**BACKGROUND**
- India is the world's largest user of groundwater.
- Power subsidies in the agriculture sector are responsible for groundwater depletion.
- In most Indian states, farmers pay a flat rate for the use of electricity for groundwater pumping which does not reflect the true cost of provision of electricity.
- Prior to 1997, farmers in Punjab paid a flat rate fee of 50 rupees per horsepower per month.
- Policy of free farm electricity was introduced in Punjab in February 1997.

**RESEARCH QUESTION**
What is the impact of lowering fixed electricity charges for tubewell use from flat-rate to zero on number and type of wells installed, and on groundwater depth?

**DATA SOURCES AND DESCRIPTIVES**
- **Minor Irrigation Census [village-level data]**
  Average groundwater level; number of dugwells, shallow tubewells and deep tubewells; number of wells by water lifting device (diesel/electric), horsepower, status.

- **Central Groundwater Board [test well-level data]**
  Groundwater levels recorded for four times in a year in January, April/May, August and November.

**RESULTS & POLICY IMPLICATIONS**
- Free agricultural electricity pricing policy has implications for groundwater depletion in Punjab.
- Differential increase in the average groundwater depth by 16% post the policy through the channels of increased investment in electric-operated tubewells and pumps of higher horsepower rating.
- Increase in average groundwater depth is sharper (21%) around the depth of 10 meters where shift in technology is required for access to water pumping.
- Policy implications – reforms in agricultural sector – alternative pricing policy for farm electricity to promote efficient use of resources.

**METHODOLOGY**
Difference-in-difference model with villages/wells in the neighbouring and agro-climatically similar state, Haryana as the control group.

Consider the following model,

$$ Y_{ijs} = \sum_{t} \sum_{i} \frac{y_{ijsi}d_{District_i}}{d_{Post_t}} + d_{Post_t}c_{ij} + \beta(d_{Punjab_t}, d_{Post_t}) + e_{ijs} $$

where $i$ – village/well, $j$ – district, $s$ – state, $t$ – year

Outcome variables of interest:
- Number of wells
- Number and proportion of electric-operated tubewells
- Horsepower load of all pumps
- Groundwater depth

**CHANNELS OF CHANGE**
1. Post the policy of free electricity, electric pumps became cheaper to use in Punjab due to lower operational costs – greater incentive for farmers to invest in electric pumps.
2. Farmers not charged a flat-rate fee based on the horsepower rating of the pump – incentive to invest in pumps with higher horsepower rating.
3. Heterogenous impact on groundwater depth in regions where farmers lie closer to the cut-off about 10 meters – technological shift from centrifugal to submersible pumps.