Ryan and Sudarshan 2020 - Rationing the Commons

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November 4, 2020

EEE Presentation

Introduction

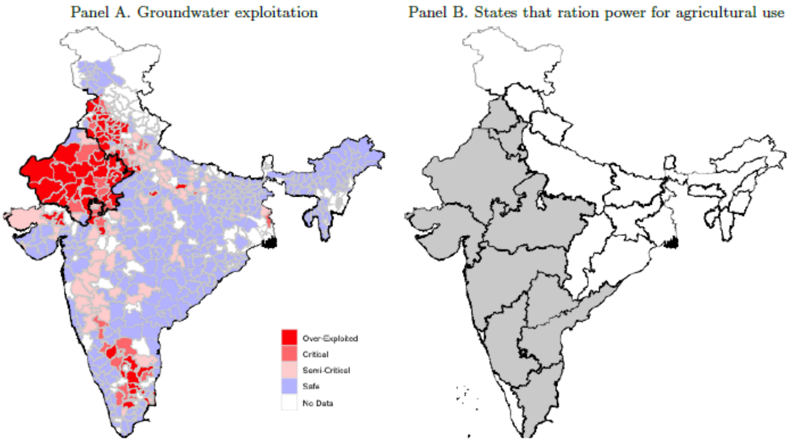
Motivation

- Economic development often has led to the mass depletion of natural resources
- India is now the largest user of groundwater in the world
- Economists have tools that should lead to efficient outcomes
- But do we balance equity and efficiency?

Research question: how does the current groundwater rationing system in India balance the trade-off between efficiency and equity?

Context: Common Pool Problem in Indian Groundwater

Figure 1: Groundwater Depletion in India



Weitzman (1977): Is the Price System or Rationing More Effective in Getting a Commodity to Those Who Need It Most?

"There is a class of commodities whose just distribution is sometimes viewed as a desirable end in itself, independent of how society may be allocating its other resources. While it is always somewhat arbitrary where the line should be drawn, such "natural right goods" as basic food and shelter, security, legal aid, military service, medical assistance, education, justice, or even many others are frequently deemed to be sufficiently vital in some sense to give them a special status. The principal of limited dimensional equity in the distribution of a commodity is an open violation of consumer sovereignty."

Weitzman Detour: Model

1. Measures each consumer's relative need vs. ideal allocation based on that need.
2. Social objective function: quadratic loss between ideal and actual allocations
3. Limited-information assumption: government needs to choose an allocation system without perfect information on where individuals lie on a distribution

Weitzman Detour: Results

If people's needs are more widely dispersed or if the society is relatively egalitarian $\rightarrow$ price mechanism

If people's needs are quite uniform or there is great income inequality $\rightarrow$ rationing mechanism

Model of agricultural production under rationing

Modelling the Optimal Ration

$$\underbrace{\sum_i \frac{d\widetilde{\Pi}_i\left(W_i\left(\bar{H}^*, D_i\right)\right)}{d\bar{H}^*}}_{\text{Marginal benefit}} = \underbrace{\sum_i c_E P_i + \rho \frac{P_i}{D_i} \lambda_W}_{\text{Marginal social cost}}$$

Farmer profits = Direct cost of elec. + Opportunity cost

Sufficient Statistic for Electricity Ration

$$W_i\left(H_i, D_i\right) = \rho \frac{P_i H_i}{D_i}$$

$$\sum_i \frac{d\widetilde{\Pi}_i\left(W_i\left(\bar{H}, D_i\right)\right)}{d\bar{H}} = \sum_i -\frac{d\widetilde{\Pi}_i}{dD_i}\frac{D_i}{H_i}$$

Calculating Marginal Benefits v Costs

Hedonic IV Regression to Estimate Marginal Benefits

$$\Pi_{ic} = \beta_o + D_i\beta_1 + X_{ic}'\beta_2 + \alpha_s + \alpha_p + \epsilon_{ic}$$

$$D_i = \delta_0 + Z_i'\delta_1 + \eta_{ic}$$

Coefficient of interest: $\beta_1 = \frac{d\Pi}{dD}$

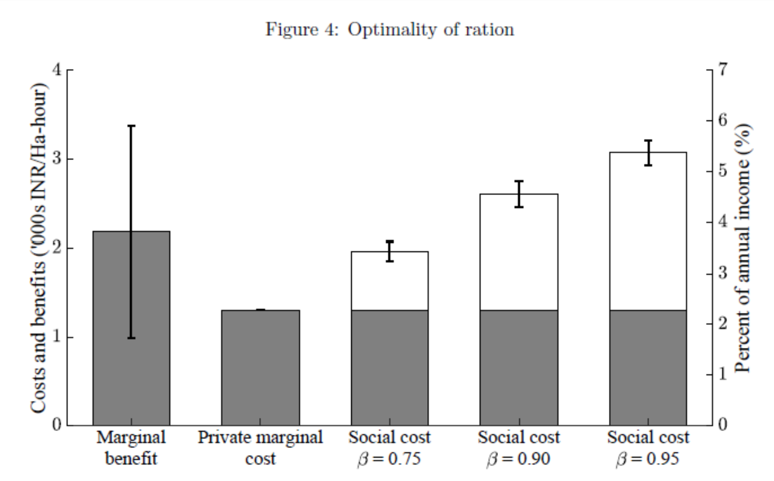
Discussion

Results of Hedonic Regressions

Table 2

	OLS (1)	OLS (2)	IV-PDS (3)	IV-PDS (4)
Well depth (1 sd = 187 feet)	0.69	−2.71*	−8.87***	−7.01***
	(1.25)	(1.56)	(2.47)	(2.70)

Comparing Marginal Benefits and Costs of Ration



Discussion

Structural Estimation and Counterfactuals

Structural Model of Agricultural Production

$$y_{ic} = \alpha_L l_{ic} + \alpha_X x_{ic} + \alpha_K k_{ic} + \alpha_W w_{ic} + \omega_{Yic}$$

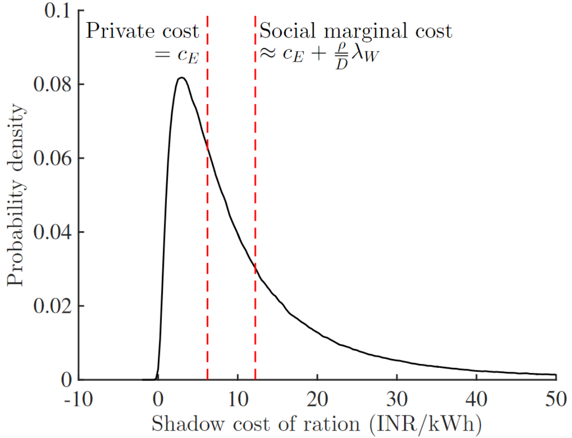
farmer i planting crop c

$$\omega_{Yic} = \underbrace{\overbrace{W_{Eic}\beta_E}^{\text{known output shifters}} + \overbrace{\omega_{ic}}^{\text{farmer-specific shock}}}_{\text{obs. by farmer}} + \underbrace{\epsilon_{Yic}}_{\text{unobs. shock at harvest}}$$

Questions

Model Estimates and Dispersion of Shadow Costs

Figure 6: Shadow cost of the status quo ration



Running Counterfactual Regimes and Transfers

Counterfactual Regimes

1. Ration set at optimal, rather than 6 hours
2. Pricing regimes instead of ration, sets price of electricity at private marginal cost
3. Pigouvian regime $\rightarrow$ sets price of electricity at social marginal cost

Transfer Methods

1. Flat (uniform) transfers across farmers
2. Transfers on basis of land size
3. Transfers on basis of pump capacity

Equations

Counterfactual Regimes Results

Table 4
Counterfactual Production and Social Surplus

	Rationing		Pricing	
	Status quo (1)	Optimal (2)	Private cost (3)	Pigouvian (4)
Surplus (INR 000s)	10.13	10.26	12.29	14.77
Water (liter 000s)	1592.37	1322.45	2853.76	1548.15
Power (kWh per season)	1011.60	840.86	1572.73	806.97
Hours of use (per day)	5.96	4.95	10.99	6.12
Output (INR 000s)	54.61	52.00	68.67	59.21
Gain in output from status quo (pp)		-5	26	8
Gain in output due to input use (pp)		-5	19	2
Gain in output due to productivity (pp)		-0	7	6

Distributional Impacts of Pigouvian Reform

Table 5
Distributional Effects of Pigouvian Reform

	Rationing	Pigouvian			
Transfers:	None (1)	None (2)	Flat (3)	Pump (4)	Land (5)
A. Inequality under different transfer schemes					
Mean profit (INR 000s)	45.36	32.90	32.90	32.90	32.90
+ Mean transfer (INR 000s)	0.00	0.00	22.24	22.24	22.24
Mean net profit (INR 000s)	45.36	32.90	55.13	55.13	55.13
Share who gain		0.10	0.74	0.68	0.61
Share who lose		0.90	0.26	0.32	0.39

Summary

- On average, the current 6-hour ration is set at the roughly efficient level
- With farmer heterogeneity, even the optimal ration produces allocative inefficiency
- Pigouvian pricing would lead to large increases in social surpluses, but about 90% of farmers would lose out if no transfers are given
- Even with transfers, significant portions of farmers would still be worse off

Discussant

Musings

- Appreciate a comparison between efficiency and distribution
- Comparing current policy to realistic policies that government could take $\rightarrow$ Coase would be proud!
- Extremely well written and and straightfoward to understand, even with all the moving parts
- Agricultural survey is very impressive

Importance of This Paper

- Agriculture is 16% of India's GDP, but a huge portion of consumer surplus
- 60% of Indian population works in the agriculture sector
- India's agricultural output accounts for about 7% of world agricultural output
- How we use water today has many feedback components that are made worse with climate change
- Direct Benefit Transfers (DBT) of Electricity subsidies

How Should We Think About the Future?

- Found that the rationing status quo seems close to being efficient, but "Rajasthan as a state is extracting groundwater at 137% of the rate that can naturally be recharged."
- Are they picking the right discount rate? Fig. 4
- Method of estimating costs does not incorporate the feedback components discussed Dynamic Model

Instrument Variable Exclusion Restriction

To estimate marginal benefits from more water, authors use geological features as an instrument for water depth. IV

How does this get rid of the endogeneity concern?

Possible Extension

- What are the implications if we take into account that farmers can adapt or switch crops when the government sets a high enough ration? Put another way, what other dimensions can we learn if we use panel data?
- Does quality of electricity matter here?

Questions

1. Do most farmers pay their electricity bills?
2. Are microgrids or alternative energy sources used to get around the ration?
3. In equation (9), why is it important to include W_{Eic} in the residual if those are observable? Structural Eqn

Extra Slide: Pigouvian vs Rationing

Pigouvian Regime: $p_E^* = \underset{p_E}{\arg\max} \sum_i \mathbb{E}\left[\widetilde{\Pi}_i\left(p_E\right) - c_E P_i H_i\left(p_E\right) - \rho_i \frac{H_i(p_E)}{D_i}\lambda_W\right]$

Rationing Regime: $\bar{H}^* = \underset{\bar{H}}{\arg\max} \sum_i \left[\widetilde{\Pi}_i\left(W_i\left(\bar{H}, D_i\right)\right) - c_E P_i \bar{H} - \rho \frac{P_i}{D_i} \bar{H} \lambda_W\right]$

Counterfactuals

Extra Slide: Dynamic Model (Appendix E)

Farmer's Problem: $\max_{H_t \leq \bar{H}} \Omega \left(W_t \left(H_t, D_t\right)\right)^{\alpha_W} - p_E P H_t$

$$H_t^* = \min \left\{ \left(\frac{\Omega \alpha_W}{p_E}\right)^{\frac{1}{1-\alpha_W}} \left(\frac{\rho}{D_t}\right)^{\frac{\alpha_W}{1-\alpha_W}} \frac{1}{P}, \bar{H} \right\}$$

$$W_t^* = \rho \frac{P H_t^*}{D_t}$$

LOM: $D_{t+1} = D_t + \gamma \left(W_t - R\right)$

Social Surplus: $S\left(D_t\right) = \sum_{t=0}^{\infty} \beta^t \left[\Pi \left(W_t \left(H_t^* \left(D_t\right), D_t\right)\right) - \left(c_E - p_E\right) P H_t^* \left(D_t\right)\right]$

Opp. Cost: $\lambda_W = \frac{dS(D_{t+1})}{dD_{t+1}} \frac{dD_{t+1}}{dW_t} = \frac{dS(D_{t+1})}{dD_{t+1}} \gamma$

Discussion