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

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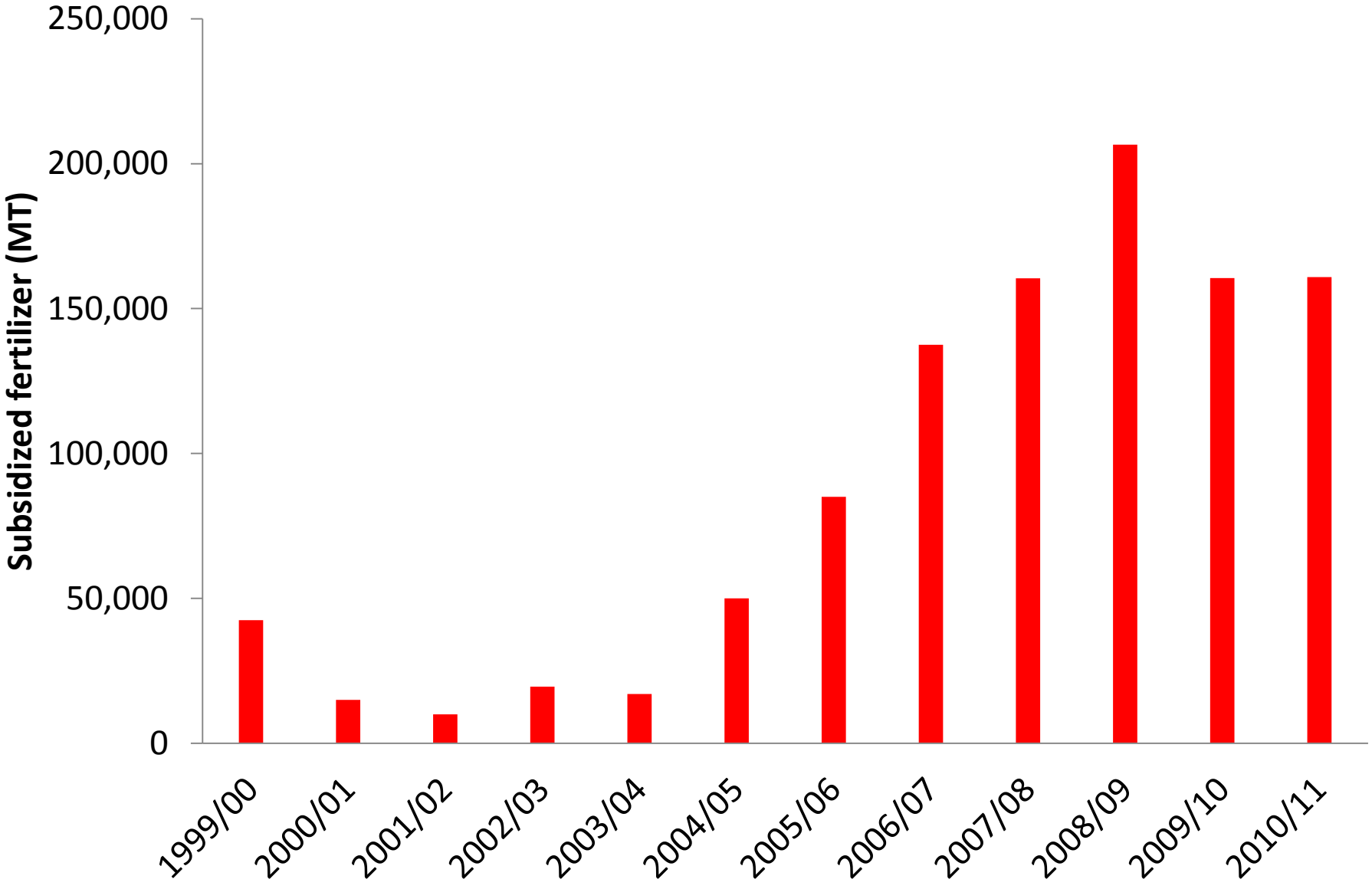
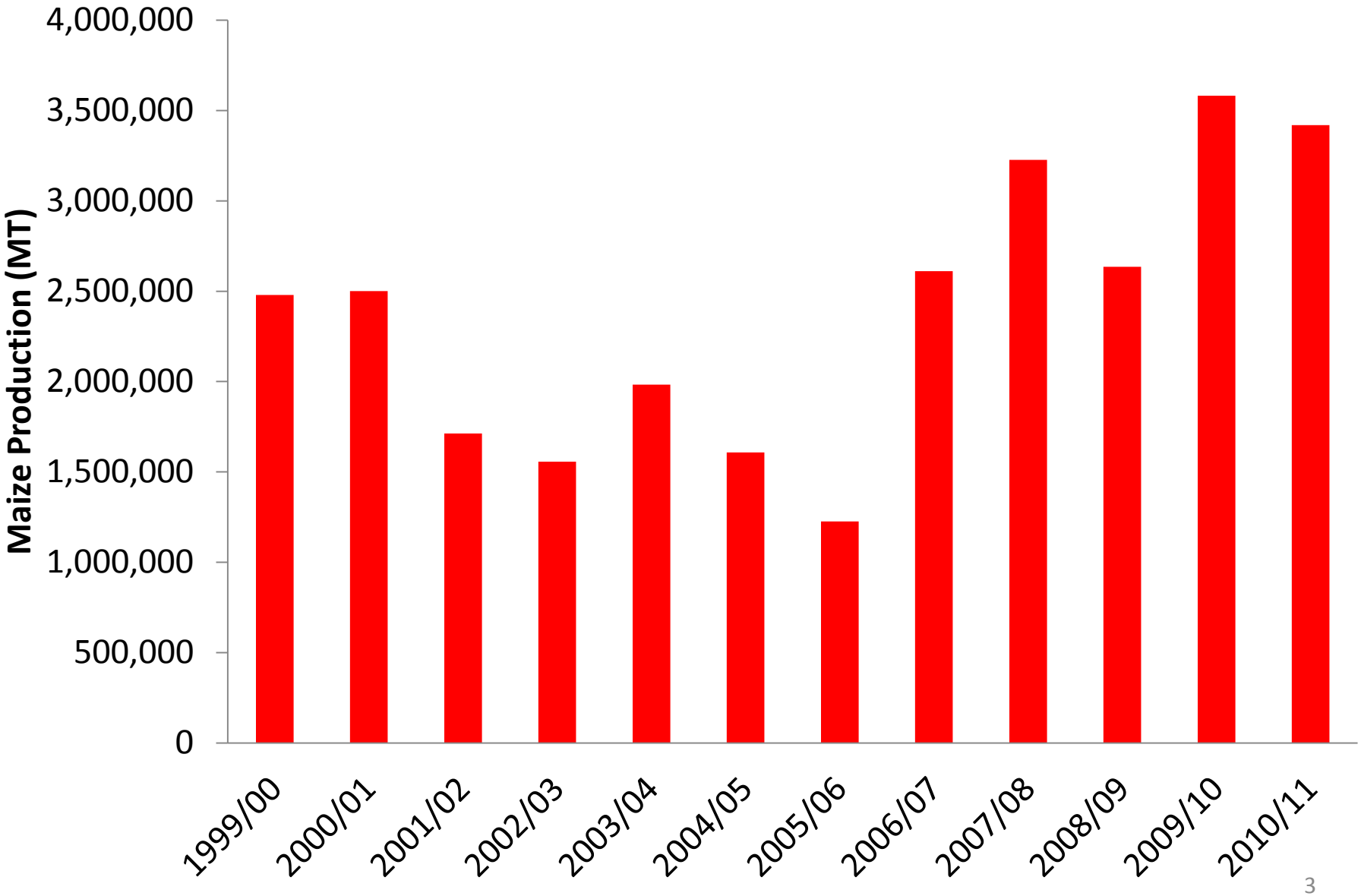
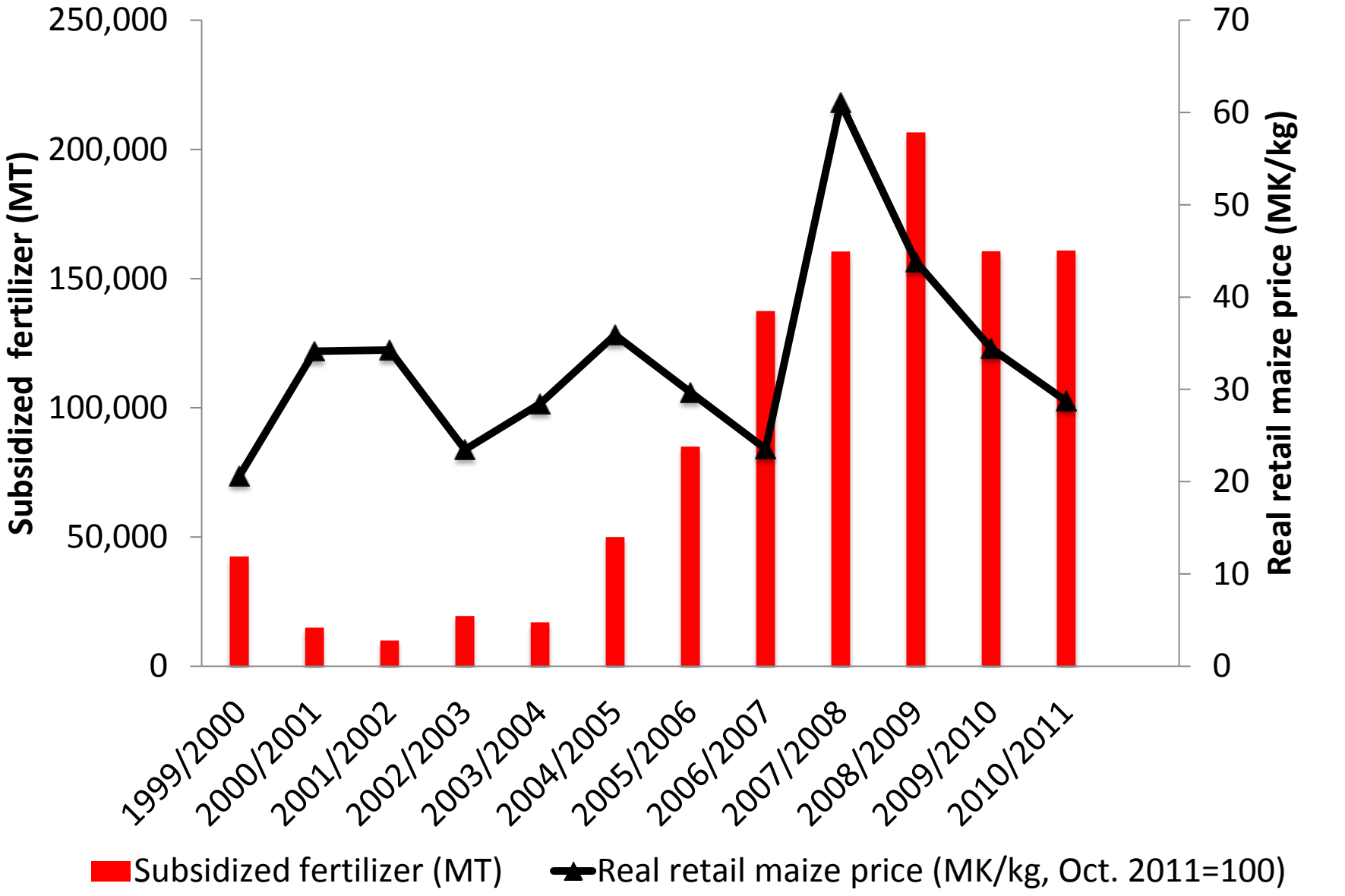
Subsidized fertilizer by year - Malawi



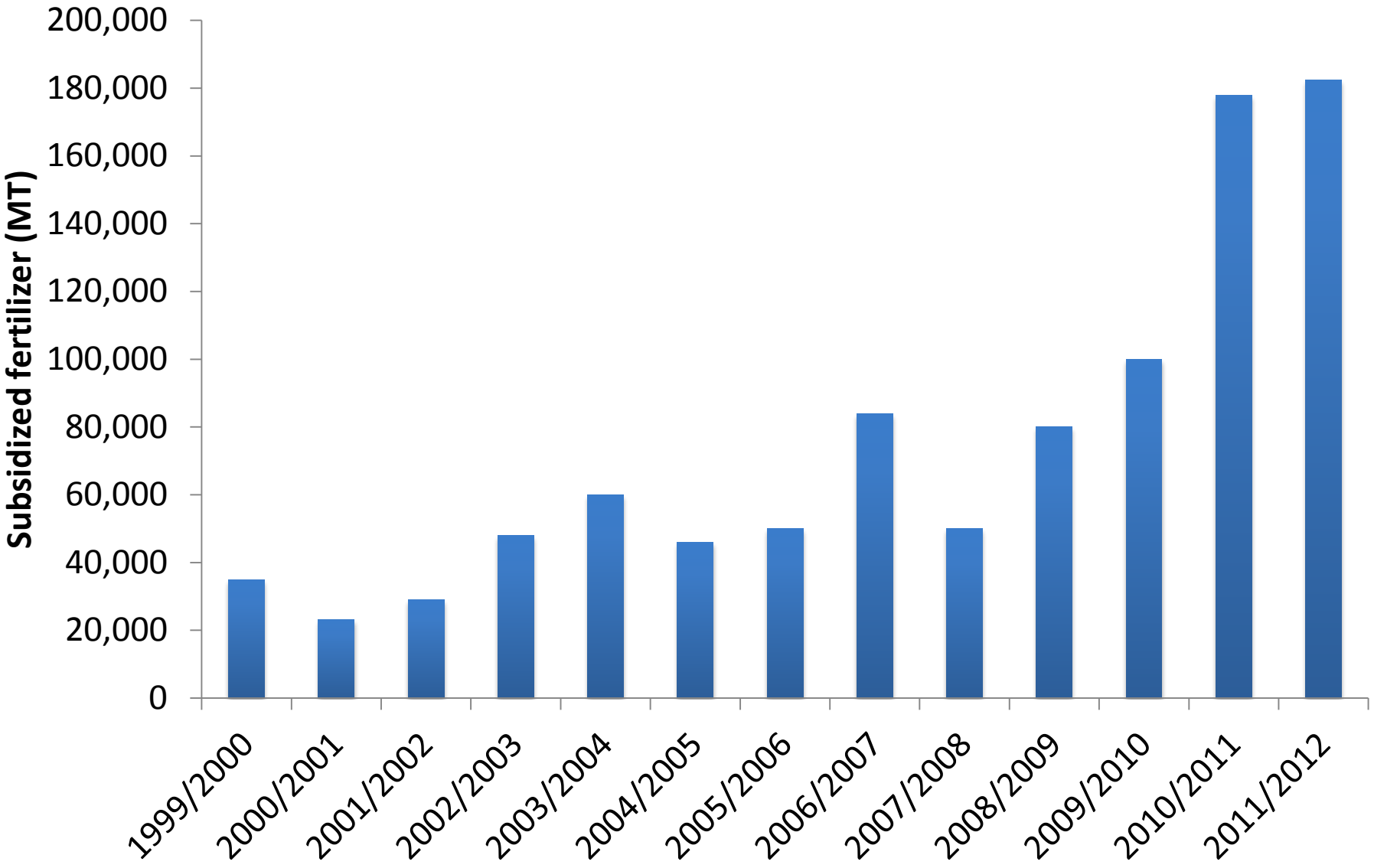
Official maize production by year – Malawi



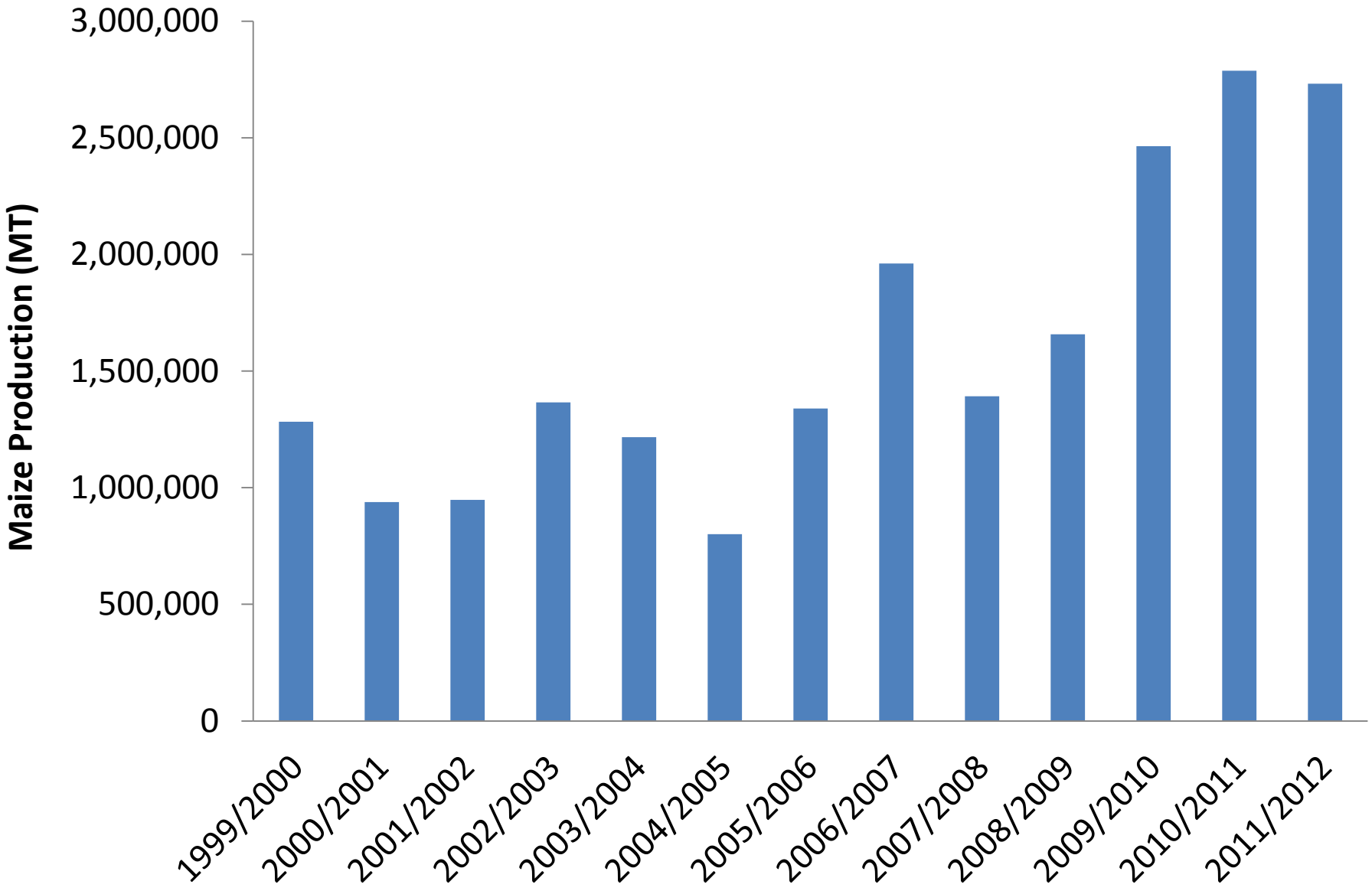
Subsidized fertilizer & real retail maize prices (harvest season) - Malawi



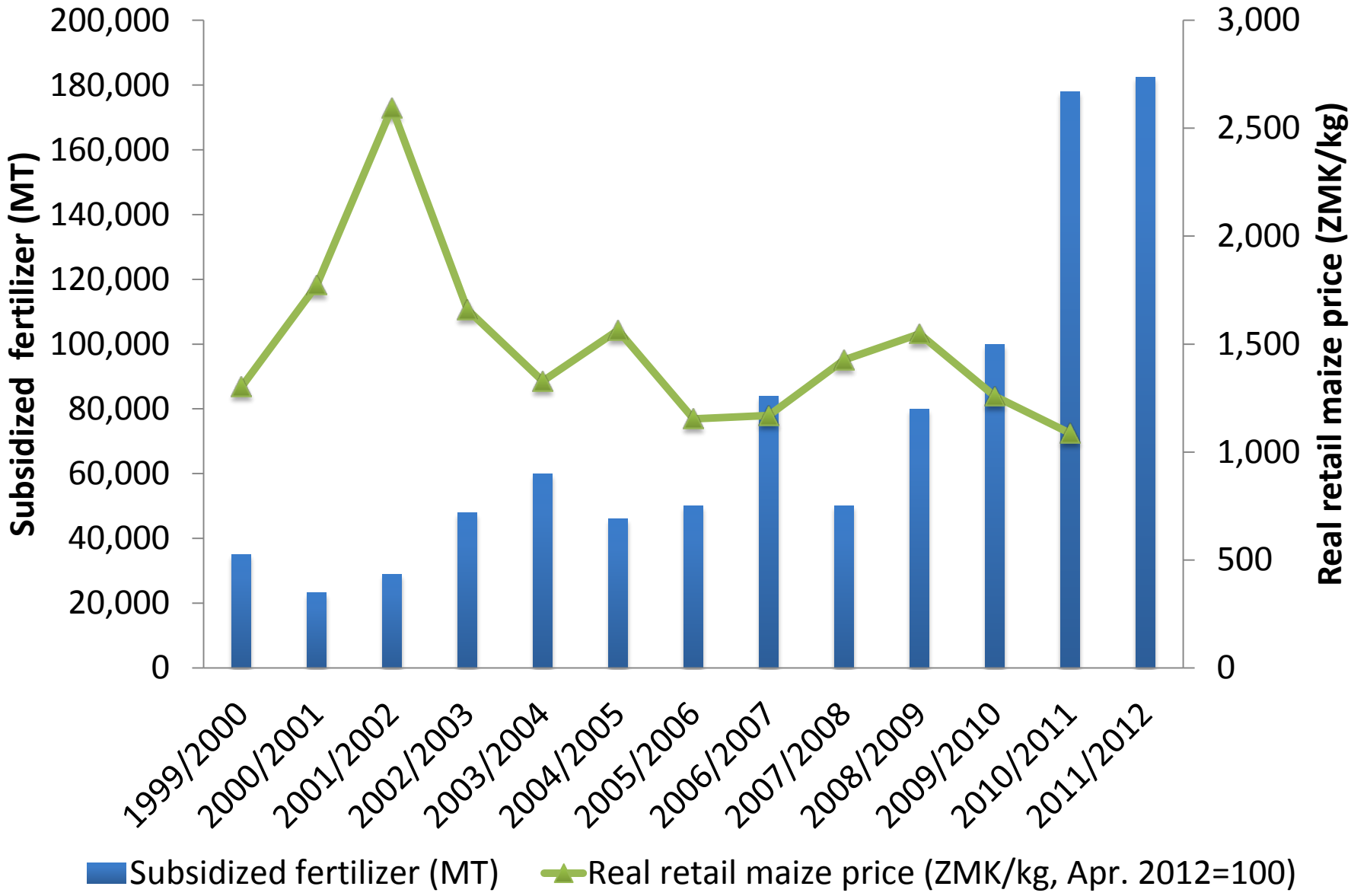
Subsidized fertilizer by year - Zambia



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?

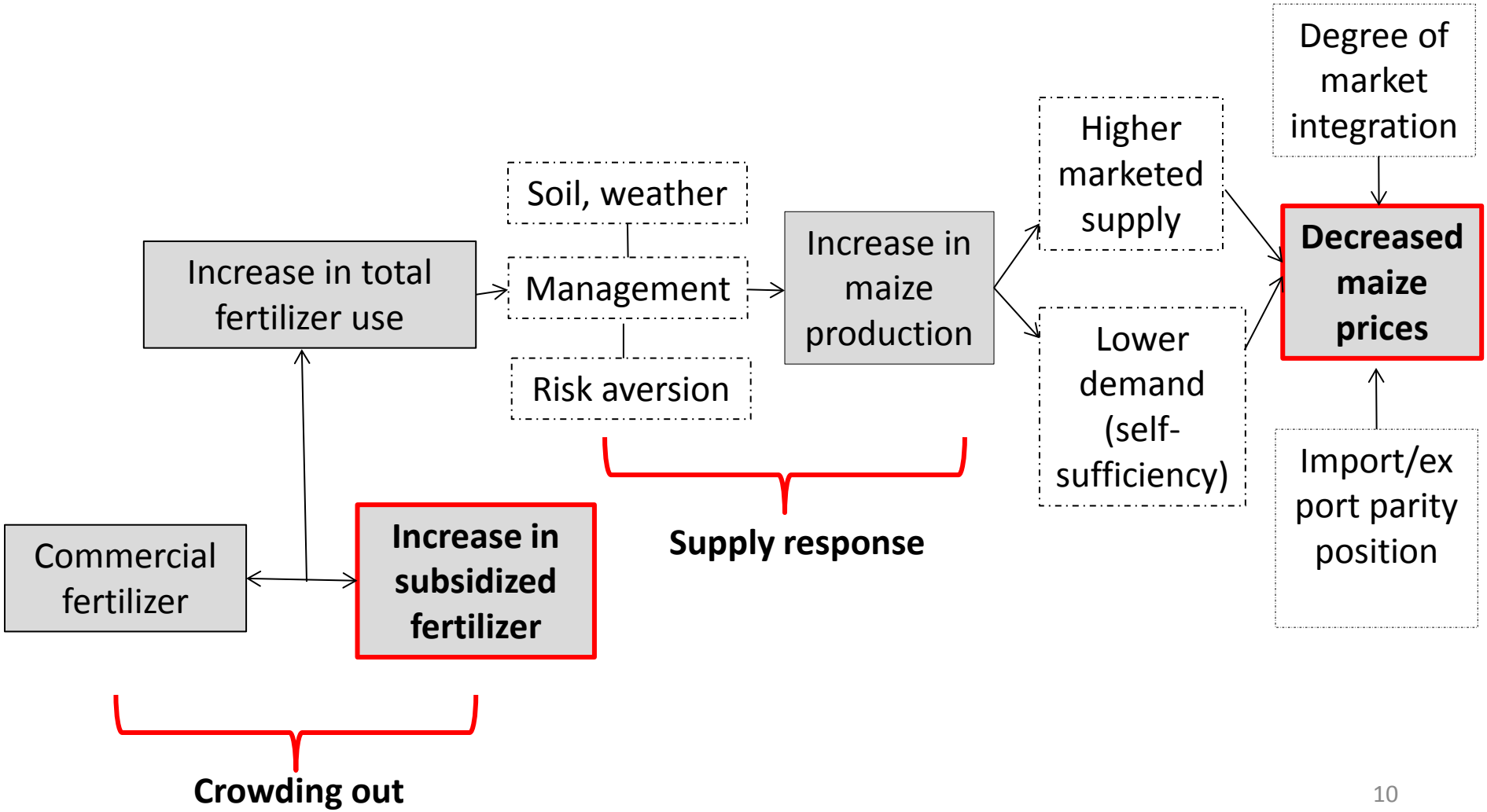
- Very little empirical evidence to date

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
  - Goletti & Babu 1994; Chriwa 1999; Tostau & Brorsen 2005; Loy & Wichern 2000; Awudu 2007; Myers 2008; Burke 2012; Myers & Jayne 2012
- Malawi at import parity during most of study period

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

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

Variable	Data	Source
Retail maize prices	Monthly, 72 markets in 26 districts	Min. of Ag. & Food Security
Subsidized fertilizer MT	Annual district allocation	Logistics Unit Reports

Zambia

Variable	Data	Source
Retail maize prices	Monthly, 50 districts	Central Statistical Office
Subsidized fertilizer MT	Annual district allocation	Min. of Ag. & Livestock

Price data run from 2000-2011 in Malawi, and 1999-2012 in Zambia.

Empirical model

$$p^r_{i,t} = \psi + \alpha FISP_{i,t} + \sum_{j=0}^{J} \gamma_j p^r_{i,t-j} + \boldsymbol{X}_{i,t}\boldsymbol{\beta} + \boldsymbol{Z}_t\boldsymbol{\theta} + c_i + u_{i,t}$$

Retail maize price in market/district *i* at time *t*

Qty of subsidized fertilizer allocated to the district

Lagged retail maize price

District-level S/D/MM shifters

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

Variables included in X and Z

District-level variables (X)	Country
Real retail rice prices	Malawi & Zambia
Real retail bread prices	Malawi & Zambia
Marketing board purchases	Zambia
Growing season rainfall	Malawi & Zambia
Rainfall stress (dry spells)	Malawi & Zambia
District dummies	Malawi & Zambia
Diesel prices	Zambia

National-level variables (Z)	Country
Diesel prices	Malawi
Commercial interest rate	Zambia
Electricity prices	Zambia
Zambia border maize prices	Malawi
Malawi border maize prices	Zambia
Northern Mozambique maize prices	Malawi
South African Futures Exchange (SAFEX) maize prices	Malawi & Zambia

Also include: year dummies, lean season dummy, year dummies * lean season dummy, & a linear time trend

Estimation strategy

$$\Delta p_{i,t}^{r} = \alpha \Delta FISP_{i,t} + \sum_{j=0}^{J} \gamma_j \Delta p_{i,t-j}^{r} + \Delta \boldsymbol{X}_{i,t} \boldsymbol{\beta} + \Delta \boldsymbol{Z}_t \boldsymbol{\theta} + \Delta u_{i,t}$$

- **First-difference (FD)** estimation removes c_i (omit LDV)
- **Arellano-Bond (AB)** to estimate dynamic panel data model (with LDV)

- 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

Results - Malawi

Factors affecting log real retail maize prices at the market level

	Sparse Model		Full Model	
Explanatory Variables	**A) FD**	**B) AB**	**C) FD**	**D) AB**
Subsidized fertilizer ('000 MT)	-0.003*	-0.003*	-0.004**	-0.003*
Rainfall variables	Yes	Yes	Yes	Yes
Other controls	No	No	Yes	Yes
Lagged maize prices?	No	Yes	No	Yes
Time dummies & time trend?	Yes	Yes	Yes	Yes
Long-run effect of subsidized fertilizer	N/A	-0.004	N/A	-0.004*
Observations	1,112	969	1,020	969
Overall model F-test for FD, Wald test for AB	2,616***	26,668***	2,246***	36,500***
R-squared	0.80	N/A	0.82	N/A

*, **, ***, 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

	Sparse Model		Full Model	
Explanatory Variables	**A) FD**	**B) AB**	**C) FD**	**D) AB**
Subsidized fertilizer ('000 MT)	-0.028**	-0.020***	-0.023**	-0.005
Rainfall variables	Yes	Yes	Yes	Yes
Other controls	No	No	Yes	Yes
Lagged maize prices?	No	Yes	No	Yes
Time dummies & time trend?	Yes	Yes	Yes	Yes
Long-run effect of subsidized fertilizer	N/A	-0.030***	N/A	-0.007
Observations	1,145	745	1,145	745
Overall model F-test for FD, Wald test for AB	448***	20,697***	478***	31,368***
R-squared	0.80	N/A	0.80	N/A

*, **, ***, 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

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

- Subsidized fertilizer - small negative effect on prices

- 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

Conclusions (continued)

- 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!

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Questions/Comments are appreciated

Potential reasons for high maize prices in Malawi when subsidy was scaled up (Dorward, Chirwa & Jayne 2010)

1) National maize production estimates overstated.
2) Increased exports by Malawian government (2008), and purchases for strategic grain reserve.
3) Increased household income
   - NSO 2012, rural poverty rates constant
4) Increased storage loss resulting from increased use of hybrid maize.
5) Rising world food prices, and Malawi remaining at import parity relative to neighboring countries.

   - Malawi imported from Mozambique in most months

Estimation strategy

$$\Delta p^{r}_{i,t} = \alpha \Delta FISP_{i,t} + \sum_{j=0}^{J} \gamma_j \Delta p^{r}_{i,t-j} + \Delta \boldsymbol{X}_{i,t} \boldsymbol{\beta} + \Delta \boldsymbol{Z}_t \boldsymbol{\theta} + \Delta u_{i,t}$$

- FD removes c_i from model
- $\Delta p^{r}_{i,t-1}$ correlated with $\Delta u_{i,t}$ since $\Delta p^{r}_{i,t-1}$ depends on $u_{i,t-1}$
- Use $p^{r}_{i,t-j}$ for $j \geq 2$ as instrumental variables for $\Delta p^{r}_{i,t-1}$
- This is the Arellano-Bond Estimator, for dynamic panel models (Arellano and Bond 1991)
- Include enough lags of $p^{r}_{i,t}$ as necessary to remove serial correlation.
  - 3 lags for Malawi; 8 lags for Zambia

How large are these price effects?

- In Malawi between 1999 – 2011, average district received 4,373 MT of fertilizer
  - Roughly doubling program size in **every** district reduces maize price by 1.2% to 1.6% on average
- In Zambia between 1999 – 2012, average district received 1,108 MT of fertilizer
  - Roughly doubling program size in **every** district reduces maize price by 2.0% to 2.8% on average
- Statistically significant but small-in-magnitude price reduction