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Power Sector Reform in India: Current Status and Issues

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Introduction

As of November 2015, the total installed capacity of the Indian power sector reached 280,328 MW, the fourth largest capacity in the world following China, the US, and Japan. The Indian power sector is a concurrent subject under Article 246 of the Indian Constitution, which gives the state governments major roles in power supply. For more than five decades up to the mid-2000's, the Indian power sector mainly consisted of State Electricity Boards (SEBs) established in the Indian states under the Electricity Supply Act enforced from 1948. The SEBs are set up as vertically integrated utilities handling generation, transmission, and distribution. The central government is basically responsible for interstate power supply through the agency of National Corporations such as the National Thermal Power Corporation and National Hydroelectric Power Corporation.

This framework of the Indian power sector has been instrumental in promoting industrialization to a certain degree since independence, but serious problems such as frequent power outages, power shortages, and low electrification ratios in rural areas have been pointed out repeatedly over the decades. India's underdeveloped infrastructure, particularly in the power sector, is widely expected to remain a significant bottleneck for industrialization and economic growth in the coming years.

The deteriorated financial status of the power utilities can be singled out as the most crucial factor underlying the bottleneck in India's power infrastructure. The SEBs have operated for many decades without regard to commercial concerns. Electricity became a tool of social policy, or sometimes a channel to provide political patronage. As a consequence, the SEBs in most states set electricity tariffs under supply costs and collected insufficient revenues to sustain operations. The tight fiscal constraints continue to hamper investment in the establishment, operation, and maintenance of facilities and substantially burden state government finances. As such, successful power sector reform hinges on management reform in the power utilities. The reconstruction and commercialization of India's power utilities came to be recognized important issues for the economy during India's era of economic reform earlier in the 1990s. The distribution sector, which has accumulated huge financial debt due to low recovery ratios, will hold the key to the fiscal improvement of the power utilities going forward.

Starting from this premise, this paper begins with an assessment of the current status of power sector reform by comparing data from the fiscal years 2004 and 2012. We employ six proxies to capture the various aspects of the power sector –(a) Per capita consumption of electricity, (b) Energy balance, (c) Unit cost of power supply, (d) AT&C loss, (e) Tariff distortion, and (f) Profit margin without subsidy– and assess the current

status of power sector reform in each state.

Next, we investigate the impact of the financial status of power utilities on the quality of the power supply. We assume that the deteriorated financial status is a result of both mismanagement and "moral hazard," with financial backing from the state governments quashing incentive to improve the poor quality of the power supply (Ruet 2005). In parallel, we also consider how the tariffs set under costs for agricultural consumers have been used as a channel to subsidize farmers and implement social and economic development in rural areas. Shah (2009) pointed out that power subsidy furthered the promotion of the Green Revolution by reducing the cost of irrigation with electric pumps. If the power utilities provide service of good quality and the cost for state finance can be tolerated, we can think of the tight financial condition and heavy dependence on fiscal transfers from the state government as mere manifestations of the state policy. Moving forward from this discussion, we investigate how the financial status of the power utilities impacts the quality of the power supply using establishment-level data on commercial losses due to power outages. The data are available from "The India 2014 Enterprise Survey Data set" issued by the World Bank.

The two types of analysis just described provide the following findings. (a) The power sectors in most states have made substantial progress in several areas such as per capita consumption and AT&C loss, but not in their financial conditions. It thus remains difficult to conclude whether the goal of power sector reform is achieved at present. (b) The gap between the top states (Delhi and Gujarat) and backward states (Uttar Pradesh and Bihar) has been expanding. (c) The financial status of power utilities has significant adverse impacts on commercial loss due to power outages, which suggests that the financially deteriorated utilities are not providing good-quality service.

The remainder of this paper is organized into four sections. In section 2 we briefly explore basic issues concerning the power sector in India. In section 3 we sketch the processes applied for power sector reform and then assess the current status of the power sector in each sector. In section 4 we empirically assess how the financial status of the power utilities impacts the quality of the power supply. Section 5 concludes the paper.

2 Issues in the Indian Power sector

2.1 Problems in power supply

India of the 21st century has become one of the world's fastest growing economies and a key destination for foreign direct investment with a huge potential market. Yet India's underdeveloped infrastructure, particularly in the power sector, is widely expected to remain a significant bottleneck for industrialization and economic growth in the coming years. Power outages are a serious problem for the power sector and common occurrences in most of the Indian states. While the exact frequency and damage due to power outages are difficult to assess, the report from FICCI (FICCI 2013) estimates that the total cost of power outages reaches 68 billion dollars, or 0.4 % of the GDP. The World Bank enterprise survey conducted in 2012-13 reported a 3.2 % loss of sales directly attributable to power outages, on average, in India's industrial and service sector. The ailing power infrastructure compels hospitals and industrial firms to invest in generators and stabilizers in order to manage power cuts and fluctuations in voltage and frequency, which incurs direct management losses for medium and small

Table 1 Source of lighting: 2001–2011

	Total Households		Percentage of housholds that have lighting							
			Electricity		Kerosene		Other sources		No lighting	
	2011	2001	2011	2001	2011	2001	2011	2001	2011	2001
All India	246,692,667	191,963,935	67.2	55.8	31.4	43.3	0.8	0.5	0.5	0.3
Rural	167,826,730	138,271,559	55.3	43.5	43.2	55.6	1	0.6	0.5	0.3
Urban	78,865,937	53,692,376	92.7	87.6	6.5	11.6	0.5	0.5	0.3	0.4

Source: Census of India, Source of Lighting: 2001–2011

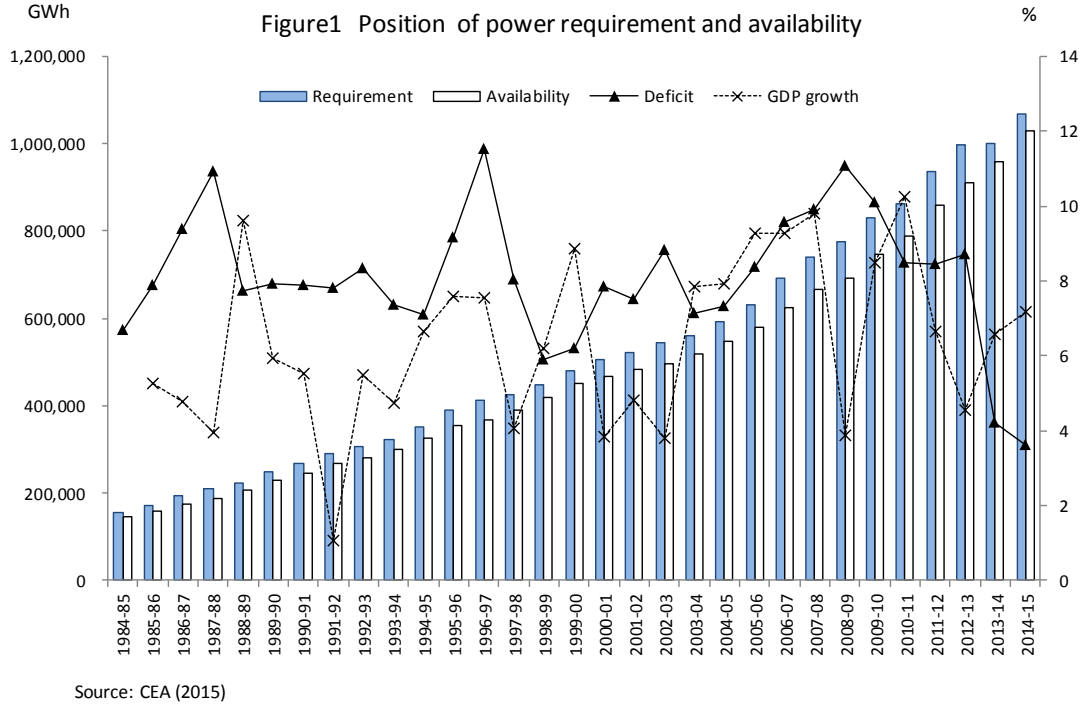


Figure1 Position of power requirement and availability

Source: CEA (2015)

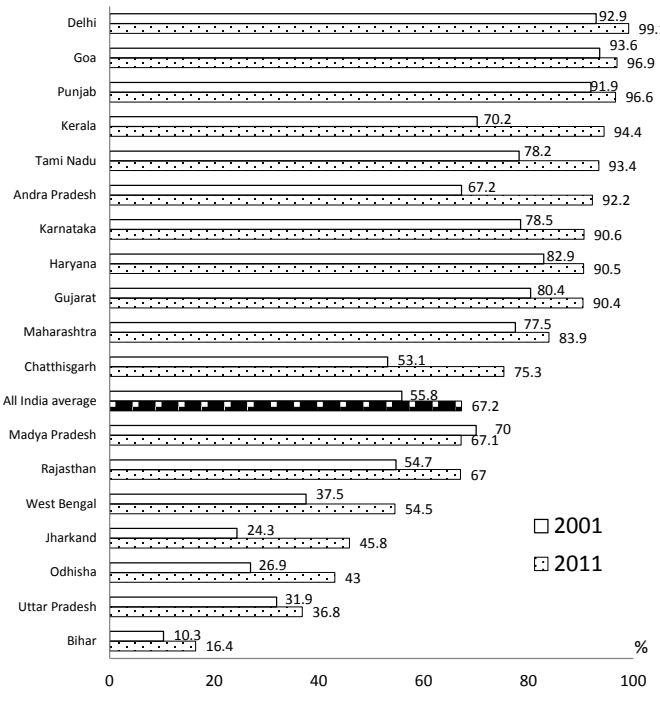
companies with poor financial bases.

Troubles in transformers and distribution networks stemming from poor maintenance and investment only partly account for the power outages in India. Scheduled power cuts due to power shortages are a more frequent cause. The power shortage problem became increasingly serious during the process of industrialization in the 1980s.

From figure 1, a plot of the demand and supply balance from the years 1984-85 to 2014-15, we see that the gap between requirement and availability remained narrow from the late 1990s to 2003 and then widened to 11.07% by fiscal 2008. The installed capacity was expanded over the same years, but not by enough to cope with the high growth in the power requirement. This trend then turned in 2009-10, when the economic slowdown in India restrained the expansion of the power requirement. Another noteworthy factor was the launch of thermal power plants by private companies such as Adani power, Tata power, and Essar Power as a part of the Ultra Mega Power Projects promoted by the central government. The power shortages nonetheless persist, and it remains to be seen whether the current downward trend of the power deficit will continue once the Indian economy starts rapidly growing again in the future.

A second major problem is the delay of electrification, especially in rural areas. According to the 2011 Census of India (see Table 1), the rates of household electrification are 55.3% in the rural areas, 92.7% in cities, and 67.2% on average. If we compare these to the figures in 2001 –43.5%, 87.6%, and 55.8%, respectively– we see that electrification has been rapid. Overall, however, more than 30% of households in India still lack electricity. There are also huge disparities in

Figure 2 Statewise electrification status



Source Census of India 2011, Source of Lighting: 2001-2011

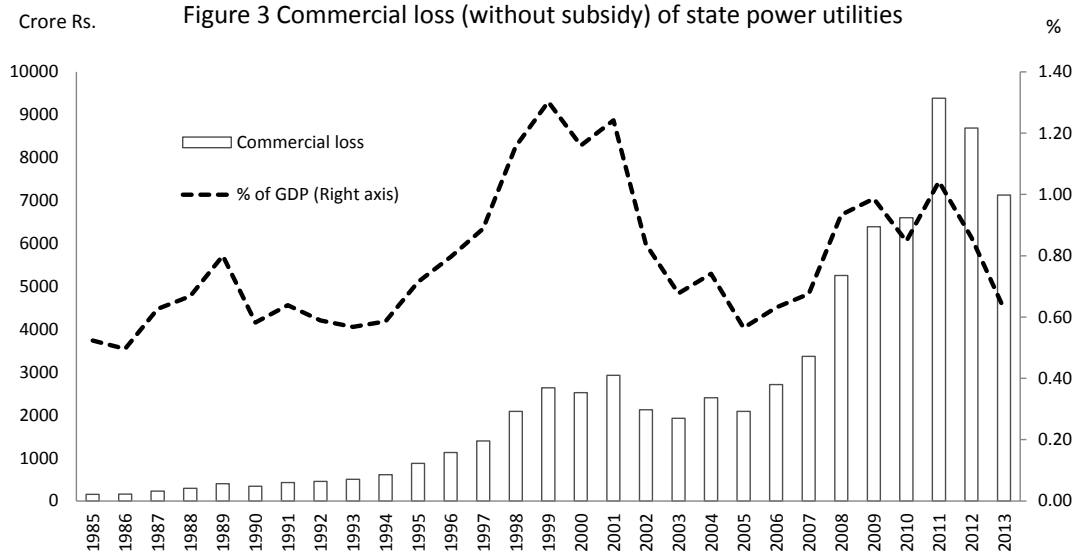
electrification among the states of India, particularly between urban and rural states. At the extremes, the household electrification rate ranges from almost 100% in Delhi to only 16.4% in Bihar (see figure 2). And as to be expected, the huge disparity in electrification comes with comparable inequality in per capita electricity consumption among regions.

2.2 Financial deterioration of state power utilities

All of the abovementioned problems are closely related to the serious financial challenges confronting the state power utilities. From figure 3, which plots the commercial loss of state power utilities as a percentage of GDP, we see that commercial loss rose rapidly in the late 1990s, reaching 1.3 % of GDP by 1999-2000, moved back down in the early 2000s, and then ballooned again to its second-highest peak, 1.04% of GDP, in 2011-2012.

Table 2 shows the financial status of the State Power Utilities. At a glance we find that the majority of states produce commercial loss, and that distribution companies selling electricity directly to consumers cause most of the loss. While the total commercial loss of Uttar Pradesh amounts to Rs. 22853 crore, for example, generation and transmission companies in Uttar Pradesh produce a loss of Rs. 955 crore, or only 4.1% of the total commercial loss of the state. This figure underlines the importance of management reform in the distribution sector for the reconstruction of the power sector in India.

Figure 3 Commercial loss (without subsidy) of state power utilities



Source Authors calculation basing on Power Finance Corportation (2008) , Plannning Commission (2012),(2014) and Reserve Bank of India (2015)

Table 2 Financial status of State Power Utilities (2013-14)

Rs Crores

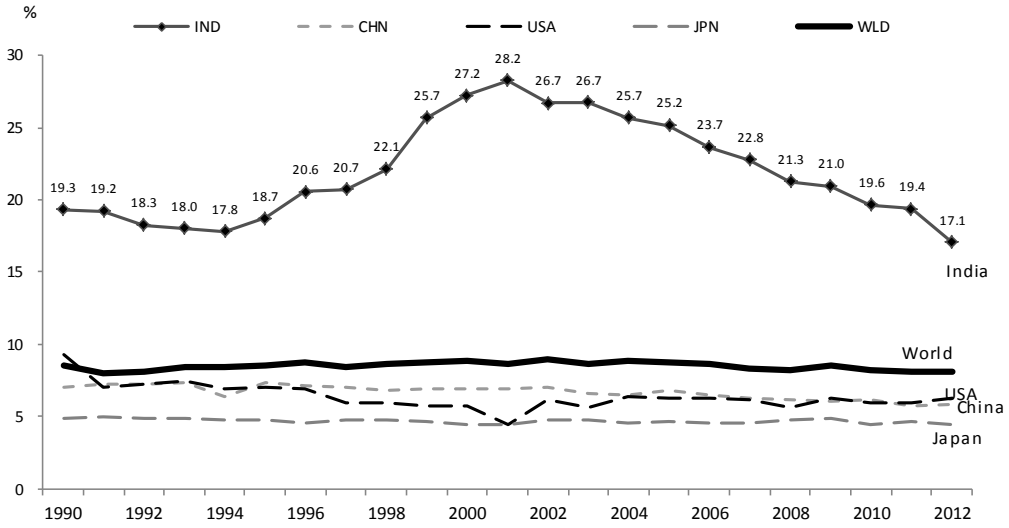
	Utilities Selling Directly to				Gencos, Transcos and Trading				State (1+2)		
	Income without subsidy	Expenditure	Profit without subsidy	Subsidy	Income without subsidy	Expenditure	Profit without subsidy	Subsidy	Profit without subsidy	% of combined income	Total subsidy
Bihar	4259	7258	-2999	2656	251	275	-24	0	-3023	-67.0	2656
Jharkhand	2339	4816	-2,477	966				0	-2477	-105.9	966
Odisha	8326	8668	-342	0	8,301	9535	-1,300	0	-1642	-9.9	0
West Bengal	17880	17850	19	0	8,470	7905	447	0	466	1.8	0
Delhi	20223	19770	353	0	3698	3112	339	0	692	2.9	0
Haryana	16728	24822	-8,094	4981	7,268	7466	-201	0	-8295	-34.6	4981
Punjab	16956	21396	-4,439	4695	1,346	855	386	0	-4053	-22.1	4695
Rajasthan	21658	38826	-17,168	1523	10,557	10840	-283	2	-17451	-54.2	1525
Uttar Pradesh	25394	47292	-21,898	5173	46358	47258	-955	0	-22853	-31.8	5173
Andhra Pradesh	32962	40767	-7,685	6306	15,390	14288	659	0	-7026	-14.5	6306
Karnataka	22763	24868	-2,104	1570	9,977	9687	319	0	-1785	-5.5	1570
Kerala	11394	11283	111	0				0	111	1.0	0
Tamil Nadu	31611	50581	-18,970	4918	2,877	1569	1,308	0	-17662	-51.2	4918
Chhattisgarh	7112	7742	-630	0	3,162	3636	-687	0	-1317	-12.8	0
Gujarat	28965	29937	-1,004	1099	38,153	37517	488	0	-516	-0.8	1099
Madhya Pradesh	16386	24957	-8,570	2194	7,822	8207	-571	0	-9141	-37.8	2194
Maharashtra	52262	53429	-280	0	22,116	19276	1,812	2	1532	2.1	2
All India	354652	455714	-100188	36128	188458	184165	1593	4	-98595	-18.2	-62154

Source: Power Finance Corporation 2015

The very high ratio of T&D and AT&C losses[1] should be pointed out as core components of the huge commercial loss. Figure 4 shows the T&D loss ratio in India, China, the U.S, and Japan, along with the world average. We see that T&D loss in India is remarkably high compared to the world average but has fallen to as 17.1% in recent years. Beyond the technical factors stemming from inadequate investment in transmission and distribution facilities, the spread of electricity theft and nonpayment raise the loss further. Later we will see that the situation is improving, but the problem clearly persists, especially in rural areas, for the following reasons: (a) meters are insufficiently set and maintained, (b) state power utilities lack data on the number and capacity of electric irrigation pumps used as criteria to set flat rate tariffs, (c) the formal procedures to connect to the electricity network are lengthy and time consuming, (d) farmers bear vacillating electricity costs, (e) corrupt employees of state power utilities allow electricity theft and nonpayment in exchange for commissions.

[1] T&D (Transmission and distribution) losses include losses in transmission and distribution due to technological factors as well as pilferage. AT&C (Aggregate Technical and Commercial) losses include non-billing, incorrect billing, and inefficiency in collection, in addition to T&D losses.

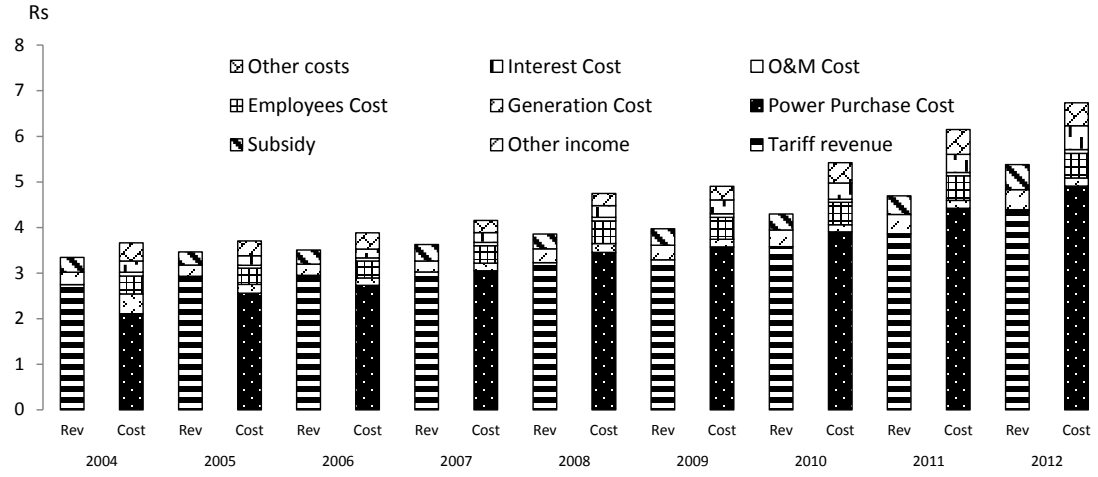
Figure 4 Electric power transmission and distribution losses (% of output)



Source World Development Indicator

Meanwhile, (a) rising power purchase costs along with coal prices and (b) delays in tariff revisions to offset the cost increases are pushing cost recovery ratios to very low levels, which further constrains power utility financing. Figure 5 presents the composition of the power supply cost and revenue and its change up to 2012-2013. We see that the tariff revenue grows too slowly to offset the rises in the power purchase cost after 2008-09. Next, in figure 6, we see that the recovery ratio without subsidy is a fairly low 75% in 2012-13 and rises only slightly to 83% after state government subsidy is received. The irrational tariff structure should be pointed out as another factor behind the failure to increase recovery ratios. While agricultural users enjoy preferential

Figure 5 Composition of power supply cost and revenue per Kwh



Source: Author's caluculation using data from Power Finance Cooporation (various issues)
Note: Data of the utilities directly selling electricity to consumers

electricity tariffs, industrial and commercial tariffs are set over cost and the surplus is used as cross-subsidy to partly offset the deficit. In Punjab and Tamil Nadu, for example, the tariff for agricultural consumers is set at zero while industrial consumers are charged more than the cost. This irrational tariff structure promotes investment in captive power plants, which in turn reduces tariff revenue and brings down recovery ratios.

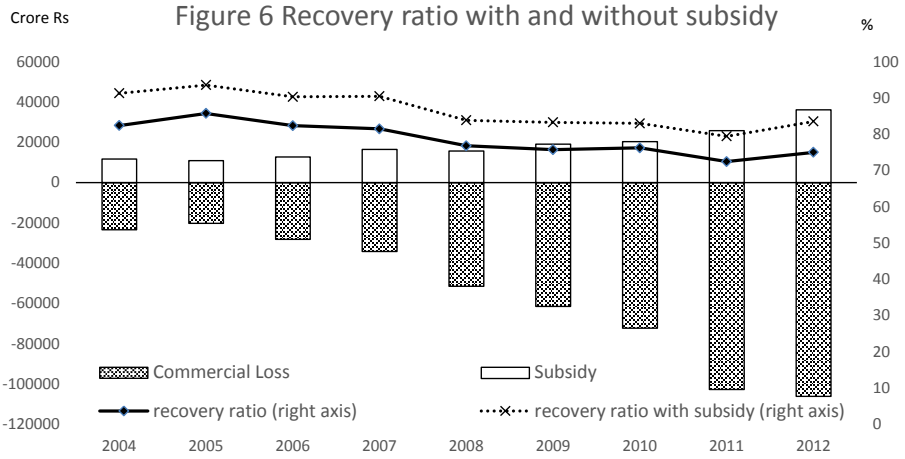


Figure 6 Recovery ratio with and without subsidy

Source Author's caluculation using data from Power Finance Cooporation (various issues)

3. Power sector reform

3.1 The way to reform

After the institution of the New Economic Policy in the early 1990s, power sector reform was started in tandem and several measures were implemented to allay the problems of the Indian power sector. In terms of the impact of the Electricity Act 2003, the process of reform can be largely divided into two major phases before and after the Act was enforced.

The reform process before the Act can be divided into three stages. The first was the period of deregulation, which allowed private companies to enter the power generation market and promoted the establishment of Independent Power Producer (IPPs) in the early 90s. Foreign capital was duly attracted, but the IPPs generated only a fraction of the newly required electricity. These initial efforts failed to address the management problem, especially in the distribution sector (Tongia 2007), which left it risky and unappealing to invest in the generation business.

The second stage of reform took place in the mid-1990s, when the central government came to recognize the need for priority reform in the distribution sector and initiated several drastic measures. One of the most important measures was the unbundling of the SEBs into generation, transmission and distribution corporations

Table 3 The state-wise status of power sector reform

	Per capita electricity consumption (kWh/year)		Energy balance (%)		Unit cost of power supply (Rs/KWh)		AT&C loss (%)		Tariff distortion		Profit margin without subsidy (%)	
	2004	2012	2004	2012	2004	2012	2004	2012	2007	2012	2004	2012
Andhra Pradesh	765	1135	-0.70	-17.60	2.85	4.30	21.2	13.6	0.98	0.97	-13.2	-77.5
Bihar	75	145	-10.10	-16.70	6.07	5.67	82.5	54.6	0.86	0.75	-52.6	-85.0
Chhattisgarh	685	1495	-1.70	-1.70	3.25	2.20	32.3	25.1	0.79	0.69	4.7	-7.4
Delhi	1554	1613	-1.00	-0.50	3.80	3.94	42.9	15.2	0.65	0.58	2.6	1.8
Gujarat	1299	1796	-11.70	-0.20	3.74	3.12	35.2	19.9	0.74	0.63	-21.2	-3.7
Haryana	951	1722	-5.70	-7.70	3.83	3.87	43.7	32.6	0.91	0.91	-40.2	-74.4
Jharkhand	546	847	-2.20	-3.90	6.96	4.50	62.8	47.5	0.90	0.89	-35.2	-68.2
Karnataka	660	1129	-4.20	-13.90	3.53	2.99	33.7	20.8	0.84	0.50	-21.7	-14.2
Kerala	398	630	-1.20	-4.00	3.73	4.30	32.1	10.5	0.74	0.74	-7.3	2.1
Madhya Pradesh	516	753	-13.50	-9.60	3.25	3.73	54.3	31.2	0.75	0.40	7.4	-42.2
Maharashtra	879	1239	-12.10	-3.20	3.45	3.52	28.0	22.0	0.61	0.66	-5.1	-1.9
Orissa	735	1209	-0.80	-3.30	3.33	3.23	42.9	42.9	0.63	0.79	-13.2	-7.0
Punjab	1245	1761	-9.00	-5.30	4.68	3.00	24.0	17.7	1.00	1.00	-76.2	-34.7
Rajasthan	583	982	-0.80	-3.00	4.52	3.77	46.7	20.0	0.71	0.72	-37.1	-84.4
Tamil Nadu	918	1226	-0.60	-17.50	3.37	4.81	19.4	20.7	1.00	1.00	-17.8	-59.7
Uttar Pradesh	309	450	-20.10	-16.60	3.78	3.62	46.8	42.9	0.62	0.62	-43.0	-70.2
West Bengal	414	594	-1.60	-0.70	3.48	3.83	23.9	34.4	0.71	0.55	-6.4	0.5
India	613	914	-7.30	-9.00	3.66	3.75	34.8	25.4	0.81	0.72	-21.6	-33.4

Note:

·Colored values are improved.

**Definition of variables

Per capita electricity consumption : Calculated by dividing total sales of electricity by the population in each state.

Energy balance: Gap between the total estimated requirement and the available power in the year.

Unit cost of power supply: Calculated by dividing the total cost by total generation (kWh) at a constant 2004 price.

Tariff distortion: Calculated using the following equation : Tariff distortion = 1 - (Tariff for agricultural consumers/ Tariff for Industrial consumers) . Thus, a value equal to one means that agricultural consumers enjoy free power (the tariff structure is most distorted) and zero means no distortion. Because of availability, we use the data in 2007-08 instead of 2004-05.

Profit margin without subsidy: The ratio profit (loss) to the total revenue without subsidy from state governments.

Source: Author's calculation. Original data on tariff distortion are from the Planning Commission (2011), (2014). Others are from PFC(2006)(2014).

with a view to improving their management. Orissa became the first state to unbundle its SEB in 1996, through initial arrangements by the World Bank, and other states like Haryana, Andhra Pradesh, and Rajasthan followed in varying degrees up to the end of the 1990s. The establishment of the Electricity Regulatory Commissions (ERC) was another important reform in the same period. The ERC has the authority to set tariffs and seeks to rationalize the tariff structure and raise recovery ratios.

In the third stage of reform, the central government took initiative to provide a general environment of reform for a few years beginning from the late 1990s. In order to reduce commercial loss, the central government started the Accelerated Power Development and Reform Program (APDRP), an initiative to provide state governments with funds for meter installation and other infrastructure improvements and to encourage reform by providing extra financial assistance to the more reform-oriented states.

Following these efforts, the Electricity Act 2003 enforced in June 2003 repealed all of

the existing electricity laws and made electricity reform compulsory. The aims have been to promote management reform in the distribution sector and competition through the transition from a single-buyer model to a multiple-buyer-and-seller model. The Act has mandated the unbundling of the SEBs and constitution of the state regulatory commissions in a time-bound manner, which has played a very crucial role in accelerating the reform process. To expand the generation capacity and promote entry to the power business, the act also institutes rules promoting (a) the deregulation of licensing for generation business, (b) open access in distribution, and (c) power trading business[2]. In the more than 10 years since the Act was enforced, all of the major states have reconstructed their SEBs. The requirements under the Act have been basically completed, at least as a matter of form, though exceptions can be found and several states will need longer periods for implementation[3].

3.2 The current status

To what extent has each state improved the conditions of its power sector since the enforcement of the Electricity Act 2003? Table 3 compares the state-wise status of power sector reform between the years 2004-05 and 2012-13. We employ six proxies to capture the various aspects of the reform: (a) per capita consumption of electricity, (b) energy balance, (c) unit cost of power supply, (d) AT&C loss, (e) tariff distortion, and (f) profit margin without subsidy[4]. On one hand, we find major improvements in the per capita consumption of electricity and AT&C loss in most of the states, and moderate progress on tariff distortion in half of the states. On the other hand, the table shows declines in the energy balance (especially in the southern states), unit cost of power supply, and profit margin without subsidy in more than half of the states. Turning to the financial status of the power utilities, the most crucial feature of reform, hikes in the unit cost of the power supply offset the improvements gained in AT&C loss and tariff distortion, which resulted in larger commercial loss.

To compare the status among states, we normalize the data by assigning every parameter a value between 0 (worst) to 1 (best). Table 4 presents the normalized values and the averages of the six proxies, along with rankings, among the states. From the average values of 2012-13, Gujarat, Delhi, Chhattisgarh, Maharashtra can be grouped as good performers. Gujarat showed especially strong progress from a 9th ranking in

[2] See Bhattacharyya (2005), Planning Commission (2011) for the details of the reform and The Electricity Act 2003.

[3] Kerala SEB still operates a vertically integrated utility. The power sectors in Jammu and Kashmir, Puducherry, Goa, Sikkim, Arunachal Pradesh, Manipur, Mizoram, Nagaland and Tripura have not been reformed and are administered through government departments.

[4] See the notes to table 3 for details on the variables.

2004-05 to the top ranking in 2012-13, mainly through its success in capacity expansion and management reform. Meanwhile, the states with the lowest rankings in 2004-05, Bihar and Uttar Pradesh, remained at the bottom and showed declines in the averages of the six proxies in 2012-13. These results show an expanding gap between the top and bottom groups, though Bihar and Uttar Pradesh did make moderate progress in some proxies such as per capita electricity consumption compared to the base year. This result suggests that Bihar and Uttar Pradesh, states generally regarded to be socially and economically backward, tend to be losing ground in the power sector reform, which in turn has further expanded the interstate disparity in social and economic development.

Table 4 The state wise status of power sector reform (Normalized values from Table 3)

	Per capita electricity consumption		Energy Balance		Unit cost of power supply		AT&C loss		Tariff distortion		Profit margin without subsidy		Average and rank			
	2004	2012	2004	2012	2004	2012	2004	2012	2007	2011	2004	2012	2004	Rank	2012	Rank
Andhra Pradesh	0.47	0.60	0.99	0.00	1.00	0.39	0.97	0.93	0.06	0.05	0.75	0.09	0.71	7	0.34	14
Bihar	0.00	0.00	0.51	0.05	0.22	0.00	0.00	0.00	0.37	0.41	0.28	0.00	0.23	17	0.08	17
Chhattisgarh	0.41	0.82	0.94	0.91	0.90	1.00	0.80	0.67	0.55	0.51	0.97	0.89	0.76	3	0.80	3
Delhi	1.00	0.89	0.98	0.98	0.77	0.50	0.63	0.89	0.90	0.69	0.94	1.00	0.87	1	0.82	2
Gujarat	0.83	1.00	0.43	1.00	0.78	0.74	0.75	0.79	0.67	0.61	0.66	0.93	0.69	9	0.84	1
Haryana	0.59	0.96	0.74	0.57	0.76	0.52	0.62	0.50	0.22	0.14	0.43	0.12	0.56	13	0.47	12
Jharkhand	0.32	0.42	0.92	0.79	0.00	0.34	0.31	0.16	0.27	0.18	0.49	0.19	0.38	16	0.35	13
Karnataka	0.40	0.60	0.82	0.21	0.84	0.77	0.77	0.77	0.40	0.83	0.65	0.81	0.65	10	0.67	5
Kerala	0.22	0.29	0.97	0.78	0.79	0.39	0.80	1.00	0.67	0.42	0.82	1.00	0.71	6	0.65	7
Madhya Pradesh	0.30	0.37	0.34	0.46	0.90	0.56	0.45	0.53	0.65	1.00	1.00	0.49	0.61	12	0.57	10
Maharashtra	0.54	0.66	0.41	0.83	0.86	0.62	0.86	0.74	1.00	0.56	0.85	0.95	0.75	5	0.73	4
Orissa	0.45	0.64	0.99	0.82	0.88	0.70	0.63	0.27	0.94	0.35	0.75	0.90	0.77	2	0.61	9
Punjab	0.79	0.98	0.57	0.71	0.55	0.77	0.93	0.84	0.01	0.00	0.00	0.58	0.48	15	0.65	8
Rajasthan	0.34	0.51	0.99	0.84	0.59	0.55	0.57	0.79	0.75	0.47	0.47	0.01	0.62	11	0.53	11
Tamil Nadu	0.57	0.65	1.00	0.01	0.87	0.25	1.00	0.77	0.00	0.00	0.70	0.29	0.69	8	0.33	15
Uttar Pradesh	0.16	0.18	0.00	0.06	0.77	0.59	0.57	0.27	0.97	0.62	0.40	0.17	0.48	14	0.32	16
West Bengal	0.23	0.27	0.95	0.97	0.85	0.53	0.93	0.46	0.75	0.74	0.83	0.98	0.76	4	0.66	6

Note: Colored values are improved.

Source: See Table 3

4. Financial status of power utilities and the power supply

4.1 What does the financial status of the power utilities signify?

It would be natural to expect the financially burdened power utilities to lack the resources necessary to cover the investments and maintenance costs required for good quality service. We can also assume that the deteriorated financial status results from both mismanagement and "moral hazard," with the financial backing from the state governments suppressing incentive to invest in service improvements (Ruet 2005). From another standpoint, we can interpret the tight financial status of power utilities as the result of the redistributive policy of the state governments. In this latter case, commercial loss does not necessarily result in poor-quality service even though the power utilities heavily depend on state finance. While agricultural power subsidies have been criticized as a form of political patronage[5], they have also been recognized as a driver of social and economic development, especially in rural areas. Shah (2009) discussed that power subsidies helped promote the Green Revolution by reducing the cost of irrigation with electric pumps. In other words, if the financially troubled power utilities can provide good service, the tariff policy can be revaluated as an instrument of social policy to some degree, though the problem of fiscal sustainability still remains.

Table 5 State-wise description of loss due to power outages (%)

	Obs.	Mean	S.D	Max	Obs.with value 0
Andhra Pradesh	548	5.55	6.87	60	62
Bihar	297	10.02	12.09	60	87
Chhattisgarh	280	0.28	0.87	5	244
Delhi	470	0.41	1.76	25	401
Gujarat	472	0.00	0.00	0	472
Haryana	298	2.78	3.59	30	49
Jharkhand	242	7.71	11.30	50	100
Karnataka	558	1.60	1.72	20	138
Kerala	408	3.88	4.44	20	138
Madhya Pradesh	329	1.41	2.65	20	189
Maharashtra	606	0.56	1.48	10	492
Orissa	203	3.70	4.19	30	19
Punjab	395	6.38	7.49	60	103
Rajasthan	281	1.69	3.01	20	138
Tamil Nadu	445	7.93	11.71	100	98
Uttar Pradesh	377	3.30	6.66	90	59
West Bengal	467	1.25	2.54	20	276
Total	6676	3.20	6.52	100	3065

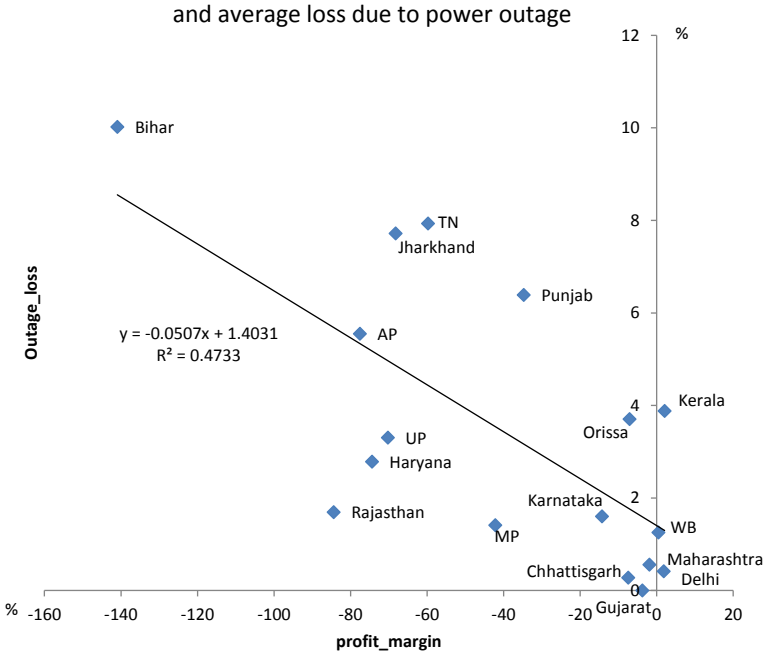
Souce: Authors calculation

[5] According to Dubash and Rajan (2001), the first use of power subsidy as patronage was introduced in the election manifesto of the Congress Party during the Andra Pradesh state assembly election in 1977, which committed itself to the adoption of a flat-rate tariff. This was followed by initiatives in other states, such as a program to provide free electricity by AIADMK in Tamil Nadu.

4.2 The data and model specification

Based on the discussion above, we use establishment-level data on power outages to investigate how the financial status of the power utilities affects the quality of the power supply. Original data are sourced from "The India 2014 Enterprise Survey Data set" from a World Bank survey on firm performance and various aspects of the business environment such as access to finance, corruption, infrastructure, crime, and competition. The survey covers the manufacturing sectors[6] and nine service sectors, namely, construction, retail, wholesale, hotels, restaurants, transport, storage, communications, and IT. Formal companies with five or more employees are

Figure 7 Relationship between average profit margin of power utilities and average loss due to power outage



interviewed.

Regarding the quality of the power supply, the survey contains information on estimated loss due to power outages as a percentage of total annual sales. Survey respondents were only asked to "estimate" the losses resulting from power outages as a percentage of total annual sales, so the data are more subjective than precise. We nonetheless employ this variable as a proxy for power supply quality, on the assumption

[6] This corresponds to firms classified with ISIC codes 15-37, 45, 50-52, 55, 60-64, and 72 (ISIC Rev.3.1), which are Basic metals, Chemicals, Electronics, Fabricated metal products, Food, Furniture, Garments, Leather, Machinery and equipment, Non metallic mineral products, Paper, Plastics & rubber, Precision instruments, Publishing, printing, and Recorded media, Recycling, Refined petroleum product, Textiles, Tobacco, Transport machines and Wood. The website of the World Bank Enterprise Survey (http://www.enterprisesurveys.org/methodology) provides further detail.

Table 6 Definition of variables

Name	Data level	Definition	Source	Type	Obs.	Mean	Max	Mini	S.D.
outage_loss	Estabslhimen t	Estimated loss as a percentage of total annual sales due to power outage	World Bank "The India 2014 Enterprise Survey Data set"	Numeric	6676	3.20	100	0	6.52
size		The number of permanent, full-time workers as of the end of the last fiscal year		Numeric	7854	115.3	9999	2	364.29
EPZ		Dummy denoting whether the establishment is located in EPZ or an industrial park (Equal to zero if the establishment is located in either)		Binary	7859	0.57	1	0	0.50
City		Dummy for mega city (Equal to zero if the establishment is located in a city with a population of over 1 million)		Binary	7859	0.447	1	0	0.50
Profit	State	The ratio of profit to the total revenue without subsidy from state governments, taking the average value for the utilities selling to consumers directly in the state.	PFC(2014)	Numeric	7859	−0.35	0.02	−0.85	0.34
Profit_s		The ratio of profit to the total revenue with subsidy from state governments, taking the average value for the utilities selling to consumers directly in the state.	PFC(2014)	Numeric	7859	−0.20	0.06	−0.71	0.24
SDP		SDP per capita	Central Statistical Organization	Numeric	7859	57963	145922	14903	33430
energy		Electricity balance = (Available electricity − Requirement electricity) / Requirement electricity	CEA(2013)	Numeric	7859	−7.69	−0.20	−17.60	6.51
tariff		Tariff distortion = 1 − (Tariff for agricultural consumers / Tariff for Industrial consumers)	Planning Commission (2014)	Numeric	7859	0.72	1.00	0.40	0.18

Note

All data are values for the year 2012-13

Regarding the data on utility finance, we take the average if multiple utilities operate in a state.

that it faithfully reflects the respondent's perception of the degree to which power outages disturb the operations of the establishment.

Table 5 provides a data description of loss due to power outages state by state. The mean values for Gujarat, Chhattisgarh, and Delhi are less than 1%, while that of Bihar exceeds 10%. The data indicate that the establishments are unaffected by power outages in the states grouped as good performers in the preceding section, while the establishments in Bihar, the worst ranked state, suffer heavily. On this point, Figure 7 shows the state-level relationship between the financial status of power utilities and the loss due to power outages. There appears to be a negative relationship, which implies that financially deteriorated power utilities cannot provide a good quality of service.

In order to investigate this relationship more empirically, we employ the following equation as the basic model.

$$outage\_loss_i = c + \propto \cdot profit_j + \beta \cdot sdp_j + \gamma \cdot size_i + \delta \cdot city_i + \varepsilon \cdot epz_i + \sum_{k=1}^{n} \theta_k \cdot ind_{ik} + u_i$$

Where $outage\_loss_i$ is the estimated loss due to power outages of establishments i; $profit_j$ is the financial status of power utilities in state j, the most important explanatory variable in this analysis; sdp_j is SDP per capita to capture the development level of the state where the firm located; $city_i$ is a dummy variable denoting whether establishment i is located in a megacity; $size_i$ is the size of the establishment i captured by the number of employees; epz_i is a dummy variable denoting whether establishment i is located in an export-processing zone or industrial

Table 7 Correlation matrix

	outage_loss	profit	profit_s	sdp	energy	tariif	size	city	epz
outage_loss	1								
profit	−0.29	1							
profit_s	−0.13	0.80	1						
sdp	−0.11	−0.07	−0.05	1					
energy	−0.27	0.64	0.49	0.10	1				
tariif	0.32	−0.47	−0.34	0.14	−0.27	1			
size	−0.03	0.02	0.02	−0.03	−0.03	−0.03	1		
city	−0.05	0.31	0.27	0.09	0.19	−0.13	−0.01	1	
epz	−0.02	−0.09	−0.07	0.04	0.01	−0.07	0.04	−0.05	1

park; and ind_{ik} is a dummy variable denoting whether establishment i belongs to industry k.

The model also employs the state-level variables $profit\_s_j$, $Energy_j$, and $Tariff_j$, respectively representing the profit ratio with received subsidy, the electricity balance, and the index of tariff distortion. The descriptive statistics and correlation matrix of the variables included in the empirical model are given in Tables 6 and 7. Since the dependent variable has a value of zero for a number of establishments, we estimate this model by the maximum likelihood estimation of the Tobit model.

4.3 Estimation results

Table 8 gives the maximum likelihood estimation results of the Tobit model. The first noteworthy finding is the negative and significant impact of the coefficients on $profit_j$ at the 1% level of significance in Eq (1). This result implies that the financial status of a utility has crucial impact on the quality of service, which in turn suggests that an improved power supply requires reconstruction of the power utilities. In Eq. (2), we employ $profit\_s_j$ the profit ratio with subsidy, as a proxy for the financial status of power utilities. This variable has a negative and significant impact at the 1% level, which suggests that subsidy does not offset the negative impact of deteriorated financial status on power outages. In Eqs. (3) and (4) we assess the impacts of two more state-level variables $Energy_j$ and $Tariff_j$. Both are significantly related at the 1% level, which confirms that an energy deficit and distorted tariff structure result in a poor quality of service. Just as we saw the financial status of the power utilities mediate the effects of the tariff structure on the power supply quality, we now see correlations of these two variables with the financial status of the power utilities. We can find such relationships in the reduced magnitudes of $profit_j$ in Eq. (3) and $profit\_s_j$ in Eq. (4). The estimated coefficients of $Energy_j$ and $Tariff_j$ appear to be particularly important, as both are more statistically significant than the coefficient of $profit\_s_j$ in Eq. (4). More effort to expand the capacity and rationalize the tariff structure may be

needed to improve the quality of the power supply. We also find from the results on sdp_j which has a negative and significant impact in all specifications, that establishments gain an advantage by locating in developed states.

Turning to the estimation results for $size_i$, epz_i and $city_i$, we cannot easily conclude that these establishment-level variables have significant effects: $city_i$ and epz_i only have significant effects at the 10 % level in Eq. (1), while several industrial

Table 8 Estimation results of the tobit model

	Eq (1)			Eq (2)			Eq (3)			Eq (4)		
	Coef.	S.E		Coef.	S.E		Coef.	S.E		Coef.	S.E	
profit	−0.153	(0.009)	***				−0.071	(0.009)	***			
profit_s				−0.170	(0.012)	***				−0.018	(0.01)	*
energy							−0.337	(0.044)	***	−0.501	(0.045)	***
tariff							0.058	(0.013)	***	0.089	(0.013)	***
sdp	−0.107	(0.008)	***	−0.102	(0.01)	***	−0.881	(0.009)	***	−0.075	(0.009)	***
size	−0.001	(0.001)		−0.001	(0.001)		−0.001	(0.000)		−0.001	(0.)	
city	0.905	(0.497)	*	0.258	(0.499)		0.776	(0.512)		0.467	(0.516)	
epz	−1.028	(0.575)	*	−0.932	(0.57)		−0.456	(0.581)		−0.260	(0.569)	
industrial dummies												
Basic metals	−2.947	(1.165)	**	−3.673	(1.256)	***	−2.108	(1.156)	*	−1.902	(1.183)	
Chemicals	−3.363	(1.228)	***	−4.430	(1.309)	***	−3.314	(1.242)	***	−3.463	(1.269)	***
Electronics	−1.950	(1.14)	*	−3.039	(1.215)	**	−1.604	(1.136)		−1.618	(1.156)	
Fabricated metal products	−1.255	(1.204)		−1.946	(1.28)		−1.223	(1.21)		−1.333	(1.228)	
Food	−0.093	(1.266)		−0.730	(1.316)		−0.075	(1.263)		−0.088	(1.275)	
Furniture	−4.539	(2.062)	**	−6.220	(2.168)	***	−3.879	(1.978)	*	−4.005	(1.983)	**
Garments	0.586	(1.417)		−0.239	(1.469)		−0.107	(1.412)		−0.534	(1.424)	
Leather	1.282	(1.594)		0.375	(1.654)		1.313	(1.624)		1.209	(1.656)	
Machinery and equipment	−1.532	(1.328)		−2.375	(1.438)	*	−1.376	(1.309)		−1.550	(1.331)	
Non metallic mineral products	−3.374	(1.289)	***	−3.521	(1.335)	***	−2.574	(1.25)	**	−2.063	(1.258)	
Paper	0.569	(1.829)		−0.457	(1.872)		0.852	(1.797)		0.794	(1.796)	
Plastics & rubber	−1.344	(1.158)		−2.239	(1.232)	*	−1.168	(1.157)		−1.165	(1.177)	
Precision instruments	−3.139	(1.873)	*	−4.557	(1.882)	**	−3.290	(1.97)	*	−3.506	(1.983)	*
Publishing	−4.505	(1.535)	***	−5.888	(1.594)	***	−4.881	(1.556)	***	−5.294	(1.579)	***
Recycling	−3.816	(1.889)	**	−2.691	(1.182)	**	−2.487	(1.4)	*	−1.310	(1.766)	
Refined petroleum product	9.207	(5.23)	*	9.275	(5.621)	*	11.043	(5.513)	**	11.913	(5.769)	**
Textiles	2.056	(1.478)		1.055	(1.525)		1.861	(1.439)		1.671	(1.441)	
Tobacco	−8.206	(2.51)	***	−9.527	(2.538)	***	−7.292	(2.349)	***	−7.101	(2.304)	***
Wood	−0.389	(1.326)		−1.405	(1.364)		−0.182	(1.35)		−0.263	(1.374)	
Retail	−4.711	(1.302)	***	−6.195	(1.358)	***	−4.744	(1.328)	***	−5.087	(1.34)	***
Construction Section F	−7.241	(1.559)	***	−8.844	(1.598)	***	−6.943	(1.519)	***	−7.236	(1.52)	***
Hotel and restaurants	−4.599	(1.29)	***	−6.670	(2.517)	***	−4.196	(1.304)	***	−5.843	(2.143)	***
IT	−5.622	(1.5)	***	−5.704	(1.348)	***	−5.137	(1.563)	***	−4.279	(1.317)	***
Services of motor vehicles	−7.082	(1.971)	***	−7.398	(1.545)	***	−6.142	(2.003)	***	−5.297	(1.624)	***
Transport Section I	−5.825	(1.352)	***	−7.029	(1.424)	***	−5.268	(1.357)	***	−5.278	(1.374)	***
Wholesale	−4.217	(1.484)	***	−5.495	(1.602)	***	−3.529	(1.518)	**	−3.527	(1.573)	**
Constant	2.964	(1.223)		5.391	(1.29)	***	−3.239	(1.65)	*	−5.724	(1.686)	***
Obs.	6671			6671			6671			6671		
Log pseudolikelihood	−617675			−627653			−613209			−615438		
Pseudo R2	0.088			0.073			0.094			0.0909		
Note												
Dependent variable: outage_loss												
left-censored observations at outage_loss<=0: 3060												
uncensored observations: 3611												
right-censored observations: 0												
"***","**" and "*" denote statistical significance at the 1%, 5%, and 10% levels, correspondingly												
The industrial dummy of Transport machines is not included.												

dummies have significant effects throughout the analysis. These results imply that apart from the industrial characteristics, the features of the establishments, such as the locations and sizes of firms, are dominated by the characteristics of the states where they are based. In other words, state-level efforts to improve have a crucial impact on the operation of private firms throughout the power supply.

5 Concluding remarks

This paper begins with an assessment of the current status of power sector reform. Comparing the data from the fiscal years 2004 and 2012, we report that the power sectors in most states have made substantial progress in several areas such as per capita consumption and AT&C loss, but not in their financial well-being. As such, we cannot readily conclude that the goals of power sector reform are fully achieved. Next, in our analysis, we show that Bihar and Uttar Pradesh, states generally regarded to be socially and economically backward, tend to be losing ground in the power sector reform. This situation has further expanded the interstate disparity in social and economic development.

Singling out the financial reconstruction of the distribution sector as the key to successful power sector reform, we then use establishment-level data to investigate how the financial status of power utilities impacts the power supply quality. Our estimation result shows that the financial status of power utilities has significant adverse impacts on commercial loss due to power outages, which suggests that the financially deteriorated utilities fail to provide good-quality service even in the several states where they receive huge subsidies to support their operations. This finding supports a mode of power sector reform that puts priority on the reconstruction of the financial status of the power utilities, though some states like Punjab and Tamil Nadu still set the agricultural tariffs far below costs as a subsidizing policy.

Finally, we should point out the improvements needed in parts of this analysis. It will be important, for example, to identify the background factors explaining why subsidized utilities fail to provide good service. One possible explanation we can draw from our estimation results is a reverse causality in which the financially troubled power utilities require subsidization from the state governments. Further, the incentives of the players in the power sector may change when subsidies are received. Further research will be needed to clarify these unresolved questions.

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