Ogg + Gollehon

Use econometric approach

Instead of estimating a production function, they estimate a demand function for water.

Ogg + Gollehon Issues

- control for crop type by limiting analysis to counties growing field crops other than rice

  omit - rice
  orchards
  vegetables

- control for climate (which affects ET) by performing separate analyses for different regions defined in terms of ET.

- control for irrigation technology by estimating separate equation for sprinkler-irrigated farms

- control measurement error in water price by restricting analysis to counties that use groundwater.

- controls for possible simultaneity bias by using instrumental variables for price variable.

- explore a variety of functional forms (although none that allows for demand to become <u>more</u> elastic at a higher price)

- Finds low elasticity of demand. - about 0.25

Estimation of groundwater demanded (Q) as a function of price (P) employed the following equations:

Linear $$Q = \beta_1 + \beta_2 P + \varepsilon$$

Log-log $$\ln(Q) = \beta_1 + \beta_2 \ln(P) + \varepsilon$$

Quadratic $$Q = \beta_1 + \beta_2 P + \beta_3 P^2 + \varepsilon$$

Where Q equals producer's average water application (centimeters per land unit), taken directly from the survey; P equals energy costs for pumping in dollars per 1000 m^3; and β_1, β_2, and β_3 are estimated coefficients. The linear specification assumes a constant slope but changing elasticity. The log-log specification allows the demand curve to change slope but assumes a constant elasticity. The quadratic specification allows both the slope and elasticity to vary.

TABLE 3. Least Squares Water Demand Estimates Using Three Functional Forms for the 16 State Western Region

Functional Form	β_1	β_2*	β_3*	Elasticity at the Mean	Adjusted R^2, %
Linear	41.88	−0.083 (−7.447)		−0.07	3
Log-Log	4.23	−0.262 (−18.67)		−0.26	15
Quadratic	45.29	−0.212 (−10.22)	0.000234 (7.34)	−0.18	5

*Numbers in parentheses are the *t* statistics.

TABLE 4. Groundwater Demand Estimates by Climatic Region Using a Log-Log Form

	Region			
Item* and Units	All Regions†	Low CIR	Medium CIR	High CIR
Intercept	4.23	4.37	4.20	4.32
Elasticity	−0.26	−0.34	−0.22	−0.24
t Value‡	18.67	14.77	12.98	3.15
Adjusted R^2, %	15	21	16	8

*The equations are based on observations weighted by the expansion factor. Interpretation of the equations is ln (*Q*) equals intercept plus (elasticity times ln (*P*).

†The 16 western states which exclude California.

‡All values refer to the price variable and are significant at the 1% level.

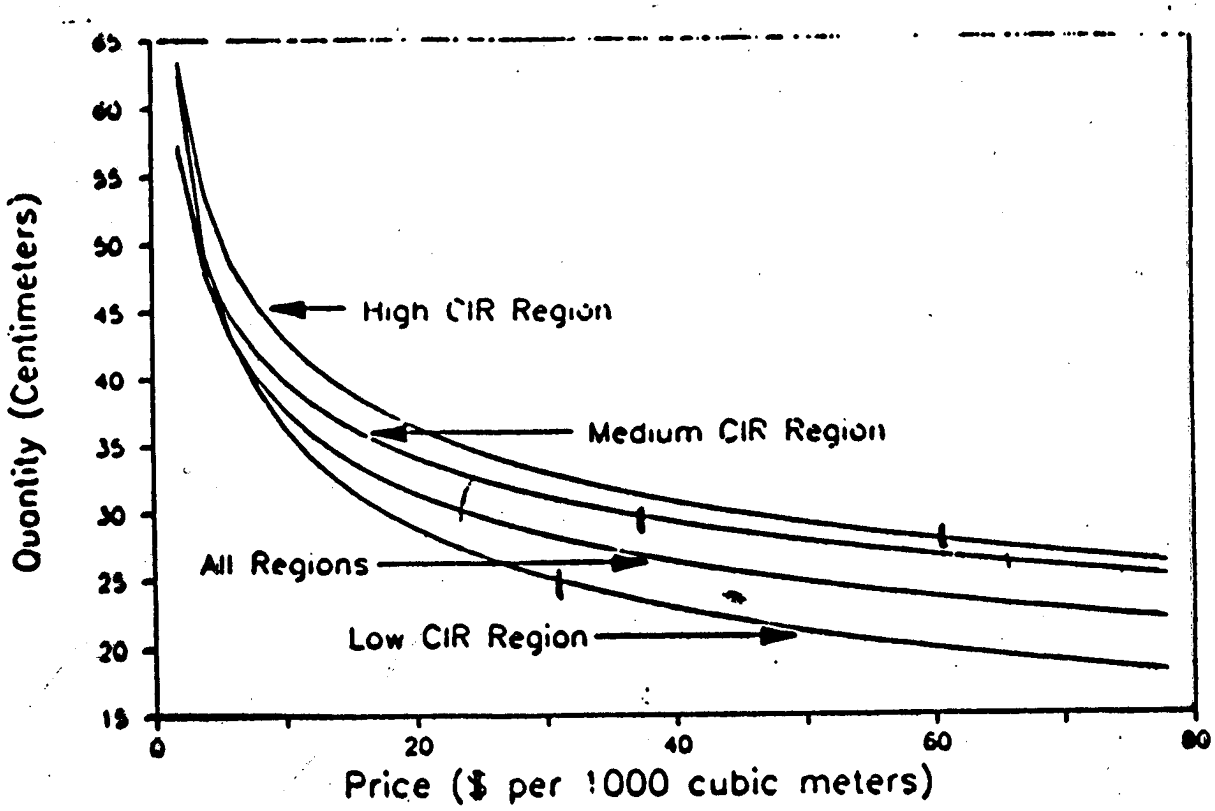


Fig. 2. Western irrigation water demand by region, log-log form, 1984.

what can explain this finding?

- They use econometric approach, instead of programming approach
- They estimate demand function directly rather than indirectly, in sense of estimating a production function or profit/cost function directly and then infering the demand function, which gives an indirect estimate
- They use observational data – not data from agronomic experiments
- Their data covers a broad range of the western US – many states
- Their data is for individual farms rather than county-wide aggregates.

COMPLICATIONS IN ANALYZING INPUT DEMAND FOR WATER IN AGRICULTURE

- QUANTITY RATIONING BY IRRIGATION DISTRICTS

  Water scarcity in areas that require irrigation

  Water use is spread over growing season while often greatest water supply is available in the spring

(Kanazawa paper)

- MULTI-CROP PRODUCTION BY INDIVIDUAL GROWER

Rationed Demand vs Price-Responsive Water Use?

(Kanazawa)

input demand function quantity unconstrained

" " quantity constrained).

unconstrained input demands

$$x_W = x_W(P_W, P_{NW}, P_y)$$

$$x_{NW} = x_{NW}(P_W, P_{NW}, P_y)$$

P_W = surface water price

P_{NW} = nonwater input price

P_y = output price

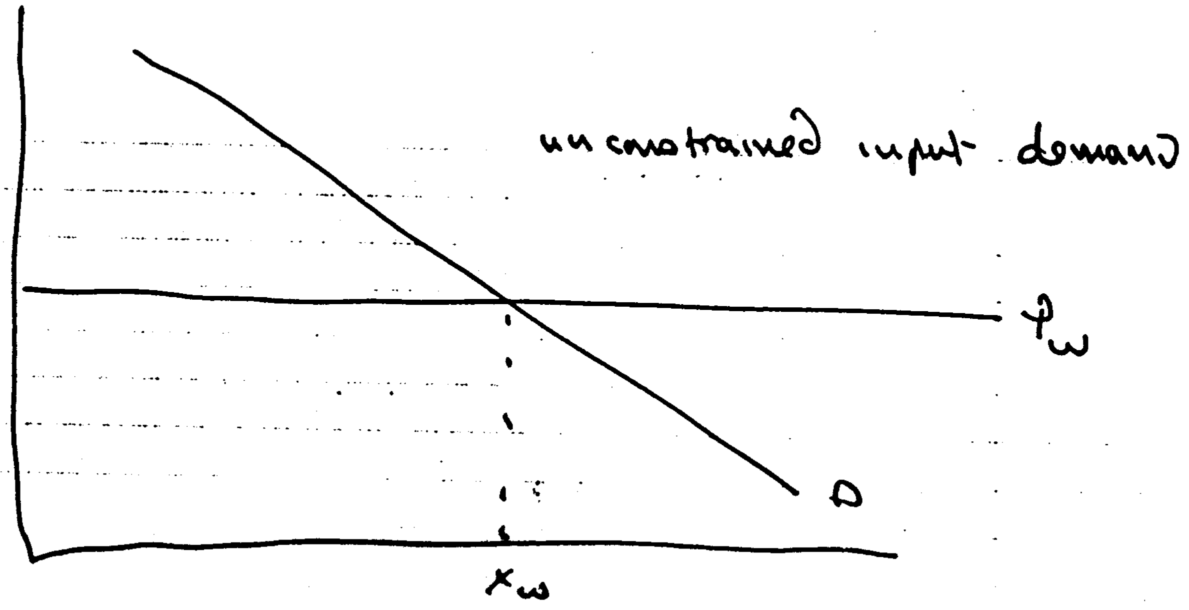
constrained input demands

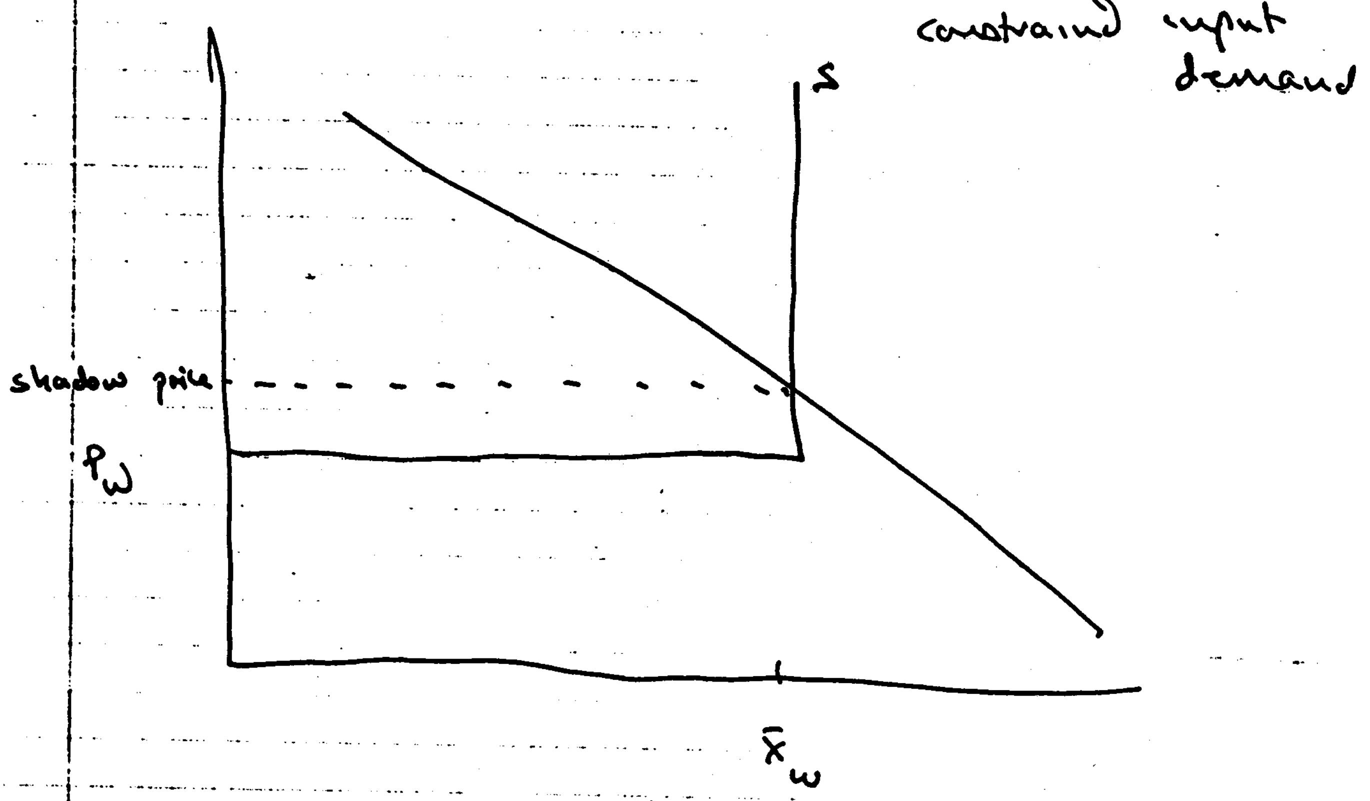
$$x_W = \bar{x}_W$$

$$x_{NW} = x_{NW}(\bar{x}_W, P_{NW}, P_y)$$

Effect on water use

- shadow price vs actual price with binding quantity constraint



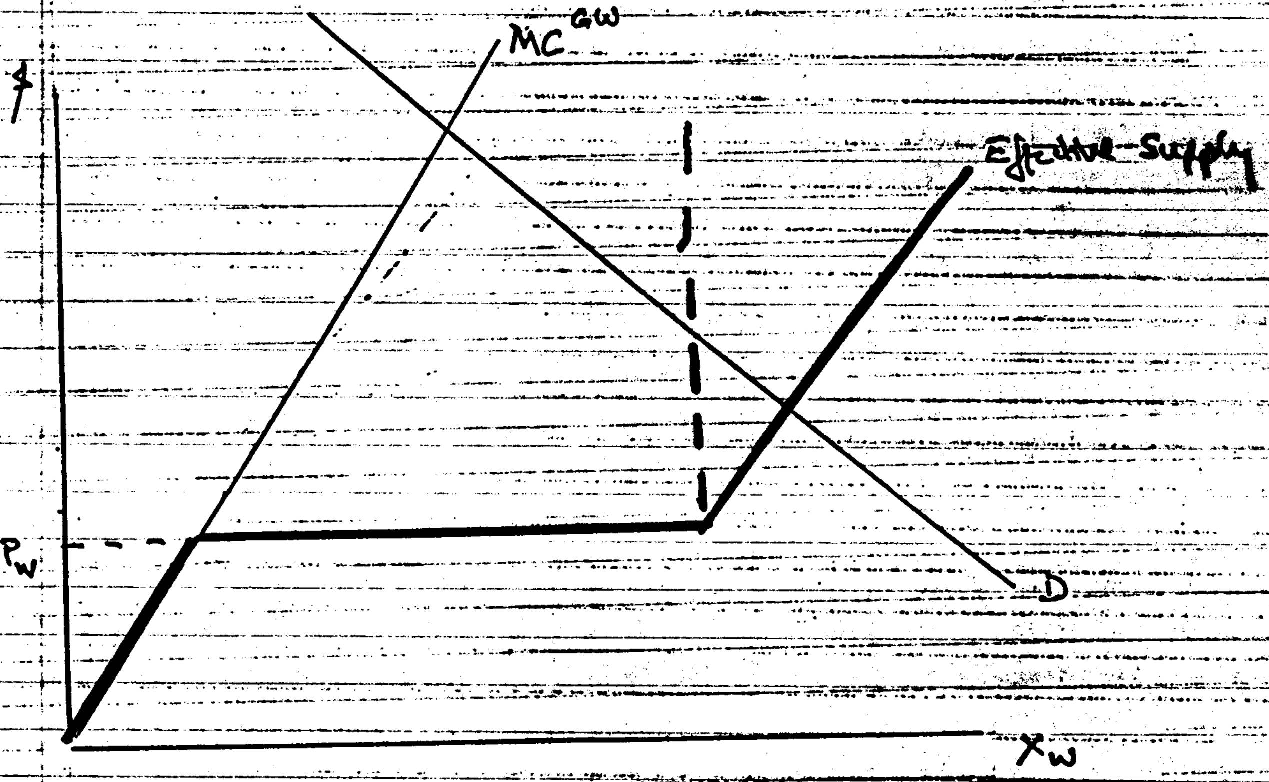


Further complication

fixed supply of surface at constant price

plus

upward sloping supply curve of groundwater



Constrained Input Demand with GW

MC_{GW} = marginal cost of ground water

$$x_W = x_W(MC_{GW}, P_{NW}, P_Y)$$

$$x_{NW} = x_{NW}(MC_{GW}, P_{NW}, P_Y)$$

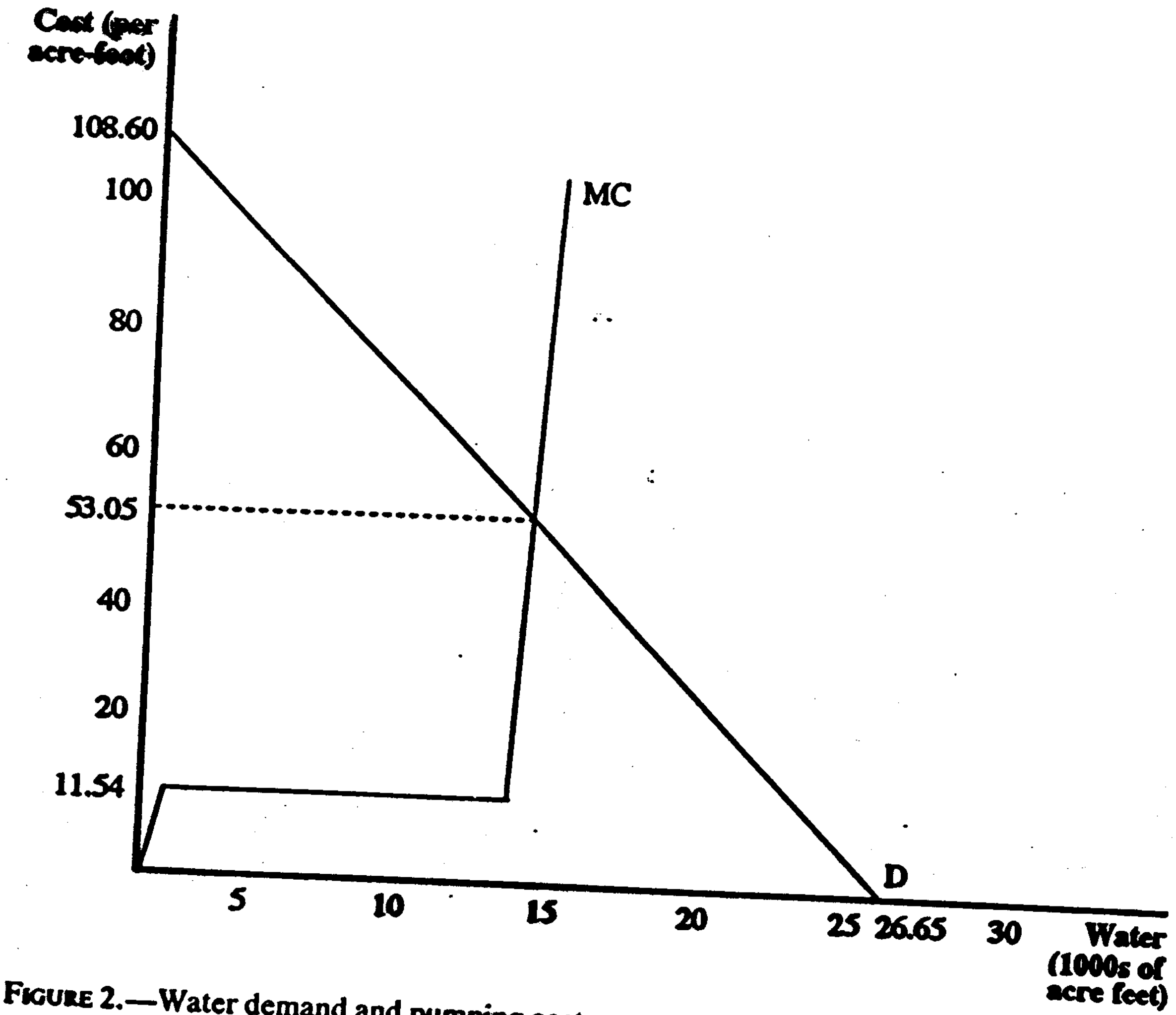


FIGURE 2.—Water demand and pumping costs, average Westlands quarter township, 1982

TABLE 3

ESTIMATED PRICE ELASTICITIES OF DEMAND FOR WATER

	(1)		(2)	
STUDY	Price (1977 Dollars)	Point Price Elasticity	Price (1977 Dollars)	Point Price Elasticity
Moore	9.60	−.14	29	−.59
Moore and Hedges	8.20	−.19	32	−.70
Shumway	12.00	−2.03	. . .	. . .
Howitt, Watson, and Adams	. . .	. . .	25–35*	−1.50†
Study estimates	10.00	−.10	30	−.38

SOURCES.—Charles V. Moore, Economics of Water Demand in Commercialized Agriculture, 54 Am. Water Works Assoc. J. 913 (1962); Charles V. Moore and Trimble R. Hedges, A Method for Estimating the Demand for Irrigation Water, 15 Agric. Econ. Res. 131 (1963); C. Richard Shumway, Derived Demand for Irrigation Water: The California Aqueduct, 5 S. J. Agric. Econ. 195 (1973); and Richard E. Howitt, William D. Watson, and Richard M. Adams, A Reevaluation of Price Elasticities for Irrigation Water, 16 Water Resources Res. 623 (1980).

* 1976 dollars.

SOME CONCLUSIONS

1. Approaches that derive irrigation input demand via optimization based on a production function (Moore & Hedges, Howitt, Ayer & Hoyt, Hooker & Alexander) probably overstate the elasticity of demand.

2. Econometric estimation of input demand is likely to be more realistic, in my view (Ogg & Gollehon, Kanazawa). But to the extent that they ignore possible changes in irrigation technology, they understate long-run elasticity of demand.

3. Purely cross-section studies of irrigation technology adoption provide at best a long-run elasticity of technology adoption; they are likely to overstate the short-run elasticity.