Distortions from Electricity Subsidies in an Agriculture-Dominated Economy: The “Agricultural-Groundwater Nexus” in India

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(See also paper on reading list by Greenstone)
Objectives of this analysis and discussion

• The very simple model illustrates trade-offs between different types of allocation problems for countries where cheap electricity is used to pump groundwater by farmers (as in India).
• We show that subsidies to agricultural users of electricity can be highly wasteful.
• We also show that it may be constrained efficient to ration electricity to farmers.
• We even show that it may be advantageous to waste some of the electricity that should go to farmers (since, if it went to them, it would be used in a highly distortionary way).
Some features of the electricity market in India

- Total consumption 1066 GWh (third globally after China and US)
- Domestic share 24.3%
- Industry share 40%
- Other commercial share 9.2%
- Agricultural share 18.3% (highest agricultural electricity consumption globally)
- Overall losses 22.8% (due to theft, and distributional losses)
- Fossil share 67% (of which coal 59%)
- Renewable share 31% (of which hydro 15%, wind 10%, solar 4%)
- Share of households covered 81%
- Average private electricity consumption (2009): rural 88 kWh/capita, urban 288 kWh/capita
Basic simple model: Electricity allocation among different users

Consider first three basic users (ignore industrial and commercial consumption): 1) households, 2) farmers, 3) illegal consumption (electricity theft by individuals not paying), where \( E \) is total electricity consumption, split between the three types of users:

\[
E = E_1 + E_2 + E_3
\]

The welfare function is expressed as

\[
U = V_1(E_1) + V_2(E_2) + G(E_3) - hE_2 - cE
\]

\( h \) is here the marginal externality cost of pumping groundwater (the water table is falling thus increasing the cost of pumping, and reducing water supply for the future).

\( c \) is the (true) cost of electricity supply (long-run marginal cost)
Basic simple model: Electricity allocation among different users

Social optimality conditions for the given welfare function are for famers given by:

\[ V_2' = c + h \]

Social optimality for households and illegal consumers:

\[ V_1' = G' = c \]

Farmers ought to face a water price of \( c+h \), which is higher than the optimal price to be paid by other consumers (only \( c \)). This is because farmers cause a negative externality by using their electricity to pump groundwater. Groundwater pumping leads to a negative externality since it increases future pumping costs.

Also illegal consumers of course face a too low price and should pay, but it is not clear which distortion is more important, for farmers or for illegals.
Summing-up of basic implications of the model

• Agricultural consumers pay (almost) nothing. They are however typically rationed (in terms of their electricity delivery); otherwise their electricity (and water) consumption would have been even higher.

• Households face a positive price, which is however typically lower than long-run marginal supply cost for the utility.

• Illicit consumers pay nothing. This thus leads to an additional fiscal drain.

• One might still argue that agricultural electricity consumption is worst at the margin, since the potential for electricity consumption here is very great. Most illegal consumers do not consume much, since they don’t have a lot of equipment that needs electricity.
Political equilibrium in India: What is behind the pricing principles in the electricity market?

• Basic underlying problem: Poor governance, poor ability to deliver improved infrastructure services (such as water, sewage and electricity services; education and health services).

• Local governments are in charge of electricity pricing for their regional utilities.

• Frequent local elections; high voting propensity among farmers.

• Low electricity prices are a short-term benefit to voters that is easy to promise by politicians, to attract voters (often, almost the only economic benefit that politicians can credibly promise).

• The political equilibrium then implies that agricultural electricity prices are set very low. Agricultural consumption is usually not metered (so that marginal consumption is priced at zero).
Agricultural sector problems with zero pricing of electricity to agricultural consumers

• Excessive groundwater extraction, and falling groundwater tables in India. This is a very serious problem in the long run in many regions.

• True pumping costs do not influence pumping behavior, since farmers pay nothing at the margin. When the groundwater table falls, it becomes more costly to pump up 1 m3 of water, but this has no influence on pumping.

• Pumping efficiency is not considered by farmers. Many have inefficient pumps which would have been replaced or repaired if pumping costs were paid for.

• Electricity consumption by farmers must be controlled by rationing. The implication is that each farmer can pump only certain hours per day, often only in the night. The pump is then left on, and often the field is flooded in the morning. This is very inefficient, also as viewed by farmers.

• Choice of crop. Too high availability of pumped groundwater leads to too water-intensive crop choice, which is inefficient given the real pumping cost.
Implications for the water utilities

The water utilities’ incomes stem from 3 main sources:

1. Households: These face a positive price by lower than marginal cost.
2. Farmers: These pay virtually nothing for electricity.
3. Industrial and other business consumers: These are charged electricity rates above marginal cost. Utilities try to recover some of their losses by overcharging industry. But this is far from sufficient to cover the losses.

An implication is persistent losses among water utilities in India.
Several and wide-ranging implications of under-charging for water in India

• Persistent losses by regional water utilities. Local politicians do not consider this problem as they know that regional utilities will, when the situation becomes sufficiently bad, be «bailed out» by the central Indian government, to prevent the utility from going bankrupt. Utilities face «soft budget constraints», and these are being abused.

• What happens with long-run system expansion, and supply?

• Utilities will rationally expect the situation with underfunding to persist also for the future.

• This takes away their incentive to expand supply, since such expansion can be expected to only lead to greater deficits in the future.

• Incentives for system maintenance are also reduced. India is famous for widespread «blackouts» whereby the entire electricity grid shuts down, causing severe problems to the entire economy. The most serious blackout in world history happened on July 30-31, 2012, when most of India was shut down.

• Incentives to prevent theft is also reduced when utilities cannot in any case charge properly from their customers.
The problem with over-charging to large industrial consumers

• Assume that an electricity utility will try to recuperate losses due to under-pricing of agricultural consumers, and due to stolen electricity, by charging proportionately higher electricity prices from industrial consumers.

• Assume that 40% of electricity supply (including what is stolen and lost from the system) is priced at zero, and 20% is priced at c/2 (half of long-run marginal cost c). 40% of consumption goes to industry, and is priced at p. How high price must industry pay to exactly recuperate the utility’s losses, thus preventing that the utility runs a deficit, and eventually goes bankrupt?
The problem with over-charging to large industrial consumers (cont.)

• We then find:

\[
0.2 \frac{c}{2} + 0.4p = c \iff p = 2.25c
\]

Industry must then be charged 2.25c = 2.25 times long-run marginal cost for the utility to break even.

But industry may have other options, e.g., to install diesel generators, say, at cost 2c per kWh of electricity produced. Many will then switch to diesel (as many have done), perhaps even at higher cost as security of delivery is higher with one’s own generation.

Utilities’ fiscal costs will then worsen (since high-paying customers are lost by the utility), and social costs, and carbon and pollution emissions, will increase when fewer industrial consumers buy electricity from the utility. Conditions for businesses will also be more hostile than under a system where businesses only pay for the actual cost of electricity service.
Summing up the «electricity-groundwater nexus» in India

• Reliable and increasing electricity supply is necessary for development.
• But in India, the electricity system is lagging far behind other economies it tries to compare to, notably China. This is likely a major factor behind the lower long-term growth rate in India, relative to China.
• Almost one third of the population still does not have regular electricity supply.
• The overall supply is high unreliable.
• For businesses, electricity is expensive and many are opting for private supplies as a remedy.
• Free electricity to agriculture causes a looming catastrophe for food production as the groundwater table is falling.
• On the other hand, as a cynic one might argue that, since most of India’s electricity expansion is based on coal, carbon emissions are kept in check this way ...
Can something be done?

• A «positive» issue is that many farmers in India are unhappy with today’s system and may want to change it. In particular, many farmers are willing to pay for electricity, in return for more regular and predictable supply.

• The World Bank has started to test out policies whereby electricity consumption of individual farmers are metered.

• Many farmers are skeptical toward metering, as they suspect this is simply a scheme to extract more income from them.

• The main challenge is to credibly tie limited pricing to better service relations, making farmers, and everyone else (including water utilities) better off.
What can be done (cont.)?

• Charges to households ought to be increased to eventually reach long-run marginal cost (c).
• When the utilities become solvent, and (even better) earn some surplus, further improvements are possible:
  • 1. The utilities have incentives to prevent theft. This will facilitate charging for more electricity consumption, thus further increasing surpluses in utilities.
  • 2. Incentives for system maintenance increases. Blackouts and system losses will then be further reduced.
• Long-run supply expansions become easier to accomplish, as utilities make money from increasing supply.
• Over-charging to industry becomes less necessary. This may spur business and economic growth, and also lead more businesses to opt for the regular electricity supply, thus increasing delivery to industry, and surpluses, further.