Food Security for Whom?

The Effectiveness of Food Reserves in Poor Developing Countries

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THE OHIO STATE UNIVERSITY

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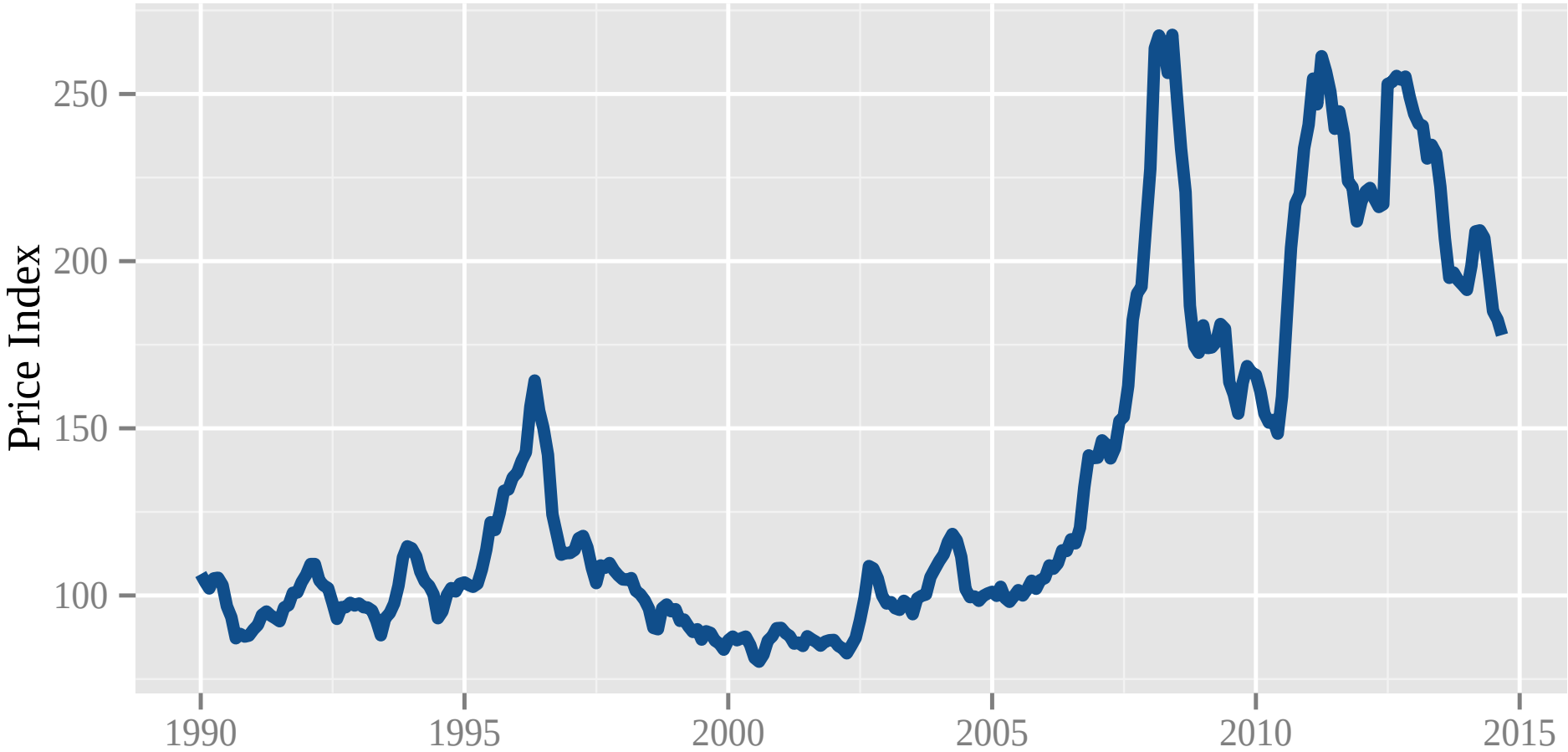
Outline

The Problem

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



Source: FAO's cereal price index

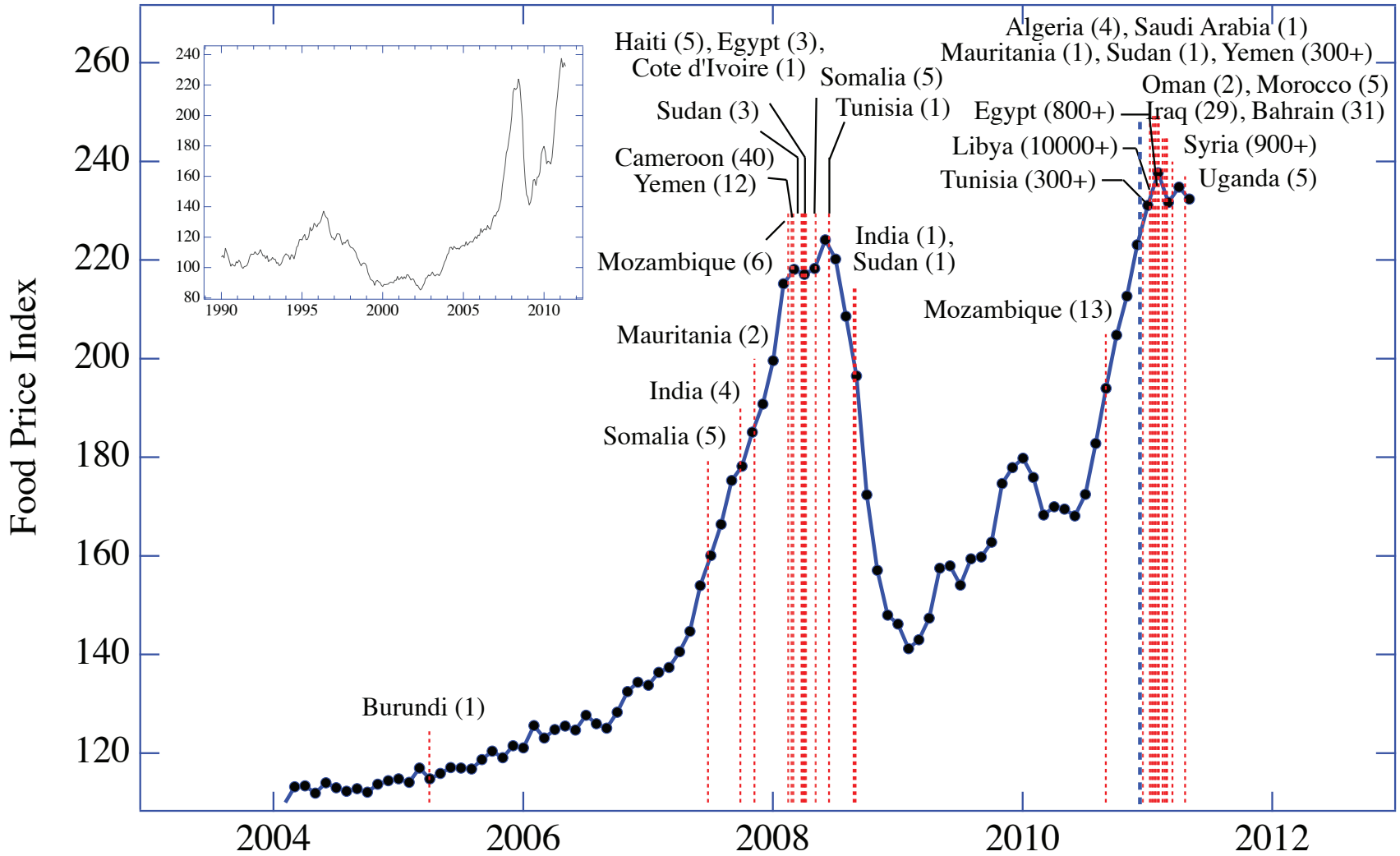
Undernourished people in the world

…causing more (?) people to suffer hunger…

Source: The Economist, Oct 10th 2012, based on FAO's SOFI reports.

Food riots

…and in turn leading to increasing violence.



Source: Lagi, Bertrand, and Bar-Yam 2011

Food reserve as a solution?

If a poor grain-importing country decides to operate a grain reserve to stabilize prices…

- what is the ultimate target: welfare vs. hunger
- what is the optimal size of the reserve?
- is it better to use a financial asset?
- how is the country's hunger rate affected by its operations?

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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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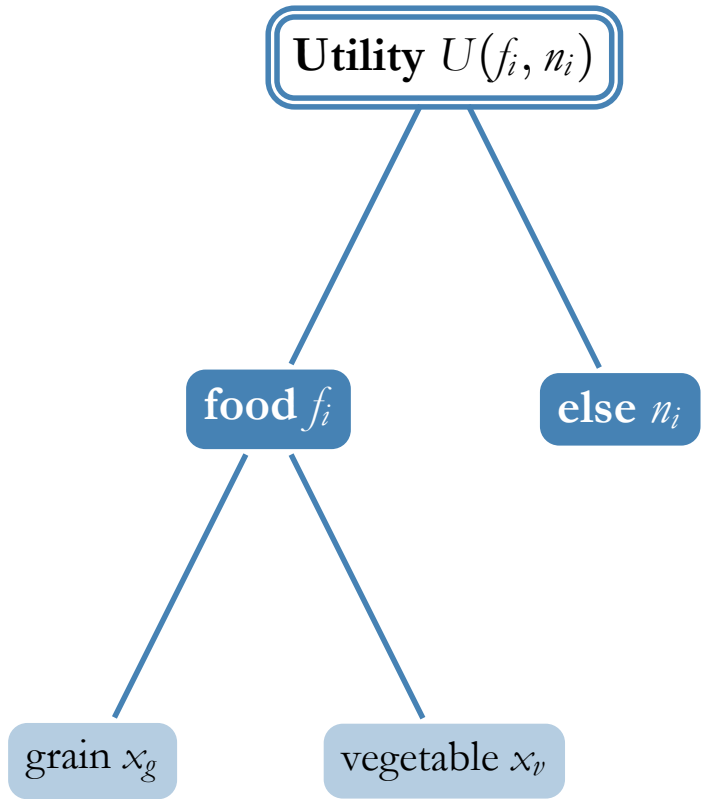
Key features of the model

- 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



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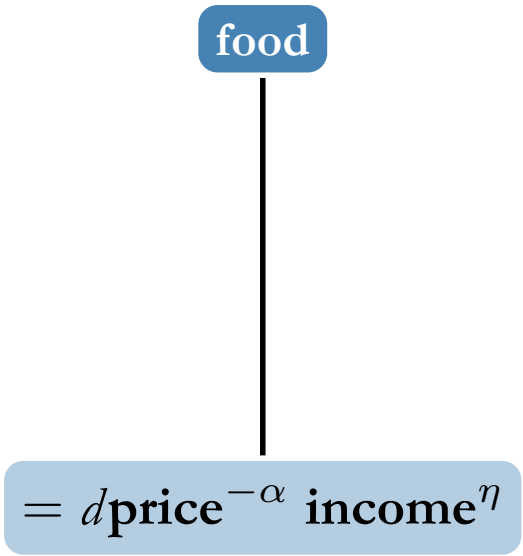

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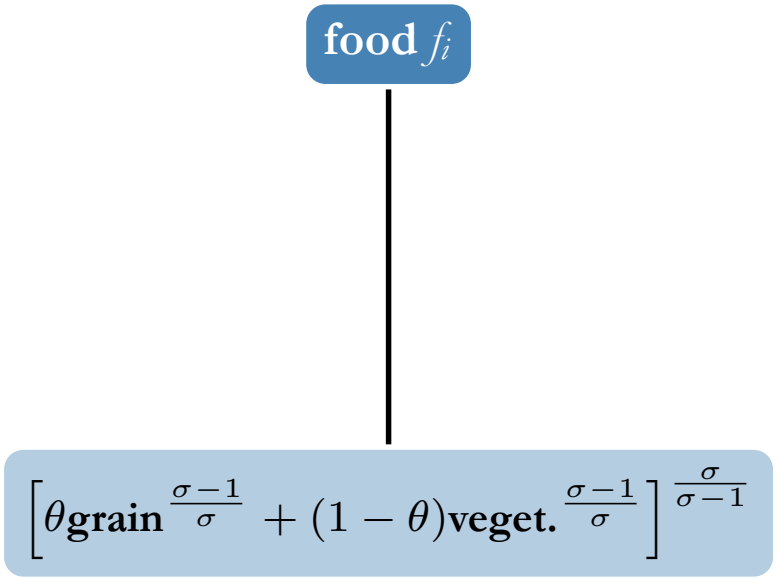

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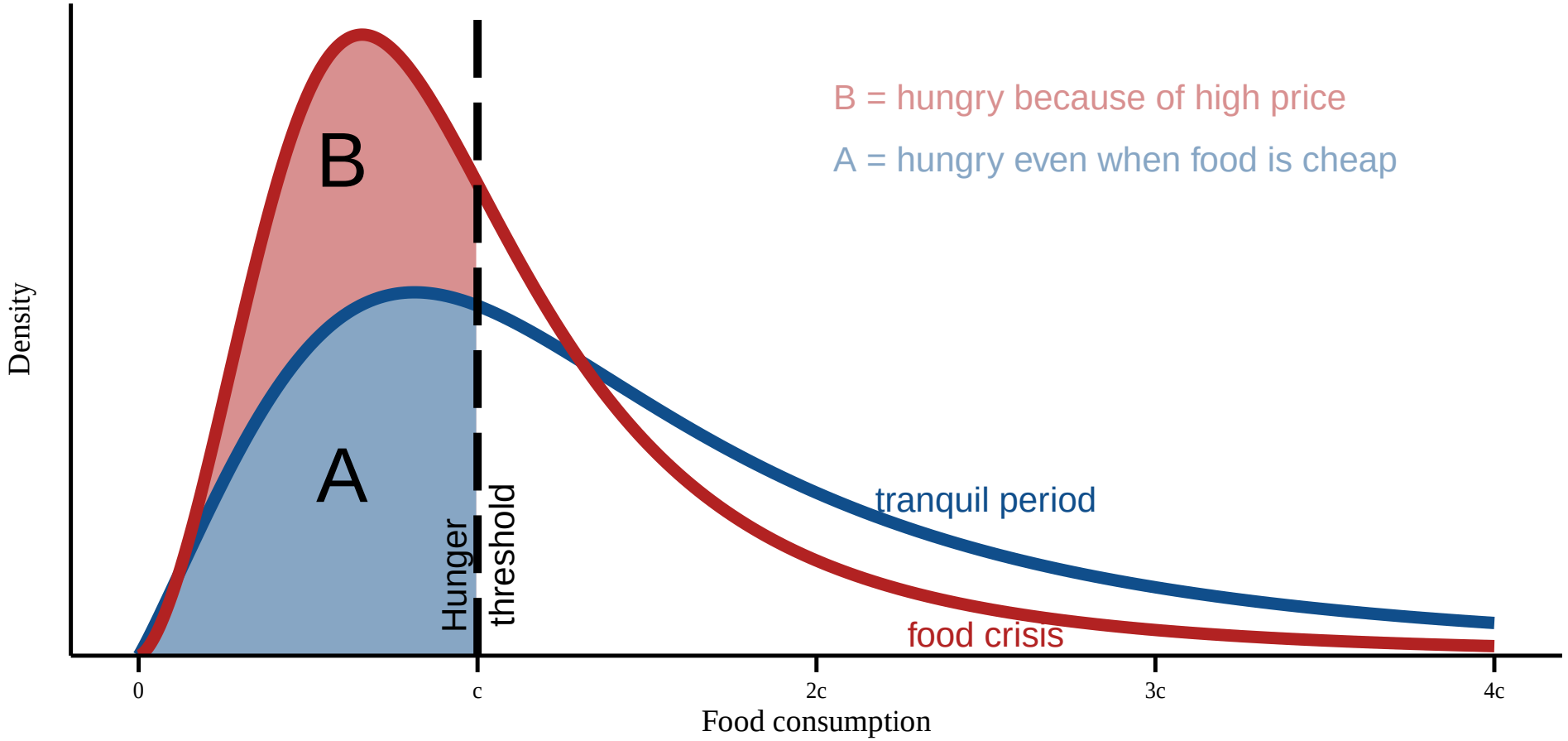
Hunger changes in response to food prices

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



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

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

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

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

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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
- April 12: Prime Minister Jacques Adouard Alexis ousted

Residents protest on the streets in Port-au-Prince. Photograph: Eduardo Munoz/Reuters

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Food reserve in Haiti

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- "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."

Prime Minister, Laurent Lamothe

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
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Baseline parameters

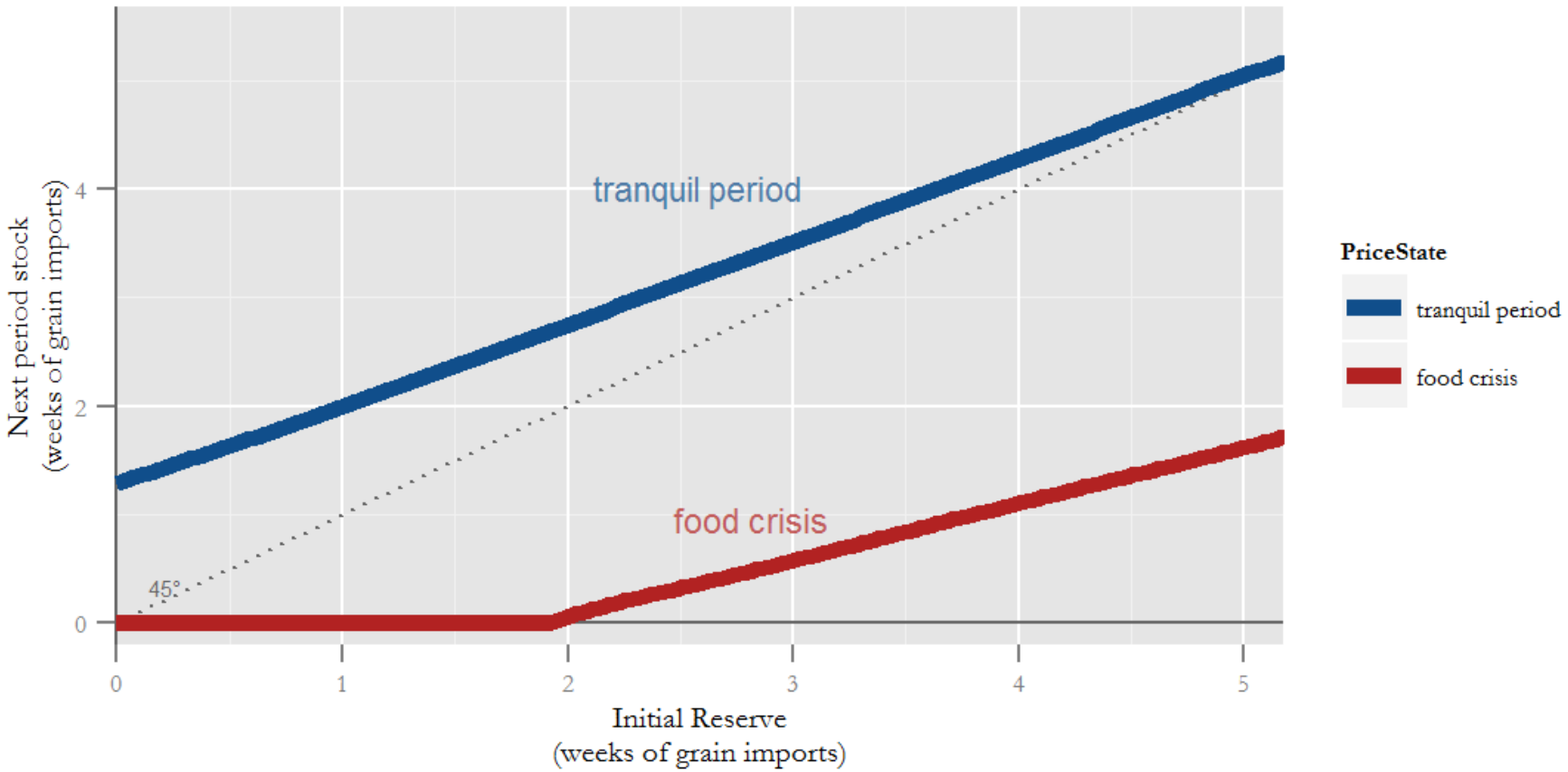
Parameter	Value	Description
α	0.788	price elasticity food demand
η	0.814	income elasticity food demand
σ	0.500	elasticity of substitution
θ	0.333	share of grain in food budget
c	30.258	hunger threshold
ζ	1.208	food demand scale
Y	114.925	income per capita
G	0.590	Gini coefficient
p_L	1.000	price of grain when low
p_H	1.850	price of grain when high
p_v	1.000	price of vegetable
γ	0.200	proportion of years in crisis
ψ	3.000	expected duration of food crisis
δ	0.970	government discount factor
ρ	2.500	government relative risk aversion
ϕ	0.025	marginal cost of storage
r	0.010	interest rate

Outline

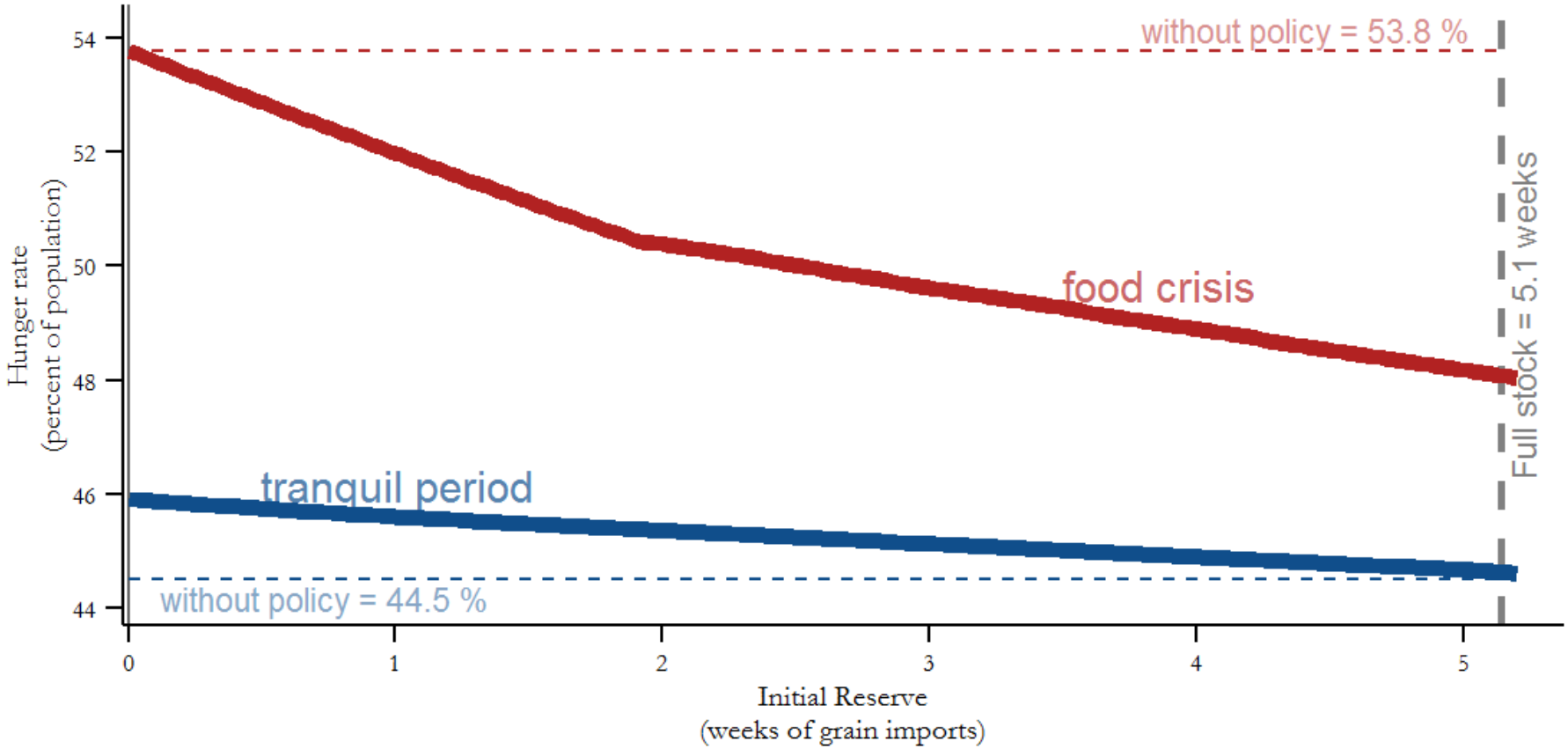
The effects of crisis, without policy

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

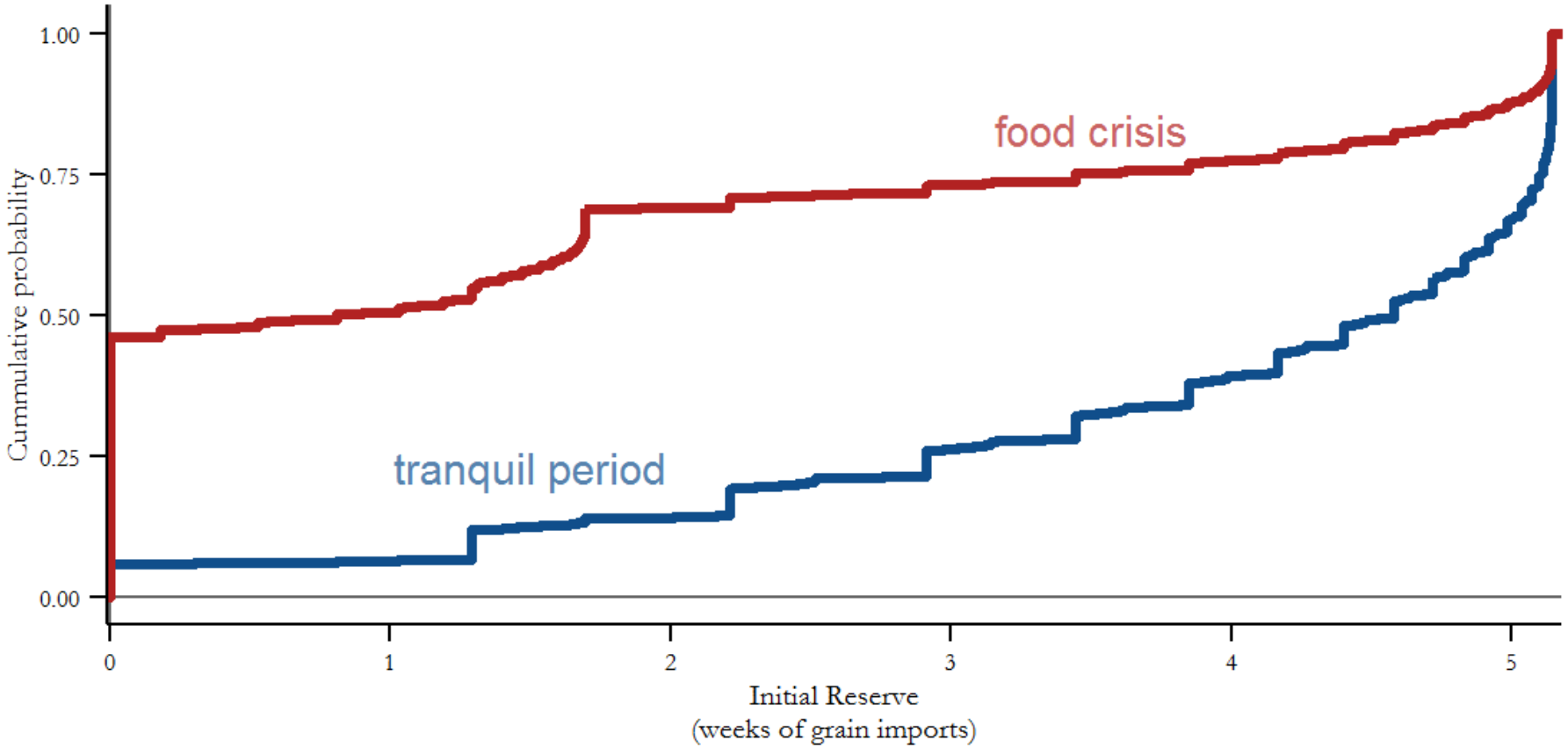


Effects of storage policy on hunger



Long-term distribution of grain reserve

In half of the crisis, the reserve would be empty!

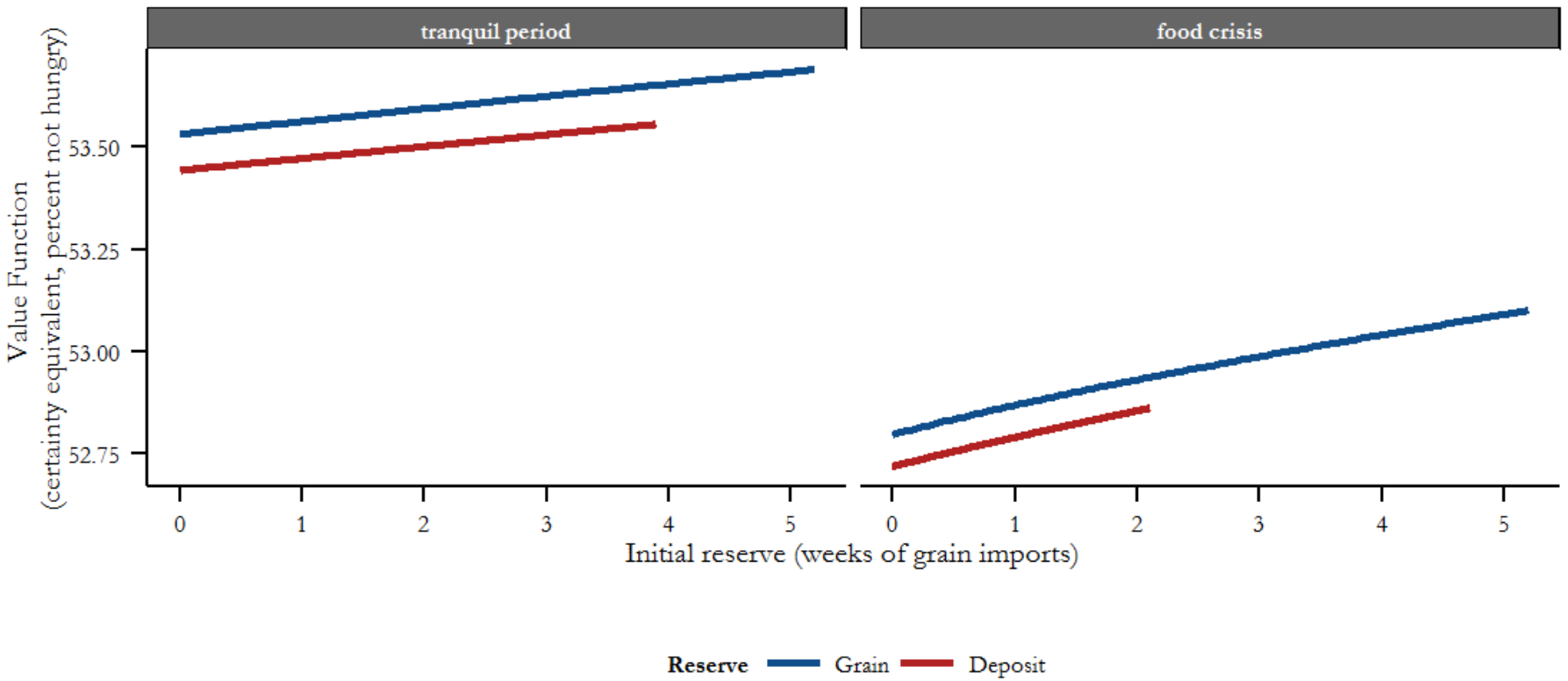


Long-term distribution of hunger

The reserve would fail at preventing extreme hunger.

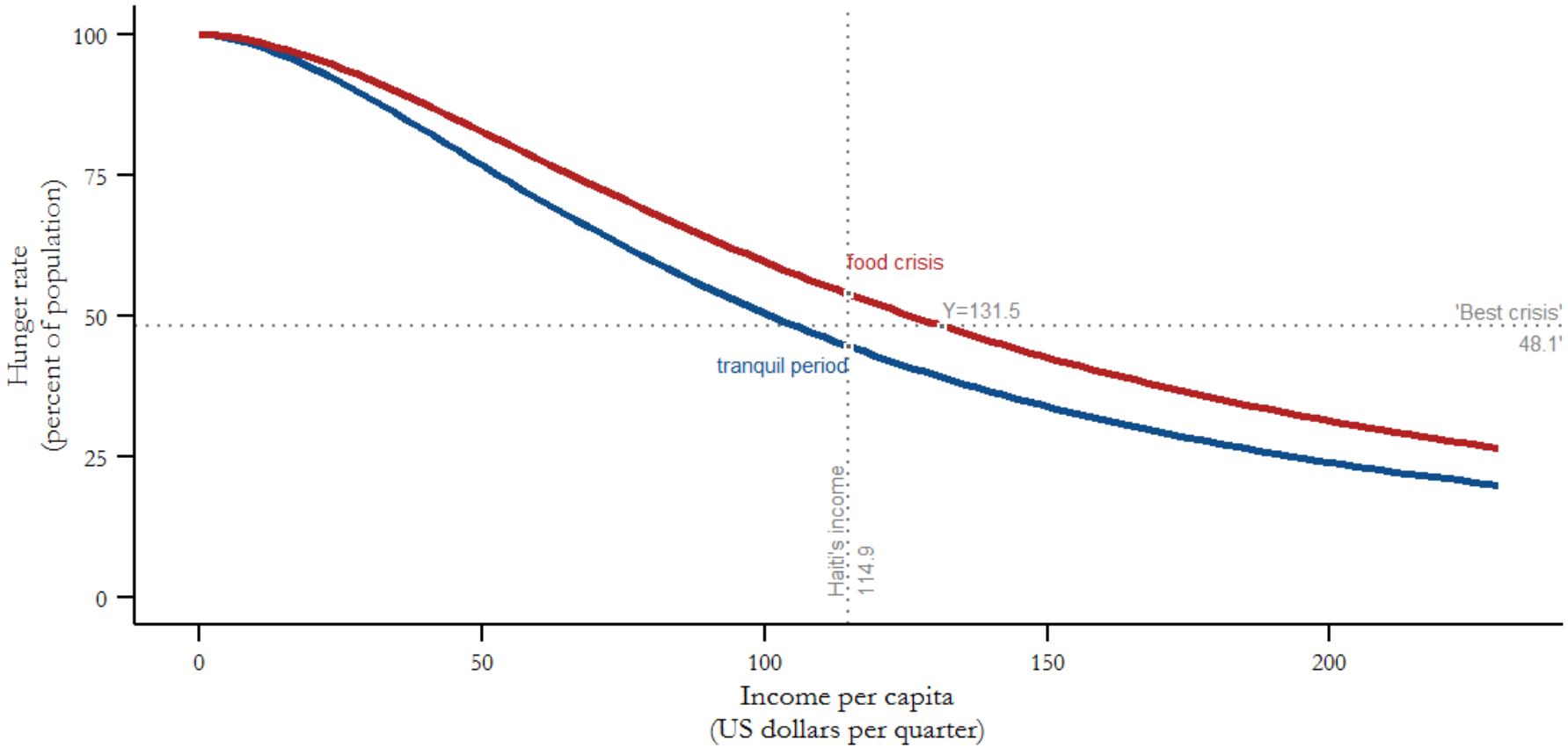
Cash vs. grain reserve?

- In this scenario, a grain reserve outperforms a cash reserve, but difference is small.



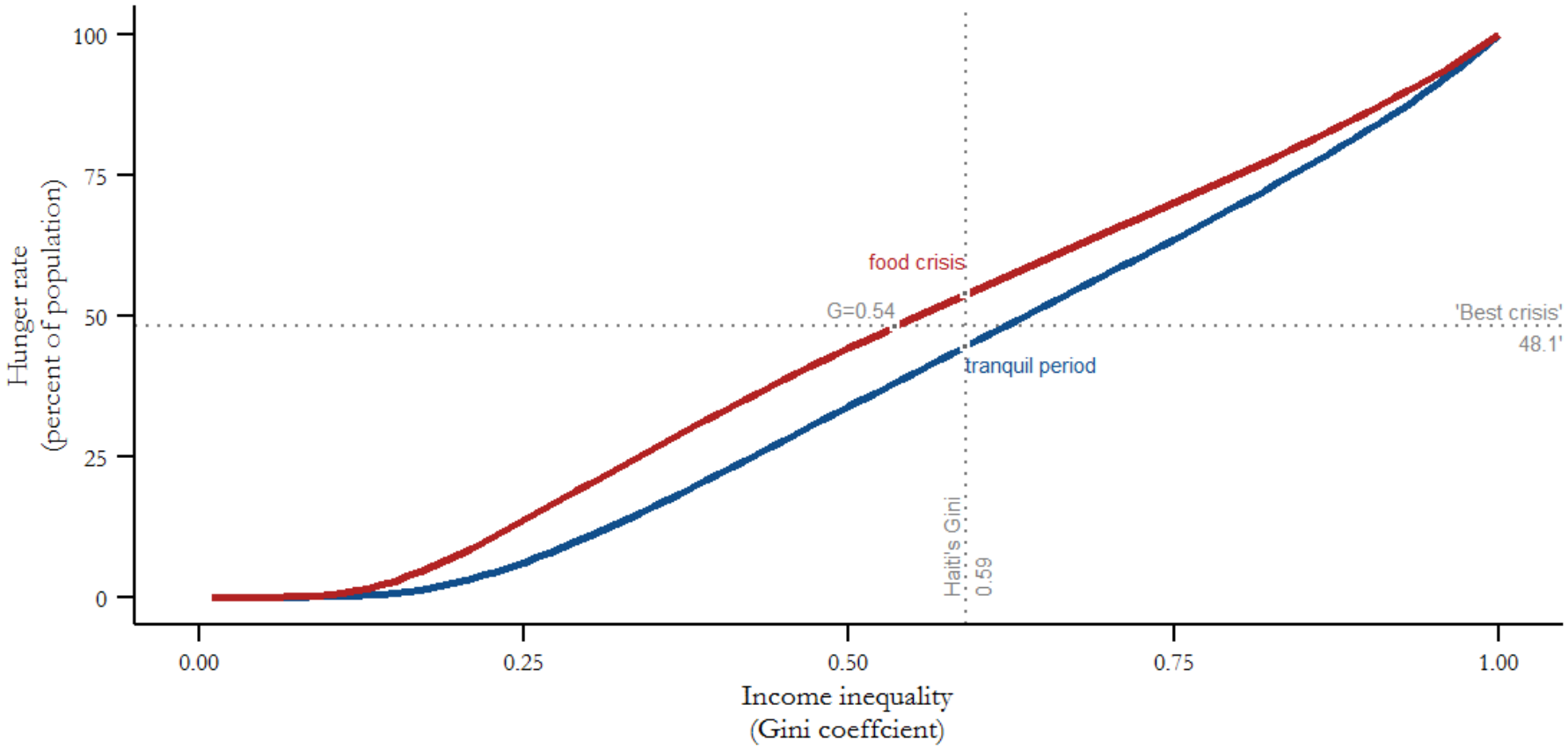
Food storage vs. fighting poverty

- 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.



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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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References

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.

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.

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.

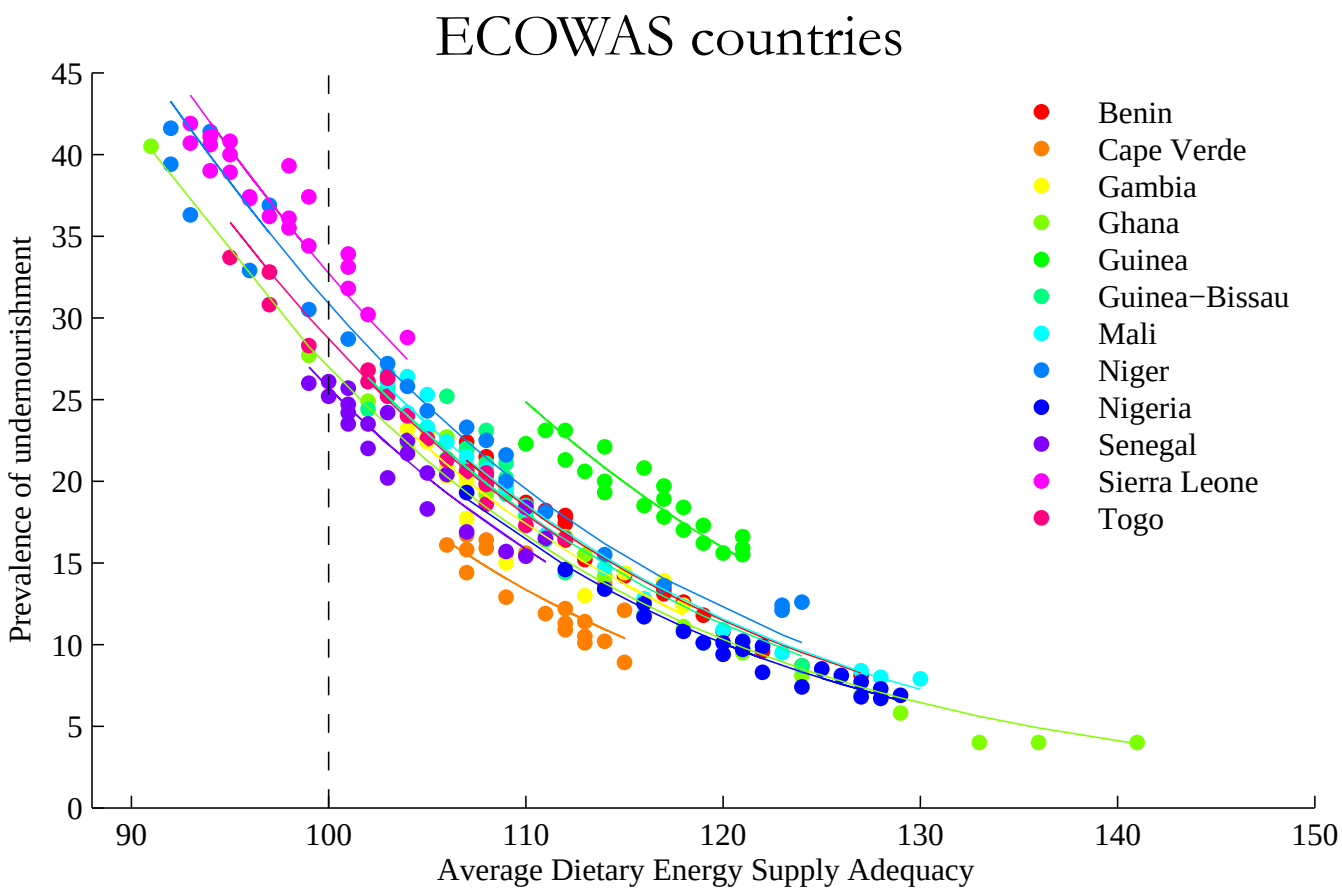
Empirical relevance of the model

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



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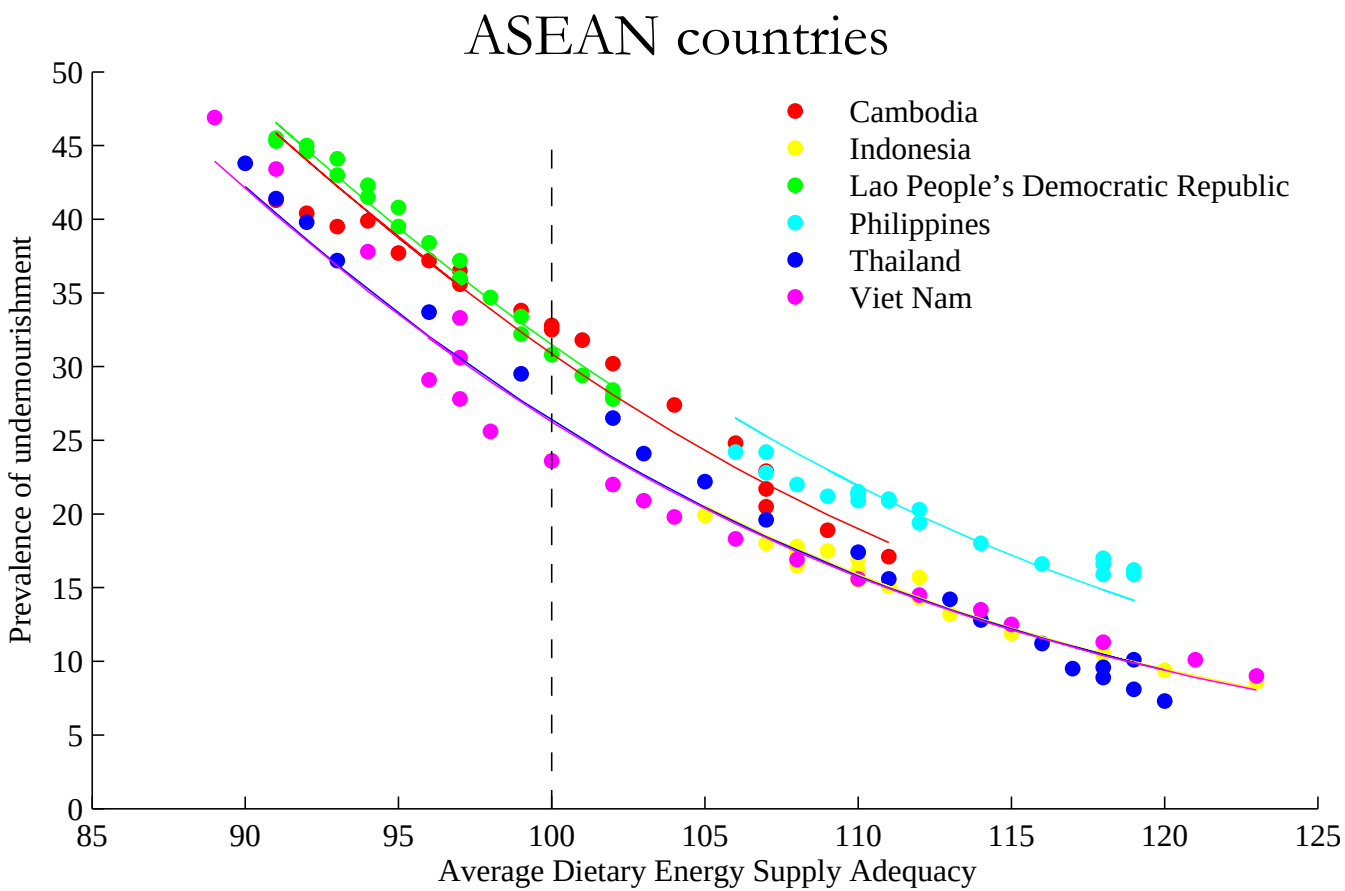


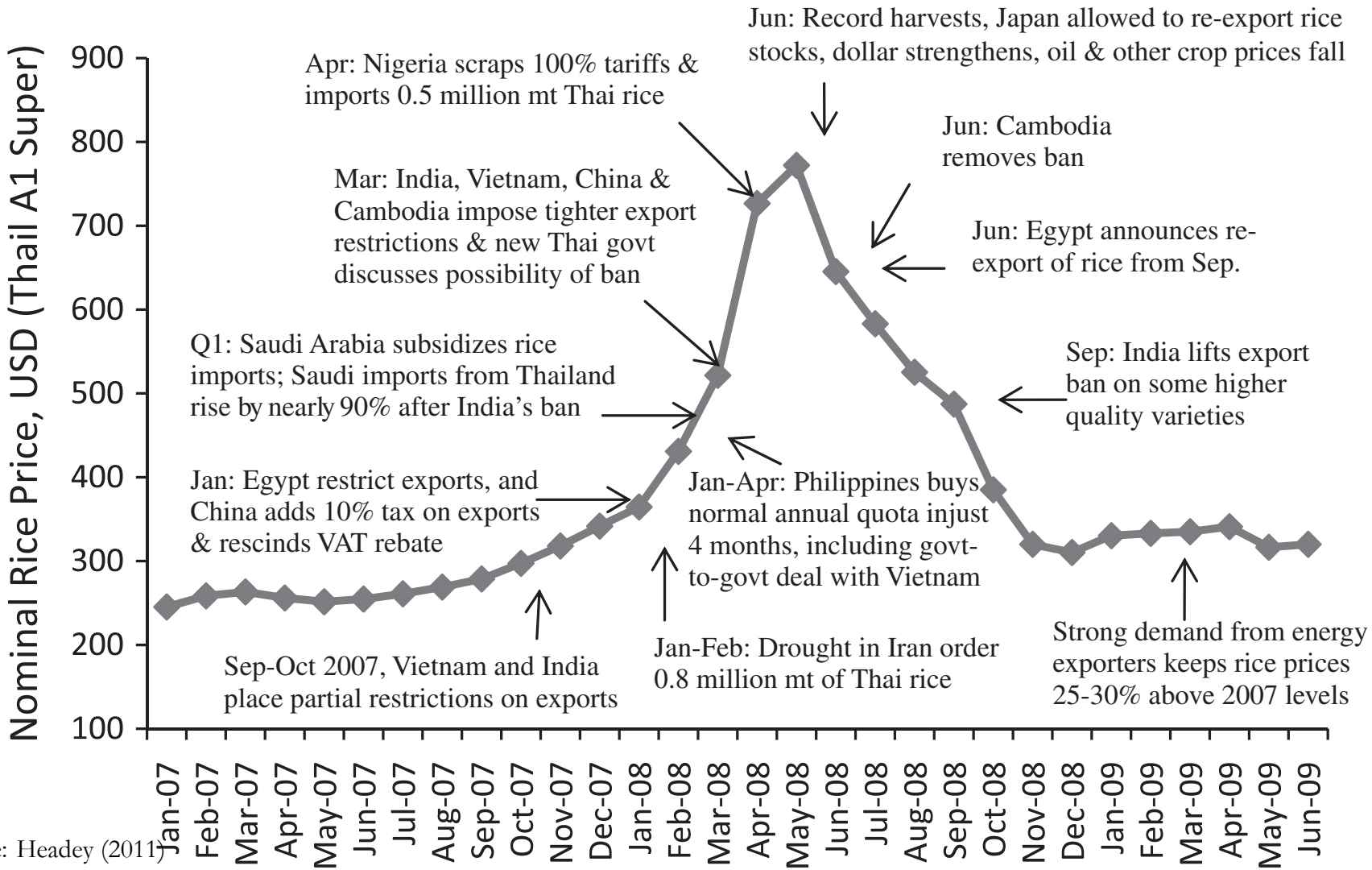
Alternative scenarios

1. Baseline
2. Increased risk aversion, from $\rho = 2.5$ to $\rho = 3.0$
3. Crisis expected to last $\psi = 4$ quarters, instead of $\psi = 3$
4. Double the cost of storage, $\phi = 0.05$
5. Less severe crisis: $p_g^* = 1.6$ instead of 1.85

Summary statistics for other scenarios

		Scenario 1: (baseline)		Scenario 2: $\rho = 3.0$		Scenario 3: $\psi = 4$		Scenario 4: $\phi = 0.05$		Scenario 5: $P_H = 1.60$	
Variable	Stat.	p_L	p_H	p_L	p_H	p_L	p_H	p_L	p_H	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	3.34	-11.70	3.79	-12.99	2.02	-7.05	2.01	-6.17	1.39	-5.03
	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	3.86	1.67	4.46	2.01	2.88	0.94	1.73	0.63	1.51	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	4.17	0.41	4.81	0.60	3.06	0.21	1.89	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	44.94	51.64	45.00	51.39	44.77	52.51	44.77	52.67	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

The effects of export restrictions on rice prices



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