# The Macroeconomic Impact of Agricultural Input Subsidies

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# Agricultural productivity in developing countries

**Motivation:**

- Agriculture is at the heart of government policy:
  - reliable supply of food is important
  - e.g. over half of EU budget spent on subsidies and development of agriculture.
- Differences in agricultural productivity could explain differences in economic development.
- 1960s, rapid industrialization in Asia was led by a "Green Revolution".
- 2003 Maputo Declaration: SSA's attempt at catching-up.
- Implementation of Input Subsidy Programs (ISPs) primarily targeting staples production:
  - (+) improve food security, redistribute resources to poor farmers, relax credit constraints.
  - (−) may divert resources from exportable cash crops, slow down structural change

**Goal:**

- Evaluate the macroeconomic impact and associated trade-offs of ISPs.

# This project

**Quantitative evaluation of the input subsidy policy:**

- Standard DSGE model: heterogeneous households, productivity shocks, occupation choice
- Frictions: incomplete markets, working capital constraint, *transaction costs in food sector*
- Analysis of macro and micro effects of FISP, consideration of alternative use of public funds.
- Empirical evidence supporting the model from Malawi

**Preview of results:**

- Misallocation losses dominate redistribution gains and welfare is lower
- ISP is too generous, cutting it down by 50% equates the gains and losses
- Transaction cost is key, an infrastructural investment program is superior to ISP

# Malawi is a great opportunity to evaluate Input Subsidy Programs

▸ Data details

- Country with largest ISP in SSA, costs 3-6% GDP annually, 85% financed by Malawi govt.
- Poor and developing: $367 per capita GDP, 47% of children stunted, 80% pop in rural areas.
- Large gap between at-farm-gate and in-shop food prices (transaction costs):


**Figure 1:** Constructed using Living Standards Measurement Survey (LSMS) 2010-2013 panel.

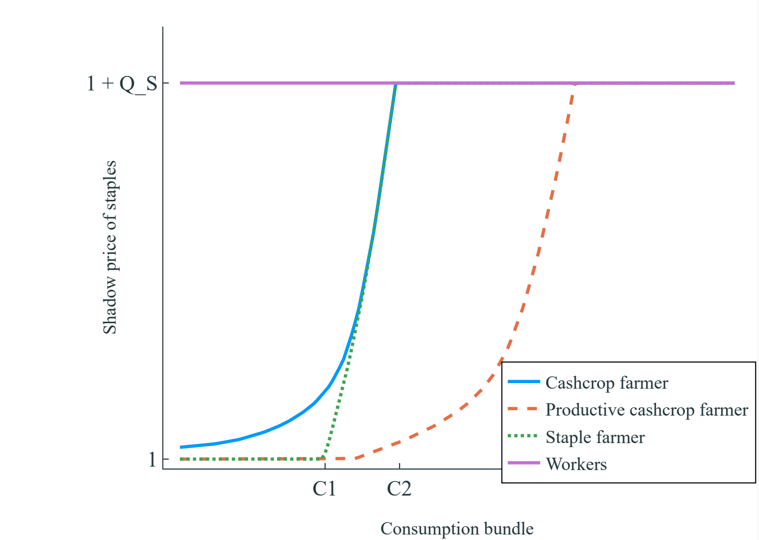
# Related strands of literature

1. Micro studies of the Malawian FISP experience:
   [Chirwa and Dorward, 2013], [Jayne et al., 2018], [Chibwana et al., 2014]
    - We complement micro-evaluations with a macro-evaluation in a DSGE setting.
2. Evaluations of ISPs in other countries:
   [Garg and Saxena, 2022] (India), [Diop, 2023] (Zambia), [Bergquist et al., 2022] (Uganda)
    - We account for both the redistributional and efficiency impact of FISP in a GE setting with externalities arising due to incomplete markets.
3. Role of transaction costs in agriculture.
   [Omamo, 1998], [Arslan, 2011], [Gollin and Rogerson, 2014]
    - We introduce transaction costs into a workhorse macroeconomic model with financial frictions.

# DSGE Aiyagari-like model w/ hetero agents and frictions ‣ HH problem

- Households are subject to idiosyncratic **agricultural-** and **labor-productivity shocks**.
- Decide about **consumption, wealth accumulation, occupation, agr production**.
- **Occupational choice** with frictional reallocations due to entry/maintenance costs:
  - **urban:** wage income from representative manufacturing firm with Cobb Douglas technology,
  - (two) **rural:** individual farms producing (i) staple- or (ii) cash-crops,
  - all goods consumed; cash-crop also **exported according to a demand function**.
- **Food security** - creating room for policy:
  - **Subsistence food constraint:** Stone Geary utility in staples
  - **Transaction costs:** 1 unit of staples *purchased on the market* requires $1 + Q_S$ transported
  - $\Rightarrow$ Profit maximization is not always optimal, HHs minimize expenditures.
- **Financial frictions** represented by a working capital constraint
- **Government** running the ISP financed from either foreign aid or labor taxation.
- **General equilibrium** via prices of staples, cash crops, manuf. & labor (fixed interest rate).

# Key feature: consumption choice implications for shadow price of food



# Calibration to Malawi in 2010: targeted moments

▸ Calibration strategy

| Parameter | Value | Target/Source | Data | Model |
|---|---|---|---|---|
| Labor augmenting TFP in manuf $A_W$ | 2.85 | 20% urban population [LSMS2010] | 20% | 20% |
| Cash crop export demand shifter $a_D$ | 0.86 | Share of 2010 exported cash crops in total prod. of cash crops [FAO 2010] | 73% | 76% |
| Subsidy rate for staple inputs $\tau_S$ | 81% | Aggregate cost of program (% GDP) [Chirwa and Dorward, 2013] | 3% | 3% |
| Urban entry cost $F_M$ | 285 | Rural-urban migration rate [Bick et al., 2022] | 1% | 1% |
| Cash crop maintenance cost $FM_B$ | 2.2 | Share of rural pop. cultivating only staples [LSMS2010] | 50% | 61% |
| Working capital constraint $\kappa$ | 10% | Share of cash crop farmers with suboptimal inputs [Brune et al., 2016] | 70% | 67% |
| Returns to scale in land for farming $\rho$ | 0.74 | Aggregate cashcrop to staple fertilizer expenditure ratio [FAO 2010] | 2.6 | 2.4 |
| Correlation of urban/rural shocks $\rho_{RU}$ | 0.24 | Agricultural productivity gap [Gollin et al., 2014] | 6.5 | 6.7 |

# Calibration: Non targeted moments

| Moment / Source | Data | Model |
|---|---|---|
| Agriculture output share in GDP [WB 2010] | 30% | 30% |
| Production value improvement to cash grant [Daidone et al., 2019] | 11% | 3% |
| Share of land devoted to staples among cash crop farmers [LSMS2010] | 30% | 18% |
| Standard deviation of average product of fertilizer [LSMS2010] | 0.76 | 1.3 |
| **Inequality measures from [De Magalhaes and Santaeulalia-Llopis, 2018]:** | | |
| Urban-rural wealth ratio | 3.0 | 2.0 |
| Urban-rural income ratio | 2.4 | 4.7 |
| Urban-rural consumption ratio | 2.2 | 2.7 |
| Share of wealth of the top 10% | 58% | 35% |
| Share of income of the top 10% | 48% | 61% |
| Share of consumption of the top 10% | 34% | 33% |
| Share of wealth of the top 1% | 25% | 7% |
| Share of income of the top 1% | 18% | 13% |
| Share of consumption of the top 1% | 8% | 6% |

# The macroeconomic impact of FISP in Malawi

| | No FISP | FISP aid-financed | FISP tax-financed $\tau_W = 19\%$ |
|---|---|---|---|
| Consumption equivalent welfare | - | -2.5% | -8.4% |
| Prices: $p_B/p_M/w$ | 1.2/0.2/0.1 | $+27\%/+39\%/+73\%$ | $+28\%/+49\%/+63\%$ |
| Share of staple-only farmers | 59% | +5% | +3% |
| Staple production | 0.3 | +43% | +37% |
| Staple productivity | 0.6 | +34% | +28% |
| Cash crop production | 0.9 | -2% | +1% |
| Cash crop productivity | 3.6 | +3% | +1% |
| Manufacturing production | 9% | +9% | +1% |
| Urbanization rate | 24% | -8% | -15% |
| Agricultural productivity gap | 3.8 | +61% | +75% |
| Avg urban-rural consumption rate | 1.9 | 2.8 | 2.7 |
| Dispersion in ARPX | 0.83 | +92% | +104% |
| Consumption | 3.8 | +10% | -1% |
| Transaction cost | 0.3 | +13% | +3% |
| Current account surplus % of GDP | 8% | -1% | 0% |

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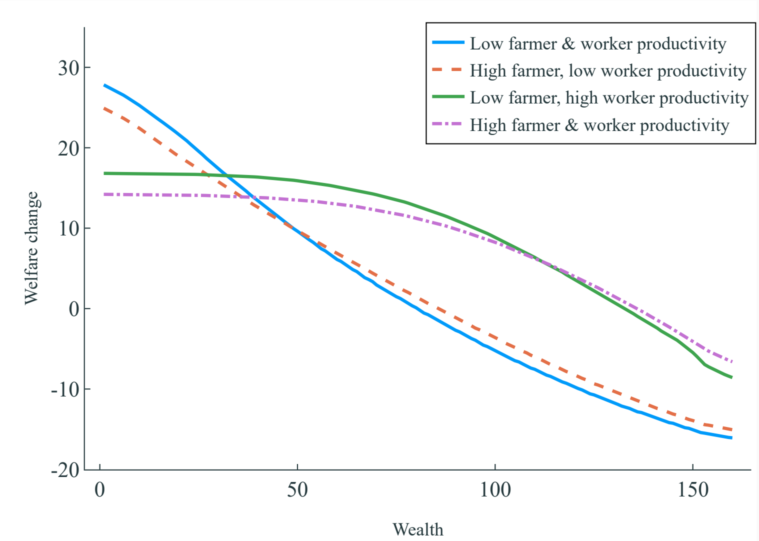
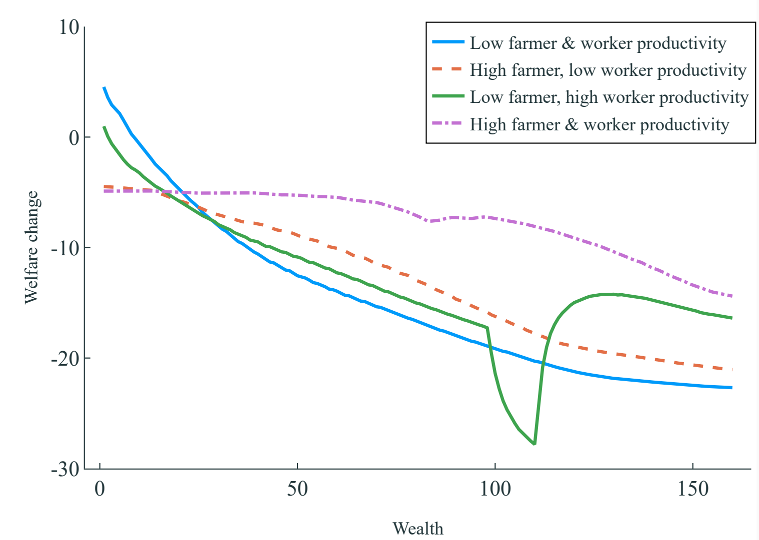
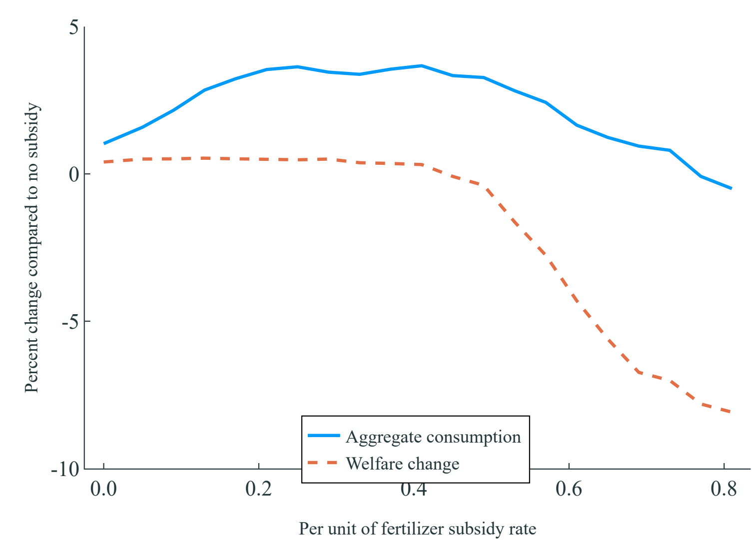
# Asset-poor workers gain the most from FISP



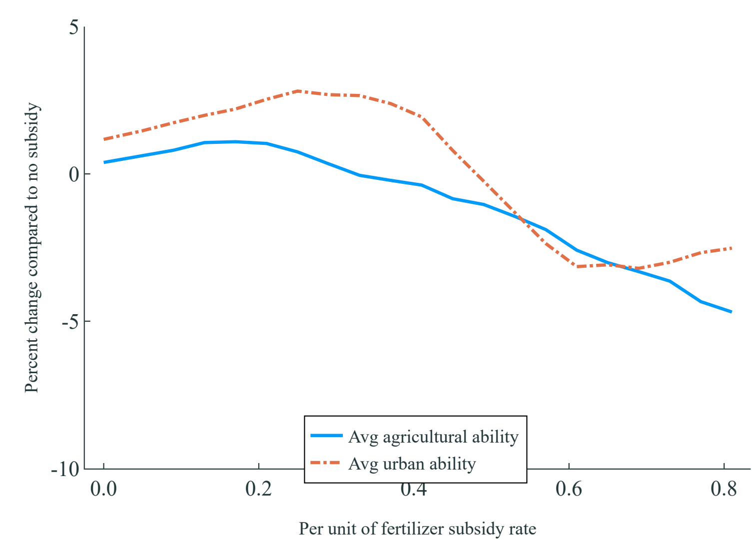
# Wealthy farmers lose the most from FISP



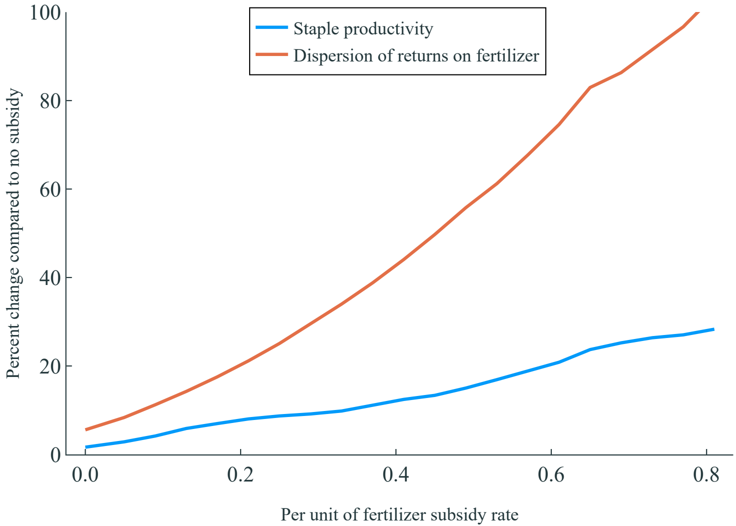
# Smaller programs can be at least welfare neutral



# Selection of types initially improves



# Gains in staple productivity hurt by misallocation of fertilizer



# Conclusion

We evaluate large-scale agricultural input subsidy programs focusing on Malawi:

- The current program results in welfare losses, despite the help it provides to poor households
- Quantitatively possible to have welfare-neutral ISP, even with full government financing.

What else we have done:

- Decompose the contribution of each friction to loss/ gains of ISP - transaction cost is key
- An infrastructure investment of funds may generate higher welfare gains
- Country panel DiD to test the macro implications of the model

What we are working on now:

- Transition path - misallocation and price effects tend to be long-run relative to redistribution
- Using local variation in the Malawi data to test the micro implications of the model

# Thank you!

Any feedback will be highly appreciated: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- ltetenyi@bportugal.pt

# Data employed

## Cross-country panel from FAOStat (1961-2020):

| Variable | Control group | Treatment group |
|---|---|---|
| Number of countries | 36 | 10 |
| Log yields of staples | 9.18 | 9.32 |
| Log yields of cash crops | 10.07 | 9.97 |
| Share of population stunting | 33.56% | 36.20% |
| Share of rural population | 69% | 75% |

## Cross-sectional LSMS data from Malawi 2010:

| Variable | Average |
|---|---|
| Number of households | 12,015 |
| Household size in rural/urban areas | 4.59/4.46 |
| Cons. in rural/urban areas | 1,318/2,951 |
| Income in rural/urban areas | 1,142/2,795 |
| Wealth in rural/urban areas | 1,309/3,976 |
| % of population in rural areas | 82% |
| Size of total household land | 1.97 |
| % of HHs cultivating only maize | 41% |
| % of staple harvest self-consumed | 84% |

# Macro diff-in-diff on FAOStat data

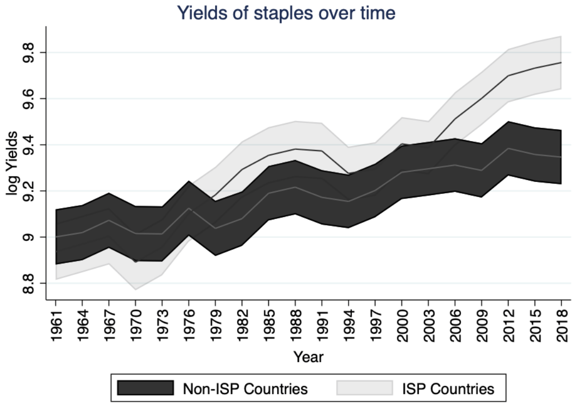
Other findings:

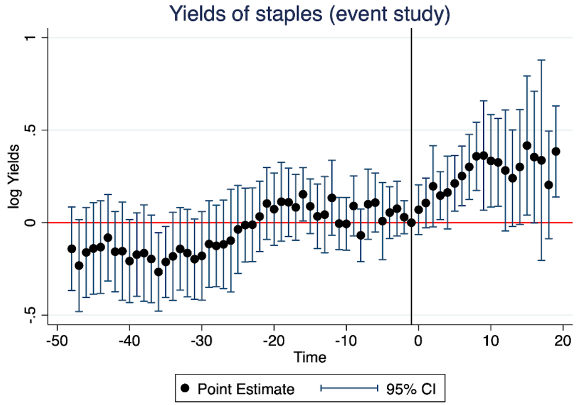
- improve food security;
- relative price of cash crops (to staples) increase;
- ... and so does the land share of cash-crop production;
- increase urbanization.

▸ more

# Macro diff-in-diff on FAOStat data: staple productivity

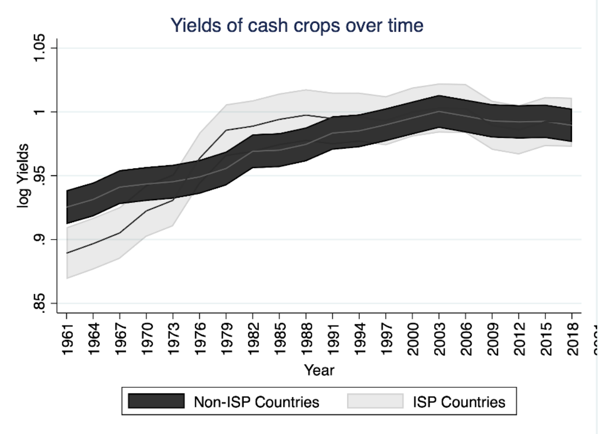
Yields of staples increase by 323 kg per ha. ▸ Regression

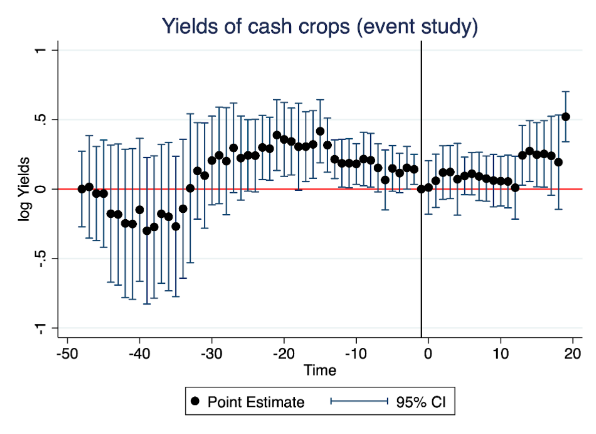


# Macro diff-in-diff on FAOStat data: cash crop productivity

Yields of cash crops are not affected. ▸ Regression



# Macro diff-in-diff on FAOStat data: regression evidence

**Regression:** $Outcome_{i,t} = \alpha + \beta ISPCountry_i \times ISPIntroduction_{i,t} + \gamma_i + \gamma_t + \epsilon_{i,t}$ Back

- ISPs increase staple yields by 323kg per ha.
- ISPs decrease cash crop yields by 46kg per ha (not-sign.).
- ISPs decrease share of land devoted to staples by 9%.
- ISPs increase ratio of "cash crop to staple" prices by 20%.
- ISPs decrease share of stunted children by 11 %.
- ISPs increase urbanization rate by 10 %.

| | log Staple yields | log Cash Crop yields | Share of land with staples | log Relative prices | Stunting | Urbanization rate |
|---|---|---|---|---|---|---|
| ISP-treatment | 0.26*** | -0.03 | -0.06*** | 0.20*** | -3.67*** | -4.07*** |
| | (0.04) | (0.04) | (0.01) | (0.03) | (0.37) | (0.58) |
| Time FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.17 | 0.33 | 0.09 | 0.16 | 0.74 | 0.48 |
| N | 2490 | 2490 | 2490 | 2490 | 900 | 1421 |

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## Appendix: cross-sectional evidence from Malawi

Being a HH devoting 10 p.p. (18%) less of land to maize:

- increases the *value* by 5%
- 2.4 kg less of fertilizer used
- 24 p.p. lower share of self consumed crops

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | $share\ maize_i$ | $\log(value_i)$ | $fertilizer_i$ | $\%self\ consumed_i$ |
| $FISP\ recipient_i$ | -0.06*** | 0.08*** | 70.96*** | -4.05*** |
| $share\ maize_i$ | | -0.52*** | 24.27** | 24.30*** |
| Controls&Village FEs | Yes | Yes | Yes | Yes |
| $R^2$ | 0.34 | 0.34 | 0.16 | 0.35 |
| N | 8,544 | 8,544 | 8,544 | 8,544 |

*Note:* Value is in per capita & per land area unit terms. Controls include household head's sex, age, marital status, religion, language, education, household size, and land controls (avg soil quality, total area, total kgs of fertilizer used).

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| Controls&Village FEs | Yes | Yes | Yes | Yes |
| $R^2$ | 0.34 | 0.34 | 0.16 | 0.35 |
| N | 8,544 | 8,544 | 8,544 | 8,544 |

*Note:* Value is in per capita & per land area unit terms. Controls include household head's sex, age, marital status, religion, language, education, household size, and land controls (avg soil quality, total area, total kgs of fertilizer used).

Back

# Appendix: cross-sectional evidence from Malawi

Being a HH devoting 10 p.p. (18%) less of land to maize:

- increases the *value* by 5%
- 2.4 kg less of fertilizer used
- 24 p.p. lower share of self consumed crops

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | $share\ maize_i$ | $\log(value_i)$ | $fertilizer_i$ | $\%self\ consumed_i$ |
| $FISP\ recipient_i$ | -0.06*** | 0.08*** | 70.96*** | -4.05*** |
| $share\ maize_i$ | | -0.52*** | 24.27** | 24.30*** |
| Controls&Village FEs | Yes | Yes | Yes | Yes |
| $R^2$ | 0.34 | 0.34 | 0.16 | 0.35 |
| N | 8,544 | 8,544 | 8,544 | 8,544 |

*Note:* Value is in per capita & per land area unit terms. Controls include household head's sex, age, marital status, religion, language, education, household size, and land controls (avg soil quality, total area, total kgs of fertilizer used).

Back

# Calibration: preferences

Back to targeted moments

- Assume per period log utility over CES consumption aggregator $C$:

$$u(\mathbf{c}) = \log\left(\psi_S\left(c_S - \bar{c}_S\right)^{\frac{\epsilon-1}{\epsilon}} + c_B^{\frac{\epsilon-1}{\epsilon}} + \left(1-\psi_S-\psi_C\right)c_M^{\frac{\epsilon-1}{\epsilon}}\right)^{\frac{\epsilon-1}{\epsilon}}$$

- High discount rate $\beta = 0.85$ (as in Kaboski, Buera & Shin 2021).
- Long-run consumption expenditure shares taken from US data:
  - staples: $\psi_S = 12.4\%$ (food),
  - cash crops: $\psi_B = 7.6\%$ (beverages, tobacco etc),
  - manufacturing good: $\psi_M = 80\%$ (everything else).
- Elasticity of substitution $\epsilon = 0.95$
  - In line with Kaboski, Buera & Shin 2011 and Herrendorf, Rogerson & Valentinyi 2013.

# Calibration: agriculture production technology

- Revenue from agricultural production for a farmer with assets $a$ and current productivity $\theta^r$:
  - staple farmers: $\theta^r x_S^{\zeta_x}$ ($p_S \equiv 1$),
  - cash crop farmers: $\theta^r x_S^{\zeta_x}(1-l)^{\zeta_l} + p_B \theta^r x_B^{\zeta_x} l^{\zeta_l}$
  - financial constraint for choice of inputs $x$: $(1+\tau_S)\, p_x x_S + (1+\tau_B)\, p_x x_B \leq \kappa a$
    - $\Rightarrow$ **Comparative statics:** land allocated to cash crops declines in subsidy rate $\tau_S$,
    - ... but increases in relative price $\frac{p_B}{p_S}$!
- Cost share of intermediate inputs (feritlizer, seeds) $\zeta = 0.15$ (from aggregate data).
- Price of fertilizer/seeds $p_X = 1.26$ - taking farmers' optimality condition to FAO data.
- Severe financial friction: $\kappa = 0.1$
- Coefficient $\rho = 0.74$:
  - match ratio of cashcrop to staple expenditure in the data

# Calibration: idiosyncratic productivity shocks

- Again - revenue from agricultural production of farmers:
  - staple farmers: $\theta^r x_S^{\zeta_x}$ $(p_S \equiv 1)$,
  - cash crop farmers: $\theta^r x_S^{\zeta_x}(1-l)^{\zeta_l} + p_B \theta^r x_B^{\zeta_x} l^{\zeta_l}$
  - financial constraint for choice of inputs $x$: $(1+\tau_S)\, p_x x_S + (1+\tau_B)\, p_x x_B \leq \kappa a$
- Labor income in urban $= \theta^u w$, where $w = MPL$ of repr. CRS Cobb-Douglas manuf. firm.
- We estimate the persistence and variance of both processes using the urban and rural samples of LSMS Malawi panel waves of 2010 & 2013.
- We address selection bias using the two-step Heckman correction.
- Results:
  - rural shocks more persistent: $\rho^r = 0.57 > \rho^u = 0.49$
  - urban shocks more volatile: $\sigma^u = 0.94 > \sigma^r = 1.11$
- Allow for cross-correlation btw two shocks $\rho^{RU} = 0.24$ - set to match APG$\approx$ 4 Malawi.

# Calibration: frictions

- Financial frictions governed by $\kappa$ and the no borrowing constraint.
- Food security governed by:
  - subsistence level of consumption $\bar{c_S} = 0.03$ - chosen at maximum level of subsistence that can be financed by poorest farmer.
  - high transaction cost $Q_S = 2.0$ - conservative estimate from de Magalhaes & Santaeulalia-Llopis 2018.
- Massive cost of migration (occupational switch) from rural to urban $F_W = 285$
  - match the 1% migration rate in 2010-2013-2016 LSMS Malawi panel (as documented in Lagakos, Marshall, Mobarak, Vernot & Waugh, 2020).
- Maintenance cost of cash crop farms $F_M = 2.2$ to account for the marketing of cashcrop

# Calibration: cash crop exports & current account

- Cash crops consumed domestically and exported.
- Important feature to pin down the right elasticity of cash crops (main export item in MWI) to changes in agricultural policies.
- Assume external export demand function: $D_B = a_D \cdot p_B^{\epsilon_D}$
- Estimate this elasticity on tobacco's price and quantity exported panel of SSA countries from FAO.
- Results: $a_D = 0.86$ and $\epsilon_D = -0.45$.
- Assume balanced current account in baseline.

# Effect of frictions on the calibration

| Variable | Data | Baseline | $\bar{c}_S = 0$ | $Q_S = 0$ | $\bar{c}_S = 0$ & $Q_S = 0$ | $F_W = 0$ | $FM_B = 0$ | $\kappa = \infty$ |
|---|---|---|---|---|---|---|---|---|
| Urban population | 20% | 20% | 20% | 32% | 31% | 37% | 20% | 25% |
| Share of 2010 exported cash crops in total prod. of cash crops | 73% | 76% | 74% | 79% | 78% | 74% | 75% | 67% |
| Rural-urban migration rate | 1% | 1% | 1% | 2% | 2% | 24% | 0% | 1% |
| Share of rural pop. cultivating only staples | 50% | 61% | 61% | 59% | 59% | 49% | 0% | 61% |
| Share of cash crop farmers with suboptimal inputs | 70% | 67% | 68% | 67% | 67% | 62% | 32% | 3% |
| Aggregate cashcrop to staple fertilizer expenditure ratio s | 2.62 | 2.44 | 2.23 | 2.09 | 2.01 | 2.41 | 2.19 | 1.67 |
| Agricultural productivity gap | 6.5 | 6.7 | 6.0 | 2.8 | 2.9 | 3.0 | 6.0 | 6.4 |
| Avg urban-rural consumption rate | 6.5 | 2.7 | 2.4 | 1.4 | 1.5 | 1.0 | 2.5 | 2.5 |

**Table 1:** Change in the calibration without each frictions

# Effect of no transaction cost on introducing subsidy

| | FISP<br>tax-financed $\tau_W = 19\%$ | FISP with $Q_S = 0$<br>$\tau_W = 18\%$ |
|---|---|---|
| Consumption equivalent welfare | -8.4% | -0.7% |
| Prices: $p_B/p_M/w$ | $+28\%/+49\%/+63\%$ | $+27\%/+25\%/+24\%$ |
| Share of staple-only farmers | +3% | -1% |
| Staple production | +37% | +34% |
| Staple productivity | +28% | +43% |
| Cash crop production | +1% | +0% |
| Cash crop productivity | +1% | +8% |
| Share of financially constrained farmers | 0% | +2% |
| Urbanization rate | -15% | +18% |
| APG | +75% | -9% |
| Consumption | -1% | +11% |
| Transaction cost | +3% | - |
| Current account surplus % of GDP | -8% | -4% |
| Fraction of farmers without surplus | -12% | -12% |
| Program cost % of GDP | 3% | 3% |
| Migration rate | -48% | +46% |

**Table 2:** Caption

# Effect of no transaction cost on introducing subsidy

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**Table 2:** Caption

## Reallocation of public funds to infrastructure development (aid-financed)

We turn off FISP and consider alternatives of investing in broadly understood infrastructure:

- case 1 (no spillovers): reduction in $Q_S$ (12.5%) equivalent to the cost of FISP (1% of GDP);
- case 2 (spillovers): reduction in both $Q_S$ and $F_W$ (each reduced by 12.5%).

# Reallocation of public funds to infrastructure development (aid-financed)

| | FISP | $Q_S$ reduction no spillovers | $Q_S$ reduction $F_W$ reduction |
|---|---|---|---|
| Consumption equivalent welfare | +2.3% | +0.8% | +13.3% |
| Prices: $p_B$, $p_M$ | +3%, +3% | -2%, -2% | -16%, -25% |
| Staple production | +10% | -4% | -14% |
| Staple productivity | +13% | -3% | +0% |
| Cash crop production | -2% | +2% | +3% |
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| Consumption | +4% | -1% | +3% |
| Transaction cost | -2% | +2% | -11% |
| Current account surplus % of GDP | -0.6 | -0.1 | -2 |

**Table 3:** All statistics are relative to the "No FISP" allocation.

# Reallocation of public funds to infrastructure development (aid-financed)

| | FISP | $Q_S$ reduction no spillovers | $Q_S$ reduction $F_W$ reduction |
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## Appendix: Household's problem

$$V(z,a,e) = \max_{C,a',e'} u(C) + \beta \mathbb{E} V(z',a',e') \quad (1)$$

$$st.: Y + a' = (1+r)a \quad (2)$$

$$Y = \min_{e' \in \{S,CC,M\}} \{Y_S(C), Y_{CC}(C), Y_M(C)\} \quad (3)$$

- z: productivity vector of $\{\theta, l_Z\}$, $a$: wealth, $e$: occupation, $Y$: net expenditure
- $u(C) = \frac{1}{1-\sigma} \left( \psi_S \left( c_S - \bar{c}_S \right)^{1-1/\epsilon} + \psi_C c_C^{1-1/\epsilon} + \left(1 - \psi_S - \psi_C\right) c_M^{1-1/\epsilon} \right)^{\frac{1-\sigma}{1-1/\epsilon}}$
- Example for workers:
  - Net expenditure: $Y_M \equiv P_M C - w l_Z = (1+Q_S) c_S + p_C c_C + p_M c_M - w l_Z$
  - Price index: $P_M = (\lambda^{1-\epsilon} \psi_S^{\epsilon} + p_C^{1-\epsilon} \psi_C^{\epsilon} + p_M^{1-\epsilon} \psi_M^{\epsilon})^{\frac{1}{1-\epsilon}}$, where $\lambda = (1+Q_S)$
- But for farmers, the price index depends on consumption chosen $\implies$ $C$ & $e'$ are linked

# Staple producer's problem

- Staple producers profits: $\pi_S = p_S \theta^r x_S^{\zeta} - (1 - \tau_S)\, p_x x_S$
  - $\theta^r$: productivity of farm, $p_x, x_S$: price & quantity of fertilizer applied, $\tau_S$: subsidy
- Collateral constraint: finance $(1 - \tau_S)\, p_x x_S$ from household's wealth$\cdot\kappa$ before production takes place
- Objective: minimize expenditure to obtain optimal consumption bundle.

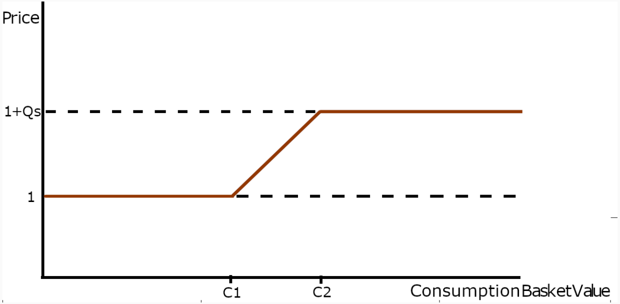



**Figure 2:** Staple consumption price conditional on consumption chosen (output held fixed)

# Cash crop producer's problem

- Cash crop producers profits:

$$\pi_B = p_B \theta^r l^\rho x_B^\zeta + p_S \theta^r (1-l)^\rho x_S^\zeta - (1-\tau_S)\, p_x x_S - (1-\tau_B)\, p_x x_B$$

  - $\theta^r$: productivity of farm, $p_x, x_S$: price & quantity of fertilizer applied, $\tau_S$: subsidy
  - $l$ is land-split choice
  - $\rho \in (0,1)$ is aimed at capturing variety of motives for mixing (insurance, timing of operations).

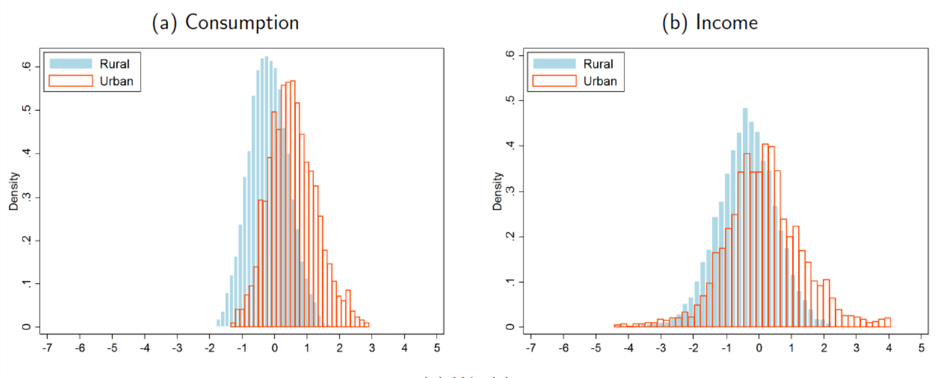
- Collateral constraint: finance $(1-\tau_S)\, p_x x_S + (1-\tau_B)\, p_x x_B$ from household's wealth$\cdot\kappa$ before production takes place

- Objective: minimize expenditure to obtain optimal consumption bundle.

- **Comparative statics:** land optimally allocated to cash crops $l$:
  - declines in subsidy rate $\tau_S$,
  - increases in relative price $\frac{p_B}{p_S}$. Back

# Appendix: Calibration strategy

- Calibrate to Malawi: preferences, production technology & shocks, market frictions
- $Q_S = 0.5$: compare consumer to producer prices, and relative to US
- Productivity to match: $log(harvest_{i,t}) = \beta_0 + \beta_1 \cdot log(harvest_{i,t-1}) + \beta_2 X_i + \gamma_v + \epsilon_{i,t}$
- Follow an RCT of capital injection by Amber et al.(2020) for working capital constraint



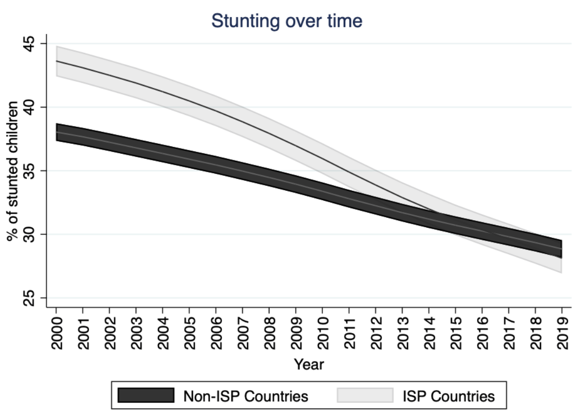
# Calibration to Malawi in 2010 ▸ Back

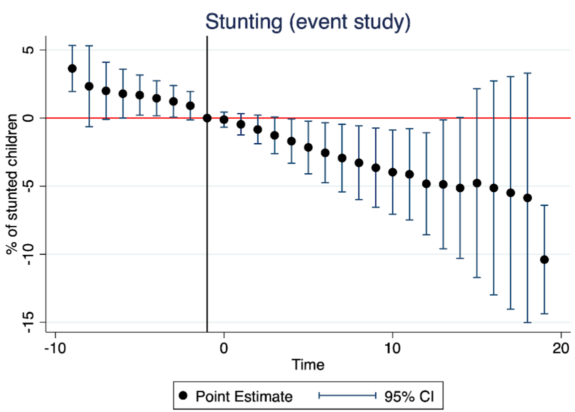
| Parameter | Value | Target/Source | Data | Model |
|---|---|---|---|---|
| **Preferences** | | | | |
| Time preference $\beta$ | 0.88 | Capital-output ratio [UN, 2014] | 3.84 | 3.84 |
| Staple consumption share $\psi_S$ | 0.54 | Agriculture share of GDP [World Bank] | 30% | 47% |
| Cash crop consumption share $\psi_B$ | 0.02 | Share of cash crops exported [FAOstat] | 60% | 95% |
| Subsistence consumption $\bar{c}_S$ | 0.02 | Share of staple producers selling output [IHS2010] | 10% | 98% |
| Export demand shifter $a_D$ | 0.16 | Balanced current account (15) | 0 | 0 |
| Export demand elasticity $b_D$ | -0.2 | Export elasticity in reg. (28) | -0.2 | -0.2 |
| **Production** | | | | |
| Returns to scale in farming $\zeta$ | 0.1 | Cost share of intermediates in value of agr. output [IHS2010] | 10% | 10% |
| Input tax rates $(\tau_S, \tau_C)$ | (-0.49, 0.0) | Avg relative post-subsidy to market price of inputs [IHS2010] | 51% | 51% |
| Transaction costs $Q_S$ | 0.5 | Share of producer to consumer price in Malawi relative to US | 0.5 | 0.5 |
| Avg productivity staples | 1.06 | Share of Malawian population in rural areas | 80% | 82% |
| Avg produtivity cash crops $\phi_C$ | 0.6 | Expenditure ratio of staple- vs cash crop [IHS2010] | 2 | 0.8 |
| Price of inputs $p_x$ | 0.97 | Fiscal cost of FISP [Chirwa and Dorward, 2013] | 3% | 5% |
| Persistence of rural AR1 $\rho_\theta$ | 0.92 | Urban-rural avg consumption ratio [IHS2010] | 2.2 | 2.2 |
| Var of rural AR1 innovations $\sigma_\theta^2$ | 0.15 | Top10% share of wealth in rural [IHS2010] | 49% | 56% |
| Persistence of urban shocks $\rho_l$ | 0.52 | Urban-rural avg wealth ratio [IHS2010] | 3.0 | 4.87 |
| High & low urban prod. $(\bar{l}_z, \underline{l}_z)$ | (2.0,0.0) | Top10% share of wealth in urban & no UI assumed | 73% | 31% |
| Urban entry cost $F_M$ | 2.5 | Rural-urban migration rate [Lagakos et al., 2020] | 1% | 4% |
| Cash crop entry cost $F_B$ | 0.38 | Share of rural pop. cultivating only staples [IHS2010] | 41% | 8% |
| Working capital constraint $\kappa$ | 1.62 | Impact of grant on crop output [Daidone et al., 2019] | 7% | 0.0 |

**Table 4:** Internally calibrated parameters

# Macro diff-in-diff on FAOStat data: food security

Share of children stunted drops by 11%. ▸ Regression

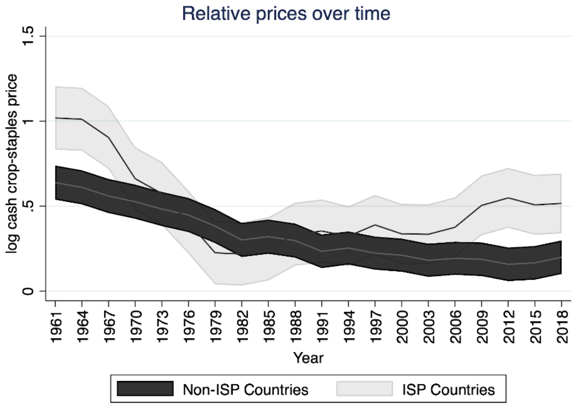


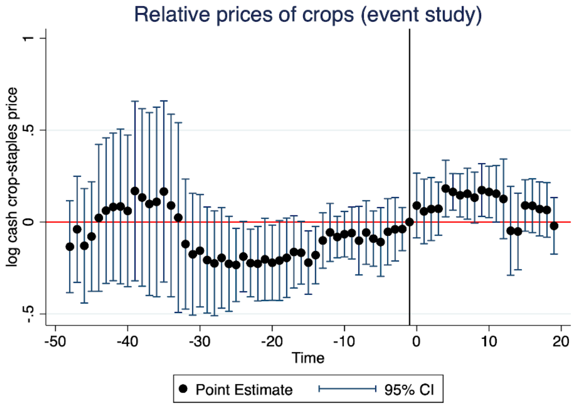




▸ back

# Macro diff-in-diff on FAOStat data: relative prices

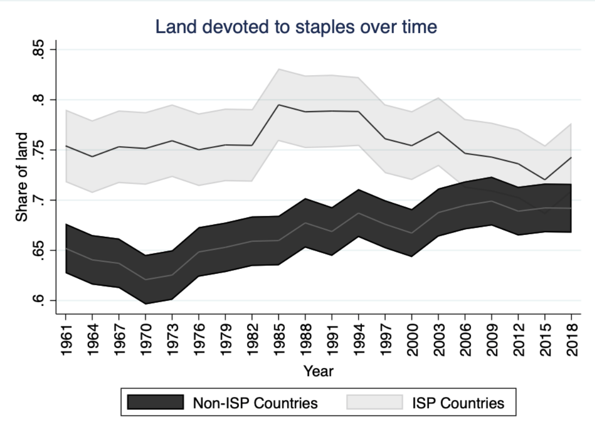
Relative price of cash crops to staples increases by 20%. ▸ Regression

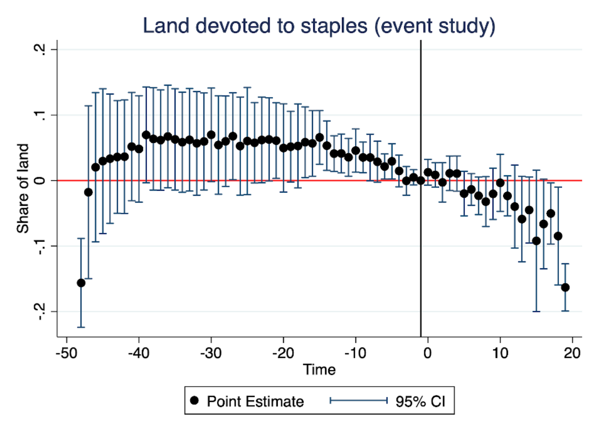


# Macro diff-in-diff on FAOStat data: land allocation

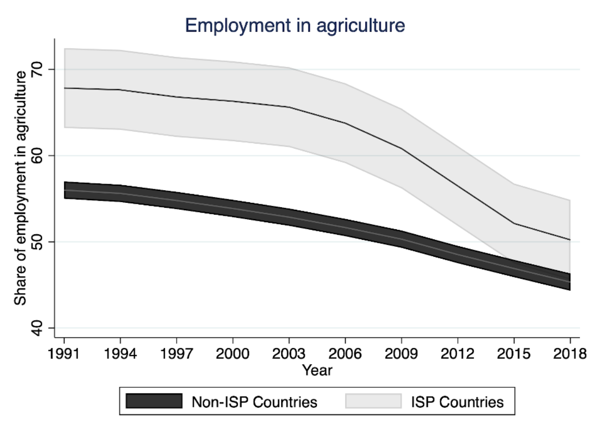
Share of land devoted to staples decreases by 9%. ▸ Regression

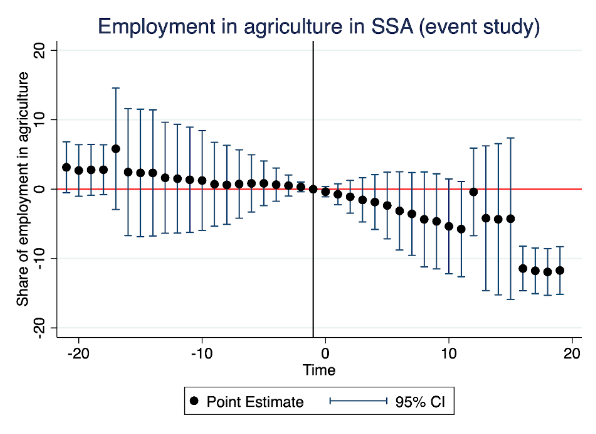


# Macro diff-in-diff on FAOStat data: urbanization rate

Share of population employed in agriculture decreases by 10%. ▸ Regression ▸ Cross-Sectional Evidence



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