Malaria Policy: Alternative Prevention and Eradication Strategies in a Dynamic Model

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The Question

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- Malaria is bad

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- Agreement:

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- Agreement: something needs to be done.

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The Question

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- Agreement: something needs to be done.
- Disagreement: what should be done.
- Our question here:
  What malaria control policy is most effective in a dynamic model economy that takes individual incentives into account?

The Context

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- 40% lives in regions with endemic malaria

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- Malaria costs 40% of GDP and 1.3% of growth
- 300 mio episodes of acute illness every year
- 1 mio deaths every year

Principle

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- Households face various shocks:

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Principle

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- Protection decisions

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- Savings, borrowing constraints

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- Households face various shocks: income/productictity, health
- Protection decisions
- Endogenous infection rate
- Endogenous factor prices, production
- Savings, borrowing constraints $\Longrightarrow$ heterogeneous agents

Households

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- $\max_{\{c_{it},k_{i,t+1},p_{it}\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \ln(\gamma c_{it})$

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- S.T. $c_{it} + k_{i,t+1} + p_{it} q = w_t h_{it} \pi_{it} + r_t k_{it}$

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- π_{it} random

Households

- $\max_{\{c_{it}, k_{i,t+1}, p_{it}\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \ln(\gamma c_{it})$
- S.T. $c_{it} + k_{i,t+1} + p_{it} q = w_t h_{it} \pi_{it} + r_t k_{it}$
- π_{it} random
- h_{it} random

Technology

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- $L_t = \sum_i h_{it}\pi_{it}$

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- $Y_t = K_t^{\alpha} L_t^{1-\alpha}$

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- $r_t = \alpha K_t^{\alpha-1} L_t^{1-\alpha}$

Technology

- $L_t = \sum_i h_{it}\pi_{it}$
- $K_t = \sum_i k_{it}$
- $Y_t = K_t^{\alpha} L_t^{1-\alpha}$
- $r_t = \alpha K_t^{\alpha-1} L_t^{1-\alpha}$
- $w_t = (1-\alpha) K_t^{\alpha} L_t^{-\alpha}$

Malaria

Malaria

- infection rate:

Malaria

- infection rate:
- infected people:

Malaria

- infection rate: $i = Z\left(\frac{S}{N}\right)^{\mu}$
- infected people:

Malaria

- infection rate: $i = Z\left(\frac{S}{N}\right)^{\mu}$
- infected people: $\frac{S'}{N'} = \frac{N[S - d_s S + [iH(1-V) + iHVe](1-d_h)]}{N - d_s S - d_h H + fN}$

Equilibrium

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savings, protection decisions, infection rate, proportion infected, laws of motion, distributions such that:

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Equilibrium

savings, protection decisions, infection rate, proportion infected, laws of motion, distributions such that:

- households optimize
- factor markets are in equilibrium
- population distribution is ergodic

Policies

Policies

Treatment

Policies

Treatment

Cost

Policies

Treatment	Cost	Efficacy

Policies

Treatment	Cost	Efficacy
Insecticide-treated bednets (ITN)		

Policies

Treatment	Cost	Efficacy
Insecticide-treated bednets (ITN)		
Long-lasting insecticide nets (LLIN)		

Policies

Treatment	Cost	Efficacy
Insecticide-treated bednets (ITN)		
Long-lasting insecticide nets (LLIN)		
Residual spraying (IRS)		

Policies

Treatment	Cost	Efficacy
Insecticide-treated bednets (ITN)		
Long-lasting insecticide nets (LLIN)		
Residual spraying (IRS)		
Vaccine		

Policies

Treatment	Cost	Efficacy
Insecticide-treated bednets (ITN)	$45	
Long-lasting insecticide nets (LLIN)		
Residual spraying (IRS)		
Vaccine		

Policies

Treatment	Cost	Efficacy
Insecticide-treated bednets (ITN)	\$45	
Long-lasting insecticide nets (LLIN)	\$20–30	
Residual spraying (IRS)		
Vaccine		

Policies

Treatment	Cost	Efficacy
Insecticide-treated bednets (ITN)	$45	
Long-lasting insecticide nets (LLIN)	$20–30	
Residual spraying (IRS)	$16–32	
Vaccine		

Policies

Treatment	Cost	Efficacy
Insecticide-treated bednets (ITN)	\$45	
Long-lasting insecticide nets (LLIN)	\$20–30	
Residual spraying (IRS)	\$16–32	
Vaccine	\$50–75	

Policies

Treatment	Cost	Efficacy
Insecticide-treated bednets (ITN)	\$45	70%
Long-lasting insecticide nets (LLIN)	\$20–30	
Residual spraying (IRS)	\$16–32	
Vaccine	\$50–75	

Policies

Treatment	Cost	Efficacy
Insecticide-treated bednets (ITN)	\$45	70%
Long-lasting insecticide nets (LLIN)	\$20–30	70%
Residual spraying (IRS)	\$16–32	
Vaccine	\$50–75	

Policies

Treatment	Cost	Efficacy
Insecticide-treated bednets (ITN)	\$45	70%
Long-lasting insecticide nets (LLIN)	\$20–30	70%
Residual spraying (IRS)	\$16–32	80%
Vaccine	\$50–75	

Policies

Treatment	Cost	Efficacy
Insecticide-treated bednets (ITN)	\$45	70%
Long-lasting insecticide nets (LLIN)	\$20–30	70%
Residual spraying (IRS)	\$16–32	80%
Vaccine	\$50–75	50%

Policies

Treatment	Cost	Efficacy
Insecticide-treated bednets (ITN)	$45	70%
Long-lasting insecticide nets (LLIN)	$25	70%
Residual spraying (IRS)	$24	80%
Vaccine	$62.5	50%

Policies

Treatment	Cost	Efficacy
Insecticide-treated bednets (ITN)	\$45	70%
Long-lasting insecticide nets (LLIN)	\$25	70%
Residual spraying (IRS)	\$24	80%
Vaccine	\$62.5	50%

GDP/capita: \$400

Experiments

Experiments

$Z = 0.5$

Treatment	sick	sick/prot.	K	Y	C
no malaria	0.000	0.000	12.08	2.45	2.27
no prot.					
ITN					
LLIN					
IRS					
Vaccine					

Experiments

$Z = 0.5$

Treatment	sick	sick/prot.	K	Y	C
no malaria	0.000	0.000	12.08	2.45	2.27
no prot.	0.866	0.000	2.99	1.40	1.16
ITN					
LLIN					
IRS					
Vaccine					

Experiments

$Z = 0.5$

Treatment	sick	sick/prot.	K	Y	C
no malaria	0.000	0.000	12.08	2.45	2.27
no prot.	0.866	0.000	2.99	1.40	1.16
ITN	0.616	0.616	3.74	1.54	1.45
LLIN					
IRS					
Vaccine					

Experiments

$Z = 0.5$

Treatment	sick	sick/prot.	K	Y	C
no malaria	0.000	0.000	12.08	2.45	2.27
no prot.	0.866	0.000	2.99	1.40	1.16
ITN	0.616	0.616	3.74	1.54	1.45
LLIN	0.616	0.616	3.76	1.55	1.29
IRS					
Vaccine					

Experiments

$Z = 0.5$

Treatment	sick	sick/prot.	K	Y	C
no malaria	0.000	0.000	12.08	2.45	2.27
no prot.	0.866	0.000	2.99	1.40	1.16
ITN	0.616	0.616	3.74	1.54	1.45
LLIN	0.616	0.616	3.76	1.55	1.29
IRS	0.523	0.523	4.44	1.65	1.41
Vaccine					

Experiments

$Z = 0.5$

Treatment	sick	sick/prot.	K	Y	C
no malaria	0.000	0.000	12.08	2.45	2.27
no prot.	0.866	0.000	2.99	1.40	1.16
ITN	0.616	0.616	3.74	1.54	1.45
LLIN	0.616	0.616	3.76	1.55	1.29
IRS	0.523	0.523	4.44	1.65	1.41
Vaccine	0.715	0.715	3.25	1.46	1.20

Experiments

$Z = 0.7$

Treatment	sick	sick/prot.	K	Y	C
no malaria	0.000	0.000	12.08	2.45	2.27
no prot.	0.901	0.000	2.96	1.39	1.16
ITN	0.684	0.684	3.41	1.49	1.23
LLIN	0.684	0.684	3.43	1.49	1.23
IRS	0.601	0.601	3.85	1.56	1.31
Vaccine	0.767	0.767	3.08	1.42	1.16

Experiments

$Z = 0.9$

Treatment	sick	sick/prot.	K	Y	C
no malaria	0.000	0.000	12.08	2.45	2.27
no prot.	0.921	0.000	2.93	1.38	1.15
ITN	0.728	0.728	3.18	1.44	1.19
LLIN	0.728	0.728	3.26	1.46	1.20
IRS	0.654	0.654	3.60	1.52	1.26
Vaccine	0.798	0.798	3.01	1.41	1.15

Experiments

$Z = 0.3$

Treatment	sick	sick/prot.	K	Y	C
no malaria	0.000	0.000	12.08	2.45	2.27
no prot.	0.793	0.000	3.12	1.43	1.19
ITN	0.497	0.497	4.63	1.68	1.45
LLIN	0.497	0.497	4.65	1.68	1.45
IRS	0.397	0.397	5.80	1.83	1.62
Vaccine	0.616	0.616	3.72	1.54	1.28

Experiments

$Z = 0.1$

Treatment	sick	sick/prot.	K	Y	C
no malaria	0.000	0.000	12.08	2.45	2.27
no prot.	0.550	0.000	4.31	1.63	1.41
ITN	0.241	0.241	7.98	2.08	1.87
LLIN	0.241	0.241	7.90	2.07	1.87
IRS	0.170	0.170	8.98	2.18	1.98
Vaccine	0.353	0.353	6.37	1.90	1.71

Experiments

$Z = 0.7$

Treatment	sick	sick/prot.	K	Y	C
no malaria	0.000	0.000	12.08	2.45	2.27
no prot.	0.901	0.000	2.96	1.39	1.16
ITN	0.684	0.684	3.41	1.49	1.23
LLIN	0.684	0.684	3.43	1.49	1.23
IRS	0.601	0.601	3.85	1.56	1.31
Vaccine	0.767	0.767	3.08	1.42	1.16

Experiments

$Z = 0.7$, free protection

Treatment	sick	sick/prot.	K	Y	C
no malaria	0.000	0.000	12.08	2.45	2.27
no prot.	0.901	0.000	2.96	1.39	1.16
ITN	0.616	0.616	3.80	1.55	1.31
LLIN	0.616	0.616	3.80	1.55	1.31
IRS	0.523	0.523	4.47	1.66	1.42
Vaccine	0.715	0.715	3.32	1.47	1.22

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- Treatments need to be more efficient

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- Treatments need to be more efficient to have an impact as they are always adopted
- Cost of treatment matters little
- Free treatment is not the solution
- Ecological factors matter much more