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Health interventions in low income countries: A (not so) low hanging fruit?[1]

Alessandro Tarozzi

1. Introduction

Health is now widely accepted in economics as a key form of human capital, not only because of its direct importance for individual's welfare, but also for its now well-documented association with other key economic indicators such as productivity and schooling (for reviews see Glewwe and Miguel 2007, Strauss and Thomas 1998, 2008). Unfortunately, and despite the remarkable secular progress in many health dimensions worldwide, there remain huge differences both between and within countries in numerous key health indicators, from life expectancy at birth to child mortality, from the prevalence of infectious disease and parasites to the pervasiveness of malnutrition (Deaton 2013).

Lack of resources, both at the household and at the government level, is surely a major determinant of these realities. In developed economies, massive investments have been necessary to create the infrastructure and public health systems that are enjoyed today. Vast amounts of money

are spent to provide not only screening for and treatment of disease, but also for the creation and maintenance of public health infrastructure that is essential to prevent disease. For instance, virtually everyone in developed countries has access to safe drinking water and sanitation, and virtually all children are immunized against diseases that once killed millions; many countries mandate fortification of staples such as rice, flour or salt, with vitamins and minerals that are essential for human health; diseases such as malaria, once endemic in many parts of Europe and the United States, have been completely eliminated in these areas, with the determinant role of enormous public health projects. And yet, many diseases that afflict the poor in developing countries are preventable, easily and often at low or no cost. Water can be made safe by boiling or with a few drops of chlorine, diarrhea can be treated with oral rehydration solutions that require little more than salt and sugar, malaria risk can be considerably reduced by using regularly bed nets treated with insecticide; intestinal worms can be eliminated with a few pills.

It is thus tempting to think that investment in certain health-protecting technologies can be an easy way to alleviate, if not resolve, many of the health disparities that we observe between rich and poor countries. However, while even the poor spend a non-trivial share of their budget for (often ineffective) treatment, much less is done for prevention, and the simple and inexpensive solutions listed above are often left unheeded.

In this *opuscle*, I review some of the key recent advances in the literature that has studied these important issues, documenting the extent of the problem, offering theories as to its determinants and, in a number of cases, proposing and evaluating possible solutions.[2] In the process, I will highlight some areas where I have directly contributed with my own research.

I first look at work that has analyzed the role of prices and income: the poor, being poor, may lack the necessary means to invest in health. Next, I look at the role of information: the low hanging fruit may not be picked because, in populations where literacy rates are low, many people may either not see the fruit, or may believe that it will not do any good. I will then review research that has borrowed insights from behavioral economics to argue that low investments may also be the result of 'biases' in decision-making that do not allow people to translate good intentions into good choices. Lastly, I will conclude and highlight other factors, such as supply-side deficiencies, which —while beyond the scope of this review— remain essential for understanding the key stylized facts that form the object of this area of research.

2. Cost

Perhaps the most obvious factor accounting for the low demand of health products in low income countries is the low ability to pay of many potential beneficiaries. Poverty often imposes stark choices in the allocation of scarce resources, and little is left after the poor have satisfied basic needs such as food, clothing and shelter. Good health is itself a basic need, and there is ample evidence that the poor spend considerable resources for the *treatment* of illnesses, but investment in *prevention* often lacks the urgency that instead characterizes many daily needs.

Indeed a well established stylized fact is that the elasticity of demand with respect to prices is often very high among the poor, even at very low prices (Holla and Kremer 2009). Such observation is a common thread among several randomized controlled trials (RCTs) conducted recently in a number of countries where the price was ran-

domly determined, thereby eliminating concerns about the endogeneity of prices. In Kenya, Kremer and Miguel (2007) found that a 20 percent co-pay for drugs to eliminate intestinal worms reduced uptake from 75 to 19 percent, while Cohen and Dupas (2010) found that a 10 percent co-pay for insecticide-treated bed nets (ITNs) was sufficient to reduce demand by 90 percent relative to free distribution. I and my coauthors also observed an elasticity of demand for ITNs of 2.5 in rural areas of Orissa, India (Tarozzi et al. 2014). Similarly, very elastic demand curves for water disinfectants, quite inexpensive but very effective against waterborne diseases, have been documented in urban Zambia (Ashraf, Berry and Shapiro 2010) and rural Kenya (Kremer et al 2009). More recently, Berry et al. (2015) have found similarly high elasticities of demand for water filters in Ghana, although they also estimate lower responsiveness at lower prices, a result in contrast with other studies.

Other researchers have studied the price elasticity of demand for health-related *information* that may be used, at least in principle, to significantly reduce health risks, finding somewhat mixed results. Barnwal et al. (2016) study demand for test kits to gauge the extent of (naturally occurring) arsenic contamination in well water in Bihar, India. They find that an increase in price from Rs 10 to Rs 50 (about 3 USD using the PPP exchange rates in World Bank 2008) reduced demand from 69 to 22 percent. Cohen et al. (2015) find limited responses to changes in the subsidy offered for rapid diagnostic tests (RDT) to detect malaria infection in Kenya, although the price range in their experiment was limited. Thornton (2008) carried out an RCT in Malawi of incentivized testing for HIV status, and found that even small monetary incentives (which could be interpreted as changes in negative prices) led to huge increases in the fraction of individuals tested.

2.1 Demand for insecticide-treated nets and sales on credit

Respondents in household surveys frequently state that liquidity constraints are a key reason underlying these findings. In Tarozzi et al. (2014) we thus study whether switching from cash payments to micro-consumer loans may lead to substantively higher demand for health-protecting technologies. Specifically, we studied demand for ITNs in rural and malarious areas of Orissa, India, in the context of a RCT conducted between 2007 and 2009 in 141 villages, in collaboration with BISWA (Bharat Integrated Social Welfare Agency), a micro-lender with a large presence in the state. Villages were randomly allocated to one of three groups. A control group that received no further interventions, a treatment group where lender clients received free ITNs, and a second treatment group where clients were offered contracts for the purchase of *unsubsidized* ITNs, using consumer loans with a one-year repayment period. The ITNs were of good quality and relatively expensive, with prices (depending on their size) corresponding approximately to 3–5 times the local daily agricultural wage.

Unlike the studies we summarized earlier, and despite the non-negligible prices of the ITNs, we observed relatively high demand. Fifty-two percent of sample households purchased at least one net, and many purchased more than one (2.3 on average among the buyers). A significant fraction of the households already owned some bed nets before our intervention (although mostly of much lower quality) but sales on credit more than doubled the average number of nets owned. In addition, we find that indicators of malaria risk were important predictors of purchase. First, households who had used bed nets prior to our sales were 21 percentage points more likely to purchase more from us. This is consistent with bed nets being an experience good, with past usage perhaps associ-

ated with higher perceived benefits (Dupas 2014). Second, both past high monetary costs of malaria episodes and malaria-related deaths were associated to higher demand. Lastly, both self-reported malaria episodes and current infection detected by blood tests conducted by our survey teams were very strong predictors of purchase: a 50 percentage point increase in the fraction of members who tested positive to malaria was associated with a 10 percentage point increase in the probability of purchasing ITNs, and a similar increase in the fraction of members reported to having been sick with malaria in the previous six months increased demand by 13 percentage points. In contrast, in a sample of women in rural Kenya, Cohen and Dupas (2010) found no correlation between anemia (a health condition often associated with malaria) and willingness to pay for ITNs. This is possibly due to anemia being a noisy indicator of malaria exposure, but an alternative hypothesis is that demand among at-risk women was reduced by positive correlation between malaria risk and liquidity constraints, that is, by a negative correlation between willingness to pay and ability to do so. In our setting, liquidity constraints were relaxed by the loan offer, and so correlates of demand were less likely to confound willingness and ability to pay. This is potentially important in situations where cost-sharing is the chosen option in public health initiatives that aim to increase uptake of health products.

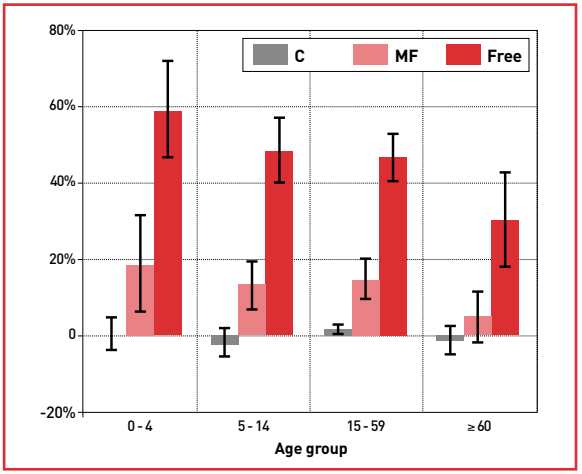
Of course, owning a bed net confers no protection against malaria-transmitting mosquitoes without consistent usage during sleeping hours.[3] Although we could not directly monitor regular usage, we collected detailed information about usage of each household member during the night before the interview. To minimize reporting bias, we recorded usage in two separate and independent sections of the questionnaire, finding overall highly correlated response patterns. These data showed that sales on credit significantly increased the fraction of individuals who slept under an ITN the previous night to 15 percent, up from only two percent in control areas.

Because we recorded usage for every individual, we could also look at *who,* within the household, was more likely to use the bed nets. Interestingly, we found that both sales and credit and (to a much larger extent) free distribution increased substantially usage rates for all demographic groups, although the largest increases were observed among children under five. Figure 1 shows the change in ITN usage by age group and gender, for each experimental arm. Sales on credit increased usage rates by about 15–20 percentage points among children 0–4 of either gender, while the increase remained below 10 percent for older individuals. The age gradient was even more pronounced with free distribution, which increased usage by a remarkable 60 percentage points among young children, by 45–50 percentage points among individuals 15–60, and only 30 percentage points among older members. The larger increases for young children were welcome news, given that (together with pregnant women) they suffer the highest malaria risk. It is also interesting to note that these results were in contrast with other empirical evidence that suggested that cost-sharing may lead to ITNs being disproportionately allocated to the bread-winners within the household. In a study carried out in rural Uganda, Hoffmann (2009) found that usage rates of bed nets purchased with cash transfers given to households was *lower* for children under five than for any other age group, while free distribution achieved the opposite result.

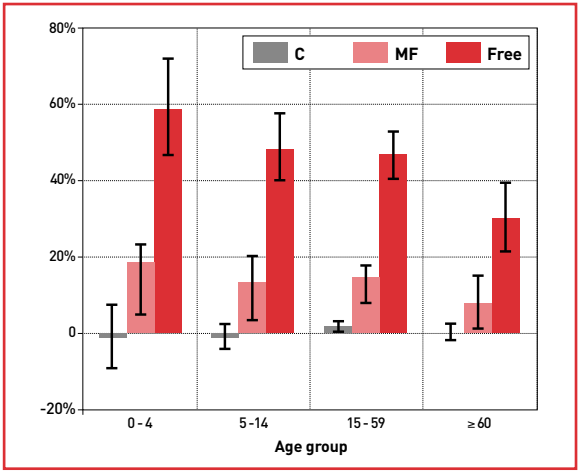
The encouraging results on increased ITN ownership and usage in Tarozzi et al. (2014), however, were offset by a number of drawbacks. First, while relatively high, demand for ITNs was not

Figure 1. Changes in previous night usage of ITNs, by age and gender

(a) Change in usage of ITNs, Males



(b) Change in usage of ITNs, Females



Notes: Each column shows the change from baseline to follow-up survey in the fraction of household members in a specific age-gender group who slept under an ITN the night before the interview, by experimental arm. Each column also displays 95% confidence intervals, robust to intra-village correlation. By construction, the changes are calculated only for individuals who were part of the household both at baseline and at follow-up. The labels C, MF and Free denote the three experimental arms: control (C), micro-financed ITNs (MF) and free distribution (Free).

universal, so many at-risk households remained unprotected. The fact that we only offered ITNs on credit to households with members affiliated to our micro-lender partner BISWA (about one in five, on average in the study villages) further reduced the fraction of the community impacted by our intervention. In addition, usage of bed nets was apparently irregular, as demonstrated by the self-reported usage rates summarized above. These considerations were likely important determinants of the disappointing results we achieved in terms of health outcomes. Neither malaria *prevalence* (the fraction of individuals who tested positive to malaria infection in a blood test) nor anemia improved relative to control areas, and prevalence was actually higher in treated areas, although the differences were not statistically significant at standard levels. We did find, however, an improvement in self-reported malaria *incidence*, that is, the number of cases that occurred during the six months before the survey. We conjecture that the low overall coverage of the intervention and irregular usage were key reasons why our results contrast with several earlier RCTs that found large health benefits from ITNs (see Lengeler 2004 for a review). The large majority of such earlier studies, unlike ours, were *efficacy* studies where free distribution of ITNs and intensive monitoring of usage and health outcomes led to large coverage and regular use. Also, and consistent with results from a number of earlier studies, reductions in prevalence are harder to observe than improvements in incidence, and the former are only observed when the improvements in the latter are (unlike in our study) very substantial (Beier, Killen and Githure 1999).

In conclusion, micro-loans may help in increasing adoption of preventive health products in situations where cost-sharing is necessary, but one needs to be aware that in most cases credit will likely increase adoption without making it

universal.[4] This may be particularly problematic in situations where (as for the case of malaria) epidemiological externalities are important. For instance, the epidemiological model in Killeen et al. (2007) shows situations where regular usage of ITNs can reduce malaria risk for an individual by 60 percent relative to non-use if no other ITNs are used around him/her, but the reduction becomes close to 100 percent if everyone else in the community is also regularly using ITNs.

Overall, these results suggest that cost factors will make it necessary, in many situations, to resort to heavy subsidization or even free distribution of health products in situations where large coverage is deemed important (Cohen and Dupas 2010).

3. Information

Another important factor that often limits the ability of the poor to adopt health improving behavior is the scant access to reliable information about health risks and about ways to reduce them. In richer societies, with a well-functioning public health system, competent doctors and health workers, and relatively high schooling levels, individuals are continuously reminded of the health risks associated with a number of factors such as smoking, poor eating habits, or pollution levels. In addition, individual health is frequently monitored through contacts with the health sector and a number of health risks are largely taken care of for the populace, without the need to consciously change behavior in order to avoid them. For instance, in developed countries there is no need to purify water to make it drinkable, health safety standards are widespread, and some countries mandate fortification of certain foods —such as salt or flour— to reduce micro-nutrient deficiencies in the population.

Misperceptions about health risks and remedies are very common in populations where schooling levels are low and contact with knowledgeable health workers rare. For instance, nationally representative data from the 2005–2006 Indian National Family Health Survey (NFHS-3) show the striking finding that among the nine percent of children who had diarrhea during the two weeks preceding the survey, only 43 percent were treated with oral rehydration therapy (ORT) or increased fluids while a staggering 40 percent received *less* to drink, thus *increasing* the risk of dehydration (IIPS and Macro International 2007). In many developing countries, infants below six months of age are given solid food and/or unsafe water to drink, leading to frequent gastrointestinal infections and growth retardation, and contrary to World Health Organization (WHO) recommendation of exclusive breastfeeding up to this age. In our work on malaria and ITNs in Orissa, while 95 percent of respondents were aware that malaria is a mosquito-borne disease, about 15 percent thought that it is also caused by contaminated water or soil. Misperceptions about HIV risks have been widely documented, especially at the beginning of the epidemic. In Malawi, Delavande and Kohler (2009) found a substantial *overestimation* of mortality risks, a factor that may lead to underestimate the benefits of adopting HIV risk-mitigating behavior.

A number of studies have now shown that the provision of information about health risks can substantially affect behavior, making information a potentially important policy tool in developing countries because information campaigns can often be conducted at relatively low cost. Using experimental data from Delhi, India, Jalan and Somanathan (2008) find that households informed of the unsafe levels of fecal bacteria in their drinking water showed an increased demand for clean water relative to a control group. Fitzsimons et al.

(2014) find that a program that provided information on child nutrition to young mothers improved child feeding patterns and health, and showed that the improvements were made possible by increased male labor supply. Keskin, Shastry and Willis (2015) show that information on low-dose arsenic contamination of well water in Bangladesh induced mothers to breastfeed their babies longer, also reducing child mortality as a consequence.

Several researchers have found that learning about one's HIV status can change substantially risky behavior, although not always in the desired direction. Thornton (2008) uses data from an RCT in rural Malawi, and finds that awareness about HIV-positive status increased threefold the likelihood of purchasing condoms among sexually active individuals, although the number of condoms purchased was very small. In a study carried out in western Kenya, Goldstein et al. (2008) estimate that learning one's HIV status had a marked impact on women's health-seeking behavior and investment decisions. In an RCT in Kenya, Dupas (2011) finds that girls exposed to information on the age profile of male HIV prevalence led to sizeable changes in self-reported sexual behavior and to a 28 percent decrease in pregnancies, while no such impact was associated to standard abstinence-only HIV education curriculum. On the other hand, Gong (2015), using data from RCTs which randomly assigned incentives for HIV testing in Kenya and Tanzania, found that individuals surprised by an HIV-positive test were over five times *more* likely to contract a sexually transmitted disease compared to individuals in a control group, while others surprised by an HIV-negative test where about 70 percent *less* likely to do so. Qualitatively similar results were found in Baird et al. (2015).

Information campaigns, however, rarely if ever succeed in inducing everyone to adopt the

risk-mitigating behavior. Bennett, Naqvi and Schmidt (2015) show that misperceptions about causes of disease can limit substantially the impact of information provision on the importance of water and sanitation hygiene. They describe a RCT in rural Pakistan where a random subset of individuals received not only information but also demonstrations done with microscopy to show the widespread presence of microbes in substances such as unsafe water and food. While information alone was not effective at changing behavior, the demonstrations led to substantial improvements in health and hygiene.

Information asymmetries have also been shown to be important when they involve not directly the effectiveness of certain health products but rather the presence of counterfeit products in the market or incorrect medical recommendations. Health products of substandard quality are unfortunately widespread in poor countries where regulations and oversight are weak. For instance, in a review of literature on the quality of antimalarial drugs in Southeast Asia and sub-Saharan Africa, Nayyar et al. (2012) find that about one third of drug samples contained either insufficient quantities of the appropriate active ingredients or none at all. Björkman-Nyqvist, Svensson and Yanagizawa-Drott (2013) study drug quality in Uganda, in areas where they estimate that more than one third of anti-malarials were of poor quality. They find that sub-standard quality drugs were more common in areas where MISperceptions about the causes of malaria were more common. They conducted a RCT where they randomly induced entrance in local markets of authentic and certified drugs. While they find that the better products on average improved the quality of the drugs sold by other sellers, they also find that misconceptions about the causes of malaria reduced the benefits of the increased supply of good drugs. Adhvaryu (2014) uses data from Tanzania to show that misdi-

agnosis of malaria (in particular, over-treatment of non-malarial fevers) reduced the adoption of new, effective therapies because they made it harder for individuals to acquire information about their effectiveness. He shows that learning and adoption of new, effective, antimalarial drugs were faster among individuals whose reference group or network experienced fewer misdiagnoses.

3.1 Information and risk mitigation of arsenic risks in Bangladesh

There is also evidence that information can be very important in inducing behavioral change to avoid environment-related health risks. A salient example is health risk due to naturally occurring contamination of well water with low-dose arsenic, a problem that occurs in several parts of the planet and is particularly dire in Bangladesh and other parts of South Asia. Long-term exposure to arsenic in drinking water has been linked to several health risks, including skin lesions, cancers, cardiovascular diseases, and increased mortality (see Argos et al. 2010, Chen et al. 2011 and references therein). Recent studies have also documented large economic costs of this phenomenon (Pitt, Rosenzweig and Hassan 2015).

In 1990, an estimated 95 percent of the rural population of Bangladesh was using well water as the primary source of drinking water (World Bank, 2005). This was done for convenience (many households dug a well in their own compound) but also as a reaction to a massive campaign conducted during the previous years to eradicate the use of surface water for drinking, a key reason behind the dramatically high rates of childhood disease observed at the time in the country. Unfortunately, it later became apparent that many areas suffered from high level of naturally occurring arsenic, leading the World Bank to create the Bangladesh Arsenic Mitigation Water Supply Program (BAMWSP) that tested and labelled by safety status five million tube- wells countrywide using field kits, for free, during 1999–2003.

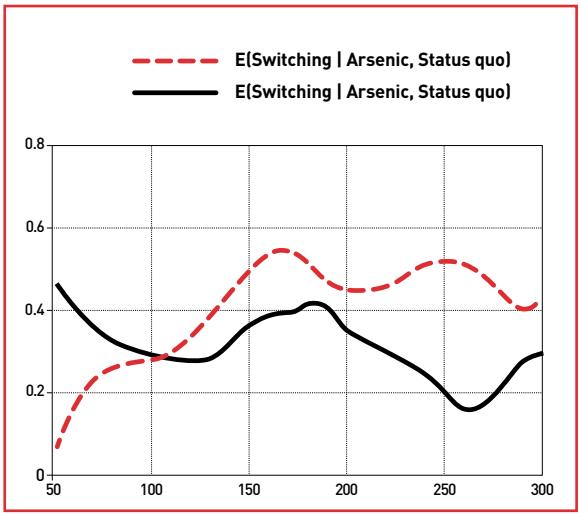
Arsenic in aquifers is caused by geological factors, its concentration is generally stable over time, and in many areas contamination can vary enormously over space, even within a village, also as a function of well depth (British Geological Survey, 2001; van Geen et al., 2002). Such geographical heterogeneity offers the opportunity to use testing and labeling of wells as a public health measure, by encouraging 'well switching' away from unsafe wells and towards safer wells, a choice often possible because well-sharing is usually culturally accepted in these areas. At least in the short-run, reductions in arsenic exposure achieved through well testing and switching have been larger than that achieved via any other means (Ahmed et al., 2006).

A number of studies have documented that many households, after learning about the unsafe arsenic concentration in their well water, switch to alternative, safer sources. Chen et al. (2007) found that arsenic levels measured in urine had dropped over time among members of households that reported well switches, while they remained stable in households that reported no change in drinking water source. Madajewicz et al. (2007) found that general information on arsenic risk disseminated through television did not lead to well switching, while well tests led over half of those at unsafe wells to switch, despite having to walk longer distances. In the same areas, Opar et al. (2005) found one year later that switching rates had increased to almost two-thirds of the households at unsafe wells, albeit in some cases to untested wells. Increased rates of switching over time were also observed in Balasubramanya et al. (2014), who documented that in their study area switching rates doubled between 2005 and 2008, after well testing conducted up to 2003.

Despite the encouraging reductions in arsenic risk achieved through testing, it must be recognized that much remains to be done. First, even the most successful information campaigns have not achieved a 100 percent reduction in arsenic risk, even in situations where switching to safer alternatives was an available option. Second, it has been difficult to design ways to deliver information in ways that substantially increase the adoption of risk-mitigating behavior. For instance, George et al. (2012) randomly varied whether arsenic-related education and well testing were conducted by a member of the community or by an outsider, in the expectation that the former, by leveraging local networks and trust, would have been more effective at inducing switching to safer sources. However, after adjusting for the availability of arsenic safe drinking water sources, well switching did not differ significantly by type of arsenic tester.

It is also not clear that more detailed information about arsenic risk can lead to more switching. In Bennear et al. (2013), we studied how variation along this dimension affected responses to information on arsenic concentrations in well water, in the context of a two-arm RCT. Households in both randomized treatment arms were informed about the arsenic level in their well and whether that level was above or below the Bangladesh standard for arsenic, which follows a simple, binary (safe vs. unsafe) format. Households in one group of villages were then simply encouraged to seek water from wells below the national standard. Households in a second group of villages received additional information emphasizing that lower-arsenic well water is always safer and these households were encouraged to seek water from wells with lower levels of arsenic, irrespective of the tested level of well water arsenic relative to the national standard. We found that switching rates were actually *lower* in villages that received the richer message, with the results driven by households

Figure 2. Switching rates as a function of arsenic level



Notes: The lines show non-parametric locally linear regressions, with a bandwidth equal to 50 ppb. "Status quo" refers to the simpler, binary message, while "Emphasis" refers to the richer message that emphasized that switching to a lower arsenic well was always beneficial.

with very *high* levels of arsenic. Figure 2 shows switching rates conditional on the level of arsenic found in the well water, separately for the two types of message. The two lines show that, at arsenic levels of about 100 or below, switching rates were actually higher when the richer message was delivered. However, above this threshold (when switching to a safer well would have presumably led to *larger* health gains) the sign of the gap was reversed, with switching rates substantively *lower* among families receiving more information over a broad range of arsenic values.

The overall differences in switching were not statistically significant (although they were, conditional on high arsenic levels), but even so the estimates are sufficiently precise to rule out large beneficial effects of the richer message.

3.2 Eliciting beliefs about health risks

While it may be relatively easy to identify what kind of information is *available* to individuals, figuring out to what extent such information is received and internalized in decision-making can be a significantly more complex task. This distinction is important not only conceptually but also from the perspective of policy, given that a policy maker can control which information to provide and in what format, but s/he cannot control directly to what extent and how the information will be actually used by the target population. The discussion in Section 3.1 above has indeed made clear that while information about health risks can be a relatively inexpensive policy tool, it is rarely if ever effective at eliminating completely risky behavior.

The measurement of individual perceptions about health risk can thus be important to understand decision making and to design policies better able to sway behavior in a desired direction. Conceptually, measuring "subjective beliefs" about the consequences of different decisions can be crucial, because if one only observes choices it is impossible to identify separately the role of preferences, beliefs and constraints. For instance, the choice not to switch away from a high-arsenic tubewell may be due to the lack of better alternatives, or it could be due to the household not being worried about arsenic risk. As another example, the choice not to purchase an ITN may be due to the price, or to the belief that its use will not reduce substantively malaria risk, or to the perceived discomfort of sleeping under a net during hot and humid tropical nights.

The standard approach to integrating expectations into structural economic models of choice under uncertainty has relied on making assumptions about individual information as well as the process of expectations formation. However, mistakes in the description of what information individuals face and/or in the way they use such information to form their beliefs can lead to incorrect estimates (Manski 2004). Eliciting subjective probability distributions, however, allows researchers to replace these assumptions with data. Since the 1990s, an increasing number of surveys have successfully elicited probabilistic expectations from their respondents, including in populations with very low literacy and numeracy levels. Delavande (2014) provides a recent overview of advances in the measurement of beliefs in developing countries.

Especially in situations where respondents are not familiar with the formal concept of probability, training of interviewers and appropriate questionnaire design are of paramount importance. Examples need to be provided to clarify the concept, preliminary questions should be used to probe the respondent's understanding, and context-specific ways need to be developed and piloted. These issues were taken into account in my and my co-authors' work on ITNs and on arsenic contamination, given that in both settings it was important to measure individual perceptions of health risks. We thus used an approach similar to that adopted in Delavande and Kohler (2009). The interviewer gave the respondent ten marbles and a box, and instructed her to place a number of objects in the box increasing in the perceived likelihood that a specific event will happen.[5] The subjective probabilities were then estimated by dividing the number of marbles in the box by ten. Hypothetical examples were described to make sure that the respondent understood the rationale. We used questions related to the probability of two nested events to probe whether the concept of probability was understood by the respondent. We first asked "[i]n your opinion, from 0 to 10, what are the chances that you or someone else in your family will purchase some food tomorrow?" and we then asked the same question, but with a 7-day

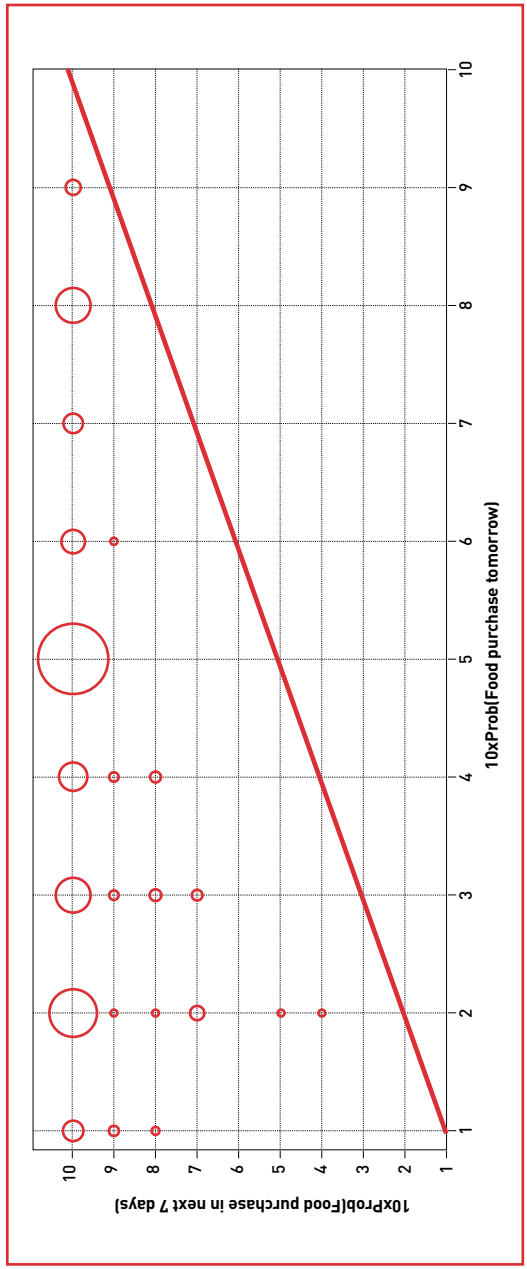
reference period. By construction, the number of marbles set aside when responding to the former question should be no larger than when responding to the latter one. Interviewers were instructed to empty the box after each question, so that respondents were not implicitly led to merely add to the marbles placed in the box after the first question.

Figure 3 plots the results of this exercise carried out before the information about well safety was distributed in our study areas in Bangladesh. The horizontal axis shows (10 times) the subjective probability of buying food the next day, and the vertical axis (10 times) the probability of buying food during the next 7 days. All the points are on or above the 45-degree line, showing that all respondents reported higher probabilities with the longer time horizon. The number of non-responses was also remarkably low, with two non-responses out of 668.

Next, we measured perceived risks from exposure to well water contaminated with arsenic. Respondents were asked to report the perceived probability of someone developing either skin lesions (a frequent marker of arsenicosis) or more generic "serious health problems" as a consequence of drinking water from a well with unsafe levels of arsenic. The survey instrument described "serious health problems" as conditions that can impair normal daily activity such as working, going to school, playing or helping out with household chores.

Figure 4 displays the results, with each graph showing the histogram of (10 times) the reported probabilities that someone in a given demographic group will develop health conditions within a given time frame as a consequence of drinking arsenic-contaminated water. The risk of health conse-

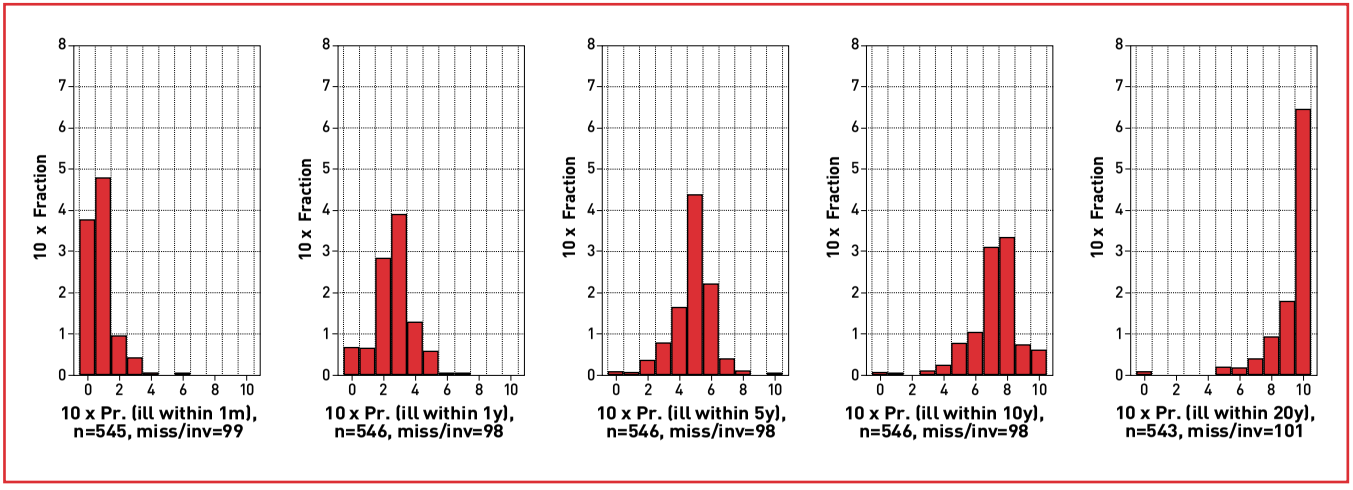
Figure 3. Subjective expectations of two nested events



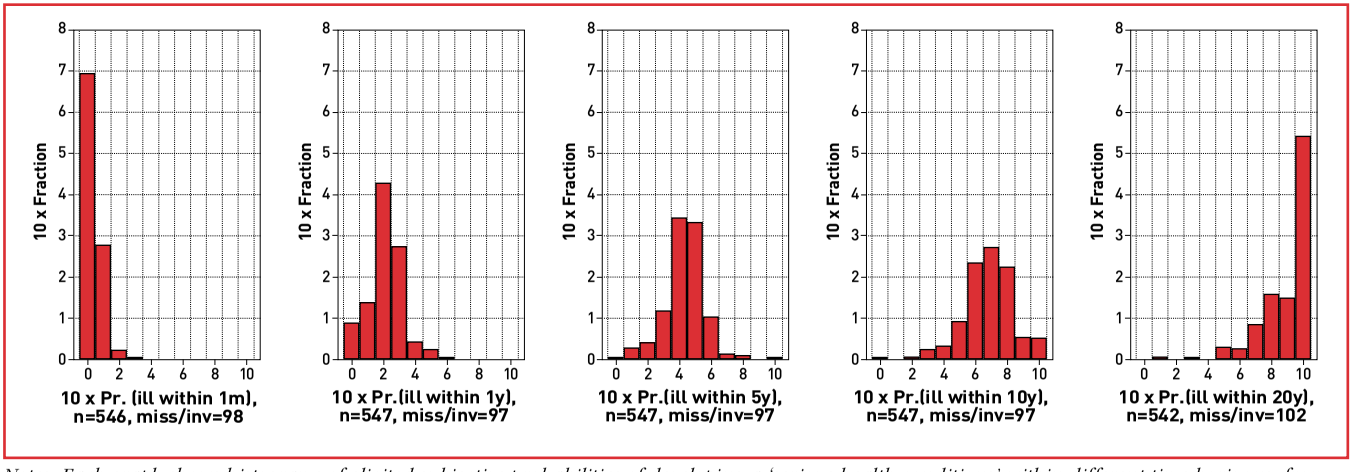
Notes: Data from baseline survey in rural Bangladesh (Spring 2008; n= 666). The size of the circle is proportional to the number of responses in each cell.

Figure 4. **Perceived health risk from drinking arsenic-contaminated water**

(I) Demographic group: Children



(II) Demographic group: Adults



Notes: Each graph shows histograms of elicited subjective probabilities of developing a 'serious health conditions' within different time horizons, from one month (left) to 20 years (right), and for children (top) and adults (bottom). Beliefs are measured on a scale from 0 (impossible event) to 10 (certain event). The label 'miss./inv.' indicates missing or invalid data.

quences was assessed for children (graphs on top) and adults (bottom), and for exposure durations of one month (left-most graphs) and then (moving to the right) one, five, ten or twenty years. A number of interesting patterns emerge. First, there was widespread awareness that arsenic may lead to skin lesions. Second, the elicited beliefs clearly show that respondents were aware of the cumulative effect of exposure to arsenic, with progressively higher probabilities of skin lesions reported as the time horizon lengthens. For instance, almost no one reported a probability of serious health damage above 30 percent for a 1-month exposure, while more than half of respondents thought that health damage would certainly appear after 20 years of exposure. Overall, these elicited beliefs appear remarkably credible, with no heaping for focal values such as zero, five or ten, except in cases where such heaping could be expected because of the very likely or very unlikely nature of the event described.

On the one hand, these elicited beliefs help explaining why many households, when informed about the actual unsafe status of their usual drinking water, decided to switch to a different source. On the other hand, they also show that other considerations were important when deciding about water sources: in fact, among the 215 households who were still using an unsafe well at follow-up, 133 (62 percent) recognized that the well water was unsafe to drink.

A high degree of awareness about health risks was also present in our study of malaria and bed nets (Tarozzi et al. 2014). In this context, we measured perceptions about the probability of falling sick with malaria when not using bed nets, or when using regularly a bed net not treated with insecticide, or one treated with insecticide. For almost all respondents, the risk was decreasing substantially moving from the first to the third option.

Besides being descriptively interesting, these elicited beliefs about the protective power of bed nets were a crucial ingredient for the analysis of the potential role of 'behavioral biases' in explaining low adoption of ITNs, a topic that we specifically studied in separate work (Mahajan and Tarozzi 2011) that will be summarized in the next section.

4. Preferences

As for all choices, the decision whether to invest in health prevention also depends on preferences. On the one hand the poor, like the rich, surely care about their health. On the other hand, some of the preventive technologies we have described earlier have potentially undesirable aspects. For instance, sleeping under a bed net, while protecting from mosquito bites, can be difficult in hot and humid weather; the drugs effective against infection with intestinal worms often have unpleasant if short-lived side effects; chlorinating water changes its taste. It can be particularly difficult to enhance prevention when doing this requires substantive behavioral changes. For instance, in rural Bangladesh, switching away from one's own tubewell water because of arsenic contamination was made harder by the fact that many households value greatly the convenience and privacy of drawing water from their own backyard (Madajewicz et al. 2007). A number of studies have shown that improved cook stoves that could significantly reduce the incidence of respiratory diseases via a reduction of indoor pollution are often not used, even when provided for free, because they require undesirable changes in the way food is cooked (see, for instance, Miller and Mobarak 2015).

In addition, development economists have recently started emphasizing the possible role

played by model of non-standard preferences borrowed from the 'behavioral economics' literature.[6] In models where individuals take decisions over time, it is usually assumed that they maximize expected future utility flows under an intertemporal budget constraint. Such models have provided invaluable insights in understanding economic decisions such as savings, asset allocation or investment in health and education. However, insights from psychology and behavioral economics have suggested alternative models to rationalize certain behaviors such as under-investment in activities with apparent low cost and high expected returns, or the willingness to pay *positive* prices for commitment devices that *limit* future choices (Mullainathan 2004). A common thread in this literature is the existence of 'present-biased' preferences that lead individuals to forsake more productive choices (such as saving or investment in health) in favor of options that are less productive or even damaging in the long-term (such as the purchase of addictive goods). Another common thread is that individuals are often "naïve" in the sense that they systematically downplay the role of 'temptations', leading to their inability to stick to their plan of action, and to the widespread problem of procrastination of actions requiring effort. In contrast, 'sophisticated' individuals who suffer from present bias but are aware of it may be willing to opt for commitment devices that force them to stick to their plans for the future, see Bryan, Karlan and Nelson (2010) for a review of the related literature.

A number of recent papers have analyzed the possible role of these preference biases for health-seeking behavior. For instance, the tendency to procrastinate may have been a key reason why Banerjee et al. (2010) found that in rural Rajasthan, India, small 'nudges' in the form of relatively small in-kind incentives led to a massive increase in the proportion of women who took

their children to an easily accessible health camp where they would be administered, free of cost, the WHO/UNICEF Extended Package of Immunization (EPI). The EPI is the package recommended by the Indian government, and includes one dose of tuberculosis vaccine, three doses of Diphtheria, tetanus, and pertussis vaccine, three doses of oral polio vaccine, and one dose of measles vaccine. While the presence of the health camps only increased the fraction of children of age one to three who received the full immunization package from 6 to 16 percent, the offer of one kilogram of lentils per immunization administered, and a set of metal plates upon completion of the package further increased the take up rate by 22 percentage points. On the one hand, these results suggest that many parents had neither strong objections to immunization nor strong beliefs about their effectiveness, but another possible factor may have been a widespread tendency to procrastinate which small nudges may have been sufficient to overcome. On the other hand, the fact that a large fraction of children did *not* receive the full immunization package despite the conveniently located health camps and the incentives suggest that beliefs played an important role in many parents' decisions.

Nudges, in this case in the form of SMS reminders, have also been shown to increase considerably adherence with life-saving anti-retroviral treatment (ARV) against HIV. Pop-Eleches et al. (2011) find that weekly reminders increased from 40 to 53 percent the proportion of patients of a rural clinic in Kenya that achieved at least 90% adherence during the 48 weeks of the study.

In another RCT in Kenya, Dupas and Robinson (2013) found that saving products that earmarked savings to specific expenditure types increased substantially funds set aside to face health emergencies, although earmarking for investment in preventive health products was on average not

equally effective. In this study, earmarked savings could *only* be used for the stated purpose, thereby providing a strong commitment device. That earmarking for prevention did not increase savings on average is consistent with individuals preferring commitment devices that are not too strong, in the sense that they may be 'broken' in case of emergencies (such as, in this case, a health emergency).

Interestingly, the availability of commitment devices can also lead to undesirable outcomes if individuals (as they often do) systematically underestimate their present bias. In other words, an individual may be sophisticated enough to recognize the need for commitment in order to achieve a certain outcome, but may also fail to recognize that his/her future self will be so present biased to opt for the 'tempting behavior' despite having to incur the cost of breaking the commitment in order to do so. A well-known example is gym membership. Many individuals choose expensive membership plans as a commitment device, thinking that they will then exercise regularly to avoid paying the psychological cost of being aware of having wasted money if they don't exercise. But then many of these same individuals end up not going anyway, therefore paying *both* the cost of the membership *and* the psychological cost (DellaVigna and Malmendier 2006). In ongoing work, Bai et al. (2015) develop commitment contracts for individuals with hypertension in rural Punjab, India, but find that partial naïveté is likely responsible for the inability of the contract to actually increase compliance with follow-up control visits, leading plausibly to welfare losses.

4.1 Commitment devices, present bias, and demand for technologies for malaria prevention

Commitment devices also played a role in our analysis of demand for ITNs on credit (Tarozzi et al. 2009, 2014), see Section 2. A key consideration for what follows is that the bed nets sold during our project were high-quality but 'standard' bed nets that needed to be periodically re-treated with insecticide to retain their capacity to kill mosquitoes on contact. Given the choice of insecticide and the appropriate concentration, re-treatment was recommended approximately every six months. In villages where bed nets were sold on credit, we offered the possibility of choosing one of two contracts. One (standard) contract offered the possibility of buying the nets, treated on the spot by our personnel. Buyers knew that our research team would return after about six and twelve months to *offer* re-treatment, and the owner would then choose whether to pay in cash for it or to do without it. With the other ("commitment") product, the buyer would purchase not only the net but also a sequence of two re-treatments. The price of this second contract was higher, to cover the cost of the re-treatment. In this case, the owner would commit to repay the whole loan, but did not have to come up with any cash at the time of the first and second re-treatment.

Demand for the commitment contract was high, and of the 52 percent of sample households who purchased any net, about half of them chose this option. Not surprisingly, re-treatment rates were significantly higher among these households relative to those who opted for the standard contract. After six months, 92 percent of the bed nets purchased with commitment to re-treat were re-treated, and 84 percent were after 12 months. In most cases, the reason for non-retreatment was our inability to reach the household, or the fact

that the ITN was no longer present. However, re-treatment rates of bed nets purchased with the standard contract was only 36 and 19 percent, respectively, after six and 12 months. Of course, the contract was *chosen* and so these results are not conclusively causal, but the differences in re-treatment rates between contracts remain almost unchanged when we control for a large number of household characteristics, including also measures of perceived effectiveness of bed nets and re-treatment at reducing malaria risk.

4.1.1 Structural estimation of present biased preferences

Evaluating rigorously the actual importance of present bias, however, requires a significantly more complex approach, which is what we set out to do in Mahajan and Tarozzi (2011). This paper describes under what conditions one can identify and estimate preference parameters that directly measure the degree of present bias. In this subsection I describe the key modeling ingredients and intuition, although the content of this paper is very technical, and a thorough description of it is beyond the scope of this review.

Present bias is often modeled through "hyperbolic discounting" (Laibson, 1997) so that, at time t, future utility at time s ($> t$) is discounted not by the usual geometric factor δ^{s-t} but by a (smaller) factor $\beta\delta^{s-t}$ where $0 < \beta < 1$. The so-called intertemporal utility function (a quantitative representation of the 'welfare' that each decision-maker wants to maximize through his/her choices, conditional on resource constraints) thus takes a form such as the following

$$u_t(x_t,a_t) + \beta \sum_{j=t+1}^{T} \delta^{j-t} E_j(u_j(x_j,a_j)),$$

where $u_t(.)$ is the 'utility' in period t, a_t are 'actions' (the choices taken in each period, for instance, whether to buy a health-related product) and x_t are 'states' (for instance, whether the economic agent is poor or rich, sick or healthy). In this intertemporal utility function, the discount factor β only matters when the agent, at time 0, is comparing current utility $u_t(x_t,a_t)$ with any future utility $u_j(x_j,a_j)$, $j > t$, while only δ matters when the agent, at time 0, is comparing two future utilities.[7]

One can show that a consequence of hyperbolic preferences is that agents have an incentive to deviate from previously determined consumption paths even in the absence of new information, consuming more than they had previously decided. While such models promise to help in explaining the often observed inability of the poor to save or invest even when the budget constraint would allow it, structural estimation of the discount factors that characterize hyperbolic preferences is hard. In fact, time preference parameters are generically not identified in standard dynamic choice models (Rust, 1994; Magnac and Thesmar, 2002).

In Mahajan and Tarozzi (2011) we describe conditions under which the time preference parameters β and δ can be identified, in the context of a rich model where different degrees of time inconsistency (and of sophistication or naïveté) can coexist, with different agent "types" characterized by different preference parameters. A key insight is that *directly elicited beliefs* about the evolution of state variables (such as the malaria status, as a function of choices about bed net purchase and re-treatment) can facilitate identification. As we have seen in Section 3.2, our data also included subjective beliefs about the protective power of ITNs, as well as other information on perceived costs of malaria episodes and on the expected

evolution of income. We then show that our data allow the identification of the preference parameters, permitting us to evaluate the extent of present bias in the study population, and gauging to what extent it can explain sub-optimal investment in health-protecting strategies.

In the empirical application, we consider a situation where there are three periods when the economic agent makes choices. In the first period, the agent chooses whether to purchase a bed net for protection from malaria, and if so chooses whether to purchase it jointly with a sequence of future treatments with insecticide that will keep it more effective against mosquitoes. In periods 2 and 3 the choice is made whether to re-treat the net with insecticide, a choice that is only possible for those who purchased in period 1.

The simplest framework assumes that there are three type of agents: "consistent" agents (C) are "standard", that is, not present biased, and thus have $\beta = 1$; hyperbolic "sophisticated agents" have $\beta < 1$ and are aware of their present bias, so that they take into account that in $t+1$ their "future self" will have an incentive to deviate from the consumption path set at time t; hyperbolic naïve agents also have $\beta < 1$ but are *not* aware of their present bias, so they take decisions in a way that is different from the sophisticated agents.

In the empirical analysis, we estimate that time-inconsistent agents account for more than half of the population and that sophisticated inconsistent agents are considerably more present biased than their naïve counterparts. However, we also estimate that such naïve inconsistent agents do not suffer from a substantively large degree of present bias (that is, their β is close to one), so that in the end their behavior is very similar to that of the time-consistent agents. In sum, at least in the empirical setting of our study, we found that present bias was *not* a key reason for the low ownership rates of ITN observed before our intervention took place.

5. Conclusions

Like virtually all complex phenomena, the low adoption of potentially high-return health protecting behavior is most likely the result of a combination of many factors, with the weights of the different factors varying over time and across space. The literature survey in this *opuscle* has shown that cost, information and preferences all play important roles in explaining the low adoption of preventative health technologies in developing countries. We conclude highlighting two broad themes that, while beyond the scope of this survey, are also very important.

First, our focus has been on health *prevention*, but inadequate access to and usage of appropriate *treatment* are also of paramount relevance. On the one hand, there is considerable evidence that even the poor spend large amounts of resources seeking treatment, at least relative to their income. For instance, McIntyre et al. (2006), reviewing research on the economic consequences of illness, find that direct costs such as drugs, doctors or hospitalizations accounted for 5–16 percent of total household expenditure in a number of poor countries. Xu et al. (2003) estimate in a large number of countries the fraction of households who had to face 'catastrophic' health costs, defined as those larger than 40 percent of income net of subsistence expenses. They find that in many developing countries such fraction was enormous (higher than 5 percent in a number of cases) relative to most developed economies, where the fraction always remains well below 1 percent. Raban, Dandona R. and Dandona L.

(2015) focus on data from India during the years 2003–2010 and show that, using a similar definition of catastrophic health expenditure, the fraction of households who had to face such events ranged between 3.5 and 33.9 percent, depending on the data used.

The second broad theme that we have not discussed extensively is that in most low-income countries both the public and the private health system are in very poor shape, with limited financial resources, poor infrastructure, frequent stockouts of drugs, and widespread absenteeism and incompetence. In a number of countries, the health system is close to or even beyond the point of collapse due to conflict (Blattman and Miguel 2010). In other words, even in situations where households may have the necessary awareness and (when necessary) wealth to seek appropriate health care, it is often the case that good quality care is absent. The low *supply* of appropriate health care is thus as important or perhaps more important that the low *demand* for health care which has been the focus of this survey. Chaudhury et al. (2006) show that in primary health centers, 25 to 40 percent of health workers were found absent during working hours in a sample of countries that included Bangladesh, Ecuador, India, Indonesia, Peru and Uganda. Das and Hammer (2007) document widespread incompetence and low effort among doctors in Delhi, India, especially in poor areas and in the public sector. Banerjee, Deaton and Duflo (2004) discuss similarly dispiriting evidence in rural Rajasthan, India. A number of researchers are now studying ways to improve the functioning of the health care system in developing countries, for instance by using insights from contract theory to achieve better selection of workers and maximize their effort, see for instance Ashraf, Bandiera and Jack (2014), Luo et al. (2015), Deserranno (2016).

In conclusion, despite great improvements in health outcomes and life expectancy in most countries, and despite the impressive advances in medicine, health inequalities remain both within and across countries. Important advances have been made in public health and social sciences in understanding causes and possible solutions, but a number of formidable demand and supply factors still severely limit advances in many places, so that much remains to be learned and done in order to achieve further significant progress.

Notes

(1) I thank an anonymous referee for comments. All remaining errors are my own.

(2) For earlier related surveys see also Holla and Kremer (2009) and Dupas (2011).

(3) Mosquitoes of the genus Anopheles*, responsible for the transmission of malaria, most frequently bite during the night (Pates and Curtis 2005). Numerous studies have shown that high coverage and use rates of ITNs are efficacious at reducing malaria-related morbidity and mortality, as documented in the extensive survey in Lengeler (2004).*

(4) Fink and Masiye (2012) also find substantial demand for bed nets sold via an agricultural loan program in Zambia. They also find very large reductions in malaria incidence, although they can only rely on self-reported morbidity. Devoto et al. (2012), in a RCT in Morocco, show that households were much more likely to request piped water connections when they were informed about a credit program that allowed payment in installments.

(5) Other approaches have been used as well, with varying degrees of success, for instance using rulers and a 0-100 scale, or shading scales. Note also that this way of measuring beliefs only provides a point estimate for the probability. More complex elicitation processes can been used to gauge the degree of certainty about the belief or, in the case of continuous outcomes such as income, to approximate the whole distribution of beliefs.

(6) For pioneering contributions in this literature see for instance Strotz (1955) or Laibson (1997). An early example in development economics is Asbraf, Karlan and Yin (2006) who study the role of present biased preferences in savings decisions in urban areas of the Philippines.

(7) In technical terms, while only δ *appears in the "intertemporal rate of substitution" between any two future periods, the rate between current time* t *and future periods also depends on* β.

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