

Free Distribution or Cost-Sharing?: Evidence from a Randomized Malaria Prevention Experiment

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Subsidizing Public Goods

- Generally accepted that products with positive health externalities (e.g. vaccines) should be publicly-funded
- I confer benefit to others by getting the vaccine, but I don't take that value into account when I decide if I want it or not
 - Implies that demand for public health products too low
- Public finance theory: government should subsidize the product to increase demand and thus social welfare

How should we price public health products?

- How much should it be subsidized?
 - “Optimal” subsidy depends on private costs/benefits relative to social benefit
- Figuring out the “correct” subsidy, when possible, is time-consuming and expensive
- So with most public health products, use rules of thumb and trial/error for pricing...

Free Distribution vs. Cost-Sharing

- Two common models for public health programs in Africa are full-subsidization (zero financial price) and moderate cost-sharing (user fees)
- Arguments for and against both of these models have been advanced

Example: ITNs

- Public health product (used to prevent malaria) w/ private benefits and proven externality
 - Sleeping under ITN repeatedly been shown to be highly effective at preventing infant mortality, maternal anemia and poor birth outcomes
 - Helps avert substantial direct and indirect costs of malaria on lost income
 - Health benefits of ITNs for non-users as long as enough users in vicinity
 - Rand. trial in Kenya shows that impact of ITNs on child mortality, etc. was as strong in control villages w/in 300m of covered villages as in covered themselves (Gimnig 2003, Hawley 2003)

ITNs (Cont.)

- ITNs cost about \$6 in Kenya (vs. \$360 GDP/cap)
- Many of the most vulnerable populations (esp. pregnant women & children in rural areas) cannot afford
- General consensus that ITNs should be subsidized...but how much?
 - Distribution to vulnerable populations has primarily taken the form of free distribution and cost-sharing

Arguments for Cost-Sharing: Sustainability

- Cost-recovery allows program to be run longer, be taken up by communities with limited budgets
- Allows potential retail sector to emerge/persist
 - Some populations can afford to pay more
- What if donor money dries up or government initiative goes elsewhere?

Arguments for Cost-Sharing:

Usage Intensity & Need

- Selection: positive prices induce selection of people who value the product more/are more likely to use it
- Psychological: paying more may *induce* usage
 - Sunk Cost Effect/Cognitive Dissonance
 - Prices act as signal of importance or quality
- Similar argument about need: those willing to pay more are probably sicker (more vulnerable to malaria) and more in need of ITN
- Are resources wasted on those receiving ITNs free?
Are those that pay more likely to use it and need it?

Arguments for Full Subsidization:

Demand, Externality & the Importance of Zero

- Coverage may be much lower under cost-sharing than free distribution
- Some evidence that the elasticity of demand near zero price is large (Kremer and Miguel 2007)
- Change in demand may overwhelm the benefits coming from positive selection
- Even if higher prices induce selection of people more likely to need & use, what happens to “effective coverage”?
- Effective coverage is particularly important w/ ITNs because of the form of the externality: 50% coverage necessary for strong social benefits to emerge

Arguments for Full Subsidization: Willingness vs. Ability to Pay

- Rather than screening out people who value the product less, positive price might just screen out those who can't afford it
 - Particularly problematic in context of credit constraints & gender inequality in control of household resources
- If ability to pay negatively correlated with health, positive price may screen out those who value the product most and would use it more intensively
- Subsidy for ITNs has to be low enough to discourage those w/ low valuation from getting it, but high enough for those who value it but cannot afford

What are the Tradeoffs between Full and Partial-Subsidization?

- Impact of subsidy level on the targeted health outcome will depend on a few key factors:
 - 1) Elasticity of demand with respect to price
 - 2) Elasticity of usage with respect to price (selection + psychological effects)
 - 3) “Elasticity of need” with respect to price
 - 4) The presence of non-linearities or externalities in the health production function

Our Approach: Randomized Trial with ITNs

- We estimate these parameters and explore tradeoffs between cost-sharing & free distribution for ITNs
- Randomize price prenatal clinics in Kenya can sell ITNs to pregnant women from zero to just below prevailing cost-sharing price
- Explore impact of price variation on:
 - (1) **Demand/Uptake**; (2) **Usage**; (3) **Need** (Health)
- Use these estimates to compare cost-effectiveness for a range of forms of the externality

Preview of Findings

- Find no evidence that cost-sharing reduces wastage on those who will not use the product
 - Those who receive free ITN not less likely to use it than those who paid higher prices
- Also find no evidence that cost-sharing induces selection of those who need net more
 - Those paying higher prices appear no sicker (in terms of measuring anemia) than control group
- Cost-sharing does considerably dampen demand
 - Uptake drops by 75% from zero to prevailing C/S price
- Combine estimates in cost-effectiveness model w/ private and social benefits to ITN use on child mortality
 - In some settings free distr. may be as cost-effective as C/S

Experimental Design

- Field experiment in Western Kenya (4 districts), area of endemic malaria
- Randomized price at which prenatal clinics (20 of them) could sell LL ITNs to pregnant women
- 4 **control** clinics, 5 clinics **0Ksh**, 5 clinics **10Ksh** (\$.15), 3 clinics **20Ksh**, 3 clinics **40Ksh** (90% subsidy)
 - Highest price is \$0.15 below prevailing cost-sharing price in this region (PSI)
 - Ave. daily wage in area is \$1.50
- Clinics chosen from about 70 in the area based on size, services offered, and so that they were far apart
- Program lasted at least 3 months

Outcomes Measured

- Want to know how variation in price affects:
 - (1) **Demand/Uptake** (measured with clinic surveys on random days)
 - (2) **Need** (measured with hemoglobin at time of visit)
 - (3) **Usage** (measured with home visits 1- 2 months after purchase)
- Empirical strategy: regress outcomes on price (or price dummies, or binary zero vs. positive price)
 - Standard errors clustered by clinic and use two different corrections to deal with small # of clusters
 - Series of specification checks in paper
 - District fixed effects

Disentangling Usage

- Relationship between prices & usage could come from combination of selection and psychological effects (sunk cost)
- To disentangle selection and sunk cost effects, implement a second stage evaluation based on (Ashraf, et al. 2007)
- On random (unannounced) days, women who express willingness to pay posted price are offered additional discount based on lottery (final price varied from offer price to free)
 - Difference in usage between those willing to pay same posted price but actually paying different final price is sunk cost effect

External Validity/Context

- Conducted in context of high valuation of ITNs
 - Vulnerable population, incurred costs to come to clinic (less targeted distribution or different product might have different results)
 - ITNs have been socially-marketed and are sold in shops so value is known
- Conducted in area of high poverty and severe credit/cash constraints, ability to pay is low
- ITN distribution through Measles Initiative (2006)
 - We estimate all specs on sample of women with first pregnancy to check

Results: Uptake

- Uptake of ITNs drops significantly at modest cost-sharing prices (20% decrease in demand for 10Ksh increase at the mean)
- No large change in demand resulting from small increase in price from zero
- Significant coefficient of $-.015$ on price variable
 - Demand drops by 15% for a 10Ksh increase in price from 0 (or 60% when price increases to 40Ksh)
 - Demand response slightly higher ($-.018$) for women in first visit and lower ($-.011$) for first pregnancy
- If 100 women take net for free, 25 of them will buy it at prevailing cost-sharing price

Demand for ITNs: Monthly Net Sales by ITN Price

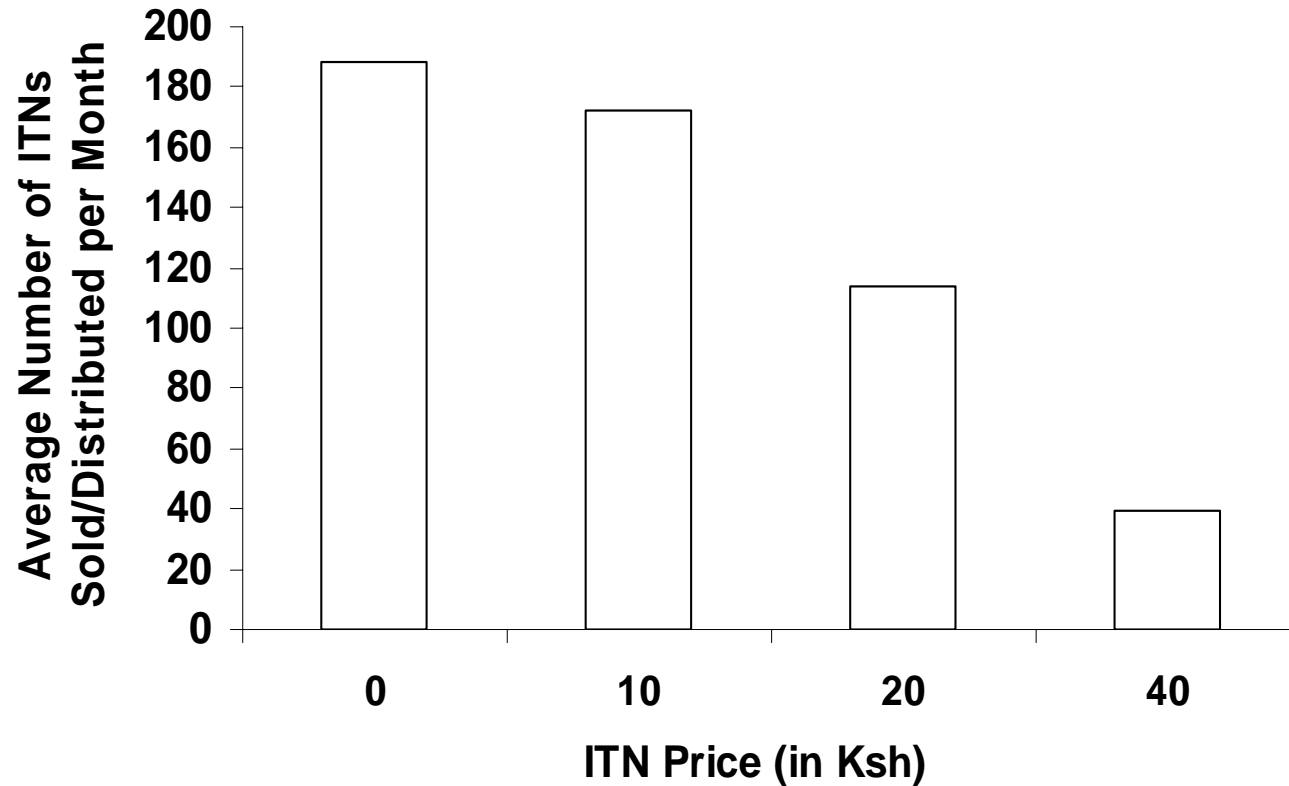
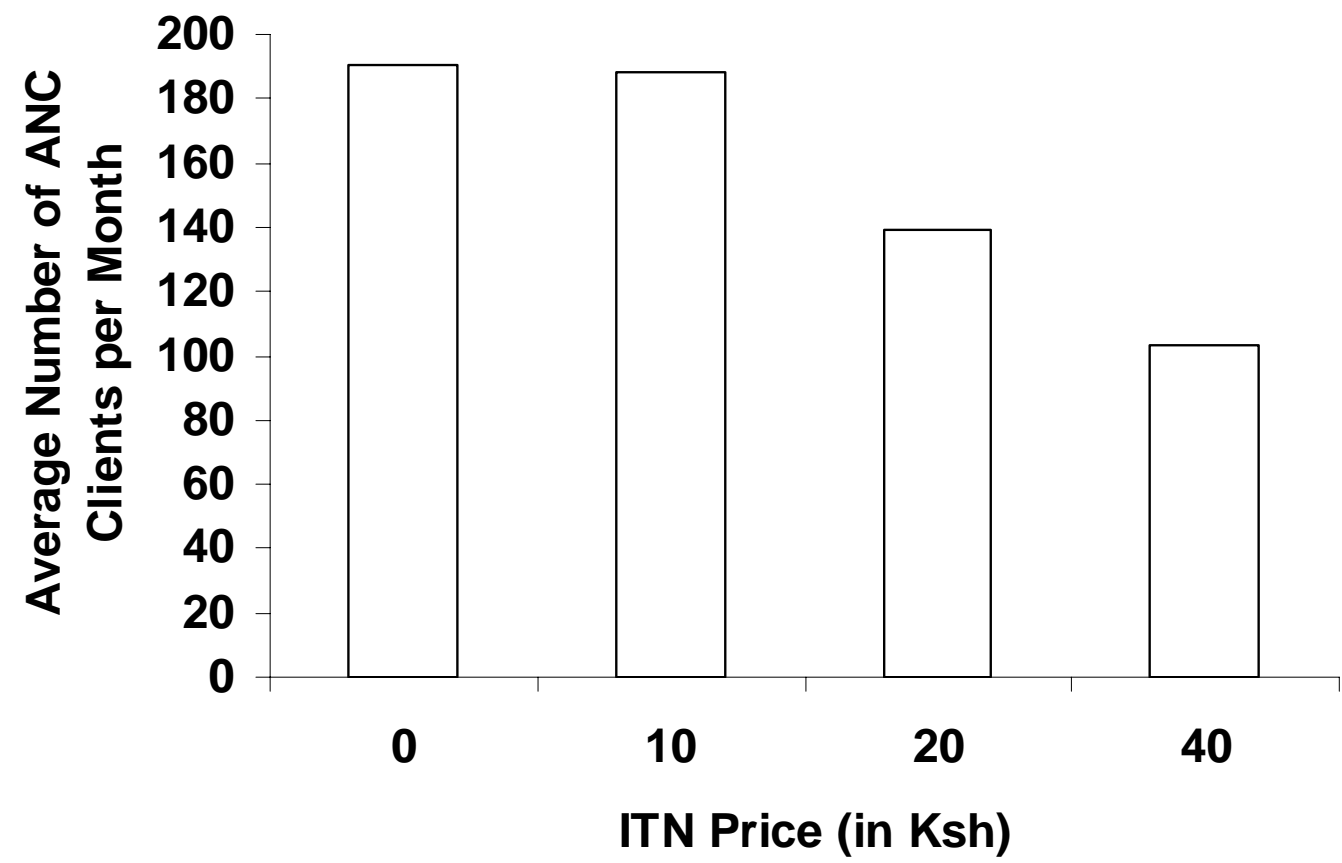


Table 3. Demand for ITNs Across Prices

	<i>Dependent Variable is:</i>			
	Indicator for Bought/Received an ITN			
	(1)	(2)	(3)	(4)
ITN Price in Kenyan Shillings	-0.015 (.002)		-0.018 (.003)	-0.011 (.002)
Constant (ITN Price = 0)		.989 (.010)		
ITN Price = 10 Ksh (\$0.15)		-0.073 (.018)		
ITN Price = 20 Ksh (\$0.30)		-0.172 (.010)		
ITN Price = 40 Ksh (\$0.60)		-0.605 (.035)		
First Visit Only			X	
First Pregnancy Only				X
Observations	424	424	201	134
Sample Mean of Dep. Var	0.98	0.98	1.00	0.97

Demand for ITNs: Monthly Prenatal Visits by ITN Price



Results: Usage

- 60 – 70% usage (increasing with time since purchase, with birth of child & for first pregnancy)
- None of women re-sold net & 95% of those claiming to be using net had it hanging
- No evidence that usage intensity increases with price
- No clear discontinuity between zero & positive prices
- Combining uptake and usage: 63% of women covered by ITN under free distribution, versus 14% at 40Ksh
 - Reject hypothesis that coverage is equal at 0 & 40Ksh

ITN Usage Rates by Price: Share of “Takers” who Report Using ITN at Home

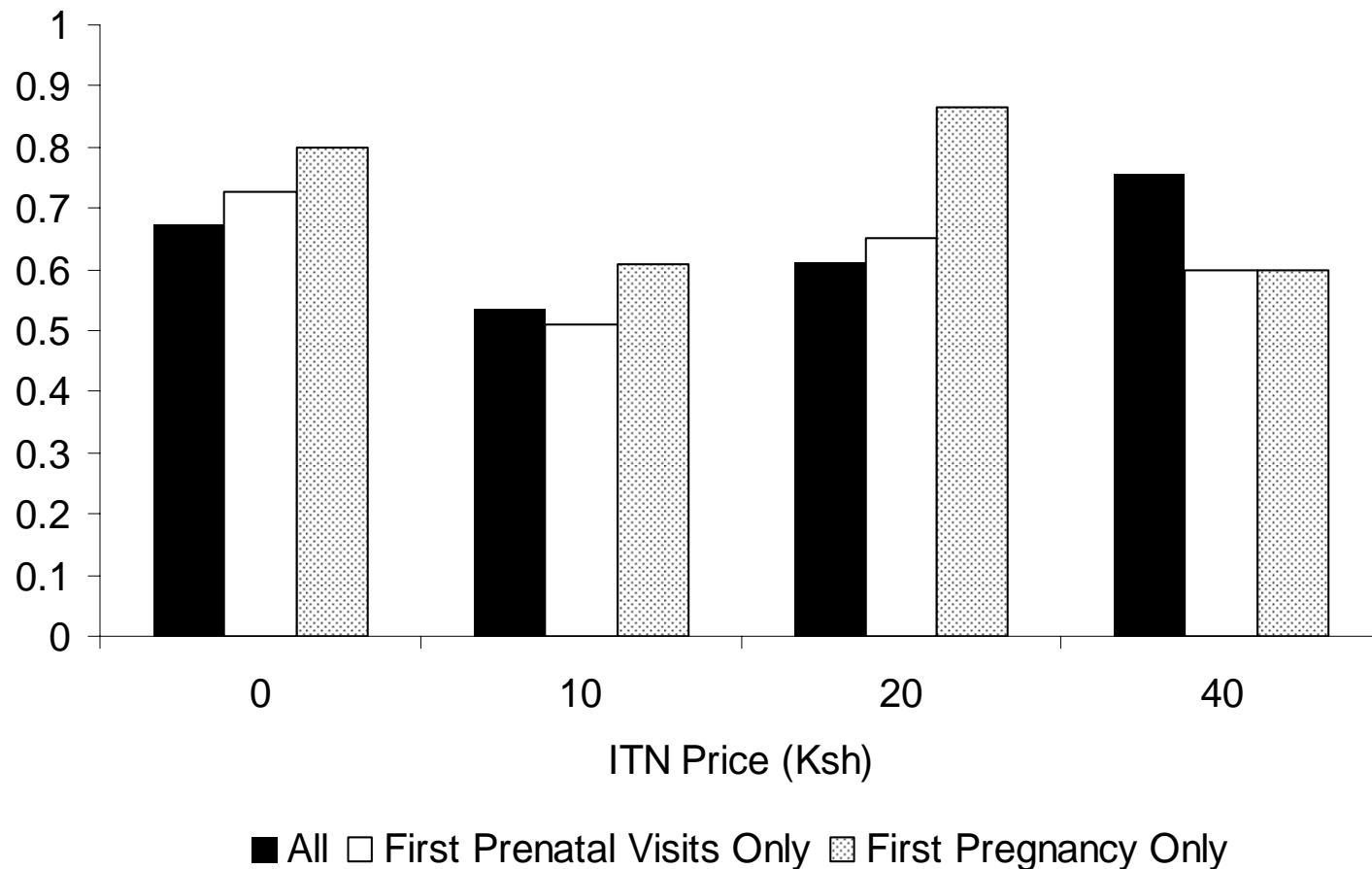
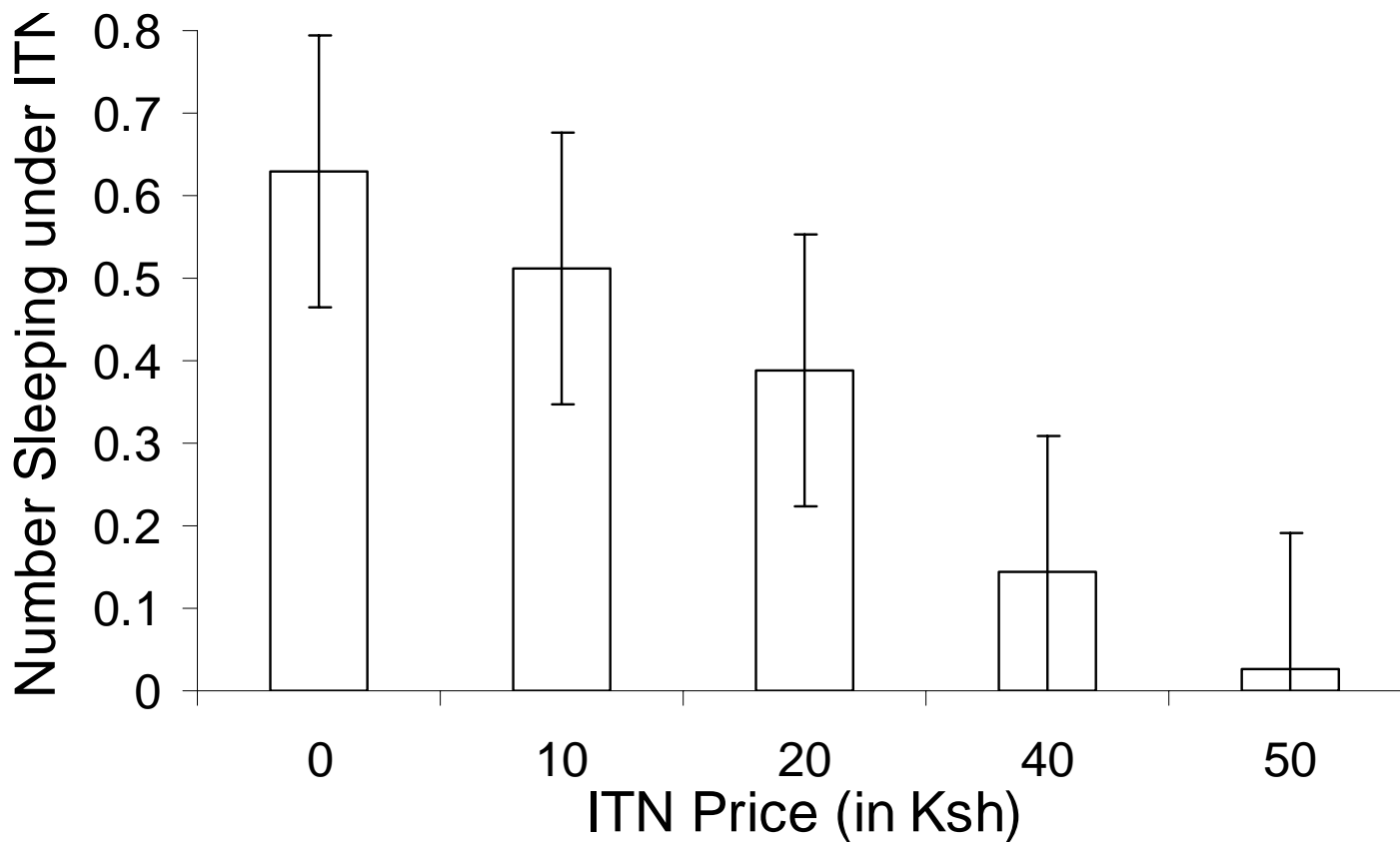


Table 4. ITN Usage Rates Across Prices

	<i>Dependent Variable is:</i>					
	Using ITN acquired through program				ITN is Visibly Hanging	
	(1)	(2)	(3)	(4)	(5)	(6)
Constant (ITN Price = 0)	.564 (.069)	.656 (.093)	.604 (.083)	.744 (.058)	.524 (.074)	.637 (.109)
ITN Price	.004 (.004)		.000 (.004)	-.002 (.004)	.003 (.003)	
ITN Price = 10ksh		-.126 (.119)				-.155 (.128)
ITN Price = 20ksh		-.020 (.105)				-.093 (.122)
ITN Price = 40ksh		.106 (.134)				.081 (.127)
First Visits Only			X			
First Pregnancy Only				X		
Obs	224	224	125	58	220	220
Mean of Dep. Var	0.62	0.62	0.61	0.72	0.57	0.57

Effective Coverage: Share of Prenatal Clients Sleeping Under ITN, by Price



Psychological Effects of Price on Usage

- Previous results on usage combine selection and sunk cost effects
- Consistent with no overall effect of price on use, no significant psychological effect of price on use
 - Estimates are all over the place, but no pattern is visible and point estimates are negative
- Also consistent with previous field work on sunk cost effects of price (Ashraf et al. 2007)

Selection Effects of Price on Health

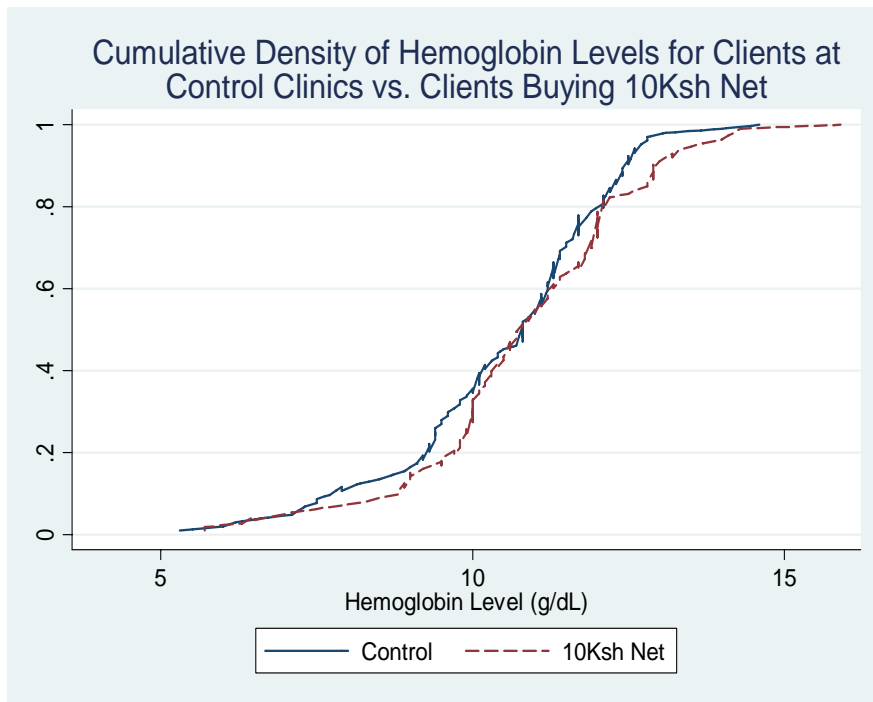
- Want to know whether higher ITN prices induce selection of more vulnerable women (i.e. sickest)
- Ability of prices to target the neediest depends on relative effect of “**willingness**” vs. “**ability**” to pay (esp. in poor/credit constrained areas)
 - Sicker women probably willing to pay more
 - Sicker women probably able to pay less
- We use hemoglobin at clinic visit as measure of need
 - Hb is morbidity measure sensitive to presence of malaria in pregnant women
 - Anemic women likely to be those with most exposure & least resistance to malaria

Results on Selection

- Compare hemoglobin of women buying/receiving net at each price to that of control group
- CDF for buyers at each price is on top of (10, 20Ksh) or to the right of (0, 40Ksh) that for control
- Women taking free ITN 20% less likely to be anemic & have Hb levels $.86 >$ control
- Higher prices do not select sicker women, but free net selects healthier women). Why?
 - Strong incentive effect of low price ITNs on prenatal attendance
 - Appears that women coming for free net came back for revisit sooner, and walk further/paid more for visit than control

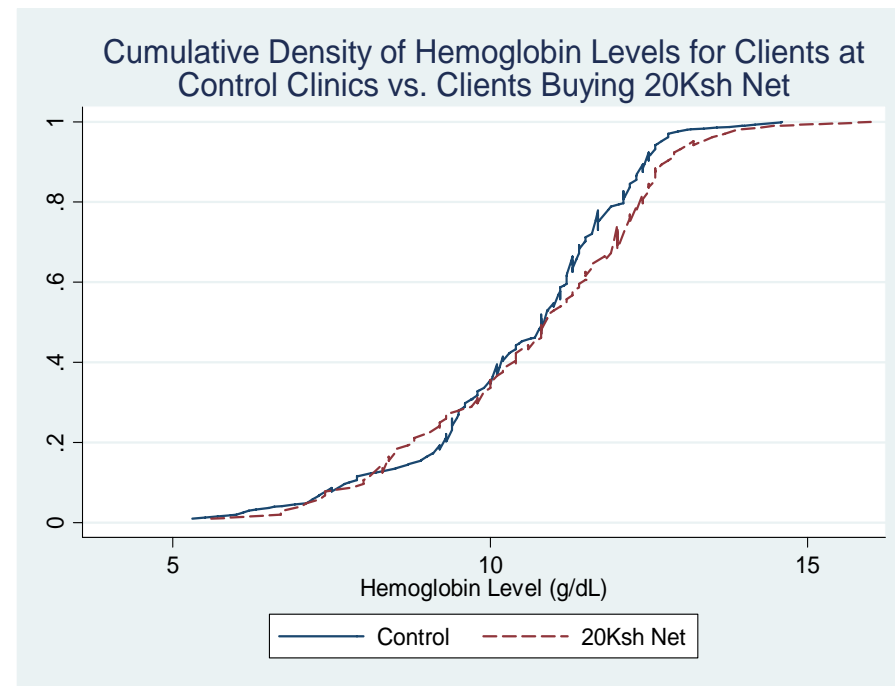
No Difference between Control Group and Buyers of 10 and 20Ksh ITNs

Control vs. 10Ksh Buyers



P-value = .47

Control vs. 20Ksh Buyers

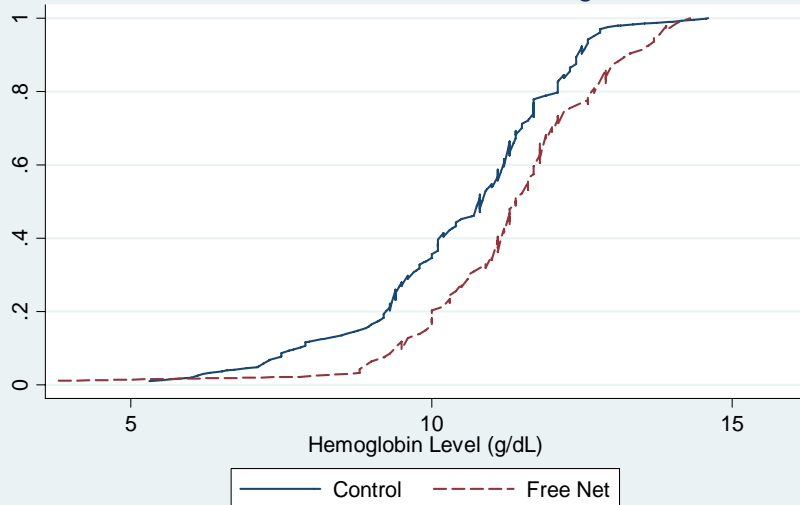


P-value = .30

Takers of Free Nets and 40Ksh appear Healthier than Control Group

Control vs. 0Ksh Takers

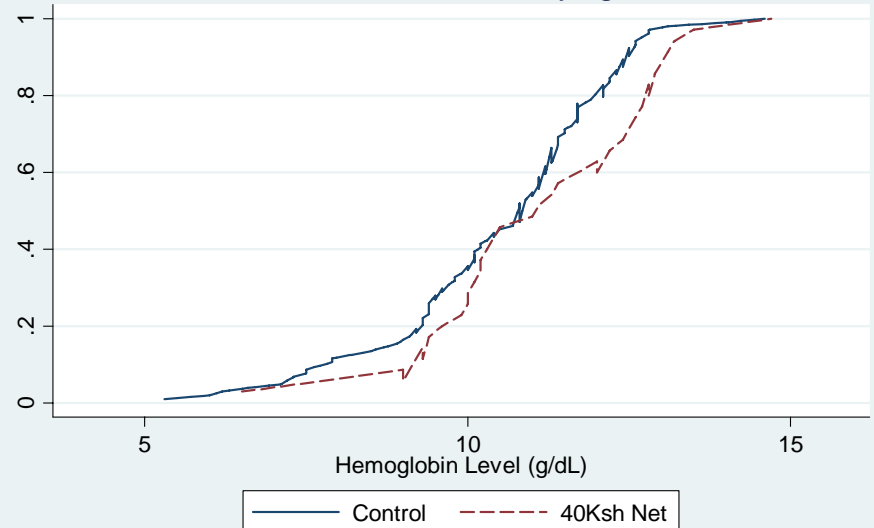
Cumulative Density of Hemoglobin Levels for Clients at Control Clinics vs. Clients Receiving Free Nets



P-value = .02

Control vs. 40Ksh Buyers

Cumulative Density of Hemoglobin Levels for Clients at Control Clinics vs. Clients Buying 40Ksh Net



P-value = .17

Characteristics of Prenatal Clients Buying/Receiving Nets Relative to Control

	Control	<i>Differences with Control Clinics</i>			
	Mean	0 Ksh	10 Ksh	20 Ksh	40 Ksh
	(1)	(2)	(3)	(4)	(5)
	Health Status				
Hemoglobin Level (Hb)	10.49	0.86	0.39	0.13	0.50
	<i>1.76</i>	(0.35)	(0.48)	(0.47)	(0.72)
Moderate Anemia	0.55	-0.20	-0.03	-0.01	-0.01
	<i>0.50</i>	(0.07)	(0.11)	(0.11)	(0.15)
Severe Anemia	0.16	-0.10	-0.01	0.07	-0.06
	<i>0.37</i>	(0.06)	(0.07)	(0.09)	(0.15)
	Characteristics of Visit to Prenatal Clinic				
First Prenatal Visit	0.48	-0.12	-0.02	0.03	0.02
	<i>0.50</i>	(0.06)	(0.04)	(0.06)	(0.04)
First Pregnancy	0.21	0.09	0.15	0.08	0.14
	<i>0.41</i>	(0.04)	(0.04)	(0.04)	(0.15)
Paid for transport to Clinic	0.17	0.14	0.04	-0.07	0.16
	<i>0.37</i>	(0.14)	(0.06)	(0.06)	(0.06)
Price paid for transport	4.58	3.52	0.79	-1.17	4.27
	<i>10.83</i>	(3.29)	(1.78)	(1.37)	(1.94)
Obs	108	38	120	99	28

Cost-Effectiveness Analysis

- Combine uptake and usage estimates in C/E model incorporating private and social benefits of ITNs
 - Measure effectiveness and cost-effectiveness of each subsidy level in reduction of child mortality
 - Many other benefits to ITNs (e.g. prenatal attendance) so estimates should be conservative
- We assume that only difference in cost is the subsidy
 - Could be that transport/storage expenses higher for free distr. (b/c of higher demand), unless economies of scale
 - Could also be that supervision/accounting expenses higher for cost-sharing

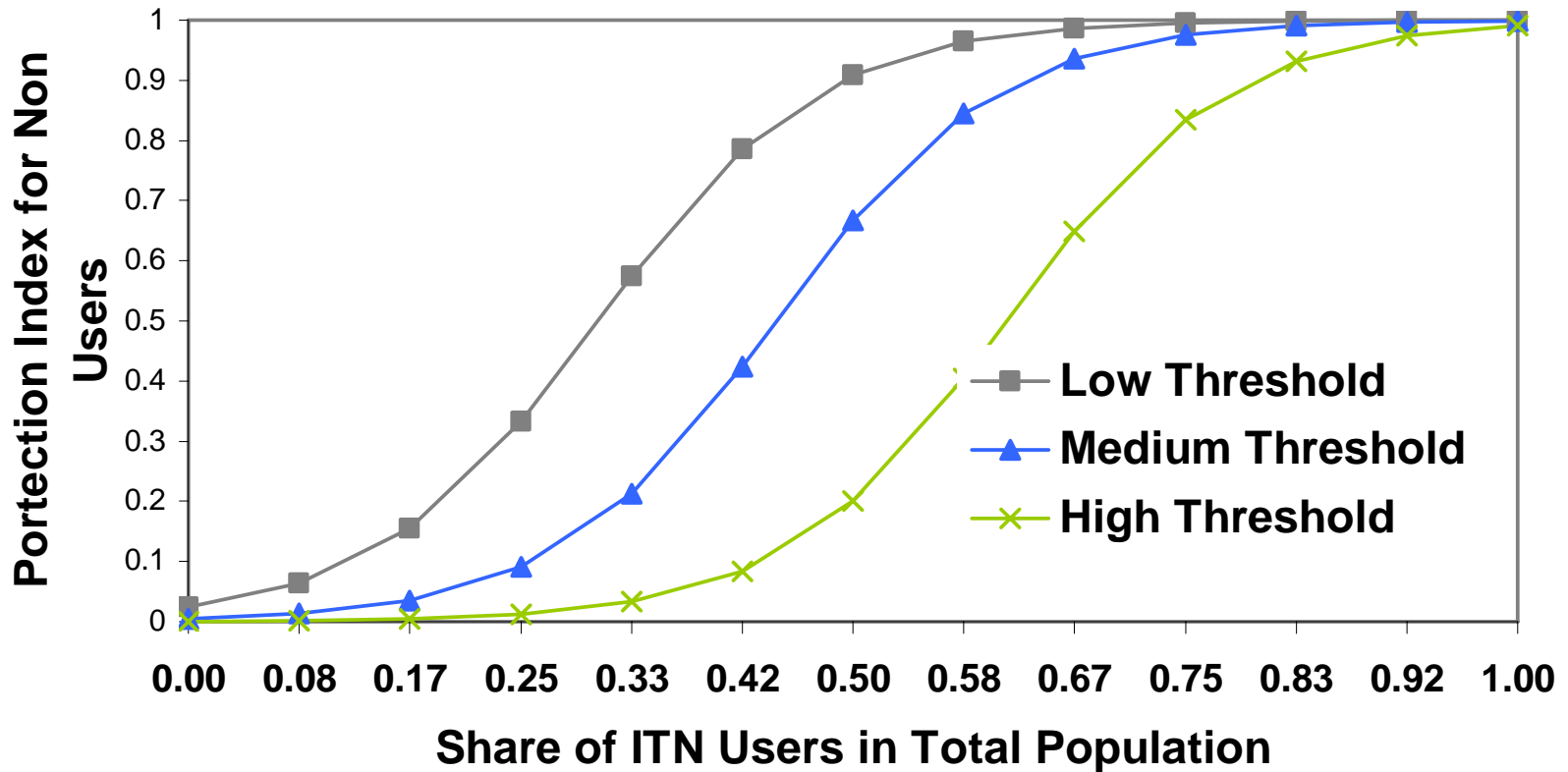
Cost-Effectiveness Analysis (cont.)

- Evidence suggests non-linear external effects of ITN use on non-users
 - Area-wide effects of ITNs on disruption of mosquito pop. may be as strong or stronger than physical barrier
- We construct protection indices for non-users (logistic function of share of users in pop.) & users (weighted sum of phys. barrier effect + externality, w/ weights depending on share of users)
- Assume that program is run for 5 years & try various assumptions about fertility rate
- Compute C/E for various assumptions about the relative benefits of both effects

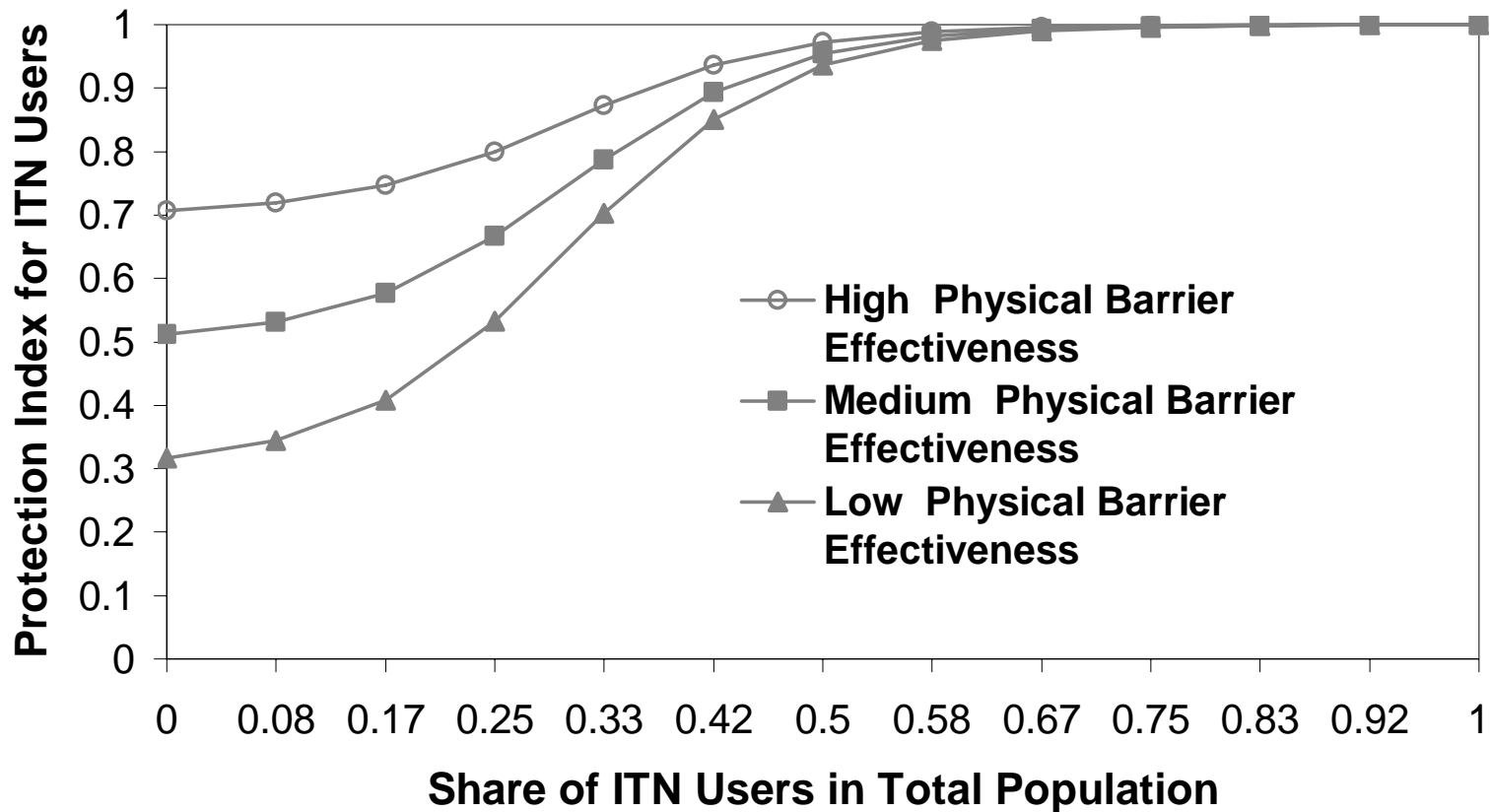
Cost-Effectiveness Results

- Due to demand response, number of child lives saved under each scenario is highest under free distribution
- When externality threshold is low & phys. barrier effect is high, 40Ksh is more c/e than free distribution
 - As assumptions about phys. barrier less optimistic, free distr. is equally or more c/e
- As externality threshold increases to medium levels, free distr could dominate cost-sharing
- When threshold is very high cost-sharing again slightly cheaper b/c even free distr. cannot generate high enough coverage, but this would reverse under less conservative assumption about fertility

**6a. Three hypothetical Scenarios on the “Externality Threshold”:
How the Protection Index for Non-Users Varies with
the Proportion of ITN Users in the Population**



**6b. For a Given Hypothesis on the Externality Threshold:
How the Protection Index for Users Varies with
Assumptions on Effectiveness of ITNs as “Physical Barriers” for Users**



External Validity/Other Concerns

- Scaling Up
 - Other prenatal clients (e.g. in wealthier areas or areas of less intense malaria transmission) could respond to prices differently
 - RE often ignores heterogeneous treatment effects
- General Equilibrium
 - RE speak to partial equilibrium; scaling up this program could lead to price and wage changes
- Supply-side response to price variation
 - Requires another evaluation
 - Could supply-side response change incentives from demand side? Or just conclusions about cost-effectiveness?

Conclusions

- This evaluation seeks to fill two gaps in debate over pricing of public health products:
 - (1) Is conventional wisdom about price targeting and selection correct in the case of ITNs?
 - (2) How do benefits from price targeting combine with demand response to yield effective coverage rates?
- We find that cost-sharing for ITNs cannot offset what is lost in demand by improved targeting toward those who value it most
- Results suggest that in this context, free distribution is more effective, and possibly more cost-effective than cost-sharing

Table 1. Characteristics of Prenatal Clinics in the Sample, by Treatment Group

	Control Group	Treatment Groups			
		<i>ITN Price:</i>			
		0 Ksh (FREE)	10 Ksh (\$0.15)	20 Ksh (\$0.30)	40 Ksh (\$0.60)
(1)	(2)	(3)	(4)	(5)	
Average monthly attendance in 2006 (First visits ONLY)	75 (53)	63 (41)	61 (41)	54 (20)	62 (31)
Average monthly attendance in 2006 (First + Subsequent Visits)	124 (80)	117 (66)	123 (92)	106 (48)	122 (68)
Prenatal Enrollment Fee (in Ksh)	10 (12)	12 (8)	14 (9)	20 (20)	13 (11)
Fraction of clinics with HIV testing services	.75 (.50)	.40 (.55)	.75 (.45)	.66 (.58)	.33 (.58)
Total other prenatal clinics within 10 kilometers (km)	2.75 (2.5)	3 (1.22)	3.6 (.54)	4.3 (2.5)	4.3 (1.15)
Distance (in km) to closest prenatal clinic in the sample	12.69 (2.28)	13.45 (1.2)	13.32 (1.3)	12.05 (1.0)	12.92 (2.5)
Number of Clinics	4	5	5	3	3

Table 2. Weekly ITN Sales Across Prices

	<i>Dependent Variable is:</i>					
	(1)	(2)	(3)	(4)	(5)	(6)
ITN Price in Kenyan Shillings (Ksh)	-.797 (.396)		-.680 (.189)	-.756 (.096)		
ITN Price = 10 Ksh (\$0.15)		-.330 (16.617)			-1.645 (5.640)	6.346 (1.816)
ITN Price = 20 Ksh (\$0.30)		-9.502 (15.855)			-4.870 (13.089)	-8.737 (1.521)
ITN Price = 40 Ksh (\$.60)		-32.420 (15.199)			-29.051 (7.397)	-33.081 (.419)
Control for Clinic Attendance in 2006			X	X	X	X
Other Clinic Controls				X		X
Mean of Dep. Var in Clinics with Free ITNs	41	41	41	41	41	41
Intracluster Correlation	0.57					

Table 5. ITN Usage Rates Across Prices, Holding Willingness to Pay Constant

	<i>Dependent Variable is:</i>							
	Respondent is currently using the ITN acquired through the program						ITN is Visibly Hanging	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Transaction Price	-.003 (.006)	-.006 (.006)	-.006 (.006)					
Transaction Price > 0				-.008 (.100)	-.072 (.101)	-.065 (.100)	.010 (.101)	-.047 (.103)
<i>Individual Controls</i>								
Got a Free ITN the Previous Year			-.192 (.100)			-.191 (.101)		-.147 (.103)
Has not yet delivered		-.198 (.121)	-.234 (.121)		-.195 (.122)	-.231 (.122)		-.216 (.124)
Bought ITN at First Prenatal Visit		.199 (.102)	.202 (.102)		.199 (.103)	.202 (.104)		.131 (.107)
First Pregnancy		.180 (.100)	.148 (.104)		.184 (.100)	.153 (.104)		.120 (.107)
Time to clinic		.001 (.001)	.000 (.001)		.000 (.001)	.000 (.001)		.000 (.001)
Time Elapsed since ITN Purchase		.014 (.006)	.015 (.006)		.014 (.006)	.015 (.006)		.017 (.006)
Constant	.591 (.052)	.152 (.200)	.248 (.200)	.579 (.054)	.147 (.201)	.242 (.201)	.537 (.055)	.165 (.207)
Observations	130	124	123	130	124	123	128	121
Sample Mean of Dep. Var	0.58	0.58	0.58	0.58	0.58	0.58	0.52	0.52
F Stat		2.64	3.23		2.99	3.6		1.97
Prob >F		0.02	0.00		0.01	0.00		0.07

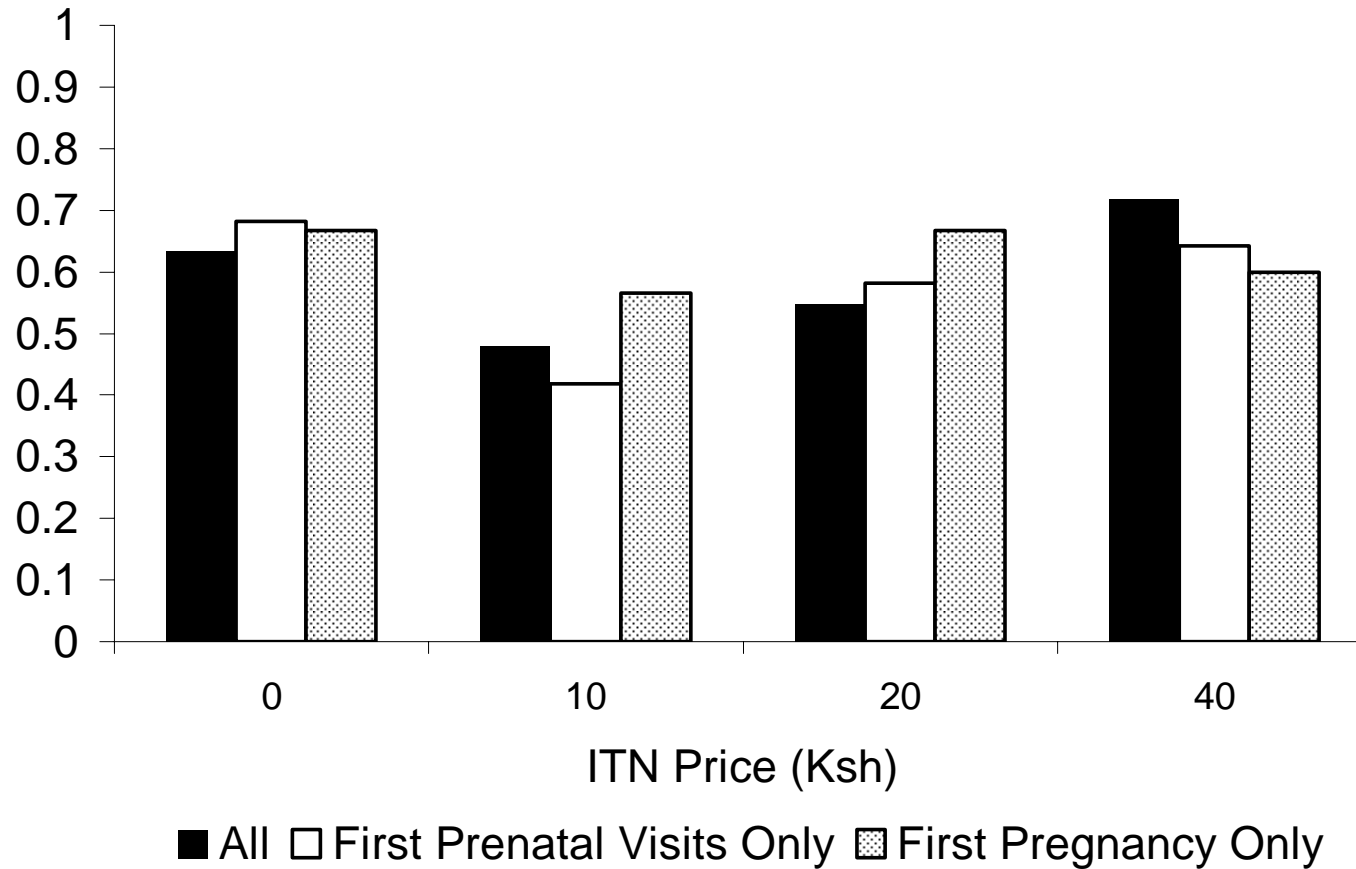
Table 7. Share of Households Using an ITN in Total Population

ITN Price (Ksh)	Subsidy per ITN (Ksh)	Share of Prenatal Clients Who get an ITN (<i>Table 3, Col. 2</i>)	Actual Cost (Ksh)	% of ITN owners that are using it (<i>Table 4, Col. 4</i>)	Share of Users among Housholds With Prenatal Client	Subsidy Cost per User Household (Ksh)	Share of Net Users in Total		
							If 65% of HH experience a pregnancy within 5 years	If 75% of HH experience a pregnancy within 5 years	If 85% of HH experience a pregnancy within 5 years
0	455	0.98	446	0.66	0.64	694	0.42	0.48	0.55
10	445	0.93	414	0.53	0.49	840	0.32	0.37	0.42
20	435	0.83	361	0.64	0.53	684	0.34	0.40	0.45
40	415	0.40	166	0.76	0.30	545	0.20	0.23	0.26

Table 8. Cost-Effectiveness Comparisons

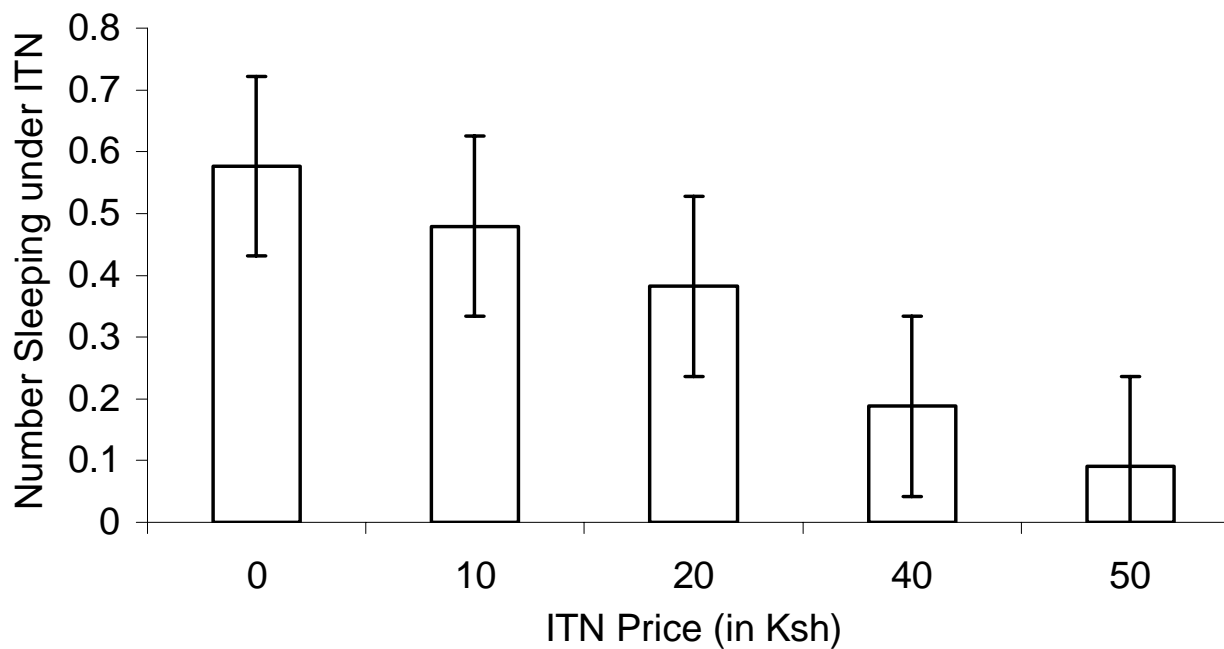
		<i>Hypothesis on Externality Threshold:</i>								
		Low			Medium			High		
		<i>Hypothesis on Physical Barrier effectiveness:</i>			<i>Hypothesis on Physical Barrier effectiveness:</i>			<i>Hypothesis on Physical Barrier effectiveness:</i>		
Subsidy Level	ITN Price (Ksh)	High	Medium	Low	High	Medium	Low	High	Medium	Low
		1	2	3	4	5	6	7	8	9
<i>A. Protection Index for Non-Users</i>										
100.0%	0	0.80	0.80	0.80	0.45	0.45	0.45	0.09	0.09	0.09
97.5%	10	0.53	0.53	0.53	0.19	0.19	0.19	0.03	0.03	0.03
95.0%	20	0.60	0.60	0.60	0.23	0.23	0.23	0.04	0.04	0.04
90.0%	40	0.21	0.21	0.21	0.05	0.05	0.05	0.01	0.01	0.01
<i>B. Protection Index for Users</i>										
100.0%	0	0.94	0.90	0.86	0.83	0.72	0.61	0.73	0.55	0.36
97.5%	10	0.86	0.77	0.67	0.76	0.59	0.43	0.71	0.51	0.32
95.0%	20	0.88	0.80	0.72	0.77	0.62	0.46	0.71	0.52	0.33
90.0%	40	0.76	0.60	0.44	0.71	0.52	0.33	0.70	0.50	0.30
<i>C. Children Lives Saved Per 1000 Prenatal Client</i>										
100.0%	0	38	37	36	30	27	24	22	17	11
97.5%	10	29	28	26	20	16	13	15	11	7
95.0%	20	32	30	28	22	19	15	17	12	8
90.0%	40	16	14	12	11	8	6	9	7	4
<i>D. Cost per Child Life Saved (USD)</i>										
100.0%	0	\$200	\$206	\$212	\$255	\$284	\$321	\$352	\$460	\$662
97.5%	10	\$234	\$251	\$270	\$348	\$421	\$531	\$448	\$609	\$949
95.0%	20	\$189	\$200	\$213	\$274	\$325	\$399	\$361	\$487	\$748
90.0%	40	\$175	\$201	\$235	\$261	\$339	\$483	\$302	\$418	\$678

2b. Share of "Takers" who have the ITN visibly hanging at home visit, by ITN



Notes: Observations: All: 226, First visit: 175, First Pregnancy: 122

Figure 5. Share of Anemic Prenatal Clients Sleeping under an ITN, by ITN Price



Notes: Figure shows coefficients estimated with a Linear Probability Model. Error bars represent +/- 2.14 standard error (5% confidence interval with 14 degrees of freedom).

