Food Security for Whom?
The Effectiveness of Food Reserves in Poor Developing Countries

Randall Romero-Aguilar

Seminar at Banco Central de Costa Rica
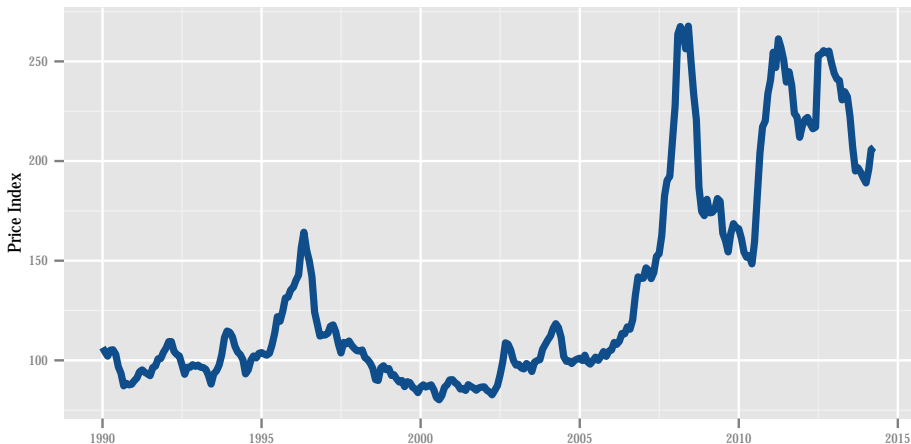June 02, 2014

Outline

The Problem

Despite rising production, food prices are higher and increasingly volatile.

Source: FAO's cereal price index

…and its consequences

- More price uncertainty $\Rightarrow$ increase in risk for farmers.

- Increase in hunger among poor net food buyers …

    -

- More than 60 food riots in 30 different countries.

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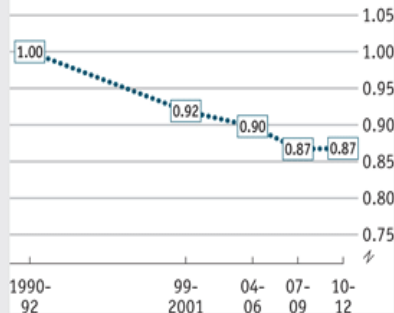- More than 60 food riots in 30 different countries.

© Reuters
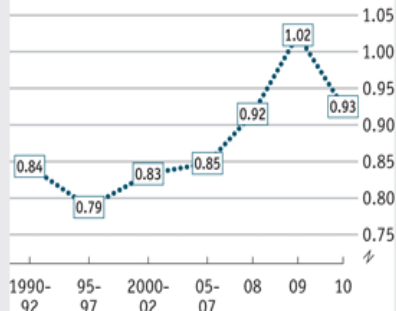
Undernourished people in the world

Now and then
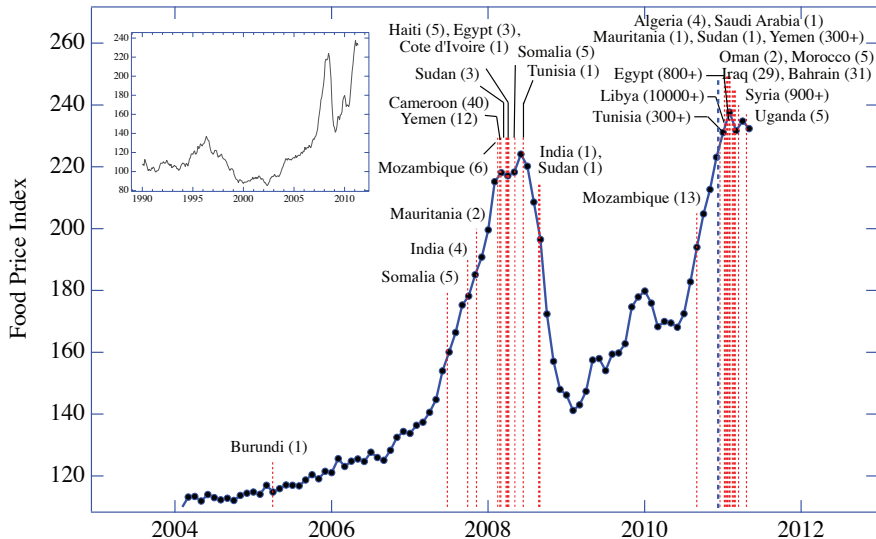Estimates of undernourished people in the world, bn

2012 report | 2010 report

Source: FAO

Source: The Economist, Oct 10th 2012

Food riots

Source: Lagi, Bertrand, and Bar-Yam 2011

Possible causes of high food prices

Affecting supply:

1. rising oil prices;
2. declining stocks and reserves;
3. regional catastrophic weather;
4. export restrictions;
5. decline in productivity and R&D in agriculture.

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Affecting demand:

1. strong income growth in China and India;
2. biofuel production in the USA and Europe;
3. preventive imports surges;
4. speculation in financial markets.

The effects of export restrictions on rice prices
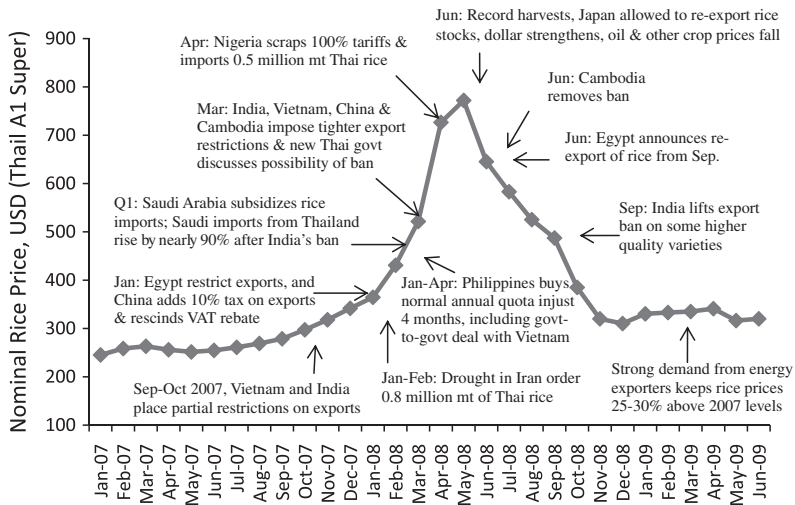
Source: Headey (2011)

Food reserves as a solution?

- Several authors have called for food reserves.

- Objective: welfare? hunger?

- Intermediate target: price stabilization vs. humanitarian assistance.

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Some questions

If a country decides to operate a grain reserve…

- what is the optimal size of the reserve?
- how is the country's hunger rate affected by its operations?
- is it better to store cash?
- how does the optimal operation of the reserve change if the objective is to maximize 'social welfare'?

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Motivation: Is grain storage a good idea?

The logic behind grain storage is simple:

- Seven years of abundance followed by seven years of famine…
- What if country never has years of abundance?
- Opportunity cost of storing grain is very high!

- the increase on national hunger induced by an international crisis;
- to what extent a reserve alleviates this increase, and at what cost.

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Key features of the model
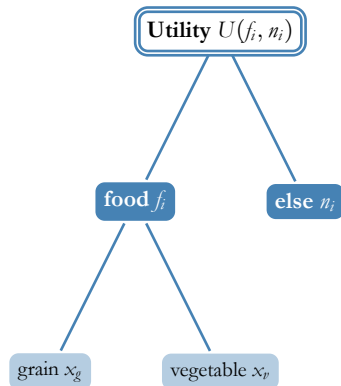
- Nested utility: two goods, two food ingredients

- Constant demand elasticities

- Substitution between ingredients

- Intertemporal, two grain prices

- Heterogeneous households: log-logistic income distribution

- Log-logistic food consumption

Utility $U(f_i, n_i)$

food f_i

else n_i

grain x_g

vegetable x_v

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food

$$= d\,\mathbf{price}^{-\alpha}\,\mathbf{income}^{\eta}$$

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food f_i

$$\left[\theta \mathbf{grain}^{\frac{\sigma-1}{\sigma}} + (1-\theta) \mathbf{veget.}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

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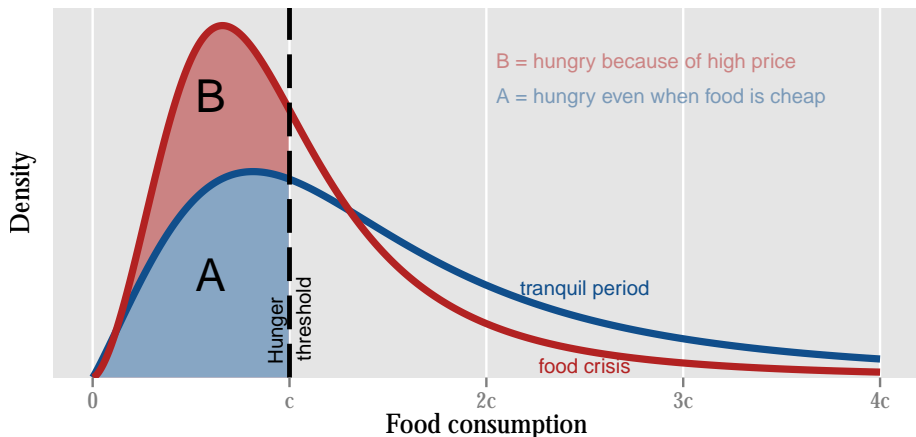
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Hunger changes in response to food prices

$$\Gamma(P) = \left[1 + \left(\frac{cP^{\alpha}(G\pi)^{\eta}}{\zeta Y^{\eta}\sin^{\eta}(G\pi)}\right)^{1/G\eta}\right]^{-1}$$
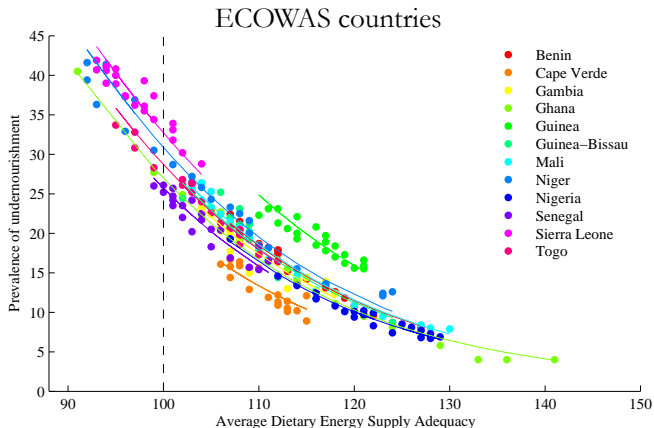
Empirical relevance of the model

Food adequacy x_{it} and undernourishment Γ_{it} in ECOWAS and ASEAN

$$\log\left(\frac{\Gamma_{it}}{1-\Gamma_{it}}\right) = d_i^* - b_f \log x_{it} + \epsilon_{it}$$

Model approximates
FAO's hunger
estimates reasonably
well.

- FAO data

- Fixed-effects

- 1991-2011

ECOWAS countries

Legend:
- Benin
- Cape Verde
- Gambia
- Ghana
- Guinea
- Guinea–Bissau
- Mali
- Niger
- Nigeria
- Senegal
- Sierra Leone
- Togo

x-axis: Average Dietary Energy Supply Adequacy
y-axis: Prevalence of undernourishment

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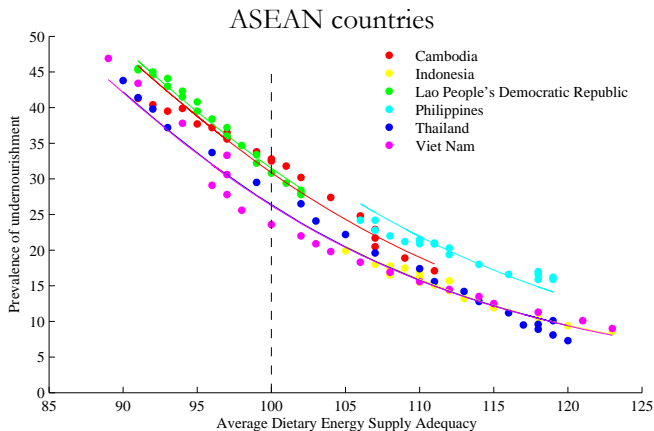
- FAO data
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ASEAN countries

Legend:
- Cambodia
- Indonesia
- Lao People's Democratic Republic
- Philippines
- Thailand
- Viet Nam

(x-axis: Average Dietary Energy Supply Adequacy; y-axis: Prevalence of undernourishment)

Government problem: objectives and tools

Government runs a grain stockpile to deal with price fluctuations.

- Two alternative objectives: welfare vs. hunger
- One policy tool: tariff on grain imports
- Two state variables: initial stock and grain price

$$V\left(s, p_g^*\right) = \max_{\tau}\left\{ r(\tau, p_g^*) + \delta\, \mathbb{E}\, V\left(s', p_g^{*\prime}\right)\right\}$$

subject to $\quad s' = (1 - \phi)\left[s + \frac{1}{p_g^*}\Upsilon\left(\tau, p_g^*\right)\right] \geq 0$

$$\pi_{ij} = Pr\left(p_g^{*\prime} = p_j \quad | \quad p_g^* = p_i\right)$$

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Reward function $r(\tau, P)$, by objective

Objective, V	Reward function, $r(\tau, p_g^*)$
Hunger, Γ	$\frac{1}{1-\rho} \left[1 - \Gamma(\tau, p_g^*) \right]^{1-\rho}$
Utility, $\mathbb{S}(v_i)$	$\frac{1}{1-\rho} \, \mathbb{S} \left[v(\tau, p_g^*) \right]^{1-\rho}$

Solving the model: The food crisis in Haiti

- Calibration of parameters: Haiti
  - $\Gamma_{2011} = 44.5\%$
  - Imports $\approx 70\%$ of cereals consumed
  - p_g^* increased 85% during crisis

- Food Crisis in Haiti:
  - Dec2007-Mar2008: rice price doubles
  - Early April 2008: violent protests in Port-au-Prince
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Food reserve in Haiti

- Jul2013: gov't begins construction of reserve, 35.000 tonnes

- "The construction of this strategic reserve reflects the desire of my Government to promote national agricultural production, stabilize the market price of commodities and combat food insecurity. Indeed, the fight against hunger and extreme poverty constitutes the main pillars of government action."

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Solving the model: Numerical methods

- Numerical solution:
    - Collocation method (*dpsolve* solver in *CompEcon*)
    - Chebyshev polynomials with 12 nodes for continuous state s_t
    - One discrete variable, price, with values 1.0 and 1.85

- Once solved, run Monte Carlo simulations to assess performance of the policy

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Outline

The effects of crisis, without policy

Variable	p_L	p_H	$\Delta\%$
Price of grain	1.0	1.85	85.0
Price of food	1.0	1.25	25.5
Food consumption	50.8	42.5	-16.4
Grain consumption	16.9	11.7	-31.1
Vegetable consumption	33.9	31.8	- 6.3
Hunger rate (%)	44.5	53.8	20.8

Storage policy
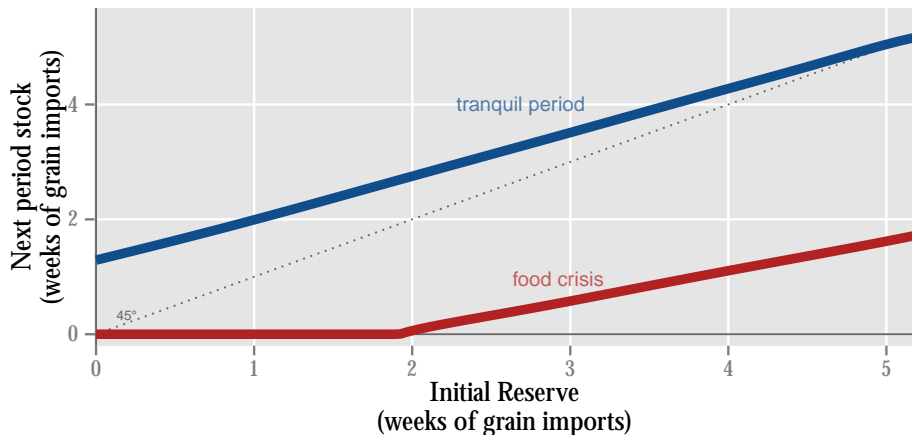
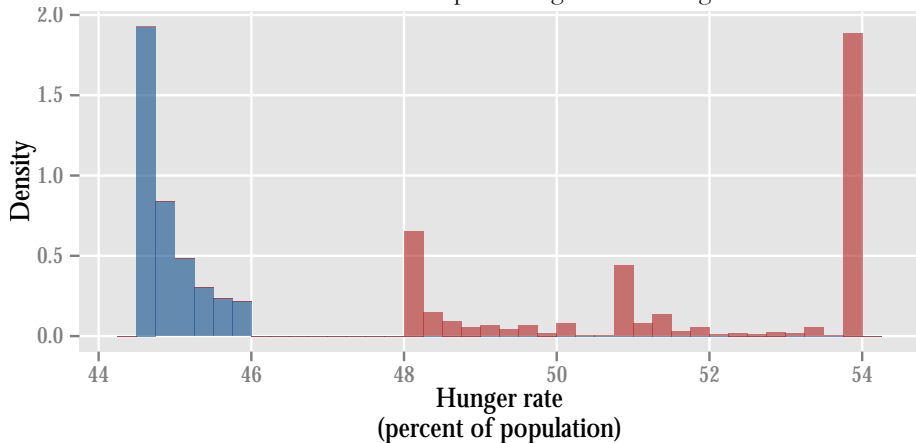# Effects of storage policy on hunger
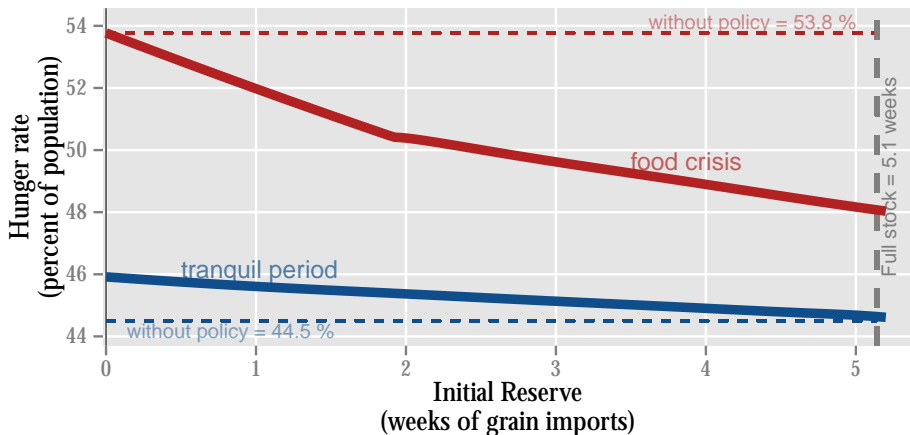
Long-term distribution of grain reserve

In half of the crisis, the reserve would be empty!
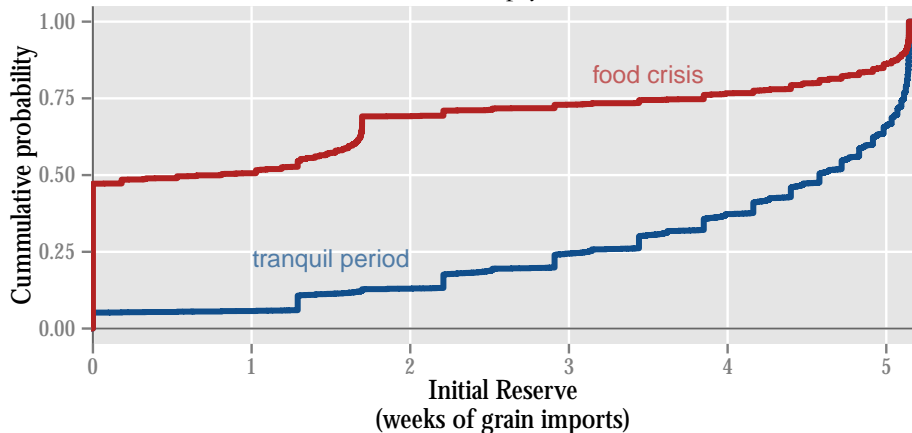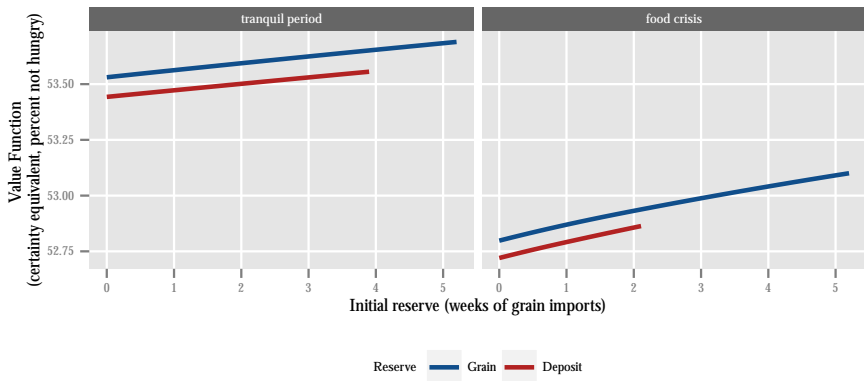
Long-term distribution of hunger

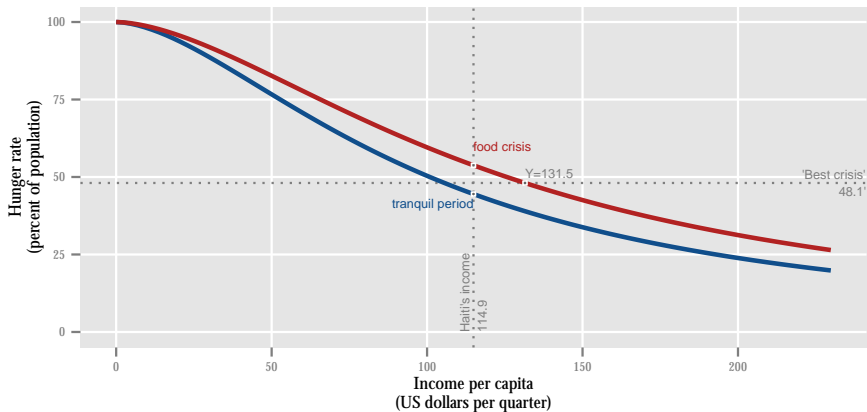The reserve would fail at preventing extreme hunger.

Cash vs. grain reserve?

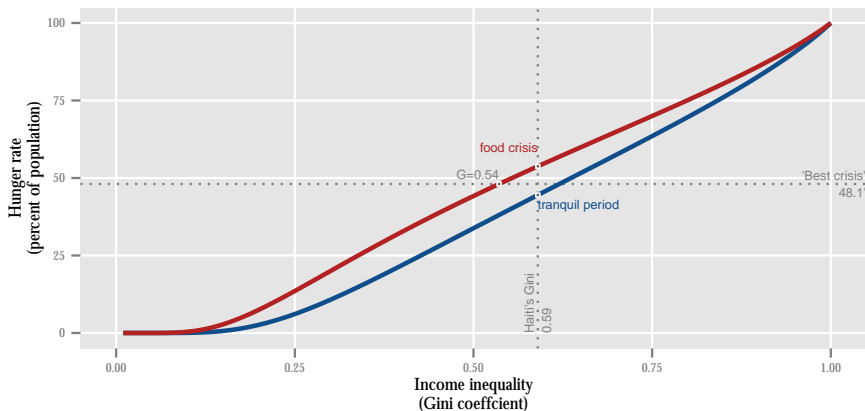In this scenario, a grain reserve outperforms a cash reserve

Food storage vs. fighting poverty

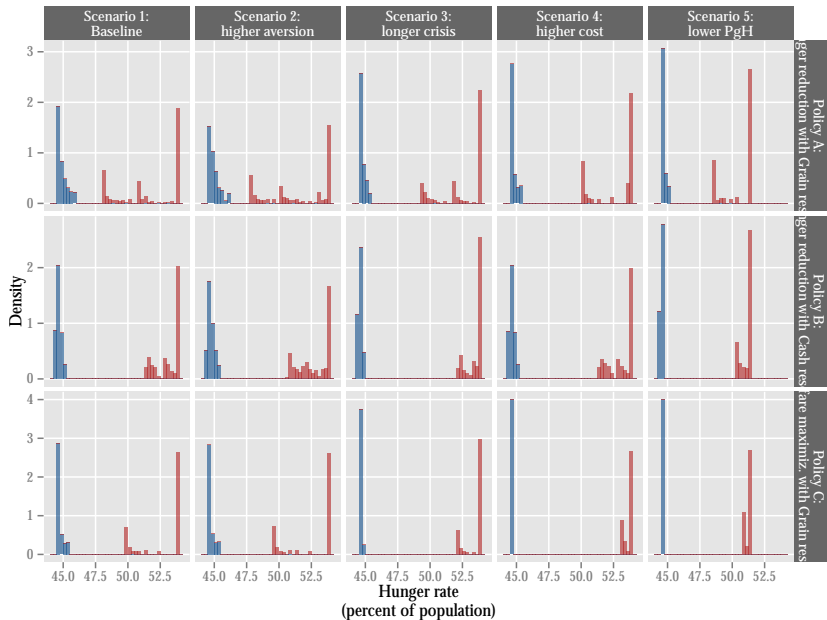Resources used for grain reserve might be better spent at promoting growth.

Price stabilization vs. safety net?

Income redistribution, targeting the poor, may have a better outcome.

Summary statistics for other scenarios

Variable	Stat.	Scenario 1: (baseline) p_L	p_H	Scenario 2: $\rho = 3.0$ p_L	p_H	Scenario 3: $\psi = 4$ p_L	p_H	Scenario 4: $\phi = 0.05$ p_L	p_H	Scenario 5: $P_H = 1.60$ p_L	p_H
Tax rate, %	min	1.02	-30.45	1.22	-31.94	0.72	-23.90	0.89	-20.72	0.39	-17.23
	mean	3.23	-11.67	3.75	-12.62	2.02	-7.35	2.07	-6.51	1.41	-5.02
	max	10.83	-0.00	11.91	-0.00	7.35	-0.00	6.70	-0.00	5.07	-0.00
Initial stock	min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	mean	3.92	1.68	4.49	1.95	2.88	0.98	1.71	0.67	1.50	0.55
	max	5.14	5.14	6.14	6.14	3.65	3.65	2.18	2.18	1.95	1.95
End stock	min	1.29	0.00	1.41	0.00	0.89	0.00	0.80	0.00	0.62	0.00
	mean	4.22	0.42	4.84	0.57	3.06	0.22	1.88	0.01	1.64	0.01
	max	5.14	1.70	6.14	2.46	3.65	1.10	2.18	0.04	1.95	0.05
Food price	min	1.00	1.09	1.00	1.08	1.00	1.13	1.00	1.15	1.00	1.10
	mean	1.01	1.19	1.01	1.19	1.01	1.22	1.01	1.22	1.00	1.16
	max	1.04	1.25	1.04	1.25	1.02	1.25	1.02	1.25	1.02	1.18
Hunger rate, %	min	44.64	48.07	44.66	47.75	44.60	49.43	44.62	50.06	44.55	48.50
	mean	44.93	51.64	45.00	51.46	44.77	52.46	44.78	52.61	44.69	50.57
	max	45.92	53.77	46.05	53.77	45.47	53.77	45.39	53.77	45.17	51.42

Density vs. Hunger rate (percent of population)

Columns: Scenario 1: Baseline, Scenario 2: higher aversion, Scenario 3: longer crisis, Scenario 4: higher cost, Scenario 5: lower PgH

Rows: Policy A: ...ger reduction with Grain res..., Policy B: ...ger reduction with Cash res..., Policy C: ...are maximiz... with Grain res...

PriceState: tranquil period, food crisis

Outline

Conclusions

The optimal grain storage policy…

- would not fully stabilize food prices.
- would not prevent extreme hunger, yet it would reduce its frequency.
- is very sensitive to key parameters (price process, storage costs)
- might be outperformed by policies that attack poverty directly.
- in many cases, no better than accumulating financial assets.
- is more "active" when objective is avoiding extreme hunger.

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Additional material

▶ buyers Net buyers of staple foods

▶ maize Historical real prices of maize

▶ wheat Historical real prices of wheat

▶ rice Historical real prices of rice

▶ soybeans Historical real prices of soybeans

Net buyers of staple foods

Net buyers of staple foods

	All households			Poor households		
	Urban	Rural	All	Urban	Rural	All
	(Percentage)					
Albania, 2005	99.1	67.6	82.9	*	*	*
Bangladesh, 2000	95.9	72.0	76.8	95.5	83.4	84.2
Ghana, 1998	92.0	72.0	79.3	*	69.1	*
Guatemala, 2000	97.5	86.4	91.2	98.3	82.2	83.1
Malawi, 2004	96.6	92.8	93.3	99.0	94.8	95.0
Nicaragua, 2001	97.9	78.5	90.4	93.8	73.0	79.0
Pakistan, 2001	97.9	78.5	84.1	96.4	83.1	85.4
Tajikistan, 2003	99.4	87.0	91.2	97.1	76.6	81.4
Viet Nam, 1998	91.1	32.1	46.3	100.0	40.6	41.2
Unweighted average	96.4	74.1	81.7	97.2	87.9	78.5

* Insufficient data.

Source: FAO.

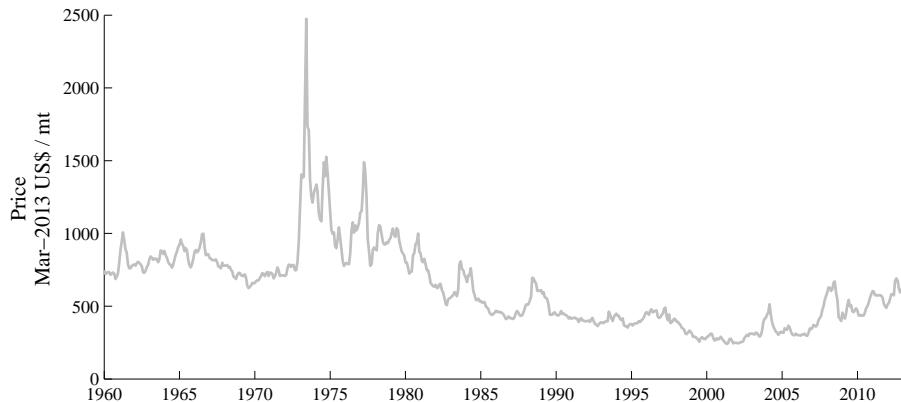Source: FAO (2008) ◄ ▲

Historical maize price

Maize (US), no. 2, yellow, f.o.b. US Gulf ports
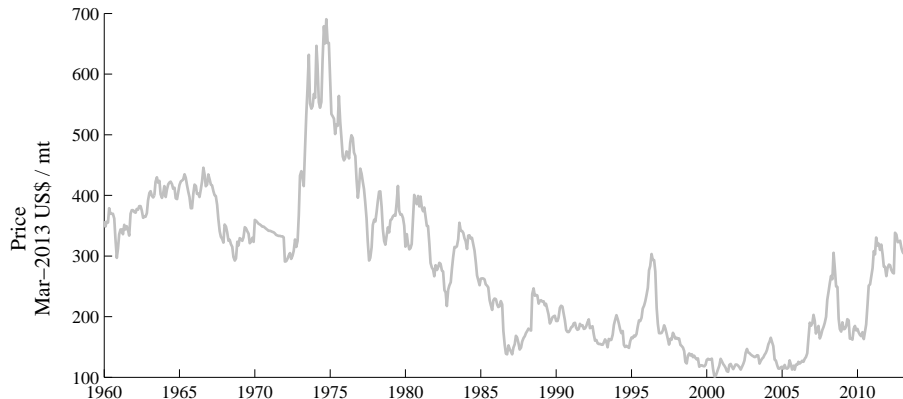
Source: Nominal prices from World Bank's GEM database, deflated by U.S. CPI

Historical wheat price

Wheat (US), no. 1, hard red winter, ordinary protein, export price delivered at the US Gulf port for prompt or 30 days shipment

Source: Nominal prices from World Bank's GEM database, deflated by U.S. CPI
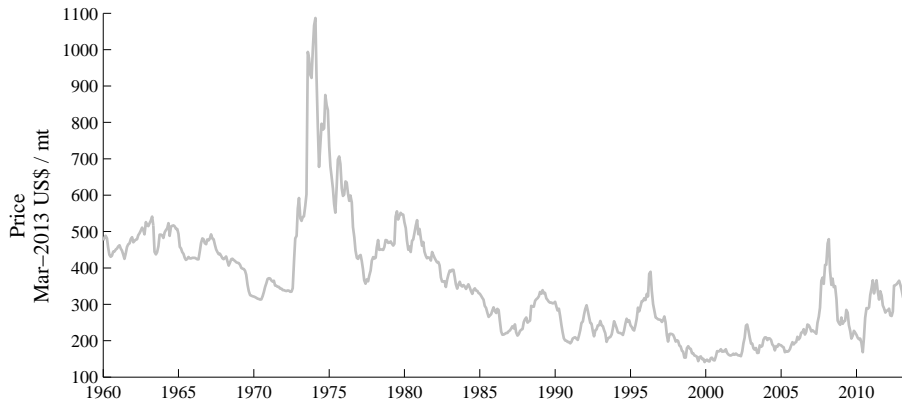
Historical rice price

Rice (Thailand), 5% broken, white rice (WR), milled, indicative price based on weekly surveys of export transactions, government standard, f.o.b. Bangkok
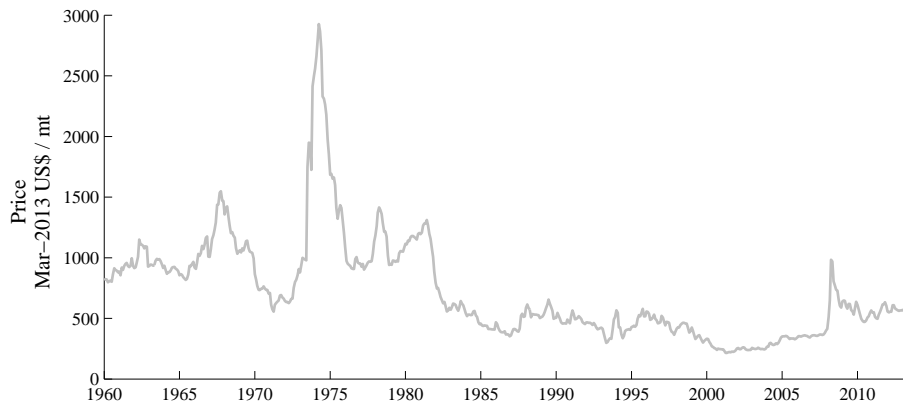
Source: Nominal prices from World Bank's GEM database, deflated by U.S. CPI ▲

Historical soybeans price

Soybeans (US), c.i.f. Rotterdam

Source: Nominal prices from World Bank's GEM database, deflated by U.S. CPI

References I

📄 Food and Agriculture Organization of the United Nations (2008). *The State of Food Insecurity in the World 2008. High food prices and food security -- threats and opportunities.* FAO. ISBN: 978-92-5-106049-0.

📄 Headey, Derek (2011). ``Rethinking the global food crisis: The role of trade shocks''. In: *Food Policy* 36.2, pp. 136–146.

📄 Lagi, Marco, Karla Z. Bertrand, and Yaneer Bar-Yam (2011). ``The Food Crises and Political Instability in North Africa and the Middle East''. In: *ArXiv e-prints*, p. 15. arXiv: 1108.2455.