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

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Outline

Introduction A Model Economy Policies Experiments To conclude...

Introduction

The Question The Context

A Model Economy

Principle Households Technology Malaria Equilibrium

Policies

Experiments

To conclude...

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The Question The Context

The Question

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The Question The Context

The Question

Malaria is bad

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The Question The Context

The Question

Malaria is bad, very bad.

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The Question The Context

The Question

- Malaria is bad, very bad.
- Agreement:

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The Question The Context

The Question

- Malaria is bad, very bad.
- Agreement: something needs to be done.

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The Question The Context

The Question

- Malaria is bad, very bad.
- Agreement: something needs to be done.
- Disagreement:

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The Question The Context

The Question

- Malaria is bad, very bad.
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- Disagreement: what should be done.

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The Question The Context

The Question

- Malaria is bad, very bad.
- Agreement: something needs to be done.
- Disagreement: what should be done.
- Our question here:

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The Question The Context

The Question

- Malaria is bad, very bad.
- 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?

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The Question The Context

The Context

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The Question The Context

The Context

▶ 40% lives in regions with endemic malaria

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The Question The Context

The Context

- ▶ 40% lives in regions with endemic malaria
- ▶ Malaria costs 40% of GDP and 1.3% of growth

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The Question The Context

The Context

- ▶ 40% lives in regions with endemic malaria
- ▶ Malaria costs 40% of GDP and 1.3% of growth
- 300 mio episodes of acute illness every year

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The Question The Context

The Context

- ▶ 40% lives in regions with endemic malaria
- ▶ Malaria costs 40% of GDP and 1.3% of growth
- 300 mio episodes of acute illness every year
- 1 mio deaths every year

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Principle Households Technology Malaria Equilibrium

Principle

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Principle Households Technology Malaria Equilibrium

Principle

Households face various shocks:

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Households face various shocks: income/producticity,

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► Households face various shocks: income/producticity, health

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- Households face various shocks: income/producticity, health
- Protection decisions

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Principle

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- Households face various shocks: income/producticity, health
- Protection decisions
- Endogenous infection rate

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Principle

Households face various shocks: income/producticity, health

Principle

Malaria

Households

Equilibrium

- Protection decisions
- Endogenous infection rate
- Endogenous factor prices, production

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Principle

Households face various shocks: income/producticity, health

Principle

Malaria

Households

Equilibrium

- Protection decisions
- Endogenous infection rate
- Endogenous factor prices, production
- Savings,

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Principle

► Households face various shocks: income/producticity, health

Principle

Malaria

Households

Equilibrium

- Protection decisions
- Endogenous infection rate
- Endogenous factor prices, production
- Savings, borrowing constraints

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Principle

Households face various shocks: income/producticity, health

Principle

Malaria

Households

Equilibrium

- Protection decisions
- Endogenous infection rate
- Endogenous factor prices, production
- ► Savings, borrowing constraints ⇒ heterogeneous agents

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Households

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Principle Households Technology Malaria Equilibrium

Households

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

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Principle Households Technology Malaria Equilibrium

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

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Principle Households Technology Malaria Equilibrium

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

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Principle Households Technology Malaria Equilibrium

Households

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

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Principle Households Technology Malaria Equilibrium

Technology

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Principle Households Technology Malaria Equilibrium

Technology

•
$$L_t = \sum_i h_{it} \pi_{it}$$

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Principle Households Technology Malaria Equilibrium

Technology

•
$$L_t = \sum_i h_{it} \pi_{it}$$

• $K_t = \sum_i k_{it}$

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Principle Households Technology Malaria Equilibrium

Technology

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

$$K_t = \sum_i k_{it}$$

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

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Principle Households Technology Malaria Equilibrium

Technology

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

$$K_t = \sum_i k_{it}$$

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

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

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Principle Households Technology Malaria Equilibrium

Technology

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

$$K_t = \sum_i k_{it}$$

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

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

$$w_t = (1-\alpha) K_t^{\alpha} L_t^{-\alpha}$$

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Principle Households Technology Malaria Equilibrium

Malaria

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Principle Households Technology Malaria Equilibrium

Malaria

infection rate:

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Malaria

- infection rate:
- infected people:

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Malaria

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

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Malaria

▶ infection rate: i = Z (S/N)^µ
 ▶ infected people: S'/N' = N[S-d_sS+[iH(1-V)+iHVe](1-d_h)]/N-d_sS-d_hH+fN

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Principle Households Technology Malaria Equilibrium

Equilibrium

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Equilibrium

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

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Principle Households Technology Malaria Equilibrium



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

households optimize

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Principle Households Technology Malaria Equilibrium



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

- households optimize
- factor markets are in equilibrium

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Principle Households Technology Malaria 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

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Policies



Treatment

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Treatment

Cost

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Treatment

Cost Efficacy

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Treatment Insecticide-treated bednets (ITN)

Cost Efficacy

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

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

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

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

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

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



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



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%



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%



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

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Experiments

Z = 0.5sick/prot. Κ Y С Treatment sick 12.08 2.45 2.27 no malaria 0.000 0.000 no prot. ITN LLIN IRS Vaccine

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Experiments

Z = 0.5					
Treatment	sick	sick/prot.	K	Y	С
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					

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Experiments

Z = 0.5					
Treatment	sick	sick/prot.	K	Y	С
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					

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Experiments

Z = 0.5					
Treatment	sick	sick/prot.	K	Y	С
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					

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Experiments

Z = 0.5					
Treatment	sick	sick/prot.	K	Y	С
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					

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Experiments

Z = 0.5					
Treatment	sick	sick/prot.	K	Y	С
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

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Experiments

Z = 0.7					
Treatment	sick	sick/prot.	K	Y	С
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	С
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	С
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	С
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

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Experiments

Z = 0.7					
Treatment	sick	sick/prot.	K	Y	С
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	e protection
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Treatment	sick	sick/prot.	K	Y	С
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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To conclude...

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Treatments need to be more efficient

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> Treatments need to be more efficient to have an impact

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 Treatments need to be more efficient to have an impact as they are always adopted

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- Treatments need to be more efficient to have an impact as they are always adopted
- Cost of treatment matters little

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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

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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

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