Can Good Products Drive Out Bad?
A Randomized Intervention in the Antimalarial Medicine Market in Uganda

Martina Björkman Nyqvist
Stockholm School of Economics

Jakob Svensson
IIES, Stockholm University

David Yanagizawa-Drott
University of Zurich

JEEA Teaching Material
2022

Introduction

- Some hard evidence (and mostly anecdotal) suggest that product quality in markets for experience/credence goods is notoriously low in many developing countries.
  - quality of hybrid seeds and fertilizer (Bold, Kaizzi, Svensson, and Yanagizawa-Drott (2017))

- Poor quality arising from weak incentives for building a reputation can have adverse welfare consequences: consumption and health, but also productivity and technology adoption

- Little is known about the feasibility and cost-effectiveness of interventions to move the market out of this suboptimal equilibrium

Introduction

- One such experience/credence good is antimalarial drugs
  - quality is unknown to the consumer prior to consumption, and may only be partially observable afterward

- Malaria is a major killer disease in developing countries
  - Roughly 384,000 deaths in Africa alone in 2019 (WHO, 2020)
  - Accounts for 22% of all child deaths in Sub-Saharan Africa

- Malaria is curable
  - ACT (artemisinin combination therapy): recommended first-line treatment

- But the market for antimalarial medicines is plagued by counterfeit and substandard products
  - 32% of medicines in public and private outlets in sub-Saharan Africa and South-east Asia are fake (counterfeit and substandard) (Nayyar et al., 2012) ▸ data figure

Introduction

- Poor-quality medicines are a global public health problem

- **Short-term consequences:**
  - ▶ Individuals sick in malaria not properly treated
  - ▶ Potentially deadly for children

- **Long-term consequences:**
  - ▶ Human capital and productivity losses (Bleakley, 2010; Cutler, 2010; Barofsky, 2011)
  - ▶ Drug resistance (WHO, 2011)

- Finding evidence of ways to drive out bad drugs is important

- Understanding the market is important from a policy perspective

Introduction

- A wide variety of regulatory policies have been put forward to address the problem of fake drugs.

- Strengthening the enforcement of regulations to safe-guard public health by controlling the quality, safety and efficacy of medicines circulating in the market

.....**such reforms are not easily implemented in the short run in countries with weak institutions**.

- *This paper studies one segment of the market for ACT malaria drugs ⇒ Retail markets in rural Uganda*

- *Assess how the entry of a seller committed to **high quality** influence the market equilibrium (incumbent sellers)*

Related Literature: Lemons Theory

- Large theoretical literature on asymmetric information in product markets
  - Starting with Akerlof (1970)

- One strand of the literature focuses on reputation mechanisms, where quality depends on consumers' ability to infer quality (Shapiro, 1982; 1983)
  - **Key trade-off**
    - ★ Set lower quality (lower MC) and increase profit today
    - ★ If consumers detect lower quality, firm will lose reputation and future demand, which leads to decreased profits in the future
  - However, inferring antimalarial drug quality is potentially very noisy (will discuss more...)

This paper

- Measure antimalarial (ACT) quality in rural, local markets
- Combine the market data with HH surveys and provide facts and correlations
  - quality
  - price
  - consumer beliefs
  - quantity
- Exploit experimental variation in competition in the market for antimalarial drugs to assess how incumbent private outlets and consumers react to the entry of an NGO selling authentic ACT drugs below local market prices.

Background: Disease Burden and Diagnostics

- *Plasmodium falciparum*—most severe form of malaria and most common type in Sub-Saharan Africa—responsible for the vast majority of malaria deaths

- Adequately and promptly treated (preferably within 24 hours of the first symptom), malaria is *curable*

- Artemisinin-based combination therapy (ACT) is recommended by WHO as the first-line treatment of malaria:
  - a package of tablets (24 for adults and 12 for kids) to take at the first sign
  - low drug resistance
  - $\sim$ 3-8 USD per dose
  - found in >80% of all local drug shops in rural Africa (Birabwa, 2014)

- In Africa, however, treatment is mostly done using traditional remedies or drugs bought from local (mostly private and unregulated) drug stores
  - In our sample, 58% of the malaria-sick patients went to buy antimalarials at the local drug shop.

- Self-diagnosis is the norm:
  - 70% of malaria cases in Africa are diagnosed at home (Amexo, 2004)

Background: Prevalence of Low Quality Drugs

- The market of counterfeit drugs is large and experienced
  - counterfeit and substandard drugs sales at USD 32 billion globally (WHO, 2003)
  - produced in China, India, Nigeria etc. and end up in local markets across the world (Lybecker, 2004)

- It is estimated that 0.25 million deaths could be preventable should episodes treated with counterfeit or substandard drugs were treated instead with high quality drugs (Harris, Steven, and Moris, 2009)

Background: Observability and Beliefs about Drug Quality

- Drug quality is difficult to distinguish based on visual characteristics

- Even when consumers are aware of the existence of counterfeit drugs, it is still difficult to observe the quality before purchase
  - 26% of households in our baseline sample believe that nearby drug store sells fake drugs
  - Many households also report distrust of private drug outlets, and subsequently tend to acquire drugs from public drug outlets

- In this context, there is a noisy learning of drug quality despite the non-observable quality characteristics prior to purchase

Background: Observability and Beliefs about Drug Quality

Fake **Authentic**

Background: The Market Structure in Uganda

- The formal structure of drug market in Uganda requires drug stores to have licenses to purchase and distribute drugs

- However, unregulated pharmaceutical market where non-licensed drugs shops are common due to weak enforcement of regulations
  - Uganda: out of 215 drugs shops, 88% were unlicensed. 91% of all drug shops sold ACT drugs (Buchner et al. 2019)

- A local drug shop owner may acquire pre-packaged counterfeit, or substandard, ACT from wholesaler
  - buy repackaged non-ACTs in ACT blister packages done in-country
  - use non-ACTs or old ACTs and label them falsely

Background: The Market Structure in Uganda

- In theory, drugs in Uganda are provided for free, but public healthcare is largely unreliable due to procurement issues
    - private drug outlets play a major role in selling essential medicines
    - 54% of our baseline sample sourced their ACT drugs from private sources

- There is little variation in ACT supply both between and within village
    - two-third of drug stores in our baseline sample sell Lonart as ACT medicines, one-forth sell Artefan, which both are the generic version of Coartem
    - within each village, there are 1.2 drug stores on average

- The market in rural areas is characterized by relatively low competition
    - 26% of villages in our sample served by a local monopoly

Conceptual Framework

Main implications of the conceptual framework

- *Proposition 1*
  - ▸ If the cost of providing high-quality drugs is sufficiently high, the equilibrium with only one seller on the market will be characterized by low quality
  - ▸ The equilibrium price is a positive function of expected quality, but since firms pool on the same price within a (village) market, firms selling different quality drugs will charge the same price
- *Proposition 2*
  - ▸ With the NGO on the market, consumers' ability to learn about quality improves
- *Proposition 3*
  - ▸ When facing competition from the NGO selling high-quality drugs at a subsidized price, opportunistic incumbents will either sell high quality (low cost types) or exit (high cost types) after the first period

The Intervention

- Implement a randomized controlled trial on a community health care program in four districts in Uganda with high and endemic *P. falciparum* prevalence

- **Intervention:** collaborating NGOs recruited and trained woman from the villages – *Community Health Promoter (CHP)* – to act as the health sales agents
  - CHP buy drugs from NGOs branch office (including *authenic* ACT drugs) at 40% below the market price
  - CHP sell the drugs to households at a fixed retail price set by NGO - approximately 20-30% lower than local market price
  - CHP sell several preventive and treatment products on top of authentic ACTs
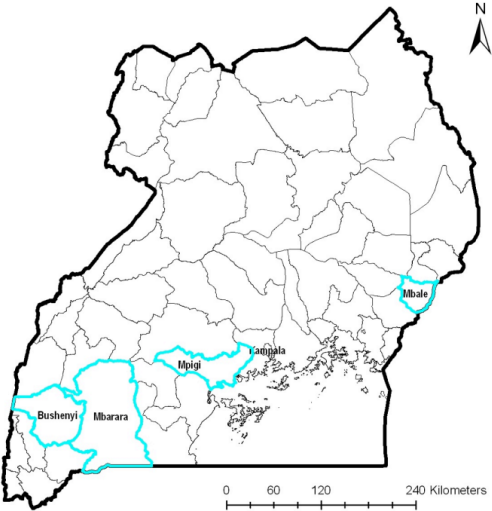 - Sales margin were kept by the CHP

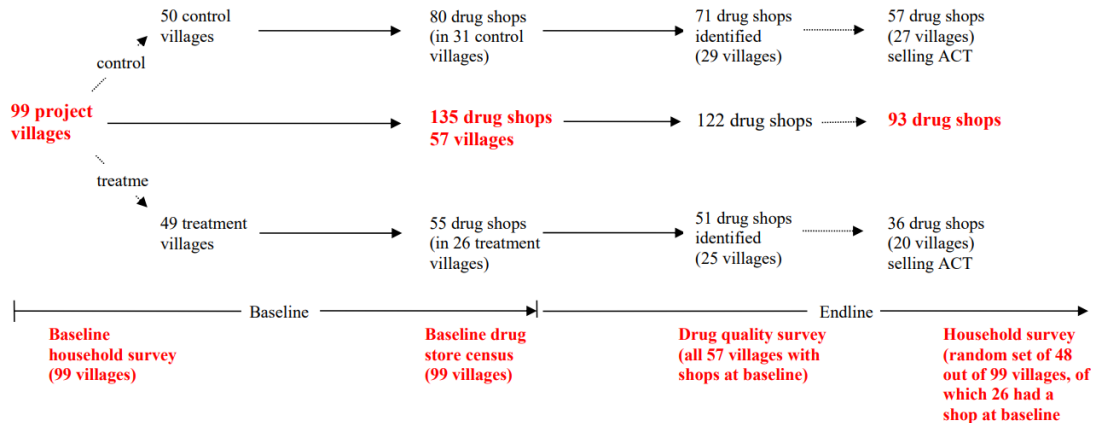# Community Health Promoter

The Sample

- 99 villages from 4 districts (although, not all villages have a drug shop)

- Two rounds of household surveys (baseline and 16-20 months into the intervention)

- Measure drug quality and prices about a year into the intervention in all drug shops

Sample Districts in Uganda

Trial Profile

Measurement: Purchase of Drugs to be Tested

- Conducted a census of local drug shops in 99 villages in 4 districts in Uganda

- Sent mystery covert shoppers to purchase ACT drugs from each drug shop
  - Knows the local language; local ethnic group, etc.
  - Trained to use a script: buy antimalarial ACT for an uncle sick with malaria
  - Record the price and test for drug quality

Measurement: Purchase of Drugs to be Tested

Measurement: Drug Quality Tests

- Chemical analyses of medicines like ACTs can be performed using several different techniques

- This study uses the Raman spectroscopy for drug testing (a TruScan handheld scanner)
  ▸ details
  - expose the pill to laser and measure the reflecting Raman spectra: molecular composition of the pill is tested against an authentic reference pill
  - detects if the pill is authentic or not (pass/fail).

- Method is used by 9 out 10 pharmaceutical companies, and a growing number of drug enforcement agencies, and the method is very common in medical literature

- Very similar results as lab testing, more suitable for the field (Bate et. al, 2009; Ricci et. al, 2008)

- **Limitation**:
  - Cannot determine exact ingredients, only if the drug standard is fulfilled

Baseline Characteristics

Table: Baseline Characteristics

	Panel A: All Villages					Panel B: Villages with drug store at baseline				
	Obs.	Mean, Treatment	Mean, Control	Diff.	P-value	Obs.	Mean, Treatment	Mean, Control	Diff.	P-value
Household Characteristics										
Male head of household has secondary education, dummy	2,980	0.30	0.27	0.03	0.32	1,817	0.32	0.29	0.03	0.47
Male head of household has tertiary education, dummy	2,980	0.05	0.05	0.00	0.74	1,817	0.07	0.05	0.02	0.06*
Radio ownership, dummy	2,980	0.82	0.79	0.03	0.17	1,817	0.85	0.82	0.03	0.33
Electricity, dummy	2,980	0.19	0.16	0.03	0.52	1,817	0.26	0.19	0.06	0.29
Thatched roof, dummy	2,967	0.03	0.04	-0.01	0.36	1,810	0.02	0.04	-0.02	0.15
Muslim HH, dummy	2,980	0.19	0.17	0.02	0.46	1,817	0.19	0.19	-0.00	0.94
Number of u5 children in HH	2,980	1.72	1.75	-0.02	0.57	1,817	1.68	1.73	-0.05	0.41
Child reported sick in malaria in past month, dummy	5159	0.43	0.41	0.03	0.32	3,087	0.44	0.39	0.05	0.14
Sick child was treated with ACT, dummy	2,169	0.41	0.37	0.04	0.26	1,263	0.40	0.35	0.05	0.31
The ACT was bought in a drug shop, dummy	749	0.60	0.58	0.01	0.84	415	0.64	0.54	0.10	0.23
# ACT pills for treating sick child, any source	751	6.49	6.69	-0.20	0.52	415	6.67	6.87	-0.20	0.68
Has heard of ACT, dummy	2,980	0.95	0.95	0.00	0.99	1,817	0.95	0.95	0.00	0.98
Believes ACT is highly effective, dummy	2,728	0.90	0.90	0.01	0.73	1,670	0.91	0.89	0.03	0.15
Believes non-ACTs are highly effective, dummy in past month, dummy	2,930	0.83	0.86	-0.04	0.26	1,785	0.86	0.85	0.01	0.88
Believes nearest drug shop sells fake drugs, dummy	2,841	0.28	0.26	0.03	0.42	1,723	0.29	0.26	0.04	0.43
Village Characteristics										
Number of households in the village	99	192.80	190.82	1.98	0.96	57	197.62	208.35	-10.74	0.84
Number of drug stores in the village	99	1.12	1.60	-0.48	0.20	57	2.12	2.58	-0.47	0.34
Village has at least one drug store	99	0.53	0.62	-0.09	0.37	57	1.00	1.00	0.00	.
Village is a local monopoly (one drug store)	99	0.27	0.26	0.01	0.95	57	0.50	0.42	0.08	0.55

- Baseline characteristics is well-balanced

# Prevalence of Fake Drugs

Table: Prevalence of fake antimalarial drugs

	Drug stores selling fake drugs	Share of tested drugs that are fake	
	(1)	(2)	(3)
		<u>All stores</u>	<u>Conditional</u>
All districts	36.8%	19.4%	51.5%
	($N = 57$)	($N = 346$)	($N = 130$)
By district			
Bushenyi	40.0%	30.0%	75.0%
Mbale	33.3%	11.1%	33.3%
Mbarara	53.3%	25.6%	47.9%
Mpigi	26.1%	14.1%	50.0%
By local competition			
Monopoly	30.8%	15.9%	46.4%
Competition	38.6%	20.5%	52.9%

Observability of Drug Quality Before Purchases

- Assumption: quality of antimalarial medicine can not be inferred *before* purchase

- This assumption is tested by asking ten individual surveyors in the control group to visually inspect each drug sample and infer as to whether the drug is fake or not
  - Surveyors were given the information on the overall share of fake drugs to set prior belief that is consistent with the data
  - R-square from a regression of visual quality indicates that visual assessment only accounts for 3% of the variation in actual quality

- Hence, observability of drug quality before purchase is very low

Price-Quality Distribution

Figure: Price-Quality Distribution
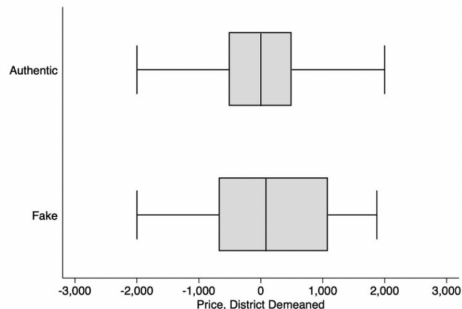
- The price distribution of authentic and fake drugs strongly overlap
- Hence, using the price to infer quality appears to be very noisy in this context

Results: Drug Quality

Table: Effects of NGO entry on drug quality

Unit of analysis	Village		Drug shops			
Dependent variable:	Number of drug stores selling fake drugs in the village		Drug stores sell fake drugs, dummy		Drug stores does not sell ACT drugs, dumy (exit)	
	(1)	(2)	(3)	(4)	(5)	(6)
NGO Entry	-0.263**	-0.194*	-0.153**	-0.167**	0.076	0.084
	(0.118)	(0.105)	(0.072)	(0.066)	(0.082)	(0.072)
Observations	99	99	135	135	135	135
R-squared	0.229	0.378	0.076	0.096	0.059	0.073
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes	No	Yes
Mean in control	0.420	0.420	0.263	0.263	0.287	0.287

Results: Drug Price

Table: Effects of NGO entry on drug price

Unit of analysis	Drug stores					
Dependent variable:	Log (price, Uganda shilling)		Price, '000 Uganda shilling		Price, % absolute deviation from NGO	
	(1)	(2)	(3)	(4)	(5)	(6)
NGO Entry	-0.146**	-0.153***	-1.449**	-1.512***	-18.093**	-18.815**
	(0.058)	(0.053)	(0.564)	(0.512)	(7.848)	(7.659)
Observations	93	93	93	93	93	93
R-squared	0.53	0.56	0.52	0.55	0.39	0.41
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes	No	Yes
Number of villages	47	47	47	47	47	47
Mean in control	9.0	9.0	8.9	8.9	35.8	35.8

Results: Consumer Beliefs

Table: Effects of NGO entry on consumer beliefs

Dependent variable:	Household believes nearest drug store sells fake drugs			
	(1)	(2)	(3)	(4)
NGO Entry	-0.065**	-0.082**	0.019	0.023
	(0.028)	(0.037)	(0.031)	(0.029)
NGO Entry*Post-survey			-0.112**	-0.119**
			(0.051)	(0.050)
Observations	674	674	2,397	2,397
R-squared	0.01	0.01	0.04	0.05
Unit of analysis	Household	Household	Household	Household
Survey data	Post only	Post only	Pre and post	Pre and post
District FE	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes
Post-survey dummy	No	No	Yes	Yes
Sample of villages	Shops at baseline	Shops at baseline	Shops at baseline	Shops at baseline
Number of villages	26	26	57	57
Mean Control	0.34	0.34	0.29	0.29

Results: Quantity

Table: Effects of NGO entry on drug quantity

Dependent variable:	Treated with ACT, dummy		# ACT pills, any source		# ACT pills, sourced from drug stores	
	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	OLS (6)
NGO Entry	-0.024 (0.068)	0.056 (0.047)	1.898*** (0.635)	-0.340 (0.441)	0.610 (0.927)	0.375 (0.555)
NGO Entry*post-survey		-0.068 (0.067)		2.391** (0.946)		0.377 (0.815)
Observations	322	1,585	204	619	204	619
R-squared	0.021	0.083	0.108	0.032	0.148	0.087
Unit of analysis	Household/child	Household/child	Household/child	Household/child	Household/child	Household/child
Sample of villages	Shops at baseline	Shops at baseline	Shops at baseline	Shops at baseline	Shops at baseline	Shops at baseline
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Post-survey dummy	No	Yes	No	Yes	No	Yes
Survey data	Post	Pre and post	Post	Pre and post	Post	Pre and post
Number of villages	26	57	26	54	26	54
Mean Control	0.66	0.42	6.7	6.8	2.7	3.3

Treatment of children reported sick in malaria

Conclusion

- First study on the determinants of drug quality in developing countries using a randomized intervention

- The study documents that market for antimalarial medicine in Uganda is plagued by low-quality drugs
- Entry of an NGO that sold a superior product had a significant impact on the market equilibrium:
  - The share of incumbent drug stores selling fake drugs dropped by more than 50% in the intervention markets compared to the control markets.
  - Drug price decreased
  - Market size increased through higher demand
  - Incumbent drug stores got a better reputation among households living in the village

Conclusion

- **Policy Implications**
  - In markets for experience goods and credence goods, reputational incentives are key for driving quality
  - Improving drug quality is related to decreasing consumer misconceptions and enhancing their ability to update their priors about drug quality
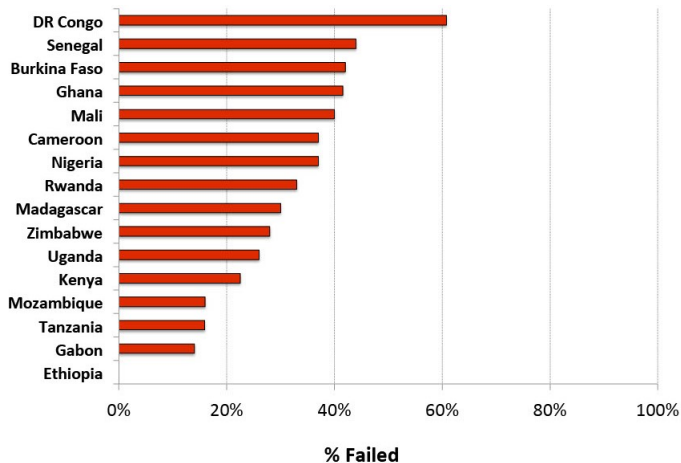 - Directly improving drug quality at the local drug stores through government random testing could be an alternative

- **Next step**
  - More reserach is needed to understand the feasibility and cost-effectiveness of alternative interventions to improve reputation building mechanisms in these market.

Appendix

Quality of Antimalarials

Figure: Quality of Antimalarials in Sub-Saharan Africa (Nayyar et al., 2012)

% Failed

▸ Back