Dams

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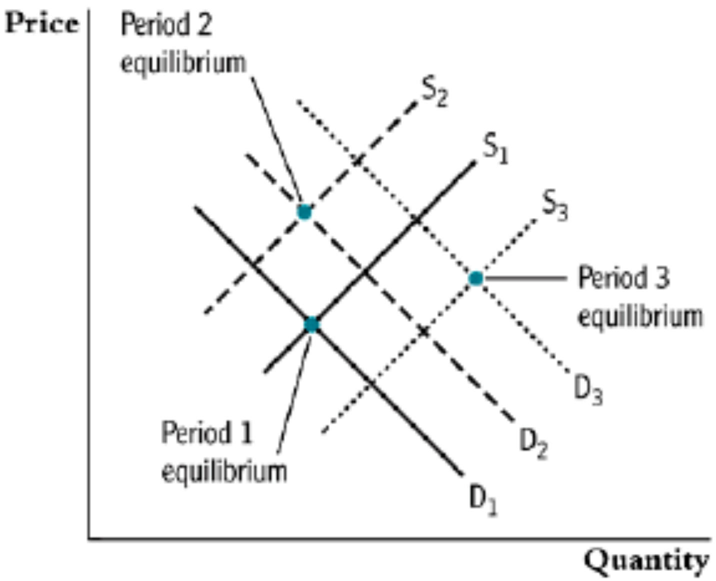
Simultaneous causality bias in the OLS regression of $\ln(Q_i^{butter})$ on $\ln(P_i^{butter})$ arises because price and quantity are determined by the interaction of demand *and* supply

FIGURE 10.1

(a) Price and quantity are determined by the intersection of the supply and demand curves. The equilibrium in the first period is determined by the intersection of the demand curve D_1 and the supply curve S_1. Equilibrium in the second period is the intersection of D_2 and S_2, and equilibrium in the third period is the intersection of D_3 and S_3.

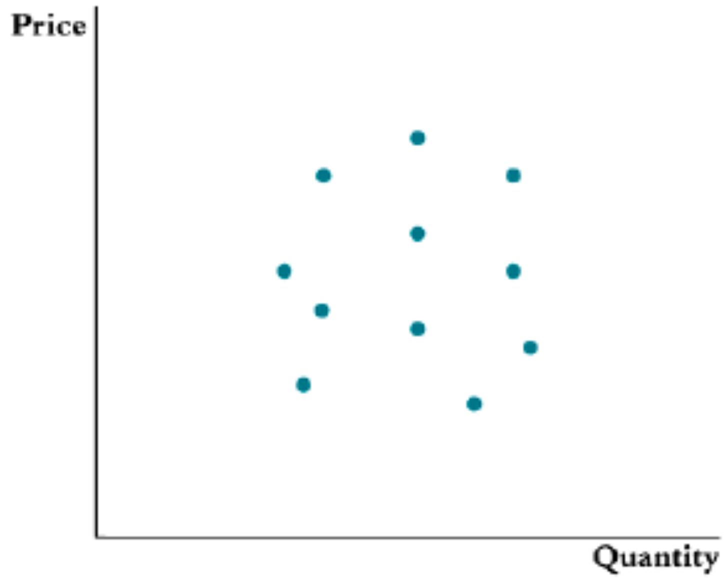


(a) Demand and Supply in Three Time Periods

This interaction of demand and supply produces…

FIGURE 10.1

(b) This scatterplot shows equilibrium price and quantity in eleven different time periods. The demand and supply curves are hidden. Can you determine the demand and supply curves from the points on the scatterplot?



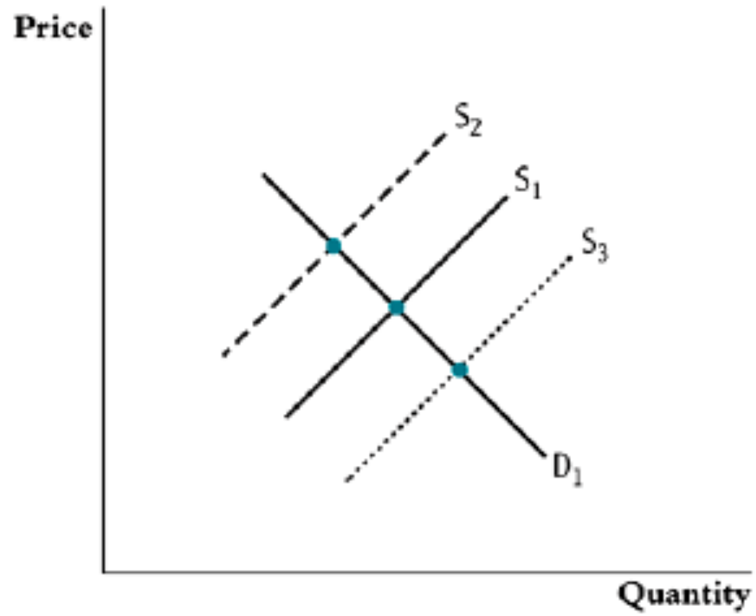
(b) Equilibrium Price and Quantity for Eleven Time Periods

Would a regression using these data produce the demand curve?

What would you get if only supply shifted?

FIGURE 10.1

(c) When the supply curve shifts from S_1 to S_2 to S_3 but the demand curve remains at D_1, the equilibrium prices and quantities trace out the demand curve.



(c) Equilibrium Price and Quantity When Only the Supply Curve Shifts

- TSLS estimates the demand curve by isolating shifts in price and quantity that arise from shifts in supply.
- Z is a variable that shifts supply but not demand.

Summary of IV Regression with a Single X and Z

- A valid instrument Z must satisfy two conditions:

  (1) *relevance*: $\text{corr}(Z_i, X_i) \neq 0$

  (2) *exogeneity*: $\text{corr}(Z_i, u_i) = 0$

- TSLS proceeds by first regressing X on Z to get $\hat{X}$, then regressing Y on $\hat{X}$.
- The key idea is that the first stage isolates part of the variation in X that is uncorrelated with u
- If the instrument is valid, then the large-sample sampling distribution of the TSLS estimator is normal, so inference proceeds as usual

- Worldwide, over 45000 large dams have been built
- 2000: 19% world' s electricity, 30% irrigated area
- Displaced over 40 million people
- Distribution of costs and benefits remain debated
- Absence of systematic empirical evidence on:
- **How does the average large dam affect welfare, especially of the rural poor?**

Data

- Dams: World Registry of Large Dams. Lists all large dams in India, date of completion, nearest city to the dam.
- Geography: District area, river km, elevation, overall gradient, and river gradient, files from internet, processed by Earth Institute Columbia University.
- Agriculture: Evenson and McKinsey India Agriculture and Climate dataset, on net. Covers 271 districts, 1971-1987.

Data

- Rural poverty estimates for 1973, 1983/84, 1993/94, and 1999/00 from NSS data. Topolova (2004) computed district-wise statistics using Deaton's proposed poverty lines. Had to 'match' districts where boundaries changed.

Background

- Irrigation dams, 90% of India's large dams
- Planning Commission: five year water storage targets
- State government agency and farmers jointly manage irrigation system associated with a dam.
- Government agency often restricts water withdrawal upstream of the dam to ensure water flow from dam is good

Background

- Dam irrigation literature: reasons for relationship between geography and dam site.
- Reservoir should be wide in comparison to the dam site
- Gradient should be high enough so water can flow by gravity but not so high that it erodes the canal
- High gradient favours hydroelectricity

Background

- Simple agricultural production framework, based on Evenson and McKinsey
- $Y = F(L, K, A, I, r, u, e)$
- Y agricultural production, L labour, K land, A land quality, I inputs, r climate, u farmer ability, e productivity shock
- F_1 with irrigation, F_2 without irrigation
- Irrigation reduces volatility, and complementary to other inputs

Background

- If irrigation has a fixed cost, then dams will induce some farmers to switch to irrigation, but not those who have already incurred sunk costs of irrigation
- Dams increase irrigated area but by less than the area served by the dam
- In catchment area, however, you have submergence and displacement of people
- Estimates of displaced in India vary between 16 and 40 million people, large proportion of displaced are scheduled tribes

Background

- Waterlogging and salinity
- In drought years, water restrictions in catchment will affect farmers adversely
- Dams may prevent floods, and may result in greater malaria etc.
- Land Acquisition Act 1894, landless those without title not recognized, compensation has been inadequate (Dreze).

Unit of analysis

- Districts: those upstream of dam and those downstream of dam or those in which the dam is downstream or those in which the dam is upstream will have effect of dam

Empirical strategy

- Detailed Indian district panel data
- OLS regression estimates are likely to be inconsistent
- Dams→agricultural production (dams affect agricultural production)
- But
- Agricultural production→ dams (states with high agricultural production can build more dams; and states that expect larger increases may build more dams)

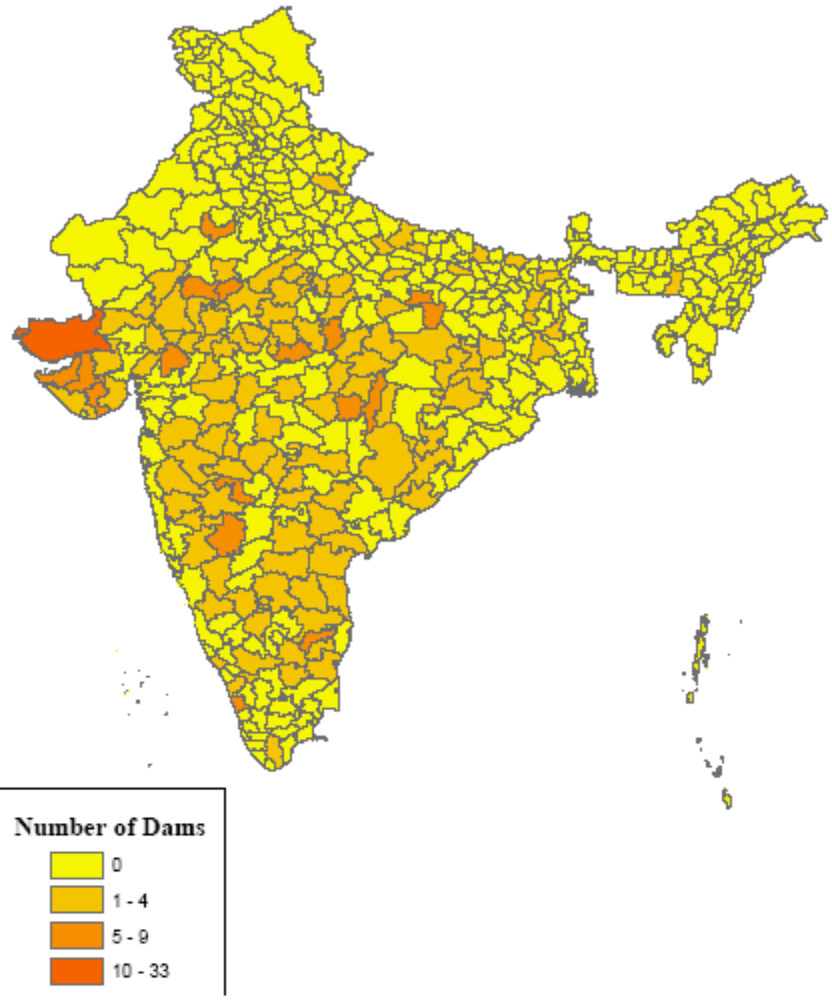
Identification strategy

- Relies on within-state differences in dam construction, differences across districts in a state
- Yist = b1 + b2Dist + b3DUist + b4Zit + b5ZUit + vi + ust + wist
- i: district, t time s state
- D number of dams in district, DU number of dams located upstream, v district fixed effect, Z and ZU are time varying control variables for district and upstream districts

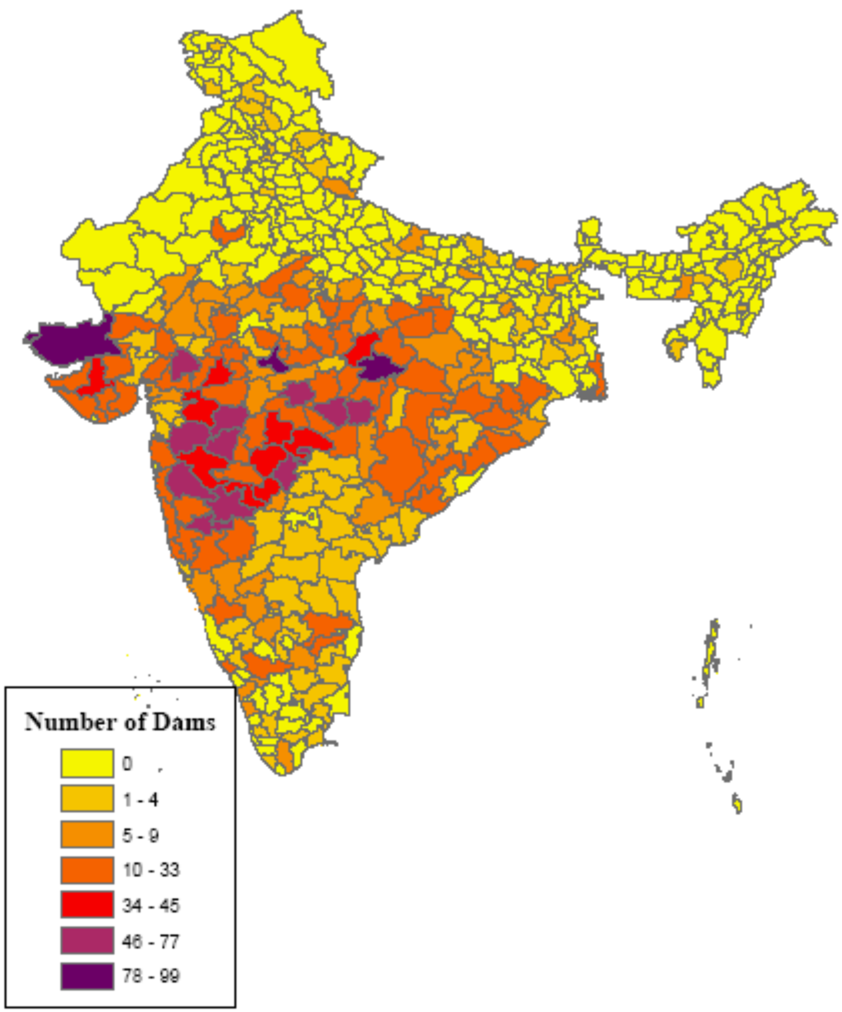
Instrumental variables

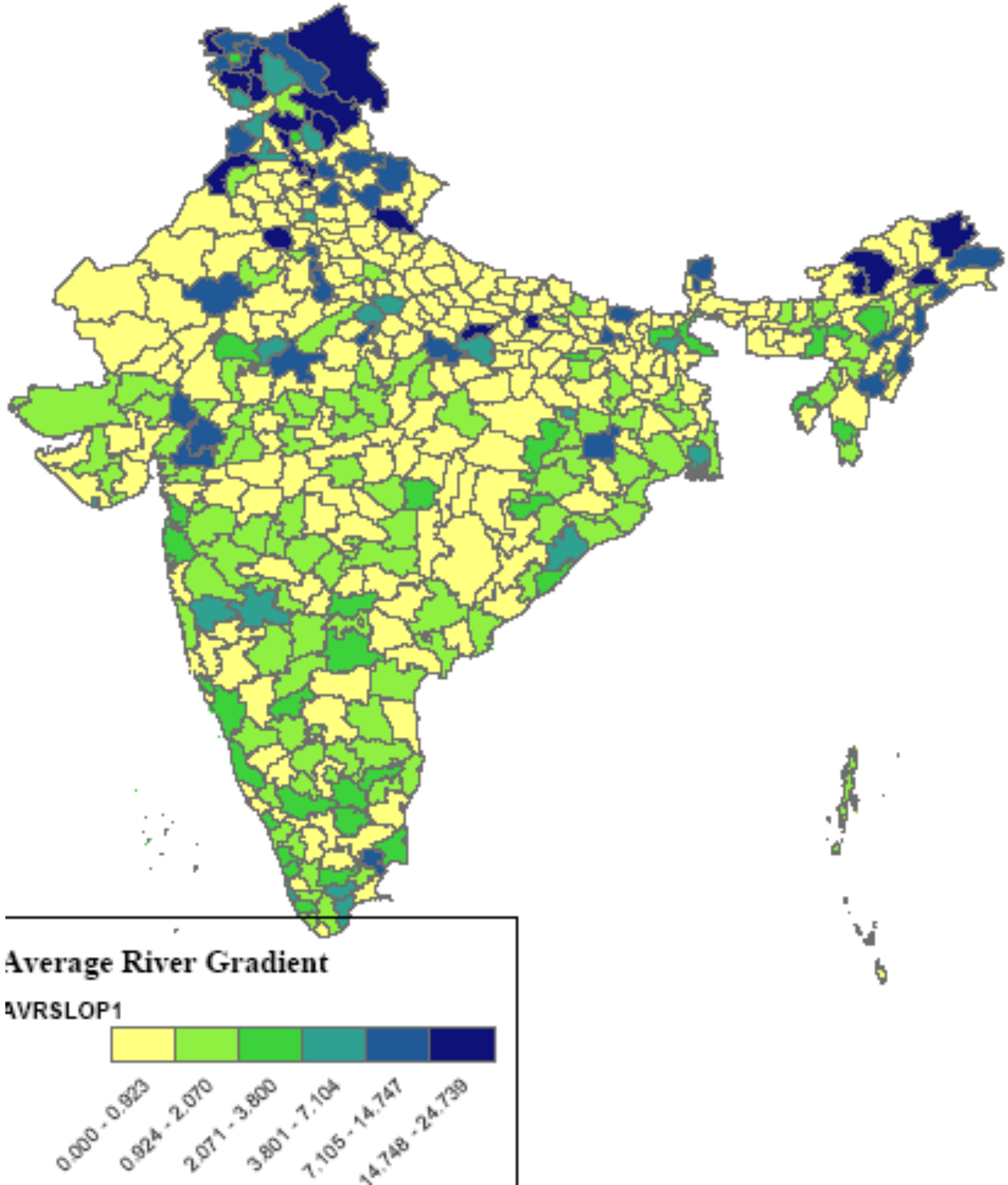
- D and DU are instrumented for by river gradient
- Use information on surface elevation to compute the fraction of district area in four different elevation categories: 0-250 metres, 250-500 metres, 500-1000 metres and above 1000 metres. Then see fraction of district falling into different gradient categories.
- Control for elevation, overall gradient and river length in a district.

1965


Number of Dams
0
1 - 4
5 - 9
10 - 33

1995


Number of Dams
0
1 - 4
5 - 9
10 - 33
34 - 45
46 - 77
78 - 99



Average River Gradient
AVRSLOP1
0.000 - 0.923
0.924 - 2.070
2.071 - 3.800
3.801 - 7.104
7.105 - 14.747
14.748 - 24.739

River gradient

- Humans, or the public sector, create dams
- But river gradient is part of nature, not under human control.
- Therefore, valid instrument.
- QED.

QED?

- The Nobel laureate Deaton (2010) distinguishes between variables that are external (whose variables are not set or caused by the variables in the model) and variables that are exogenous (orthogonal to the error term). Deaton (2010, p. 31) writes:
- “Failure to separate externality and exogeneity—or to build a case for the validity of the exclusion restrictions—has caused, and continues to cause, endless confusion in the applied development (and other) literatures.

QED?

- Natural or geographic variables … distance from the equator, … land gradient (as an instrument for dam construction in explaining poverty, Duflo and Rohini Pande 2007), … are not affected by the variables being explained, and are clearly external. … Whether any of these instruments is exogenous (or satisfies the exclusion restrictions) depends on the specification of the equation of interest, and is not guaranteed by its externality.

QED?

- And because exogeneity is an identifying assumption that must be made prior to analysis of the data, empirical tests cannot settle the question. … Passing an overidentification test does not validate instrumentation."
- As I [vikram] see it, statistical models are enigmatic, not only because we require judgment with respect to their assumptions (S: <u>A</u>), but also because we need to use judgment with respect to the tests of statistical assumptions.

Feasible Optimal IV estimates (extracts from the tables)

Dams	Log (Agricultural yield)	Headcount ratio
Own district	-0.033 (0.451)	0.772 (0.324)
Upstream	0.193 (0.097)	-0.154 (0.068)
…		

Results

- Instrumental variable estimates indicate a significant increase in gross irrigated area in downstream districts—and additional dam increases irrigated area in the downstream district by roughly 0.33%.
- Dam construction significantly increases agricultural production (0.34%) and yield (0.19%) in the downstream districts. This is due to increase in water-intensive crops.

Results

- Their estimate: an additional 3191 ha are irrigated by a dam. Planning Commission: 8759 ha irrigated by dam (1985). 36% of the area irrigated by dams would not have been irrigated otherwise.
- Having a dam upstream *reduces* the adverse effect of a negative rain shock
- Dams *amplify* the effect of a rain shock in own district. Likely to be particularly harmful to the poor.

Results

- Each dam is associated with a significant poverty increase (headcount ratio) of 0.77% in its own district.
- Poverty decreases in downstream districts.
- Since, on average, 1.75 districts downstream of each dam, the poverty reduction in downstream districts is insufficient to compensate for the poverty increase in the dam's own district.
- On average, between 1973 and 1999 the average district had five dams built in own district and ten dams upstream. Their point estimate: this led to a 2.35% increase in the head count ratio.

Results

- Poorly functioning institutions of redistribution.
- World Commission on Dams [2000b] describes the rehabilitation policies of Indian states as 'knee-jerk reactions to the manifestations of disaffection…'
- Does 'institutional quality' affect dam impact?
- Poverty impact of dams is independent of the tribal population share of the district.
- Historic land tenure arrangements significantly affect the poverty implications of dam construction. → in non landlord districts population better able to organize itself for compensation