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The Economic Effects of Electricity Deregulation AN EMPIRICAL ANALYSIS OF INDIAN STATES

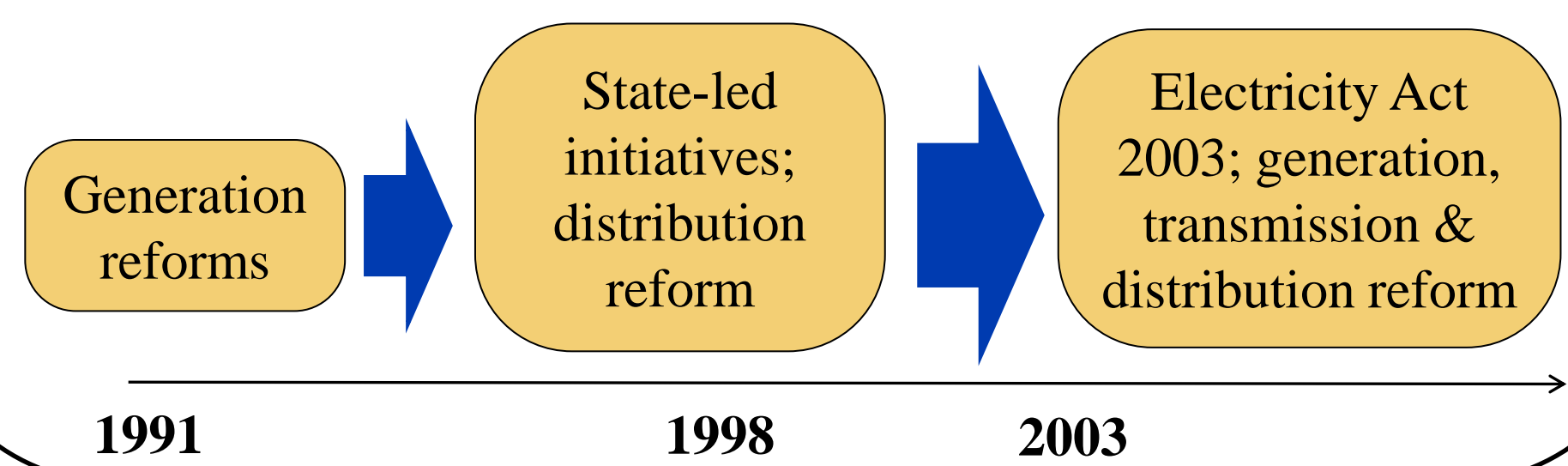
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1 INTRODUCTION

Background: Electricity policy is decentralised in India. All 29 states have autonomy in implementation, subject to national legislation and guidelines. States differ in their pace of implementation of deregulation. Prior to 1991, the sector remained largely under public ownership and the functions of generation, transmission and distribution were administered by vertically integrated State Electricity Boards. Reforms were initiated in the early nineties, and can be classed in 3 phases.

Figure 1: Phases of Deregulation



RESEARCH QUESTION:

How do different regional (state) regulatory regimes in electricity provision lead to differing economic impacts in Indian states?

Context: Decades of state-ownership and the lack of separation from political influence have created severe economic distortions in the Indian electricity sector. Free electricity was granted to agricultural consumers as an election strategy, dating back to 1977. Cross-subsidies were used to finance free electricity, leading to unsustainably high prices for industrial and commercial consumers. An inverse relationship between the cost of supply and price of electricity thus resulted. Technical & commercial losses were indistinguishable. Undocumented wastage by the agricultural consumer segment and consequent hidden losses have led to the eventual bankruptcy of State Electricity Boards. Deregulation aims at correcting these distortions, and includes measures for structural reform, and for competitive reform of the sector.

Gap in Literature: Existing evidence largely focuses on cross country reform studies of developed economies. These point to a set of commonly observed impacts of electricity deregulation.

IMPACT	KEY EVIDENCE
Efficiency	Toba (2004), Jamash et al (2004)
Price Distortions	Nagayama (2007), Steiner (2001)
Cross Subsidies	Hattori & Tsutsui (2004)
Sector Reinvestment	Zhang et al (2003), Harris (2003)
New Investment Flows	Victor (2004), Jamash et al (2004)

2 EMPIRICAL METHOD

An empirical study on Indian states avoids common problems faced by cross-country econometric studies, such as differing economic and political systems, and currency conversions. Based on existing evidence, a set of hypotheses was formulated for each commonly-observed economic impact of deregulation.

Box 1: Set of Hypotheses

- H1:** States advanced in deregulation have experienced improvements in technical and operating efficiency.
- H2:** Deregulation has had a substantive effect on prices for the end-consumer
 - H2.1:** Average unit price of electricity
 - H2.2:** Industrial unit price of electricity
- H3:** Deregulation has had a substantive effect on pricing
 - H3.1:** Relative industrial to residential price
 - H3.2:** Relative industrial to agricultural price
- H4:** Deregulation has led to investments in the distribution and supply network, thereby improving the quality of service
- H5:** Deregulation has led to substantive changes in industrial electricity consumption

A panel dataset of inflation-adjusted variables was used to test each hypothesis, spanning the reform period 1991-2007, covering 19 states and 85% of the population. Indicators were used for efficiency (Plant Load Factor, technical losses, gross generation), electricity prices, cross subsidies (ratios of industrial to residential price, and of industrial to agricultural price), network investment (total energy deficit) and new investment (industrial consumption). A Reform Index was developed for Indian states, based on Bacon (1995). Controls were included for population numbers, state GDP and states' resource endowments (percentage of hydroelectric capacity).

	REFORM INDEX	Score
Structural	Independent Power Producers in Generation	1
	Unbundling of State Electricity Board	1
	Establishment of Independent State Regulator	1
Governance	Tariff (Price) Corrections	1
	Open (Third Party) Access to the Network Grid	1
	Privatisation of Distribution	1
	TOT=6	

We used fixed effects models for panel data. Each Indian state is a distinct socio-economic and political system; the fixed effect represents this unobserved heterogeneity. The dataset constituted an unbalanced panel with a small time dimension T . For some hypothesised relationships (H2 to H5), the behaviour of dependent variables were seen as contingent on past values of themselves. Based on characteristics of the data, we used a bias-corrected LSDV Estimator (LSDVC). The generic form of the model is:

$$Y_{it} = \gamma Y_{it-1} + X\beta + \eta_i + \varepsilon_{it}$$

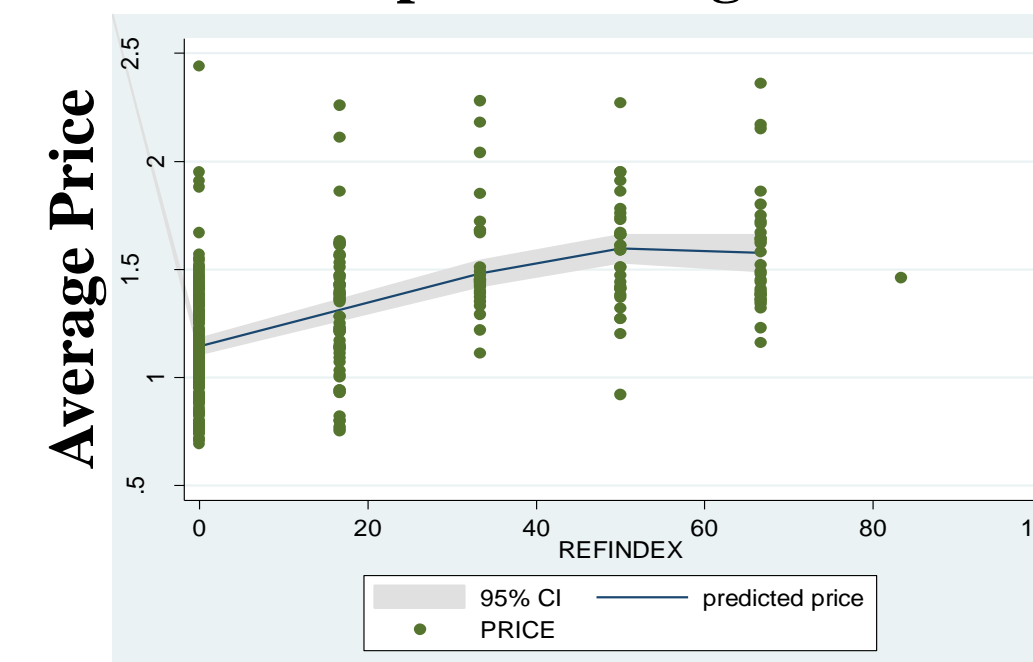
A three stage least squares estimation was used for H1, as the concept of technical efficiency was considered with 3 interrelated dependent variables.

3 RESULTS AND ANALYSIS

The results showed that the hypothesised economic impacts have manifested in Indian states, but in a counterintuitive manner.

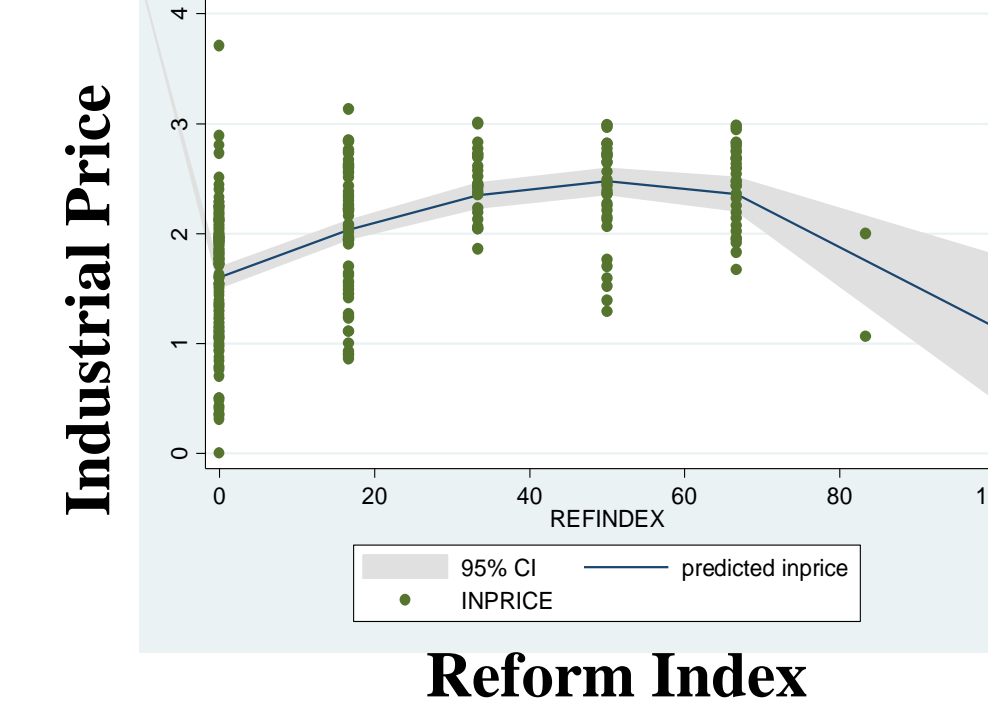
Efficiency outcomes reflected immediate improvements for Plant Load Factor, and gradual improvements for gross generation. The levels of cross subsidy determine whether the net impact is positive or negative, as improvements in the above accompanied by a high cross subsidy are indicative of excessive agricultural consumption. Technical losses improved only in later stages of deregulation.

Graph 1: Average Prices



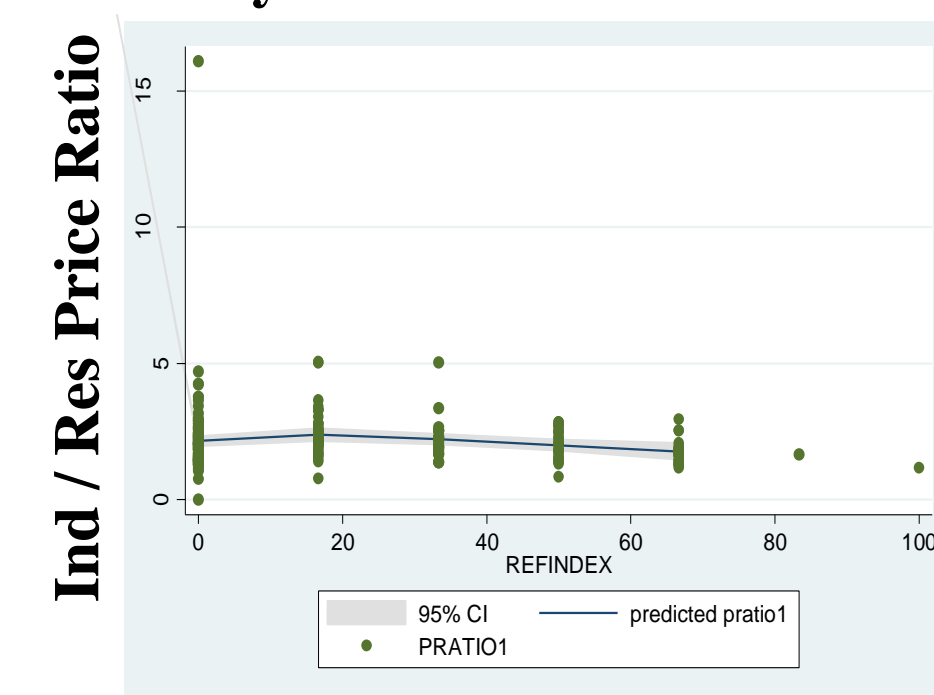
The average price of electricity for the end consumer stabilises in states more advanced in deregulation, measured by a point on the Reform Index. Average prices are open to non-economic influences and are less indicative of the effects of reform.

Graph 2: Industrial Prices



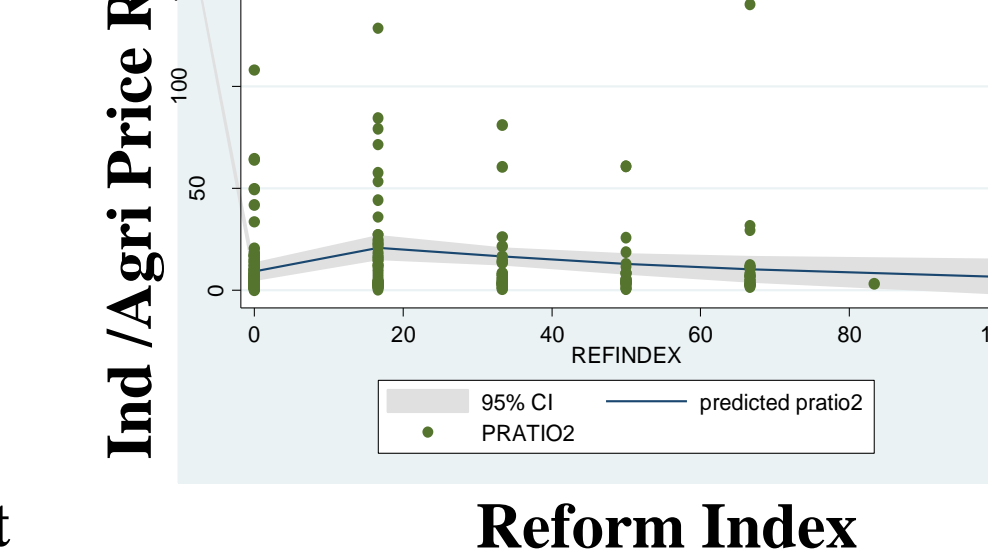
The industrial price of electricity reduces in states more advanced in deregulation.

Graph 3: Cross subsidies between Industry and Residential Consumers

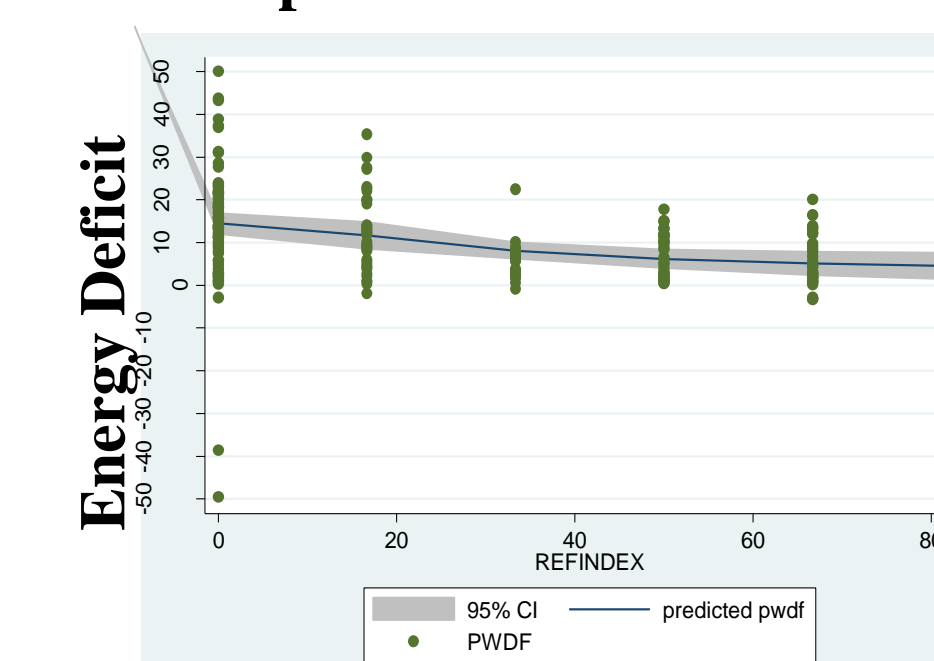


The ratio of industrial to residential price shows a marginal decrease with deregulation; this ratio is not as significant for the case of India as compared to international experience.

Graph 4: Cross subsidies between Industry and Agricultural Consumers

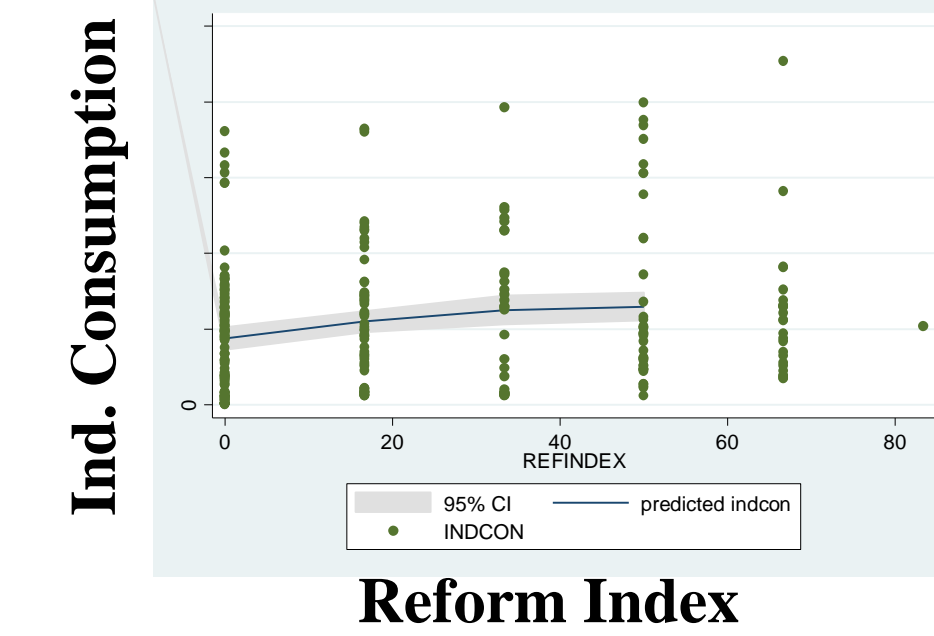


Graph 5: Network Reinvestment

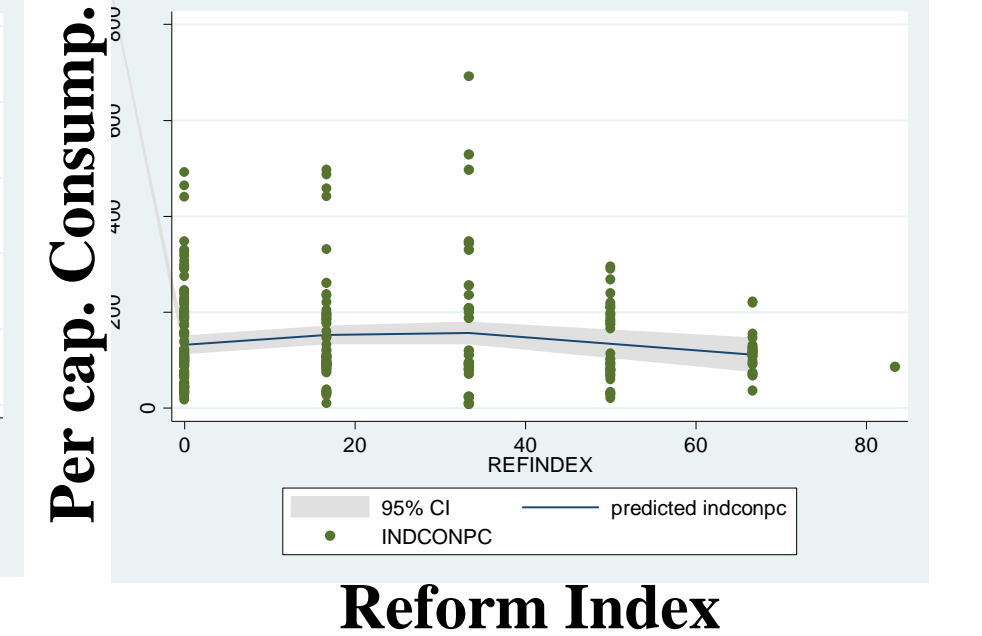


Efficiency indicators could have a visible high-end impact on parameters reflecting network quality. The total energy deficit reduces with the implementation of reform. Data availability on variables measuring quality of supply is limited.

Graph 6: Industrial Consumption



Graph 7: Industrial Consumption Per Capita



Absolute industrial consumption shows a marginal increase with deregulation. Per capita industrial consumption appears to decrease; however, the data only includes grid-connected consumption, and this could indicate that states at higher levels on the Reform Index have successfully implemented competitive measures such as Open Access to the network, consequently reducing grid consumption.

Summary of Main Findings

- Hypothesised impacts are manifested in unconventional ways, conditioned by the political economy of reform in Indian states
- The economic outcomes are negative in initial stages of reform, as previously hidden distortions are revealed
- Substantial changes in economic variables occur only once a baseline level of reform is crossed; on the Reform Index, this would be beyond the halfway point i.e. beyond structural reform
- Future research can be carried out on the importance of sequencing, on whether electricity reform will remain in a 'halfway house' requiring us to develop second-best solutions, and on investigating the lag times to achieving the baseline level

4 REFERENCES

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Further Information:

<http://www.eprg.group.cam.ac.uk/category/publications/working-paper-series>

5 ACKNOWLEDGMENTS

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