General equilibrium effects of input subsidy programs on maize prices: Evidence from Malawi and Zambia.

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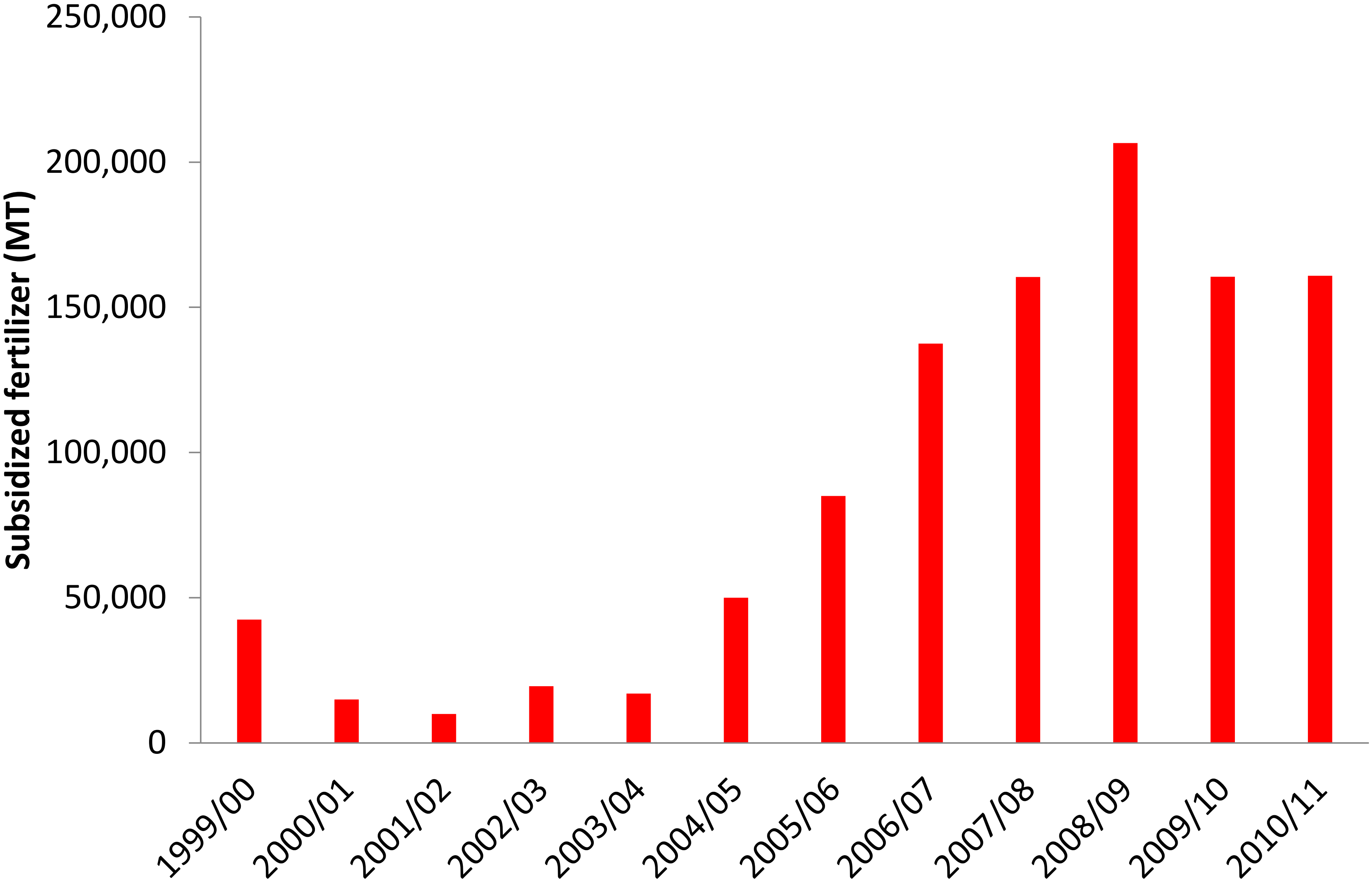
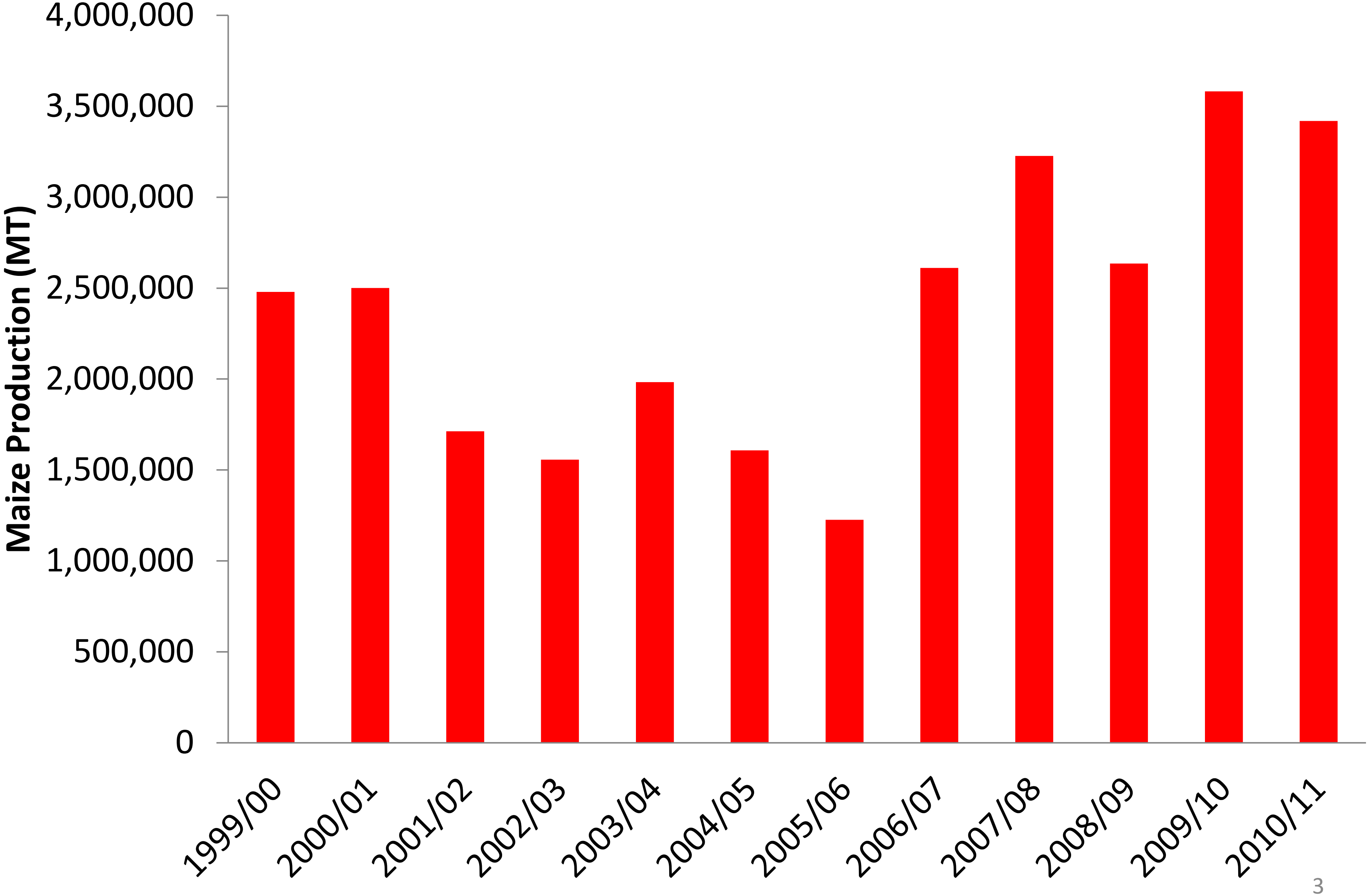
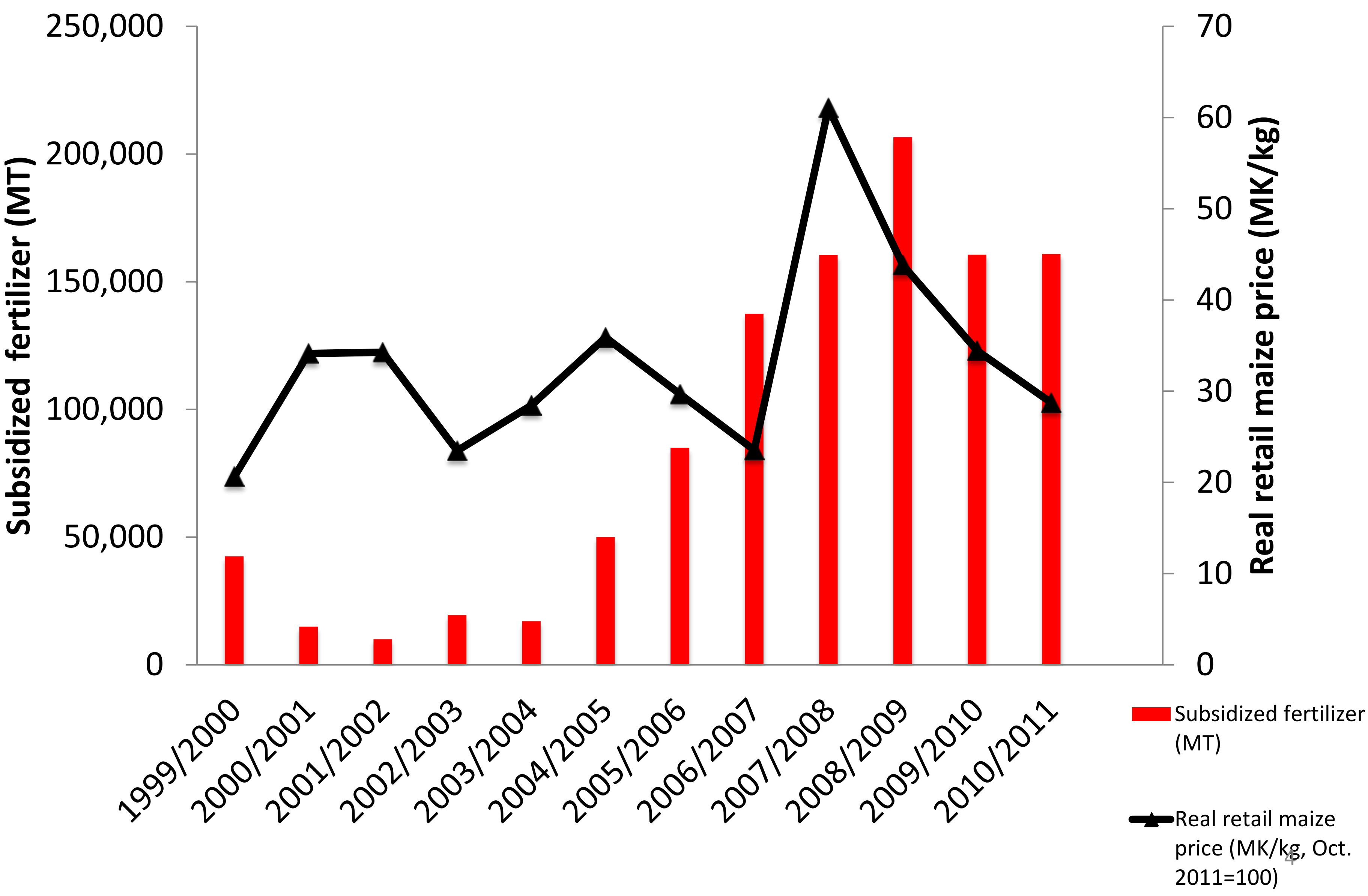
Subsidized fertilizer by year - Malawi



Official maize production by year – Malawi



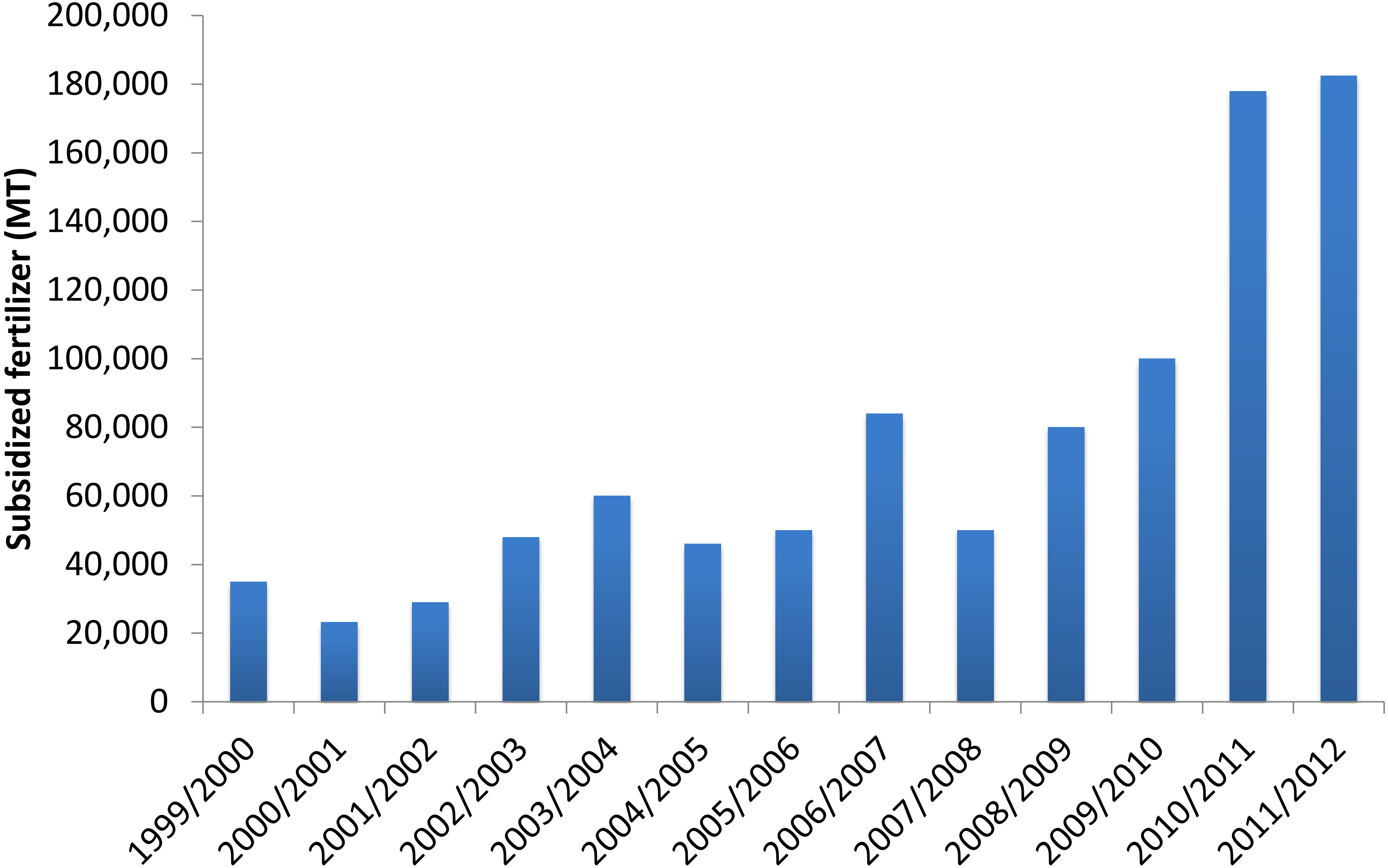
Subsidized fertilizer & real retail maize prices (harvest season) - Malawi



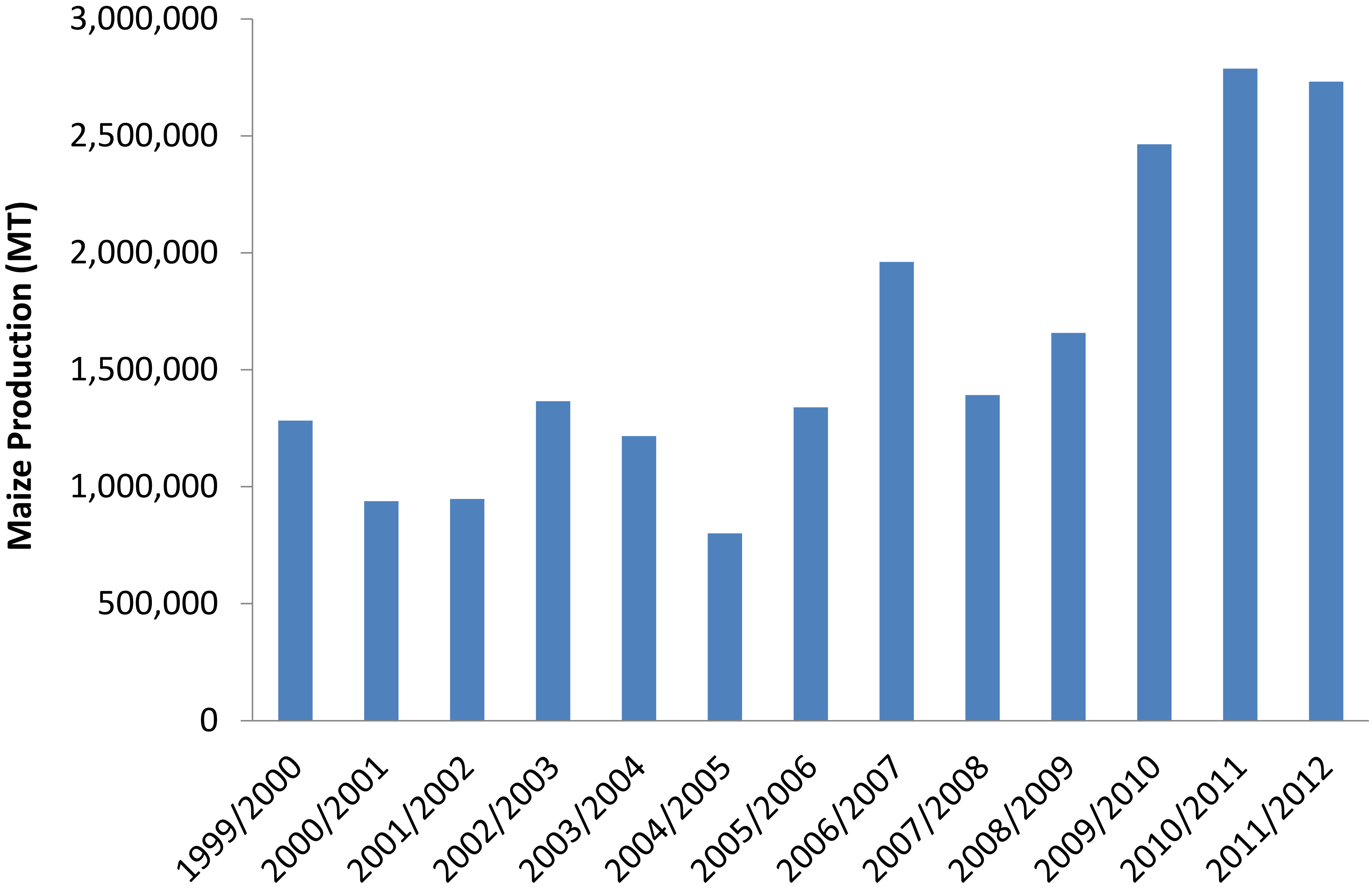
Potential reasons for high maize prices in Malawi when subsidy was scaled up (Dorward, Chirwa & Jayne 2010)

1) National maize production estimates overstated.
2) Increased exports by Malawian government, 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

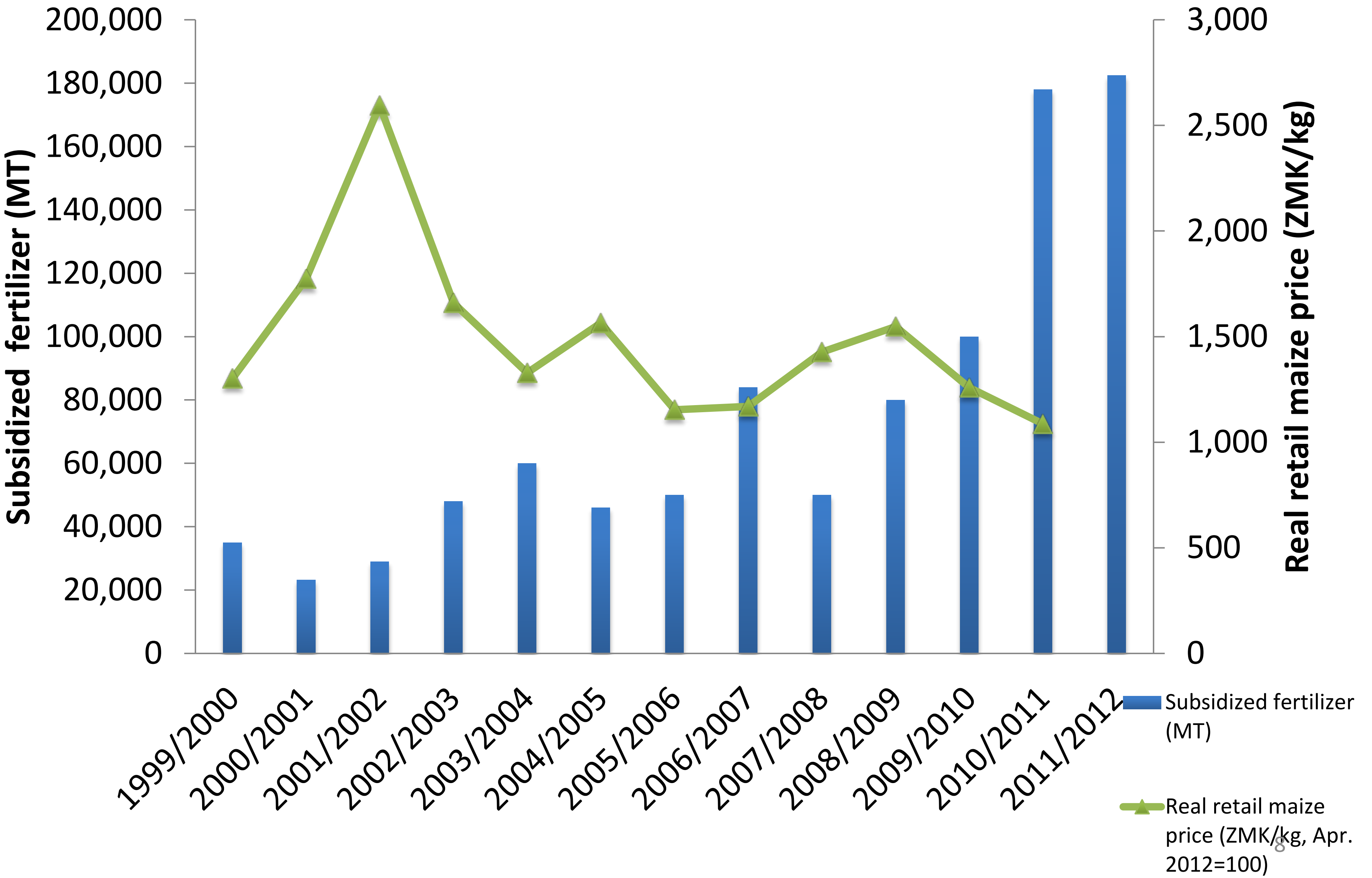
Subsidized fertilizer by year - Zambia



Official maize production by year – Zambia



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



Research Question/Testable Hypothesis

- How does an increase in subsidized fertilizer distributed to a district affect maize prices in that district?

- To our knowledge this has yet to be empirically estimated.

Why does the impact of subsidized fertilizer on maize prices matter?

- Huge public expenditure on subsidized fertilizer.
  - 7 countries spending US $2 billion in 2012 (Ricker-Gilbert et al. 2013)
- States goals are to increase fertilizer use, boost staple crop production, improve food security, & reduce poverty.
- Urban consumers and majority of rural poor are net buyers of maize.

Ability of subsidy programs to lower maize prices could have positive welfare implications for millions of HH in sub-Saharan Africa

Data

Malawi

Variable	Data	Source
Maize prices	Weekly retail: 72 markets in 26 districts	Min of Ag. & Food Security
Subsidized fertilizer MT	Annual district allocation	Logistics Unit Reports

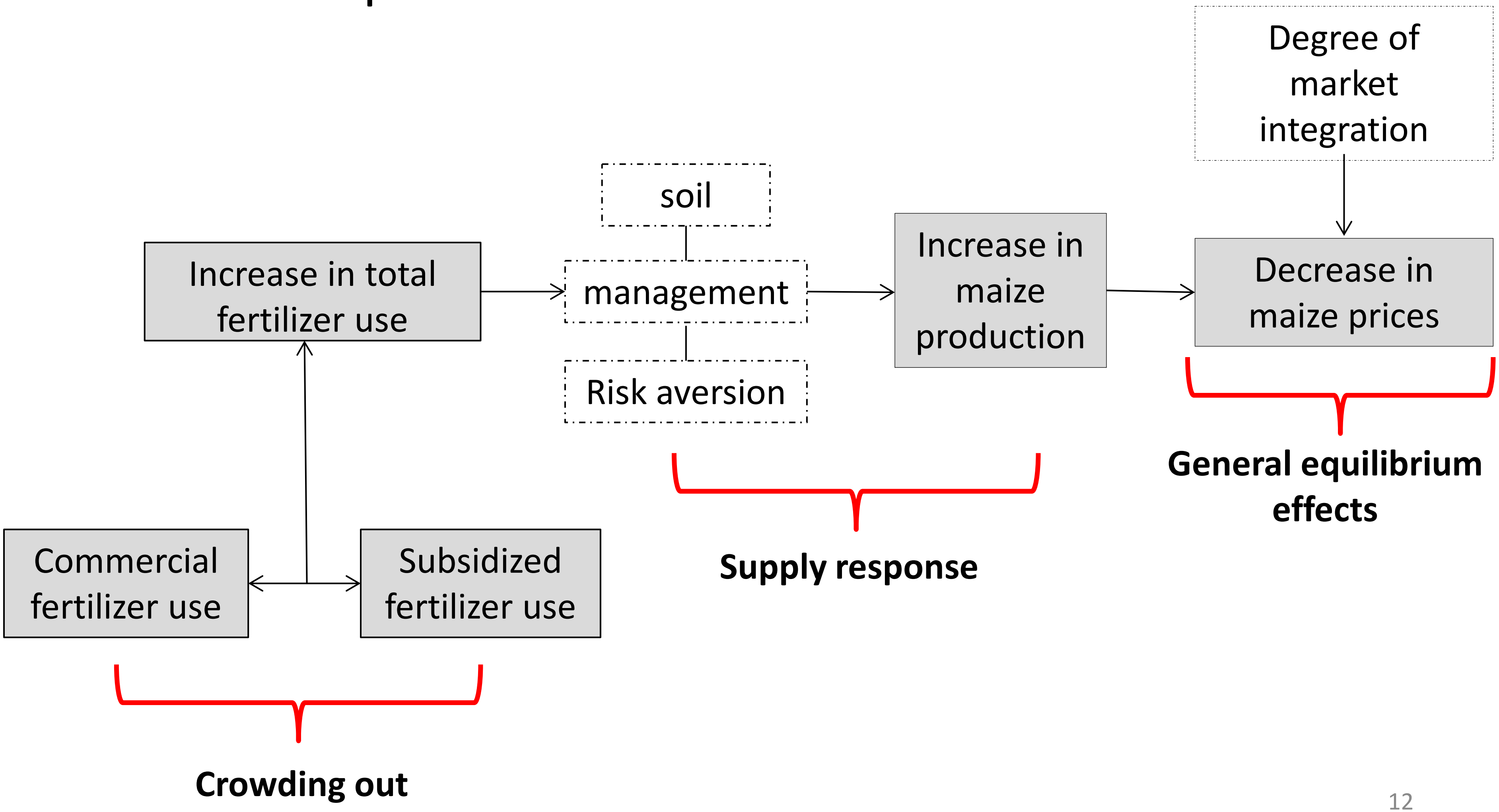
Zambia

Variable	Data	Source
Maize prices	Weekly retail: 50 districts	Central Statistics Office
Subsidized fertilizer MT	Annual district allocation	Min of Ag & Coops

Data run from 1999-2011 in Malawi, and 1999-2012 in Zambia.

Conceptual Framework

Framework for understanding how subsidy program may affect maize prices.



Previous Literature in Malawi and Zambia

- HH-level data shows that subsidized fertilizer crowds out commercial fertilizer in both countries.
  - (Jayne et al. this issue)
- HH level data suggest that production increases are positive but modest.
  - Malawi (Holden and Lunduka 2010, Ricker-Gilbert and Jayne 2011, Shively et al. 2012)
  - Zambia (Mason & Jayne Forthcoming).
- Previous literature shows markets in region reasonably well-integrated.
  - (Goletti and Babu 1994; Chriwa 1999; Tostau and Brorsen 2005, Loy and Wichern 2000, Awudu 2007, Myers 2008, Burke 2012, Myers and Jayne 2012).

Producer and Consumer Response to Subsidy

1) Maize output supply

$Q^s = Q^S(p^{f*}, \; FISP, \boldsymbol{z^s})$

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

2) Retail maize demand

$Q^d = Q^d(p^r, \boldsymbol{z^d})$

- Q^d, maize qty demanded
- p^r, retail maize price
- $\boldsymbol{z^d}$, vector of demand shifters

3) Retail maize price

$p^r = p^f + M(\boldsymbol{z^m})$

- p^f realized producer prices
- $\boldsymbol{z^m}$, vector of factors affecting marketing margins

4) Market clearing condition

- $Q_t{}^d = Q_t{}^s$

5) retail price equation

- $p^r = p^r\left(p^{f*}, FISP, \boldsymbol{z^s}, \boldsymbol{z^d}, \boldsymbol{z^m}\right)$

Empirical Specification

Retail maize price for district i in season t:

$$p^{r}_{i,t} = \Psi + \alpha FISP_{i,t} + \sum_{j=0}^{J} \Upsilon_j \, p^{r}_{i,t-j} + \mathbf{X}_{i,t}\boldsymbol{\beta} + \mathbf{Z}_{t}\boldsymbol{\theta} + c_i + \mu_{i,t}$$

- $\alpha FISP_{i,t}$: Qty of Subsidized fertilizer
- $\sum_{j=0}^{J} \Upsilon_j \, p^{r}_{i,t-j}$: Lagged maize price
- $\mathbf{X}_{i,t}$: District-level factors
- $\mathbf{Z}_{t}$: National-level factors

c_i = time-constant errors

$\mu_{i,t}$ = time-varying errors

H_0: $\hat{\alpha} = 0$; test if subsidized fertilizer affects maize prices

$$\frac{\hat{\alpha}}{1 - \sum_{j=1}^{J} \hat{\gamma}_j}$$ = long-run impact of subsidized fertilizer on maize prices

Estimate model via First-Difference

$$\Delta p^r_{i,t} = \Psi + \alpha \Delta FISP_{i,t} + \sum_{j=0}^{J} \Upsilon_j \Delta p^r_{i,t-j} + \mathbf{\Delta X_{i,t} \beta} + \mathbf{\Delta Z_t \theta} + \Delta \mu_{i,t}$$

- FD estimation removes c_i from model
- $\Delta p^r_{i,t-j}$ correlated with $\Delta\mu_{i,t}$ since $\Delta p^r_{i,t-1}$ depends on $\mu_{i,t-1}$
- Use $\Delta p^r_{i,t-j}$ for $j \geq 2$ as instrumental variable for $\Delta p^r_{i,t-j}$
- This is the Arellano-Bond Estimator (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
- Estimate separate models for Malawi and Zambia.
- 2 observations per market, per year, (harvest and lean)

Variables included in X and Z

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

National-level variables (Z)	Country
Diesel prices	Malawi
Lending rate	Zambia
Electricity rate	Zambia
Zambia border prices	Malawi
Malawi border prices	Zambia
South Africa Commodity Exchange (SAFEX) maize prices	Malawi & Zambia

We also include, year dummies, lean season dummy, and a linear time trend

Results - Malawi

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

Explanatory Variables	Sparse Model A) FD	Sparse Model B) AB	Full Model C) FD	Full Model C) 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
Marketing year dummies?	Yes	Yes	Yes	Yes
Time period dummies?	Yes	Yes	Yes	Yes
Long-run effect of subsidized fertilizer	N/A	-0.004	N/A	-0.003
Observations	1,112	969	1,070	969
Overall model F-test for FD, Wald test for AB	2,615***	26,875***	1,992***	27,680***
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 of real retail maize prices at the district level

Explanatory Variables	Sparse Model A) FD	Sparse Model B) AB	Full Model C) FD	Full Model C) AB
Subsidized fertilizer ('000 MT)	-0.024**	-0.019***	-0.0184*	-0.005
Rainfall variables	Yes	Yes	Yes	Yes
Other controls	No	No	Yes	Yes
Lagged maize prices?	No	Yes	No	Yes
Marketing year dummies?	Yes	Yes	Yes	Yes
Time period dummies?	Yes	Yes	Yes	Yes
Long-run effect of subsidized fertilizer	N/A	-0.024***	N/A	-0.006
Observations	1,145	745	1,1145	745
Overall model F-test for FD, Wald test for AB	491***	17,381***	573***	29,562***
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

Conclusions

- In Malawi between 1999 – 2011, average district received 4,373 MT of fertilizer
  - Doubling program 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 reduces maize price by 1.8% to 2.4% on average
- Results robust to different specifications
  - real prices, level-level
  - nominal prices, log-log
  - nominal prices, level-level

Conclusions continued

- Findings are consistent with household-level data showing small increases in maize production from subsidy.
  – Malawi and Zambia at import parity. Local production increases likely just off-set imports. No effect on local prices
- Consistent with government reports that rural poverty rates have not dropped in Malawi or Zambia over the past 10 years.
- Even small decreases in maize price can help poor.
  - but if these economies are reasonably well integrated into regional markets, should not expect to see large changes in maize price.

Thank you for your time!

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Questions/Comments are appreciated