A discrete choice experiment to assess perceptions of environmental health risks: The case of indoor residual spraying to reduce malaria in northern Uganda

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Background

Indoor residual spraying (IRS) of insecticides is an important method for controlling malaria in Uganda

- 9-14% of all hospital deaths in Uganda attributed to clinically-diagnosed malaria (USAID-PMI Country Profile 2010 for Uganda).

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- In 2008, Uganda was one of 45 countries where the spraying of insecticides in homes was the primary method for eliminating mosquito vectors of malaria (WHO World Malaria Report 2009).

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Overview of northern Uganda IRS programs

- 1 round of spraying prior to survey in the study area. DDT was used district of the study area, and synthetic pyrethroid in the other (USAID-PMI Uganda Malaria Operational Plan 2010).

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  - Remain outside of homes for 2 hours

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  - Have 10 litres of water to provide to the spray team when they arrive
  - Remove all of their belongings from home
  - Remain outside of homes for 2 hours
  - Cannot re-plaster floors or walls following spraying

Research Questions

(A)

WHAT ATTRIBUTES MOST AFFECT HOUSEHOLDS' VALUES OF THE SPRAY PROGRAMS, E.G. MALARIA RISK REDUCTION, INSECTICIDE EXPOSURE, DISRUPTION TO HOUSEHOLD ACTIVITIES?

Research Questions

(A)

What attributes most affect households' values of the spray programs, e.g. malaria risk reduction, insecticide exposure, disruption to household activities?

(B)

How do changes in infectious disease risk affect monetary valuations of that program, e.g. WTA/WTP for changes in malaria risk?

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How do changes in infectious disease risk affect monetary valuations of that program, e.g. WTA/WTP for changes in malaria risk?

(C)

What are the implications for different subsidization/fee schemes for spray program participation?

Peer-reviewed Literature

Previous studies of IRS acceptance are sparse and qualitative

- *Montgomery et al (Soc Sci & Med 2010).* Focus groups to study community acceptance of spray program in 2006. They find:
  - Households perceived the programs to be ineffective.
  - A high level of community acceptance.
  - A sense of obligation to participate in government programs.

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- *Rodriguez et al (Salud Pública de Méx 2006).* Household survey following spray program. Found:
  - About 84% of respondents "accepted" the program.
  - The disruption caused by the spray activities and the smell were most frequently mentioned as problems among those who didn't like spraying.
  - Health-related side effects of spraying were not a major concern for respondents.

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- *Govere et al (SAMJ 2000).* South African survey. Similar findings to Rodriguez et al.
  - Radio was an important factor for disseminating info.

Peer-reviewed Literature

Valuation studies for reductions in malaria risk

- *Chase et al (Malaria J. 2009).* Contingent valuation to estimate WTP for insecticide-treated bednets in Nigeria. They find:
  - Contingent valuation to estimate WTP for insecticide-treated bednets.
  - Full or partial subsidies necessary to stimulate net uptake.
  - *Participation in a spray program associated with lower WTP for bednets.*
  - *Malaria risk, perceived or actual, was not included in the study.*

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- *Whittington (J. Health & Pop in Dev Countries 2003).* Contingent valuation study to estimate WTP for hypothetical malaria vaccine. They find:
  - WTP of US$14 to eliminate malaria risk for one year; observed baseline risk was 0.6 cases per person per year. Roughly equates to a WTP of US$1.16 per month to reduce monthly malaria risk by 7%. Much higher estimates than productivity (COI) methods.
  - Baseline risk not varied in the experiment.
  - Conclude that substantial revenues could be raised to finance malaria control.
  - Income estimates included in the study, but income constraints not accounted for.

Methods

Discrete choice experiment for hypothetical spray programs

- Alternative spray programs or compensation schemes with different attributes:
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  - Malaria risk per month
  - Compensation level
  - Insecticide type: DDT or synthetic pyrethroid called ICON (or no spraying)
  - Number of times home is re-sprayed over the course of the year

Methods

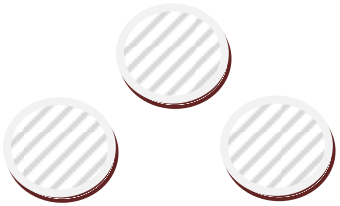
Discrete choice experiment for hypothetical spray programs

	i. Insecticide	*ii. Number of Re-sprayings per year*	*iii. Malaria risk **PER MONTH***	*iv. Compensation*
TASK A	*DDT*	*1*	*8 people sick out of 10*	*0*
	DDT	*4*	*7 people sick out of 10*	*0*
	--	*0*	*9 people sick out of 10*	*10,000 UGX*
	Would not participate			

- Three different alternatives per choice task:
  - 2 different spray programs with different malaria risk and no compensation
  - 1 monetary compensation offer in lieu of spraying (with higher malaria risk)

Methods

Visual aids

	Spray Program 1 (DDT)		
Insecticide + No. re-sprays / compensation			
Number of people sick with malaria			
Number of people healthy			

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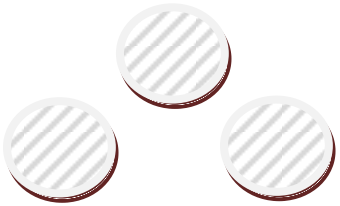
	Spray Program 1 (DDT)	Spray Program 2 (ICON)	
Insecticide + No. re-sprays / compensation			
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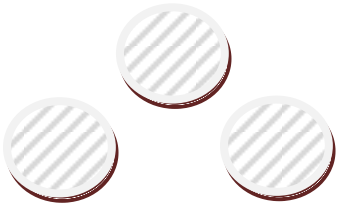
Insecticide + No. re-sprays / compensation			
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Insecticide information frame

Properties of DDT (*dudumaki*):

- Was used for many years in Africa and other places in agriculture.
- May hurt people's health over a long time (e.g. *cancer*), but scientists aren't sure.
- Approved for use in spraying homes by the Ugandan government.
- Can harm/kill animals, such as birds.
- Can kill many other insects in addition to mosquitoes that cause malaria, such as cockroaches and bedbugs.
- Its effects—good and bad—last for a very long time.

Methods

Insecticide information frame

Properties of ICON:

- Its effects—good and bad—last for a shorter time than DDT.
- May hurt people's health, but scientists aren't sure.
- Approved for use in spraying homes by the Ugandan government.
- Can harm/kill animals, such as fish.
- Only kills the mosquitoes which cause malaria, not other insects.
- Crops with high amounts of DDT may get a lower price if sold or "exported" to other parts of the world.

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Survey details

- Focus groups in June/July 2009
- 2 weeks of pre-tests in October
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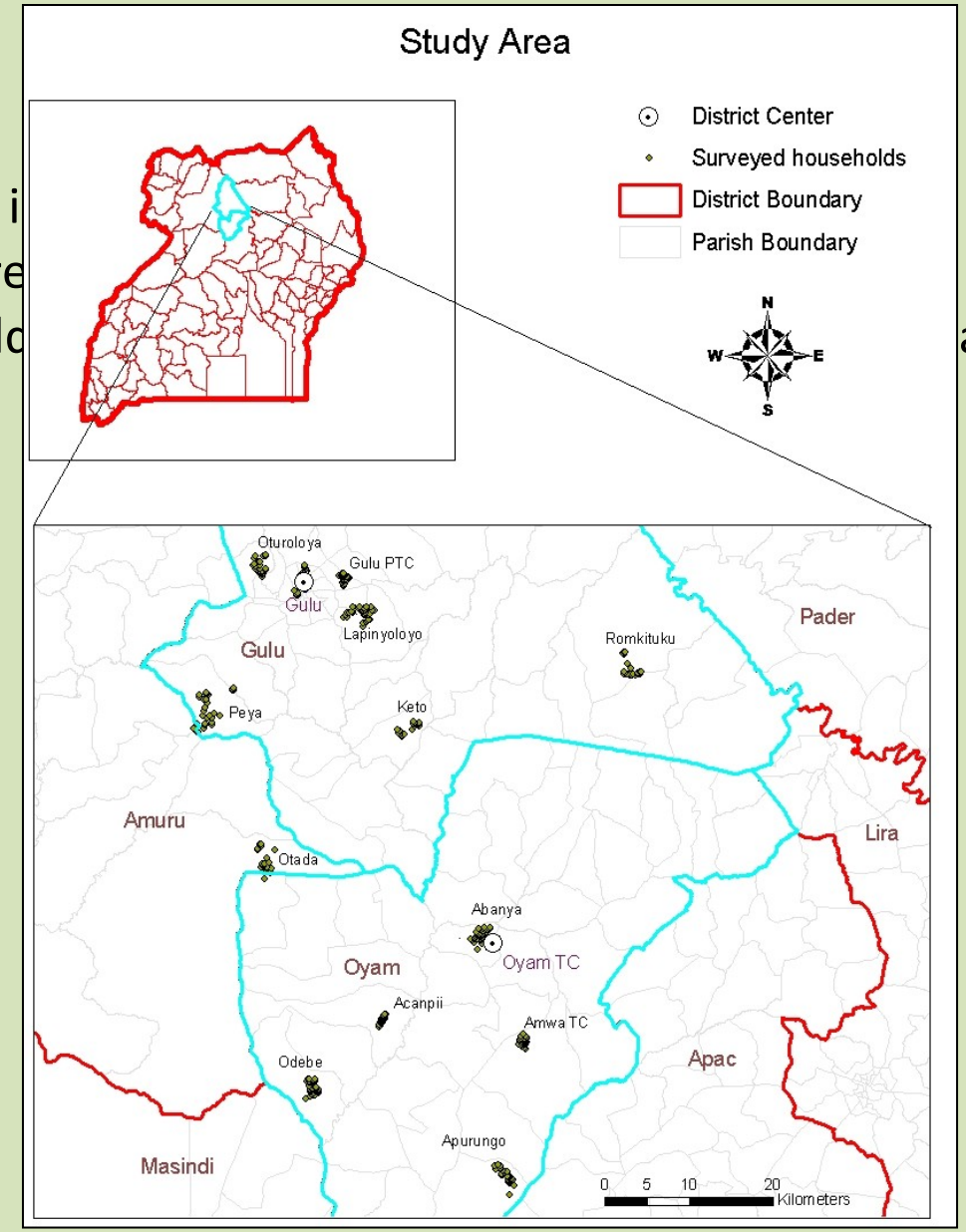

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  5. Wealth and assets other than land.
  6. Household subsistence.
  7. Land access and plans for the future.

Results

Econometric specification

Random expected indirect utility model

$$V_{hit} \equiv p_i[m_h + \beta_h F(I_h + c_i^m)] + (1 - p_i)\left[\beta_h F(I_h + c_i^0)\right] + \gamma_h X_{hit} + \epsilon_{hit}$$

Variable definitions

i	*Alternative index*
h	*Household index*
t	*Choice task index*
m	*Marginal disutility of malaria infection*
β	*Marginal utility/elasticity of money (interpretation depends on F)*
γ	*Marginal effects contingent on respondent characteristics*
X	*Interactions between attributes and respondent characteristics*
p	*Malaria risk (number sick / 10)*
I	*Monthly income*
c^m	*Compensation contingent on getting malaria*
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ϵ	*Econometric error*
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Multinomial probit and logit

VARIABLES	(1) Probit Marg. Utility of Money	(2) Probit Income elasticity	(3) Logit Marg. Utility of Money	(4) Logit Income elasticity
Malaria Risk	-0.235**	-0.231**	-0.867***	-0.870***
No. of resprays	0.0195*	0.0192*	0.617***	0.615***
DDT	1.037***	1.189***	-1.429***	-1.287***
ICON	1.034***	1.186***	-1.417***	-1.277***
DDT x Obs. Participation	0.482**	0.420**	0.722***	0.642***
ICON x Obs. Participation	0.469**	0.406**	0.586***	0.530**
DDT x District	-0.401***	-0.325**	-0.411*	-0.310
ICON x District	-0.405***	-0.329**	-0.556***	-0.486***
Income elasticity		0.134***		0.130**
Marginal utility of money	0.000262***		0.000285***	
Observations	5196	5196	5196	5196
Log likelihood	-1263	-1263	-1316	-1317
Degrees of Freedom	12	12	9	9
Akaike Information Crit.	2550	2550	2650	2652
Bayes. Information Crit.	2628.67	2628.67	2709.00	2711.00

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

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Probit versus mixed logit

VARIABLES	(1) Probit Income elasticity	(2) Mixed Logit Income elasticity	(2) Standard Deviation on random coeff.
Malaria risk	-0.231**	-2.20***[2]	0.0136[2]
No. of resprays	0.0192*	1.735***	2.677[a]
DDT	1.189***	0.358[x]	
ICON	1.186***	0.379[x]	
DDT x Obs. Participation	0.420**	0.452	2.554***
ICON x Obs. Participation	0.406**	0.119	2.805***
DDT x DDT District	-0.325**	-1.975***	0.755[x]
ICON x DDT District	-0.329**	-2.170***	1.643*
Income elasticity	0.134***	0.703***[2]	2.44***[2]
Observations	5196	5196	
Log likelihood	-1263	-1173	
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Malaria risk	-0.231**	-2.20***[2]	0.0136[2]
No. of resprays	0.0192*	1.735***	2.677[a]
DDT	1.189***	0.358[x]	
ICON	1.186***	0.379[x]	
DDT x Obs. Participation	0.420**	0.452	2.554***
ICON x Obs. Participation	0.406**	0.119	2.805***
DDT x DDT District	-0.325**	-1.975***	0.755[x]
ICON x DDT District	-0.329**	-2.170***	1.643*
Income elasticity	0.134***	0.703***[2]	2.44***[2]
Observations	5196	5196	
Log likelihood	-1263	-1173	
Degrees of Freedom	12	16	
Akaike Info. Criterion	2550	2376.541	
Bayes. Info. Criterion	2628.67	2474.876	

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

[2] Lognormal distribution assumed on random coefficient.

[a] Standard error could not be calculated.

[x] Coefficient assumed constant across the population.

Results

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Results

Value of malaria risk reductions

MODEL	Households' value of changing malaria risk by… 1%	
Probit *Constant Marginal Utility of Money*	$0.36	
Probit *Constant Elasticity of Income*	$0.38[§]	
Logit *Constant Marginal Utility of Money*	$1.22	
Logit *Constant Elasticity of Income*	$1.47[§]	
Mixed Logit *Constant Elasticity of Income*	$0.69[§]	

[§] To convert from percentage of income to monetary figures, the ratio of the risk coefficient to income elasticity was multiplied by the median monthly income of the sample, which was $22.

Results

Value of malaria risk reductions

MODEL	Households' value of changing malaria risk by… 1%	7%
Probit *Constant Marginal Utility of Money*	$0.36	$2.51
Probit *Constant Elasticity of Income*	$0.38[§]	$2.82[§]
Logit *Constant Marginal Utility of Money*	$1.22	$8.52
Logit *Constant Elasticity of Income*	$1.47[§]	$13.15[§]
Mixed Logit *Constant Elasticity of Income*	$0.69[§]	$5.39[§]

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Results

Value of other spray program attributes

- Pricing the fixed effects (from the probit model):

	Did participate	Did **not** participate
Gulu (ICON) District	$2.46	$1.82
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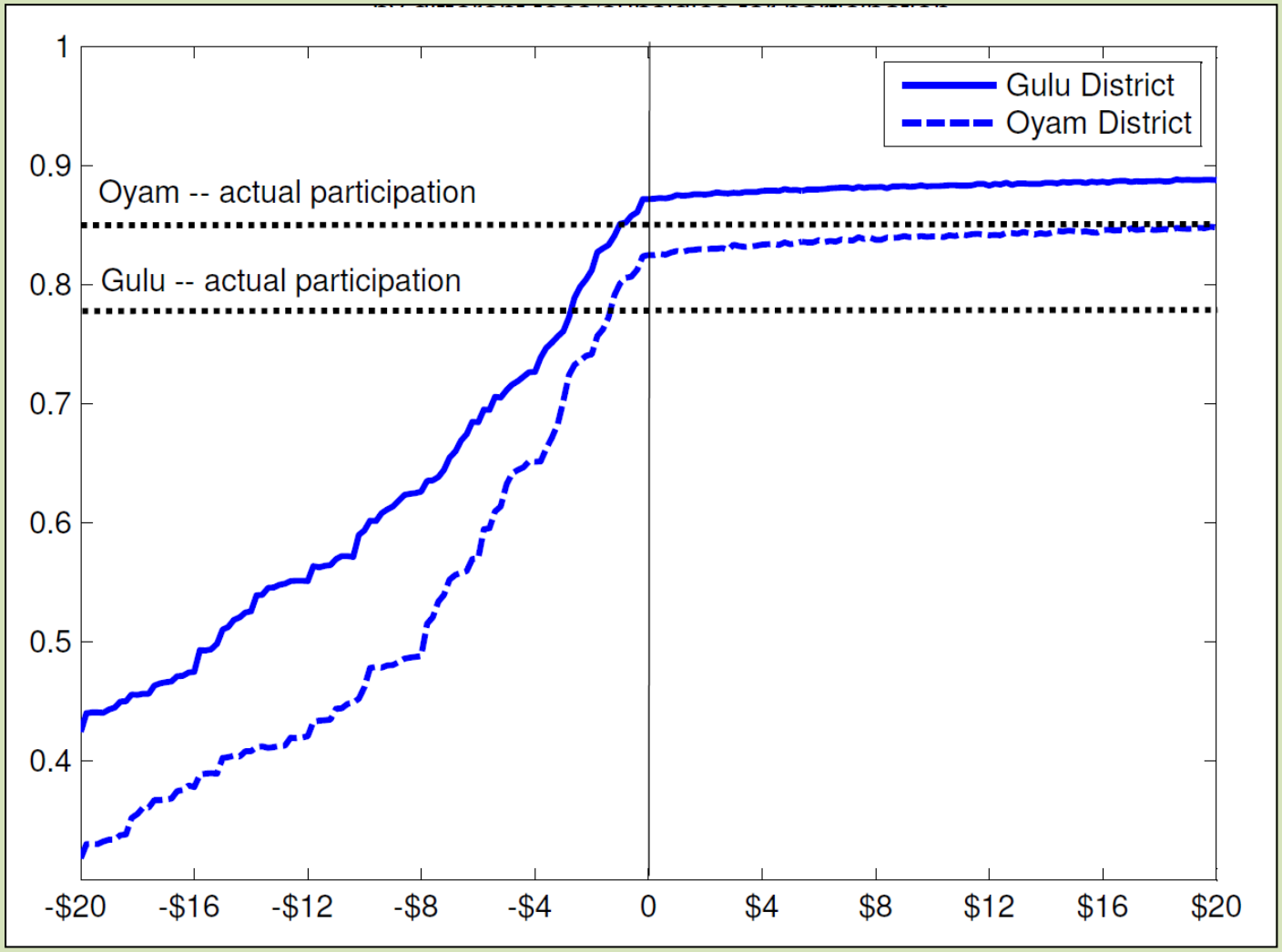
- Costs (and benefits) of more frequent spraying?
  - Taste parameter marginally significant.
  - Marginal value of around $0.02 cents per round.
  - Hypothesizing heterogeneity in the population, but still working on this.

Results

Observed and predicted participation by fee / subsidy



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- Predicted participation may be highly responsive to a fee, due to income effects, but not to a subsidy.

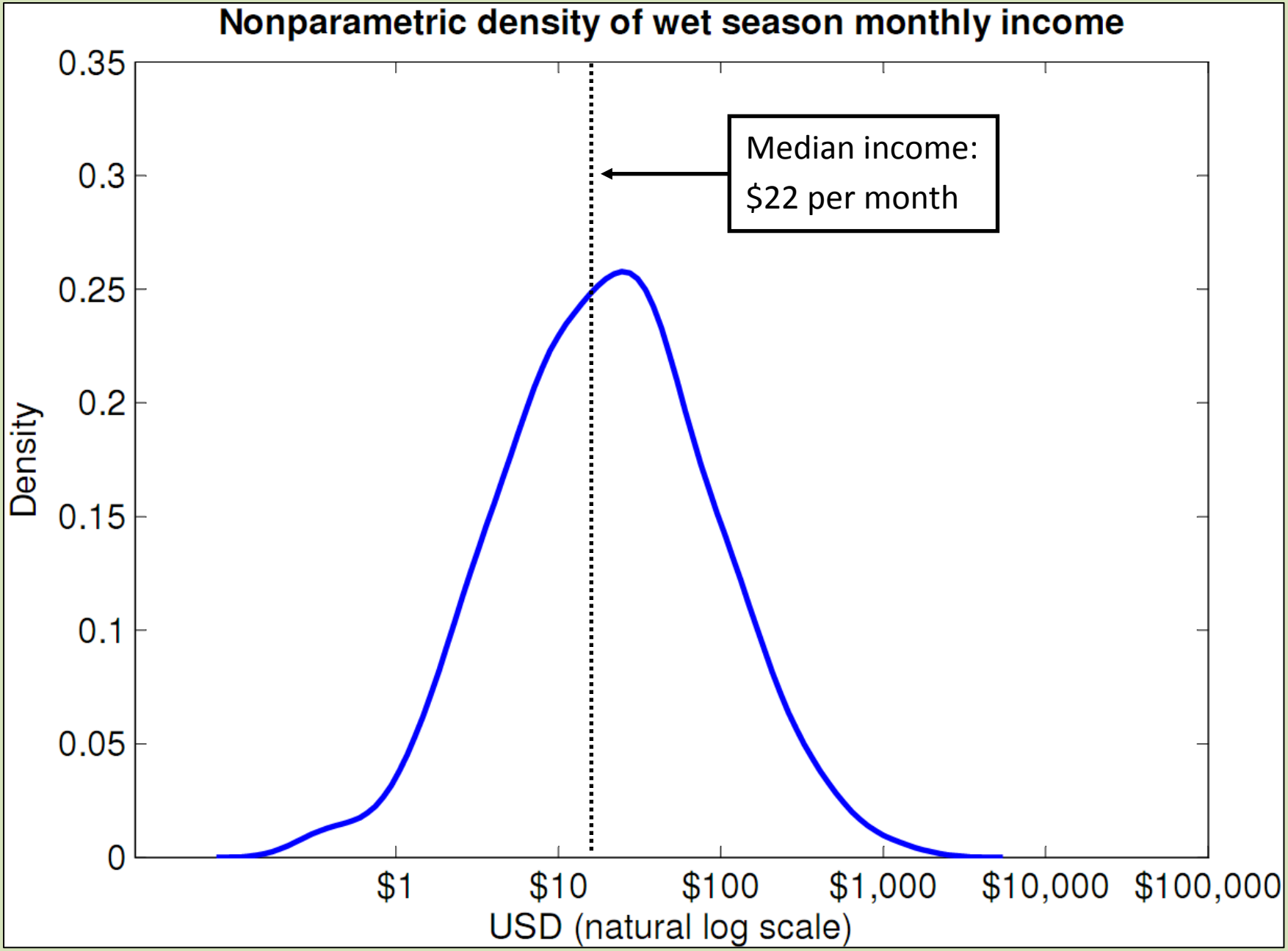
Help?

- *Model specification, nonlinear mixed logit?* Allowing for nonlinearities for…
  - Wealth effects
  - Generalizations of expected utility theory

Acknowledgements

Christine Oryema, David Ocan, Godfrey Okot, Daniela Miteva, Gulu University, National Science Foundation, Duke Global Health Institute

Thanks!


Nonparametric density of wet season monthly income
Median income:
$22 per month
Density
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
$1
$10
$100
$1,000
$10,000
$100,000
USD (natural log scale)

Outline (19 slides):

- *(2 slides PHOTO(S)—spray worker, spray tank) Malaria and spray programs worldwide and in Uganda (PMI and WHO reports)*
- *(1 slide PHOTO—pile o' shit) Spray program acceptance, desirability... Mozambique focus groups. IRS program is a nonmarket good.*
- *(1 slide--) Research questions: (a) How do households value different attributes of the spray programs, e.g. malaria risk reduction, insecticide exposure, disruption to household activities? (b) How does the magnitude of infectious disease risk, and potential reductions from a publicly administered prevention program, affect monetary valuations of that program, e.g. WTA increases in malaria risk? (c) Implications for different subsidization/fee schemes for spray program participation?*
- *(2 slides) Peer-reviewed Literature*
- (5 slides) Methods:
  - *(a) (1 slide) Household survey with a DCE over alternative spray programs, malaria risk levels, and compensation*
  - *(b) (1 slide PHOTO + Figure) Visual aids used to conduct the DCE.*
  - *(c) (1 slide) Information frame about requirements of participation, plus basic background on 2 previously used in insecticides.*
  - *(d) (1 slide-- MAP) Household survey during Oct/Nov 2010. 612 households interviewed, stratified across 2 adjacent districts, 40 households per village, with villages sampled with probability proportional to relative UBOS population figures (maps). Survey questions were about demographics, subjective expectations, DCE, malaria risk perceptions, income, wealth & assets, agriculture, land tenure & security.*
  - *(e) (1 slide) Discrete choice econometric models: multinomial probit & logit, and mixed logit with (log)normally distributed taste parameters; Stata routines.*
- *(8 slides) Results:*
  - *(a) (1 slide) Utility/choice model*
  - *(b) (1 slide) Probit/logit estimation results*
  - *(c) (1 slide) Mixed logit estimation results*
  - (d) (1 slide) Other respondent-specific chracteristics
  - (e) (1 slide) Use choice model and subjective expectations to predict observed participation levels.
  - (f) (1 slide) WTA & WTP by risk reduction level, multinomial probit.
  - (g) (1 slide) DDT v. ICON attribute diffs
  - (h) (1 slide) Predicted participation across different fee/subsidy levels, using risk reduction based on IRS impact study for northern Uganda… multonom probit, mixed logit
- (1 slide) Conclusions
  - (a) Malaria risk reduction via IRS is highly desirable when considered against monetary alternatives.
  - (b)
  - (c) Importance of insecticide type?