How do Fertilizer Subsidy Programs Affect Total Fertilizer Use?

A synthesis of the evidence on "crowding in/out" in sub-Saharan Africa

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Motivation

If an input subsidy program (ISP) distributes 100,000 metric tons of fertilizer, how many additional tons of fertilizer are applied to farmers' fields?

Motivation

- Longstanding recognition that crowding out is an issue affecting input subsidy programs (ISPs)
- Poor understanding of how crowding out may affect ISPs performance
- Virtually no evidence prior to late 2000s on how ISPs affected total fertilizer use
- Major rationale for “smart” ISPs: minimize the crowding out of commercial demand
- Need to better understand how new generation of ISPs affects total fertilizer use

$$\frac{\partial(f)}{\partial Qsub} = \frac{\partial(f)}{\partial Qtot} * \frac{\partial Qtot}{\partial Qsub}$$

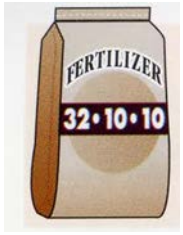

Farmer
Fertilizer retailer

Farmer

Fertilizer retailer

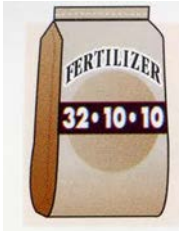
Farmer

100 mt



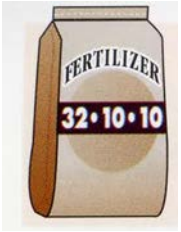
Fertilizer retailer

Government Fertilizer Program (100 mt)



Farmer

80 mt



Fertilizer retailer

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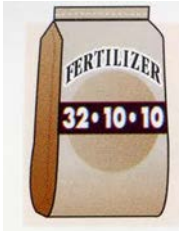

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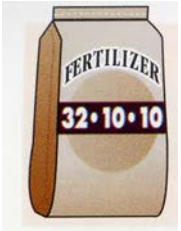


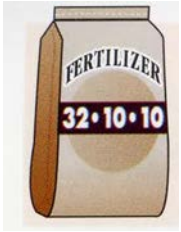
Fertilizer retailer

Crowding out:

Govt program of 100 mt reduces commercial sales from 100mt to 80mt, adding 80 mt to farmers' fields

Government Fertilizer Program (100 mt)

20 mt



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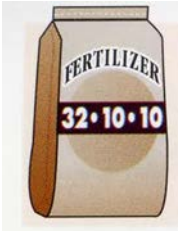
Fertilizer retailer



Government Fertilizer Program (100 mt)

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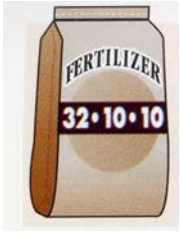

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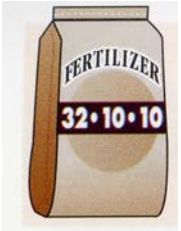
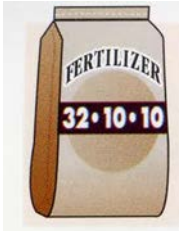


Leakage:

Govt program of 100 mt adds 80mt through govt programs and adds 20 mt through commercial channels. Total additional use to farmers' fields = 60mt

Government Fertilizer Program (100 mt)

80 mt



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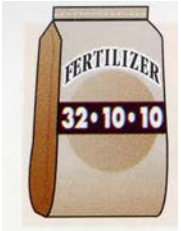

Objectives

1. To synthesize four studies carried out by MSU since 2009:
   - Xu, Burke, Jayne, Govereh (2009)
   - Ricker-Gilbert, Jayne, Chirwa (2011)
   - Mason and Jayne (forthcoming)
   - Mather and Jayne (forthcoming)
2. To consider how accounting for crowding out and leakage affects ISP's contribution to total fertilizer use

(1) $$total = govt + comm$$

(2) $$\frac{\partial total}{\partial govt} = \frac{\partial govt}{\partial govt} + \frac{\partial comm}{\partial govt} = 1 + \frac{\partial comm}{\partial govt}$$

(3) $$govt = nonleaked + leaked$$
$$comm = allcomm - leaked$$

(4) $$\frac{\partial total}{\partial govt} = \frac{\partial (govt + allcomm - leaked)}{\partial govt} = 1 + \frac{\partial allcomm}{\partial govt} - \frac{\partial leaked}{\partial govt}$$

Estimates of leakage (govt fertilizer diverted to informal channels), Zambia

	Official figures, Ministry of Agriculture and Cooperatives	Estimated from household survey data	
Agricultural Year	MT of FISP fertilizer delivered to districts	MT of FISP fertilizer received by smallholder households (% of MACO quantities)	
2002/2003	48,000	31,722	(66%)
2003/2004	60,000	33,372	(56%)
2004/2005	46,000	16,792	(37%)
2005/2006	50,000	23,595	(47%)
2006/2007	84,000	58,404	(70%)
2007/2008	50,000	43,596	(87%)
2008/2009	80,000	55,114	(69%)
2009/2010	100,000	69,103	(69%)
2010/2011	178,000	116,116	(65%)

5) $$allcomm = allcomm\left(E(\boldsymbol{p}), \boldsymbol{w}; govt, \boldsymbol{z}\right)$$

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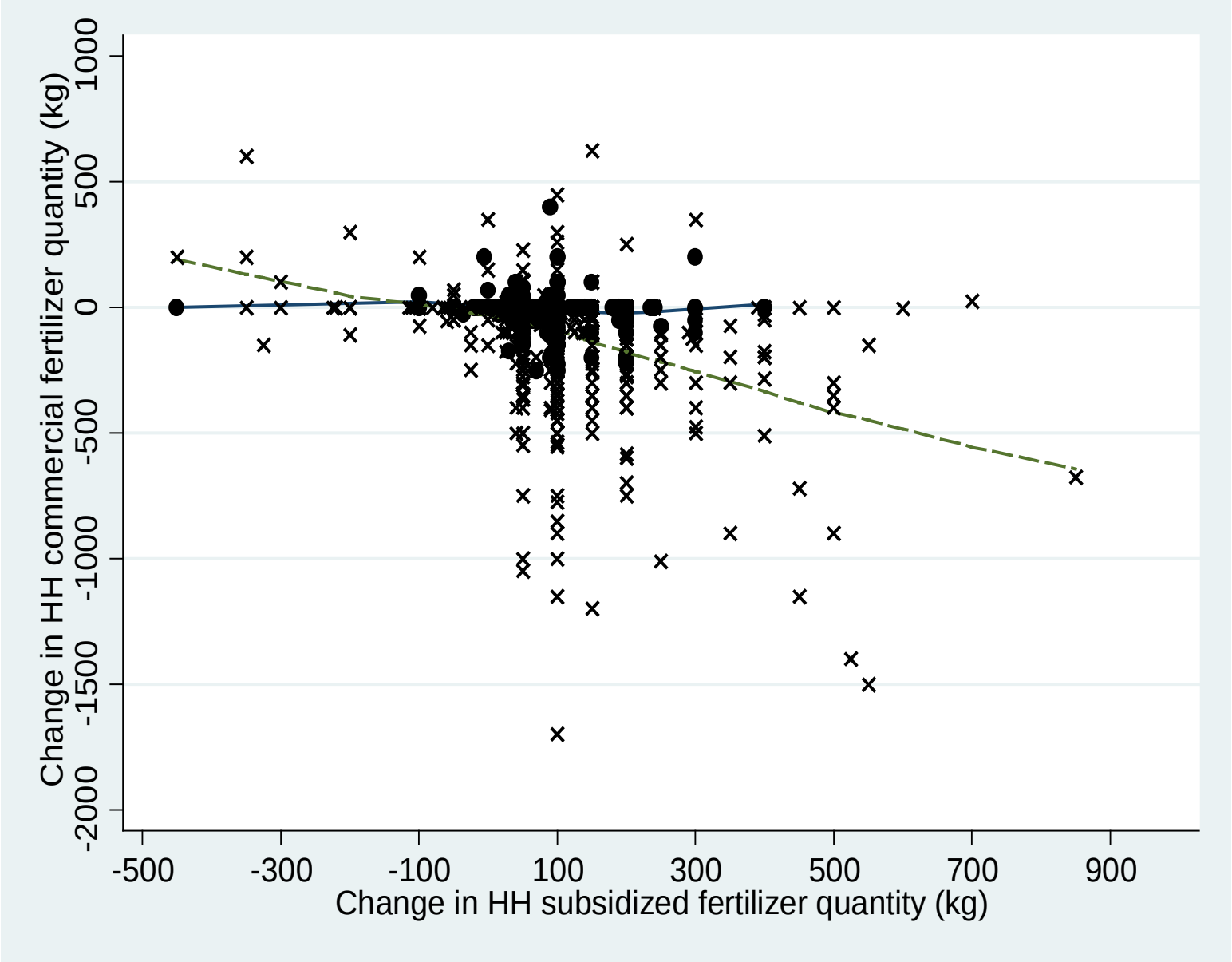
6)

$$allcomm_{i,t} = \alpha_0 + \alpha_1 \hat{p}^{*}_{i,t} + \boldsymbol{p_o}_{,k,t-1} \boldsymbol{\alpha_2} + \boldsymbol{w}_{i,t} \boldsymbol{\alpha_3} + \alpha_4 govt_{i,t} + \boldsymbol{z}_{i,t} \boldsymbol{\alpha_5} + c_i + u_{i,t}$$

where: p = expected farmgate price
p_o = price of substitute crops
w = vector of input prices, including fertilizer, ag wage rate
govt = quantity fertilizer received through government subsidy program
z = vector of other exogenous vbles (hh characteristics, market access conditions, rainfall, AEZ, etc
c_i = time-invariant hh-level unobserved heterogeneity
u_i = time-varying error term

Bivariate results, Malawi: 2003/04 to 2006/07



Summary of econometric results

1. Results of targeting models: characteristics of households receiving subsidized fertilizer
2. Results of input demand models: impact of an additional 1kg of subsidized fertilizer on commercial demand

Characteristics of households acquiring subsidized fertilizer

HH or village characteristic	Malawi	Zambia	Kenya
HH total landholding			
Gender of HH head			
Market access			
Political Economy factors (electoral results)			

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HH or village characteristic	Malawi	Zambia	Kenya
HH total landholding	HHs with larger landholding and asset wealth get more. Less of an issue in recent years.	HHs with larger landholding get more.	HHs with larger landholding get more
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Political Economy factors (electoral results)			

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Market access	Households farther from main district market get more	HHs farther from main district market and/or feeder road get less	HHs farther from motorable road get more
Political Economy factors (electoral results)			

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Market access	Households farther from main district market get ***more***	HHs farther from main district market and/or feeder road get ***less***	HHs farther from motorable road get ***more***
Political Economy factors (electoral results)	Districts where ruling party won last presidential election get more	Constituencies where ruling party won last presidential election get more (and more so the larger the ruling party's margin of victory)	Constituencies with more electoral support for challenger in the last presidential election get more

Summary of demand models: impact of 1kg of subsidized fertilizer on total fertilizer use

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- Holden and Lunduka (2012) estimates of leakage for Malawi: as high as 33%

Impact of additional 1kg subsidized fertilizer on total fertilizer use

Country	APE of 1 kg subsidized fertilizer on household commercial fertilizer use (kg)	APE of 1 kg subsidized fertilizer on total household fertilizer use (kg)			
		Un-adjusted APE	APE adjusted by estimated / assumed leakage levels		
			20%	33%	40%
Malawi	-0.185	0.815	0.615	0.485	0.415
Zambia	-0.134	0.866	0.666	0.536	0.466
Kenya	-0.431	0.569	0.369	0.239	0.169

Differential effects: high vs. low private sector activity, Zambia

Level of private sector fertilizer sales	$\frac{\partial total}{\partial govt}$		% difference
	Unadjusted	Adjusted for leakage	
High sales	0.77	0.56	38%
Low sales	0.93	0.40	133%
National	0.87	0.54	61%

Summary of Findings

1. Accounting for crowding out and leakage can seriously affect estimates of how ISPs affect total fertilizer use
2. 1 MT of fertilizer distributed through subsidy program adds the following to farmers' fields:
   - 515 kgs in Malawi,
   - 540 kgs in Zambia
   - 239 kgs in Kenya

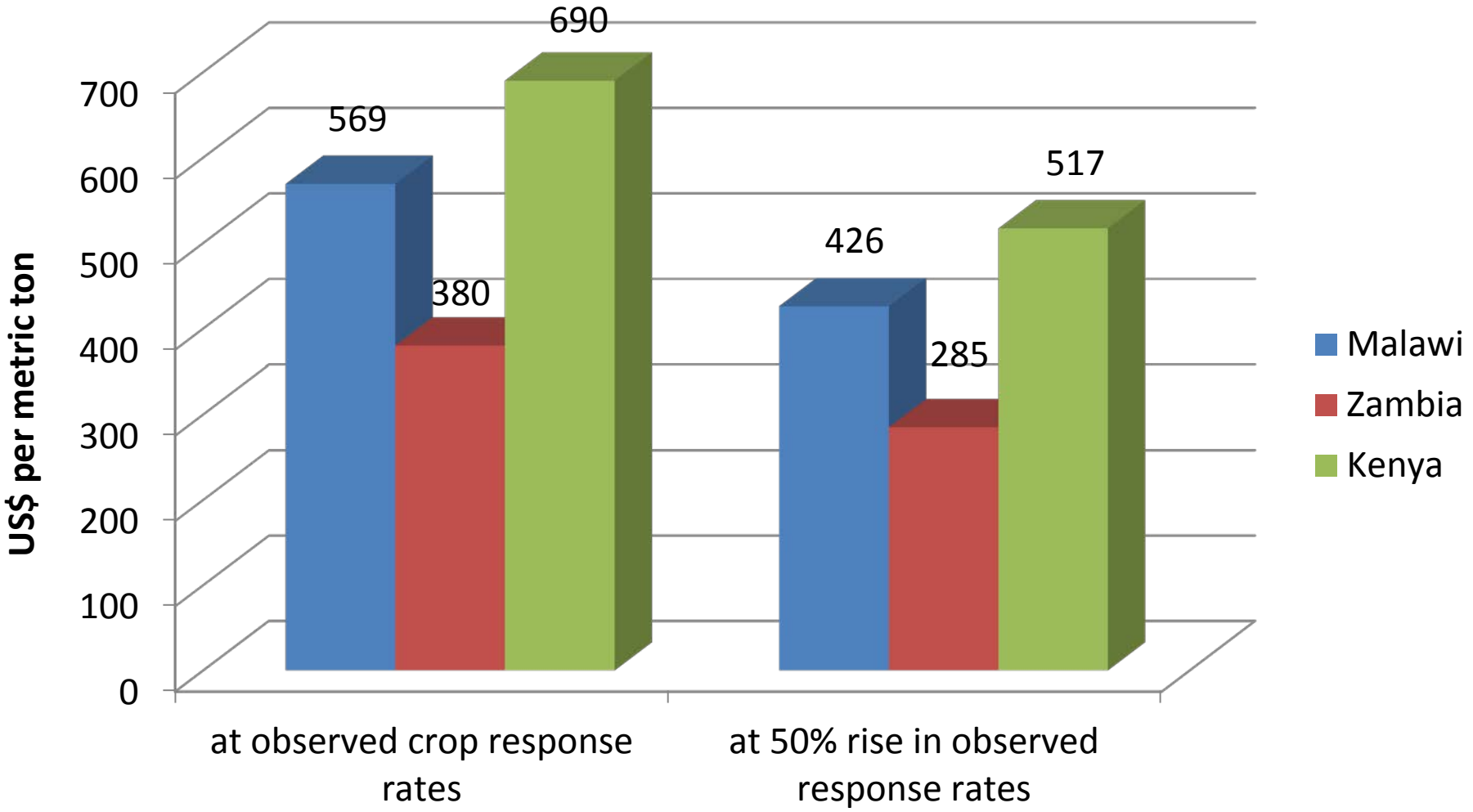
Summary of Findings (2)

3. Crowding out effect is lower in areas where commercial fertilizer demand is low
4. At actual wholesale lean season prices obtaining in each country, the value of maize production did not exceed the cost of the program in any of the 3 countries.

Summary of Findings (3)

5. The maize price required to make the programs break even were:
   - Malawi: $569 / mt
   - Zambia: $380 / mt
   - Kenya: $690 / mt

Maize price required for value of output = total cost of inputs



Summary of Findings (3)

6. These findings all pertain to the new generation of smart targeted ISPs

Policy Implications

1. Reduce leakage to increase the benefits of ISPs
   - Consider changes in program design and implementation, e.g., distribute to areas where commercial demand is not already high
   - Provide subsidized fertilizer to farmers lacking effective demand
2. Potential GE effects could alter the costs and benefits of the program and therefore need to be considered carefully

Policy Implications (2)

3. Improve crop-fertilizer response rates to raise the benefits of ISPs relative to their costs
4. Studies that do not account for crowding out and leakage are most likely seriously overestimating the contribution of ISPs to total fertilizer use

Thank you

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