KELLOGG INSTITUTE
FOR INTERNATIONAL STUDIES

working paper

INCREASING ANTI-MALARIA BEDNETS UPTAKE USING INFORMATION AND DISTRIBUTION STRATEGIES: EVIDENCE FROM A RANDOMIZED EXPERIMENT IN SENEGAL

JACOPO BONAN, PHILIPPE LEMAY-BOUCHER, DOUGLAS SCOTT, MICHEL TENIKUE

406

May 2015

The Kellogg Institute for International Studies
University of Notre Dame
130 Hesburgh Center for International Studies
Notre Dame, IN 46556-5677
Phone: 574/631-6580
Web: kellogg.nd.edu

The Kellogg Institute for International Studies at the University of Notre Dame has built an international reputation by bringing the best of interdisciplinary scholarly inquiry to bear on democratization, human development, and other research themes relevant to contemporary societies around the world. Together, more than 100 faculty and visiting fellows as well as both graduate and undergraduate students make up the Kellogg community of scholars. Founded in 1982, the Institute promotes research, provides students with exceptional educational opportunities, and builds linkages across campus and around the world.

The Kellogg Working Paper Series:

- Shares work-in-progress in a timely way before final publication in scholarly books and journals
- Includes peer-reviewed papers by visiting and faculty fellows of the Institute
- Includes a Web database of texts and abstracts in English and Spanish or Portuguese
- Is indexed chronologically, by region and by research theme, and by author
- Most full manuscripts downloadable from kellogg.nd.edu

Contacts: Elizabeth Rankin, Editorial Manager
erankin3@nd.edu

INCREASING ANTI-MALARIA BEDNETS UPTAKE USING INFORMATION AND DISTRIBUTION STRATEGIES: EVIDENCE FROM A RANDOMIZED EXPERIMENT IN SENEGAL

Jacopo Bonan, Philippe LeMay-Boucher, Douglas Scott, Michel Tenikue*

Working Paper #406 – May 2015

Jacopo Bonan is a research fellow in the Department of Mathematics and Physics of the Catholic University of the Sacred Heart, Brescia, and a visiting fellow at the Fondazione Eni Enrico Mattei (FEEM), Milan. His research focuses on development economics with an emphasis on health, agriculture, energy poverty, and formal and informal financial institutions in sub-Saharan Africa. He has coordinated household surveys in the field, designed and supervised evaluation designs, and processed and analyzed data for several research projects. He holds a PhD in economics from the University of Milan-Bicocca.

Philippe LeMay-Boucher is associate professor of economics at Heriot-Watt University, Edinburgh, UK. He holds a PhD from the University of Namur, Belgium, and his research interests lie in the field of development economics, with a particular focus on West Africa. He was a visiting fellow at the Kellogg Institute for International Studies during the fall semester 2013.

Douglas Scott has recently completed his MSc in economics for development at the University of Oxford, UK.

Michel Tenikue is an economist and senior research fellow at LISER (formerly CEPS/INSTEAD), Luxembourg. He holds a PhD from the University of Namur, Belgium, and his recent work focuses on the economics of education across a wide range of developing countries.

*This work was supported by the Nuffield Foundation (Social Science Small Grants Scheme), Heriot-Watt University (SML Internal Research Grant), and the Carnegie Trust for the Universities of Scotland. We thank Mustapha Diop, Kyle McNabb, Francesca Tamma, and Jasmine Wong for their assistance during fieldwork. Any remaining errors are our own. LeMay-Boucher wishes to thank the Kellogg Institute for International Studies at the University of Notre Dame.

ABSTRACT

This paper studies the effects of information about malaria and of bednet distribution strategies on the demand for anti-malaria bednets, using a randomized experiment in the city of Thiès in Senegal. We offer two orthogonal treatments to a random sample of households. The first is a sale treatment and consists of 1) an offer to purchase on the spot a bednet at a subsidized price or 2) an offer to purchase a bednet at the same subsidized price with a voucher valid for seven days. The second is an information treatment that consists of a ten-minute information session on malaria-related issues. We find that information has no significant effect on the demand for bednets and that receiving a voucher increases purchasing by 20%. Our results suggest that selling bednets at a subsidized price and allowing for some flexibility with a short period of seven days increases purchase compared to the on-the-spot sale approach.

Keywords: bednet, information, malaria, prevention.

RESUMEN

Este artículo estudia el efecto de la información sobre la incidencia de la malaria y el de las estrategias de distribución sobre la demanda de mosquiteros anti-malaria. Utilizamos un experimento aleatorio en la ciudad de Thiès en Senegal. Ofrecemos dos tratamientos independientes a una muestra aleatoria de hogares. El primero es un tratamiento de venta y consiste en (1) el ofrecimiento de comprar en el acto un mosquitero con un precio subsidiado o (2) el ofrecimiento de comprar un mosquitero al mismo precio subsidiado con un bono válido por siete días. El segundo es un tratamiento de información que consiste en una sesión de información de diez minutos sobre asuntos relacionados con la malaria. Encontramos que la información no tiene un efecto significativo sobre la demanda de mosquiteros y que recibir un bono incrementa las compras en un 20%. Nuestros resultados sugieren que vender mosquiteros a un precio subsidiado permitiendo alguna flexibilidad en un período corto de siete días incrementa la adquisición de mosquiteros en comparación con la compra en el acto.

Malaria is still at the heart of global public health concerns. The World Health Organization (WHO 2014) estimated 198 million episodes of malaria in 2013 worldwide. Moreover, out of 584,000 estimated malaria deaths, 90% occurred in the Africa region. The use of Long-Lasting Insecticide Treated Nets (LL-ITNs) has been shown to have a crucial impact in reducing the incidence of malaria and the mortality of vulnerable groups such as children and pregnant women (see Lengeler 2004 for a review). It is considered the most important malaria control tool by the Roll Back Malaria Partnership.

Compared to 3% in 2004, almost half of the population at risk in Africa (49%) had access to an LL-ITN in 2013 (WHO 2014). Because the use of ITNs has significant spillover effects, through the reduction of the mosquito population (Gimnig et al. 2003), there is an important scope for universal coverage. A malaria-free environment has positive effects, for example, on economic growth (Gallup and Sachs 2001), development (Bhattacharyya 2009), and school attainment and literacy (Lucas 2010). However, the target of universal access is far from being achieved and the level of use of such preventive tools remains low in countries with endemic malaria. As pointed out by household surveys, the great majority of people who have an ITN actually use it (WHO 2014), particularly during the seasons of high probability of infection. The crucial issue seems therefore effective access to, availability of, and demand for bednets.

There is an ongoing debate among health researchers and program directors as to whether it is preferable to propose free distribution of LL-ITNs or to opt for some form of cost sharing (see Sexton 2011 for a review). This issue has notably been addressed by Cohen and Dupas (2010) in a randomized experiment on pregnant women in Kenya. They find that the demand for ITNs is highly price sensitive and that cost sharing is not more cost effective, in terms of child mortality, than free distribution. However, this is not the focus of our analysis. Our study constitutes an attempt to empirically evaluate the effects of different marketing and distribution techniques on the effective purchase of anti-malaria bednets in a context where bednets are sold at a constant subsidized price for the general population.

Discussions with interested parties in the area of Thiès (Senegal) suggested that the last national distribution campaign of LL-ITNs, organized between 2007 and 2009, could potentially have been improved by offering more information on LL-ITN benefits and by using a different sale strategy. The last campaign involved a door-to-door strategy to deliver a voucher for a subsidized LL-ITN, to be redeemed at a distribution point (health facility). It was argued that

providing more information and offering a door-to-door on-the-spot sale, instead of having the LL-ITNs available at a fixed point, could potentially yield better results. This paper investigates these propositions.

We thus offered subsidized LL-ITNs at a price similar to the one set during the last national distribution campaign for a limited period of time through a scale-up intervention with no particular target and addressed to the general population (so not just to vulnerable groups, namely, pregnant women and children). We first look at two treatments for the distribution strategy for which we want to calculate the impact on effective LL-ITNs take-up. First, we distributed door-to-door vouchers for the purchase of an LL-ITN to be redeemed at a specific gathering points within seven days. This treatment mimics the government distribution campaign. Second, we proposed, at the same price, the purchase of an LL-ITN on the spot, through a door-to-door campaign. By comparing the effects of these two treatments we can assess if a larger uptake could be achieved by selling on-the-spot or with a redeemable voucher. A second component to our paper assesses the role of knowledge of malaria and its prevention on the effective purchase of LL-ITNs. We explore the effects of such informational treatment and of our two different strategies of distribution through a randomized field experiment.

Studying the demand for subsidized bednets on the overall population is relevant if we consider that people buying bednets at subsidized prices are likely to buy other bednets in the future, at even higher prices. Dupas (2012) indicates that such positive learning in health may be at play. We are able to estimate the heterogeneous effects our treatments had on relevant household characteristics at the baseline. In particular, we investigate the effectiveness of our delivery strategies for different levels of income and the effect of the information session at different level of education.

We find that compared to the on-the-spot sale, providing a seven-day voucher has, on average, a significant and positive effect on the probability of purchasing a bednet. The magnitude of the effect is around 20%. The voucher has no effect among the very poor (1st quintile) and the very rich (5th quintile). We also find that, information has, on average, no significant effect on the likelihood of buying bednets. This is contrary to the assumption that lack of information is one of the reasons for low adoption of health preventive technology. Dupas (2009) finds that social marketing treatments, in the form of promotional messages, have no effect on ITNs purchase. Health information treatments were also found to have an insignificant

role in the contexts of deworming (Kremer and Miguel 2007) and health and rainfall microinsurance (Bonan, et al. 2012; Cole et al. 2013; Thornton et al. 2010). We offer reasons as to why this might be the case below. Similarly, Rhee et al. (2005) found that households exposed to an educational module on malaria (concerning signs and symptoms, transmission, and benefits from ITN use) do not impregnate their bednets significantly more than those not exposed. Our information sessions, however, display a positive effect for households whose head has never attended school. This seems to suggest that a targeted information campaign could be more efficient.

The remainder of the article is organized as follows. The next section describes the context of the study. The third section presents our data, the design of our survey, and some preliminary results. The fourth section describes our estimation strategy and the results. The fifth and penultimate section provides further discussions of the results before the conclusion.

THE SENEGALESE CONTEXT: BEDNETS DISTRIBUTION AND HEALTH PROVIDERS

Malaria is an endemic disease throughout Senegal, and all of the population is considered at risk. Significant improvements have been made in the last ten years, due to public intervention. The share of outpatient visits motivated by malaria fell from 36% (clinically diagnosed and parasitology tested) in 2001 to 6% in 2008. About 7% of all deaths in children under five were attributed to malaria in 2008, compared to 30% in 2001 (President's Malaria Initiative 2013). Significant progress has been made in the presence in and use of ITNs by households, particularly in the most vulnerable ones, thanks to large-scale distribution campaigns which will be described below in detail. At the national level, the share of households claiming to own at least one ITN increased from 45% in 2005 to 63% in 2010 (DHS 2010-11).

In our sample, 48% claimed to have at least one LL-ITN and 33% claimed to have more than one. Eighteen % (22%) of pregnant women (children younger than five) responded that they had slept under an LL-ITN the night preceding the interview. This is slightly lower than the 22% (28%) who responded that pregnant women (children younger than five) had slept under an ITN in the previous twelve months, according to the large-scale survey DHS (2010–11). Our interviews took place between May and June 2012, at the end of the dry season, when the risk of contracting malaria is relatively low.

Bednets availability has recently improved in Africa (see Sexton 2011 and de Savigny et al. 2012). In Senegal, untargeted sale of subsidized LL-ITNs is one of the active strategies of the National Malaria Control Program (NMCP) Strategic Plan 2011–2015. As suggested by WHO, these more routine "keep-up" interventions should complement occasional "catch-up" mass distribution of free nets campaigns (WHO 2012). In the Senegalese context it is relevant to point out that all distributional campaigns in Senegal implemented some cost sharing. According to our data, the vast majority of people acquire bednets during public campaigns, and bednets are rarely acquired in the private sector at full price. At the time of our survey, no public campaign was running and the supply of subsidized bednets was nonexistent in Thiès.

NMCP is targeting by 2015 a 75% reduction in malaria-related mortality (with respect to the baseline year of 2010) and 80% of LL-ITNs coverage of the general population (President's Malaria Initiative 2013). To fulfill these objectives, a number of LL-ITNs distribution campaigns were realized according to different approaches: first, periodic free mass distribution; second, targeted subsidized LL-ITNs for vulnerable groups; third, untargeted subsidized distributions (through health facilities and community-based organizations). Between 2007 and 2009 NMCP and partners distributed more than three million LL-ITNs in the whole Senegalese territory to households with children under five years[1] and pregnant women (WHO 2011). The campaigns involved a door-to-door strategy to deliver a voucher for a free LL-ITN to be redeemed at a distribution point. The usual subsidized price was 1000 FCFA. The last campaign also included a series of communication interventions to advertise the campaign and to increase the awareness of the importance of using bednets (Thwing et al. 2011).

During our pilot survey we visited a number of health posts, health centers, and hospitals in Thiès, in order to check the availability of bednets. It turned out that no supply of bednets at subsidized prices was available for the vulnerable population (pregnant women and children younger than five years), nor for the population at large. LL-ITNs were available at privately run pharmacies at prices ranging from 5000 to 6000 FCFA (USD 10–12). Non-impregnated bednets were also available on the market at 1500 to 3000 FCFA (USD 3–6).

Health care in Thiès is organized according to a tiered system consisting of health huts (staffed by community health workers), health posts (staffed by nurses and certified midwives),

[1] The LL-ITNs distribution was bundled with the delivery of vitamin A supplementation and deworming in 2008 at the subnational level (over 1 million LL-ITNs); in 2009 2.2 million LL-ITNs were distributed nationwide together with vitamin A and mebendazole.

and health centers or hospitals (staffed by medical doctors, nurses, and certified midwives). The health district of Thiès has one regional public hospital and one privately run mission hospital (St-Jean de Dieu). Data for this region show that the ratio of inhabitants to health centers is seven times greater than WHO standards, while the ratio of inhabitants to health posts is in line with international norms (ANSD, 2008). In Thiès there is a large presence of health huts, posts, and pharmacies. These infrastructures are evenly distributed geographically. We observed that health-seeking behavior is a common practice among households. Our data indicate that sickness and in particular malaria cases are generally treated at health centers or hospitals. Also, public campaigns are currently allowing people to test for malaria at subsidized costs (around USD 1).

DATA

Survey and Sampling

Data were collected in May and June 2012 in the city of Thiès, which is the third most important city in Senegal with a population of about 263,500 inhabitants (2007 census) on an overall area of approximately twenty square Km. The city is organized in twenty-three neighborhoods. Our sample consisted of 490 households, which were randomly selected across the whole territory of the city. In order to obtain a representative sample of the population, the number of households selected in each neighborhood was proportional to the corresponding living population. Since an official list of public records was not available, in every neighborhood households were selected with a pseudo-random selection technique. A random set of streets was first selected in the neighborhood and then, on every selected street, a random sample of households was selected. Prior to the beginning of the baseline survey, all neighborhoods were visited and the list of all streets with private houses was updated. Streets hosting a great majority of economic activities (such as markets, shops, and public buildings) were excluded from the list. A random sample of streets was selected and assigned to enumerators. The enumerators were instructed to enter and survey every fifth house on the left on the assigned street. If the selected door was not that of an occupied house, the enumerator proceeded to the next door. If the residents were away or if neither the household head nor the spouse was available, a second visit was scheduled. Treatments were homogeneously assigned across neighborhoods. We employed ten local independent and qualified enumerators. All enumerators had previous experience with surveys

and field work and undertook a two-day training session given by the authors. Special sessions were dedicated to translating into the local language (Wolof) and to testing the enumerators' understanding. Enumerators were also followed by a local experienced supervisor during the early stages of their work.

Our baseline survey aimed at obtaining information on each household member's religion, level of education, and health problems (sickness and chronic diseases) and related expenditures, particularly concerning malaria. We also gathered information from the head of household or the spouse concerning work, income, and a number of other factors pertaining to trust, risk aversion, and discount rate evaluation, which we describe below in greater detail. Following Van de Walle and Gaye's (2005) analysis of Senegalese households, which proposes three levels, namely, concessions, households, and nuclear units, we adopted the latter as our unit of analysis. We consider nuclear units as composed by spouses, their children, and eventually other members of the family who economically depend on the head of the nuclear unit. Enumerators were instructed to randomly select among nuclear units when entering a house inhabited by an extended family. The reason for this choice lies in the fact that, most of the time, decisions about health behaviors are made at the nuclear unit level, not unilaterally by the traditional head of household.

In our context, which can safely be extended to the broader national level, the husband is generally considered to be the breadwinner and the head of the nuclear unit and, as such, is expected to take most economic decisions for the members of his unit (from now on called "household"). However, in order to further test this phenomenon, we interviewed, when possible, either the head or the spouse. We compensated respondents for the time spent answering the questionnaire, with a phone recharge of 1000 FCFA, which was directly provided by the enumerator before leaving the house. (Only a small minority of households did not own any mobile phones.)

Experimental Design

Treatments were randomly assigned at the household level. Around 43% of the sample received our short information session on malaria during the baseline survey; the other part of the sample did not receive such a session. After testing prior knowledge of malaria causes, ways of transmission, prevention, and use of bednets, enumerators presented a eight- to ten-minute

informational module. Our module provided information on the following eight points: 1) how malaria can be contracted; 2) incidence of malaria in Senegal and its particular impact on mortality and sickness for pregnant women and children under nine years old; 3) average amount of health expenses due to malaria in the city of Thiès (based on the data collected during our pilot survey); 4) benefits from the use of LL-ITNs in terms of lower incidence of malaria, lower expenditure and consequent possible savings from their use (also based on the data collected in Thiès during our pilot survey); 5) the importance of having a bednet for every bed and using it throughout the year; 6) availability of bednets in Thiès and where they can be purchased (namely at pharmacies at full price, around 5000 FCFA); 7) availability of subsidized bednets during public campaigns and discussion on the timing of such campaigns; 8) how to effectively use LL-ITNs.

Independently from the information treatment, households were assigned to the LL-ITN sale treatment. Half of the sample (53%) was offered an on-the-spot sale of one LL-ITN at the subsidized price of 1000 FCFA. The validity of the offer was immediate and lasted around fifteen minutes (the average time it took to complete the questionnaire at that stage). The second half (47%) of the sample received a voucher valid for seven days, during which the household head or his spouse could contact the enumerator to receive one LL-ITN at the subsidized price of 1000 FCFA. Once ordered by phone, the LL-ITN was delivered at an agreed meeting point by the enumerator. Each enumerator had one easy-to-find point of delivery in each neighborhood. Table 1 presents the allocation of the sample across treatments.

TABLE 1

ALLOCATION ACROSS TREATMENTS

	Information Treatment		
Sale Treatment	Yes	No	Total
Spot sale	102	159	261
Voucher	109	120	229
Total	211	279	490

Table A1 in the appendix shows the tests for random assignments of treatments. It presents t-test comparisons of means for a set of variables by treatment status. Our randomization with respect to the sale treatment appears to be satisfactory overall. Some

significant differences are observed between households who were given a voucher and those who were offered the opportunity to buy the bednet on the spot. These differences are related to three attributes of the household's head, including age, self-employment, and the risk preference parameter. The mean comparison tests also suggest similar issues with the randomization with respect to the information treatment. Some significant differences are observed between households who were given the information session and those who were not. Significant differences between the two groups are related to risk and time preferences, household size, and the knowledge of malaria symptoms. We present more on each of these measures below.

The reason why the random assignment of sampled households did not lead to an entirely comparable treated and non-treated group is not clear to us. One possible cause is the small sample sizes. The presence of observed differences between treated and non-treated groups should be taken into account during estimation. The first approach used for that is to systematically include all variables listed in Table A1 in the set of covariates in our estimation models. The second approach used is to re-weight the sample using entropy balancing (ebalance) so that the first three moments computed by treated and non-treated groups are equaled. We present both sets of results below.

Descriptive Statistics

Table 2 reports summary statistics for the main socioeconomic characteristics that we consider in our study and that will be used for our regression analysis. Most of the heads of household were male and lived in a couple. The average household size was six, and 58% of household heads had attended secondary school or higher levels of education (successfully completed at least six years of schooling). We computed a synthetic measure of durable goods or assets owned by the households as a proxy for wealth. It is simply the sum of a list of items comprising, among others, various kitchen and home appliances, mobile phone, bicycle, motorcycle, car, sewing machine, and various pieces of furniture. Additionally, we identified whether the household owned its dwelling unit. As a proxy for income stability we used a dummy identifying whether the head of household had a regular job or not and whether he was self-employed. Regarding malaria, we observed that 46% of sampled household had experienced at least one episode of malaria the year prior to the survey.

TABLE 2

MEAN AND STANDARD DEVIATION OF MAIN VARIABLES

Variables	Mean	Std. Dev.
Household (hh) has bought bednet (=1 if yes; 0 otherwise)	0.44	0.50
Treatment Information (=1 if information session given; 0 otherwise)	0.57	0.50
Voucher (=1 if given a voucher; 0 if offered the on-the-spot sale)	0.47	0.50
Hh has at least one bednet (=1 if yes; 0 otherwise)	0.60	0.49
Head's gender (=1 if male; 0 otherwise)	0.88	0.33
Household size	5.97	2.60
Age of the head	50.17	12.93
Head lives in couple (=1 if yes; 0 otherwise)	0.87	0.33
Years of schooling of the head	8.32	6.21
Head has no education (=1 if head has not attended school; 0 otherwise)	0.25	0.43
Head has primary education (=1 if head has attended primary school; 0 otherwise)	0.17	0.38
Head has secondary education (=1 if head has attended at least secondary school; 0 otherwise)	0.58	0.49
Head has a regular job (=1 if head has a regular source of income; 0 otherwise)	0.91	0.29
Head is self-employed (=1 if yes; 0 otherwise)	0.44	0.50
Head can read and write in French (=1 if yes; 0 otherwise)	0.68	0.47
Hh experienced at least one episode of malaria last year (=1 if yes; 0 otherwise)	0.46	0.50
Max number of years of schooling in the hh	11.01	4.93
Head owns the dwelling unit (=1 if yes; 0 otherwise)	0.74	0.44
Assets (sum of number of items)	7.98	4.51
Presence of children under 5 years old (=1 if there is a child under 5 in the hh; 0 otherwise)	0.58	0.49
Presence of pregnant woman in the hh (=1 if there is a pregnant woman in the hh; 0 otherwise)	0.02	0.15
Discount rate	0.508	0.025
Present bias	0.753	0.131
Risk preference parameter	0.531	0.164
Number of observations	490	

We tested at the baseline the knowledge of basic information about malaria and public bednet distribution policies through a set of true-false questions. With five questions we tested the level of knowledge on malaria.[2] The average score out of 5 of this variable "Malaria knowledge score" was 3.6 (median is 4). Thirteen percent answered fewer than three questions correctly, whereas 22% correctly answered all questions. The second set of questions aimed at

[2] We asked respondents to state whether the following statements were true or false (the share of correct answers is given in parenthesis). 1) Malaria is a contagious disease (30) (false); 2) mosquitoes contaminate food (68) (false); 3) mosquitoes transmit the disease in daylight (73) (false); 4) mosquitoes reproduce themselves in stagnant water sites (98) (true); 5) mosquitoes transmit malaria just by biting the skin (91) (true).

understanding the extent to which people were aware of past public bednet distribution campaigns and their features.[3] The mean of the variable "Anti-Malaria campaigns knowledge score" (out of 3) is 2.1 and half of our sample answered all questions correctly; 13% answered none correctly. There is a weak correlation (0.015) between the two knowledge scores. Across all levels of malaria knowledge scores, a large majority of people are fully aware of what public distribution campaigns involve, in terms of sites of distribution, targeted groups, and subsidized prices for bednets.

Concerning malaria prevention, we asked people to list all known methods of prevention: 93% of interviewees mentioned the use of bednets; 42% the employment of insecticide sprays; 59% the avoidance of stagnant water near the house. We also investigated what symptoms are associated with malaria. The most cited symptoms were high temperature (86%); nausea (60%); and headache (42%). Only 2% of respondents could not name any (correct) malaria symptom. These statistics convey a relatively high degree of awareness about malaria and the ways of preventing and identifying it. In spite the awareness of the importance of the use of bednets, only 28% of respondents claimed to know what an LL-ITN was. Only 12% knew the correct retail price of the product in private pharmacies.

More than half of sampled heads of household (59%) claimed to have at least one bednet at home. The most common reasons for not having bednets were negligence (47%); lack of means (19%); and use of other methods (12%). Conditional on owning at least one bednet, the average number of bednets per household was about 2.4, whereas if we consider the whole sample, the number decreases to 1.4. Considering an average household size of 5.8 members, it is more than likely that the number of owned bednets was insufficient to cover all the sampled population, even considering the possibility that several members of the household shared the same bednets, namely, children or couples. Among households owning bednets, only 17% had impregnated[4] ones. Moreover, even when respondents claimed that they had owned bednets for more than two years (on average), only 10% of owners had re-impregnated their bednets in the last year. About half of bednets owners (41%) paid to acquire their bednets (the average price

[3] We asked respondents to state whether the following statements were true or false (the share of correct answers is given in parenthesis). During a public bednet distribution campaign: 1) if I go to the health center I can get free bednets for children younger than five (65) (true); 2) pregnant women can get free bednets at health posts and health centers (69) (true); 3) everybody can get bednets at subsidized prices at health centers (76) (true).

[4] It is likely that the value of treated bednets (LL-ITNs) is underestimated due to the lack of awareness of the properties of the product.

paid is about 2000 FCFA), whereas the other 59% said that their bednets were obtained for free at health posts, centers, or hospitals or were distributed by the neighborhood chief or some NGO during previous distribution campaigns.

We use the methodology put forward in Voors et al. (2012) to elicit discount rates. The elicitation of the discount rate is based on the multiple price list approach. The household heads had to indicate their preferences between current and future rewards. The future reward was increased up to the point where the household head switched from current reward to future reward. With a starting value of 10000 FCFA, the sequence of future rewards used was the following 10500, 11000, 12500, 15000, 17500, 20000, 25000, and 30000. They represent respectively discount factors of 5%, 10%, 25%, 50%, 75%, 100%, 150%, and 200% for a given time period. We estimate our variables "present bias" and "discount rate" by using these multiple price lists questions and nonlinear estimations à la Tanaka, Camerer, and Nguyen (2010). Due to space restriction, for further details about these estimations and risk preference parameters we invite the reader to consult Bonan et al. (2014).

Table 3 presents the overall proportion of households who bought a bednet and the proportion within subsamples defined by the treatment status. After the treatments, 44% of households overall bought a bednet. About 56% of households who received a voucher redeemed it within seven days and bought a bednet at the subsidized price. Only 34% of households exposed to the on-the-spot sale treatment decided to buy the bednet. The difference of 22% between these two proportions is significant. Offering a fixed subsidized price during a week seems more effective that offering bednets at the same price on the spot. Regarding information, 46% of households who were provided with the information bought a bednet, slightly higher than the proportion of households (43%) who bought the bednet with no additional information on malaria. In this case, however, the difference is not significant. The absence of significance remains even when the sample is restricted to households who had low a "Malaria knowledge score."

The interaction of the two treatments has only a small differentiating effect. Indeed, when the sample is restricted to households who received a voucher, there is no significant difference in buying rate between informed and uninformed households. Similarly for the sample restricted to households who were offered the opportunity to buy the bednet on the spot.

TABLE 3

RATE OF HOUSEHOLD WHO BOUGHT BEDNETS BY TREATMENT

	Treatment Information		
Sale Treatment	Yes	No	Total
Spot Sale	0.36	0.33	0.34
	102	159	261
Voucher	0.55	0.57	0.56
	109	120	229
Total	0.46	0.43	0.44
	211	279	490

Public campaigns about malaria specifically target pregnant woman and children under five years of age. They represent two important vulnerable target groups. We identify households who would be targeted in case of a public campaign in our sample and then investigate whether their purchasing behavior are different compare to other households. Table 4 shows the proportion of households who bought a bednet according to their targeting status. Overall, there is no significant difference in purchasing rates between targeted and non-targeted households.

TABLE 4

RATE OF UPTAKE ACROSS DIFFERENT HOUSEHOLDS GROUPS

	Spot Sale	Voucher	Total	No Information	Information	Total
Targeted group (Rate)	0.35	0.55	0.45	0.39	0.49	0.45
(#obs)	110	94	204	89	115	204
Non-targeted group (rate)	0.33	0.57	0.44	0.51	0.40	0.44
(#obs)	151	135	286	122	164	286
Difference of rate between targeted and non-targeted	0.02	–0.02	0.01	–0.12**	0.09	0.01
Total (rate)	0.34	0.56	0.44	0.46	0.43	0.44
(#obs)	261	229	490	211	279	490

#obs is the number of households upon which the proportion (%) within each cell is computed. Thus out of the 204 households belonging to targeted groups during campaigns, 45% bought a bednets. ** indicates significant at 5%. *** p<0.01, ** p<0.05, * p<0.1.

Among households who were not given the information treatment, the proportion of households who bought a bednet among the targeted group is lower than the proportion among

non-targeted households. One possible explanation is that those in targeted group decide to wait until the next campaign to get the bednets for free. Alternatively, this could also simply reflect the fact that this vulnerable sample is significantly poorer than the other.

MEASURING THE IMPACT OF OUR TREATMENTS

To access the impact of the sale and information treatments on the effective demand of bednets, we estimate the following model:

$$Bi = X_i^{'} \beta + \alpha\, Info_i + \delta\, Voucher_i + \varepsilon_i$$

In the equation, B is a dummy variable that takes the value one when the household bought a bednet and the value zero otherwise. *Info* is a dummy variable that equals one when the household was provided with information about malaria. *Voucher* is a dummy variable that equals one when the household was given a voucher and equals zero when the household was offered an on-the-spot purchase. X is a vector of covariates that contains, among others: household heads' characteristics (gender, education, income, and employment status); an indicator of household wealth; and our two knowledge scores. Households are indexed with the subscript i.

The coefficients of interest are α and δ. They measure the effects of receiving information about malaria and of receiving a voucher on the probability of buying a bednet. Table 5 shows the results of our estimated linear probability model (LPM) with the method of OLS. It is common in this type of literature using RCT to present results of binary dependent variable models in this way. Our results are similar whether we use probit or logit estimation techniques. The first three columns present the regression coefficients in the absence of any additional control variables; in the last two columns other covariates are included, in particular, pre-intervention knowledge of malaria-related issues and household heads' education. Column 4 investigates the effect of the interaction of the two treatments.

TABLE 5

ESTIMATED COEFFICIENTS OF THE LPM OF PURCHASING A BEDNET

	1	2	3	4	5	6	7
Voucher	0.222***		0.222***	0.188***	0.209***	0.211***	0.181***
	(0.044)		(0.044)	(0.067)	(0.047)	(0.066)	(0.070)
Information session		–0.026	–0.007	–0.036	–0.002	–0.026	–0.025
		(0.045)	(0.044)	(0.062)	(0.047)	(0.062)	(0.066)
Voucher and Information				0.060		0.054	0.081
				(0.089)		(0.089)	(0.093)
Household size						0.008	0.014
						(0.009)	(0.010)
Age of the head						0.002	0.003
						(0.002)	(0.002)
Sex of the head						0.014	0.006
						(0.070)	(0.074)
Head has primary schooling						0.035	0.034
						(0.071)	(0.075)
Head has secondary schooling						0.080	0.106
						(0.065)	(0.069)
Head has post-secondary or plus						0.206***	0.236***
						(0.070)	(0.074)
Income quintile 2						0.146**	0.147**
						(0.070)	(0.074)
Income quintile 3						0.060	0.027
						(0.071)	(0.075)
Income quintile 4						0.107	0.065
						(0.069)	(0.074)
Income quintile 5						–0.103	–0.133
						(0.085)	(0.089)
Head has a permanent job						–0.100	–0.117
						(0.083)	(0.090)
Head is self-employed						0.054	0.080
						(0.050)	(0.052)
Malaria knowledge score						0.032	0.044*
						(0.023)	(0.024)
Anti-Malaria campaigns knowledge score						–0.029	–0.031
						(0.021)	(0.023)
=1 if one episode of malaria in the last year						0.085*	0.085*
						(0.046)	(0.048)
Discount rate					–0.293		–0.635
					(1.071)		(1.062)
Present bias					0.047		–0.004
					(0.201)		(0.200)
Risk preference					0.021		–0.080
					(0.147)		(0.148)
Constant	0.341***	0.460**	0.345***	0.363***	0.310**	–0.013	–0.031
	(0.030)	(0.034)	(0.040)	(0.048)	(0.152)	(0.202)	(0.244)
Observations	490	490	490	490	445	490	445
R-squared	0.050	0.001	0.050	0.051	0.044	0.118	0.124

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

We find that providing a voucher to buy a bednet within seven days has a significant and positive effect on the probability of a household's purchasing a bednet. The magnitude of the effect is around 20%. The advantage of providing a voucher is in guaranteeing a subsidized price over a week. Households who use the voucher opt for a delayed delivery and do not need to have "cash-in-hand," an amount of money to be used immediately, to purchase the bednet.

We also find that providing information about malaria has, on average, no significant effect on the probability of buying a bednet. The estimated effect is negative and not significant. This suggests that improving literacy on the prevention of malaria, on morbidity due to malaria, and on the direct and indirect costs generated by an episode of malaria has no significant effect on buying a bednet. One interpretation is that the information session did not sufficiently increase the expected benefits of using bednets to outweigh the costs of using them. Alternatively, because of liquidity constraints, people were unable to pay for a bednet, either on the spot or within a week, despite high expected benefits. The ineffective role of information on take-up is not specific to this study. It has also been observed in other contexts, notably regarding the purchase of health insurance (Bonan et al. 2012; Thornton et al. 2010) and financial technology (Cole et al. 2013). Our finding is also in line with Dupas (2009), who found that social marketing treatments, in the form of promotional messages, have no effect on bednet purchase in Kenya.

What our results seem to indicate is that the most stringent constraint faced by households is cash liquidity. Cash was not immediately available, and households had to rely on their voucher to extend the amount of time necessary to get the cash together. Another plausible explanation is that one spouse needed to consult with the other in order to approve the purchase, which imposed a delay on the decision. The importance of the "cash-in-hand" constraint on take-up is highlighted in this study and in others (Dupas 2009; Holla and Kremer 2009; Tarozzi et al. 2011).

The absence of a significant information effect could be related to issues of delivery. However, we made sure that the content of the information session was identical in each case and included health and financial framing. Health-related and financial-related consequences of malaria were described to household as well as various means of prevention. Enumerators were trained to deliver the information module uniformly. They were instructed to go through the eight information items listed above in the same sequence and to provide the same set of facts

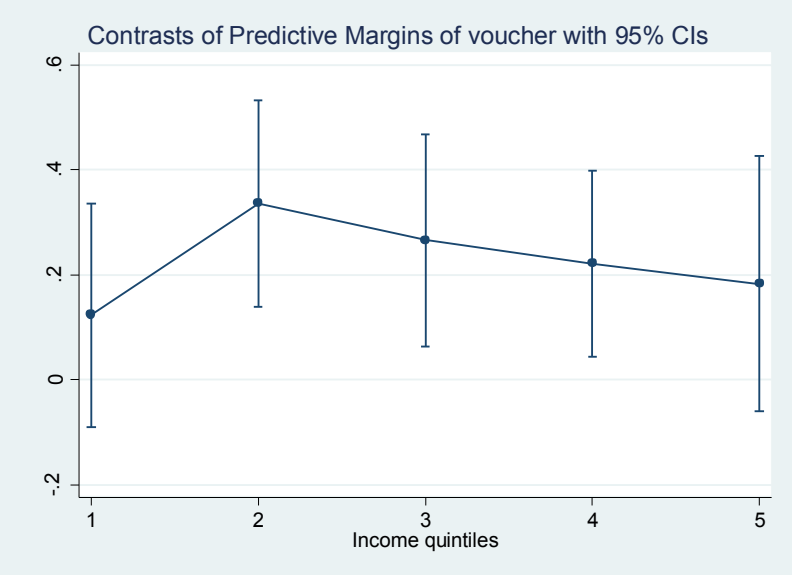
and details. It is worth mentioning that our computations (not shown due to space restriction but available upon request) show that our tests could detect expected effect size at the design phase (of 10–15%) with power well above the widely considered satisfactory threshold of 70%. So lack of power is not considered an issue.

The interaction term of having received information on malaria prevention and being offered a voucher to buy a bednet has no additional significant effect on the probability of purchasing a bednet. Table 5, column 4, shows that the coefficient of the interaction term is positive but not significant. Thus, only the sale treatment, on average, affects the demand for bednets.

We now turn to the heterogeneity of the effects observed. We start with the voucher effect and investigate whether it might be altered by the level of income. The variable voucher is interacted with income quintiles. The objective is to check whether the voucher has a similar effect across income levels. Figure 1 shows the marginal voucher effect and the 95% confidence interval throughout the five income quintiles. The chart indicates that the voucher effect is positive and significant within the second and the fourth quintile. The magnitude of the effect is between 22% and 34%. The voucher has no effect on the probability of buying a bednet among the very poor and the very rich. Among the very rich (fifth quintile), the value attached to the voucher is relatively low. We would not expect such a small amount of money to affect their behavior. Among the very poor, the result is surprising and highlights the extent to which the very poor are financially constrained. With the voucher, they still have to disburse a 1000 FCFA (USD 2) to get the bednet, an amount that remains apparently high for them. The very poor seem hampered in their access to bednets even sold at such a low, subsidized price. This represents a challenge and needs to be communicated emphatically to governments and NGOs that organize bednet distribution strategies based on cost sharing.

FIGURE 1

MARGINAL EFFECT OF THE VOUCHER TREATMENT BY INCOME QUINTILES

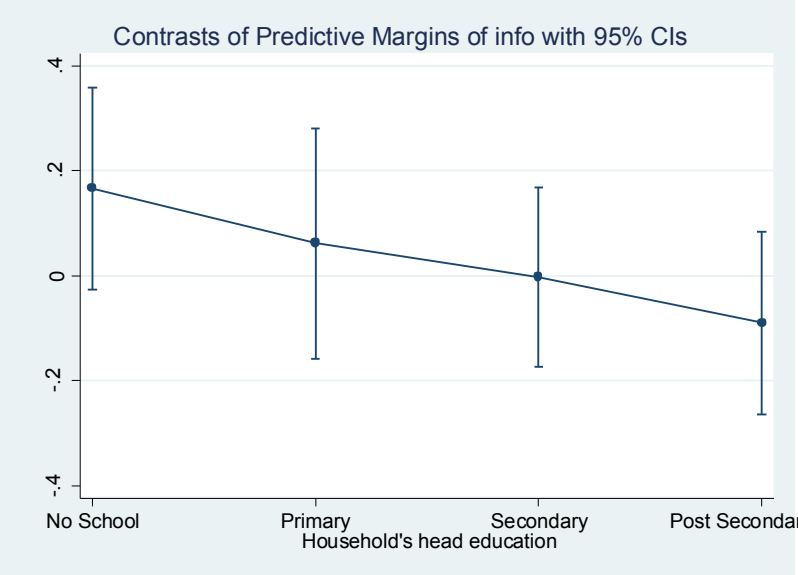


This figure is based on the estimates shown in column 5 of Table A3.

Figure 2 provides the marginal effect of attending the information session by education levels. The 95% confidence interval is also shown. Being treated with the information session increases the probability of buying the bednets by 17% for households where the head has no formal education. This effect is significant (at 10%) only for this sub-sample. If the household head has attended school, the information session has no effect on buying a bednet. The effect observed in households with uneducated heads is probably related to the assessment of various costs associated with malaria. Indeed, at baseline, there is little difference between uneducated and educated household heads for our variable "Malaria knowledge score." Given that part of the information session was devoted to stressing direct and indirect costs of a malaria episode, it is plausible that it is this type of financial information that made a difference for the heads who never attended school.

FIGURE 2

MARGINAL EFFECT OF THE INFORMATION TREATMENT BY HOUSEHOLD HEAD'S EDUCATION



This figure is based on the estimates shown in column 6 of Table A3.

FURTHER DISCUSSION

The barrier created by the lack of liquidity is also observed in households who had a bednet prior to our study. In our sample, 60% of household own at least one bednet. As discussed above, even if households already own one or more bednets, many households still have an insufficient number to make sure every household member sleeps under one. Among them, 60% acquired the nets for free during a public campaign; the remaining 40% bought them. The average price paid per bednet was 2100 FCFA (USD 4.2), which is still below the full retail price. In our sample, only five households (out of 490) paid the full retail price to get a bednet.

We investigate whether or not having a bednet before our treatments affected the results. We restrict our sample to household who had least one bednet and re-estimate the effect of the two treatments. The estimated coefficients, not shown, are similar to those presented in Table 5. Even when the households had experienced the use of bednets, they opted for delayed delivery of bednets. Likewise, the information treatment had no effect on the selected sub-sample of bednet owners.

As mentioned in the section on Experimental Design, our randomization with respect to our two treatments is not entirely satisfactory. To tackle this problem we produce a robustness check that involves rebalancing the sample. Table A1 indicates that the sample was not balanced: some significant differences were observed between treated and non-treated groups. We first accounted for these differences by adding covariates in the regression analysis (see Table 5). Now we rebalance the sample so that the first three moments computed by treated and non-treated groups are equaled. (For details on that technique see Hainmueller and Xu 2013.) Table A2 presents the estimated coefficients of the linear probability model based on the rebalanced sample. The signs of all estimated coefficients are similar to those presented in Table 5. Only some slight changes in the magnitude of coefficients are observed between Table 5 and Table A2. Also, the significance level of all coefficients is preserved across the original sample and the balanced sample. Overall the results obtained from the balanced sample are similar to those presented from the original sample. The pattern of the heterogeneity of the effects is also unaltered in the balanced sample.

CONCLUSION

This paper has investigated the demand for Long-Lasting Insecticide Treated Nets (LL-ITNs) in a region where malaria is endemic and malaria prevention weak. Our findings show that, on average, the information session has no effect on the demand for bednets. This result is not surprising if we consider some of the recent literature on the effect of information on the demand for health-related products. However, we observed a significant effect of information on household heads who had never attended school. Both our descriptive statistics and our regression analysis indicate the importance of the role played by the voucher. Having a seven-day voucher increases the probability of purchasing a bednet at a subsidized price, on average, by 20%. Thus, households, on average, are more inclined to purchase a net if they have the option of a delayed purchase rather than an on-the-spot offer. This result highlights the importance of the cash liquidity constraints faced by many households. Our results also show that the seven-day voucher has no significant impact on very poor households (1st quintile). This suggests that adopting a cost-sharing distribution strategy for bednets could be to the detriment of the very poor.

APPENDIX

TABLE A1

T-TEST COMPARISONS OF MEANS OF VARIOUS VARIABLES BETWEEN TREATED AND NON-TREATED

Variable	Obs	No Info (a)	Info (b)	Diff(b -a)	p-val	No Voucher (c)	Voucher (d)	Diff(d -c)	p-val
Household size	490	5.74	6.14	0.40	*	6.08	5.84	–0.24	
Age of the head	490	50.38	50.02	–0.36		51.19	49.01	–2.18	*
The household has at least one bednet	490	0.63	0.58	–0.05		0.61	0.59	–0.02	
Sex of the head	490	0.89	0.87	–0.02		0.89	0.87	–0.01	
Years of schooling of the head	490	8.58	8.13	–0.46		8.25	8.41	0.16	
Head has no education	490	0.20	0.28	0.08	**	0.26	0.23	–0.03	
Head attended primary school	490	0.21	0.14	–0.07	*	0.17	0.17	0.01	
Head attended secondary school or higher	490	0.59	0.57	–0.01		0.57	0.59	0.03	
Max # of years of schooling in the hh	490	11.06	10.97	–0.09		11.21	10.77	–0.44	
The head owns dwelling unit	490	0.73	0.75	0.02		0.74	0.75	0.01	
Assets (sum of items)	490	8.09	7.90	–0.20		8.23	7.69	–0.54	
Head has a permanent job	490	0.91	0.91	0.00		0.90	0.92	0.02	
Head is self-employed	490	0.47	0.42	–0.06		0.41	0.48	0.07	*
Malaria knowledge score, out of 5	490	3.73	3.51	–0.23	**	3.64	3.57	–0.06	
Anti-Malaria campaigns knowledge score, out of 3	490	2.18	2.07	–0.11		2.13	2.11	–0.01	
=1 if hh experienced at least one episode of malaria last year	490	0.49	0.44	–0.04		0.49	0.44	–0.05	
Presence of children under 5 years old	490	0.57	0.58	0.01		0.57	0.58	0.00	
Presence of pregnant woman in the hh	490	0.03	0.02	–0.01		0.01	0.03	0.02	*
Discount rate	445	0.048	0.053	0.006	**	0.051	0.051	–0.00	
Present bias	445	0.75	0.75	0		0.744	0.763	0.019	
Risk preference parameter	490	0.512	0.546	0.034	**	0.553	0.507	–0.045	**

TABLE A2

ESTIMATED COEFFICIENTS OF THE LPM OF PURCHASING A BEDNET (EBALANCED DATA)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sale treatment	0.240***		0.240***	0.216***	0.230***		0.230***	0.228***	0.199***
	(0.045)		(0.045)	(0.067)	(0.047)		(0.047)	(0.063)	(0.066)
Information session		0.002	0.002	–0.021		0.013	0.007	–0.014	–0.015
		(0.046)	(0.045)	(0.061)		(0.049)	(0.047)	(0.058)	(0.062)
Voucher and Information				0.045				0.036	0.068
				(0.089)				(0.087)	(0.091)
Household size								0.010	0.015
								(0.010)	(0.011)
Age of the head								0.002	0.003
								(0.002)	(0.002)
Sex of the head								–0.003	–0.007
								(0.074)	(0.075)
Head has primary schooling								0.008	0.013
								(0.071)	(0.072)
Head has secondary schooling								0.064	0.091
								(0.064)	(0.066)
Head has post-secondary or plus								0.184***	0.218***
								(0.070)	(0.071)
Income quintile 2								0.155**	0.163**
								(0.072)	(0.076)
Income quintile 3								0.060	0.037
								(0.068)	(0.073)
Income quintile 4								0.122*	0.089
								(0.069)	(0.074)
Income quintile 5								–0.093	–0.115
								(0.083)	(0.087)
Head has a permanent job								–0.131	–0.149
								(0.088)	(0.095)
Head is self-employed								0.054	0.083
								(0.051)	(0.052)
Malaria knowledge score, out of 5								0.032	0.044*
								(0.022)	(0.023)
Anti-Malaria campaigns								–0.032	–0.033
knowledge score, out of 3								(0.021)	(0.022)
=1 if hh experienced at least one								0.078*	0.081*
episode of malaria in the last year								(0.045)	(0.047)
Discount rate					–0.266	–0.616	–0.288		–0.555
					(1.044)	(1.076)	(1.053)		(1.028)
Present bias					0.011	0.127	0.012		–0.046
					(0.196)	(0.204)	(0.196)		(0.186)
Risk preference parameter					–0.023	–0.121	–0.025		–0.125
					(0.144)	(0.152)	(0.145)		(0.143)
Constant	0.324***	0.443***	0.323***	0.335***	0.336**	0.429***	0.334**	0.066	0.077
	(0.030)	(0.035)	(0.040)	(0.047)	(0.146)	(0.153)	(0.147)	(0.213)	(0.239)
Observations	490	490	490	490	445	445	445	490	445
R-squared	0.058	0.000	0.058	0.059	0.054	0.002	0.054	0.126	0.136

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

TABLE A3

ESTIMATED COEFFICIENTS OF THE LPM OF PURCHASING A BEDNET: INTERACTION TERMS

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Sale treatment	0.218***	0.236***	0.221***	0.242***	0.135	0.239***
	(0.068)	(0.044)	(0.060)	(0.044)	(0.101)	(0.044)
Information session	0.008	0.101	0.009	–0.017	–0.003	0.177*
	(0.045)	(0.068)	(0.045)	(0.061)	(0.045)	(0.092)
Income quintile 2 * Voucher					0.194	
					(0.140)	
Income quintile 3 * Voucher					0.120	
					(0.142)	
Income quintile 4 * Voucher					0.129	
					(0.131)	
Income quintile 5 * Voucher					0.078	
					(0.157)	
Voucher * Targeted group	0.036					
	(0.089)					
Information * Targeted group		–0.163*				
		(0.090)				
Voucher * Past malaria episode			0.041			
			(0.089)			
Information * Past malaria episode				0.052		
				(0.090)		
Information * Head has primary schooling						–0.110
						(0.140)
Information * Head has secondary schooling						–0.211*
						(0.123)
Income quintile 2					0.059	
					(0.097)	
Income quintile 3					0.016	
					(0.096)	
Income quintile 4					0.076	
					(0.090)	
Income quintile 5					–0.112	
					(0.118)	
Head has primary schooling						0.128
						(0.105)
Head has secondary schooling						0.188*
						(0.098)
Head has post-secondary schooling						0.322***
						(0.103)
Information * Head post-secondary						–0.292**
						(0.123)
Assets (sum of items)	0.012**	0.012**	0.012**	0.012**		0.010*
	(0.006)	(0.006)	(0.006)	(0.006)		(0.006)
Targeted household during campaign	–0.023	0.085	–0.006	–0.005	–0.017	–0.007
	(0.067)	(0.071)	(0.051)	(0.051)	(0.052)	(0.051)

=1 if past episode of malaria in the last year	0.093**	0.090**	0.073	0.063	0.094**	0.090**
	(0.046)	(0.046)	(0.061)	(0.068)	(0.046)	(0.046)
Constant	0.246	0.179	0.246	0.247	0.148	0.042
	(0.193)	(0.191)	(0.192)	(0.191)	(0.200)	(0.215)
Observations	490	490	490	490	490	490
R-squared	0.096	0.102	0.096	0.096	0.115	0.116

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.
The following variables—malaria knowledge score, anti-malaria campaigns knowledge, household head age, gender, education and activity, household size, risk and time preferences—were included in the regressions but for the sake of brevity their estimated coefficients are not shown.

REFERENCES

ANSD (Agence Nationale de la Statistique et de la Démographie). 2008. "Situation Économique et Sociale de la Région de Thiès." Available from http://www.ansd.sn/publications_SES_ region.html.

Bhattacharyya, S. 2009. "Root Causes of African Underdevelopment." *Journal of African Economies* 18 (5): 745–80.

Bonan, J., O. Dagnelie, P. LeMay-Boucher, and M. Tenikue. 2012. "Is It All about Money? A Randomized Evaluation of the Impact of Insurance Literacy and Marketing Treatments on the Demand for Health Microinsurance in Senegal." Research Paper No. 14, International Labour Organisation, Microinsurance Facility.

Bonan, J., P. LeMay-Boucher, D. Scott, and M. Tenikue. 2014. "Real versus Hypothetical Time-Discounting Rates: Evidence from a Randomized Experiment." Mimeo.

Cohen, J., and P. Dupas. 2010. "Free Distribution or Cost-Sharing? Evidence from a Randomized Malaria Prevention Experiment." *Quarterly Journal of Economics* 125 (1): 1–45.

Cole, S., X. Gine, J. Tobacman, P. Topalova, R. Townsend, and J. Vickery. 2013. "Barriers to Household Risk Management: Evidence from India." *American Economic Journal: Applied Economics* 5 (1): 104–35.

de Savigny, Don, Jayne Webster, Irene Akua Agyepong, Alex Mwita, Constance Bart-Plange, Aba Baffoe-Wilmot, Hannah Koenker, Karen Kramer, Nick Brown, and Christian Lengeler. 2012. "Introducing Vouchers for Malaria Prevention in Ghana and Tanzania: Context and Adoption of Innovation in Health Systems." *Health Policy Planning* 27: iv32–iv43.

(DHS) Demographic and Health Survey Program: Senegal Report 2010-2011;

Dupas, P. 2009. "What Matters (and What Does Not) in Households' Decision to Invest in Malaria Prevention?" *American Economic Review* 99 (2): 224–30.

_____. 2012. "Short-Run Subsidies and Long-Run Adoption of New Health Products: Evidence from a Field Experiment." Mimeo.

Gallup, L., and J. D. Sachs. 2001. "The Economic Burden of Malaria." *American Journal of Tropical Medical and Hygiene* 64: 85–96.

Gimnig, John E., Margarette S. Kolczak, Allen W. Hightower, John M. Vulule, Erik Schoute, Luna Kamau, Penelope A. Phillips-Howard, Feiko O. Ter Kuile, Bernard L. Nahlen, and William A. Hawley. 2003. "Effect of Permethrin-Treated Bed Nets on the Spatial Distribution of Malaria Vectors in Western Kenya." *American Journal of Tropical Medicine and Hygiene* 68: 115–20.

Hainmueller, Jens, and Yiqing Xu. 2013. "Ebalance: A Stata Package for Entropy Balancing." *Journal of Statistical Software*. 54 (7).

Holla, Alaka, and Michael Kremer. 2009. "Pricing and Access: Lessons from Randomized Evaluations in Education and Health." CGDEV Working Paper No. 158.

Kremer, M., and E. Miguel. 2007. "The Illusion of Sustainability." *Quarterly Journal of Economics* 122 (3): 1007–65.

Lengeler, C. 2004. "Insecticide-Treated Bed Nets and Curtains for Preventing Malaria." Cochrane Database of Systematic Reviews, Issue 2.

Lucas, Adrienne M. 2010. "Malaria Eradication and Educational Attainment: Evidence from Paraguay and Sri Lanka." *American Economic Journal: Applied Economics* 2 (2): 46–71.

President's Malaria Initiative. 2013. Malaria Operational Plan, FY 2013, Senegal.

Rhee, M., M. Sissoko, S. Perry, W. McFarland, J. Parsonnet, and O. Doumbo. 2005. "Use of Insecticide-Treated Nets (ITNs) Following a Malaria Education Intervention in Piron, Mali: A Control Trial with Systematic Allocation of Households." *Malaria Journal* 4: 35.

Sexton, A. R. 2011. "Best Practices for an Insecticide-Treated Bed Net Distribution Programme in Sub-Saharan Eastern Africa." *Malaria Journal* 10: 157.

Tanaka, T., C. F. Camerer, and Q. Nguyen. 2010. "Risk and Time Preferences: Linking Experimental and Household Survey Data from Vietnam." *American Economic Review* 100 (1): 557–71.

Tarozzi, A., Aprajit Mahajan, Brian Blackburn, Daniel Kopf, Lakshmi Krishnan, and Joanne Yoong. 2011. "Micro-Loans, Insecticide-Treated Bednets and Malaria: Evidence from a Randomized Controlled Trial in Orissa (India)." Economic Research Initiatives at Duke (ERID) Working Paper No. 104.

Thornton, R., L. Hatt, E. Field, I. Mursaleena, F. Diaz, and M. Gonzales. 2010. "Social Security Health Insurance for the Informal Sector in Nicaragua: A Randomized Evaluation." *Health Economics* 19 (S1): 181–206.

Thwing, J. I., R. T. Perry, D. A. Townes, M. B. Diouf, S. Ndiaye, and M. Thior. 2011. "Success of Senegal's First Nationwide Distribution of Long-Lasting Insecticide-Treated Nets to Children under Five: Contribution toward Universal Coverage." *Malaria Journal* 10: 86.

Van de Walle, E., and A. Gaye. 2005. "Household Structure, Polygyny, and Ethnicity in Senegambia: A Comparison of Census Methodologies." In E. Van de Walle, ed., *African Households: Censuses and Surveys*, 3–21. Armonk, NY: M. E. Sharpe.

Voors, Maarten J, Eleonora E. M Nillesen, Philip Verwimp, et al. 2012. "Violent Conflict and Behavior: A Field Experiment in Burundi." *American Economic Review* 102(2): 941–964.

WHO (World Health Organization). 2011, 2012, 2014. *World Malaria Report*.