries, and there are considerable differences in the average share of the endowment sent across different groups, suggesting that the level of trust is highly variable across settings and cultures (Fehr, 2009).

Even though the trust game does not perfectly mimic the decision of vaccination, it highlights the role that trust may play in this type of social interaction. Most parents are unable to control the quality of the work done by those involved in providing the vaccine, and in some instances it might be in the narrow self-interest of the health workers or other agents involved in the supply of vaccines to provide low-quality services, for example by re-using needles, ignoring problems with the cold chain, etc. For the parents, the decision to vaccinate their children is thus an act of trust. A key factor affecting the decision is therefore parents' trust in the benevolence and competence of agents at various levels in the supply chain, from the developers and producers of vaccines, via national policy-makers, distribution managers, information agents, down to the frontline service providers. A striking illustration of the consequences of lack of trust is provided by the ban on polio vaccination introduced by Muslim leaders in northern Nigeria a few years ago due to rumors that the vaccine contained HIV or was part of a campaign to sterilize Muslim girls. Clearly, if parents lack trust in the benevolence of the providers of vaccination, the demand for childhood vaccination will be low. Lack of trust might therefore contribute to explain Observation 1.

Even if economic experiments have shown that people are motivated by social preferences, they have also documented that most people, in the trade-off between

self-interest and social preferences, tend to favor themselves. The importance of the self-interested motive may contribute to explain the negative association between vaccination demand and birth-order, as well as the fact that girls are vaccinated less frequently than boys (Observation 4). It is obviously important for the financial security of parents in many low- and middle-income countries that some of their children grow up and are able to take care of them when they get older. This gives parents a strong self-interested motive to vaccinate their first children. However, as a family has more children, this motive is weakened, which may explain why parents are less likely to vaccinate their subsequent children. The higher vaccination coverage of boys could, in a similar manner, be explained by boys being more important economically for the parents.

Some policy implications

The main policy response to the challenge of low childhood vaccination coverage has been to improve the supply of vaccines. Our analysis, however, suggests that it is not sufficient to focus on the supply side. As we have illustrated with an example from India, even in situations where vaccines are provided for free, many parents do not demand vaccination for their children. We have shown that insights from behavioral economics can shed light on this puzzle and thus also contribute to a better understanding of which policies may contribute to increased vaccination coverage. We here highlight four policy implications that arguably follow from the previous section.

The first implication concerns the use of economic or material incentives directed at the parents who vaccinate their children. It is well known, as pointed out in Observation 2, that material side-benefits might strongly increase vaccination coverage. The immediacy effect suggests that the important feature of such incentives is not necessarily that they provide parents with material benefits, but that they provide an immediate gain that might help parents avoid the trap of procrastination. The timing of such incentives may therefore be at least as important as the level of the incentive. It is, in other words, important that incentives are provided at the scheduled time of vaccination and not at a later point in time.

The second policy implication concerns the framing of the vaccination choice. In light of people's tendency towards loss aversion, vaccination coverage would most likely increase if the government made vaccination the default choice for parents. In line with the proposals made by Thaler and Sunstein (2008) in other contexts, this could be done by requiring those parents to do not want their children to be vaccinated to make the active choice, and not the other way around. This could, for example, be achieved by making it mandatory for caretakers to take their children to vaccination at a certain age unless they fill out a form where they state the reason for not wanting to vaccinate their children. Even if such a process is a pure formality, it would create a focus on the loss in future health benefits for children from not vaccinating, which

would most likely work better than focusing on the gain in health benefits from vaccinating.

Our analysis also indicates that information campaigns may play an important role by providing individuals with reasonable estimates of the risks involved in the vaccination decision. Education campaigns should be broadened to not only include a careful discussion of possible outcomes, but also of how we should consider the likelihood of these outcomes. Since rare side effects of vaccination often get much attention, educational campaigns should highlight the negative effects of not vaccinating, both at for the individual and for the community. More generally, it seems important to make people aware of the tendency that we have to focus too much on very unlikely outcomes, for example with respect to potential side effects.

In our view, the most important policy implication, however, relates to the importance of building trust in the providers of vaccination. It is not sufficient that vaccines are available if people do not trust the system that is supplying them. From a policy perspective, this might imply that the government should work closely with trusted civil-based organizations (e.g. religious organizations) in the provision of vaccines. Alternatively, or in parallel, it might imply an increased focus on the overall quality of the health system, and on how health personnel communicate with the local community more generally. One way of building trust in preventive services could be to provide high quality curative services, since such quality is easier to observe for the patients (Das and Das, 2003). It is important to realize that this involves long-term processes that are far more complex than to increase in the supply of vaccines. Finally, our analysis suggests that vaccine campaigns need to address the local community as a unit, with the aim of fostering social norms of contributing to a community less exposed to communicable disease.

The policy implications we have sketched aim at steering people's choices in the direction of vaccinating their children, and one may ask whether this represents a violation of parents' freedoms. We agree with Thaler and Sunstein (2008), who argue that such soft paternalism is justifiable as long at it moves people's choices in a direction that indisputably improve their lives without significantly reducing their freedom to choose an alternative course. The justification for soft paternalism is particularly strong in the case of vaccination, where the main aim, after all, is to provide children with a healthy life free from severe diseases. Many parents do not seem to reflect deeply about whether or not to vaccinate their child, and their decision often seems to be based on rules of thumb and limited information. In such situations, design of the choice architecture, in particular what constitutes the default vaccination choice, is extremely important. Changing the choice architecture may save the lives of many children without reducing the parents' freedoms.

Acknowledgments

We are grateful to Stuart Blume, the SUM-MEDIC team and two anonymous referees for valuable comments and suggestions.

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