Introduction

India has achieved remarkable economic growth and become a key destination for foreign direct investment at the beginning of the 21st century. The country has attracted increased attention as a huge potential market since the pro-business government led by Narendra Modi came into power in 2014. Yet India's underdeveloped infrastructure, especially its unreliable power supply, is still widely expected to remain a significant bottleneck for economic development. The OECD (2014) has emphasized the negative impact of unreliable power supply as a "big constraint" for the country. To realize further industrialization and economic growth in the coming years, India urgently needs to improve the quality of its infrastructure, especially in the power sector. The power sector reform launched in the early 1990s and revision of power tariffs have become critical targets toward this end. Most Indian states set electricity tariffs for the agricultural sector far under supply costs, which worsens the financial status of the power utilities and state governments and hampers investment and maintenance expenditure.

The tariff structure in India's industrial sector also has a significant bearing. Industrial and commercial tariffs have been set over costs, providing surpluses for use as cross-subsidies to partly offset the deficits. By worsening the business environment for industrial and commercial consumers, the distorted tariff structure may ultimately compel consumers to set up their own captive power plants to reduce the consumption of grid power (Dubash and Rajan 2001). Note, however, that power subsidies to the agricultural sector can be seen as a driver of social and economic development, especially in rural areas (Shah 2009). The power tariff policy in India has been recognized as an instrument of social policy[1].

In this paper we assess the cost of India's power tariff policy with a focus on the impact on firm performance in the manufacturing sector. The tariff structure is thought to potentially affect firm performance through (a) the policy of charging higher tariffs in the industrial sector well above costs increases the input cost and (b) the financial deterioration of the power utilities and resulting power outages and other quality problems with the power supply.

To conduct a firm-level empirical analysis, we use firm-level panel data from the Indian Annual Survey of Industries (ASI) from the years 2003-04 to 2007-08. A firm's performance is measured by its total factor productivity (TFP). Taking transmission and distribution (T&D) losses as proxy for the quality of the power supply, we investigate

[1] Briner et al. (2007) suggest that a free power policy is less costly to launch since it requires no "implementation by the bureaucratic apparatus."

the impacts on firm performance. Our estimates show that the unreliable power supply has significant adverse impacts on TFP, while the industrial tariffs do not. These estimates are consistent with the situation observed, where the worsening financial status of the power utilities due to free power does not necessarily result in industrial tariff hikes for cross-subsidization. In other words, our estimates suggest that if an agricultural state can realize a reliable power supply, the tariff structure itself has no effect on firm performance. The firm performance may, however, be indirectly hindered through channels such as the misallocation of resources among sectors or the deterioration of state finances due to subsidies.

The remainder of this chapter is organized into four sections. In section 2 we briefly sketch the issues facing the Indian power sector, describe relevant background factors, and analyze the financial costs of the distorted tariff policy for the power utilities and state governments. In section 3 we empirically assess how the corporate and regulatory governance impacts the quality of the power supply. In section 4 concludes this chapter.

2. Cost of power tariff policy

2.1 Financial status of power utilities

Several surveys of investors from around the world have singled out poor power infrastructure as the biggest hurdle to investment in India. The most commonly mentioned symptoms of the problem are frequent power outages, high transmission and distribution losses, persistent power deficits, and delays in rural electrification. The first of these symptoms, frequent power outages, poses a direct obstacle for business. FICCI (2013), for example, estimates that power outages in 2012 cost the Indian economy as much as 68 billion dollars, or 0.4 % of the country's GDP. Frequent power outages and voltage fluctuations push industrial firms to invest in generators and stabilizers to mitigate damage, while medium and small companies unable to afford these expenses are left defenseless. According to data from the World Bank, the average loss of sales directly related to power outages is equivalent to 3.2 % of total sales in India's industrial and service sector[2]. Allcott et al. (2014) estimate that damage due to power outages in India's textile industry reaches 5 % of output.

The impact from the deteriorated financial status of the state power utilities is the most crucial background factor underlying this situation. Tight fiscal constraints hamper investment in the establishment, operation, and maintenance of facilities, which in turn weakens the quality of power supply service. The total commercial loss

[2] See Fukumi (2016a), table 5.

borne by the state power utilities in 2013 reached 7,127 crore rupees, or 0.63% of India's GDP. Figure 1, which plots the commercial loss of state power utilities as a percentage of GDP, shows improvement, but huge commercial losses persist. From Figure 2 showing the relationship between the financial status of power utilities and commercial loss of firms due to power outages, we also see that the financially deteriorated utilities can damage firm performance through power outages (Fukumi 2016a).

Why do such huge commercial losses persist in the Indian power sector? The very high transmission and distribution (T&D) loss is clearly a core component. From Figure 3 showing the state-wise status of T&D loss, we can see that the T&D loss has declined in all states but Bihar and Haryana, and that the national average has decreased from 31.3% in 2004 to 23% in 2012. The status is still worse, however, if we compare it with the world average 8.2 % in 2012[3].

Meanwhile, a very low cost-recovery ratio constrains power utility financing. Figure 4 outlines the major composition of the power supply cost and revenue and how its changes over the two periods. The tariff revenue grows, but not enough to offset the rises in the cost for power purchase and generation due to hikes in coal prices. The gap between cost and revenue has expanded. The recovery ratio declined from 91% in 2004 to 79% in 2012 even after subsidies were received from the state governments.

The low recovery ratio stems from the tariff structure, which granted preferential electricity tariffs for agricultural users while setting industrial and commercial tariffs over costs. While the surplus from industrial and commercial sectors has been used as cross-subsidy, it falls far below the level necessary to offset the deficit from the agricultural sector. This tariff structure has thus been criticized for hampering the business environment through (a) industrial sector tariffs set far above costs and (b) low-quality power supply (e.g., frequent power outages) resulting from the financial deterioration of the power utilities and state finances. Tariff hikes and unreliable electricity supply appear to have increasingly induced industry to invest in captive generation, instigating a process that potentially reduces the revenue of state power utilities. In addition, low-cost electricity has encouraged wasteful consumption and triggered environmental problems such as groundwater depression (Dubash 2007). This "distorted" tariff structure was originally launched in the late 1970s in Tamil Nadu (Dubash and Rajan 2001) and later adopted in other states. Electricity became a crucial input for agriculture with the shift from diesel to electricity as the main power source for irrigation pumps in the 1970s. Electric power policy was highly politicized in ensuing decades, leading to a widespread adoption of power subsidies as tools to win the

[3] From World Development Indicator (WDI) database.

votes of farmers (Ruet 2005). While many argued that the tariff structure served as a form of political patronage, power subsidies can also be recognized as drivers of social and economic development, especially in rural areas. Shah (2009) proposed that power subsidies accelerated the Green Revolution by reducing the cost of irrigation with electric pumps. Irrigation by tubewells serviced by electric pumps started spreading in the 1970s, just as agriculture's share of electricity consumption was rising. The diagram in Figure 5 illustrates how the abovementioned issues fit together in relation to the power tariff structure.

2.2 Cost of the power tariff policy

From table 1 showing the revenue per unit by consumer category, we can see the average cost, revenue, and cross-subsidy structure in each state. By comparing the power supply cost among the states in column 1, we find that Rajasthan and Tamil Nadu bear the highest costs. The power plants in these two states are thus assumed to be disadvantaged in terms of their capacities, modes, ages, plant load factors, and other factors that determine power supply costs. While the cost and revenue levels differ among the states, the average revenue falls below the power supply cost in all of the states but Delhi. In the breakdown of revenue by category, we observe a cross-subsidy structure in which the payments from agriculture consumers fall below the power supply costs[4] while payments from industrial and non-domestic consumers exceed the costs. Punjab and Tamil Nadu provide electricity to agricultural consumers for free, while Delhi, West Bengal, Gujarat, and Bihar show relatively high recovery ratios even though they collect only around 60 % of the average supply costs. Judging from the recovery ratio from industrial consumers of high-voltage electricity, we see that Madhya Pradesh and Chhattisgarh charge tariffs in excess of 1.7 times the supply costs, followed by Gujarat (1.59), and Orissa (1.54). In terms of revenue, however, Madhya Pradesh still takes in the highest amount (8.7), followed by Delhi (8.3) and Uttar Pradesh (7.4).

As discussed above, this tariff structure brings about huge commercial losses for the power utilities. Table 2 shows the commercial profit/losses in 2013 by consumer category. Commercial losses from the agricultural sector were the largest in Punjab in terms of SDP[5], followed by Andhra Pradesh, Rajasthan, Haryana, and Tamil Nadu. We also find that industrial and non-domestic consumers were charged tariffs in excess of

[4] The recovery ratio is the ratio of revenue to the average cost of supply. A value of less than one means "subsidized," or paying below the cost, while a value exceeding one means "subsidizing," or paying over the cost.

[5] According to CEA figures, the total number of pumpsets energized in 2013 was 1,216,336. The total agricultural power subsidy in Panjab was 4,827 crore rupees, or approximately 40,000 rupees per tubewell.

the costs in all but a few states for cross-subsidy, while the total collected amounts fell far below the levels required to offset the huge commercial losses in the states of Andhra Pradesh, Tamil Nadu, Rajasthan, Punjab, Uttar Pradesh, and Madhya Pradesh. In Punjab, for example, the total profit from non-domestic and industrial consumers reached 2,728 crore rupees, far less than the loss incurred in the agricultural sector, 4,827 crore rupees. The Punjab state government provided 4,695 crore rupees as subsidy to power utilities, or 1.48 % of the SDP, the highest subsidy paid in any state and half of the Gross Fiscal Deficit. This huge financial support from state finances resulted in a profitable year for the power utilities in Punjab, bringing in a surplus of 642 crore rupees. This contrasted sharply with most of the other state governments, which provided subsidies too small to recover costs. The power utilities in states such as Uttar Pradesh, Tamil Nadu, and Rajasthan therefore report huge commercial losses even after receiving state subsidies.

These two tables thus demonstrate that the power utilities generally incur massive losses, though the levels of loss vary according to the cross-subsidy schemes and financial support from the state governments. Note also that the states that provide power at very low tariffs for agricultural consumers and incur huge commercial losses do not necessarily charge higher tariffs in their industrial and non-domestic sectors. Figures 6 and 7 respectively show the revenue-per unit relationship and profit/loss relationship between the agricultural and industrial sectors. Negative relationships are difficult to identify at a glance.

3. State tariff policy and firm performance

3.1 Firm-level electricity expenditure

To assess the impact of tariff policy on firm performance, we use firm-level panel data from the Indian Annual Survey of Industries (ASI) from the years 2003-04 to 2007-08. The original data are collected from census statistics on all enterprises employing more than 100 workers. The survey provides information on the basic characteristics of factories such as their employees, capital, and the net and gross values, as well as data on electricity consumption and expenditure[6]. The expenditure on grid electricity per unit is used as a proxy for the electricity tariff.

Table 3 shows the average expenditure for grid electricity per unit by state and by industry in 2007[7]. The colored values in the table are the highest and second highest

[6] We start our analysis from 2003-04, the first year when data on the electricity consumption of firms are reported.

[7] Firm level data is aggregated at the 2-digit level from the National Industrial Classification.

values among the industries in each state. Firms in Madhya Pradesh pay the highest tariff, followed by firms in Karnataka and Gujarat. The tanning and dressing of leather (NIC code 19) is the highest-paying industry, followed by the manufacture of wearing apparel (NIC code 18)[8]. The table gives us an overview of the state and industry tariff levels resulting from the state tariff policy. Note, however, that the electricity expenditure per unit is determined by the firm's contract with the power grid, which depends upon factors such as the amount of electricity consumed and voltage. To extract the difference in tariff policy among states, we therefore run a simple OLS estimation at the firm level by regressing the expenditure for grid electricity per unit to the amount of electricity consumed and industrial and year dummy variables[9]. We employ the residuals from this estimation as a proxy for state tariff policy, since the effects of the consumption level and industry characteristics, factors potentially related to the power supply contract, are removed from the original data on the per unit expenditure for electricity.

Table 4 reports the average expenditures per unit by states and industries due to the "state tariff policy." We see that the rankings by industry change slightly after the effects of firm-specific factors on electricity expenditure are excluded. The figures show that states such as Madhya Pradesh, Karnataka, and Gujarat impose unfavorable tariff policies for industrial sectors. We also find, meanwhile, that the agricultural states providing electricity at very low rates or for free, such as Punjab, Tamil Nadu, and Andhra Pradesh, offer preferential tariffs to industrial sectors. This finding is consistent with what we reported in the previous section.

3.2 Impact of tariff policy on firm performance

Model specification

To analyze the impact of tariff policy on firm performance, we employ the log of total factor productivity (TFP)[10] as a dependent variable. As the first explanatory variables, we employ $Tariffpolicy_{it}$ residuals from the OLS estimation mentioned above. The tariff hike is expected to have a negative impact on firm performance since it directly increases the input cost. Second, to investigate the impact of the quality of power supply, we employ $T\&D\ loss_{jt}$, the ratio of transmission and distribution losses to the energy input in state j. $T\&D\ loss_{jt}$ is expected to have negative

[8] Most firms in these two industries use less electricity than firms in other industries, which increases the per unit payment because a preferential tariff is granted to mega consumers in general.

[9] The estimation result is reported in Appendix (a).

[10] Appendix (b) provides details on the estimation method, as well as the total factor productivity by state and by industry.

impact since it relates closely to the frequency of power outages, as demonstrated in Fukumi (2016b). Third, on the assumption that unstable power supply will be more harmful for firms that are more dependent on grid electricity, we employ $Energy\ intensity_{it}$, defined here as the ratio of electricity consumption (kWh) to the value of real output, as a proxy for the firm's electricity dependence [11]. $Energy\ intensity_{it}$ serves as a form of interaction term with $TD\ loss_{jt}$ with the expectation of negative impact. Table 5 presents the definitions and descriptive statistics of the variables included in the empirical model.

Estimation results

Table 6 gives the estimation results of the fixed effect model on the impact of tariff policy. The first noteworthy finding is that $Tariff policy_{it}$ has a positive sign but is not statistically significant in Eqs. (1) and (2). Though it turns significant with a negative sign, it would be safer to assume there is no stable relationship between tariff policy and firm performance. Counter-intuitively, we can say that these unstable estimation results are consistent with the finding in Table 4, where forward states attracting investment from all over the world, such as Gujarat, impose relatively unfavorable tariff policies on industrial sectors. On this point, the picture in Figure 8 more clearly suggests that no negative relationship can be found between the state-level averages of tariff policy and TFP in 2007.

Turning to the impact of $TD\ loss_{jt}$ in Eqs. (2) and (3) and its interaction term with $Energy\ intensity_{it}$ in Eq.(3), we see negative and significant impacts on firm performance. These results suggest that a poor-quality power supply disturbs firm performance and that mega consumers of grid electricity suffer more from the negative impact. To explore the impact of the power supply quality on firm performance, we calculate the impact of the reduction of T&D losses in a hypothetical scenario where all states have reduced the T&D losses to 15% of the 2007 level by March 2016, as targeted by the central government. From Table 7 reporting the impact on TFP by state and by industry, the backward states in terms of T&D losses, such as Orissa, Bihar, and Jharkhand, enjoy bigger gains, which means that they suffer the most in the real world. The table also shows that electricity-intensive industries such as basic metal industry (NIC code 27) gain a lot in this scenario.

Our estimation results thus imply that the quality of the power supply is the main channel through which state tariff policy affects firm performance. This impact is especially serious for backward states characterized by financially deteriorated utilities

[11] Appendix (c) provides state- and industry-wise statistics on this variable.

and poor-quality power supply. More important, the tariff policy in the agricultural states that provide electricity at very low rates or for free, such as Punjab, Tamil Nadu, and Andhra Pradesh, harms the manufacturing sector not by charging higher tariffs on industrial sectors in cross-subsidization schemes, but through unreliable power supply. If the power utilities in these states could supply better-quality power to reduce the adverse impacts of their tariff policies on industrial sectors, their policies could be more readily evaluated as instruments of social policy to some degree.

4. Concluding remarks

The target of this paper is to assess the cost of India's power tariff policy with a focus on the impact on firm performance in the manufacturing sector. Our estimates show that unreliable power supply has significant adverse impacts on TFP, while industrial tariffs do not. These estimates are consistent with the situation observed from the data on the financial status of power utilities, where a worsening financial status does not necessarily result in industrial tariff hikes, as the utilities depend heavily on state subsidies. In other words, our estimates suggest that if an agricultural state can realize a reliable power supply, the policy of subsidizing the agricultural sector does not in itself adversely impact firm performance. Now that the power supply is getting more stable, this finding could be important in evaluations of the cost of subsidizing policy. Readers should note, however, that firm performance may be indirectly hindered through channels such as the deterioration of state finances or the misallocation of resources among sectors.

Before closing this paper we should point out parts of our analysis in need of further refinement. First, we include no analysis on self-generation even though investigations often suggest that the spread of captive power plants is a crucial outcome of poor-quality grid power. The level of self-generation should be included to our analysis, given that it relates closely to the consumption of grid power as well as firm performance,. Second, we assume that energy intensity is constant through our analysis, even though firms can presumably change their production technology to adapt to changes in the business environment, including the cost and quality of electricity. The cost of tariff policy should be further explored, given the possibility that we underestimate it here. All of these matters are left for further study.

Reference

Allcott, Hunt, Allan Collard-Wexler, and Stephen D. O'Connell (2014). "How Do Electricity Shortages Affect Productivity? Evidence from India, " *NBER Working Paper* No. 19977

Birner, R. Gupta, S. and Sharma, N. (2011), *The political economy of agricultural policy reform in India: fertilizers and electricity in India ,* IFPRI Research Monograph 174,IFPRI、 Washington D.C.

Central Electricity Authority (various issues). *All India Electricity Statistics,* New Delhi: Ministry of Power, Government of India.

Dubash, Navroz K.. and S. C. Rajan (2001), "Power Politics Process of Power Sector Reform in India," *Economic and Political Weekly*, September 1:3367-3390.

Dubash, Navroz K. 2007. "The Electricity-Groundwater Conundrum: Case for a Political Solution to a Political Problem", Economic and Political Weekly, 42-52, December 29.

Fukumi, A. (2016a). "Power Sector Reform in India: Current Status and Issues," *School of Economics, University of Hyogo, Discussion Paper* No.88

Fukumi, A. (2016b). "Power Sector Reform and Blackout in India,"

Federation of Indian Chambers of Commerce & Industry (FICCI) (2013). *Power Transmission The real Bottleneck: An overview of the Indian power transmission sector, its challenges, and recommendations.*

OECD (2014), *OECD Economic Surveys: India 2014*, OECD Publishing, Paris.

Ruet, Joel. (2005). *Privatising Power Cuts?: Ownership and Reform of State Electricity Boards in India*, New Delhi : Academic Foundation

Reserve Bank of India (2015). *Handbook of Statistics on Indian Economy 2014-15*, Mumbai: Reserve Bank of India.

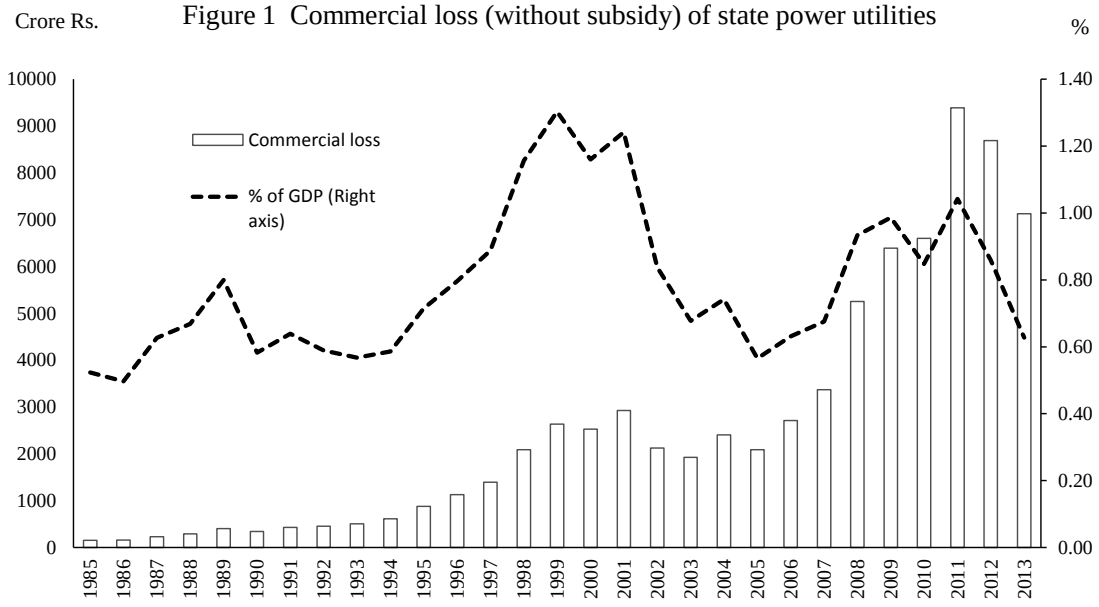
Shah, Tushaar. (2009). *Taming the Anarchy: Groundwater Governance in South Asia*, New Delhi : Routledge

Planning Commission, Government of India. (2012), (2014). *Annual Report on the Working of State Power Utilities and Electricity Departments,* New Delhi, Planning Commission , Government of India .

Power Finance Corporation Limited. (2008). *Report on the Performance of The State Power Utilities for the Years 2004-05 to 2006-07*, New Delhi: Power Finance Corporation Limited.

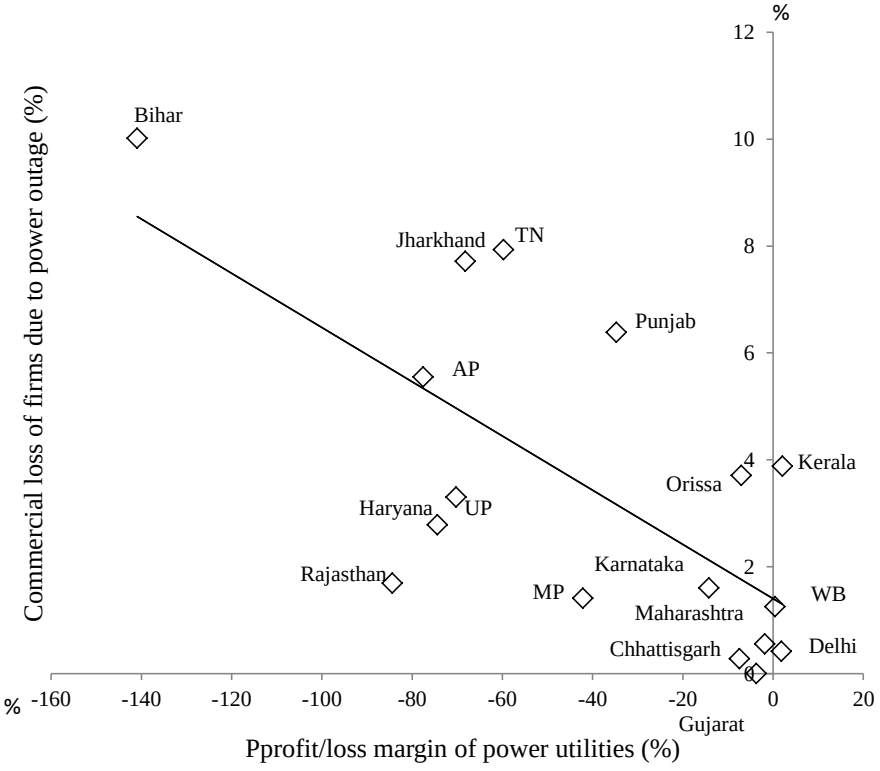
Power Finance Corporation Limited (2014). *The Performance of State Power Utilities for the years 2010-11 to 2012-13*, New Delhi: Power Finance Corporation Limited.

Figure 1 Commercial loss (without subsidy) of state power utilities



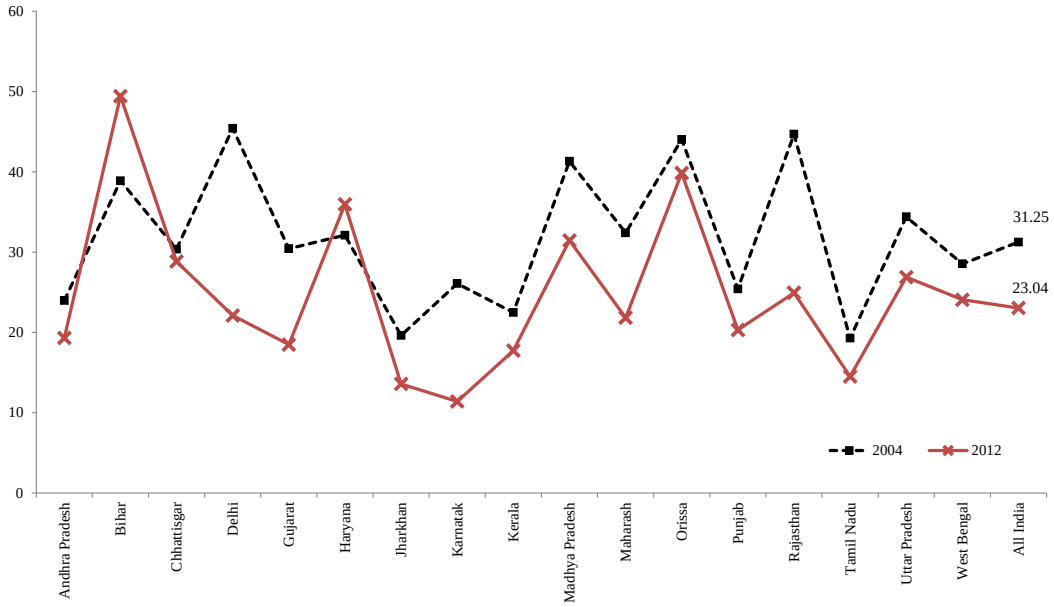
Source: Author calculation based on data from Power Finance Corporation (2008) , Planning Commission (2012, 2014), and Reserve Bank of India (2015)

Figure 2 Financial status of utilities and commercial loss of firms due to power outage



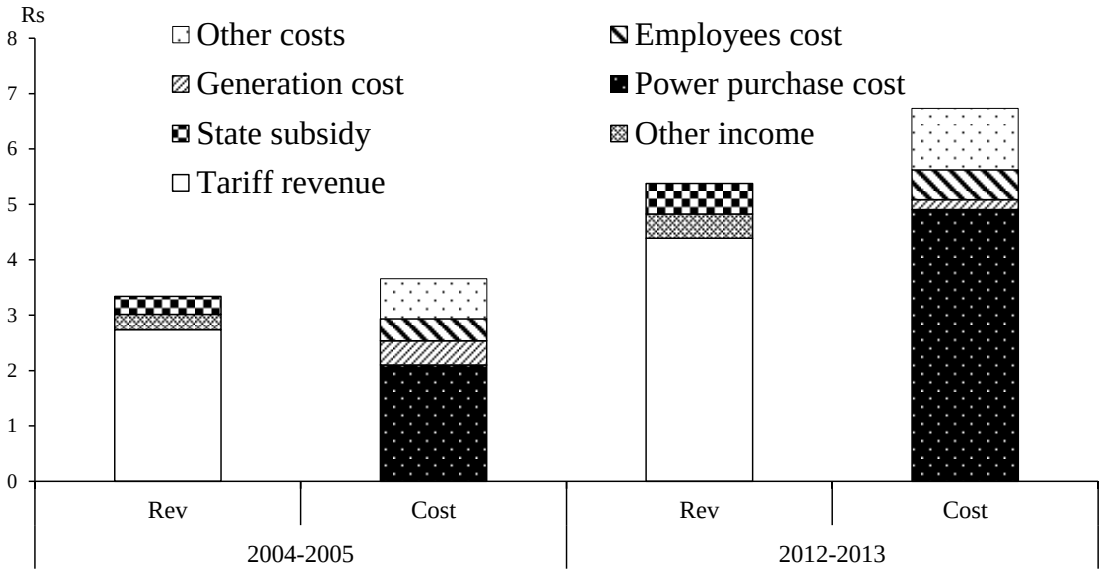
Source: Fukumi (2016). Data on commercial loss due to power outage is calculated by using World Bank Enterprise Survey.

Figure 3 State wise Transmission and Distribution loss in 2004-2005 and 2012-2013



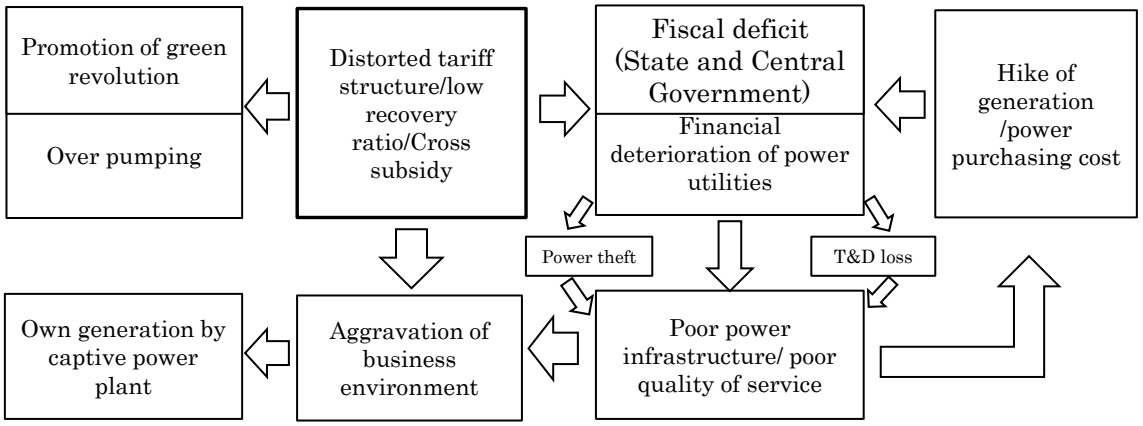
Source Central Electricity Authority (various issues)

Figure 4 Composition of Power Supply Cost and Revenue per kWh



Source: Calculated by the author from PRC (2008), (2014)
Note
*Data on utilities directly selling electricity to consumers only.
**"Other costs" include cost for Employees, O&M, Interest, Depreciation, and Admi. and General expenditure.

Figure 5 The impact of tariff policy in Indian power sector



Source: Author

Table 1 Consumer Category-wise Revenue per Unit (Rs./kwh) in the year 2013-14

	Average Cost of supply	Average revenue		Domestic		Non Domestic		Agricultural		Industrial HT		Industrial LT	
Andhra Pradesh	4.8	3.9	(0.81)	3.2	(0.66)	8.8	(1.82)	0.3	(0.06)	6.5	(1.34)	7.0	(1.46)
Bihar	5.0	3.0	(0.59)	3.2	(0.64)	6.9	(1.37)	3.0	(0.59)	6.3	(1.25)	6.2	(1.24)
Chhattisgarh	3.4	3.2	(0.92)	2.7	(0.78)	4.0	(1.16)	1.8	(0.53)	5.8	(1.7)	5.4	(1.57)
Delhi	5.8	6.0	(1.02)	5.9	(1.02)	10.2	(1.76)	3.9	(0.67)	8.3	(1.42)	8.8	(1.51)
Gujarat	4.2	4.1	(0.97)	4.7	(1.11)	5.1	(1.22)	2.4	(0.57)	6.7	(1.59)	6.1	(1.45)
Haryana	5.3	3.5	(0.66)	4.6	(0.87)	5.9	(1.11)	0.5	(0.09)	5.5	(1.03)	5.9	(1.1)
Jharkhand	6.2	3.4	(0.54)	1.4	(0.23)	7.5	(1.2)	0.7	(0.11)	5.6	(0.9)	7.9	(1.26)
Karnataka	4.4	4.0	(0.91)	4.3	(0.97)	7.9	(1.79)	2.6	(0.6)	5.9	(1.35)	5.9	(1.35)
Kerala	5.4	5.4	(0.99)	3.1	(0.57)	9.8	(1.8)	1.8	(0.33)	6.4	(1.18)	5.9	(1.08)
Madhya Pradesh	4.9	3.2	(0.66)	4.6	(0.94)	5.4	(1.1)	1.5	(0.31)	8.7	(1.77)	6.3	(1.29)
Maharashtra	5.3	5.2	(0.98)	5.5	(1.03)	10.6	(1.98)	3.2	(0.6)	7.1	(1.32)	5.7	(1.07)
Orissa	3.8	3.7	(0.96)	3.5	(0.91)	6.5	(1.69)	1.5	(0.39)	5.9	(1.54)	6.4	(1.67)
Punjab	4.7	3.7	(0.79)	4.2	(0.9)	7.0	(1.47)	0.0	(0.00)	6.4	(1.35)	6.3	(1.34)
Rajasthan	6.5	3.6	(0.56)	3.8	(0.58)	6.1	(0.93)	3.3	(0.51)	5.6	(0.86)	4.5	(0.69)
Tamil Nadu	6.5	4.1	(0.63)	2.6	(0.4)	8.1	(1.24)	0.0	(0.00)	na	na	5.6	(0.87)
Uttar Pradesh	6.1	3.3	(0.54)	2.8	(0.46)	6.6	(1.08)	1.7	(0.28)	7.4	(1.21)	6.2	(1.02)
West Bengal	4.9	4.9	(1.00)	5.3	(1.07)	6.8	(1.39)	3.0	(0.61)	7.1	(1.45)	na	na

Source: Author calculation using data from Power Finance Corporation 2015

Note

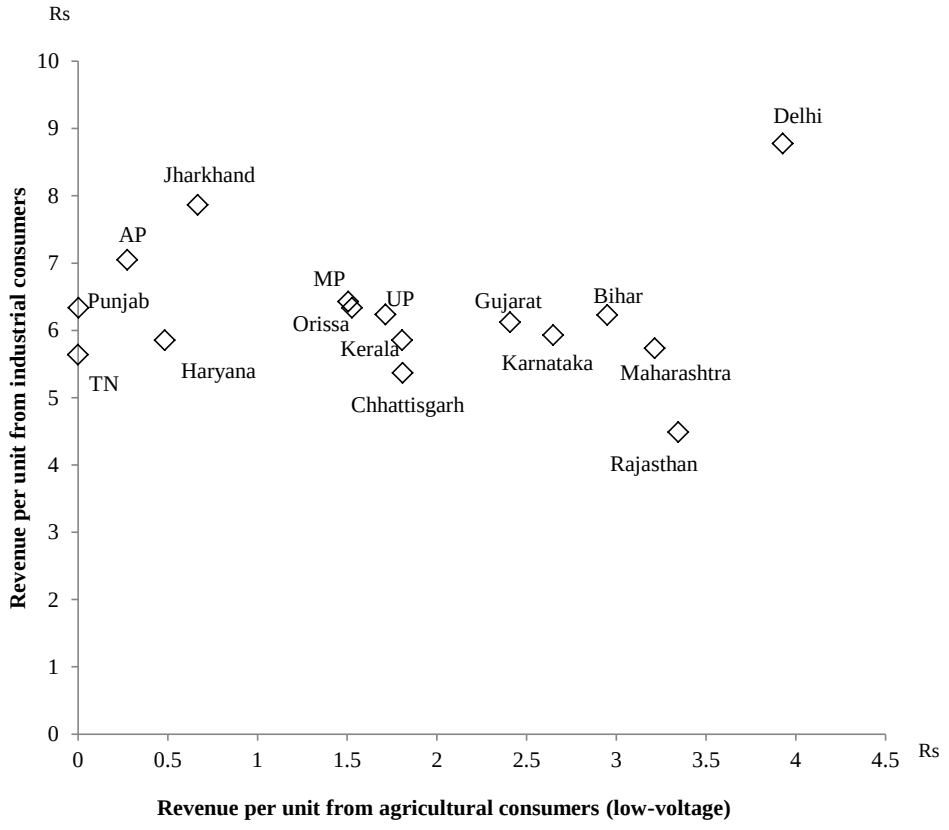
The recovery ratio of each category is reported in parentheses

Table 2 Consumer Category-wise commercial profit/loss in the year 2013-14 (Crore. Rs.)

	Domestic	Non Domestic	Industrial HT	Industrial LT	Agricultural		Total Income - excluding subsidy	Total Exp	Profit on subsidy received basis	Profit without subsidy	Subsidy from state		Gross Fiscal Deficit
						% of SDP						% of SDP	
Andhra Pradesh	-1119.3	2685.5	3160.1	603.2	-9929.0	1.16	48352	55055	-720	-7026	6306	0.74	24490
Bihar	-148.7	151.2	193.3	33.4	-67.3	0.02	4510	7533	-367	-3023	2656	0.77	8770
Chattisgarh	-89.3	64.8	1255.1	100.0	-367.6	0.20	10274	11378	-1317	-1317	0	0	5150
Delhi	66.4	2517.5	126.5	733.3	-5.3	0.00	23921	22882	692	692	0	0	-2060
Gujarat	9.4	19.0	3880.6	1731.0	-2714.8	0.35	67118	67454	583	-516	1099	0.14	20500
Haryana	-193.7	165.7	129.2	78.1	-3975.5	1.02	23996	32288	-3314	-8295	4981	1.28	8980
Jharkhand	-144.0	37.4	-107.2	19.2	-33.3	0.02	2339	4816	-1511	-2477	966	0.56	4090
Karnataka	-80.5	2063.8	1311.4	280.6	-2972.8	0.48	32740	34555	-215	-1785	1570	0.26	17450
Kerala	-499.9	937.7	392.5	51.9	-111.7	0.03	11394	11283	111	111	0	0	11870
Madhya Pradesh	-75.2	122.0	2240.0	140.3	-4262.6	0.98	24208	33164	-6947	-9141	2194	0.50	12220
Maharashtra	89.0	3096.5	4068.1	293.3	-4423.5	0.29	74378	72705	1534	1532	2	0.00	24120
Orissa	-48.2	385.1	1235.7	87.0	-43.4	0.02	16627	18203	-1642	-1642	0	0	5950
Punjab	-148.8	674.4	1599.1	454.3	-4827.5	1.52	18302	22251	642	-4053	4695	1.48	9260
Rajasthan	-880.8	-136.8	-612.7	-611.6	-5646.2	1.09	32215	49666	-15926	-17451	1525	0.29	13020
Tamil Nadu	-3301.4	1306.1	na	-525.1	-8020.3	0.94	34488	52150	-12744	-17662	4918	0.58	22940
Uttar Pradesh	-1549.1	236.9	1338.2	44.6	-4385.2	0.51	71752	94550	-17680	-22853	5173	0.60	23910
West Bengal	114.5	596.9	1552.5	na	-228.5	0.03	26350	25755	466	466	0	0	13410

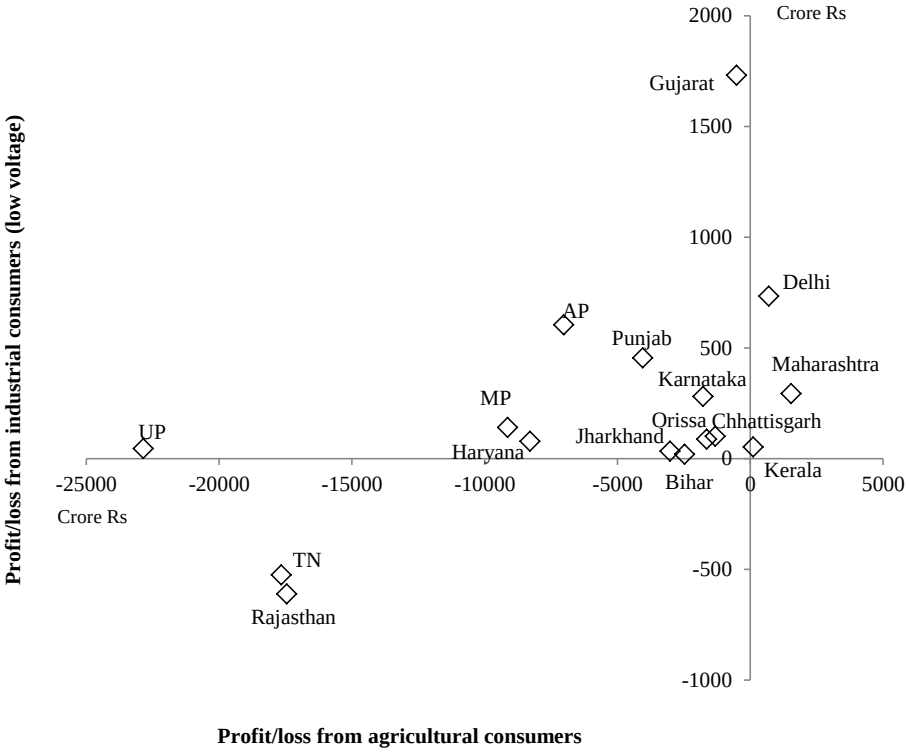
Source: Author calculation using data from Power Finance Corporation 2015

Figure 6 Relationship of the revenue per unit from agricultural and industrial consumers in 2013



Source: See table 2

Figure 7 Relationship of the proft/loss between agricultural and industrial in 2013



Source: See table 2

Table 3 The state and industry-wise average of electricity expenditure per nuit in the year 2007-08 (Rs.)

Industries (with NIC 2-digit code)	AP	Bihar	Chat	Delhi	Guj	Har	Jhar	Kar	Kerala	MP	Mah	Orissa	Punjab	Raj	TN	UP	WB	Avg.
15 MANUFACTURE OF FOOD PRODUCTS AND BEVERAGES	2.469	2.782	2.720	2.951	3.034	2.644	2.453	2.986	3.059	3.064	2.892	2.249	2.548	2.776	2.782	2.773	2.823	2.794
16 MANUFACTURE OF TOBACCO PRODUCTS	2.195	2.889	2.839	2.822	3.103	2.565	2.257	2.854	2.321	3.683	2.787	1.843	2.257	2.825	2.958	2.727	2.622	2.640
17 MANUFACTURE OF TEXTILES	2.152	2.906	2.581	2.879	2.819	2.679	2.455	3.086	2.609	3.093	2.814	2.365	2.537	2.596	2.557	2.860	2.568	2.656
18 MANUFACTURE OF WEARING APPAREL DRESSING AND DYEING OF FUR	2.403	2.822	2.398	2.883	2.989	2.558		3.247	2.874	3.182	3.222	2.610	2.610	2.776	2.967	2.887	2.711	2.950
19 TANNING AND DRESSING OF LEATHER MANUFACTURE OF LUGGAGE, HANDBAGS SADDLERY, HARNESS AND FOOTWEAR	2.702	3.115		2.827	3.030	2.517	2.822	3.270	2.802	3.134	3.328	2.822	2.413	2.851	3.138	3.038	2.686	2.970
20 MANUFACTURE OF WOOD AND OF PRODUCTS WOOD AND CORK	2.433	2.257	2.707	2.871	3.087	2.621	2.257	2.753	2.756	3.164	3.012	2.213	2.581	2.827	2.818	2.733	2.767	2.759
21 MANUFACTURE OF PAPER AND PAPER PRODUCTS	2.421	2.744	2.675	2.784	3.017	2.649	2.544	3.042	2.470	3.063	2.850	2.101	2.564	2.807	2.669	2.814	2.719	2.754
22 PUBLISHING, PRINTING AND REPRODUCTION OF RECORDED MEDIA	2.626	2.815	2.648	2.879	2.903	2.500	2.437	3.144	2.730	3.316	3.219	2.600	2.479	2.810	2.797	2.866	2.801	2.853
23 MANUFACTURE OF COKE, REFINED PETROLEUM AND NUCLEAR FUEL	2.416	2.261	2.796	2.781	3.077	2.429	2.426	2.743	2.552	3.198	2.995	2.301	2.698	2.694	2.704	2.940	2.570	2.681
24 MANUFACTURE OF CHEMICALS AND CHEMICAL PRODUCTS	2.366	2.818	2.673	2.918	2.978	2.574	2.354	3.092	2.506	2.991	2.853	2.232	2.456	2.760	2.593	2.775	2.738	2.723
25 MANUFACTURE OF RUBBER AND PLASTIC PRODUCTS	2.403	2.867	2.737	2.781	3.020	2.640	2.402	3.138	2.457	3.057	2.841	2.149	2.487	2.816	2.857	2.932	2.729	2.798
26 MANUFACTURE OF OTHER NON-METALLIC MINERAL PRODUCTS	2.296	2.761	2.707	2.818	3.054	2.620	2.394	3.014	2.651	3.064	2.885	2.268	2.564	2.708	2.734	2.687	2.539	2.709
27 MANUFACTURE OF BASIC METALS	2.451	2.882	2.530	2.804	3.059	2.575	2.426	2.830	2.633	3.039	2.786	2.237	2.528	2.839	2.795	2.878	2.545	2.671
28 MANUFACTURE OF FABRICATED METAL PRODUCTS, EXCEPT MACHINERY AND EQUIPMENTS	2.435	2.761	2.623	2.830	3.007	2.640	2.395	3.198	2.579	3.203	2.959	2.518	2.577	2.787	2.828	2.813	2.756	2.808
29 MANUFACTURE OF MACHINERY AND EQUIPMENT N.E.C.	2.526	2.677	2.844	2.847	3.069	2.562	2.433	3.135	2.425	3.056	2.963	2.317	2.544	2.752	2.764	2.882	2.768	2.824
30 MANUFACTURE OF OFFICE, ACCOUNTING AND COMPUTING MACHINERY	2.510		2.681	2.895	3.318	2.422		2.924	2.423	3.420	3.284		2.779	2.638	3.130	2.566	2.519	2.797
31 MANUFACTURE OF ELECTRICAL MACHINERY AND APPARATUS N.E.C.	2.516	2.409	2.610	2.809	3.009	2.568	2.414	3.071	2.551	3.055	3.032	2.354	2.497	2.840	2.992	2.793	2.630	2.821
32 MANUFACTURE OF RADIO, TELEVISION AND COMMUNICATION EQUIPMENT AND APPARATUS	2.561	2.257	3.025	2.916	3.019	2.581		3.219	2.463	2.875	3.145		2.369	2.845	2.898	2.895	2.558	2.881
33 MANUFACTURE OF MEDICAL, PRECISION AND OPTICAL INSTRUMENTS, WATCHES AND CLOCKS	2.554	2.032		2.889	3.048	2.584	2.257	3.106	2.298	3.231	2.948	2.173	2.560	2.735	2.806	2.859	2.638	2.814
34 MANUFACTURE OF MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	2.439			2.795	3.104	2.569	2.284	3.109	2.400	3.121	2.908	2.281	2.462	2.880	2.917	2.844	2.511	2.794
35 MANUFACTURE OF OTHER TRANSPORT EQUIPMENT	2.545	2.943	2.721	2.795	3.054	2.497	2.370	3.175	2.826	3.068	2.870		2.657	2.893	2.844	2.989	2.766	2.771
36 MANUFACTURE OF FURNITURE MANUFACTURING N.E.C.	2.418	2.762	2.677	2.825	2.889	2.557	2.351	3.220	2.390	3.132	3.401	2.540	2.474	2.783	2.783	2.832	2.806	3.001
All Industries	2.41	2.77	2.66	2.85	2.98	2.59	2.40	3.10	2.78	3.10	2.96	2.26	2.55	2.76	2.74	2.84	2.69	2.78
Rank among the states	16	9	13	5	3	14	17	2	8	1	4	18	15	10	11	6	12	

Source: Author calculation

Calasification of industries is at the 2-digit level of National Industrial Classification

Highest and second highest values among industries in the states are colored.

Table 4 The state and industry-wise average expenditure per unit due to "state tariff policy" in the year 2007-08 (Rs.)

Industries (with NIC 2-digit code)	AP	Bihar	Chat	Delhi	Guj	Har	Jhar	Kar	Kerala	MP	Mah	Orissa	Punjab	Raj	TN	UP	WB	Avg.
15 MANUFACTURE OF FOOD PRODUCTS AND BEVERAGES	-0.305	0.020	-0.030	0.176	0.266	-0.093	-0.315	0.182	0.205	0.304	0.108	-0.515	-0.158	0.022	-0.046	-0.031	0.032	0.006
16 MANUFACTURE OF TOBACCO PRODUCTS	-0.506	0.260	0.112	0.149	0.406	-0.110	-0.471	0.146	-0.423	0.965	0.072	-0.890	-0.452	0.094	0.252	0.017	-0.086	-0.071
17 MANUFACTURE OF TEXTILES	-0.513	0.192	-0.131	0.096	0.170	-0.060	-0.273	0.392	-0.093	0.433	0.152	-0.340	-0.100	-0.073	-0.077	0.108	-0.095	-0.005
18 MANUFACTURE OF WEARING APPAREL DRESSING AND DYEING OF FUR	-0.547	-0.171	-0.581	-0.058	0.044	-0.377		0.307	-0.076	0.233	0.273	-0.358	-0.335	-0.165	0.021	-0.054	-0.237	0.008
19 TANNING AND DRESSING OF LEATHER MANUFACTURE OF LUGGAGE, HANDBAGS SADDLERY, HARNESS AND FOOTWEAR	-0.290	0.123		-0.147	0.034	-0.459	-0.166	0.278	-0.207	0.146	0.324	-0.207	-0.566	-0.131	0.156	0.058	-0.296	-0.013
20 MANUFACTURE OF WOOD AND OF PRODUCTS WOOD AND CORK	-0.307	-0.557	-0.065	0.131	0.323	-0.123	-0.469	-0.005	0.016	0.399	0.269	-0.548	-0.173	0.072	0.045	-0.028	0.031	0.005
21 MANUFACTURE OF PAPER AND PAPER PRODUCTS	-0.328	-0.018	-0.081	0.010	0.278	-0.118	-0.252	0.286	-0.292	0.287	0.102	-0.642	-0.160	0.036	-0.087	0.054	-0.029	0.000
22 PUBLISHING, PRINTING AND REPRODUCTION OF RECORDED MEDIA	-0.278	-0.086	-0.277	-0.022	0.001	-0.395	-0.490	0.247	-0.170	0.400	0.333	-0.324	-0.431	-0.125	-0.100	-0.037	-0.089	-0.048
23 MANUFACTURE OF COKE, REFINED PETROLEUM AND NUCLEAR FUEL	-0.310	-0.466	0.135	0.015	0.430	-0.312	-0.199	0.087	-0.187	0.468	0.289	-0.391	0.009	0.002	-0.010	0.225	-0.103	-0.003
24 MANUFACTURE OF CHEMICALS AND CHEMICAL PRODUCTS	-0.349	0.052	-0.075	0.184	0.279	-0.159	-0.373	0.365	-0.217	0.260	0.151	-0.502	-0.264	0.029	-0.160	0.056	0.009	-0.002
25 MANUFACTURE OF RUBBER AND PLASTIC PRODUCTS	-0.381	0.036	-0.067	-0.036	0.221	-0.153	-0.395	0.343	-0.304	0.276	0.063	-0.618	-0.282	0.029	0.070	0.131	-0.051	0.010
26 MANUFACTURE OF OTHER NON-METALLIC MINERAL PRODUCTS	-0.364	0.023	0.023	0.082	0.349	-0.082	-0.297	0.322	-0.056	0.377	0.182	-0.395	-0.168	0.028	0.056	-0.047	-0.145	0.008
27 MANUFACTURE OF BASIC METALS	-0.214	0.218	-0.107	0.094	0.378	-0.115	-0.229	0.172	-0.062	0.368	0.119	-0.408	-0.140	0.154	0.098	0.210	-0.131	0.003
28 MANUFACTURE OF FABRICATED METAL PRODUCTS, EXCEPT MACHINERY AND EQUIPMENTS	-0.374	-0.068	-0.185	0.023	0.212	-0.139	-0.414	0.393	-0.240	0.397	0.180	-0.321	-0.202	-0.023	0.030	0.008	-0.057	0.009
29 MANUFACTURE OF MACHINERY AND EQUIPMENT N.E.C.	-0.317	-0.168	-0.003	-0.003	0.242	-0.264	-0.397	0.300	-0.416	0.216	0.142	-0.529	-0.282	-0.083	-0.064	0.038	-0.076	-0.009
30 MANUFACTURE OF OFFICE, ACCOUNTING AND COMPUTING MACHINERY	-0.390		-0.190	-0.011	0.401	-0.466		0.040	-0.493	0.499	0.428		-0.100	-0.246	0.255	-0.320	-0.391	-0.093
31 MANUFACTURE OF ELECTRICAL MACHINERY AND APPARATUS N.E.C.	-0.316	-0.451	-0.252	-0.043	0.165	-0.278	-0.454	0.225	-0.320	0.220	0.191	-0.491	-0.353	0.002	0.155	-0.054	-0.211	-0.024
32 MANUFACTURE OF RADIO, TELEVISION AND COMMUNICATION EQUIPMENT AND APPARATUS	-0.260	-0.840	0.126	-0.013	0.186	-0.253		0.337	-0.323	-0.024	0.263		-0.505	-0.011	0.034	0.012	-0.319	0.011
33 MANUFACTURE OF MEDICAL, PRECISION AND OPTICAL INSTRUMENTS, WATCHES AND CLOCKS	-0.305	-0.855		0.011	0.158	-0.300	-0.604	0.224	-0.578	0.355	0.075	-0.715	-0.311	-0.125	-0.071	-0.028	-0.237	-0.064
34 MANUFACTURE OF MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	-0.342			-0.006	0.314	-0.208	-0.493	0.327	-0.407	0.338	0.137	-0.539	-0.321	0.091	0.143	0.079	-0.282	0.015
35 MANUFACTURE OF OTHER TRANSPORT EQUIPMENT	-0.314	0.114	-0.181	0.030	0.245	-0.178	-0.396	0.427	-0.131	0.350	0.154		-0.003	0.211	0.083	0.267	-0.140	0.037
36 MANUFACTURE OF FURNITURE MANUFACTURING N.E.C.	-0.573	-0.166	-0.229	-0.178	-0.133	-0.387	-0.596	0.242	-0.565	0.145	0.383	-0.393	-0.545	-0.248	-0.233	-0.167	-0.210	-0.007
All Industries	-0.36	-0.02	-0.08	0.00	0.22	-0.22	-0.33	0.28	-0.04	0.34	0.17	-0.47	-0.18	-0.02	-0.03	0.02	-0.08	0.00
Rank among the states	16	7	12	6	3	14	15	2	10	1	4	17	13	8	9	5	11	

Source: Author calculation

Calasification of industries is at the 2-digit level of National Industrial Classification

Highest and second highest values among industries in the states are colored.

Table 5 Definition of Variables

Name	Data level	Definition	Source	Obs	Mean	S.D.	Min	Max
TFP	Firm	Log of total factor productivity estimated by the authors. See Appendix (a) for details.	Estimated by the authors using data provided by the Annual Survey of Industries (ASI)	74831	5.34	1.0702	-2.498	12.55
Electricity consumption		Log of the consumption level of grid electricity (kWh)	Annual Survey of Industries (ASI)	69782	12.9	2.2883	6.9165	18.0
Industrial Tariff		Expenditure for grid electricity per unit (Rs)	Annual Survey of Industries (ASI)	69341	2.7	0.5234	1.2754	4.3
Tariff Policy		Residuals from estimation shown in Appendix (b), assumed to capture the impact of state tariff policy only.	Estimated by authors using the data provided by the Annual Survey of Industries (ASI)	67857	-0.1	0.5073	-1.741	1.6
Energy Intensity		The ratio of electricity consumption (kWh) to the value of real output	Calculated by the authors using data provided by the Annual Survey of Industries (ASI)	69782	0.0	0.0189	0.0001	0.1
*T&D loss*Energy Intensity*		Interaction term of TD loss and Energy Intensity	Calculated by the authors using data provided by the Annual Survey of Industries (ASI)	66328	0.00	0.0056	2E-05	0.08
T&D loss	State*	The ratio of transmission and distribution losses to the energy input, taking the average value of the utilities selling to the consumers directly in the state. (%)	Central Electricity Authority, *All India Electricity Statistics* (various issues)	85	0.289	0.086	0.167	0.706

Note

5 periods from 2003-2004 to 2007-2008

*The 17 states employed here are Andhra Pradesh, Bihar, Chhattisgarh, Delhi, Gujarat, Haryana, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal

Table 6 Impact of tariff policy on firm performance

	Eq (1)			Eq (2)			Eq (2)		
	Coefficient	S.E.		Coefficient	S.E.		Coefficient	S.E.	
State Tariff Policy	0.004	(0.008)		0.007	(0.008)		-0.034	(0.008)	***
T&D loss				-0.986	(0.084)	***	-0.394	(0.083)	***
*T&D loss *Energy intensity*							-49.878	(1.227)	***
Constant	5.376	(0.002)	***	5.654	(0.023)	***	5.677	(0.023)	***
Number of observations	57,457			56407			55,626		
Number of firms	25,087			24,585			24,322		
R-sq (overall)	0.002			0.002			0.050		
Chi-sq (Hausman test)	58.6			245.1			284.4		
P-value	0.00			0.00			0.00		

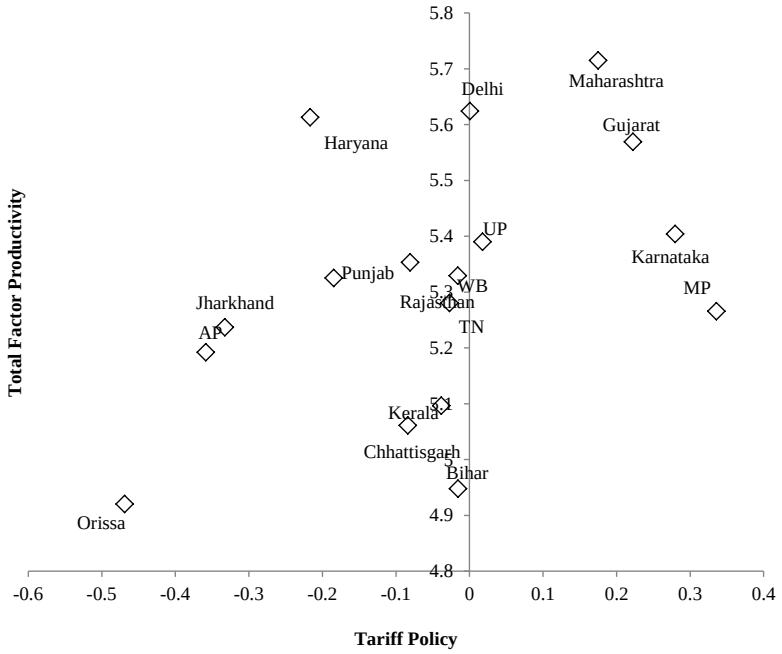
Note

Dependent variable: Logarithm of TFP

All models are estimated by the fixed effect model using the panel data from 2003-2004 to 2008-2008

"***","**" and "*" denote statistical significance at the 1%, 5%, and 10% levels correspondingly

Figure 8 Tariff policy and Total Factor Productivity in 2007-2008



Source: Author estimation using ASI.

Table 7 Industry-wise and state-wise impact of T&D loss reduction on Total Factor Productivity in a hypothetical scenario* (%)

	AP	Bihar	Delhi	Guj	Har	Jhar	Kar	Kerala	MP	Mah	Orissa	Punjab	Raj	TN	UP	WB	Avg.
15 MANUFACTURE OF FOOD PRODUCTS AND BEVERAGES	1.72	9.73	3.04	1.98	3.16	2.17	0.67	0.39	5.79	2.63	9.58	2.63	4.25	0.78	2.13	1.80	2.14
16 MANUFACTURE OF TOBACCO PRODUCTS	1.75	2.24	1.37	1.88	8.40	1.11	0.58	0.54	3.12	1.83	3.22	2.30	2.52	0.94	2.19	0.84	1.87
17 MANUFACTURE OF TEXTILES	2.78	12.12	2.02	2.96	2.96	2.59	0.94	0.77	5.97	4.12	6.12	1.48	4.92	1.19	2.64	1.67	2.37
18 MANUFACTURE OF WEARING APPAREL DRESSING AND DYEING OF FUR	1.50	3.24	1.55	1.59	2.18	0.00	0.61	0.40	3.91	2.61	4.49	1.16	2.48	0.57	1.80	0.72	1.39
19 TANNING AND DRESSING OF LEATHER MANUFACTURE OF LUGGAGE, HANDBAGS SADDLERY, HARNESS AND FOOTWEA	3.02	17.35	3.05	3.21	2.52	0.69	1.28	0.52	6.99	2.32	3.04	2.21	3.37	0.69	1.70	1.05	1.84
20 MANUFACTURE OF WOOD AND OF PRODUCTS WOOD AND CORK	2.51	12.19	1.94	2.15	6.58	1.05	0.74	1.12	4.93	4.72	16.06	4.34	4.93	0.62	4.19	1.14	3.60
21 MANUFACTURE OF PAPER AND PAPER PRODUCTS	2.45	11.12	2.95	3.23	3.09	3.77	1.02	1.00	4.11	5.12	7.50	4.00	6.98	1.09	3.32	3.21	3.45
22 PUBLISHING, PRINTING AND REPRODUCTION OF RECORDED MEDIA	1.73	9.84	3.44	1.91	4.69	1.51	0.60	0.49	3.46	2.55	7.10	1.67	2.68	1.03	3.21	1.49	2.43
23 MANUFACTURE OF COKE, REFINED PETROLEUM AND NUCLEAR FUEL	2.87	4.91	9.16	2.03	2.25	2.37	0.91	0.33	7.17	5.44	5.05	1.43	16.35	1.28	4.56	1.46	3.40
24 MANUFACTURE OF CHEMICALS AND CHEMICAL PRODUCTS	1.85	5.33	2.88	2.25	2.88	2.70	0.56	0.60	4.65	2.82	7.32	1.78	4.27	0.73	2.32	1.05	2.10
25 MANUFACTURE OF RUBBER AND PLASTIC PRODUCTS	2.55	5.55	3.72	2.24	3.59	1.97	0.90	0.67	6.32	2.64	6.06	1.57	4.27	0.72	2.44	1.41	2.58
26 MANUFACTURE OF OTHER NON-METALLIC MINERAL PRODUCTS	3.18	7.41	4.03	4.03	7.32	1.77	0.95	0.65	5.95	3.61	10.23	1.03	6.55	0.99	3.27	2.14	3.28
27 MANUFACTURE OF BASIC METALS	3.50	29.98	7.12	3.40	3.88	4.65	1.29	1.29	10.86	6.28	11.63	4.06	7.42	1.36	7.07	2.37	5.56
28 MANUFACTURE OF FABRICATED METAL PRODUCTS, EXCEPT MACHINERY AND EQUIPMENTS	1.36	7.18	2.10	1.84	2.80	1.33	0.66	0.59	4.32	2.89	6.07	1.43	5.19	0.90	2.35	1.10	2.20
29 MANUFACTURE OF MACHINERY AND EQUIPMENT N.E.C.	1.29	5.53	2.02	1.37	2.02	1.51	0.52	0.52	3.01	1.66	3.51	1.41	2.57	0.46	1.86	0.78	1.49
30 MANUFACTURE OF OFFICE, ACCOUNTING AND COMPUTING MACHINERY	0.92	0.00	1.02	0.95	2.48	0.00	0.35	0.22	2.19	1.34	0.00	1.59	2.27	0.30	2.05	1.01	1.17
31 MANUFACTURE OF ELECTRICAL MACHINERY AND APPARATUS N.E.C.	1.28	6.38	2.15	1.53	2.00	1.51	0.48	0.25	2.85	1.60	3.99	1.49	2.40	0.55	1.47	0.74	1.52
32 MANUFACTURE OF RADIO, TELEVISION AND COMMUNICATION EQUIPMENT AND APPARATUS	0.92	7.89	2.91	1.34	2.83	0.00	0.47	0.47	6.88	2.64	0.00	3.16	2.87	0.64	2.65	1.55	2.04
33 MANUFACTURE OF MEDICAL, PRECISION AND OPTICAL INSTRUMENTS, WATCHES AND CLOCKS	1.11	4.73	1.92	1.57	3.16	0.56	0.63	0.34	2.78	1.50	1.57	2.01	1.96	0.63	3.61	0.90	1.75
34 MANUFACTURE OF MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	1.47	0.00	2.54	1.73	2.12	1.70	0.53	0.46	4.09	2.20	2.76	1.50	2.99	0.55	2.00	0.93	1.68
35 MANUFACTURE OF OTHER TRANSPORT EQUIPMENT	1.24	26.15	3.52	1.33	1.91	3.08	0.50	0.32	5.84	2.29	0.00	1.46	6.30	0.51	2.47	1.00	2.11
36 MANUFACTURE OF FURNITURE MANUFACTURING N.E.C.	1.59	5.92	2.55	2.19	4.60	3.32	0.58	0.61	7.10	1.82	4.85	1.73	3.13	0.79	2.61	1.19	2.15
All Industries	1.98	10.65	2.62	2.40	2.91	2.52	0.69	0.53	5.27	2.92	8.54	1.88	4.54	0.86	2.50	1.49	2.35
Rank among the states	12	1	7	10	6	8	16	17	3	5	2	13	4	15	9	14	11

*Hypothetical scenario assuming that every state reduce T&D losses to 15% from the level of 2007-2008 (targeted level by March 2019)

Appendix (a) Determinants of power tariff payment

	Coefficient	Standard Error	
Electricity consumption	-0.015	-0.001	***
Industrial dummies (NIC 3digit)			
152 Manufacture of dairy product	-0.020	(0.019)	
153 Manufacture of grain mill products, starches and starch products, and prepared animal feeds	-0.152	(0.016)	***
154 Manufacture of other food products	0.056	(0.012)	
155 Manufacture of beverages	-0.038	(0.017)	**
160 Manufacture of tobacco products	-0.111	(0.016)	***
171 Spinning, weaving and finishing of textiles	-0.122	(0.012)	***
172 Manufacture of other textiles	0.012	(0.015)	
173 Manufacture of knitted and crocheted fabrics and articles	-0.164	(0.015)	***
181 Manufacture of wearing apparel, except fur apparel	0.153	(0.012)	***
182 Dressing and dyeing of fur manufacture of articles of fur	0.061	(0.07)	
191 Tanning and dressing of leather, manufacture of luggage handbags, saddlery & harness	0.192	(0.019)	
192 Manufacture of footwear.	0.197	(0.017)	
201 Saw milling and planing of wood	-0.116	(0.046)	**
202 Manufacture of products of wood, cork, straw and plaiting materials	-0.045	(0.021)	
210 Manufacture of paper and paper product	-0.028	(0.016)	*
221 Publishing	0.112	(0.021)	***
222 Printing and service activities related to printing	0.104	(0.018)	
231 Manufacture of coke oven products	-0.143	(0.027)	
232 Manufacture of refined petroleum products	-0.044	(0.029)	
241 Manufacture of basic chemicals	-0.078	(0.016)	
242 Manufacture of other chemical products	-0.054	(0.012)	***
243 Manufacture of man-made fibers	-0.089	(0.041)	**
251 Manufacture of rubber products	-0.020	(0.018)	
252 Manufacture of plastic products	0.041	(0.016)	**
261 Manufacture of glass and glass products	0.051	(0.022)	**
269 Manufacture of non-metallic mineral products n.e.c.	-0.117	(0.013)	***
271 Manufacture of Basic Iron & Steel	-0.129	(0.014)	
272 Manufacture of basic precious and non-ferrous metals	-0.053	(0.023)	**
273 Casting of metals	-0.023	(0.017)	
281 Manufacture of structural metal products, tanks, reservoirs and steam generators	0.038	(0.019)	*
289 Manufacture of other fabricated metal products metal working service activities	-0.002	(0.014)	
291 Manufacture of general purpose machinery	0.054	(0.014)	***
292 Manufacture of special purpose machinery	0.026	(0.014)	*
293 Manufacture of domestic appliances, n.e.c	0.072	(0.028)	***
300 Manufacture of office, accounting and computing machinery	0.099	(0.034)	***
311 Manufacture of electric motors, generators and transformers	0.085	(0.022)	***
312 Manufacture of electricity distribution and control apparatus	0.100	(0.021)	***
313 Manufacture of insulated wire and cable	0.040	(0.024)	*
314 Manufacture of accumulators, primary cells and primary batteries	-0.018	(0.029)	
315 Manufacture of electric lamps and lighting equipment	0.033	(0.03)	
319 Manufacture of other electrical equipment n.e.c	0.037	(0.025)	
321 Manufacture of electronic valves and tubes and other electronic components	0.026	(0.023)	
322 Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy	0.114	(0.033)	***
323 Manufacture of television and radio receivers, sound or video recording	0.245	(0.04)	***
331 Manufacture of medical appliances and instruments	0.084	(0.02)	***
332 Manufacture of optical instruments and photographic equipment	0.006	(0.043)	
333 Manufacture of watches and clocks	0.140	(0.04)	***
341 Manufacture of motor vehicles	0.012	(0.033)	
342 Manufacture of bodies (coach work) for motor vehicles manufacture of trailers and semi-trailers	-0.020	(0.025)	
343 Manufacture of parts and accessories for motor vehicles and their engines	0.008	(0.014)	
351 Building and repair of ships & boats	0.209	(0.036)	***
352 Manufacture of railway and tramway locomotives and rolling stock	0.071	(0.028)	***
353 Manufacture of aircraft and spacecraft	0.359	(0.059)	***
359 Manufacture of transport equipment n.e.c.	-0.124	(0.016)	***
361 Manufacture of furniture	0.045	(0.026)	*
369 Manufacturing n.e.c.	0.256	(0.015)	***
Year Dummies	0.000		
2004-2005	0.087	(0.006)	***
2005-2006	-0.022	(0.006)	***
2006-2007	-0.059	(0.006)	***
2007-2008	-0.071	(0.006)	***
Constant	5.054	(1.404)	***
Number of observation	58,466		
Adj R-squared	0.082		
Note			
Dependent variable: *Industrial Tariff*			
"***","**" and "*" denote statistical significance at the 1%, 5%, and 10% levels correspondingly			
Estimated by Pooled OLS using panel data from 2003-4 to 2007-2008.			
The reference group: food production, processing and preservation industry (code 151).			

Appendix (b): **Measuring TFP**

We first construct a measure for plant-level TFP following the methodology of Levinsohn and Petrin (2003). They use a firm's raw material inputs as a proxy for the unobservable productivity shocks to correct for the simultaneity in the firm's production function. The inclusion of a proxy that controls for the part of the error correlated with inputs ensures that the variation in inputs related to the productivity term will be eliminated.

According to Petrin et al. (2004), assuming a Cobb-Douglas production function, the estimating equation is,

$$v_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \omega_{it} + \eta_{it} \quad (1),$$

where v_{it} is the log of output of plant i at time t; k_{it} is the log of the plant's capital assets; and l_{it} is the log of labor. While η_{it} is an error term uncorrelated with the input choice, the simultaneity problem arises from the ω_{it} term, a plant-specific, time-varying productivity shock that cannot be observed by the econometrician but may be correlated with the plant's choice of variable inputs, leading to the well-known simultaneity problem in the production function estimation. Assuming that the intermediate input m_{it} depends on the variables k_{it} and ω_{it}, and monotonically increases in ω_{it}, we can represent ω_{it} as a function of k_{it} and m_{it}: $\omega_{it}(m_{it}, k_{it})$.

Then we rewrite equation (1) as,

$$y_{it} = \beta_l l_{it} + \phi_{it}(m_{it}, k_{it}) + \eta_{it} \quad (2),$$

where $\phi_{it}(m_{it}, k_{it}) = \beta_0 + \beta_k k_{it} + \omega_{it}(m_{it}, k_{it})$. Substituting a third-order polynomial approximation in k_{it} and m_{it} in place of ϕ_{it}, we estimate $\widehat{\beta_l}$ using OLS. In the second stage, for any candidate value β_k^*, we compute a prediction for ω_{it}: $\widehat{\omega}_{it} = \hat{\phi}_{it} - \beta_k^* k_{it}$. Using these values, we obtain a consistent approximation to $E[\omega_{it}|\omega_{it-1}]$ by the predicted values from the regression:

$$\widehat{\omega}_{it} = \gamma_0 + \gamma_1 \omega_{it-1} + \gamma_2 \omega_{it-1}^2 + \gamma_3 \omega_{it-1}^3 + \epsilon_{it} \quad (3),$$

with the assumption that productivity follows a Markov process.

The estimate of $\widehat{\beta_k}$ is defined as a solution to the minimization of

$$min_{\beta_k^*} \sum_t (y_{it} - \beta_l l_{it} - \beta_k^* k_{it} - E[\widehat{\omega_{it}|\omega_{it-1}}])^2 \quad (4).$$

We use the bootstrap approach to construct standard errors for the estimates $\widehat{\beta_l}$ and $\widehat{\beta_k}$. Substituting the estimated output elasticity of capital, $\widehat{\beta_k}$, and of labor, $\widehat{\beta_l}$, into the Cobb-Douglas production function, we measure the TFP of a plant.

Appendix (c) The state and industry-wise average of energy intensity

	AP	Bihar	Chat	Delhi	Guj	Har	Jhar	Kar	Kerala	MP	Mah	Orissa	Punjab	Raj	TN	UP	WB	Avg.
15 MANUFACTURE OF FOOD PRODUCTS AND BEVERAGES	0.01	0.02	0.02	0.01	0.01	0.01	0.02	0.01	0.00	0.02	0.01	0.03	0.02	0.01	0.01	0.01	0.02	0.01
16 MANUFACTURE OF TOBACCO PRODUCTS	0.01	0.00	0.00	0.00	0.01	0.03	0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.00	0.01	0.01	0.00	0.01
17 MANUFACTURE OF TEXTILES	0.03	0.03	0.01	0.01	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.03	0.01	0.02	0.02
18 MANUFACTURE OF WEARING APPAREL DRESSING AND DYEING OF FUR	0.01	0.00	0.01	0.01	0.01	0.00		0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
19 TANNING AND DRESSING OF LEATHER MANUFACTURE OF LUGGAGE, HANDBAGS SADDLERY, HARNESS AND FOOTWEA	0.03	0.04		0.02	0.02	0.01	0.00	0.02	0.01	0.02	0.01	0.00	0.02	0.01	0.01	0.00	0.01	0.01
20 MANUFACTURE OF WOOD AND OF PRODUCTS WOOD AND CORK	0.02	0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.02	0.04	0.03	0.01	0.01	0.02	0.01	0.02
21 MANUFACTURE OF PAPER AND PAPER PRODUCTS	0.02	0.02	0.05	0.01	0.02	0.01	0.03	0.02	0.03	0.01	0.03	0.02	0.04	0.02	0.02	0.02	0.04	0.02
22 PUBLISHING, PRINTING AND REPRODUCTION OF RECORDED MEDIA	0.01	0.03	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.00	0.02	0.01	0.01	0.01
23 MANUFACTURE OF COKE, REFINED PETROLEUM AND NUCLEAR FUEL	0.02	0.00	0.01	0.05	0.01	0.00	0.02	0.01	0.00	0.02	0.02	0.01	0.01	0.05	0.02	0.02	0.01	0.02
24 MANUFACTURE OF CHEMICALS AND CHEMICAL PRODUCTS	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
25 MANUFACTURE OF RUBBER AND PLASTIC PRODUCTS	0.03	0.01	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.01	0.02	0.02
26 MANUFACTURE OF OTHER NON-METALLIC MINERAL PRODUCTS	0.04	0.01	0.03	0.02	0.03	0.03	0.01	0.02	0.02	0.02	0.02	0.03	0.00	0.03	0.02	0.02	0.03	0.02
27 MANUFACTURE OF BASIC METALS	0.03	0.06	0.03	0.04	0.02	0.01	0.04	0.02	0.05	0.04	0.03	0.04	0.04	0.03	0.03	0.03	0.03	0.03
28 MANUFACTURE OF FABRICATED METAL PRODUCTS, EXCEPT MACHINERY AND EQUIPMENTS	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01
29 MANUFACTURE OF MACHINERY AND EQUIPMENT N.E.C.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
30 MANUFACTURE OF OFFICE, ACCOUNTING AND COMPUTING MACHINERY	0.01		0.01	0.00	0.00	0.01		0.00	0.00	0.00	0.00		0.01	0.00	0.00	0.01	0.01	0.00
31 MANUFACTURE OF ELECTRICAL MACHINERY AND APPARATUS N.E.C.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
32 MANUFACTURE OF RADIO, TELEVISION AND COMMUNICATION EQUIPMENT AND APPARATUS	0.01	0.01	0.00	0.01	0.01	0.01		0.00	0.01	0.01	0.01		0.02	0.01	0.01	0.01	0.02	0.01
33 MANUFACTURE OF MEDICAL, PRECISION AND OPTICAL INSTRUMENTS, WATCHES AND CLOCKS	0.01	0.01		0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.02	0.00	0.01	0.02	0.01	0.01
34 MANUFACTURE OF MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	0.01			0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
35 MANUFACTURE OF OTHER TRANSPORT EQUIPMENT	0.01	0.06	0.02	0.02	0.01	0.00	0.02	0.01	0.00	0.02	0.01		0.01	0.03	0.01	0.01	0.01	0.01
36 MANUFACTURE OF FURNITURE MANUFACTURING N.E.C.	0.01	0.01	0.02	0.01	0.01	0.02	0.03	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
All Industries	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.02	0.02	0.02	0.02	0.01	0.02	0.01
Rank among the states	5	3	4	13	11	17	2	15	14	6	12	1	7	10	8	16	8	

Source: Author calculation