Managing Wheat Price Volatility in India

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Food security in India

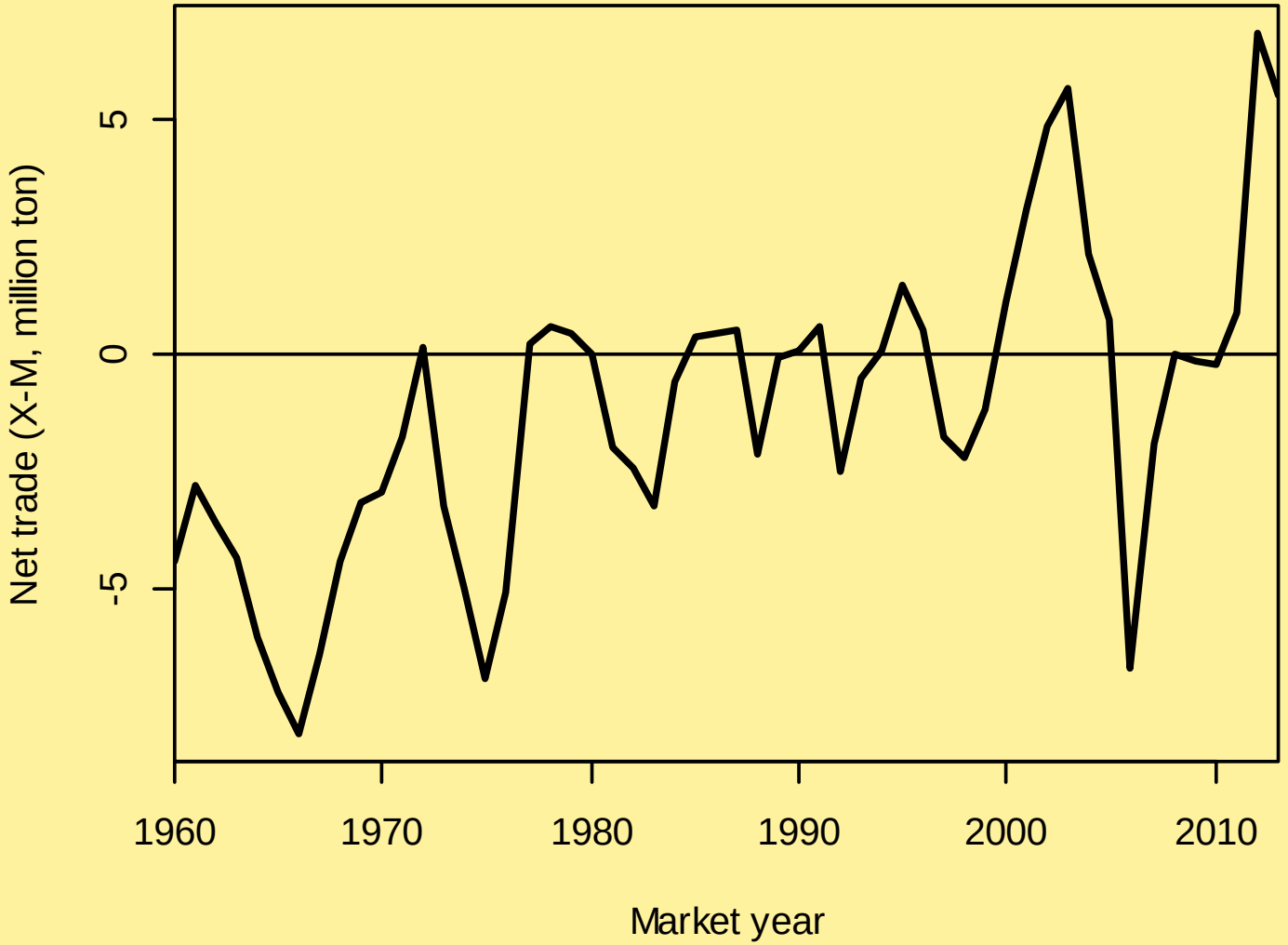
- Food security: top priority for policy makers
- Addressed through 3 pillars:
  - Availability: R&D, subsidized inputs (electricity, fertilizer, seeds, water, credit) and guaranteed prices.
  - Access: largest food schemes in the world
    - Targeted, quantity-constrained, releases of food to low income consumers
    - Set to expand under new Food Security Bill: 820 million people should receive subsidized food.
  - Stability: stable prices through active trade and storage policies.

Food security in India

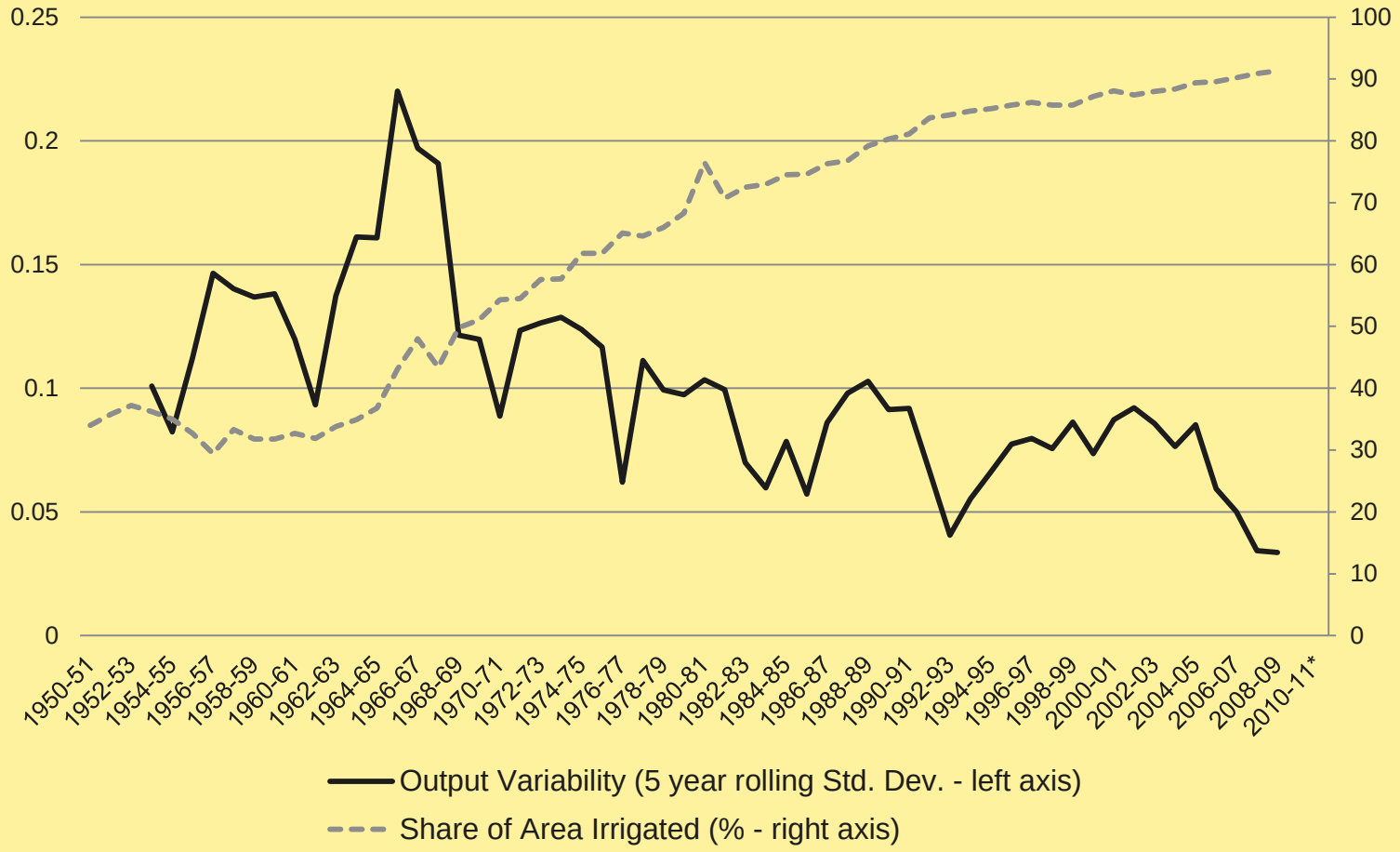
- Comprehensive and reinforcing policy instruments:
  - Trade policies insulate domestic markets
  - MSP is defended by public procurement and stockpiling.
  - Public stocks used to supply the Public Distribution System.
  - Discretionary disposal of remaining stocks to stabilize prices.
- Problems:
  - Hinders development of a private marketing network
    - 60% of marketed surplus are procured.
  - Costly and ineffective:
    - Very high food subsidy bill ($15 billion)
    - Households that are entitled can buy half of quota (Khera, 2011)
    - Grain stocks deteriorate – inadequate facilities or held too long

India’s wheat market

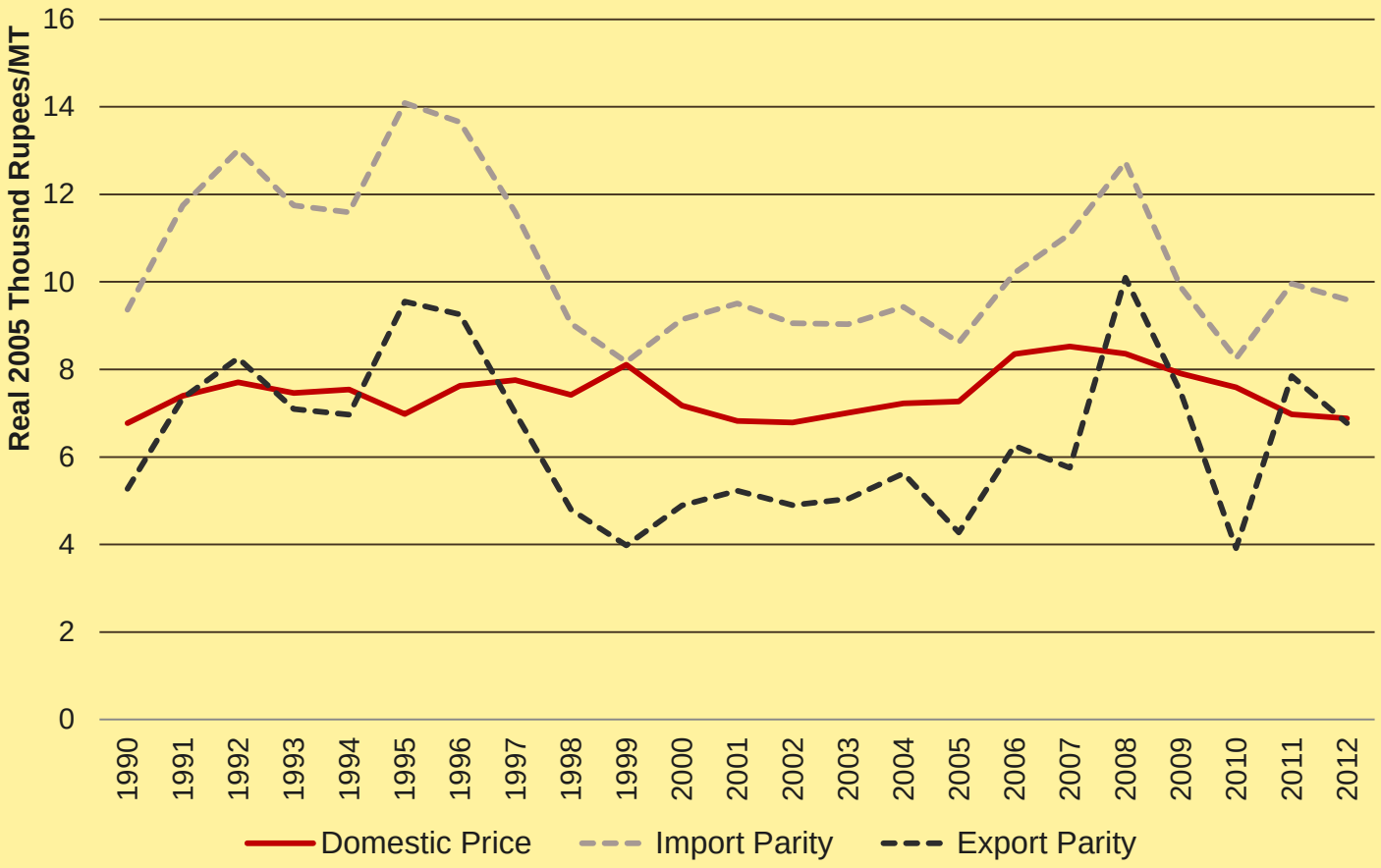
From importer to exporter



Stable Production

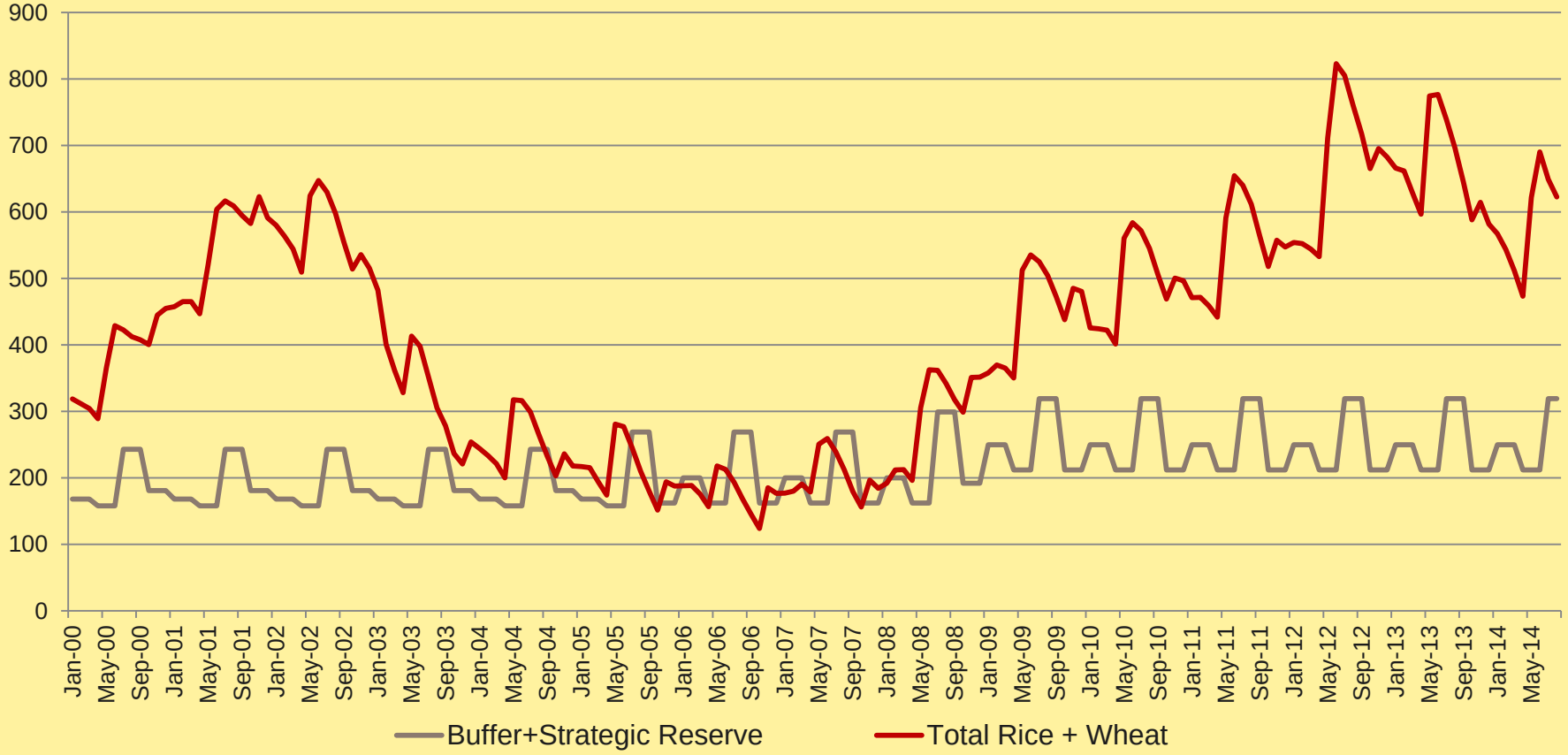


Stable domestic market



Grain stocks vs norms

Total Stock (Wheat + Rice) vis-à-vis Buffer Norms and Strategic Reserve
(Lakh Tonnes, Jan 2000 - Aug 2014)



Questions

- What are the implications of current policies?
  - For India and the world market
- Can a model identify better policies?
  - What is the optimal mix of storage and trade policies?
- Can simple rules yield similar results?

Modeling India's Wheat Market

Key features

- 2-country stochastic rational-expectations partial equilibrium model
  - India (i) & the Rest of the World (w)
  - Production, consumption, storage & trade
- A social welfare function that penalizes deviations of prices from the steady state.
- Design of optimal policy under commitment and optimal simple rules.

Producers & Consumers

Producers respond to expected prices:

$$\max \Pi^{r}_{t|t+1} = \delta E_t(P^{\mathrm{r}}_{t+1} H^{\mathrm{r}}_t \epsilon^{r}_{t+1}) - \Psi^{\mathrm{r}}(H^{\mathrm{r}}_t),$$

where H planned output, δ discount factor, ϵ a random shock to output, Ψ the production cost function.

FOC:

$$\delta E_t(P^{r}_{t+1} \epsilon^{r}_{t+1}) = \Psi^{r\prime}(H^{r}_t).$$

Consumers respond to current prices:

$$D^{\mathrm{r}}(P^{\mathrm{r}}_t) \equiv d^r P^{\mathrm{r}\,\alpha^r}_t,$$

where $d^r > 0$ is a scale parameter and $\alpha^r \geq 0$ is the demand elasticity.

Stocks & trade

Private storers arbitrage prices intertemporally

$$S_t^r \geq 0 \ \perp \ P_t^r + k^r - \delta E_t P_{t+1}^r \geq 0,$$

where S^r is private stocks & k^r storage costs.

Trade based on spatial arbitrage opportunities

$$X_t^w \geq 0 \ \perp \ (P_t^w + \theta_{w,i}) T_t^M \geq P_t^i$$

$$X_t^i \geq 0 \ \perp \ P_t^i \geq \left(P_t^w - \theta_{i,w}\right) T_t^X$$

with X^r exports from r, $\theta_{r,s}$ transport cost r to s, T_t^X & T_t^M the power of the export & import tax.

Availability and market

Availability (state variable)

$$A_t^{\mathrm{r}} \equiv S_{t-1}^{\mathrm{r}} + H_{t-1}^{\mathrm{r}} \varepsilon_t^r.$$

Market clearing

$$A_t^r + X_t^s = D^r(P_t^r) + S_t^r + X_t^r \text{ for } s \neq r.$$

Core laissez-faire model

2 state variables, $\{A_t^r\}$, and eight response variables, $\{P_t^r, S_t^r, H_t^r, X_t^r\}$, for $r \in \{i, w\}$.

Welfare

Welfare: sum of surpluses + loss function.

$$w_t^i = \left[-d^i \frac{{P_t^i}^{1+\alpha^i}}{1+\alpha^i}\right] + \left[P_t^i \bar{H}_{t-1}^i \epsilon_t^i - a^i \bar{H}_t^i - \frac{b^i {\bar{H}_t^i}^2}{2}\right] +$$
$$\left[P_t^i S_{t-1}^i - \left(k^i + P_t^i\right) S_t^i\right] - \left[Cost_t^i\right] \left[-\frac{K}{2}\left(P_t^i - \bar{P}^i\right)^2\right]$$

Where *Cost* is the sum of public storage costs and trade policy costs; $\left[-\frac{K}{2}\left(P_t^i - \bar{P}^i\right)^2\right]$ represents the dislike of policy makers for price stability.

K value specified with $K = \gamma(R - \nu)D(\bar{P})/\bar{P}$, where γ, R & ν are values of the budget share, relative risk aversion & income elasticity (Turnovsky et al., 1980, *Econometrica*).

Unpacking current policies

Key policies

- Capture the essence of discretionary policies by modeling them as simple rules.
- Price-insulating policies
  - Used to insulate from changes in world prices

$$T_{\mathrm{t}}^{M} = \alpha_M \left(P_t^w + \theta_{w,i}\right)^{\beta} \qquad T_t^X = \alpha_X \left(P_t^w - \theta_{i,w}\right)^{\beta}$$

  - $1 + \beta$ is the level of price transmission
- Purchase to defend the Minimum support price:

$$\Delta S_t^{G+} \geq 0 \ \perp P_t^i - MSP \geq 0.$$

  - The MSP assumed to be equal to the steady-state price

Stockholding policy

- Releases to supply the PDS:

$$\Delta S_t^{G-} = \min(\Theta, S_t^G + \Delta S_t^{G+}).$$

  - If stock levels are not enough, PDS is supplied by open-market purchases.
- When stocks exceeds the level $\bar{S}^G = 25$ million tons, they are exported (possibly with a subsidy)

$$X_t^{S^G} = \max\left(0, S_t^G + \Delta S_t^{G+} - \Delta S_t^{\overline{G}} - \bar{S}^G\right).$$

- Public stock level is an additional state variable:

$$S_t^G = S_{t-1}^G + \Delta S_{t-1}^{G+} - \Delta S_{t-1}^{G-} - X_{t-1}^{S^G}.$$

Parameter Values

Parameter	Value
India's Demand Elasticity	-0.3
ROW Demand Elasticity	-0.12
Wheat budget share %	10
Supply Elasticity	0.2
Private Storage Cost per ton	$22
Public Storage Cost per ton (source: FCI)	$87
Trade Costs per ton	
- Import	$65
-Export	$35
Standard deviation of production shocks in India and in ROW %	3.5

Estimating trade insulation

- Neglecting trade costs and assuming trade: $P^i = \alpha P^{w\,1+\beta}$.
- Prices likely cointegrated, so estimation in level would capture their long-run dynamics, not short-run price insulation.
- Estimate using an error-correction model

- $\boldsymbol{\beta = -0.76}$.

Solution methods

- Rational expectations storage models do not have closed form solutions.
- The solution is approximated by numerical methods
  - Projection methods: grid of points on state variables on which the model has to hold exactly.
  - Spline interpolation between grid points.
- RECS solver (http://www.recs-solver.org/)

Impacts on welfare

	Laissez-faire	Trade policy	Storage policy	Both
Δ Mean price%		-2.8	0.01	-3.3
Price CV (%)	14.4	10.7	10.1	3.1
Ave. Public storage	0	0	4.2	10.4
Ave. Private storage	0.10	0.02	0	0
RoW Price CV (%)	20.7	24.0	19.6	23.3
Contributions to India's Welfare (% of consumption expense)				
Cons Surplus		2.4	-1.3	2.1
Prod Surplus		-2.7	1.4	-2.2
Storage cost		0.0	-2.2	-3.7
Trade cost		0.08	0.0	0.13
Reduction in volatility cost		0.4	0.3	0.7
Total India welfare		0.2	-1.8	-3.0

Impacts of optimal policies & optimal simple rules

Fully optimal Policies

- Identify an active policy to maximize welfare
  - Model chooses trade tax & public storage levels
    - State-contingent policies (depend on current availability in the 2 regions and on history of the states: policies under commitment).
    - Analyze for different degrees of preference for price stability
- Allow to identify the best policy options, but
  - Very complex policies
    - Policies are function of variables that are not observable (e.g., Lagrange multipliers).

Optimal simple rules

- Compare with Simple – and potentially more tractable – rules for policy
  - Rules of public behavior with simple feedback between observables and interventions.
  - Optimal: rules' parameter are determined to maximize welfare
- Optimal Simple Rules:
  - Degree of Price insulation ($\beta < 0$: % of insulation)
  - Constant subsidy to private storage (ζ: % of physical storage costs)
    - Public storage costs too high; cannot justify a storage policy.
    - Provide incentives to more cost-effective private storers.

Key impacts, $R - \nu = 6$

	Laissez-faire	Optimal Policy	Simple Rules	Current Policies
Δ Mean price%		-2.8	-2.3	-3.3
Price CV %	14.4	4.8	8.5	3.1
Average Storage	0.10	0.95	0.95	12.5
RoW Price CV %	20.7	22.7	22.5	23.3
Contributions to India's Welfare (% of consumption expense)				
Consumer Surplus		1.66	1.70	2.1
Producer Surplus		-1.79	-1.84	-2.2
Storage cost		-0.09	-0.12	-3.7
Trade cost		0.11	0.17	0.13
Reduction in volatility cost		0.57	0.49	0.7
Total India welfare		0.46	0.40	-3.0

Optimal policies vs simple rules

$R - \nu$	Share of total welfare achieved by optimal simple rules
0	77.8%
3	85.8%
6	86.3%
9	86.1%
12	85.7%

Optimal simple rules achieves less welfare gains when $R - \nu = 0$:

- Gains come from terms-of-trade manipulation.
- OSR are not designed for this.

Optimal simple rules as $R \uparrow$

	$R - v$				
Variables	**0**	**3**	**6**	**9**	**12**
Price insulation (β)	-0.17	-0.41	-0.49	-0.53	-0.55
Storage subsidy (ζ)	0.02	0.72	0.97	1.08	1.15
Δ Mean price %	0.0	-1.2	-1.5	-1.6	-1.7
Price CV (%)	12.8	9.9	8.5	7.8	7.2
Ave Private Storage	0.1	0.5	1.0	1.3	1.7
Contributions to India's Welfare (% of consumption expense)					
Consumer Surplus	0.64	1.53	1.70	1.77	1.80
Producer Surplus	-0.72	-1.68	-1.84	-1.91	-1.94
Storage cost	0.00	-0.05	-0.12	-0.17	-0.22
Trade cost	0.10	0.16	0.17	0.18	0.18
Reduction in volatility cost	0.00	0.21	0.49	0.79	1.10
Total India welfare	0.02	0.17	0.40	0.66	0.92

With high storage costs?

- Previous results based private storage costs.
- Optimal policies with current public costs (4x)?
  - Annual cost of storage = 61% of steady-state price.
- Optimal simple rule implies negligible levels of stocks
  - Better to let annual stocks be carried out in the RoW and to use trade policy to stabilize domestic market.

Conclusions

- Current policies yield very stable domestic prices
  - But at very high costs & potential fiscal risks
  - Question whether costs commensurate with benefits
  - High cost of public storage a challenge
- Instruments appropriate but can be used more cost-effectively
  - Adopt a more rules based policy
- Optimal policies could yield significant welfare gains
  - With smaller increase in RoW price volatility
- Simple rules-based approaches may yield benefits almost as large as optimal policies
  - But would require trust with private storers

Thank you!

Error correction model

ADF test

Variable	Constant	Trend
Price		
India	-1.49 (1)	-0.73 (1)
US	-1.42 (2)	-3.15 (1)
Price differential		
India	-5.24*** (1)	-5.57*** (1)
US	-4.85*** (1)	-4.79*** (1)
Residual from cointegration eq.	-3.58** (1)	-4.00* (1)

Long-run equilibrium:

$$\ln P_t^i = \underset{(0.525)}{0.138} + \underset{(0.092)}{0.996^{***}} \ln P_t^w$$, Ad j-R^2: 0.73.

Error-correction model:

$$\Delta \ln P_t^i = \underset{(0.019)}{-0.021} + \underset{(0.106)}{0.244^{**}} \Delta \ln P_t^w - \underset{(0.080)}{0.145^{*}} EC_{t-1}$$

Adj-R^2: 0.11; DW: 2.21.

So $\boldsymbol{\beta = -0.76}$.

Data:

- India: Annual producer prices from FAOSTAT, converted to US dollars.
- World: US prices (IMF)
- Converted to real terms using US CPI.

Separating instruments

	$R - v$				
Variables	0	3	6	9	12
Optimal trade policy (when $\zeta = 0$)					
Price insulation (β)	-0.17	-0.40	-0.48	-0.52	-0.56
India price CV (%)	12.79	11.24	10.92	10.79	10.71
RoW price CV (%)	21.40	22.40	22.75	22.95	23.13
Optimal storage policy (when $\beta = 0$)					
Storage subsidy (ζ)	-0.09	0.49	0.73	0.85	0.93
India price CV (%)	14.46	13.61	12.85	12.28	11.85
RoW price CV (%)	20.72	20.56	20.41	20.27	20.16