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Market Access and Quality Upgrading: Evidence from Four Field Experiments

Tessa Bold[1], Selene Ghisolfi[2], Frances Nsonzi[3], and Jakob Svensson[1]

1) IIES (Stockholm University); 2) LEAP (Bocconi University);
3) Department of Food Technology and Nutrition (Makerere University)

Introduction

- Smallholder farmers in low-income countries produce output of low quality.
- Low quality limits the price they can command for their produce.
- Policy makers view quality upgrading as key to raising income and productivity.
- Yet, few farmers upgrade quality.

- ***Why?***

This paper: questions

- Four measurement and field experiments among smallholder maize farmers in Uganda to shed light on the ***impediments to quality upgrading*** at the farm level and ***study its potential impact***
  1. ***Quality at the farm gate?***
     - Measurement
     - Observability
  2. ***Return to quality at the farm gate?***
  3. ***Access to a market for high quality maize***
     - will farmers respond by producing higher quality if offered access to a market where quality maize is paid a (market) premium (plus training on how to produce high quality)?
     - implications for farmer income and productivity of quality upgrading?
  4. ***Extension intervention only***

This paper: methods

- Four measurement and field experiments among smallholder maize farmers in Uganda to shed light on the ***impediments to quality upgrading*** at the farm level and ***study its potential impact***
  1. ***Quality at the farm gate?***
     - laboratory tests and visual verifications
  2. ***Return to quality at the farm gate?***
     - experimental variation in the quality of the maize sold by farmers
  3. ***Access to a market for high quality maize plus extension***
     - CRCT aimed at emulating a situation where treated households gain access to an output market for quality maize plus training on how to produce high quality maize
       - follow farmers over seven seasons
  4. ***Extension only***
     - CRCT training intervention

This paper: results

- Four measurement and field experiments among smallholder maize farmers in Uganda to shed light on the ***impediments to quality upgrading*** at the farm level and ***study its potential impact***
  1. ***Quality at the farm gate?***
     - low and partly observable
       - establishes that low quality problem begins at the farm gate
       - not a classical lemons problem
  2. ***Return to quality at the farm gate?***
     - essentially zero
       - provides one explanation for why farmers are not investing in upgrading
  3. ***Access to a market for high quality maize (plus extension)?***
     - Farmers upgrade quality
     - Income and productivity increases
  4. ***Extension only?***
     - No effects

Related literature

- Relate to a number of recent papers on the implications of market (buyer) driven quality upgrading in a developing country setting
- Larger literature on agricultural productivity and technology adoption

Related literature

Road map

1. Context: local markets for maize
2. Maize quality and verifiability of quality
3. Returns to quality experiment
    - intervention
    - results
4. Market for quality experiment
    - intervention
    - results
    - extension service experiment
5. Discussion
    - a case study of commercially buying, processing and selling quality maize
    - “macro” constraints

Context: farmers in Kibale district

- Kibale
- ★ Kampala

Context

- Average income (consumption): 0.80 USD per day (UBOS, 2019)
- Maize – dominant cash crop – sold in local markets
- Local market for maize ≈ spot market
  - farmer and buyer agree right before the sale about y and p
  - farmer is paid directly and the transaction takes place at the farm gate
- Two types of buyers:
  - *local traders* (aggregators): buy from a smaller set of farmers and resell to commercial traders
    - households sold to local traders 80% of the times
  - *commercial buyers*: pass through the village with a truck (some have stores in trading centers)
    - half of the farmers sold to a commercial trader at least once during the last 5 seasons
  - sale to a commercial trader is associated with a higher price (8%)

Maize quality and verifiability of quality

- ***What is maize quality? Why does (should) it matter? To what extent is it observable?***
- Quality ≈ economic value (nutrition, safe for consumption)
- Detailed test of quality requires lab equipment; seldom done at farm-gate
- At farm gate: visual inspection of bags of grain
- A bag of maize is of high quality if: ***no non-grain substances*** (stones, dirt, insects); ***no defected kernels*** (damaged, rotten, moldy); sufficiently large & ***dry maize*** kernels of the right color

waste + increase processing costs

- ***non–grain substances***
- ***defected grains***
- ***high moisture***

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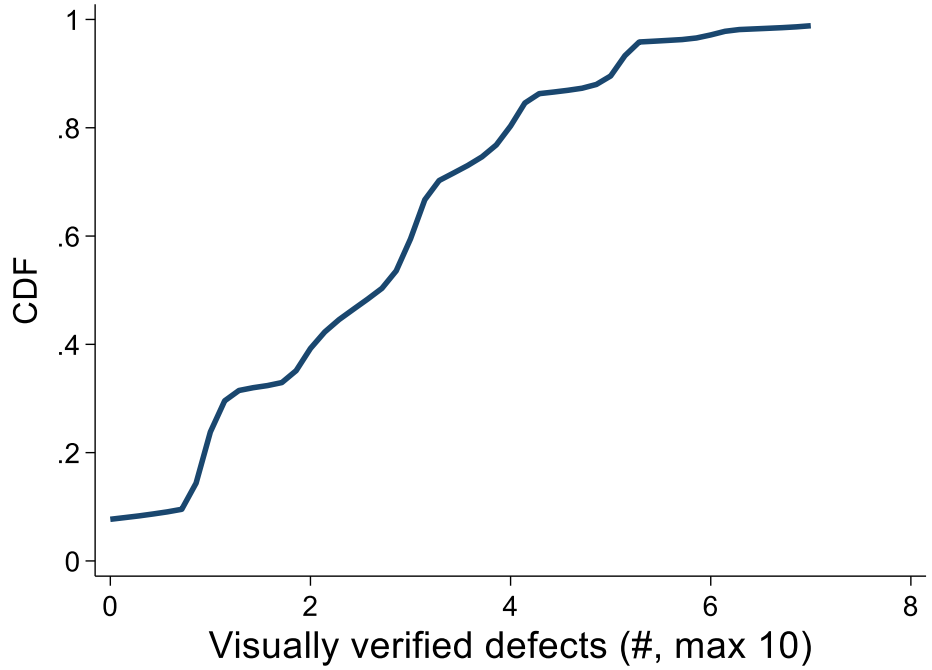
- ***non–grain substances*** ⇒ indicates maize has been stored directly on the ground ⇒ raise risk of contamination (bacteria/fungi)
- ***defected grains*** ⇒ direct indicators of various infestation in the grain
- ***high moisture*** ⇒ mold/fungi etc grow faster in wet maize

Maize quality and verifiability of quality

- The East African Quality Standard (EAS) classifies maize into three broad quality categories based on moisture level and amount of non-grain substances and defected grain: graded maize, under-grade maize and reject maize.
- Graded maize (quality maize) is further categorizes into three grades, with grade 1 having the most stringent thresholds for defects.
- Under-grade maize can in principle be sorted or treated for either grade 1, 2 or 3.

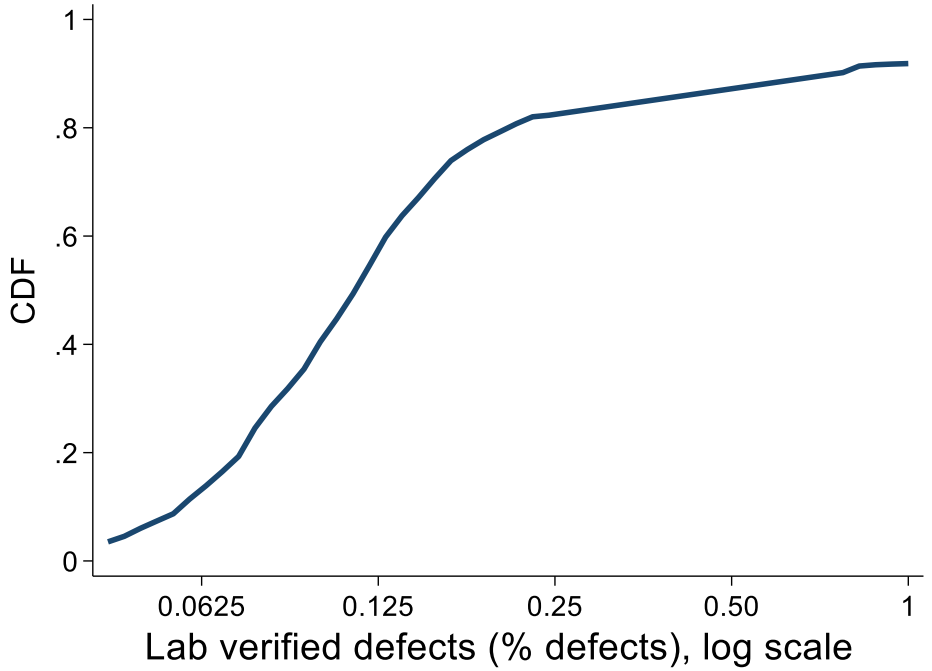
Maize quality: results and verifiability

Visually verifiable defects



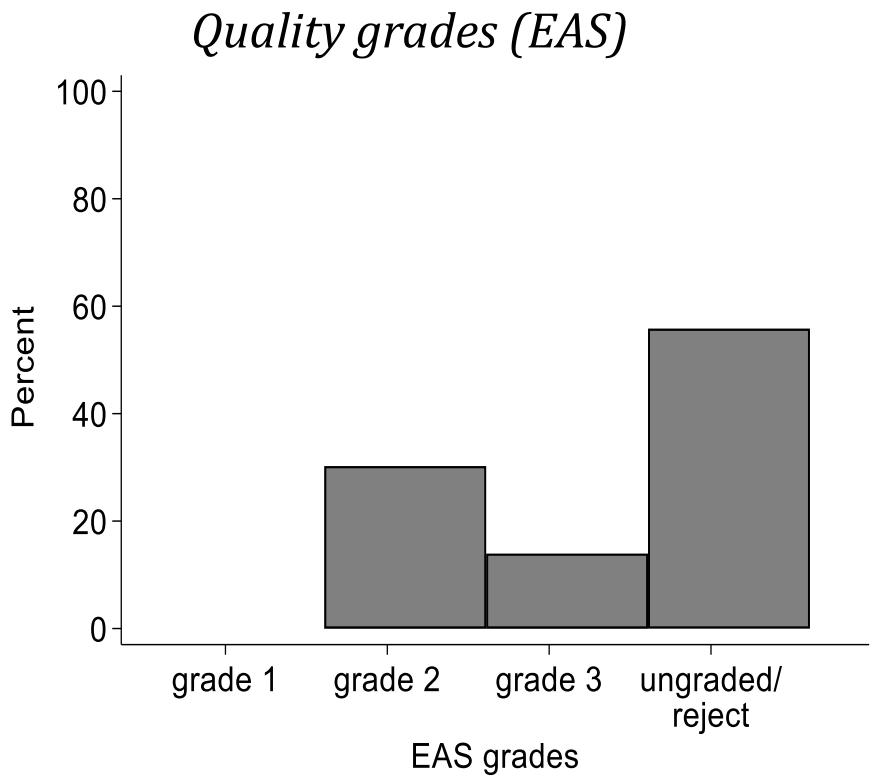
mean=2.5; median=2.0

Lab verifiable defects

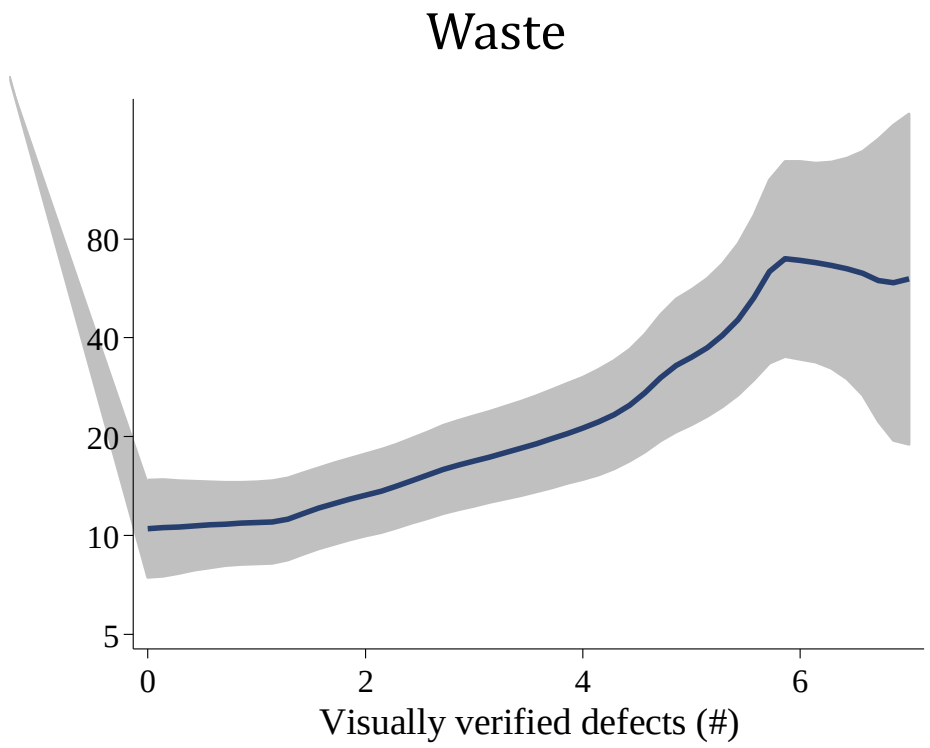


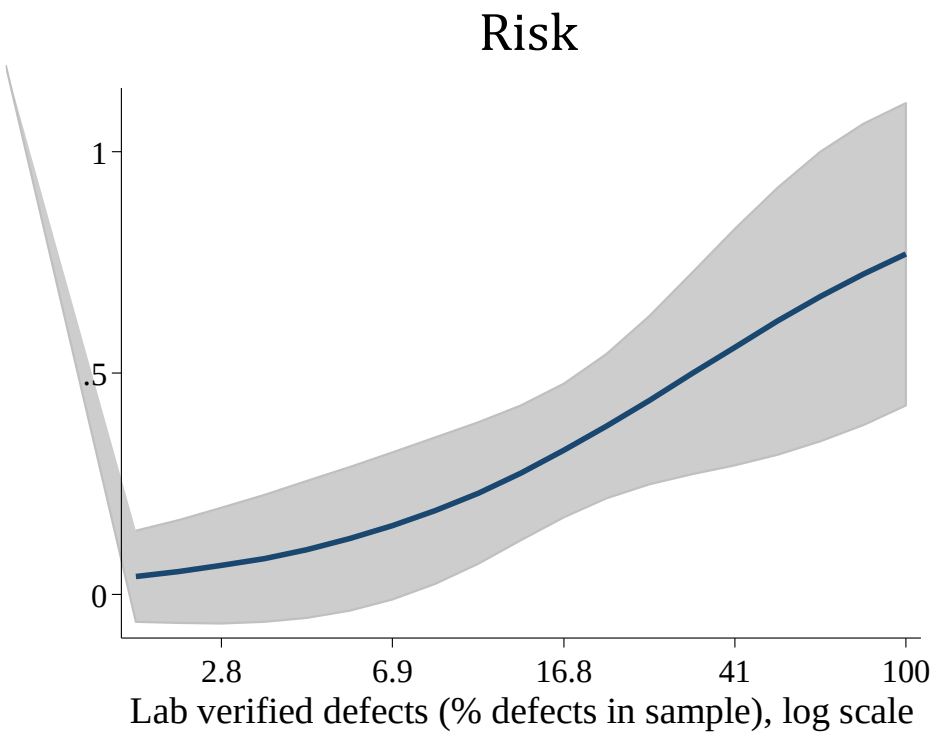
mean=0.26; median=0.14

Maize quality: results and verifiability



Maize quality: results and verifiability





- Farmers tend to sell maize of low and possibly unsafe quality
- Quality is at least partly observable

Returns to quality experiment

If the economic value of maize depends on its quality, why is the quality of maize sold by farmers so low?

- Neoclassical agriculture household model

$$\max \Pi = p(q(z))F(x, A) - c_x x - c_z z$$

$p(q) =$ price for crop of quality q; $F(.) =$ output; $\{x, z\} =$ inputs; $\{c_x, c_z\} =$ unit cost; $A =$ land

FOCs:

$$pf'A - c_x = 0$$

$$p'q'f(.)A - c_z = 0$$

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- Prices/elasticity of p w.r.t. quality are key drivers of the decision to produce high quality maize
- ***Does the (local) market reward quality?***

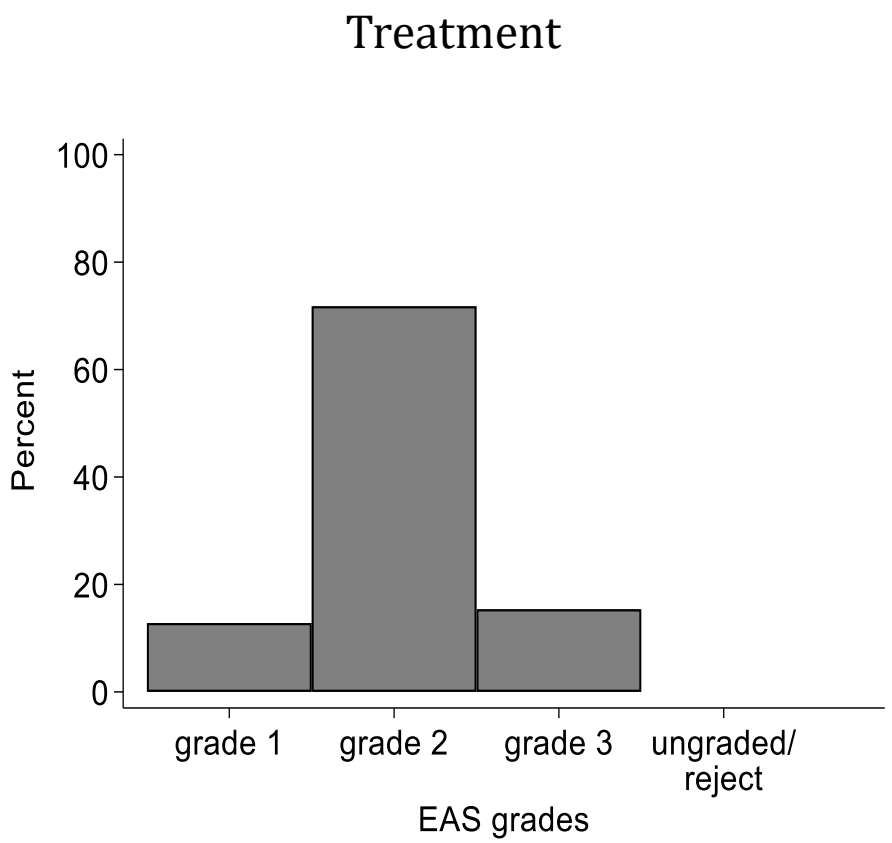
Returns to quality experiment: intervention

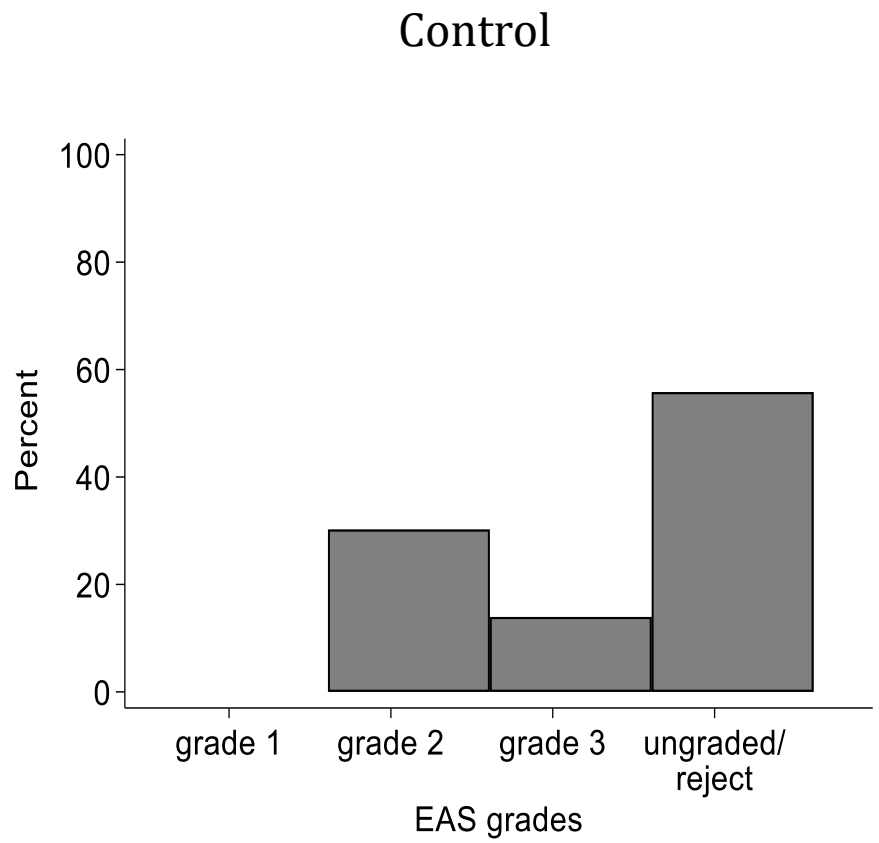
- Low quality at the farm gate is determined by a number of factors, several of which the farmer can directly influence through good agricultural practices
  - harvesting and shelling the cob without breaking or cracking the grains
  - not drying or storing cobs on the bare ground
  - drying, cleaning, and storing the grain correctly
- ***Intervention***: a service package which included assistance with several key harvest and post-harvest
  - services implemented by agricultural workers with access to portable agricultural machinery (dryer and a sheller/decobber); managed by staff from the research team.

Returns to quality experiment: intervention

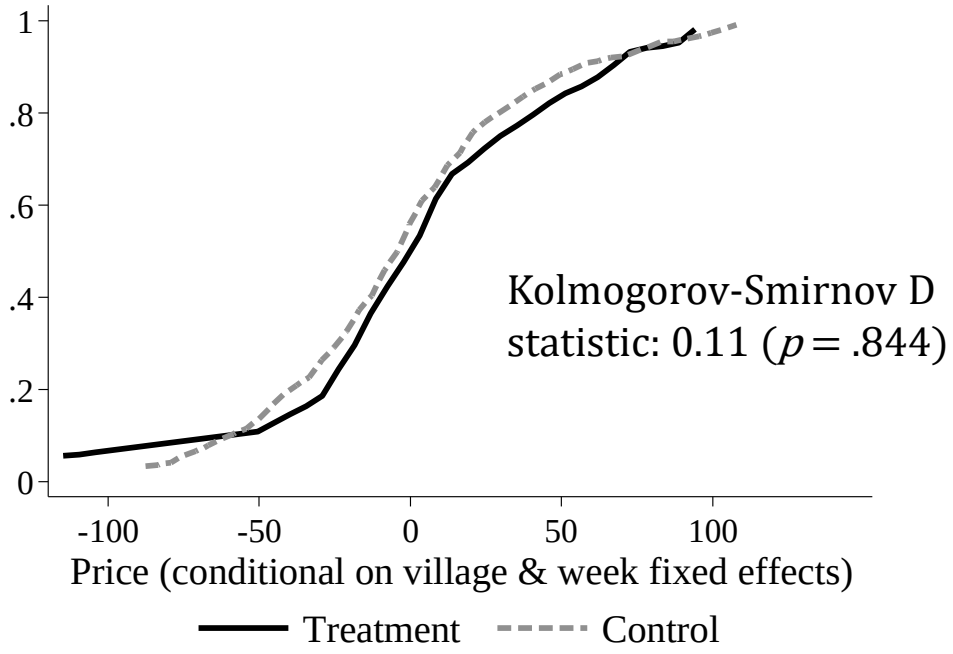
- Enrolled 100 farmers; equally split btw treatment (T) and control (C); balanced at baseline
- ***Before harvest***:
  - in T: households offered the free service package (100% compliance)
- ***When farmer ready to sell***:
  - in T/C: visual inspection of quality; measure the weight of all bags; test for moisture; one (random) bag bought and tested in the lab
- ***After selling maize***:
  - in T/C: information on sales volume and prices collected

Returns to quality: maize grade





Returns to quality experiment: results - prices



Outcome variable:	Price	Price
Specification	(1)	(2)
Model	OLS	IV
Treatment	2.95	
	(9.87)	
Visually verifiable defects		-0.15
		(.50)
Constant	530.5***	530.3***
	(14.0)	(14.1)
Observations	116	116
Households	94	94
R-squared	0.91	0.90

Market for quality experiment

- Farmers face weak incentives to invest in high quality
  - expect them to invest little
  - market would be dominated by low-quality maize

- ***Can farmers produce higher quality if quality is valued on the market?***
- ***What are the implications for farmer profit and productivity of such quality upgrading?***

Field experiment generating exogenous variation in access to a market for quality maize

Market for quality experiment

Neoclassical agriculture household model

$$\Pi = p(q(z))F(x, A) - c_x x - c_z z$$

- Intervention: offer farmers in T an inverse demand schedule: $p^T = p(1 + I_{q \geq \bar{q}} \omega)$

$\omega =$ quality premium; $I_{q \geq \bar{q}} =$ indicator function

- Intervention: extension services to improve households' ability to produce higher quality maize (increasing their general knowledge of best-practice pre- and post-harvest agricultural activities)

Market for quality experiment: intervention

- Intervention: designed to emulate a market for high quality maize
- Collaborated with an agro-trading company:
  - committed to buy quality maize at a premium throughout the main buying season
  - company's agents used visual inspections of bags and mobile moisture meters to verify quality (and an unbiased weighting scale to measure weight)
  - bought only bags with quality maize
    - bags with waste or defected maize; maize with a moisture level above 13%, were rejected
- Research team:
  - randomly selected which villages the company should be active in
  - randomly selected households in the villages who should be invited to participate
  - determined the premium for quality, with the aim of reproducing a market equilibrium
- Intervention: ***created experimental variation in access to a "market" (buyer) of quality maize (plus training on how to produce high quality maize)***

Market for quality experiment: premium

- What would one expect the premium to be if a market for quality maize existed?
- "minimum premium"⇒ farmer indifferent between upgrading or not.
- In equilibrium: ***difference in the economic value of high and low quality maize is the difference in the amount of waste in the maize, valued at premium quality prices***

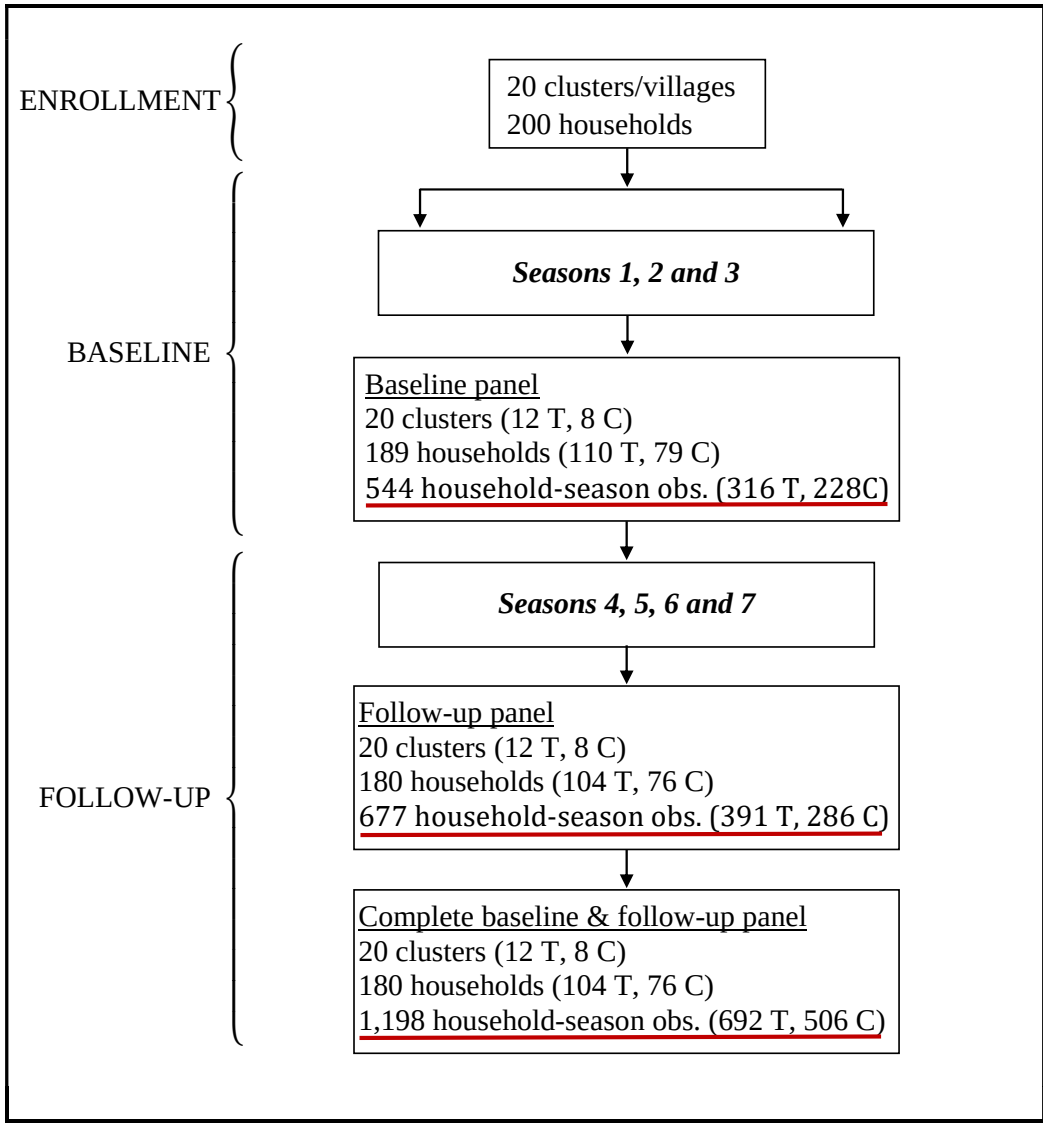
- premium ≈ ***5% above the market price at the trading centers***
- "perceived premium" (Δ price local traders pay and the price for quality) ≈ 13%

Premium: an example

Market for quality experiment: trial design

- Experimental design motivated by several features of the local market & intervention:
  - intervention = integrated value-chain, was complex and costly
  - spillovers/market effects
  - may take time before farmers decide to upgrade
  - large aggregate variation over season, impact =f (state) (Rosenzweig and Udry, 2000)
  - power to pick up reasonable treatment effects
- ***Clustered repeated measurement design***:
  - restricted the number of clusters (20); 10 households per cluster
  - expanded on the number of waves, or seasons (7)

Market for quality experiment: trial design



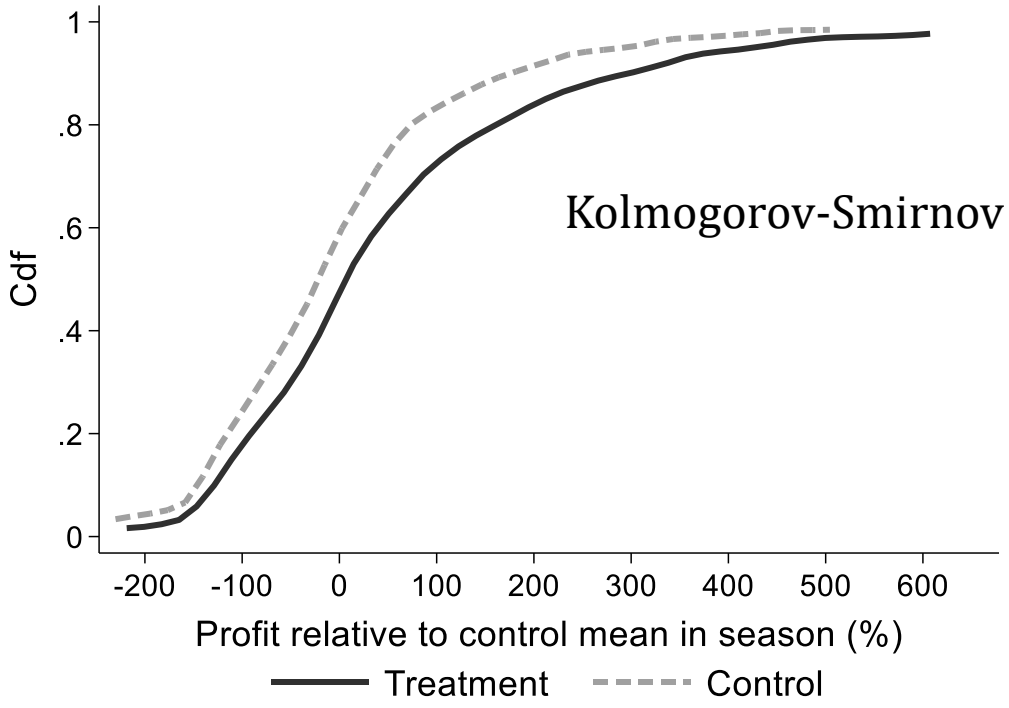
Market for quality experiment: specification

- Main specification ANCOVA

$$Y_{ijt} = \gamma TREAT_j + \sum_4^7 \delta_t + \theta \bar{Y}_{ij,PRE} + \varepsilon_{ijt}$$

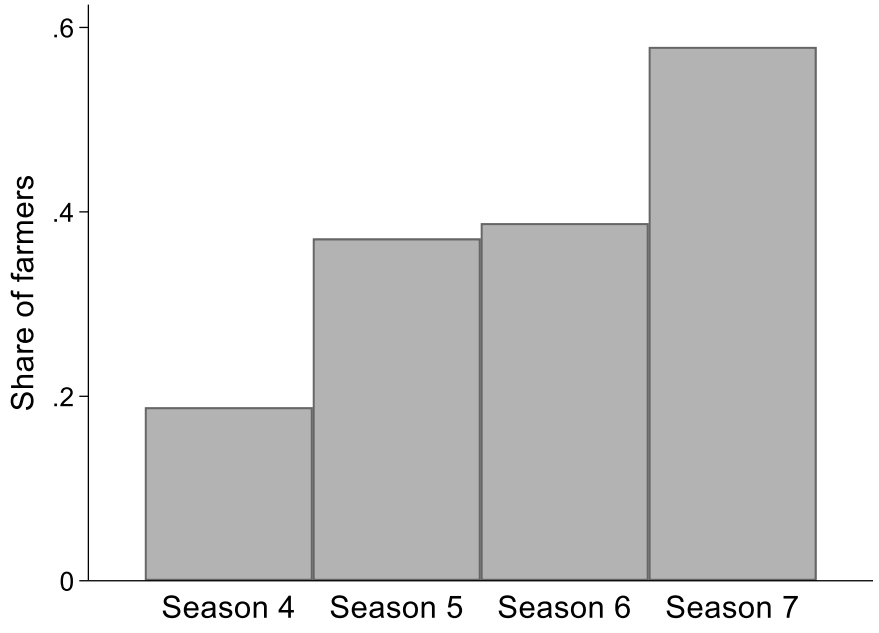
- γ: average treatment effect over the four follow-up rounds

Market for quality experiment: summary of the results

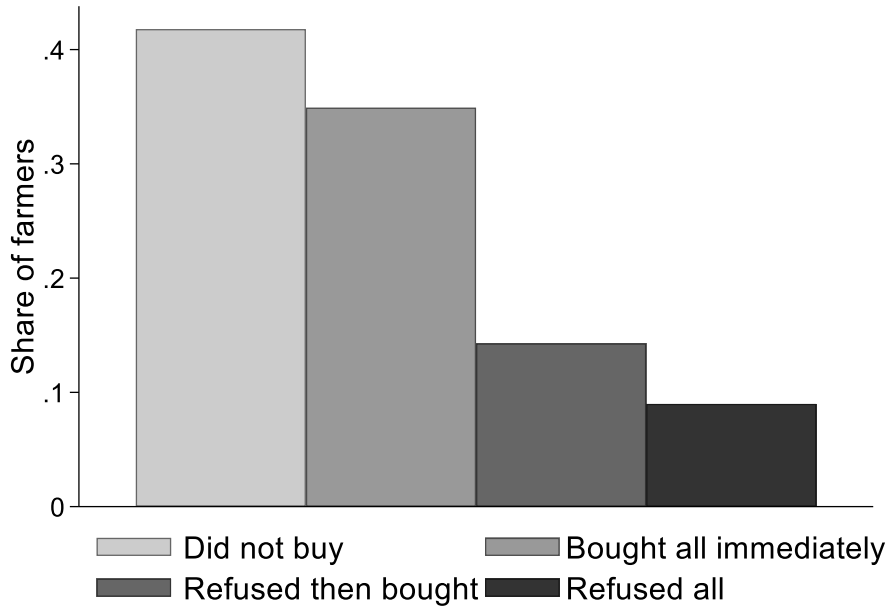


Kolmogorov-Smirnov D statistic is 0.17 ($p = .000$)

Quality upgrading and prices



Panel A. Farmers selling quality maize



Panel B. Buying pattern: quality maize

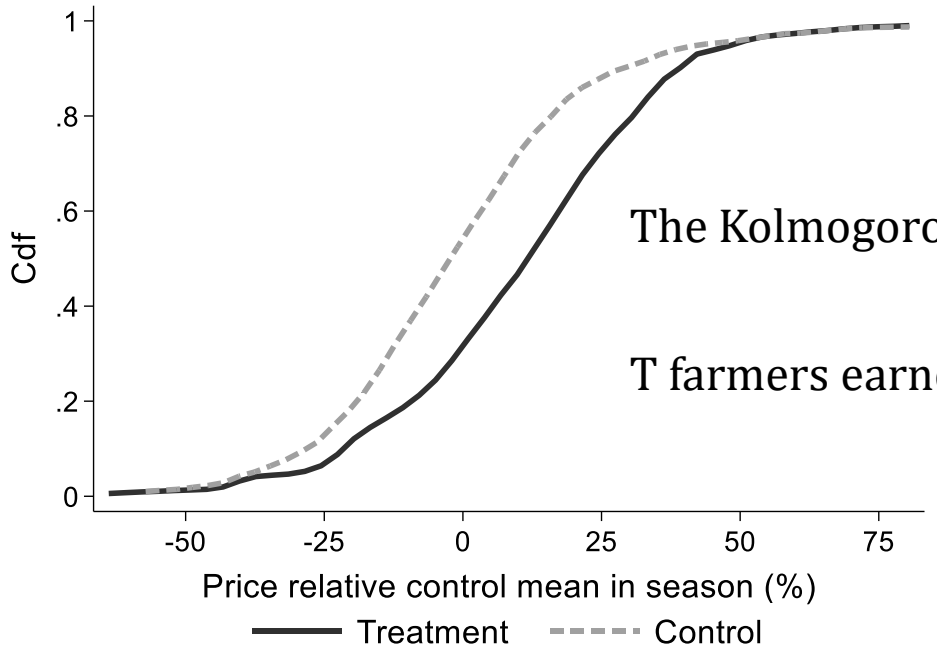
Quality upgrading and prices

TABLE 4—IMPACT ON MAIZE QUALITY

	Mean			
	Treatment (1)	Quasi-control (2)	Difference (3)	Observations (4)
Panel A. Maize quality				
Graded maize	0.89	0.30	0.593 [0.001]	86
Grade 1 maize	0.07	0.00		
Grade 2 maize	0.52	0.20		
Grade 3 maize	0.30	0.10		
Panel B. Bounds on average maize quality				
Horowitz-Manski lower bound			0.190 [0.205]	116
Lee lower bound			0.292 [0.027]	116

Quality upgrading and prices

Quality upgrading was rewarded with a significantly higher price in treatment villages



The Kolmogorov-Smirnov D statistic: 0.34 ($p = .001$)

T farmers earned $2.40 per bag (140 kg); 11%

Investments and productivity

- Neoclassical profit-maximization predicts that farmers will increase the intensity of input use across all inputs to increase the amount of (high-quality) output to be produced

TABLE 5—IMPACT ON INVESTMENT

	Expenses: seeds and fertilizer (1)	Expenses: all inputs (2)	Proper drying (3)	Sorting (4)	Winn-owing (5)	Preharvest expenses (6)	Postharvest expenses (7)	Postharvest expenses (labor) (8)
Panel A. Market access experiment								
Access to a market for quality maize	2.37	4.04	0.24	0.14	0.15	16.2	5.92	5.86
	(0.045)	(0.075)	(0.000)	(0.002)	(0.033)	(0.275)	(0.256)	(0.144)
	[0.049]	[0.089]	[0.001]	[0.001]	[0.047]	[0.296]	[0.272]	[0.153]
Observations	658	658	640	464	464	464	464	464
R^2	0.31	0.32	0.21	0.03	0.04	0.20	0.26	0.22
Mean control	3.72	13.14	0.35	0.13	0.19	53.76	30.39	15.63

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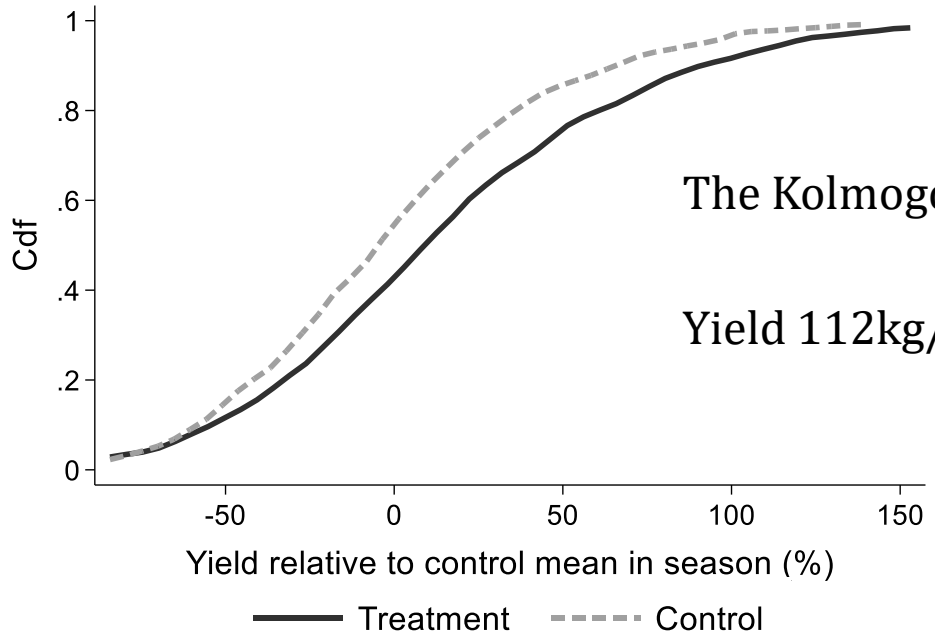
Investments and productivity



The Kolmogorov-Smirnov D statistic: 0.14 ($p = .002$)

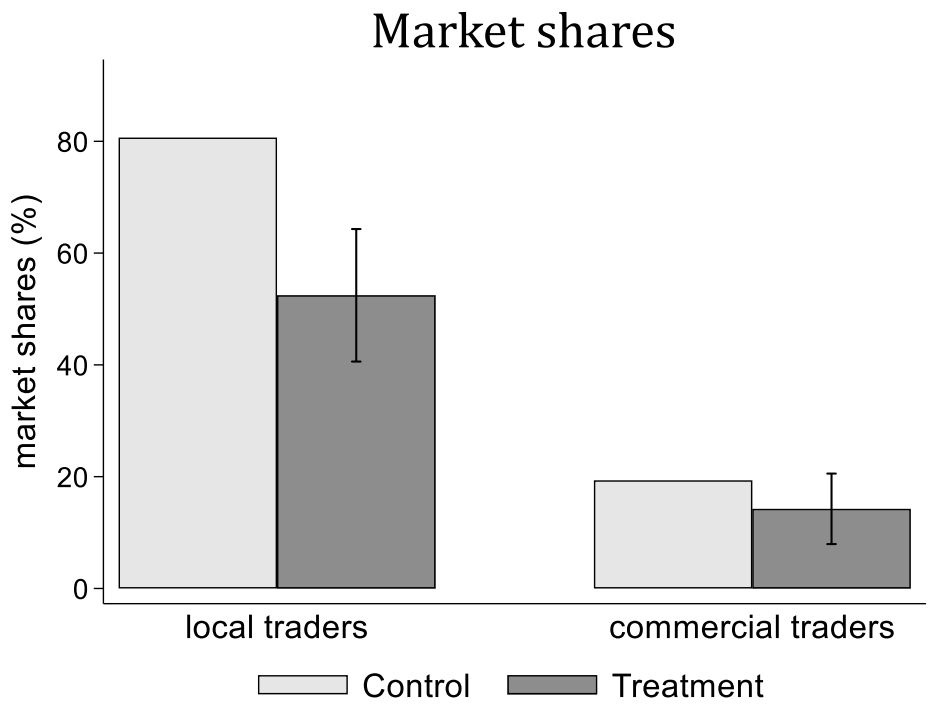
Yield 112kg/acre higher in T; 15%

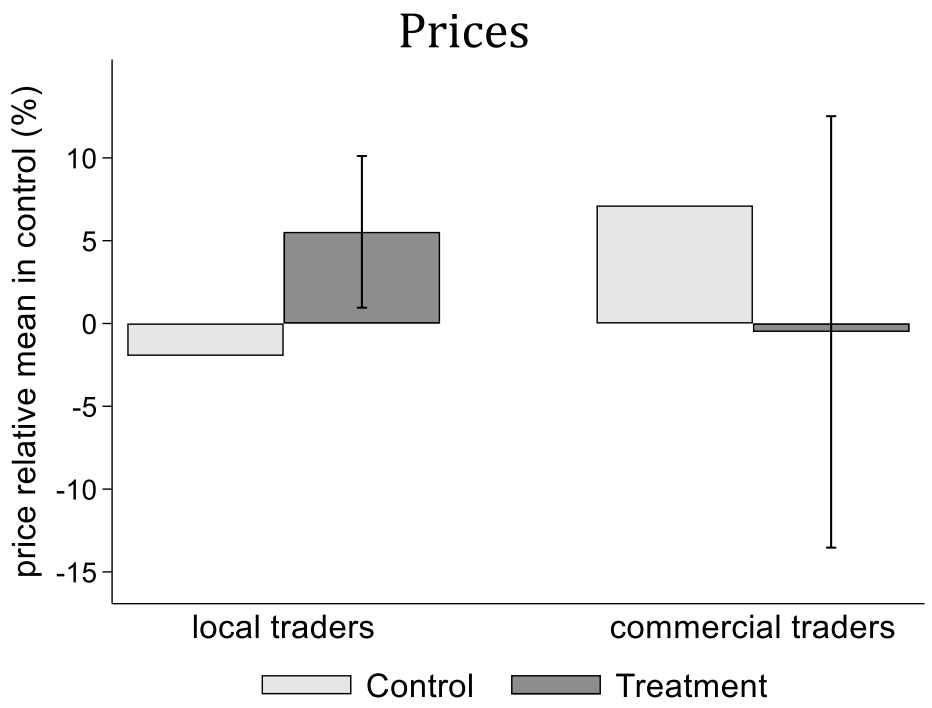
Extension only intervention

- No significant effects on the agricultural production function and income/profit.
- Increased knowledge alone is not enough to improve income, but may well be an integral part of market experiment.

Market / spillover effects

- In the case of differentiated products (higher or lower quality maize), the entry of the new buyer likely led to an increase in competition, especially in smaller village markets





Market / spillover effects: causal effect on prices

TABLE 7—IMPACT ON TRADER PRICES AND MARKET SHARES

	Other traders (1)	Local traders (2)	Commercial traders (3)
Panel A. Difference in market shares and prices			
Difference in market shares	−0.396	−0.325	−0.071
	[0.000]	[0.001]	[0.280]
Difference in prices versus control	0.045	0.061	−0.016
	[0.123]	[0.040]	[0.695]
Panel B. Difference in prices adjusting for selection			
Difference in prices versus control	0.066	0.078	0.021
	[0.071]	[0.052]	[0.680]

Market / spillover effects: implications

- ***Selection***
  - Positive selection on baseline price of selling to high quality trader.
- ***Higher average prices in T***
  - Approximately one third of the increase in average prices in T vs. C is driven by the market/spillover effect
  - Evidence that price increase came about by incumbent traders raising prices rather than selective exit.
- ***Spillover/market effect reduced the relative price of higher quality maize in local markets***
  - Mitigated the incentives for quality upgrading!

Discussion: intervention = a case study

- “Macro” constraints facing a vertically integrated domestic buyer in a LIC
  - (but not so much about the potential agency- and information problems that plague the market for (lower quality) maize)
- After factoring out all evaluation costs, the agro trading company broke even in 2 of 4 seasons

Discussion: a case study

- Three structural features of the product and the economy constrained the company's ability to increase revenues
  - ***takes time to build a reputation for high quality maize flour in domestic markets***
  - ***price elasticity of quality among large sections of domestic buyers is low***
  - ***large (fixed) costs to enter the export market where premium for quality is high***

Discussion: a case study

- Other features of the business model raised costs
  - ***company's business model was not one of pure profit-maximization***
    - buy maize from smallholder farmers ***vs.*** selecting which largeholder farmers to buy from
- Strategy decreased company profits, but also may explain the large impacts

- ***Conclusion: case study provides clues as to why market integration of large swathes of the rural population, and for many of the agricultural products they produce, is challenging – despite its potential***

Discussion: a case study

- An alternative lens: cost-effectiveness in a program evaluation
  - if a market for quality maize that smallholders could access is not financially viable, one could consider using subsidy money to generate such a market
- Various multifaceted programs to help the very poor (Bandiera et al, 2017, Banerjee et al 2015)
  - effects on profits we document suggest market access programs is at least a candidate worth investigating more closely

THANK YOU!

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