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Does shifting from in-kind input distribution to a flexible e-voucher approach improve input subsidy program outcomes? Evidence from Zambia

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Motivation

- **Agricultural input subsidy programs** (ISPs) remain a **key pillar** of many SSA governments' **ag. sector strategies**
  - US$1-2 billion/yr, 14-29% of total ag sector expenditures
    (Jayne & Rashid 2013; Ricker-Gilbert et al. 2013; Jayne et al. 2018)
- ISPs seek to **raise modern input use, productivity, and incomes**, *inter alia*
- Many ISPs implemented since the early 2000s have **aspired to be "smarter"** than pre-structural adjustment ISPs. For example, many (but not all) are:
  - Targeted instead of universal
  - Involve the private sector more than in the past

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Motivation (cont'd)

- ISPs have continued to **evolve over time** in an attempt to **better support private sector investment** and development, and/or to **overcome previous challenges** with targeting, late delivery, etc., and **reduce the burden on national treasuries**

- Yet **little rigorous empirical evidence** on if recent, major **ISP innovations** are **improving program outcomes**

  – **C.f. – the huge literature** on ISP targeting and impacts (see Jayne et al. 2018)

  – **Main exception**: Kaiyatsa et al. (2018) on supply-side effects of Malawi's decision to allow ISP beneficiaries to redeem their fertilizer vouchers at select private sector retailers' shops

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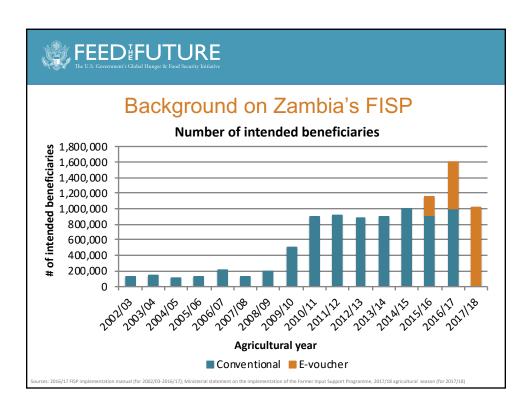## A natural experiment in Zambia

- **Zambia's piloting of an e-voucher approach** to its ISP beginning in 2015/16 offers a unique opportunity/**natural experiment** to analyze **if/how major ISP innovations affect program outcomes**
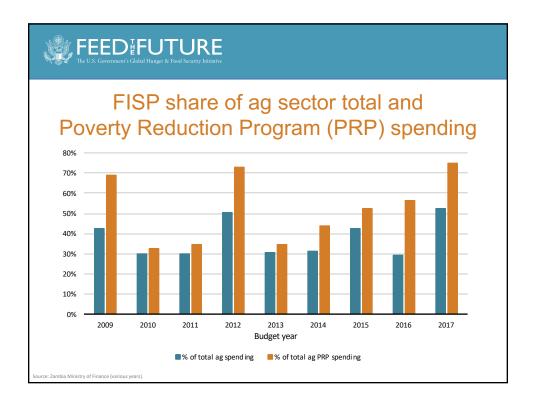- The **Farmer Input Support Programme (FISP)**

2002/03-2014/15: "Conventional" FISP		2015/16-present (phased rollout): "FISP E-voucher"
Inputs distributed in-kind	→	Beneficiaries receive e-vouchers
Private sector retailers NOT involved	→	E-vouchers redeemable at private sector retailers' shops
Maize seed and fertilizer	→	"Flexible" e-vouchers - redeemable for a wide range of inputs/equipment

Contributions

- **Add to thin literature** on effects of ISP innovations on program outcomes
- We focus on the effects of the recent major changes to Zambia's FISP on rural HHs (input use, cropping patterns, food security, others)
  - **Complements Kaiyatsa et al.**'s work on the effects of changes to Malawi's ISP on private sector retailers
  - 1st rigorous study on effects of Zambia's shift to flex. e-voucher
- We use **two different rich, complementary datasets & approaches**
  - Nationally- and district-representative pooled cross-sectional data (~40,000 obs.) spanning years before and during the FISP e-voucher phased rollout → Diff-in-diff
  - 2-year, district-representative HH panel survey data (12 districts, ~1900 obs.) during phased rollout → HH fixed effects model
    - Explore additional outcomes and mechanisms

Background on Zambia's FISP

Number of intended beneficiaries

Slide 1

FISP share of ag sector total and
Poverty Reduction Program (PRP) spending

Source: Zambia Ministry of Finance (various years).

Slide 2

Evolution of Zambia's ISPs over time

2002/03-2008/09: Fertilizer Support Program (FSP)

- **Implemented through selected farmer cooperatives**
- **Private sector retailers NOT involved**
- Selected beneficiaries got **400 kg fertilizer, 20 kg hybrid maize seed**
- **Subsidy rate:** 50-75% for fertilizer, and 50-60% for seed

2009/10-2016/17: (Conventional) Farmer Input Support Program (FISP)

- Similar to FSP but **pack halved** to 200 kg fertilizer and 10 kg hybrid maize seed
- **Very small qty of seed for other crops** (e.g., rice, sorghum, and groundnuts) included beginning in 2012/13. Farmers could only get inputs for one crop.
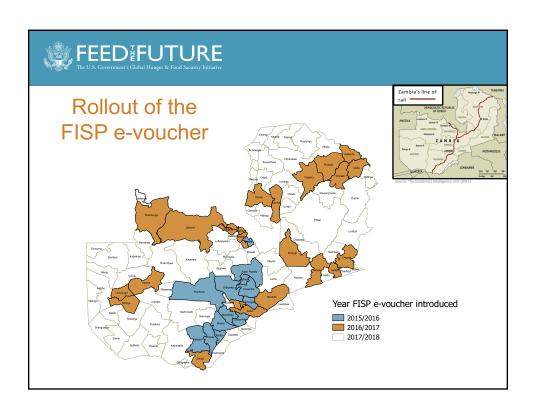
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Shift to the FISP flexible e-voucher

2015/16-2016/17: Piloting of the FISP (flexible) e-voucher
- **13** districts in **2015/16**, **39** districts in **2016/17 (of 106+ districts)**
- **Pre-paid Visa card** redeemable at participating registered agro-dealers
- **E-voucher worth K2100 (US$210)** = K400 farmer + K1700 gov't
- **Flexible**: redeemable for crop, livestock, or fisheries inputs or equipment

2017/18: FISP e-voucher program implemented nationwide
2018/19: Partial return to conventional FISP (40% of beneficiaries)

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Rollout of the FISP e-voucher

Year FISP e-voucher introduced
- 2015/2016
- 2016/2017
- 2017/2018

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What drove the shift to the e-voucher?

1. **Challenges with conventional FISP (anecdotal & empirical evidence)**
   - Diversion and resale of inputs
   - Poor targeting and leakage to farmers that don't meet selection criteria
   - Late delivery of inputs
   - Failure to build private sector networks
   - Expensive
   - Maize-centric and uniform fertilizer recommendations
2. **Perception that e-voucher could help address some of these challenges**
3. **Mounting evidence that e-voucher approach was feasible in Zambia**
   - E.g., Zoona w/ Conservation Farming Unit and Expanded Food Security Pack Program
   - Zambia National Farmers Union pre-paid Visa card platform for its Lima Credit Scheme

Source: Resnick & Mason (2016)

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What drove the shift to the e-voucher? (cont'd)

4. **Powerful advocacy coalition pushing for e-voucher**
   - Indaba Agricultural Policy Research Institute (research), Ag. Consultative Forum (advocacy)
   - Zambia National Farmers' Union, Conservation Farmer Unit
   - Donor community / Cooperating Partners
   - Civil society organizations
5. **MAL technocrats opposed to e-voucher leave in 2014**
6. **Diversifying input subsidies away from maize part of PF platform**
7. **New Minister of Ag. in 2015 (appointed after Pres. Lungu elected)**
   - Background in agricultural economics; perceived to be more open to research and other orgs
   - Called for Indabas in March & May 2015 with diverse stakeholders to work out details of pilot
8. **Needed budget resources available:** Min. of Finance and donor funding (and seen as way to reduce costs to gov't over time)

Source: Resnick & Mason (2016)

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Objectives of the conventional FISP

Overall objective:

Underlined = analyzed in this study

- "**Improve the supply and delivery of agricultural inputs to small-scale farmers** through sustainable private sector participation at affordable cost, in order to **increase household** <u>food security</u> **and incomes**"

Specific objectives:

1. "**Expand markets for private sector input suppliers/dealers** and increase their involvement in the distribution of agricultural inputs in rural areas, which will reduce the direct involvement of Government"
2. "**Ensure** <u>timely</u>**, effective and adequate supply of agricultural inputs** to targeted small-scale farmers"
3. "**Improve** <u>access</u> **of small-scale farmers to agricultural inputs**"
4. "**Ensure competitiveness and transparency** in the supply and distribution of inputs"
5. "Serve as a **risk-sharing mechanism** for small-scale farmers to cover part of the cost of **improving agricultural** <u>productivity</u>"

Source: Ministry of Agriculture 2016. 2016/17 FISP implementation manual (p. 3)

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Objectives of the FISP e-voucher

MINISTRY OF AGRICULTURE

Munobe Tasulwa

**FISP E-Voucher
Registered Agro - Dealer**

Same as the conventional FISP **plus**:

1. "**Further increase private sector participation** and hence reduce government participation in agricultural input marketing"
2. "**Ensure** <u>timely access</u> **to inputs** by smallholder farmers"
3. "Further **improve beneficiary targeting**"
4. "**Promote agricultural** <u>diversification</u>"

Underlined = analyzed in this study

Source: Ministry of Agriculture 2016. 2016/17 FISP e-voucher implementation manual (p. 1)

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Official targeting criteria (not very well enforced)

Conventional FISP	FISP e-voucher
Be a member of a selected, registered farmer organization	
Be registered with the Ministry of Agriculture	
Have the capacity to pay the farmer contribution (K400)	
Cultivate 5 ha of land or less	Cultivate 0.5 to 2 ha of land AND/OR Raise a certain amount of livestock/fish (2-10 cattle, 5-30 pigs or goats, 20-100 chickens, or 1-2 fish ponds)

Source: Ministry of Agriculture 2015 and 2016. 2015/16 and 2016/17 FISP implementation manuals (conventional and e-voucher).

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FISP e-voucher eligible inputs

- Assorted types of fertilizers
- Assorted types of seeds
- Insecticides
- Herbicides
- Fungicides
- Agricultural Lime
- Livestock feed
- Veterinary Drugs
- Dip chemicals

- Fingerlings
- Sprayers
- Farm tools
- Fencing materials for farm structures
- Breeding stock for goats, pigs, heifers
- Day old chicks
- Drinkers
- Fish feed
- Watering cans

MINISTRY OF AGRICULTURE
FISP VISA CARD
Accepted Here
VISA

E-voucher security features

Farmers are required to present their NRCs and all the details on the e-card are tied to the NRC. When a farmer redeems e-voucher, agro-dealer enters the farmer's NRC number to bring up the farmer's details and then proceeds with e-voucher redemption.

Sources:2016/17 FISP E-voucher Implementation Manual; personal communications with MoA officials.

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Research question:
To what extent did the shift to the FISP flexible e-voucher improve program outcomes relative to the conventional FISP?
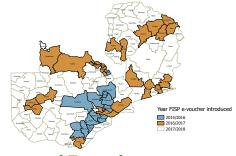
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Approach #1 (MSU/IAPRI): Data & methods

- Use Zambia **Crop Forecast Survey** (CFS) data
  - **Nationally- and district-representative pooled cross-sectional** data for smallholder farm HHs (cultivate < 20 ha)
  - Collected by Zambia Central Statistical Office & Ministry of Agriculture
  - **2013/14, 2014/15, & 2015/16** ag seasons (2016/17 to be added)
    - Approx. 13,200 HHs per year; **39,678 total obs.**
  - Data on **access to/use of inputs**, **cropped area, crop diversification**, and **FISP timeliness**, *inter alia*. Also **HH and basic plot characteristics** (size, soil fertility).

- Have CFS data for years before and during FISP e-voucher pilot
  → **Difference-in-difference (DD) analysis**

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Approach #1: Empirical model

Multi-district regression DD

(Angrist and Pischke, 2015)

Year FISP e-voucher introduced
- 2015/2016
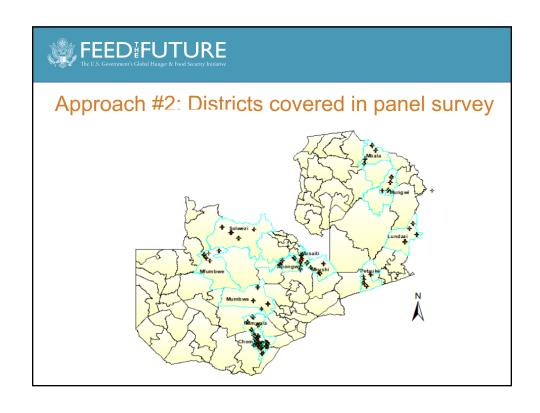- 2016/2017
- 2017/2018

$$y_{idt} = \alpha + \delta_{DD} Evoucher_{dt} + \lambda Evoucher_{dt+1}$$
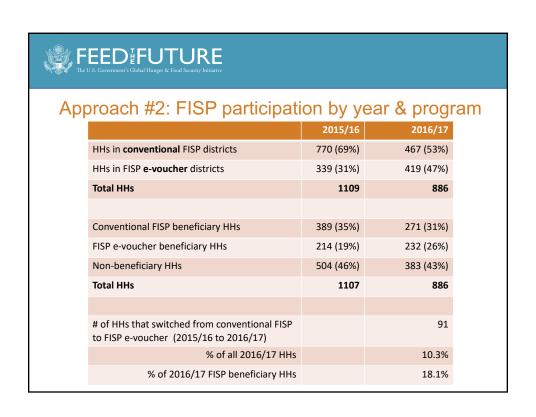$$+ District_d \beta + Year_t \gamma + X_{idt} \theta + \varepsilon_{idt}$$

- <u>Key assumption</u>: parallel trends in the absence of the policy change
  - If no differential pre-treatment trends, then $\lambda = 0$
  - Fail to reject H_0: $\lambda = 0$

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Approach #2 (UIUC): Data

- Part of NSF-funded Climate Change, Food Security, and Market Dynamics Research Project
- Includes questions on **FISP participation** (in general and e-voucher in particular)
- **2-wave HH panel survey**, covers **12 districts**
  - Wave 1: covers **2015/16** ag year, 1174 HHs
  - Wave 2: covers **2016/17** ag year, 1024 HHs re-interviewed
  - Focus on maize-growing HHs in analysis (1109/886 obs.)
- Of the 12 districts:
  - 2015/16: 10 conventional FISP + 2 FISP e-voucher
  - 2016/17: 7 conventional FISP + 5 FISP e-voucher

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Approach #2: Districts covered in panel survey

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Approach #2: FISP participation by year & program

	2015/16	2016/17
HHs in **conventional** FISP districts	770 (69%)	467 (53%)
HHs in FISP **e-voucher** districts	339 (31%)	419 (47%)
Total HHs	**1109**	**886**
Conventional FISP beneficiary HHs	389 (35%)	271 (31%)
FISP e-voucher beneficiary HHs	214 (19%)	232 (26%)
Non-beneficiary HHs	504 (46%)	383 (43%)
Total HHs	**1107**	**886**
# of HHs that switched from conventional FISP to FISP e-voucher (2015/16 to 2016/17)		91
% of all 2016/17 HHs		10.3%
% of 2016/17 FISP beneficiary HHs		18.1%

Approach #2: Empirical model

$$y_{it} = \alpha + \beta_1 FISP_{it} + \beta_2 FISP_{it} \times Evoucher_{it}$$
$$+ X_{it}\theta + c_i + d_t + \varepsilon_{it}$$

- β_2 is key parameter of interest (differential effect of e-voucher)
- **Outcome variables**: maize yield, food expenditures (cash only), and 2 food security indicators - FCS, modified HDDS (7-day recall)
  - HDDS: # of food groups consumed by HH
    - Indicator of diet quality
  - FCS: weighted score of # of food groups X frequency
    - Indicator of caloric intake and diet quality
- **Estimate via POLS and FE** (without **X**)
  - Relying on FE to control for endogeneity of FISP (i.e., assuming self-selection is related to time-constant, not time-varying HH unobservables)

Results: DD – Access to & use of fertilizer

Explanatory variables	Km to nearest fertilizer seller		=1 if used fertilizer		=1 if purchased fertilizer (not w/ e-voucher)	
	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
Evoucher$_{dt}$	**-1.85**	**2.75**	**0.027**	**0.070*****	**-0.105*****	**-0.119*****
Evoucher$_{dt+1}$	-3.53	-3.25	-0.021	-0.016	-0.018	-0.015
District dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Province X year dummies	No	Yes	No	Yes	No	Yes
HH characteristics	No	Yes	No	Yes	No	Yes
Observations	39,678	39,671	39,678	39,671	39,678	39,671
R-squared	0.172	0.178	0.242	0.272	0.151	0.176
Sample mean	39.2		0.564		0.287	

Note: *** p<0.01, ** p<0.05, *p<0.10. Standard errors clustered at district level.

- **Probability of using fertilizer (may be) higher** among HHs in e-voucher districts in 2015/16: b/c of more effective targeting under e-voucher of HHs o.w. less likely to use fertilizer (and elimination of "ghost farmers")?
- **Probability of purchasing unsubsidized fertilizer lower** among HHs in e-voucher pilot districts in 2015/16 : b/c can potentially redeem for 7x50-kg bags (K300/bag) vs. only 4 bags w/ conventional FISP?

Results: DD – Use of F1 hybrid maize seed

Explanatory variables	=1 if grew F1 hybrid maize		Hectares of F1 hybrid maize	
	Coef.	Coef.	Coef.	Coef.
Evoucher$_{dt}$	**-0.050****	**-0.016**	**-0.23*****	**-0.04**
Evoucher$_{dt+1}$	-0.018	-0.004	0.03	0.02
District dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Province X year dummies	No	Yes	No	Yes
HH characteristics	No	Yes	No	Yes
Observations	39,678	39,671	39,678	39,671
R-squared	0.193	0.225	0.127	0.486
Sample mean	0.525		0.63	

Note: *** $p<0.01$, ** $p<0.05$, *$p<0.10$. Standard errors clustered at district level.

- Some (but not robust) evidence of **reduction in hybrid maize** seed use
- Consistent w/ HH panel survey data: **e-voucher recipients spent most of e-voucher value on fertilizer** (86-92%) and only 5-9% on hybrid maize seed; they were also more likely to plant recycled hybrids. (Will discuss more later.)

Inputs purchased with e-voucher based on a sample of beneficiaries in 10 districts (IAPRI)

Input	% of e-voucher transactions by input type (among IAPRI survey farmers)	
	2015/16	2016/17
Fertilizer	60.7%	67.0%
Maize Seed	24.3%	19.9%
Veterinary Drugs	3.8%	1.4%
Dip Chemicals	2.6%	1.4%
Herbicides	2.0%	6.5%
Insecticides	1.6%	0.7%
Other (unspecified)	1.4%	0.5%
Sprayers	1.3%	--
Horticultural Inputs	1.1%	1.4%
Cowpea seed	0.6%	0.2%
Common bean seed	0.6%	--
Agricultural Lime	0.1%	0.5%
Tillage equipment	--	0.2%
Soybean bean	--	--
Livestock Feed	--	--
Live Animals	--	0.2%
Fingerlings	--	--
TOTAL	**100%**	**100%**
N (e-voucher recipients)	437	634

Source: 2016 and 2017 IAPRI FISP E-Voucher Surveys. Sample included 10 of 13 of the districts included in the 2015/16 pilot. Pilot districts excluded were Ndola, Kalomo, and Mumbwa.

Results: DD – Cropped area (hectares)

Explanatory variables	Maize			Other field crops	
	Coef.	Coef.		Coef.	Coef.
Evoucher$_{dt}$	-0.15***	0.01		0.20***	0.14**
Evoucher$_{dt+1}$	0.04	0.02		-0.03	-0.06*
District dummies	Yes	Yes		Yes	Yes
Year dummies	Yes	Yes		Yes	Yes
Prov. X year dummies	No	Yes		No	Yes
HH characteristics	No	Yes		No	Yes
Observations	39,678	39,671		39,678	39,671
R-squared	0.159	0.629		0.112	0.277
Sample mean	0.94			0.74	

- ↓ maize
- ↑ legumes & oilseeds
- ↑ cash crops
- ↑ roots & tubers
- No Δ other cereals

Note: *** p<0.01, ** p<0.05, *p<0.10. Standard errors clustered at district level.

- CFS covers maize + 22 other field crops (horticultural crops not covered)
- Compared to maize-centric conventional FISP, flexible e-voucher
  → **HHs diversifying their crop production?**

Results: DD – Crop diversification

Explanatory variables	=1 if grew at least one non-maize field crop		Number of field crops grown		Simpson index of field crop diversity	
	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
Evoucher$_{dt}$	0.06*	0.03	0.30***	0.15	0.063***	0.041**
Evoucher$_{dt+1}$	0.01	-0.01	-0.00	-0.04	0.001	-0.003
District dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Province X year dummies	No	Yes	No	Yes	No	Yes
HH characteristics	No	Yes	No	Yes	No	Yes
Observations	39,678	39,671	39,678	39,671	39,678	39,671
R-squared	0.156	0.185	0.194	0.269	0.216	0.260

Note: *** p<0.01, ** p<0.05, *p<0.10. Standard errors clustered at district level.

- Simpson index $= 1 - \sum_{c=1}^{C} s_c^2$ (increase is ~11-16%)
- Additional evidence of **crop diversification** effect of FISP e-voucher relative to conventional, maize-centric FISP
- **Mechanism** unclear: few HHs use e-voucher to buy seed for non-maize crops. Perhaps "if they give you maize seed, you'll plant it" effect w/ conventional FISP?

Results: DD – FISP fertilizer distance & timeliness (among HHs acquiring fertilizer through FISP)

Explanatory variables	Km to FISP fertilizer collection point		=1 if FISP basal fertilizer available on time		=1 if FISP top dressing fertilizer available on time	
	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
Evoucher$_{dt}$	**6.96*** **	**2.15**	**-0.117***	**-0.075**	**-0.085***	**-0.048**
Evoucher$_{dt+1}$	-1.05	0.39	0.048	-0.034	0.035	-0.047
District dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Province X Year dummies	No	Yes	No	Yes	No	Yes
HH characteristics	No	Yes	No	Yes	No	Yes
Observations	13,538	13,533	13,463	13,458	13,480	13,475
R-squared	0.043	0.053	0.075	0.111	0.095	0.141
Sample mean	6.7		0.761		0.709	

Note: *** $p<0.01$, ** $p<0.05$, *$p<0.10$. Standard errors clustered at district level.

- Some evidence that at least in the 1st year of the pilot, HHs that accessed fertilizer through the **FISP e-voucher** had to **travel farther** and were **less likely to get the fertilizer on time**, compared to those acquiring it through conventional FISP

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DD results – Main takeaways

1. Fairly robust evidence that shift to e-voucher in 2015/16 **increased crop diversification**

2. The shift may have **increased the % of HHs using fertilizer** (perhaps through better targeting/elimination of ghost farmers)

3. But the shift appears to have **reduced the % of HHs purchasing unsubsidized fertilizer** (e.g., perhaps b/c e-voucher beneficiaries spent it almost entirely on fertilizer; little residual demand for unsubsidized fertilizer)

4. **No evidence** that the shift **reduced distance** to fertilizer retailers

5. And HHs that acquired fertilizer through e-voucher **no better off** (and may have been **worse off**) w.r.t. **FISP fertilizer timeliness and proximity**

- Why #4 & #5? Private sector response may take more than 1 year

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Results: POLS/FE – Maize yield

Explanatory variables	Log maize yield	
	Coef. (POLS)	Coef. (FE)
$FISP_{it}$	0.440***	0.414***
$FISP_{it}$ X $Evoucher_{it}$	-0.208***	-0.196***
HH characteristics	Yes	No
District dummies	Yes	No
Agricultural camp dummies	Yes	No
Year dummy	No	Yes
Observations	1,904	1,975
R-squared (w/in for FE)	0.249	0.041

Note: *** p<0.01, ** p<0.05, *p<0.10. Number of observations is lower for POLS due to missing data on some HH characteristics for some HHs.

- FISP participation (conventional or e-voucher) boosted maize yields by 40-44%
- But relative to conventional FISP beneficiaries, **FISP e-voucher beneficiaries' yields were ~20% lower**

Mechanisms for lower maize yields among e-voucher beneficiaries relative to conventional?

E-voucher beneficiary HHs:

1. Had their **e-voucher cards activated later** (on average) than conventional FISP beneficiaries received their inputs in (especially in 2016/17)

2. **Spent most of their voucher on fertilizer**
   - Perhaps b/c vouchers were late & they had already planted → didn't make sense to buy seed for that year anymore

3. Were **more likely to plant recycled hybrid** maize seed (27-31% vs. 21-24% of conventional FISP HHs)
   - Info constraint and/or needed to plant and couldn't wait for e-voucher to be activated?

Results: POLS/FE – food expenditures, FCS, & HDDS

Explanatory variables	Log of food expenditures in last 7 days	FCS		HDDS	
	Coef. (FE)	Coef. (POLS)	Coef. (FE)	Coef. (POLS)	Coef. (FE)
FISP$_{it}$	17.4**	1.98**	2.22	0.20***	0.16*
FISP$_{it}$ X Evoucher$_{it}$	-43.6***	0.04	-2.75	-0.11	-0.11
HH characteristics	No	Yes	No	Yes	No
District dummies	No	Yes	No	Yes	No
Agricultural camp dummies	No	Yes	No	Yes	No
Year dummy	Yes	No	Yes	No	Yes
Observations	1,993	1,922	1,993	1,922	1,993
R-squared (w/in for FE)	0.029	0.191	0.006	0.200	0.011
Sample mean		59		5.5	

Note: *** $p<0.01$, ** $p<0.05$, *$p<0.10$. Standard errors clustered at district level.

- **Lower food expenditures** among e-FISP beneficiaries **could be good thing**. These are cash expenditures only; do not include value of consumption from own production. (Some CFS evidence that **expected gross value of production/ha greater w/ e-FISP**.)
- Greater crop diversification does not necessarily translate into ↑ FCS/HDDS but need to explore further. (Some other model specifications suggest a + effect on HDDS.)

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Additional analyses planned

1. Additional robustness checks

2. **Instrument for selection as e-voucher pilot district** in 2015/16 vs. 2016/17 (vs. non-pilot district) using **distance from line of rail X year dummy**
   – Line of rail established during the colonial period

3. Add **2016/17 data** to DD analysis

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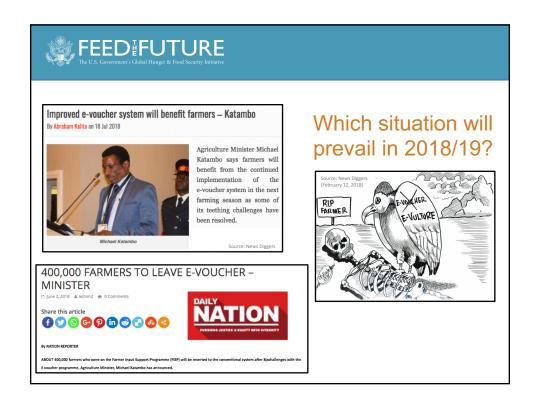The U.S. Government's Global Hunger & Food Security Initiative

Conclusions

- Good intentions but implementation challenges

- Results so far suggest that the 2015/16 FISP e-voucher pilot spurred **greater crop diversification and possibly an increase in the % of HHs using fertilizer** relative to the conventional FISP

- But at least in its first year, the **FISP e-voucher did not result in shorter distances** between farmers and fertilizer sellers or increase the likelihood that farmers purchased unsubsidized fertilizer, **nor did it improve timely availability** of FISP fertilizer

- *Why?* These are **short-run effects**. May take multiple years to build private sector confidence and catalyze major investment in retail networks (and stocking of more diverse inputs).

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Conclusions (cont'd)

- HH panel survey-based results suggest that **maize yields were 20% lower** among FISP e-voucher beneficiaries than conventional FISP beneficiaries
  - Due to **late activation and e-vouchers being spent mainly on fertilizer** and not fertilizer + hybrid maize seed

- Differential effects on food expenditure, food security mixed

- **Late activation of e-vouchers is a major problem**
  → whether it's inputs (conventional FISP) or e-vouchers, early mobilization of funds and early start to activities are critical. Fundamentally a question of political will.

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Thank you for your attention!

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