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n° 2015-03 October 2015

WORKING PAPERS

Increasing anti-malaria bednets uptake using information and distribution strategies

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Increasing anti-malaria bednets uptake using information and distribution strategies:

Evidence from a randomized experiment in Senegal.

March 2015

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Abstract

This paper studies the effect of information on malaria and of distribution strategies on the demand for anti-malaria bednets. We use a randomized experiment in the city of Thies 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 7 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 of bednets and that, receiving a voucher increases purchasing by 20%. Our results suggest that selling bednets at a subsidized prize 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.

Acknowledgements

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 field work. Any remaining errors are our own. LeMay-Boucher wishes to thank the Kellogg Institute for International Studies at the University of Notre Dame.

1. Introduction

Malaria is still at the heart of global public health concerns. 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 mortality of vulnerable groups such as children and pregnant women (see Langler 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 a LL-ITN in 2013 (WHO 2014). Because the use of ITNs has important spillover effects, through the reduction of the mosquito population (Gimming et al. 2004), 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), 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, availability and demand of bednets.

A debate is ongoing among health researchers and program directors concerning LL-ITN distribution framework as to whether it is it preferable to propose free distribution rather than opting 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 of ITNs is highly price sensitive and cost-sharing are 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 Thies (Senegal) hinted at the fact that the last national distribution campaign of LL-ITNs organized between 2007 and 2009 could potentially be improved by offering more information on their benefits and 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 more information and that instead of having the LL-ITNs available at a fixed point, a door-to-door on-the-spot sale could potentially yield better results. This paper investigates these propositions.

We thus offer subsidized LL-ITNs at a prize 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 on 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 distribute 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. Secondly, we propose, at the same price, the purchase of an LL-ITN on the spot, through a door-to-door campaign. By comparing the effect 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 (1^{st} quintile) and the very rich (5^{th} quintile). We also find that, information has, on average, no significant effect on the likelihood of buying bed nets. This contrary to the fact that lack of information is thought to be one of the reasons given to the low adoption of health preventive technology. Dupas (2009) finds that the social marketing treatments, under the form of promotional messages, have no effect on effective ITNs purchase. An insignificant role of health information treatments was also found in the context of deworming (Kremer and Miguel 2007), 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 significantly more their bednets than those not exposed. Our information session 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. Section 3 presents our data, the design of our survey and some preliminary results. Section 4 describes our estimation strategy and the results. Section 5 provides further discussions of the results and section 6 concludes.

2. The Senegalese context: bednets distribution and health providers

Malaria is an endemic disease throughout Senegal and all of its population is considered at risk. Significant improvements have been done in the last 10 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; Senegal Malaria Operational Plan FY 2013). Significant progress has been made in the presence and use of ITN by households, particularly

in most vulnerable ones, thanks to large-scale distribution campaigns which will be described below in detail. At national level, the share of households declaring to own at least one ITN increased from 45% in 2005 to 63% in 2010 (DHS 2010-11).

In our sample, we find that 48% declared to have at least one LL-ITN and that 33% declared to have more than one. 18% (22%) of pregnant women (children younger than five) responded that they slept under a LL-ITN the night preceding the interview. Slightly lower than the 22% (28%) who declared that pregnant women (children) slept under ITN in the previous 12 months according to the large scale survey DHS (2010-12). Our interviews took place between May and June 2012, at the end of the dry season, when the risks of contracting malaria is relatively small.

Bednets availability has been 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, this type of more routine 'keep-up' interventions should complement the 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 rarely in the private sectors at full prices. At the time of our survey, no public campaign was running and the supply of subsidized bednets was inexistent in Thies.

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 (Senegal Malaria Operational Plan, FY2013). To fulfill such objectives, a number of LL-ITNs distribution campaigns were realized according to different approaches: first, periodic mass free 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 CFA. 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 Thies, in order to check the availability of bednets. It turned out that no supply of bednets at subsidized price 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 (USD10-12). Non-impregnated bednets were also available on the market at 1500 to 3000 FCFA (USD3-6).

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

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), and health centres or hospitals (staffed by medical doctors, nurses, and certified midwives). The health district of Thies has one regional public hospital and one privately run mission hospital (St-Jean de Dieu). Data for this region shows that the ratio of inhabitants to health centres 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 USD1).

3. Data

3.1 Survey and sampling

Data have been collected in May and June 2012 in the city of Thies. It is the third most important city in Senegal with a population of about 263,500 inhabitants (2007 census) on an overall area of approximately 20 Km square. The city is organized in 23 neighborhoods. Our sample consists of 490 households. These households 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, household 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 (like markets, shops and public buildings) were excluded from the list. A random sample of streets were selected and assigned to enumerators. The enumerators were instructed to enter and survey every fifth house on the left on the assigned street. In case the selected door was not an occupied house, the enumerator had to select the following. In case of absence of the settlers, a second visit was programmed, as well as when neither the chief nor the spouse was available. 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-days training session given by the authors. Special sessions were dedicated to the translation in the local language (Wolof) and to test enumerators' understanding. Enumerators were also followed by a local experienced supervisor during the early stage 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 (2005) analysis of Senegalese households which proposes three levels: namely concessions, households and

nuclear units, we adopt the latter as unit of analysis. We consider nuclear units as composed by spouses, their children and eventually other members of the family who economically depend of 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 of this choice lays in the fact that, most of the time, decisions on health behaviors are made at nuclear unit and not by the traditional chief of household.

In our context, and this 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 the most relevant economic decisions for the members of his unit (from now on called 'household'). However, in order to further test this phenomenon, we interview, 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 (a small minority of households did not own any mobile phone).

3.2 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 household did not receive such session. After testing prior knowledge of malaria causes, ways of transmission, prevention and use of bednets, enumerators presented a 8-10 minutes 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 9 years old; 3) Average size of health expenses due to malaria in the city of Thies (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 its use (also based on the data collected in Thies during our pilot survey); 5) Importance of having a bednet for every bed and its use throughout the year; 6) Availability of bednets in Thies and where it 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 sell treatment. Half of the sample (53%) was proposed the 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 15 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 7 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.

[INSERT Table 1 here]

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 overall satisfactory. Some significant differences are observed between households who were given a voucher and those who offered to buy the bednet on the spot. These differences are related to four 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 below more on each of these measures.

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 group 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 in 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 below both sets of results.

3.3 Descriptive statistics

Table 2 reports summary statistics for the main socio-economic characteristics we consider in our study and which will be used for our regression analysis. Most of the heads of household are male and live in a couple. The average household size is six and 58% of household heads attended secondary school or higher levels of education (completed successfully 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 a series of kitchen and home appliances, mobile phone, bicycle, motorcycle, car, sewing machine, different pieces of furniture, etc. Additionally we identified whether the household owned their dwelling unit. As a proxy for income stability we use a dummy identifying if the head of households has a regular job or not and whether he is 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.

[INSERT Table 2 here]

We test at the baseline the knowledge of basic information on malaria and public bednet distribution policies through a set of true-false questions. With five questions we test the level of knowledge on malaria.[2] The average score out of 5 of this variable 'Malaria knowledge score' is 3.6 (median is 4). 13% correctly answered to less than three statements, whereas 22% correctly answered to all questions. The second set of questions aimed at understanding the extent to which people were aware

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

of past public bednets 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 correctly answered to all questions; 13% correctly answered to none. There is a weak correlation (0.015) between the two knowledge scores. Across all levels of malaria knowledge score, 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 mention the use of bednets, 42% the employment of insecticide sprays, 59% the avoidance of stagnant water nearby the house. We also investigate what symptoms are associated with malaria. The most cited symptoms are high temperature (86%), nausea (60%) and headache (42%). Only 2% of responders could not name any (correct) malaria symptom. These statistics convey a relatively high degree of awareness about malaria, its way of preventing and identifying it. In spite the awareness of the importance of the use of bednets, only 28% of respondents declared 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 head of households (59%) declared to have at least one bednet at home. The most common reasons for not having bednets are negligence (47%), lack of means (19%) and use of other methods (12%). Conditional on owning at least one bednets, the average number of bednets per household is 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 possible that the number of owned bednets is insufficient to cover all the sampled population, even considering the possibility that several members of the household share of the same bednets, namely children or couples. Among household holding a bednets, only 17% have impregnated[4] ones. Moreover, although respondents claimed they owned bednets since more than 2 years (on average), only 10% owners had re-impregnated their bednets in the last year. About half of bednets owners (41%) paid to acquire their bednets (the average price paid is about 2000FCFA), whereas the other 59% said that bednets were obtained for free at health posts or centers, hospitals or were distributed by the neighborhood chief or some NGOs during previous distribution campaigns.

We use the methodology put forward in Voors et al. (2010) to elicit discount rates. The elicitation of the discount rate is based on the multiple price list approach. The household heads had to indicate his 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 CFA francs, 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 non-linear estimations a la

[3] We asked to state whether the following statements were true or false (in parenthesis the share of correct answers): During a public bednets distribution campaign: 1) If I go to the health centre I can get free bednets for children less than 5 (65) (true); 2) Pregnant women can get free bednets at health posts and health centres (69) (true); 3. Everybody can get bednets at subsidized prices at health centres (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.

Tanaka et al. (2010). Due to space restriction, for further details on these estimations and risk preference paramereter we invite the reader to see Bonan et al. (2014).

Table 3 presents the overall proportion of household who bought a bednet and the proportion within subsamples defined by the treatment status. After the treatments, 44 % of household bought a bednet overall. About 56 % of household who received a voucher redeemed it within seven days and bought a bednet at a subsidized price. Only 34% of households exposed to the on-the-spot sale decide 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 household (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 household who had low 'Malaria knowledge score'.

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

[INSERT Table 3 here]

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

[INSERT Table 4 here]

Among households who were not treated with 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 that the other.

4. 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:

$$B_i = X_i' \beta + \alpha\, Info_i + \delta\, Voucher_i + \varepsilon_i$$

In the equation, *B* is a dummy variable that takes the value one when the household bought a bednets and the value zero otherwise. *Info* is a dummy variable that equals one when the household was provided with information on malaria. *Voucher* is a dummy variable that equals one when the household was given a voucher and equals zero if offered to buy a LL-ITN on the spot. *X* is a vector of covariates which 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 on malaria and of receiving a voucher on the probability of buying a bednets. 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 this way. Our results are similar if we use probit or logit estimation technique. The first three columns present the regression coefficients in the absence of any additional control variables while in the last two columns, other covariates are included. In particular, pre-intervention knowledge of malaria related issues and household's head education are included. Column 4 investigates the effect of the interaction of the two treatments.

[INSERT Table 5 here]

We find that providing a voucher to buy a bednets within seven days has a significant and positive effect on the probability of purchasing a bednets by households. 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-on-hand", an amount of money to be used immediately, to purchase the bednets.

We also find that providing information on malaria has, on average, no significant effect on the probability of buying the bednets. The estimated effect is negative and not significant. This suggests that improving literacy both on the prevention of malaria, on morbidity due to malaria, 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 increase enough the expected benefits of using bednets up to a level that outweighed the costs of using them. Alternatively, because of liquidity constraints, people are unable to pay either on the spot or within a week for a bednet despite high expected benefits. The ineffective role of information on take-up is not specific to this study. It has also been observed in different contexts notably related to 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 the social marketing treatments, under the form of promotional messages, have no effect on bednets purchase in Kenya.

What our results seem to indicate is that the most stringent constraint faced by households is related to cash liquidity. Cash was not immediately available and households had to rely on their voucher to

extend the amount of time necessary to make the cash available. 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 to purchase. The importance of the "cash-on-hand" constraints 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 and included health and financial framing. Health related consequence of malaria 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 with 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 bednets. 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 of bednets.

We now turn to the heterogeneity of the effects observed. We start by voucher effect and investigate whether the voucher effect might be altered with the level of income. The variable voucher is interacted with income quintiles. The objective is to check whether across income levels, the voucher has a similar effect. 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 bed nets among the very poor and the very rich. Among the very rich (fifth quintile), the value attached to the voucher is relatively small. We do not expect such a small amount of money to affect their behavior. Among the very poor, the result is surprising and highlight to what extend the very poor are financially constrained. With the voucher, they still have to disburse a 1000 CFA (USD2) to get the bed nets, an amount that remains apparently high for them. The very poor seem hampered in their access to bednets even when they are sold at such a low subsidized price. This represents a challenge and need to be stressed in the face governments and NGOs which organized bednet distribution strategies that are based on cost sharing.

[INSERT Figure 1 here]

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 the bednets. The effect observed within household with an uneducated head is probably related to the assessment of various cost associated to malaria.

Indeed, at baseline, there is little difference between uneducated and educated household for our variable 'Malaria knowledge score'. Given that part of the information session was devoted to stressing direct and indirect cost 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.

[INSERT Figure 2 here]

5. Further discussion

The barrier created by the lack of liquidity is also observed on households who had a bednets prior to our study. In our sample, 60 % of household own at least one bednets. As discussed above, even if households already own one or several bednets, a large number of households still have an insufficient number to make sure every member sleeps under one. Among them, 60% acquired the net for free during a public campaign; the remaining 40% bought it. The average price paid per bednet was 2100 CFA (USD4.2) which is still below the full retail price. In our sample, only 5 households (out of 490) paid the full retail price to get a bednet.

We investigate whether having a bednet before our treatments alter 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 household have experience the use of bednets, they opt for delayed delivery of bednets. The information treatment has also no effect on the selected sub-sample of bednets owners.

As mentioned in section 3.2, our randomization with respect to our two treatments is not entirely satisfactory. To tackle this problem we produce robustness check which 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 sign of all estimated coefficients are similar to those presented in Table 5. Only some slight changes on the magnitude of coefficients are observed between Table 5 and Table A2. Also, the significant level of all coefficients is preserved across the original sample and the balanced sample. Overall the results obtained on the balanced sample are similar to those presented on original sample. The pattern of the heterogeneity of the effects is also unaltered with the balanced sample.

6. Conclusion

This paper investigates 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 of bednets. This result is not surprising if we consider some of the recent literature on the effect of information on the demand of health related products. However, we observed a significant effect of information on household heads who never attended school. Both our descriptive statistics and our regression analysis indicate the importance of the role played by the voucher. Having a 7-day voucher increases by 20% on average the probability of purchasing a bednets at a subsidized price. Thus, household on average are more inclined to purchase if they have the option of a delayed purchase compare to an on-the-spot offer. This result highlights the importance of cash liquidity constraints faced by many households. Our results also show that the 7-day voucher has no significant impact on the very poor households (1^{st} quintile). This suggests that setting a cost sharing distribution strategy for bednets could be at the expense of the very poor.

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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 2: Mean and standard deviation of main variables

Variables	Mean	Std. Dev.
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
The 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
The household 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
The 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	

Table 3: Rate of household who bought bednets by treatment

Treatment Sale	Treatment Information 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

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

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 Secondary schooling						0.080	0.106
						(0.065)	(0.069)
Head 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

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 biais	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)
Treatment Sale	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 Secondary schooling								0.064	0.091
								(0.064)	(0.066)
Head 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 knowledge score, out of 3								-0.032	-0.033
								(0.021)	(0.022)
=1 if hh experienced at least one episode of malaria in the last year								0.078*	0.081*
								(0.045)	(0.047)
Discount rate					-0.266	-0.616	-0.288		-0.555
					(1.044)	(1.076)	(1.053)		(1.028)
Present biais					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

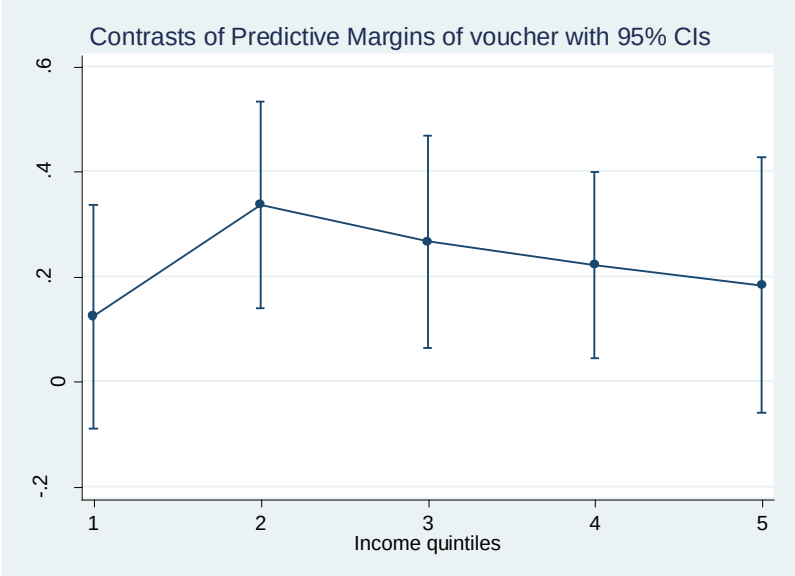
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Treatment Sale	0.218***	0.236***	0.221***	0.242***	0.135	0.239***
	(0.068)	(0.044)	(0.060)	(0.044)	(0.101)	(0.044)
Information session	0.008	0.101	0.009	-0.017	-0.003	0.177*
	(0.045)	(0.068)	(0.045)	(0.061)	(0.045)	(0.092)
Income quintile 2 * Voucher					0.194	
					(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

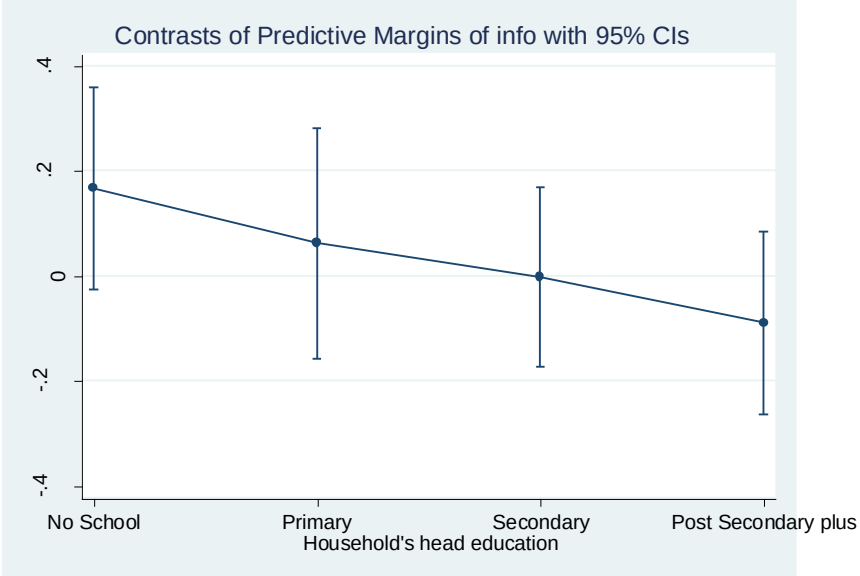
The following variables: Malaria knowledge score, Anti-malaria campaigns knowledge, household head age, gender, education and activity, household size, risk and time preferences were included in the regressions but for the sake of brevity their estimated coefficients are not shown.

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: Marginal effect of the information treatment by household's head education



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

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