What are the effects of input subsidy programs on maize prices? Evidence from Malawi and Zambia.

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N.M. Mason
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S. Tembo


Subsidized fertilizer by year - Malawi
Subsidized fertilizer by year - Zambia

Official maize production by year – Zambia
Subsidized fertilizer & real retail maize prices (harvest season) - Zambia

Research Question/Testable Hypothesis

• How does an increase in the quantity of subsidized fertilizer distributed affect maize prices?

• Very little empirical evidence to date
Why does the impact of subsidized fertilizer on maize prices matter?

- Huge public expenditure on subsidized fertilizer.
  - 7 SSA countries US $2 billion in 2012 (Ricker-Gilbert et al. 2013)
- Stated goals are to increase fertilizer use, boost staple crop production, improve food security, & reduce poverty.
- Direct impacts on subsidy recipients
- Indirect impacts on recipients & non-recipients through lower maize prices?
  - Urban consumers and most rural poor are net buyers
  - Claims of massive spillovers & poverty reduction impacts

Conceptual Framework

Pathways of subsidy program effects on maize prices.
**Previous Literature in Malawi and Zambia**

- Subsidized fertilizer crowds out commercial fertilizer
  - Malawi (Ricker-Gilbert et al. 2011)
  - Zambia (Mason & Jayne 2013)

- Subsidized fertilizer increases maize production but effects are small
  - Malawi (Holden & Lunduka 2010; Ricker-Gilbert & Jayne 2011; Shively et al. 2012)
  - Zambia (Mason et al. 2013)

- Markets in the region are reasonably well-integrated

- Malawi at import parity during most of study period

→ *A priori, don’t expect large subsidy effects on prices*

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**Economic model**

1) **Maize output supply**

\[ Q^s = Q^s(p^{f*}, FISP, z^s) \]

- \( Q^s \), maize qty supplied
- \( p^{f*} \), expected producer price
- \( FISP \), qty of subsidized fertilizer
- \( z^s \), vector of supply shifters

2) **Retail maize demand**

\[ Q^d = Q^d(p^r, z^d) \]

- \( Q^d \), maize qty demanded
- \( p^r \), retail maize price
- \( z^d \), vector of demand shifters

3) **Retail price – producer price relationship**

\[ p^r = p^f + M(z^m) \]

- \( p^r \), retail maize price
- \( p^f \), realized producer price
- \( z^m \), vector of marketing margin shifters

4) **Market clearing condition**

\[ Q^d = Q^s \]

5) **Reduced form of retail price as function of subsidized fertilizer**

\[ p^r = p^r(p^{f*}, FISP, z^s, z^d, z^m) \]
Data

Malawi

<table>
<thead>
<tr>
<th>Variable</th>
<th>Data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail maize prices</td>
<td>Monthly, 72 markets in 26 districts</td>
<td>Min. of Ag. &amp; Food Security</td>
</tr>
<tr>
<td>Subsidized fertilizer MT</td>
<td>Annual district allocation</td>
<td>Logistics Unit Reports</td>
</tr>
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</table>

Zambia

<table>
<thead>
<tr>
<th>Variable</th>
<th>Data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail maize prices</td>
<td>Monthly, 50 districts</td>
<td>Central Statistical Office</td>
</tr>
<tr>
<td>Subsidized fertilizer MT</td>
<td>Annual district allocation</td>
<td>Min. of Ag. &amp; Livestock</td>
</tr>
</tbody>
</table>


Empirical model

\[ p_{i,t}^r = \psi + \alpha FISP_{i,t} + \sum_{j=1}^{J} \gamma_j p_{i,t-j}^r + X_{i,t} \beta + Z_t \theta + c_i + u_{i,t} \]

- \( p_{i,t}^r \) = Retail maize price in market/district \( i \) at time \( t \)
- \( FISP_{i,t} \) = Qty of subsidized fertilizer allocated to the district
- \( p_{i,t-j}^r \) = Lagged retail maize price
- \( X_{i,t} \beta \) = District-level S/D/MM shifters
- \( Z_t \theta \) = National/international-level S/D/MM shifters
- \( c_i \) = time-constant error
- \( u_{i,t} \) = time-varying error

\[ H_0 : \alpha = 0 \]

Test if subsidized fertilizer affects maize prices

\[ \frac{\alpha}{1 - \sum_{j=1}^{J} \gamma_j} \]

Long-run impact of subsidized fertilizer on maize prices
**Estimation strategy**

\[ \Delta p_{i,t}^r = \alpha \Delta FISP_{i,t} + \sum_{j=1}^{J} \gamma_j \Delta p_{i,t-j}^r + \Delta X_{i,t} \beta + \Delta Z_{i,t} \theta + \Delta u_{i,t} \]

- First-difference (FD) estimation removes \( c_i \) (omit LDV)
- Arellano-Bond (AB) to estimate dynamic panel data model - with LDV in t-2 periods or later used as IV for LDV.

- Separate models for Malawi and Zambia
- 2 observations per market/district per year
  - Harvest season (May-Oct.)
  - Lean season (Nov.-Apr.)

- Explored possible subsidized fertilizer spatial spillovers:
  - Kg to neighboring districts only
  - Kg to all other districts, weighted by inverse distance between districts \( i \) and \( j \)
  - No evidence of spatial spillovers

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**Variables included in X and Z**

<table>
<thead>
<tr>
<th>District-level variables (X)</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real retail rice prices</td>
<td>Malawi &amp; Zambia</td>
</tr>
<tr>
<td>Real retail bread prices</td>
<td>Malawi &amp; Zambia</td>
</tr>
<tr>
<td>Marketing board purchases</td>
<td>Zambia</td>
</tr>
<tr>
<td>Growing season rainfall</td>
<td>Malawi &amp; Zambia</td>
</tr>
<tr>
<td>Rainfall stress (dry spells)</td>
<td>Malawi &amp; Zambia</td>
</tr>
<tr>
<td>District dummies</td>
<td>Malawi &amp; Zambia</td>
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<tr>
<td>Diesel prices</td>
<td>Zambia</td>
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</table>

<table>
<thead>
<tr>
<th>National-level variables (Z)</th>
<th>Country</th>
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<tbody>
<tr>
<td>Diesel prices</td>
<td>Malawi</td>
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<tr>
<td>Commercial interest rate</td>
<td>Zambia</td>
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<tr>
<td>Electricity prices</td>
<td>Zambia</td>
</tr>
<tr>
<td>Zambia border maize prices</td>
<td>Malawi</td>
</tr>
<tr>
<td>Malawi border maize prices</td>
<td>Zambia</td>
</tr>
<tr>
<td>Northern Mozambique maize prices</td>
<td>Malawi</td>
</tr>
<tr>
<td>South African Futures Exchange (SAFEX) maize prices</td>
<td>Malawi &amp; Zambia</td>
</tr>
</tbody>
</table>

Also include: year dummies, lean season dummy, year dummies * lean season dummy, & a linear time trend
### Results - Malawi

**Factors affecting log real retail maize prices at the market level**

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Sparse Model</th>
<th>Full Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A) FD</td>
<td>B) AB</td>
</tr>
<tr>
<td>Subsidized fertilizer ('000 MT)</td>
<td>-0.003*</td>
<td>-0.003*</td>
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<tr>
<td>Rainfall variables</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Other controls</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Lagged maize prices?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Time dummies &amp; time trend?</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Long-run effect of subsidized fertilizer</td>
<td>N/A</td>
<td>-0.004</td>
</tr>
<tr>
<td>Observations</td>
<td>1,112</td>
<td>969</td>
</tr>
<tr>
<td>Overall model F-test for FD, Wald test for AB</td>
<td>2,616***</td>
<td>26,668***</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.80</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*, **, *** denotes that corresponding coefficients are statistically significant at the 10%, 5% and 1% level respectively

### Results - Zambia

**Factors affecting log real retail maize prices at the district level**

<table>
<thead>
<tr>
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<th>Full Model</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>A) FD</td>
<td>B) AB</td>
</tr>
<tr>
<td>Subsidized fertilizer ('000 MT)</td>
<td>-0.028**</td>
<td>-0.020***</td>
</tr>
<tr>
<td>Rainfall variables</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Other controls</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Lagged maize prices?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Time dummies &amp; time trend?</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Long-run effect of subsidized fertilizer</td>
<td>N/A</td>
<td>-0.030***</td>
</tr>
<tr>
<td>Observations</td>
<td>1,145</td>
<td>745</td>
</tr>
<tr>
<td>Overall model F-test for FD, Wald test for AB</td>
<td>448***</td>
<td>20,697***</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.80</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*, **, *** denotes that corresponding coefficients are statistically significant at the 10%, 5% and 1% level respectively
How large are these price effects?

- Roughly doubling the program size in every district reduces prices by an average of:
  - 1.2% to 1.6% in Malawi
  - 2.0% to 2.8% in Zambia

- Statistically significant but small-in-magnitude price reduction.

- Robustness: when estimated on a per capita basis
  - Malawi: doubling program reduces maize price by 2.5%
  - Zambia: doubling program reduces maize price by 1.8%

Gains are small in Consumer Surplus (CS) terms, too

- Malawi: 1.6% reduction in price generates a CS gain of US $3.32 million per year.
  - = 2.4% of average total program cost per year.

- Zambia: 2.8% reduction in price generates a CS gain of US $5.81 million per year.
  - = 5.2% of average total program cost per year.

- Even small decreases in maize price can help poor
- But price effects insufficient to justify program costs
Conclusions

• Findings consistent with previous studies showing:
  – Subsidized fertilizer crowds out commercial fertilizer
  – Small increases in maize production from subsidy

• **Malawi**: at import parity most of the time. Local production increases likely just off-set imports.

• **Zambia**: favorable rainfall & marketing board activities also raised maize production, not just FISP.

• Markets in both countries fairly well-integrated → price effects small & short-lived

Take Home Message

• Little support for claim that large expenditures warranted because fertilizer subsidy programs have massive spillover effects and reduce poverty by reducing maize prices.
Thank you for your time!

Questions/Comments are appreciated

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