Do Fertilizer Subsidies Affect the Demand for Commercial Fertilizer? An Example from Malawi.



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Introduction

- Consider the role of public policy for economic development
  1. How does that policy affect people's incentives?
  2. What impact does that policy have on the private sector?

Introduction (cont.)

- Renewed interest in input subsidies in sub-Saharan Africa
  - Many countries have initiated large-scale subsidy programs after eliminating them in the 1990s.
  - However, still a paucity of information about the effects of input subsidies on behavior of African farmers
  - Growing availability of household panel data sets → possible to examine in greater detail the impacts of input subsidies on behavior

Objectives of this study

Determine how participation in subsidy program affects demand for commercial fertilizer

- Two parts to this:
  1. Understand which farmers were targeted to participate in subsidy program (potentially endogenous)
  2. Estimate effect of participation in subsidy program on farmer decision to purchase commercial fertilizer

Previous research

- Many studies on input market participation & demand

  – Adugna (1997), Nkoya et al. (1997), Isham (2002) Croppenstedt et al. (2003), Xu et al. (2009)

  - Credit, soil quality, weather, relative prices affect input use

Contributions of our study

1. Adds to sparse literature that use panel data to analyze market participation (partially controls for unobserved heterogeneity)

2. Framework to deal with the likely endogeneity of subsidized fertilizer in commercial demand equation.

3. Provides policy-relevant information on a topical but largely ignored issue in current development debates

   The magnitude of crowding-out determines how much a subsidy program actually contributes to the quantity of fertilizer used on farmers' fields

Recent fertilizer subsidy program

- Poor harvest during 2004/05 in Malawi
- 2005/06 season
  - 147,000 metric tons of subsidized fertilizer distributed
  - Farmers paid US $6.75 for one 50kg bag of fertilizer
- Good harvest in 2005/06
- 2006/07 season,185,000 metric tons distributed
  - Farmers again paid US $6.75 for bag of fertilizer
  - Market price US $24.50
  - Total program cost US $73 million

Fertilizer Coupon Allocation

- Distributed regional level based on area under cultivation
- Methods for local coupon allocation had the potential to vary across villages
  - Village leaders & distribution committee
  - Raises questions of who was targeted?

Conceptual Framework

Participation decision, following McFadden (1974)

(1) $U_{Pit} \geq U_{nit}$

$U_{Pit} = X_{it}\gamma + \varepsilon_{it}$ $\quad P_{it}$ = 1 if participate

0 otherwise

X_{it} = factors affecting participation

ε_{it} = error term

Demand

(2) $Y_{it} = Z_{it}\beta + v_{it}$

Y_{it} = Fertilizer purchase

Z_{it} = Factors affecting purchase; v_{it} = error term

Methodology

- Sequential decision making
  - Double Hurdle Model fits (Cragg 1971)
    - Considers fixed costs in the first hurdle
    - Some variables may affect participation and demand in different ways
    - **Hurdle 1 uses probit** to estimate participation equation
    - **Hurdle 2 uses truncated normal regression** to estimate demand equation

Methods: Commercial fertilizer participation & demand

$$Fertilizer_{it} = \beta_0 + \beta_1 Subfert_{it} + \beta_2 Credit_{it} + \beta_3 Road\_dist_{it} + \beta_4 Dealers_{it} + \beta_5 Assets_{it} + \beta_6 Land_{it} + \beta_7 HH\_characteristics_{it} + \beta_8 Prices_{it} + \beta_9 Rainfall_{it} + \beta_{10} Year_{it} + \beta_{11} Region_i + C_i + V_{it}$$

Blue indicates dummy variable

Correlated Random Effects to control for unobserved heterogeneity (C_i)

Methods: Subsidized fertilizer acquisition (reduced form)

$$Subfert_{it} = \beta_0 + \text{variables from structural model} + \beta_{12} Years\_in\_village_i + C_i + V_{it}$$

Green indicates Instrumental Variable

Tobit Estimator used

Correlated Random Effects to control for heterogeneity (C_i)

Methods: Controlling for time varying unobservables (v_{it})

Control Function Approach

1. Run Subsidized fertilizer model (IV included) with Tobit Estimator

2. Obtain Residuals from Tobit ($\hat{\omega}_i$)

3. Run Commercial fert. model with residuals. Tests and controls for endogeneity

Rivers Vuong 1988, Vella 1993, Papke & Wooldridge 2008

Data come from two surveys in Malawi

- First Survey Collected during 2002/03 & 2003/04 season
- Subsidy scaled up during 2005/06 season
- Second Survey Collected during 2006/07 season
- Balanced Panel 2,406 HH, nationally representative

VII. Results
Fertilizer use (from the sample)

Source of fertilizer	Years before Subsidy (in kg)	Years after subsidy (in kg)	Difference (in kg)
Subsidized	10,333	184,252	**173,919**
Commercial	158,209	60,648	**-97,561**
Total Fertilizer per Year	**168,542**	**244,900**	**76,358**

- Sub fert use up.
- Com fert use down.
- Total fert use up but evidence of displacement

VIII. Results
Significant factors affecting subsidized fertilizer acquisition (Reduced form)

Variables **dep var:** Subsidized fert	**Tobit estimator** N = 4,812, R^2 = .04
Yrs lived in village	0.09**
Farm Credit in village	-9.60***
Assets (1,000 Mk)	0.02*
Land holding in ha	3.16***
# of males over 65 yrs	13.62**
# of females over 65 yrs	-11.21**
Last season's harvest maize price (May – Oct)	-0.97***
Fertilizer price during planting (Oct – May)	-0.98***
Long run rainfall (in cm)	0.08***

Note: Coefficients are APEs;
***, **, * denotes sign at 10%, 5%, and 1% respectively

VIII. Results
Significant factors affecting commercial fertilizer (sub fert endogenous)

Variables **dep var:** Commercial fert	**Hurdle 1: Participation** N = 4,812, R^2 = .19	**Hurdle 2: Demand** N = 1,339; $Corr^2$ = .11
Subsidized fert	-0.0005***	-1.34*
Residual $\hat{\omega}_{it}$	-0.002**	Not significant
Assets (1,000 Mk)	-0.0003**	4.12**
Land holding in ha	0.037***	451***
Age of hh head	-0.001*	Not significant
# of children under 12 yrs	-0.02**	Not significant
Last season's harvest maize price (May – Oct)	Not significant	11.37**
Fertilizer price during planting (Oct – May)	0.010***	-1.94
Long run rainfall (in cm)	Not Significant	2.70*

Note: Coefficients are APEs; ***, **, * denotes sign at 10%, 5%, and 1% respectively

Evidence of endogeneity in hurdle 1 but not in hurdle 2

VII. Results
Unconditional APE of sub fert on commercial fert. (estimate of displacement)

DH model APE = - 0.20

APE of sub fert on commerc fert at different quintiles of asset distribution

Asset Quintile		**APE of sub. fertilizer**	**Mean asset value in US $**
Lowest	1	-0.164	4.70
	2	-0.172	21.17
	3	-0.199	50.35
	4	-0.201	105.82
Highest	5	-0.254	858.16

Note: All coefficients significant at 1% level

Conclusions

- Subsidies cause total fertilizer use to increase by less than the total quantity of subsidized fertilizer introduced
- Displacement rate is 20%
- Subsidized fertilizer is endogeneous in commercial market participation decisions but not demand equations
- Once participation decision has been made, market conditions are important

Conclusions

1. Fertilizer subsidies appear to go to people who have better connections and are wealthier.

2. Targeting the relatively poor households would result in
   - less displacement of commercial sales
   - greater contribution of subsidy program to total fertilizer use

3. Targeting criteria and implementation affects overall performance

Thank you for your time!

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