Fertilizer subsidies & the role of targeting in crowding-out: The case of Kenya

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Motivation

- Concept of 'smart' subsidy, circa 2007 (from Morris et al 2007)
  - Subsidies targeted to sub-set of population (not universal), often via voucher
  - quantity to be subsidized is limited (e.g., enough fertilizer/seed for one hectare)
  - Government role is to distribute vouchers; private sector role is to distribute commercial fertilizer and redeem vouchers
- Input subsidy programs (ISPs) vary greatly as to 'smart-ness' in design & implementation (Wanzala et al, 2013)

Motivation

- How much do ISPs contribute to additional fertilizer use?
- If an ISP distributes 100,000 metric tons of fertilizer, how many additional tons of fertilizer are applied to farmers' fields?
  - concept of "crowding in/out"

Motivation

- Evidence of crowding in/out from existing studies of ISPs is mixed -- varies by country and by context
- Crowding-out
  - Zambia (Xu et al, 2009; Mason and Jayne, 2013), Malawi (Ricker-Gilbert et al, 2011)
  - Why? Vouchers predominantly went to larger smallholders with pre-existing commercial demand
- Crowding-in
  - Pilot districts in Nigeria (Liverpool-Tasie, 2013); some areas in Zambia (Xu et al, 2009)
  - Why? Targeted areas had low prior fertilizer use

Motivation

- Kenya makes an interesting case study of how displacement may vary by targeting criteria
- Kenya recently scaled up two separate programs in 2007/08
- Prior to ISPs, there was considerable variation in commercial fertilizer use by zone in Kenya
  - Low potential zones: 30-40% smallholders applied fertilizer to maize in 2006/07, low/medium application rates
  - Moderate/high potential zones: 88-97% use fertilizer; high rates

Background on Kenyan ISPs

- National Cereal & Produce Board (NCPB)
  - 30-40% subsidy on limited quantities of fertilizer (per HH and in aggregate) available at NCPB depots, quantities scaled up in 2008
  - No clear targeting criteria, though depots almost exclusively in medium/higher potential zones
- In 2007/08, GOK initiated a second program (NAAIAP) that scaled up rapidly in 2008/09
  - Voucher = 100% subsidy on two 50kg bags fertilizer, one bag of maize seed
  - Official targeting criteria: ‘smaller / poorer’ farmers in ‘poorer’ districts’

Research questions

1. To what extent is official targeting criteria met in practice?
2. Effect of subsidized fertilizer (SF) on smallholders' quantity of commercial fertilizer (CF) purchased and total fertilizer use?
3. Do marginal effect of SF on CF vary by agro-ecological zone, household landholding size and wealth?

Data

- Rural household panel survey data
  - Collected by Tegemeo Institute / MSU
  - Ag years 1999/0, 2003/4, 2006/7, 2009/10
  - Covers 8 main crop-oriented provinces, 8 agro-ecological zones
  - N=1,064 HHs each year (balanced panel)
- Wholesale market crop prices
- Geo-spatial village-level data
  - Village-level elevation, rainfall, etc

Methods

Empirical model for estimation:

Commerc. Fertilizer$_{it}$ = β_0 + β_1 Sub. fert$_{it}$ + Other Factors + c_i + v_{it}

$\widehat{\beta_1}$ is the crowding-out estimate

Step 1: Probit of participation decision (1=HH bought C.Fert)
Step 2: Truncated normal regression of HH quantity of Commercial Fertilizer purchased (kgs)

1) Use panel methods (correlated random effects) to control for unobserved time-constant heterogeneity (c_i)

- Assume c_i is correlated with time-averages of household and village-level time-varying factors

Methods

2) Test / control for potential endogeneity of household receipt of subsidized fertilizer

- Control function approach (similar to 2SLS but preferable for non-linear models)

Step 1: Tobit of quantity of subsidized fertilizer received by household (in 2009/10)

- IVs = constituent-level electoral threat (% of votes for runner-up in 2007 presidential election / % of votes for winner); district level % ethnicity of Kikuyu (Kamba, Luo)
- The IVs satisfy over-identification restriction & other IV assumptions

Methods

Step 2: Add tobit residual + endogenous variable (subsidized fertilizer received by HH) to double-hurdle model of commercial fertilizer demand

- Residual is not significant, thus we assume subsidized fertilizer received by HH is exogenous

3) Test / control for panel attrition

- evidence of attrition using Wooldridge (2002) test
- Inverse Probability Weighting to correct for panel attrition bias

Methods: Model co-variates

- Prices
  - Village price of DAP fertilizer; village ag wage
  - Naïve price expectation for maize, beans, irish potatoes, coffee, bananas, kale, avocado (nearest wholesale market)
- Market access (village)
  - Distance to nearest wholesale market (km)
  - Distance to nearest motorable road (km)
  - Distance to nearest fertilizer seller (km)

Methods: Model co-variates

- Agro-ecological (village-level)
  - Expected rainfall in main season
  - Expected drought shock in main season
  - Elevation (m)
  - Length of growing period (days)
  - Soil type groups (Sheahan, 2014)
    - High humus (higher potential); Rankers soils; Rankers/Podzols soils (low clay), etc
  - Dummies for agro-zones (5 of 6 zones included)
  - Year dummies

Methods: Model co-variates

- Household
  - Assets: total landholding, total farm asset value, head's age (& square)
  - Available family labor: # of adults age 15-59 (and square)
  - Human capital: Head's education
  - Demographics: 1=single-female head; # of children
  - Shocks: HH suffered a death in last 3 years; HH experienced direct (indirect) effects of 2007 post-election violence

Results: Targeting in practice

1) NAAIAP vouchers (slightly pro-poor)
   - Did primarily target 'poorer' districts
   - Recipients were slightly poorer on average (assets)
   - Yet recipients just as likely to be in top or bottom 50% of village land distribution; only slightly more likely to be in bottom 50% of village asset/AE distribution
2) NCPB subsidized fertilizer (not pro-poor)
   - Received by smallholders with more total landholding; recipients just as likely to be in village top/bottom 50% of land/AE, assets/AE

Results: Targeting in practice (2)

3) Did programs reach households who previously were not using fertilizer on maize?

What % of subsidy recipient HHs (in 2009) purchased commercial fertilizer for use on maize in 2006/07?			
	----- Subsidy program -----		
	NAAIAP	NCPB	Both
Agroecological zones	(% of subsidy recipients)		
Low potential	87.4	75.1	86.2
Medium/high potential	91.9	96.8	94.7
Total	89.3	94.6	91.3

Results: Targeting in practice (3)

3) GOK justified subsidies in part because of 2008 food/fertilizer price spikes
   - % of HHs purchasing commercial fertilizer fell from 82% in 2006/07 to 73% in 2009
   - Yet % of HHs obtaining ONLY commercial fertilizer in 2009/10 fell by only 2 to 10% depending on zone
     - Exception E.Lowlands, '% HHs obtaining CF only' fell by 18% but 21% of HHs received NAAIAP
   - Also, median application rates of fertilizer use on maize (kg/ha) from the 'only CF group' were actually somewhat higher in 2009 in most zones
   - 8.2% of HHs received subsidized fertilizer in 2009

Results: Crowding-out

1) Average crowding out (displacement) of smallholder commercial fertilizer demand in Kenya is -0.43
   - An additional kg of subsidized fertilizer reduces commercial fertilizer demand by -0.43
   - …. Thus average increase in fertilizer use from each kg of subsidized fertilizer is +0.57
2) Kenya's average displacement (-0.43) much higher than in Malawi (-0.18) or Zambia (-0.13)
   - Not surprising given that % of farmers using fertilizer on maize before subsidy quite high in Kenya

Results: Crowding-out

3) Crowding out much higher in areas where application rates prior to subsidies were higher
   - Crowding out in medium/high potential zones (-0.53) is double that in low potential zones (-0.28)
   - 88 to 97% of smallholders in medium/high zones used commercial fertilizer on maize prior to subsidies (45% in lower potential zones)
4) Crowding out much higher among HHs in top 50% of landholding (top 50% of farm asset value/AE)
   - Crowding out among top 50% is -0.65 (-0.62), bottom 50% is -0.24 (0.24)

Results: Crowding-out

5) Magnitude of crowding out similar for recipients of NAAIAP or NCPB subsidized fertilizer (and significant in both cases)
   - Even though NAAIAP had 100% subsidy and NCPBs was 30-40%, both were received almost entirely by farmers who had previously been using commercial fertilizer
   - Most recipients for both were in the moderate/high potential highlands zones where prior to subsidies (2006/07) both % of HHs using fertilizer on maize and application rates were
   - NAAIAP quantities were between 25 and 100kgs per HH; NCPB quantities between 100 and 800 kgs per HH

Policy Implications

1) NAAIAP was intended to improve access to fertilizer use for 'resource-poor' farmers and those not using fertilizer on maize
   - Targeting in practice was only slightly pro-poor
   - did policymakers not know how prevalent fertilizer use was on maize in high potential areas?

Policy Implications

2) Both programs intended (and claimed, *ex post*) to increase total fertilizer use on maize by recipient farmers
   - Yet to achieve this one needs targeting criteria (in design and in practice) to reach households not already using substantial amounts of fertilizer on maize

Policy Implications

3) If program was intended to ‘maintain fertilizer use due to high prices in 2008-2009’....
   - Why are both programs still on-going even though fertilizer prices are still somewhat high, but much lower than in 2008?

Policy Implications

4) Some say that “even if displacement occurs, it still helps smallholders”
   - In lowland areas, displacement is not that high and perhaps there are learning effects that can have a lasting positive impact
   - However, in medium/high potential zones, the two programs are essentially income transfers
   - How efficient is this form of income transfer to an alternative transfer program (cash transfer?)

Policy Implications

5) Others say "ISPs reduce poverty" even if it is mainly a transfer
   - Mason et al (2015) did find significant positive effects in reducing incidence and severity of poverty (for NAAIAP)
   - What are the returns of ISPs relative to traditional public goods..?
     - Fan et al (2008); EIU (2008) found highest rates of return to favorable policy environment, ag R&D and roads

Policy Implications

6) Debate should perhaps not be “ISP vs no ISP”, but rather:
   - When/where is an ISP appropriate, for how long, is there a clear exit strategy, and how much of ag sector budget should it merit
   - Ag Sector budgets dominated by ISPs are not financially sustainable for most countries, and do not appear to have lasting effects on poverty reduction (Zambia, Malawi)
   - If a country implements an ISP, it must consider how targeting criteria (in design & in practice) affects displacement
     - If displacement is difficult to avoid, consider that other forms of transfers may be more efficient

Thank you

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Results: Targeting (3)

	---------- HH fertilizer use/source type by year ----------							
	------- 2006/07 -------			---------- 2009/10 ----------				
Agroecological zone	Did not acquire any comm. fertilizer (%)	Acquired comm. fertilizer (%)	HH median fertilizer rate (kg/ha)[1]	Did not acquire any fertilizer (%)	Acquired comm. fertilizer only (%)	Median fertilizer rate (Comm. fert only) (kg/ha)	Acquired comm. & subsidized fertilizer (%)	Acquired subsidized fertilizer only (%)
E. Lowlands	37.8	62.2	37	33.9	44.1	66	13.4	8.7
W. Lowlands	70.4	29.6	34	68.3	26.1	43	4.9	0.7
W. Transitional	12.0	88.0	161	14.1	84.5	139	1.4	0.0
W. Highlands	5.7	94.3	155	5.7	89.3	171	4.1	0.8
Cent.Highlands	2.1	97.9	288	4.6	88.7	308	5.9	0.8
High Potential	6.8	93.2	174	6.5	82.9	165	6.8	3.8
Total Sample	18.5	81.5	168	18.5	72.9	178	6.1	2.4

Results

Explanatory variable: Quantity of subsidized fertilizer received by HH (by source)	# of HHs with sub. fert.	Unconditional APE of 1 kg increase in HH quantity of subsidized fertilizer received on quantity of HH commercial fertilizer purchased		
		APE	*p-value*	
National				
Any source	91	-0.431	0.005	***
NAAIAP & NGO	56	-0.593	0.049	**
NCPB	36	-0.502	0.012	**
Low potential zones				
NAAIAP	32	-0.285	0.091	*
Medium & High potential zones				
Any source	55	-0.534	0.029	**
NAAIAP & NGO	24	-0.587	0.131	
NCPB	32	-0.531	0.044	**

Results

Explanatory variable: Quantity of subsidized fertilizer received by HH (by source)	# of HHs with sub. fert.	Unconditional APE of 1 kg increase in HH quantity of subsidized fertilizer received on quantity of HH commercial fertilizer purchased		
		APE	*p-value*	
Bottom 50% of total HH landholding				
Any source	47	-0.235	0.046	*
NAAIAP & NGO	31	-0.311	0.128	
NCPB	17	-0.229	0.055	*
Top 50% of total HH landholding				
Any source	44	-0.647	0.004	***
NAAIAP & NGO	25	-0.732	0.048	**
NCPB	19	-0.641	0.007	***
HHs in bottom 50% of total HH farm asset value/AE				
Any source	44	-0.241	0.042	**
NAAIAP & NGO	32	-0.346	0.105	
NCPB	13	-0.232	0.051	*
HHs in top 50% of total HH farm asset value/AE				
Any source	47	-0.622	0.005	***
NAAIAP & NGO	24	-0.677	0.061	*
NCPB	23	-0.619	0.009	***