Sustainability of Regional Food Reserves When Default Is Possible

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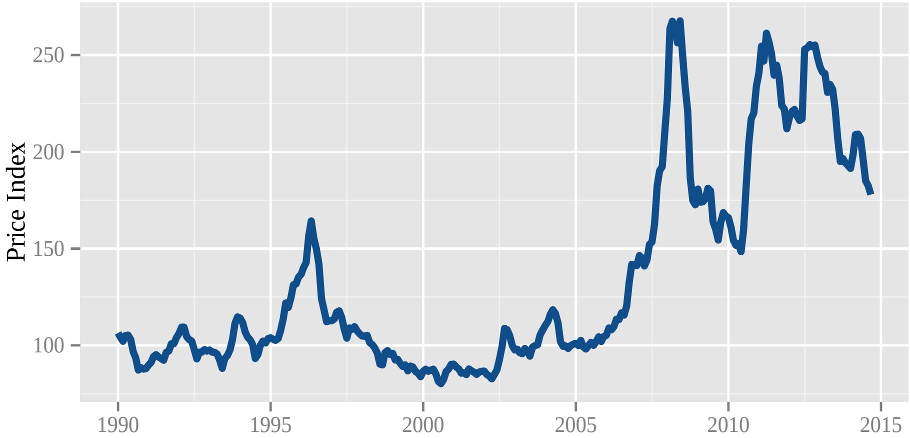
The Problem

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



Source: FAO's cereal price index

The case for joint reserves

The promises

- risk diversification
- economies of scale
- independent management, free of political influence
- provision of forum for collective agreements

The challenges

- implementation procedures
- financial sustainability
- implications for free trade
- commitment of member countries

The Model

- Two countries
- No trade
- One grain
- Countries share a fraction of their grain
- Objective: maximize lifetime utility of representative agent
- Dynamic game with limited commitment
- Nash-Markov sub-game perfect equilibria

- Solved numerically, develop new computational tools algorithm

A country in autarky

Availability

$$\underbrace{\tilde{q}_i}_{\text{production}} + (1-\phi)\underbrace{s_{i,-1}}_{\text{past storage}} \equiv \underbrace{a_i}_{\text{availability}} = \underbrace{c_i}_{\text{consumption}} + \underbrace{s_i}_{\text{storage}}$$

Bellman equation

$$V(a) = \max_{s\in[0,a]} \left\{ u(\underbrace{a-s}_{\text{consumption}}) + \delta E V\left(\underbrace{(1-\phi)s + \tilde{q}'}_{\text{new stock}}\right)\right\}$$

A joint reserve

Redistributing availabilities: country B transfers $l = \psi(a_B - a_A)$ units of grain to country A

Insurance contract

$$\hat{a}_A = (1-\psi)a_A + \psi a_B$$
$$\hat{a}_B = \psi a_A + (1-\psi)a_B$$

Credit contract

$$\hat{a}_A = (1-\psi)a_A + \psi a_B - l_{-1}$$
$$\hat{a}_B = \psi a_A + (1-\psi)a_B + l_{-1}$$

If any country defaults, they remain in autarky forever

Default

$$\hat{a}_A = a_A$$
$$\hat{a}_B = a_B$$

A game of default

		Country B	
	j	Cooperate	Default
Country A	Cooperate	$W^A(a_A, a_B), W^B(a_A, a_B)$	$V^A(a_A), V^B(a_B) - \sigma$
	Default	$V^A(a_A) - \sigma, V^B(a_B)$	$V^A(a_A) - \sigma, V^B(a_B) - \sigma$

where

$$\underbrace{W(a_A, a_B, l)}_{\text{value of cooperating}} = \max_{s \in [0, \hat{a}]} \left\{ u(\hat{a} - s) + \delta E \underbrace{U(a'_A, a'_B, l)}_{\text{game payoff}} \right\}$$

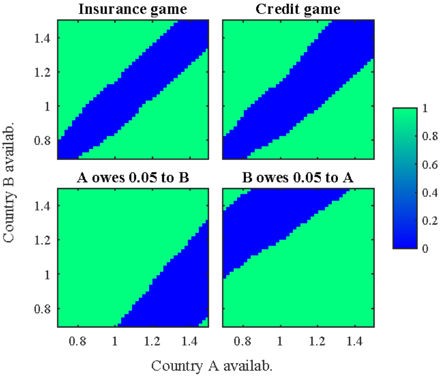
Main results

Because bigger liabilities drive countries to default, reserve is more sustainable when

- production shocks are positively correlated plot
- the shared fraction of availabilities is smaller plot
- the reserve is operated as an insurance union rather than a credit union plot

Default regions

- Default occurs when the required transfer exceeds a critical value l^*
- In insurance contract, only the country with higher availability has incentive to default.
- In credit contract, a debtor also has incentive to default if own availabily is low.

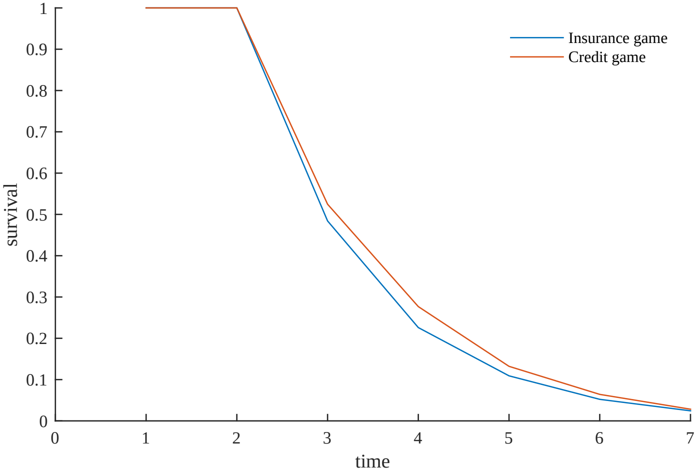


Appendix

...only if there is time

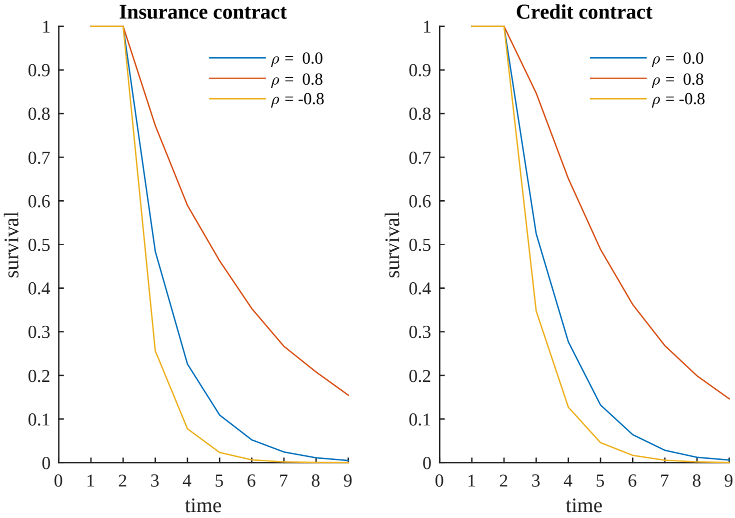
Time to default

The reserve would last only a few years, regardless of contract.



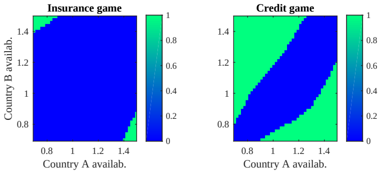
Production correlation and time to default

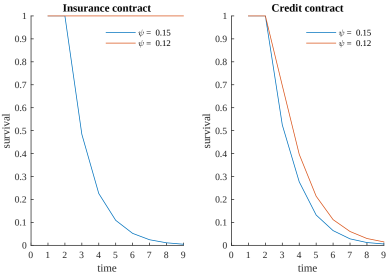
The reserve would be more stable for negatively-correlated production shocks.



Default when sharing less grain

When sharing less grain, insurance contract is very stable.





Solving the game

Numerical solution builds on CompEcon's *gamesolve*:

- to allow discrete states
- to allow discrete actions

Approximation algorithm

0. Discretize the production shocks
1. Compute the value of autarky V
2. Guess W^A and W^B, using Chebyshev polynomials
3. Get the payoffs U^A and U^B by solving the discrete game
4. Update W^A and W^B
5. Iterate steps 3 and 4 until convergence

Baseline parameters

Parameter	Description	Player 1	Player 2
ρ	relative risk aversion	2.00	2.00
φ	marginal cost of storage	0.05	0.05
δ	government discount factor	0.95	0.95
σ	stigma	0.05	0.05
α	beta distribution parameter	1.25	1.25
λ	max. production shock	0.30	0.30
ψ	shared availability	0.15	
ϱ	production correlation	0.00	