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Is Electrification in India Fiscally Sustainable?

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Abstract

We study the fiscal health of state electricity distribution companies (discoms) in India and its bearing on the supply of electricity. India has, in a policy landmark, lately achieved near-universal household electrification, in large part through Central funding of infrastructure totaling Rs. 5 lakh crores as well as state bailouts totaling Rs. 35 lakh crores since 2001 (both figures in 2022 INR, totaling roughly USD 500 billion). Central and state transfers enable state distribution companies to run ongoing losses, which, in turn, threaten the supply of energy to agriculture and rural households. We find that: (i) the fiscal health of state distribution companies remains concerning, with declared losses of only 2% in 2021-22, far lower than recent trends, rising to 22% when excluding central and state government subsidies; (ii) the proportional losses of the distribution companies, excluding subsidies from the central and state governments, have declined 6 percentage points (on a base of 28%) in the last decade, but their aggregate yearly loss has increased by Rs. 77,000 Cr (43%) due to growth in subsidized consumption; (iii) most gains in reported discom finances are due to the increasing formalization of states bringing electricity subsidies onto their budgets; (iv) states that drew funds under the most recent Central bailout program (the UDAY scheme) have seen smaller gains in efficiency and reductions in losses in recent years than states that did not participate in the bailout. We conclude by discussing the promise of delivering subsidies via Direct Benefit Transfers for Electricity (DBTE) to give discoms incentives for both fiscal independence and more reliable supply and service.

Keywords: *Public sector reform, Electricity, Government bailouts, Direct Benefit Transfer*
JEL Classification: *L94, Q48, H83*

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1. Introduction: Electrification Achieved, Electrification at Risk

Electrification has been a landmark of economic development for more than a century and electricity continues to find new uses today. The Government of India, after decades of effort and investment, in 2019 declared household electrification to be complete. While no census has been run as confirmation, multiple sources of data show that grid electrification has indeed reached near-universal levels (the electrification rate in the nationally representative National Family Health Survey V, 2019-21 was reported at 96.8%; see Figure 1). The pace of electrification has been rapid. In lagging states of Northern and Eastern India, the household electrification rate, from the time of the 2011 Census, has leapt up by 43 percentage points in West Bengal, 48 pp in Jharkhand, 53 pp in Odisha and Uttar Pradesh, and a staggering 79 pp in Bihar (Figure 2).

The historic completion of household electrification in India is a feat not mainly of engineering but of fiscal capacity, and specifically cooperation across the Central and State governments. The Central government invested in lagging states through a succession of infrastructure investment and connection subsidy programs, including, most recently, the Rajiv Gandhi Grameen Vidyutikaran Yojana, to extend the grid to all villages, and the Pradhan Mantri Sahaj Bijli Har Ghar Yojana ("Saubhagya") scheme, to then reach all households. At the final stage of this "big push" for electrification, new electricity connections, which cost Rs. 3,374 per household to provide,[1] were given out for free to all households Below the Poverty Line and at a nominal cost of Rs. 500 to rural households Above the Poverty Line (which some states have also waived). Once on the grid, newly-connected households in many states enjoyed domestic tariffs below the cost of energy supply. Even this number understates the support to households via the electricity grid, since high rates of non-payment lower the effective tariff further, and power for agricultural use is often free. This generous support for both new connections and the supply of electricity is a main reason why India has been able to achieve universal electrification at a relatively low level of per capita national income (Lee et al. 2020).[2]

Is electrification in India fiscally sustainable? India has achieved universal electrification by treating electricity not as a business, but as a right. The Prime Minister stated this explicitly: "Everyone has a right to a life of dignity. Traditionally, food and shelter have been seen as the most basic necessities. However, the Modi government has gone beyond this core basket of necessities to include even electricity" (Modi 2019). The policy goal of improving the lives of low-income households by connecting them to the grid may raise social welfare. However, the treatment of electricity as a right may undermine the reliability of electricity supply to both newly-connected households and those already on the grid (Burgess et al. 2020). The risk for electrification achieved through a large dose of external support is of backsliding: are the states, which were not capable to complete electrification on their own, able nonetheless to maintain supply? Many of the state distribution companies that supply power in India are in a poor fiscal position and remain dependent on State and Central support to stay afloat. If these long-

[1] As of June, 2021, Rs 8,840 Cr was released to states to electrify 262 lakh households, yielding an average cost of connection as calculated. See https://powermin.gov.in/en/content/saubhagya for details.
[2] It is probably also the reason why household solar systems, which have a large market share among households in sub-Saharan Africa, even in areas with the grid, have been relegated to a small role in the Indian market (Burgess et al. 2023).

standing problems are not ameliorated, the huge investment in electrification may increase the fiscal strain on state distribution companies and undercut power supply in the years to come.

This paper attempts to draw out a path through which electrification can be fiscally sustained while providing reliable electricity supply. We have three main aims. First, to review the fiscal position of state electricity distribution companies in India and to decompose the reasons for ongoing losses. Second, to relate the fiscal position of discoms to both recent funding programs and the stress created by universal electrification. Third, to suggest what institutional investments and technological reforms might plausibly help to increase fiscal discipline on the part of states and sustain power supply.

In the first part of the paper we review the fiscal position of the state distribution companies (hereafter, discoms). We find that the fiscal position of the distribution companies is poor and, when considered before the receipt of state subsidies, has remained essentially unimproved for the last decade, despite large central investments. The average discom runs a large operating loss. In fiscal year 2021 - 2022, India's discoms in aggregate had losses of INR 16,968 Cr, representing 2% of total discom expenditures (it has fallen from INR 70,398 Cr - 9.3% of the total expenditures - in 2020-21). This number counts subsidies and some kinds of central support as revenue. Without these sources of income, discom losses balloon to INR 178,694 Cr, representing 22% of total discom expenditures or roughly 1% of India's Gross Domestic Product (this figure stood at INR 187,903, 25% of the total discom expenditures, in 2020-21). This loss as a proportion of expenditures has been nearly flat since 2009-10, but, as discom expenditures have increased, the absolute level of losses has grown. The main progress that has been made in recent years, exemplified by the contrast between 2020-21 and 2021-22, is that states have brought ongoing discom losses onto their books in the form of greater budgeted subsidy expenditures. State support to discoms constitutes a significant portion of their budget. Additionally, other income, revenue grants and regulatory income are added by discoms to their revenue on booked basis, though not all of them realize. Devaguptapu and Tongia (2023) discuss the breakdown of discom finances in a comprehensive way by decomposing discom finances using cash-flow accounting, compared to the accrual-based accounting followed by PFC. As shown in Devaguptapu and Tongia (2023), losses using cash-flow accounting are much higher compared to losses reported on the book. For 2020-21, the ACS-ARR gap (after including all subsidies, grants and income) for state discoms is Rs. 1.14 when calculated using cash-flow accounting, compared to Rs. 0.64 reported in PFC report. The way discom finances are currently being reported, it becomes difficult to track losses.

The magnitude of the discom losses in aggregate is staggering. As a basis for comparison, total expenditure in 2020-21 on the Mahatma Gandhi National Rural Employment Guarantee Program (MGNREGP) was estimated at Rs. 61,500 Cr, and on the Pradhan Mantri Kisan Samman Nidhi (PM-Kisan) scheme at Rs. 75,000 Cr (Budget of India, 2020). Distribution company losses and subsidies are larger than the combined expenditures on these two flagship schemes—with enough of a gap left over to cover the National Education Mission and the Swachh Bharat Mission, for good measure. We show that even these discom operating losses and subsidies are an understatement of government support to the electricity sector, since many of the fixed costs of investment in the power grid have also been built with Central government support.

In the second part of the paper, we attribute distribution company losses to underlying structural problems in the power sector. The proximate cause of operating losses is that distribution companies buy more power than they sell and often sell power below the cost of purchase. On average across all of India, in FY 2021-22, the most recent year for which data is available, the average cost of supply is INR 6.29 per kWh. Against this figure, distribution companies bill INR 6.02 per kWH (95.7% of cost) and collect INR 6.12 (97.3% of the cost). However, this number overstates the financial performance of discoms, since much of what they bill and collect is paid by state governments and not customers. If we exclude revenue from subsidies and central government contributions, collections from paying customers amount to INR 4.35 per kWh, only 69% of cost. Moreover, the FY 2021-22 subsidy commitment from state governments to discoms is well above recent norms. It remains to be seen if these transfers will be sustained.

The largest risks to distribution company finances are therefore twofold. First, power that is never billed, either because of technical losses in distribution or theft. Second, power that is billed but to the government and not to customers. This second category is a risk because historically state governments have funded only a part of the subsidies that their own state distribution companies book so that distribution companies run up debt over time. Only in 2021-22 – an exceptional year since 2009– states tariff transfer was higher than the subsidy billed. In all other years from 2009 till 2021, state tariff subsidy transfer to discoms was less than the subsidy billed by discoms to states – totalling up to 86,000 cr shortfall on discoms books. Indeed, states have an incentive to do so, in order to build up debt that can be reduced in periodic central bailouts. Each unit of power paid with debt costs the state less than if it were paid in full upfront, once bailouts are taken into account. It is also hard to take distribution company accounting at face value, since, in the absence of thorough energy accounts, booking a high degree of consumption to subsidized consumers, and therefore state governments, can be used to paper over inefficiency, losses and theft.

The weak fiscal position of state discoms and the incentives created by bailouts keep electricity distribution dependent on Central government support. We analyze how fiscal indicators have responded to the most recent Central government program of state support, the Ujjwal Discom Assurance Yojana (UDAY), launched in 2015, in which the Central government requires states to assume 75% of discom debt and offered additional grant and equity support. We find that there has been essentially no change in the last ten years in the share of discom operating expenditures covered by revenue from paying customers. Excluding state and central subsidies, distribution companies ran on average operating losses of 22% in FY 2021-22, as compared to operating losses of 24% in FY 2010-11. The main fiscal change in 2021-22, when compared to earlier years, is that state and central support has been brought onto the books to a greater extent, so that losses net of state subsidies have declined. Aggregate Technical & Commercial losses (AT&C)—an omnibus measure of power that is supplied but not paid for—have declined, although at a moderate pace, from 30.7% in FY 2010-11 to 16.4%, still well above global norms, in FY 2021-22. Interestingly, once we drop the energy sold to the agricultural sector and the state subsidy booked and received against it, ATC losses appear mostly stagnant, changing marginally from 42% to 38.5% over the same ten year period. Moreover, in the period after UDAY, AT&C losses stagnated at a high level for states that participated, so that AT&C losses for states taking UDAY funds rose by 5 percentage points as compared to states that did not take

UDAY funds. The lagging states are still lagging, and UDAY did not provide a forceful incentive to improve operational performance.

The risk of this stagnation is that the additional customers added by the achievement of universal electrification may compound the fiscal losses of discoms and lead to a deterioration in power supply. Distribution companies that run up debt tend to delay payments to power generators; the risk of non-payment, in turn raises power procurement costs (Ryan 2021). Newly-connected customers tend to be rural and poorer than customers already on the grid, which may tend to increase discom losses over time.

The final part of the paper turns to policy solutions to the problem of discom finances. The modern era of the Indian electricity sector can be dated from the Electricity Act of 2003 and associated reforms (Kumar and Chatterjee 2012). Many knowledgeable commentators, from academics to participants in the Indian power sector, have discussed the slow progress of distribution reform and specifically the need for discoms to adopt a more commercial orientation (Bhattacharya and Patel 2008; Wolak 2008). The poor state of distribution company finances have been thoroughly and recently documented (Devaguptapu and Tongia 2023). We therefore feel comfortable taking a narrow approach to policy recommendations and emphasize one main idea:

All subsidies must be delivered via direct benefit transfers for electricity (DBT-E) directly to each customer, rather than to the distribution company on their behalf.

Why direct benefit transfers (DBT)? The fundamental problem is that the distribution companies serve governments: the state, to draw subsidies, the Center, for distribution infrastructure investments and bailout funds. The discoms do not serve, as their main or only audience, customers. It is this disconnection that distorts the fiscal incentives of discoms and threatens the reliability of power supply. Yet the fact that discoms do not have a "commercial orientation" is to be expected when their solvency does not depend on customers. Only in a system where subsidies to customers flow through the customers themselves will the discoms serve those customers and not the state.

The investments of the last decade have made universal DBT feasible in the electricity sector. First, *Aadhar and linked bank accounts* mean that households have a pre-existing financial connection to the government through which to receive subsidies. Second, as noted above, more of the subsidies to the electricity sector have moved from off-the-books to on-the-books over the last decade, which is a prerequisite for redirecting those subsidies to customers. Third, investments in metering infrastructure, both past and ongoing through the Revamped Distribution Sector Scheme (RDSS), have formalized many customers and made it possible to measure consumption more accurately at the customer level.

There is no panacea for distribution reform; however, this single change to universal DBT would at least align the incentives of the distribution companies with service to their customers. There is no reason the states should be paying subsidies on consumption as aggregated and reported by the distribution companies, rather than paying subsidies on consumption to the customers who are using the power. Under such a system, the discoms would naturally assume a commercial orientation, because their viability would rely entirely on collecting revenue from customers.

The rest of the paper goes as follows. In Section 2, we describe how fiscal federalism in the electricity sector has both enabled universal electrification and perpetuated fiscal losses and poor operating performance in state distribution companies. In Section 3, we summarize the fiscal performance of state discoms in the last decade, emphasizing the relative stagnation of operating indicators in states taking UDAY funds over the last five years. In Section 4, we discuss our policy recommendation and how it interacts with planned investments in the sector in the next several years. In Section 5 we conclude.

2. Fiscal Federalism as both a Blessing and a Risk for Electrification

The Government of India and the states both serve major and interdependent roles in the electricity sector. Electricity is part of the concurrent list (seventh schedule, list III) of the Indian Constitution, meaning that both the Government of India and the various states can make laws concerning electricity. The states run electricity distribution, transmission and generation companies and also regulate intrastate matters via State Electricity Regulatory Commissions (SERCs). The Center has an overarching regulatory role, performed by the Central Electricity Regulatory Commission, and roles of system coordination, operations and planning via institutions such as the National Load Dispatch Center (NLDC) and Central Electricity Authority (CEA). These Central policy and coordination functions are common in electricity systems around the world. In India, the Center also has a direct role in investment and fiscal support to all segments of the electricity sector. The National Thermal Power Corporation generates electricity. The Solar Energy Corporation of India (SECI) and NTPC procure solar power. The Ministry of Power (MoP) and the Rural Electrification Corporation (REC) invest in transmission and distribution, via programs of investment support to the states and their discoms.

The progress of electrification in India has to be understood as the consequence of this fiscal federalism in the electricity sector. Electrification has been achieved due to massive central investments in transmission and distribution infrastructure and new household connections. Electrification is at risk because, with states having connected many households through a great reliance on Central support, the state discoms may themselves be unable to sustain electricity supply to tens of millions of new customers, who are often rural, poor and not remunerative to serve. Universal electrification, in other words, may exacerbate the dependence of state distribution companies on Central funds, which has been an ongoing source of fiscal instability in the sector. The main question in the electricity sector is therefore how the Center can ensure electrification is sustained without also sustaining, or worsening, this dependence.

2.1 Central Support for Investments in Electrification

Universal electrification in India has been achieved by the Union of India investing in lagging states to pull them up to a common, national standard (Lakshamanan, 2020). As recently as the 2011 Census, the electrification rates in states like Bihar (16.4%), Uttar Pradesh (36.8%), Jharkhand (45.8%) and Odisha (43%) reflected a countryside that was largely dark at night, with electrification reaching public facilities but few household connections. Several massive national investment programs helped states invest in infrastructure and household connections. The most recent nationally

representative survey we could find, conducted independently of the electrification campaign itself, is the National Family and Health Survey (NFHS) 2019-21. The NFHS asks households "Does your household have electricity?". By 2021, NFHS data show 96.8% of households reporting they use electricity for lighting. The rates in lagging states have leapt up to 95.6% in Bihar, 89.8% in Uttar Pradesh, 93.8% in Jharkhand and 96.3% in Odisha (see Figure 2).

This electrification was accomplished in stages with continual Central support across multiple governments. The major programs in the last two decades include the following:

- **Rajiv Gandhi Grameen Vidyutikaran Yogana** (RGGVY), 2005 - 2009. The RGGVY invested Rs. 82,308 Cr in distribution infrastructure and household connections across the 10th, 11th and 12th 5-year plan periods. The initial target of the program was to connect approximately 100,000 unelectrified villages and to increase household connections in an additional 300,000 villages (Burlig and Preonas, 2022).
- **Deendayal Upadhyaya Gram Jyoti Yojana** (DDUGJY), 2013 - 2022. A program of transmission and distribution infrastructure investment, designed to support higher levels of rural power supply and household connections.
- **Pradhan Mantri Sahaj Bijli Har Ghar Yojana** (Saubhagya), 2017 - 2019. Under Saubhagya the charges for household electricity connections were further reduced, to Rs. 500 for households Above the Poverty Line and zero for households Below the Poverty Line (BPL). The Central Government supported 90% of the cost of connections in Special Category states and 75% in all other states.
- **Integrated Power Development Scheme** (IPDS), 2014 – 2021. Investments in low-voltage transmission and distribution network, feeder and distribution transformer metering, and advanced metering infrastructure (AMI). Expenditures of roughly INR 9,000 Cr through 2019 (Shankar and Avni 2021).
- **Restructured Accelerated Power Development and Reforms Program** (RAPDRP), 2008 – 2014. Investments in transmission and distribution infrastructure in urban areas, including both traditional infrastructure (substations, transmission lines) and information technology investments for metering of electricity flows in the grid.
- **Revamped Distribution Sector Scheme (RDSS)**, 2021 - 2026. The RDSS is a program of investment in electricity distribution and particularly in smart meters and the segregation of feeders. The aim of the program is to reduce Aggregate Technical & Commercial losses to 12-15% by 2024–2025 and to increase the reliability of power supply. The RDSS has a budget estimate of Rs 97,631 Cr. towards a total expected outlay over 5 years of Rs. 303,758 Cr.

2.2 Central Bailouts of State Distribution Companies

The above programs provide Central funding for investment by state distribution companies in fixed infrastructure. These outlays, while large, are only a part of the

Central support for state investments in power. Additional channels of support include lending by public sector banks to state distribution companies and periodic bailouts by the Central government of the states and state discoms.

We tabulate large-scale bailouts in Table 1. Since the year 2001, there have been four large scale bailouts of distribution companies, with an average expenditure of 1.42% of GDP per bailout. This budgetary expenditure is, again, probably an understatement of the extent of fiscal support to the states, because the structure of a typical bailout includes debt restructuring wherein the public sector banks assume a portion of distribution company debts at very low base rates. As distribution companies are functionally bankrupt at the time of these refinancing episodes, it is unlikely that they could secure funding from a private sector lender on any terms. It is therefore difficult to calculate the value of the interest rate subsidy offered through public lending. We describe the

These bailouts are meant to have two purposes—to restore distribution companies to fiscal health and to foster investments and institutional reforms meant to prevent future losses and debt accumulation. Bhattacharya and Patel (2008) call this second purpose a "commercial orientation" for discoms. Historically, bailouts have only had any success on the first count, of restoring fiscal health, and even in that case any success has been temporary. No program of reform has achieved commercial orientation.

The dual purpose of bailouts can be seen in the Central response to the payments crisis of 2000-2001. The Center simultaneously intervened with a bailout, the so-called One-Time Settlement (OTS) scheme, as well as a program of distribution reforms (initially the Accelerated Power Development Program, or APDP, later reworked into the Accelerated Power Sector Development and Reform Program, or APDRP) (Bhattacharya and Patel 2008). The bailout component of the intervention involved state governments assuming the liabilities of state distribution companies through tax-free bonds backed by the Reserve Bank of India. The total value of the bailout amounted to approximately INR 400 billion. The investment component was meant specifically to fund investments in transmission and distribution that would help reduce losses and increase revenue collection. The Central government was therefore at once supporting debt relief but attempting to head off the need for further relief in the future.

The reform program embodied in the APDRP did not impart fiscal discipline. About a decade after the "One Time Settlement" program, discoms had accumulated a large stock of debt, and the Center again intervened, offering a INR 1,900 billion Financial Restructuring Plan. The package restructured discom liabilities into a combination of long-term state bonds and loans, subject to a three-year moratorium on principal payments, and imposed performance conditions including tariff increases and reductions in losses. However, as shown by Table 2, state discom losses continued at roughly their prior rate of INR 70,000 Cr per year in 2012-13 and 2013-14. The states that adopted the bailout terms did not meet the performance criteria. Piyush Goyal, the Minister for Power, Coal and New and Renewable Energy, remarked "We have inherited INR 3,00,000 crore (INR 3 trillion) of losses; every year (we are) adding INR 60,000-70,000 crore (to this number). That's a reality. I can't wish it away" (Bhaskar 2014). As soon as the moratorium on principal payments had ended, another bailout was announced.

That bailout, the Ujwal DISCOM Assurance Yojana (UDAY), was launched in November 2015 with the same dual objective of restoring fiscal health and imparting incentives for reform. The UDAY budget amounts to 2,090 billion. This budget supported a financial restructuring under which states would assume 75% of discom debts by issuing state bonds and returning the proceeds to the discoms. Aside from the total amount of debt relief, there are large subsidies built into the program through its Central backing. The new state bonds are treated as sovereign debt by investors, with corresponding low rates, but were temporarily not counted as debt when the Central government calculated the fiscal position of the state for borrowing norms. Moreover, the smaller share of debt that remains with the distribution companies is forced under a regulated interest rate, which is only possible because discoms rely on state-sponsored financing. Regarding the bonds issued after the 2012 bailout, a banker commented "There cannot be any default on these bonds. The RBI is responsible for the servicing of interest on these bonds. These are also ultimately state liabilities and no Indian state government will ever default." (Dalal 2015)

One novel element of the UDAY plan was putting in safeguards against its own failure: even future debts built up by the discoms would be assumed by the states (Ministry of Power 2015; Chitnis et al. 2018). The UDAY scheme built in a schedule whereby, from 2015-16 on to 2020-21, states would assume an increasing share of discom losses from the prior year (up to 50% of 2019-20 losses to be assumed in 2020-21). It also set limits on how much short-term debt banks and financial institutions, which in effect means state banks, the only willing lenders, could issue to discoms in the future.

The performance objectives of UDAY were explicit and measurable and targeted to "improving operational efficiencies." These objectives were of two kinds: what discoms must do and what targets they must achieve. The discoms were obligated to meter feeders and distribution transformers, index consumers, install smart meters for large consumers, implement a program of demand side management to reduce consumption, and other similar measures. These measures were supposed to achieve two high-level objectives: bring AT&C losses down to 15% by 2018-19 and reduce the gap between the Average Cost of Supply and Average Revenue Realized per unit to zero by 2018-19. Neither of these targets has been achieved or was even close to being achieved. AT&C losses in 2018-19 were 23% across India (25% in states claiming UDAY funds). We review the relative performance of UDAY states in more depth in Section 3.

The bailout cycle has just begun anew. The distribution companies in 2020 received a bailout of INR 90,000 Cr in loans from Central Government bodies as part of the Government of India's response to Covid-19 (Shankar and Avni 2021). This bailout was followed in 2021 by the Revamped Distribution Sector Scheme (RDSS), a package of INR 3 lakh Cr of investments in many of the same grid elements covered by prior efforts, including distribution network strengthening and loss reduction, the separation of distribution feeders for agricultural customers and universal metering coverage, including in the agricultural sector. This scheme has adopted some of the very same targets that were not achieved under UDAY: a reduction in AT&C losses to 12-15% nationwide by 2024-25 and an elimination of the gap between the cost of supply and revenue by 2024-25.

The brief history of bailouts given here draws out several common themes. First, fiscal restructuring that assumes discom debt is always accompanied or followed by a

large program or Central investment in distribution. Second, both of these components are planned to work together to improve "commercial orientation" and reduce losses, but have not done so; progress towards loss reduction has been very slow. Third, in successive packages, one sees an increasing tendency by Central programs to reach further and further into the operations of discoms—not only should discoms build substations or transmission lines, they should use central funds for metering the grid, and then for metering customers.

2.3 The Agency Problem Created by Fiscal Federalism in the Electricity Sector

The two fundamental problems in the Indian electricity sector are well-known in economics. First there is a problem of *agency*, in that the state distribution companies are spending money that is not their own, and therefore spend too much. A state distribution company that expects to pay for investments, working capital and operating losses with funds from the state government or the Center has no incentive for fiscal discipline. The discom therefore makes wasteful investment decisions and under-invests in revenue collection and enforcement. This agency problem also harms customers. Because the discom does not have to supply power reliably or collect revenue to fund its operations, it has little incentive to maintain a high quality of supply or provide good customer service.

The second problem, underlying the agency problem, is one of *commitment*. The Central government would like state distribution companies to improve their fiscal and operational problems. It repeatedly has set targets to reduce losses, raise tariffs and cover the costs of supply. Yet, if these targets are not met, the Central government renews them again with a fresh injection of funds. It cannot commit to cutting off states and their distribution companies if they do not improve, because doing so, once the discoms have dug a fiscal hole, would amount to turning out the lights. Discoms would first default on power purchase agreements, reducing procurement and power supply, and also bankrupting independent power producers. Rapidly, the state of the distribution network in rural India—built up at great Central expense—would deteriorate, and the achievement of universal electrification would be unwound. The Central government has declared a national interest in universal electrification and therefore committed to back those discoms that cannot meet or sustain this goal on their own.

The irony of this agency problem is that the Central government understands perfectly well that the distribution companies are poor stewards of public investment. Every past Central intervention has attempted to impose conditions to improve discom performance. The Central government wants to reach every Indian household with low-cost, reliable power. To do so, it must act through the states. If the same amount of money as has been spent on bailouts and public investment for state distribution companies, had been channeled through distribution companies with the low procurement costs and high operating efficiency of a private player—such as Tata Power in Delhi, for example—then the Center would have bought more power for more households with its investment. Yet the agency problem means that the fact of Central backing weakens the incentives of state distribution companies to improve. It has not proven possible, in the present electricity sector, both to make transfers on the scale needed to sustain electrification and to give distribution companies incentives for

operational improvement. The following Section 3 reviews the slow progress of state discoms in recent years.

3. The Fiscal Standing of India's State-owned Distribution Companies

The modern era in the Indian electricity sector arguably began with the passage of the Electricity Act of 2003. Some 20 years on, the fiscal health of the state distribution companies remains poor, with ongoing high losses and dependence on state government subsidies and central government bailouts to ensure solvency. We review the fiscal position of the state distribution companies and flag both positive and concerning trends. The best recent development is that losses, while high, have been coming down, and the subsidies between state governments and state distribution companies are being made as formal transfers upfront, rather than an accumulation of debt. The worrying case is that the operational performance in lagging states has improved only slowly, and some critical measures, such as the gap between the cost of supply and revenue, have continued to deteriorate.

3.1 Current Fiscal Standing

State discoms incur substantial losses while selling electricity (Figure 4). In the latest data from 2021-22, the average cost of supply for state discoms was Rs. 6.29 per power unit on the basis of energy input. However, discoms received 69% of their total expenditure from paying customers (operational income only, excluding any state tariff subsidy and grant), resulting in an Average Realizable Revenue (ARR) of Rs. 4.35 per unit only. Primarily, with state tariff subsidies received adding Rs. 1.24, the revenue goes to Rs. 5.59. Once we add other income and revenue grants (including UDAY) and regulatory income, it reaches Rs. 6.12. Earlier years had even larger gaps between the cost and revenue, primarily due to state subsidy received being lower than state subsidy billed by discoms. Considering only the operational income and excluding major subsidies, grants, and other cash adjustments, state discoms sold electricity at a loss of 31% in 2021-22, 34% in 2020-21, and 31% in 2019-20.

The liability to the generator for unpaid bills of power purchased also has been gradually increasing over time – from 233,000 Cr in 2019-20 to 260,000 Cr in 2021-22. Discoms also report large trade receivables that are primarily consumer bills pending, though they may not realize completely.

State discoms report yearly after-tax loss of 35,000 crores in 2021-22, 52,000 crores in 2020-21, and 33,000 crores in 2019-20. Building on these yearly losses, state discoms' total accumulated loss has been steadily increasing – from 5.12 lakh crores in 2019-20, 5.40 lakh crores in 2020-21, and 5.74 lakh crores in 2021-22.

3.2 Sources of Discom Losses

Discom losses are often attributed to their Aggregate Technical and Commercial (ATC) losses, though it does not provide a complete picture. We explain that below in the next two paragraphs followed by a description of key sources for discom losses.

Discoms in India show very poor performance in terms of Aggregate Technical and Commercial (ATC) losses. Total power transmission and distribution losses in OECD

countries have been stable at around 6% for a long time. In India, the transmission-related technical losses of about 6.5% – that are separate from the discoms' ATC losses – alone exceed this (Devaguptapu and Tongia 2023). In contrast, ATC losses in electricity distribution alone hovered around the 20-35% range for a long time in India (Figure 5, Panel A). After removing the reported agricultural sales and revenue (primarily state subsidy), the ATC losses come out to be even larger and this is consistent across states (Figure 5, Panel B). Mismanagement, including theft of power, is likely one key reason behind large ATC losses in India. Two specific aspects of ATC losses are critical to understanding the fiscal situation of discoms. First, discoms do not separate the technical losses from "commercial" losses, so reported ATC loss remains a black box. Second, since a large number of electricity connections remain unmetered and many times even in the case of metered connections discoms use assumed readings. This adds uncertainty to the billing efficiency discoms report. Since ATC loss calculations are based on the calculated billing efficiency, the reported ATC loss is likely to be much lower than the actual ATC loss.

On the brighter side, discoms' reported ATC losses have been gradually decreasing albeit at a sluggish pace. The year 2021-22 has been an exception in the sense that a substantial reduction in ATC is reported by discoms– from 22.25% in 2020-21 to 16.42% in 2021-22 (Figure 5, Panel A), though the revenue efficiency has hardly shown a comparable level of improvement (Figure 3). In general, the reported ATC losses decreased from 31% to 16% during the 2009-10 to 2021-22 period, while operating revenue increased only 3% during the same period – 75% in 2009-10 to 78% in 2021-22.

To understand this inconsistency, it is critical to discuss the potential sources of non-technical losses.

First, state governments offer heavy electricity subsidies to households and farmers, but often fail to reimburse discoms regularly. We looked into data for 2020-21 (the latest year for which consumer category-wise data is available) from five states that have high agricultural energy consumption (Table A1). About one-third of all units sold are categorized under the agricultural category. Since farmers receive electricity mostly for free, the revenue collected against these sales is often insignificant. Not surprisingly, these states' discoms report an operation revenue collection rate of 69% which is worse than the national average. For instance, Punjab discom reports selling 26% of total units to farmers, against which no revenue was collected. Likewise, albeit to a smaller degree, states also offer households tariff subsidies. States and discoms do not provide a breakdown of the tariff subsidy, so we have no easy way to see their growth. However, the category-wise power sales data in PFC reports shows that agriculture power sales almost doubled and household sales increased by about 150% since 2009. The impact on aggregate state subsidy has been much higher – it increased about eight times in the same time period.

Discoms bill the state against this subsidized consumption. While states are required to reimburse discoms against these household and agricultural subsidies, they often fall behind. Among these five states, the agricultural sector tariff subsidy itself amounted to about 84,000 crores in 2020-21 but the respective state governments provided a total subsidy of 47,000 crores only. In the latest year 2021-22, discoms received exceptionally high state tariff subsidy transfer (157,000 cr against the billed

144,000 cr), likely because of conditional dor states laid down in UDAY as we discuss later in Section 3.4.

Second, a significant proportion of consumers are neither billed nor do they make the payment when billed, a concern that will exacerbate with universal electrification. The reasons can vary from weak enforcement on defaulters to electricity theft following collusion between discom officials and consumers. The reported billing efficiency shows a large variation across states – 73% in Jharkhand to 92% in Andhra Pradesh (PFC report 2021-22). Even when a part of the gap between the energy input and the energy billed is due to technical losses, it is obvious that most state discoms are not able to account for a significant part of the energy they are selling. Further, collection against recorded sales is also often lacking, although most states have improved their collection efficiency significantly over time.

Third, related to the point that a significant number of connections remain non-metered, such non-metered connections often help conceal power theft. Specifically, discoms report that about one-quarter of the energy is consumed by agriculture consumers, but since these agriculture connections are rarely metered, they allow for the scope of disguising unbilled and stolen electricity as agricultural consumption. Saubhagya scheme increased the proportion of metered connections for households, though agricultural non-metered connections have mostly remained untouched due to various factors.

The fact that the billing efficiency of state discoms and private sector discom, as reported in PFC reports, are often comparable is quite surprising. Private discoms hardly observe this level of losses as state discoms have. The reason is that state discoms' "billing efficiency" also includes bills issued to the state government on account of customers that have no meters and bills, primarily, farmers and households without meters. Discoms do not provide segregation of billing efficiency across metered and non-metered connections, which could help clarify it further.

3.3 Accounting of Discom Finances

We find two aspects of discom finance reporting worth highlighting here since these have implications for how losses are calculated and reported in PFC reports. Both points make a strong case for bringing in more transparency in how state discom finances are reported.

First, discoms sell a large amount of electricity to farmers, usually to the tune of 23-24% of total energy input. These connections are almost always unmetered which may allow discoms to mask losses coming from other sources by including them in agriculture consumption. We see very little effort in improving reporting of the agriculture sector, despite the fact that about 90% of the state tariff subsidy is usually to compensate for agricultural consumption.

Second, discoms add various unrealized revenues that are quite unlikely to realize. Regulatory income that leads to the creation of regulatory assets on discoms books for future tariff recovery. Also, excess consumer non-collection – that are recoverable in theory, but not in practice – is termed as "Trade receivable" on discoms' books. While we don't go into details in this paper, Devaguptapu and Tongia (2023) have rigorously mapped these sources of discom losses by adopting a cash-flow-based accounting approach in place of accrual accounting practiced by PFC.

3.4 Recent Trends in Fiscal Position and Operational Performance

We show key statistics that summarize the trend in discom finances in Figure 6. The reported ATC losses have been gradually decreasing. In the data we compiled since 2009-10, it has almost reduced to half, starting from 31%. Billing efficiency has also shown a consistently positive improvement over time with an improvement of roughly 1 percentage point per year on average. Collection efficiency has also improved despite variations over time, and it now reaches close to 97% in the latest year data. However, a more practical view of trends in losses comes from the gap between ACS and ARR. It uses to be close to Rs. 1 per unit in 2011-12 but has come down significantly since then. 2021-22 is an exceptional year that state subsidy transferred to discoms was relatively higher than in other years. However, once we exclude subsidies and grants, the ACS-ARR gap has actually increased over time — from Rs. 1 per unit to almost Rs. 2 per unit. This contrast (between the two figures on the gap) underscores the key point that discoms have gradually become more dependent on state subsidies and grants.

Another useful approach to understanding discom fiscal challenges is to compare actual operational revenue against the total expenditure. The gap between expenditure and operational revenue (including regulatory income, other revenue and grants, excluding state tariff subsidy or UDAY grant) has been massive but stable since 2009, hovering around 25% (Figure 3). Taking a more rigorous approach of cash-flow-based accounting to break down discom finances, Devaguptapu and Tongia (2023) show even these figures are inflated in the accrual-based accounting that discoms and PFC follow. As per the PFC reports on the performance of power utilities, all discoms together reported a loss of Rs. 43,000 crores in 2009-10 which increased to Rs. 70,000 crores in 2020-21 (Table 2). The calculation of these loss figures combines subsidies and grants to operational revenue. Once we exclude explicit state tariff subsidies and UDAY grants, the net loss increases threefold from 62,000 crores to 188,000 crores during the same period.

The revenue split shown in Figure 3 shows the gap between expenditure and operational revenue (inclusive of other revenue/grants and regulatory income). The revenue percentage (over total expenditure) improved marginally from 75% to 80% between 2009 and 2014 and has been mostly stable within this range in later years. The situation significantly varies across states. For example, Rajasthan improved operational revenue from the base of 46% to 65% during 2009-14, while Uttar Pradesh discoms operational revenue remained around 65-67% during the same period. The states also often overstate their success in reducing fiscal losses using non-transparent calculations ignoring state and central support. For example, Rajasthan discom declared a profit in 2017-18 (The Times of India, 2018), while its collection when including state subsidy was only 78% and 62% after excluding state subsidy (Figure A1). The big difference here was solely due to grants provided to Rajasthan under UDAY.

3.5 Relative Performance of States drawing UDAY Funds in Recent Years

UDAY provides a useful case study to understand the impact of bail-outs on the fiscal position of discoms. A total of 16 states (29 discoms) have received grants under UDAY, another 12 states (33 discoms) have joined UDAY but haven't received any grant, and the remaining 3 states (13 discoms) haven’t joined UDAY. Among the three states that

did not join UDAY, Delhi already had privatized their electricity distribution and Odisha did the same more recently. West Bengal is the only state with state-controlled discoms that haven't joined UDAY. A list of states by their UDAY status is provided in Table A2. In total, states receive a total of about Rs. 72,000 crores under UDAY during 2015-20.

Using an event study design, we analyze the performance of discoms in states that received grant under UDAY and the states that didn't[3]. One would expect states receiving UDAY grants are subjected to specific conditions related to the fiscal management of discom finances, and so are likely to perform better. On the contrary, we find that states that did not receive any funds under UDAY are performing better than states that drew funds under UDAY (Figure 7). Specifically, we estimate that ATC losses are about 5% higher in UDAY grant states when compared to states that did not receive UDAY grants. Further analysis reveals that this impact is shaped primarily by relatively slower gains in billing efficiency in UDAY states. Overall, we find little impact of UDAY grants on the gap between ACS and ARR. In fact, in some cases, such as in the case of Tamil Nadu, the Comptroller and Auditor General Report has found that discom losses, instead of decreasing, have rather increased since UDAY (Indian Express, 2022).

We also conduct a similar analysis after removing agricultural consumption and subsidy transferred by states to pay for it. First, the left panel in Figure 8 shows the trends, without agriculture sales and revenue. ATC losses are much higher for all states. The billing efficiency is much lower. ACS-ARR gap reaches about 1.4 for UDAY states. We see no impact of UDAY on these key parameters (right panel). These graphs shown in Figure 8, when compared to graphs shown in Figure 7, highlight the point that agricultural consumption and state support make it difficult to understand the actual extent of fiscal deficits and the inefficiency of discoms.

On the bright side, even though UDAY does not show immediate gains, there are definitely some unique features of UDAY that may help improve the fiscal sustainability of the discoms. A key aspect of UDAY program is that it does not focus only on past debt like previous bailouts but also restructures future finances in a way that would potentially increase the commitment of state governments to improving discom finances. This provision requires states to take over 75% of the standing discom debt and 50% of discom losses gradually. This itself helps increase accountability since it brings losses on the book ex-ante that were earlier being cleared in subsidies and bailouts ex-post. So, even when losses gross of subsidy are about the same, more of the losses are at least being accounted for as state subsidies.

UDAY's nudge to states to take over discoms losses from discom's books to the state's own book is the key driver of the enhanced financial condition of discoms in recent times. At the same time, since it is essentially a transfer of discom debt to the states, UDAY has imposed a significantly large cost to the state. Rajasthan provides a good case in point. In 2017-18, the state discom was declared to be in profit for the first time in many years. This however was primarily due to UDAY grant revenue that was about 23% of the discom's total expenditure (Figure A1). The 2017-18 state budget of the Rajasthan government, on the other hand, shows the true picture, with a revenue deficit of 1518 Cr with the effect of UDAY and 13528 Cr with the effect of UDAY (Government of Rajasthan, 2018). This additional 12,000 Cr revenue deficit was about

[3] We use a two way fixed effect model to estimate the effect of state joining UDAY on discom performance. We add discom and year fixed effects and cluster standard errors at the discom level. Treatment is defined as the state of the discom joining UDAY (which happen in different years, 2016 and 2017).

1.5% of the state GDP. This, however, varies from state to state. For example, Tamilnadu discoms observe significant transfer under UDAY, while Uttar Pradesh discoms do not (Figure A2-A3).

3.6 Discom Losses and Quality of Service

Discoms' fiscal losses directly affect discoms' performance and the quality of service citizens receive. Using data on AT&C Losses from the PFC Performance Reports and Disruption Index from REC, Figure A4 shows that discoms with higher ATC losses are also the ones having more disruption in power supply. Except for a few discoms on the right tail of ATC losses, this holds for discoms in general. A key cause of disruption is the failure of distribution transformers due to poor load management and maintenance. Data on DT failure rate from REC further confirms this relationship between high ATC losses and poor quality (Figure A5). Ultimately, one would expect that consumers served by discoms that observe high ATC losses are likely to receive fewer hours of power. Figure A6 confirms this. To sum up, large fiscal losses of discoms not only put pressure on state and central government finance but also directly hurt the main objective of providing universal and reliable electricity to all households.

The increased rural electrification may counteract any gains discoms make in terms of reducing losses. On the backdrop of underlying inefficiencies, there is little reason to not be pessimistic about the impact of increased rural electrification on the fiscal sustainability of the electricity sector. Universal electrification may increase losses in two ways. First, since most of the newly electrified households are poor and they have a low ability to pay, the operational revenue per unit input is going to suffer. Due to household subsidies, state tariff subsidies have to increase significantly to compensate for them. And second, while the hope is that Saubhagya helps convert illegal and unmetered connections to metered connections, and thus, improves tracking, an expanded grid may also provide more opportunities for illegal connections, especially in the far-flung places. Such losses are eventually going to be covered by state subsidies or pile up as debt. Comparing gains in the electrification with the ratio of state subsidy and cost of power, we see that the state subsidy increased proportionally with the electrification gains in the last decade for most states, if not all (Figure A7).

4. Direct Benefit Transfers for Electricity as the Centerpiece of a Reform Program

What is to be done? The agency and commitment problems we identify in Section 2 are structural in nature. The Central government must act through the states to expand or sustain energy access for citizens, which allows state distribution companies to persist and grow despite ongoing losses. The problem in this arrangement is not Central transfers per se, which may improve energy access and welfare, but that the transfers enable inefficiency and waste, raising costs for all citizens. The analysis in Section 3 shows that these problems have not been addressed, at their core, by any of the prior reform programs; we emphasize that in the post-UDAY period the gaps in losses and operating performance between states reliant on UDAY and those that are not have only widened. Yet the Central government has made a remarkable and, at least for now, successful investment in universal electrification. The Central government's renewal of the reform program through RDSS shows that it will do everything it can for this

investment not to depreciate. The success of universal electrification has made the Central commitment to the states arguably stronger than ever before.

Today there are two broad currents for reform in the power sector, which flow on from the recent history of reform. The first current we would call *deepening Centralization*: the greater involvement of the Central government, through its investments in all segments of the power sector, in managing the operations of state distribution companies in an increasingly granular and detailed way. This current can be seen quite literally in, for example, the move from Central schemes funding only power meters on the electricity *grid* to funding power meters on each customer's *house*. The second current we would call *commitment at the margin*: through regulation, policy coordination, and conditions attached to Central investments and aid, move state distribution companies towards a greater, though an incomplete, degree of commercial orientation. Full *commitment* would mean the Central government committing to not financially support state distribution companies so that they would be forced to a more independent and commercial orientation. We judge this is not possible, for either the Central government or the respective state governments, given their stakes in electricity access. However, they can move to bring their support as fully on-the-books as possible, to sustain transfers while cutting back at the waste and loss that has been associated with such transfers to this point. We call this current of reform *commitment at the margin* because it seeks small (marginal) ways to incentivize discoms through regulation, institutional reforms, policy guidance and conditions on central support.

Our reading of the recent experience in Sections 2 and 3 is that *deepening Centralization* has not improved operating efficiencies and cannot be expected to do so on its own. The broad prescription for distribution reforms has been recognized almost since the Electricity Act of 2003 was passed. Strengthen the role of regulators and Central coordination to raise tariffs to levels that cover costs (Wolak 2008). Bring subsidies onto the books of distribution companies and states, rather than financing discom losses ex post through bailouts (Bhattacharya and Patel 2008). Invest in metering and distribution infrastructure, not for their own sake, but to improve energy accounting and reduce technical and commercial losses, which would lower costs for all paying customers.

We will not lay out a complete reform program here. Space is short, and many recent reports have gone into more depth than is possible in this Forum. We recommend in particular Devaguptapu and Tongia (2023) on the need for tariff true-ups to cover discoms' realized revenues and costs and a recent NITI Aayog report on distribution reforms (Prasanth et al. 2021). In the place of a complete program, we restrict ourselves to make one narrow point: Direct Benefit Transfers for Electricity offer one of the best tools to align Government, discom and customer interests in the sector. The following subsections lay out the rationale for a DBTE program, the design of such a scheme and experience from both the DBT for LPG and from small pilots of DBTE in two states.

4.1 Direct Benefit Transfers for Electricity can act as Commitment on the Margin

The idea of Direct Benefit Transfers is for government to give citizens benefits directly through financial transfers rather than in kind or via an intermediary. For example, the PM-Kisan scheme gives farmers an unconditional cash transfer up to Rs. 6,000 as income support. The logistical case for such a scheme is that it may be easier to ensure

that all of the money reaches the beneficiary than when giving support indirectly. Beyond the logistics, the efficiency benefit of an unconditional DBT is that the farmer, or any other beneficiary, can use the support for their own purposes. The Government does not have to judge what kind of subsidized good—from fertilizer and power to improved seeds, a drip irrigation system or a solar pump—would be the most valuable to the farmer, it just has to ensure that these inputs are available and that cash reaches the farmer, who can then decide for himself what to spend it on.

The idea of Direct Benefit Transfers is very powerful and well-suited to the problems of the electricity sector. A DBT for electricity would reorient the entire distribution segment towards better-serving electricity customers, including crores of households connected under Saubhagya. DBTE addresses in particular:

- *Do benefits reach the beneficiary?* An ongoing concern with distribution company accounting is that it is impossible to say for sure what share of subsidized electricity benefits actually reach consumers. Most agricultural consumers are unmetered. Many domestic households do not have meters read reliably or accurately. The power reaching consumers may be far less than what distribution companies claim. In this case, the state governments are paying a sum of subsidies, which bring down apparent technical and commercial losses. Yet it may serve to cover distribution company losses. Under DBT-E this concern would be eliminated by subsidies being paid directly to *Aadhar*-linked accounts.
- *Who does the distribution company serve?* The risk of backsliding on universal electrification comes from the discom not depending on its customers for revenue. Even if losses are high and electricity supply is irregular, the discom may still be able to recover its losses by billing the state government, or by accumulating debt. This removes the natural check on the quality of service provided by customers not buying a product that is badly made or sold at a high price. Under DBT, consumers with subsidy support would choose to purchase electricity from the discom. If supply was interrupted, for example, they could still receive the DBT, but would buy less power, and discom revenues would decline. The DBT routed via the customer therefore moves the risk for non-performance from the customer—who cannot control the reliability of supply—to the discom, who ought to run that risk, because it runs the grid.
- *What is the commitment of the Central government or the state to electrification?* The objective of the Central government and the states is to increase energy access. To this point, that objective has committed the respective governments to a more-or-less open-ended support of distribution companies. If the support of government instead flowed through electricity customers, the boundary of this support would be explicit: the government would support the customer to purchase a certain amount of electricity, defined at the beginning, and the responsibility of the discom is to serve that customer to recover its revenue.
- *Is subsidized electricity put to good use?* A main concern with subsidising any good is that it leads to waste. If I do not bear the cost of a good I do not seek to economize on its use. In the extreme, if electricity is free, a farmer may let their pump keep running, even after a paddy field is flooding over, raising electricity costs and draining groundwater at the same time. A DBT-E, depending on how it

is designed and whether the subsidy support depends on electricity use, can improve the incentives for conserving electricity by setting a subsidy that does not increase with further electricity use.

The prerequisites for a mass-scale DBT-E are either in place or in plan. One of the main accomplishments of the last decade, and of the UDAY scheme in particular, has been to move more support for discoms from ex post bailouts to ex ante subsidy transfers (Section 3). This step financially prepares the states to then reassign the recipient of the subsidies to be customers, rather than discoms themselves. The Government of India, via the Unique ID Authority of India, has successfully launched *Aadhar*, the world's largest biometric identification system, and used *Aadhar* to link benefit transfers for schemes such as the Mahatma Gandhi National Rural Employment Guarantee (MGNREGA) and the Direct Benefit Transfer for LPG (DBT-L). The same could be done for electricity. The main snag for the confirmation of the receipt of benefits in the electricity sector is that the state of electricity metering for subsidized customers, especially in agriculture, is poor. The Revamped Distribution Sector Scheme (RDSS) plans to change this with a massive investment in universal smart metering by 2025-26.

In the subsections below we briefly introduce a design for a direct benefit transfer for electricity scheme. This design is meant to be a model; the actual terms and details of such a scheme will depend on the existing tariff and subsidy structures in a state, and therefore cannot be written down in general for all. We then discuss the experience with pilots of DBTE for agricultural consumers in Rajasthan and Punjab.

4.2 Design of a Direct Benefit Transfer for Electricity Scheme

The design principles of a basic DBT-E are given in Table 3 below. Consumers are entitled to a fixed number of discounted units of electricity. The subsidy value of this entitlement is transferred to the consumer at the time a bill is issued. The consumer is then billed at the full tariff rate.

Under a DBT-E, the consumers are allocated a lump sum subsidy entitlement and in return charged the full tariff rate for units consumed. Table 4 illustrates how DBTE could work, for a domestic consumer (in panel A) and an agricultural consumer (panel B). The numbers in each example are chosen to be broadly realistic, but of course the parameters of the scheme would vary from state to state, depending on the pre-existing subsidy structure and other factors.

Consider the case of a domestic consumer in panel A. Suppose the cost of supply is Rs. 6 per kWh and the subsidy is Rs. 4 per kWh on the first 200 kWh only, which is a simple kind of increasing block tariff where the subsidy applies to the first slab of units. The value of the subsidy entitlement is then Rs 800. A consumer who uses only 100 kWh (column 1) spends less on power than they are entitled to. This consumer would earn a DBT refund of INR 200, deposited in their bank account, for the gap between the entitlement and their expenditure on power. Any bill less than the subsidy entitlement would earn the consumer a refund. If consumption were higher, as in columns 2 or 3, the consumer would not receive a refund, but would have their bill net or subsidy reduced by the subsidy entitlement. However, the marginal charge for additional units would remain at Rs. 6 per kWh. In this example, the value of the entitlement is calculated on the basis of the existing tariff. On consumption above the lump sum subsidy, the consumers pay at the full tariff rate.

Panel B shows the case for an agricultural consumer with a 5 HP pump. Here we assume that the state supplies up to 9 hours of agricultural power and that the subsidy entitlement is calculated, generously, as the farmer using the full 9 hours of power. The status quo is that the subsidy is the entire cost of power supply, here Rs. 6 per kWh, which adds up to just over Rs. 6,000 per month, the size of the PM-Kisan scheme transfer (column 3). If the farmer *does* use the full 9 hours of power, then, their tariff would equal the cost of supply and the subsidy value (column 3). The subsidy covers the full value of consumption. If the farmer chooses to use less than the full entitlement, for example cutting back to 6 hours (as in column 2), then the cost of supply and tariff would come down. The consumer is paid the difference between the entitlement and the tariff, which amounts to INR 2,013 per month. Because the consumer—here, the farmer—has the chance to be paid for each unit conserved, they have an incentive to reduce consumption even though they do not face a positive bill. The consumer has, in a sense, a negative bill (transfer) that could be larger or smaller depending on their consumption. This is a key feature that allows DBTE to be introduced in agriculture without upsetting the expectations of consumers who have long been accustomed to free power.

There are several variants on the basic design. Not all these variants are equally efficient. The two most important variations are whether the subsidy is: (i) *conditional:* the subsidy entitlement is either a fixed amount or conditioned on consumption, (ii) *refundable:* the subsidy is only payable against bills or is refundable to the consumer. The two examples above are both unconditional and refundable DBTE programs. In an unconditional DBT, the subsidy is fixed as a lump-sum amount regardless of the consumption of power. For example, the consumer is entitled to 200 kWh even if the household uses 400 kWh, rather than having a per unit subsidy which increases with consumption. This is equivalent to an increasing block tariff, already commonly used in India, in which the subsidy is reduced or removed on higher slabs of consumption. In a conditional DBT, the amount of subsidy would depend on consumption. For example, the consumer in Panel A, column 1 would not receive the full amount of subsidy, since their total bill was less than the entitlement; instead, they would get a bill of zero, but no transfer or refund. In a refundable DBT, the fixed lump-sum amount may also be returned, in part, to the consumer, if they use less than the entitlement. For example, the consumer is entitled to 200 kWh even if the household uses only 100 kWh, as in Panel A, column 1.

The most economically efficient DBT scheme, providing the strongest incentives for conservation, is one where the subsidy is unconditional and refundable. Consumers then have the strongest incentive to conserve because they can always reduce their bill to increase their refund. A risk is that such a scheme would involve committing to power subsidies even for consumers who do not use much power; however, that is the choice of the consumer, and the State Electricity Regulatory Commissions can set the level of subsidy entitlement so that it is revenue neutral for the distribution company. A lump-sum entitlement simply replaces current expenditure on per unit electricity subsidies. This form of tariff structure also helps governments decrease the subsidy burden through better targeting of beneficiaries. This is because the subsidy is implemented using a lump-sum entitlement, which is equivalent to granting the entire subsidy on the first block of consumption units, rather than also subsidizing higher slabs. The appropriate choice of subsidy structure will be subject to the approval of the SERCs, as are subsidies for current tariffs.

4.3 Experience with Direct Benefit Transfers in India

There has been substantial experience with Direct Benefit Transfers in India. Muralidharan et al. (2022) discuss in detail the implementation of biometric authentication and DBT reforms in India. We review relevant experience for the electricity sector, from the DBT scheme for LPG and from small-scale pilots for DBT in electricity itself.

4.3.1 Comparison with Direct Benefit Transfers for LPG (DBTL)

Direct Benefit Transfer for LPG (DBTL) also known as PAHAL (Pratyaksh Hanstantrit Labh) scheme is the largest Direct Benefit Transfer (DBT) scheme in the energy sector in India to date. Under DBTL, some 30 Cr households moved from a system in which subsidies were included in the over-the-counter price to a system in which households purchase LPG cylinders at market price and receive a subsidy transfer in their bank account to offset this expense. Since 2013, when the scheme was first piloted, to December 2022, Rs. 147,000 Cr in subsidies have been transferred to LPG consumers.

The LPG subsidy reforms were implemented over a decade in three phases following the roadmap in the Nilekani committee report (Nilekani 2011). Phase 1 was to cap LPG cylinders for universal LPG subsidies, which was done in 2012-13. Phase 2 proposed using *Aadhaar* and bank accounts to decouple subsidies from distribution and provide them directly to households (DBTL/PAHAL implemented in 2013-15). DBTL was first rolled out in 2013, but was soon terminated. A modified version of DBTL, known as PAHAL, was implemented in 2014-15. Phase 3 outlined the broad objective of targeting the LPG subsidy to poor households, which was implemented with the Ujjawala scheme, Give it Up, exclusion of high-income households, and ultimately by restricting subsidies only to poor households (targeted on the basis of BPL status and the Socio Economic and Caste Census (SECC)). When this reform program was started, the LPG distribution sector in India was grappling with challenges similar to that of the current electricity sector, with total subsidy outlays, driven by market prices, reaching Rs. 50,000 crores in 2013-14. DBTL has led a turnaround that relieved the fiscal burden of the LPG sector on the central government to a great extent, if not completely.

The introduction of DBTL has raised the portion of LPG subsidy expenditures that are actually reaching beneficiary households. Before DBTL, household LPG cylinders were highly susceptible to being diverted to commercial users through a black market. The DBT-L scheme reduced LPG purchases by household accounts by about 20%. A significant part of this apparent reduction is due to a reduction in the diversion of LPG cylinders to black markets, as confirmed by the associated impact on the commercial LPG sales and black market prices (Barnwal, 2023).

The core idea of DBT, decoupling a subsidy from the distribution of a good, is equally applicable to LPG and electricity. In the LPG case, distributors had little incentive to monitor and enforce rules when they were able to make additional profit through diversion. In the electricity case also the distribution companies have little incentive to bill and collect revenue from customers when they expect the government to pay for any losses through subsidies and bailouts. In electricity, as in LPG, the introduction of DBT could reduce technical losses and theft that are, in the present accounting system, misattributed to agricultural consumption. The connected nature of the electricity grid could, in theory, limit the scope of diversion. However, energy

accounting has remained incomplete despite decades of effort, so that it remains impossible to reliably demarcate legitimate consumption by subsidized categories, particularly agriculture, from power that is stolen or lost for technical reasons. DBTE would remove the discoms' incentive to obfuscate what is consumption and what is loss.

While the basic design of the DBT-L scheme is transferable to the electricity sector, some elements differ from what we have proposed, particularly on the conditionality of the subsidy and the structure of the sector. First, on conditionality, we propose an unconditional electricity subsidy that can be drawn regardless of consumption. This flat subsidy would be progressive and create the strongest political buy-in from customers and the strongest incentives to conserve, but contrasts with the conditional model adopted for LPG, where the purchase of LPG is necessary to receive the subsidy.[4] Second, the institutional structures of LPG and electricity distribution are radically different. The three Central government Public Sector Undertakings (PSUs), Indian Oil, Bharat Petroleum and Hindustan Petroleum, distribute all LPG in India, whereas some 117 power utilities, largely state-owned, distribute electricity.

The decentralized structure of distribution means that the roll-out of DBTE would surely be slower and more variegated than the roll-out of DBTL was. It also means that the states would have to be urged and incentivized to adopt DBTE. We note three channels that the Government of India has available to urge such adoption:

1. *RDSS conditions*. The Revamped Distribution Sector Scheme (RDSS) is funding smart meters for many customers in India, capable of remote meter reading and disconnection of customers. The data from such smart meter readings would become the basis of consumption measurement for any DBTE program. It is therefore sensible that the RDSS terms should require, in order for discoms to receive Central funding towards smart meter installation, that states should adopt DBT at the same time for those subsidized consumers who are getting meters. Now is the time to impose this condition; the RDSS has sanctioned some 9.4 Cr smart meter installations, but only 26,800 have been installed as of April 2023.
2. *Borrowing norms*. The Central government can give financial incentives for states to adopt DBTE. A proper DBTE system would make the states' balance sheets more transparent and reduce risks of state debt, possibly lowering interest rates. The Center could augment these market benefits of DBTE by relaxing borrowing norms for states that adopt DBTE for subsidized consumer categories. In fact, the Ministry of Finance, Government of India took a step in this direction by allowing

[4] The DBT-L scheme offers a subsidy up to a fixed number of cylinders per household, similar to an electricity tariff. However, the DBT in this case is conditional on the purchase of LPG (no subsidy is issued if the household does not purchase) and non-refundable, in that the household cannot keep any part of the subsidy if they use less than their quota of LPG cylinders (typically, 12 in a year). These features mean that the DBT-L subsidy would still encourage overconsumption of LPG, relative to a subsidy that was unconditional and refundable, since the subsidy lowers the marginal price of each additional LPG cylinder to the household. Also, because the price of LPG on world markets is much more volatile than electricity prices and the subsidy is fixed, households are exposed to considerable price risk, even taking the post-purchase bank transfer of LPG subsidy into account.

a relaxation of borrowing limit equal to 0.15% of GSDP for states that adopted DBTE for farmers in one district by December 31st, 2020. As this offer came in the midst of a crisis and with little technical preparation, we expect states did not have much opportunity to respond. However, such an offer could be renewed or expanded along with technical support to design and implement DBTE.

3. *Central support for subsidies.* The Central government has historically supported electrification through investments and through ex post bailouts, which relieve discom liabilities built up in part through unpaid state subsidies. A state may reasonably expect that it is cheaper to fund subsidies in this way than via ex ante budget allocations, to which the center would not contribute. The Center may counteract this expectation by offering to fund contributions to agricultural and domestic subsidies, for a certain period of time and to a greater extent for special category states—but only if those subsidies are delivered via DBT. This offer would give states an enormous incentive to move subsidy delivery to DBT.

4.3.2 Pilot experience in Rajasthan and Punjab

There has been some positive experience experimenting with DBTE for agricultural consumers in India. DBTE has an especially powerful rationale in the agriculture sector, which is that incentivizing farmers to conserve would save not only power but also groundwater, which has no price but is a scarce, valuable resource. The existing system of limiting water use by rationing power supply does not lead to efficient use of groundwater by farmers (Ryan and Sudarshan, 2022). DBTE could in principle improve the use of water by reducing waste and encouraging farmers to switch to less thirsty crops or adopt water-saving technologies.

The states of Rajasthan and Punjab have run pilot programs for DBTE among a group of selected agricultural consumers. Co-author Nicholas Ryan, along with Anant Sudarshan of Warwick University, has been involved in the design and evaluation of these pilots. The pilot designs are tailored to the conditions in each state. In both states, power is heavily subsidized for agricultural use. In Punjab, power is completely free, and farmers are unmetered. In Rajasthan, while the tariff net of subsidy per unit is nominal (INR 0.9 per kWh during the period of study) farmers did have meters installed and were accustomed to receiving bills. Table 5 summarizes the terms of each scheme.

The pilots are in two states under both fiscal and environmental strain from agricultural power subsidies. While the scale of the pilots has been modest, and the evaluation of the pilot in Punjab is ongoing, several encouraging results have emerged.

- *Farmer acceptance*. In both states, metering and enrollment were entirely voluntary. Nonetheless, farmers signed up voluntarily to get metered and have the possibility of benefits. In Rajasthan, 96% of farmers who enrolled say they would recommend the scheme to others, and in Punjab, 89% of farmers said the same.
- *Reductions in consumption.* In Rajasthan, farmers that enrolled in DBTE reduced their consumption by 37% after enrollment, relative to farmers in the same area that remained on the original tariff. In Punjab, farmers that enrolled in DBTE had consumption 9% lower than the average energy consumption of farmers in their feeders. These comparisons may be influenced by farmers with lower planned

consumption choosing to enroll; however, the data from Rajasthan especially suggest that DBTE encourages the conservation of power.

- *Budget neutral or budget-improving for state*. The parameters in the pilots were set such that the per unit payment to agricultural consumers (around Rs. 4 per kWh) were somewhat lower than the cost of supply. Budget calculations therefore show modest budget savings from the schemes at a pilot scale, because reductions in consumption create more savings on energy procurement than they cost in payouts to farmers.

In short, the pilots, though both voluntary and on a small scale, show the DBTE scheme making good on the basic promise of its design. Farmers that enroll conserve power. Subsidy payouts are based on fixed entitlements, net of consumption as recorded by electricity meters for each farmer. Both the farmer and the government can come out ahead, in a rare policy win-win, since the farmers conservation

The next step is for a state to lead by scaling these programs and making enrollment either mandatory or at least opt-out, so that it is assumed farmers would enroll unless they choose otherwise. Farmers would have nothing to lose, and much to gain. Nothing to lose, because under the designs here farmers would generally see bills either stay the same or fall (if consumption was reduced), or would see no bills at all, as in Punjab, if exceeding the entitlement is not charged. Much to gain because a scaled-up program offers the prospect not just of payouts for DBTE but also environmental gains from large-scale conservation of groundwater resources.

5. Conclusion

Universal electrification is a historic achievement in the development of any country. India has reached it, perhaps surprisingly, without the state distribution companies that provide electricity first reaching a state of fiscal health themselves.

The main lesson of Central intervention in the power distribution sector in the last 20 years is that funds for investment and debt restructuring provide no effective incentive for distribution companies to adopt a more commercial orientation. Co-authors Barnwal and Ryan have observed some of the results first-hand. In one state, we sought data from a discom on energy supplied at the distribution transformer level. The transformers had all been metered with funds provided under RAPDRP. Nonetheless, the data did not exist. Because the discom did not keep detailed energy accounts, there was no need to maintain the meters, and the modems were no longer transmitting data. In another state, before the start of the Saubhagya drive, we toured non-electrified villages and found disused electricity poles, cast solidly in concrete, from prior efforts to electrify the same places. Residents said that the village had been electrified, but when the power supply dwindled and stopped the wires and transformers were stripped and sold off. The major risk to the sector at this point in time is therefore whether state distribution companies can sustain the accomplishment of electrification that they achieved through Central support.

Gaps between costs of service and revenue from customers remain large. Operationally, technical and commercial losses are still well above international norms, and it is likely that even these losses are understated. Because energy accounting

remains incomplete, some part of the reduction in aggregate technical and commercial losses in recent years may be due to lost power being booked as agricultural consumption. A bright spot in the recent data is that state support to distribution companies, while it has grown, has also grown more visible. State Electricity Regulatory Commissions, in pursuit of national guidance, have moved tariffs to better cover costs ex ante, and the rules of the UDAY scheme have pushed states to bring subsidies onto their books in advance rather than to bail out discoms for accumulated losses ex post. The transparency of subsidies is a sign of progress, though on its own will not necessarily reduce waste or reduce costs. It is rather a tool to enable further work toward those efficiency goals.

We advocate for using this window for the Center and States to make a coordinated push for Direct Benefit Transfers for Electricity across the sector for both domestic and agricultural consumers. Technical upgrades alone have not in the past and will not now impart a commercial orientation. DBTE is different, since it changes the structure of incentives in the sector altogether: in a system where subsidies flow from government to customers, discoms have to serve customers—not the government—to collect revenue, invest and grow. It has long been assumed that the agricultural power subsidy is politically untouchable. However, that was in an era when the assumption was that "reform" meant simply to raise tariffs, whereas DBTE would instead convert subsidies from per unit subsidies to refundable transfers. Our experience working with pilots in Rajasthan and Punjab shows that the DBTE concept is viable at a small scale. What remains is for the idea to reach the masses.

DBTE would surely be only one part of a larger reform agenda. We emphasize this part as a leading example of *commitment at the margin*: the adoption of reforms and policies that tend to increase discom independence, the goal of commercial orientation that has eluded past reform efforts. There are surely many other parts of the reform agenda that can also help build such commitment, especially in the State Electricity Regulatory Commissions continuing to impose discipline on tariff-setting, tariff true-ups and energy accounting. These steps would help ensure that the landmark achievement of universal electrification is followed by continued improvements in power supply and reductions in costs in the years to come.

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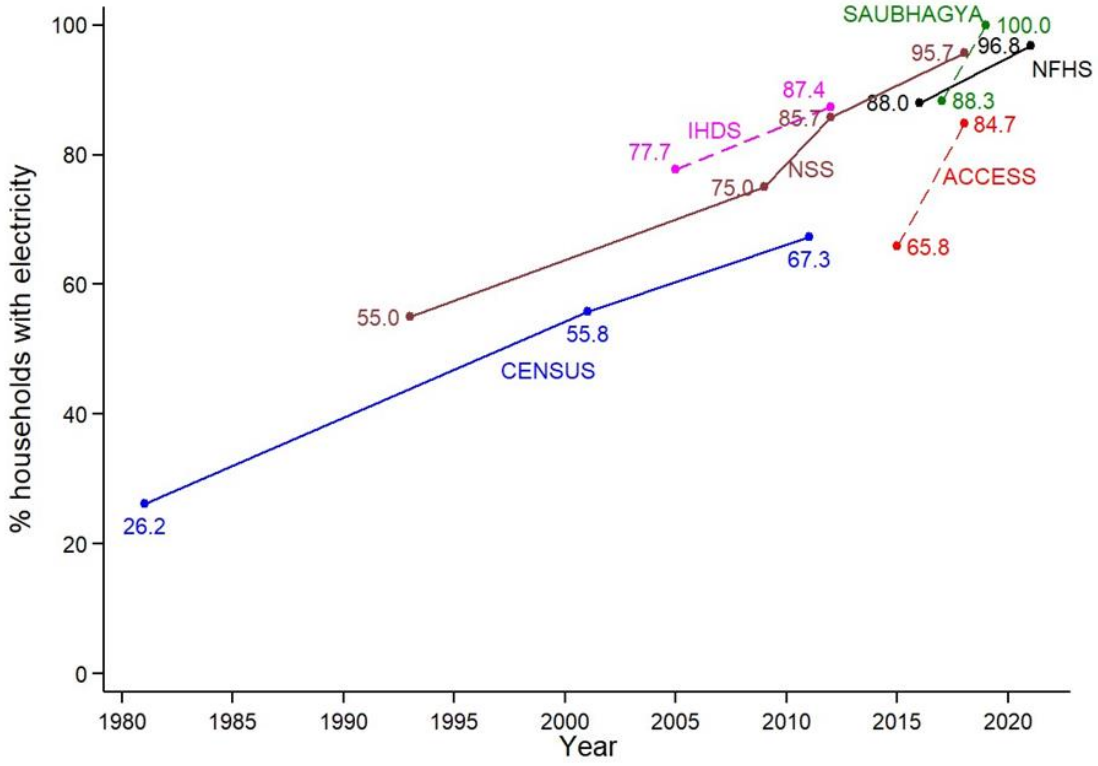
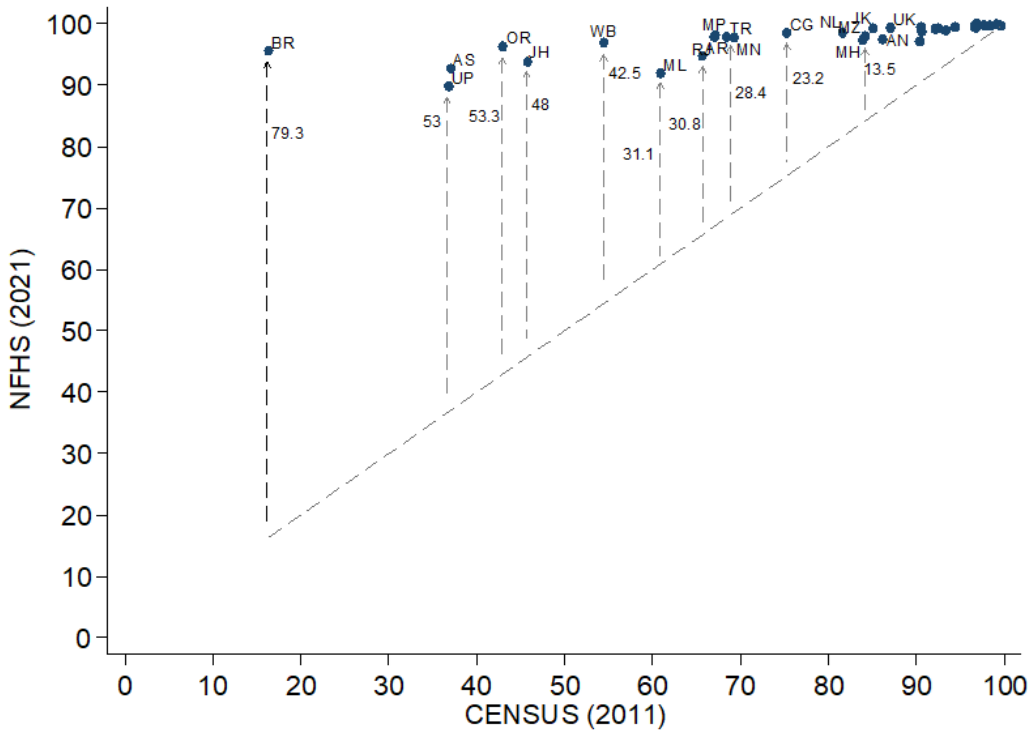
Figures

Figure 1: Household Electrification in India, 1980–2021



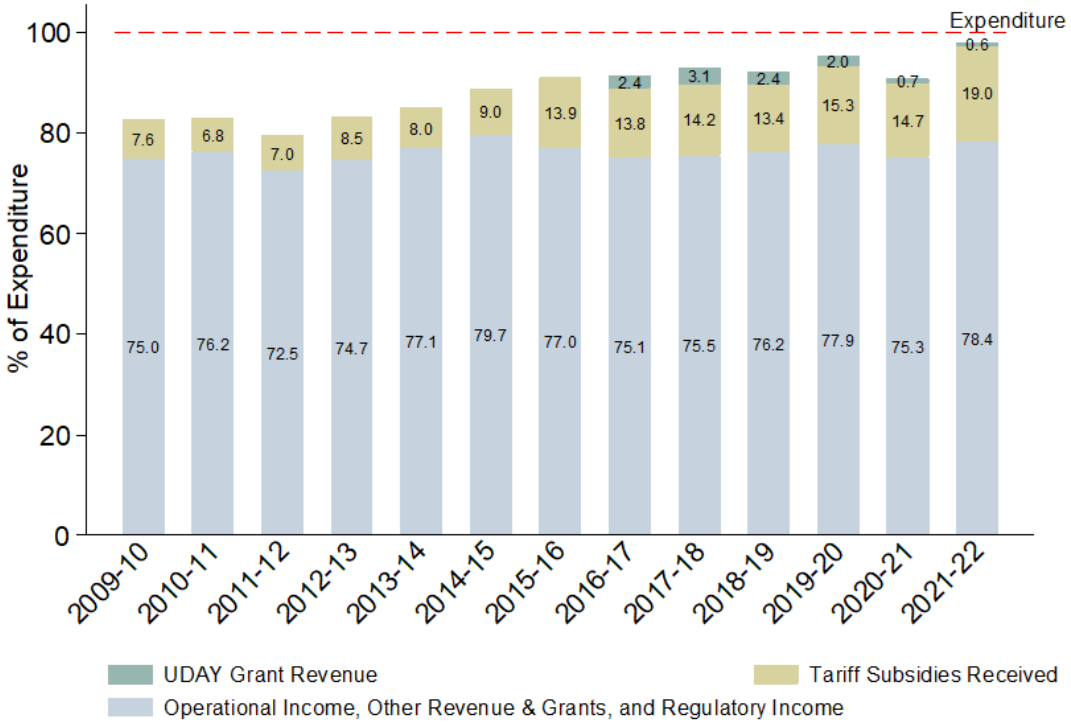
Note: The data for years 1981, 2001 & 2011 are sourced from CENSUS, and covers all the states. The data for years 2015 and 2018 includes about ~9000 households that were covered in the ACCESS survey (6 states were covered – Bihar, Jharkhand, Madhya Pradesh, Odisha, Uttar Pradesh & West Bengal). Data for 1993, 2009, 2012 and 2018 is from NSS survey (Drinking Water, Sanitation, Hygiene and Housing Condition in India) and indicates the % of electricity used by households for domestic use. 2016 and 2021 were covered under the National Family Health Survey (NFHS) and indicates the % population living in households with electricity. 2017 and 2019 data captured under SAUBHAGYA indicates the % of houses that were electrified under the scheme, from the total unelectrified households identified under the scheme at the time of implementation. India Human Development Survey (IHDS) provides the data for 2005 and 2012, based on a survey across ~42000 households.

Figure 2: Gains in Household Electrification by State (2020 vs. 2011)



Note: The graph plots the percentage of households electrified as per the National Family Health Survey (2019-2021) against the percentage of households electrified in the Census (2011). The arrows indicate the increase in % of households electrified between the two years and the figures are the increase in percentage points. Because Telangana was a part of Andhra Pradesh in 2011, for the purpose of this graph we have combined it with Andhra Pradesh in 2020 and the value is an average of the two states.

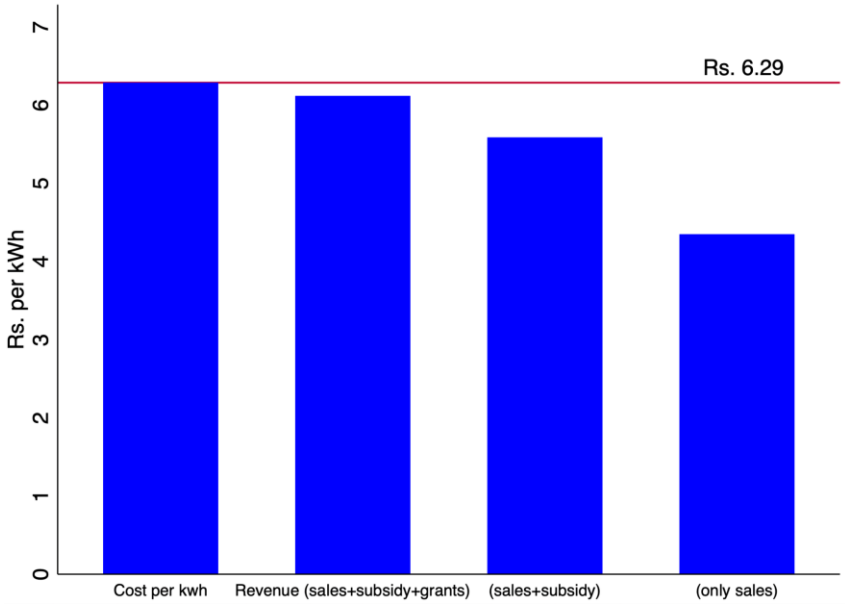
Figure 3: State Distribution Company Revenue as a Percentage of Expenditure, by Revenue Category, 2009-10 through 2021-22



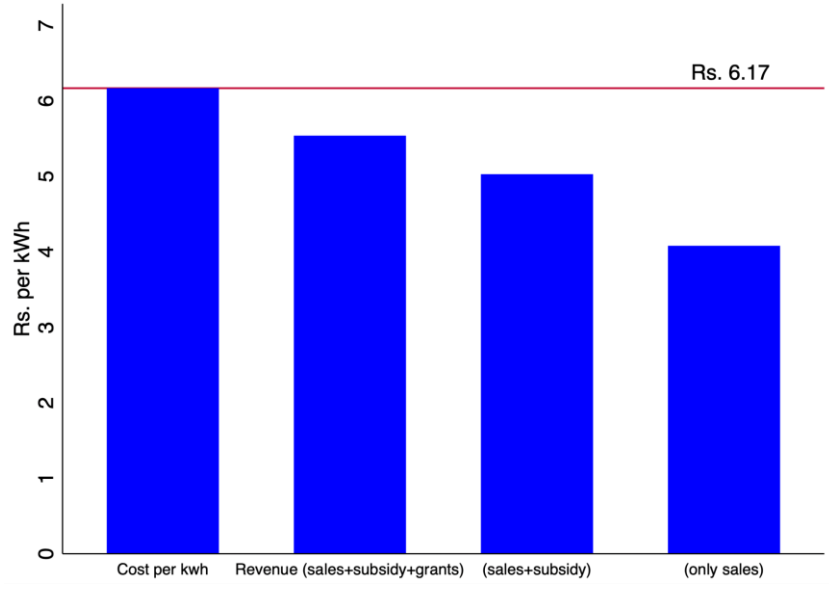
Source: Calculated using PFC Report on Performance of Power Utilities (multiple years). Other revenues include regulatory income and grant revenues other than under UDAY.

Figure 4: State Discom Supply Cost and Revenue

2021-22



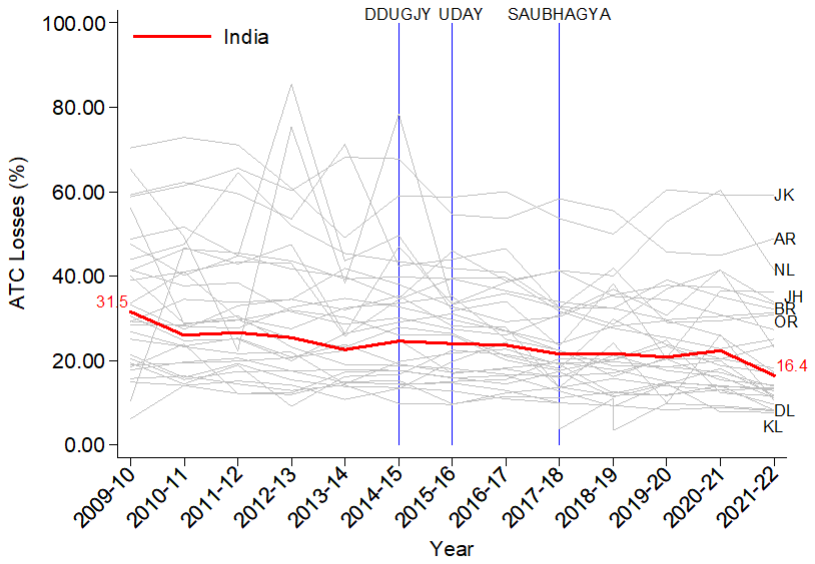
2020-21



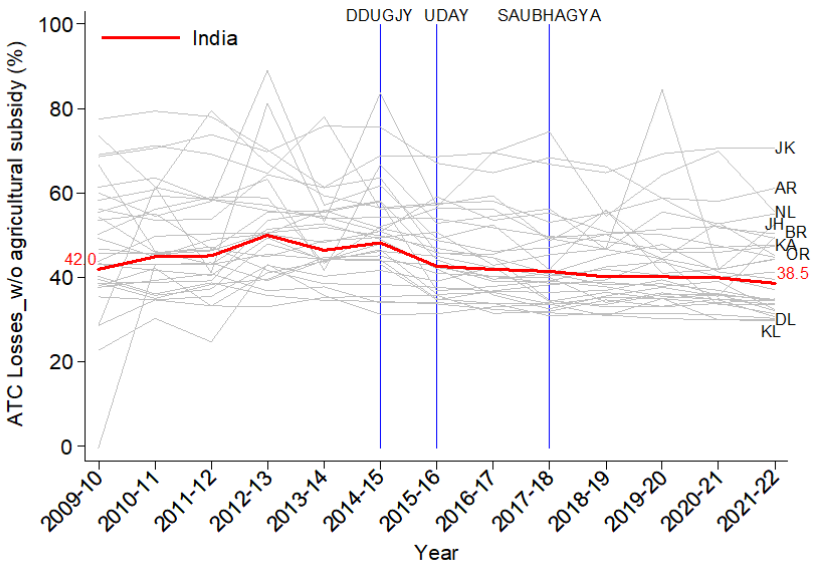
Note: Data from 2021-22 PFC report. Only state discoms data is included.Cost per kWh is calculated using total expenditure and total energy input. Revenue (sales+subsidy+grants) includes operational revenue (from sales only), state tariff subsidy, and all other grants and income including UDAY. Revenue (only sales) indicates operational revenue.

Figure 5: Aggregate Technical & Commercial Losses, 2009-10 to 2021-22

Panel A. Including Subsidies as Revenue

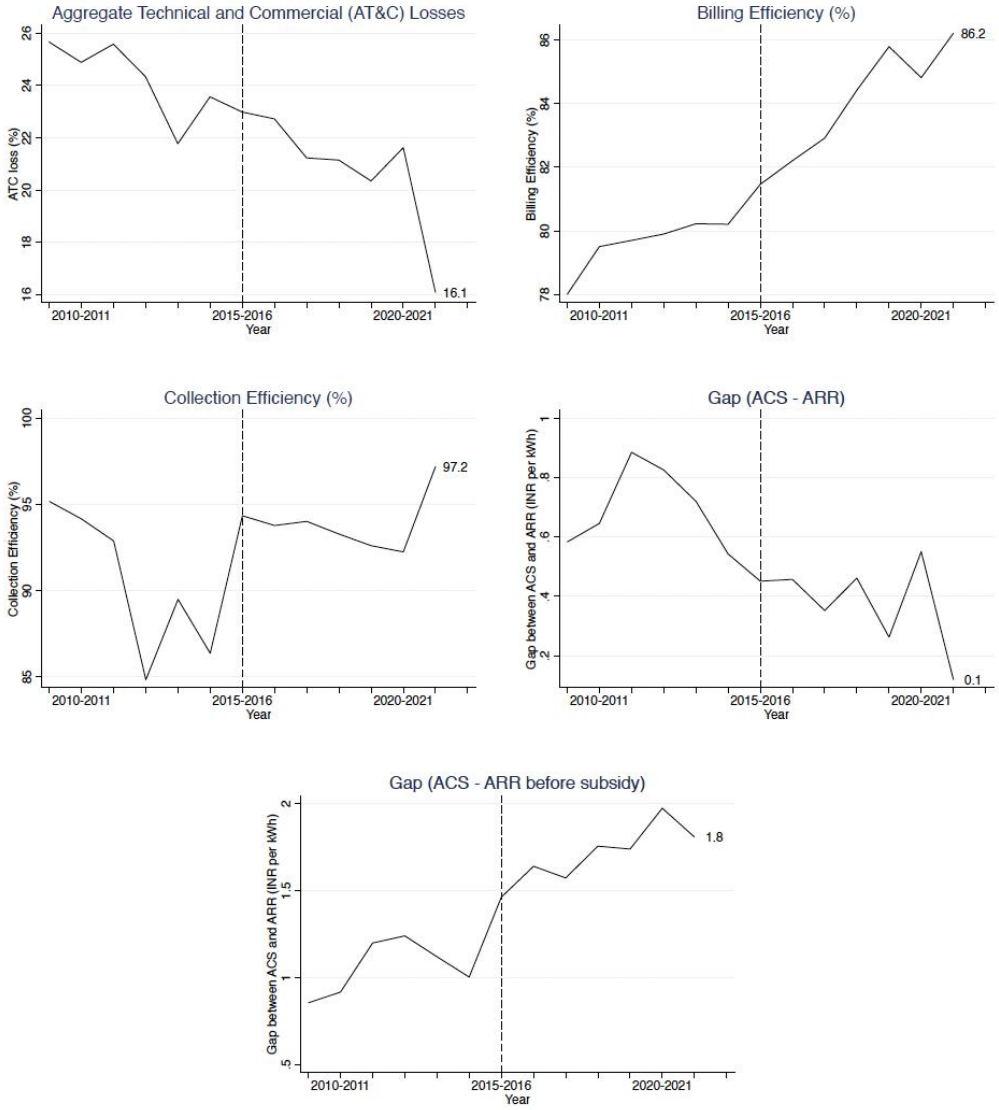


Panel B. Excluding Subsidies from Revenue



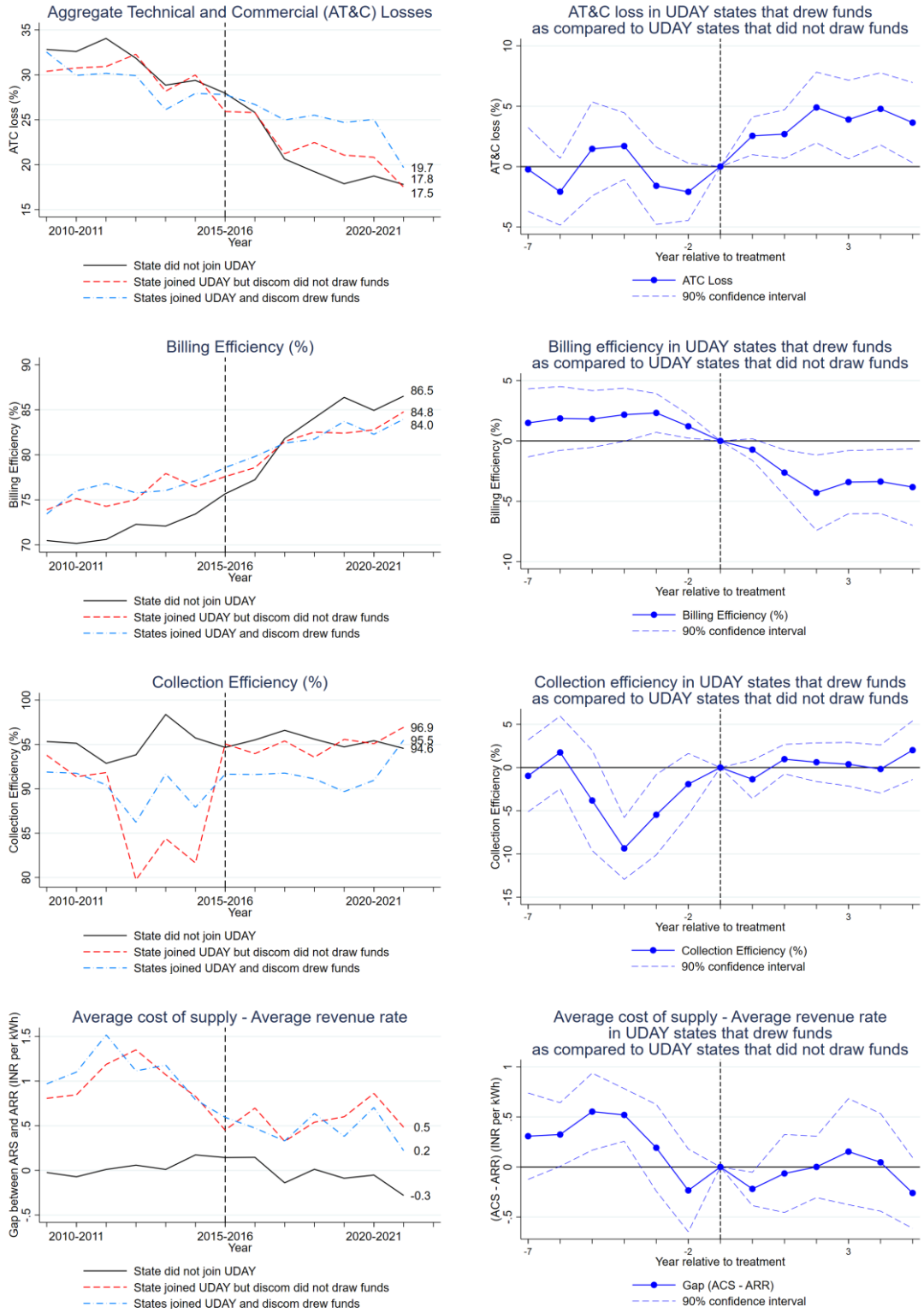
Source: PFC Reports on the Performance of Power Utilities for FY 2009-10 to 2021-22.
Note: The ATC Loss for India is an average of the ATC Losses across states every year. We assume that the agricultural sector accounts for 90% of the state subsidies (consistent with the PFC assumption) and ~24% of units sold by DISCOMs. In the second panel, we go on to exclude this consumption and subsidy from the total to highlight the losses in the absence of these state subsidies. The 2020-21 data has been carried forward to 2021-22 for three DISCOMs which have not yet submitted their data - JKPDD, Torrent Power Ahmedabad, and Torrent Power Surat. All four DISCOMs in Odisha have been privatized, and renamed to TPNODL, TPSODL, TPWODL and TPCODL, but for the purpose of this analysis we have used the old names to be consistent with previous years.

Figure 6: Trends in Key Discom Performance Variables



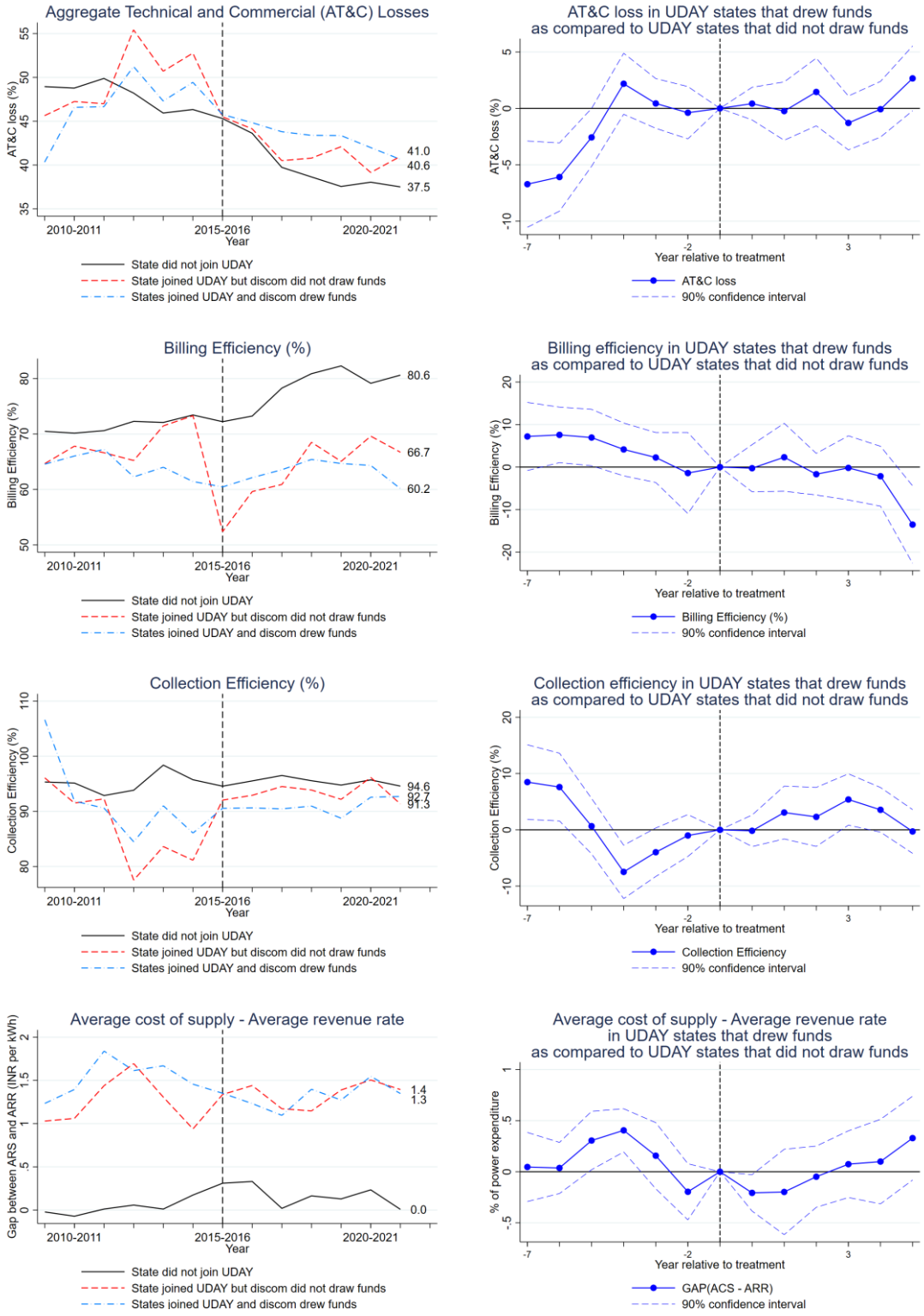
Source: PFC Reports on the Performance of Power Utilities and CAG Audit Reports.

Figure 7: Trends and Event Study Plots



Source: PFC Reports on the Performance of Power Utilities and CAG Audit Reports.
Note: The figures on the left column show the average trends for AT&C loss, billing efficiency, collection efficiency and the gap between the average cost of supply and average revenue rate, weighted by gross energy sold. There are three groups: discoms that are in a state that did not join the UDAY scheme, discoms that are in a state that joined UDAY but did not draw funds and discoms that are in a state that joined UDAY and drew funds. Discoms in states that did not join UDAY have lower AT&C losses and higher billing and collection efficiency. The difference between the average cost of supply and the average revenue rate is also lower for discoms not in a UDAY state. The figures on the right column show event study plots for the same variables, using a two-way fixed effect model with discom and year fixed effects. The set of discoms not in a UDAY state serves as the control group while the set of discoms in a UDAY state is the treated group. Treatment is defined as the state for which a discom is located in joins UDAY.

Figure 8: Trends and Event Study Plots without Agriculture Subsidy



Source: PFC Reports on the Performance of Power Utilities and CAG Audit Reports.
Note: The figures on the left column show the average trends for AT&C loss, billing efficiency, collection efficiency and the gap between the average cost of supply and average revenue rate, weighted by gross energy sold. The variables are computed without the agriculture subsidy, assuming that they are 90% of the subsidy received by a discom. There are three groups: discoms that are in a state that did not join the UDAY scheme, discoms that are in a state that joined UDAY but did not draw funds and discoms that are in a state that joined UDAY and drew funds. Discoms in states that did not join UDAY have lower AT&C losses and higher billing and collection efficiency. The difference between the average cost of supply and the average revenue rate is also lower for discoms not in a UDAY state. The figures on the right column show event study plots for the same variables, using a two-way fixed effect model with discom and year fixed effects. The set of discoms not in a UDAY state serves as the control group while the set of discoms in a UDAY state is the treated group. Treatment is defined as the state for which a discom is located in joins UDAY.

Tables

Table 1: Recent History of Bailouts of State Distribution Companies

Year	Creditors	Current Value	Constant Value (2022, INR)	% GDP	Financial Terms	Incentive Measures
2020 (Atmanirbhar Bharat Abhiyan Package)	Generators & Govt Finance Institutions	900B INR	766B	0.44%	Liquidity injection divided into two tranches: the first contingent on a repayment to creditors and the second contingent on not having any bills overdue and having a plan to bring down technical losses.	Intended as a stopgap measure until the Electricity Act Reform is introduced.
2015 (Ujjwal Discom Assurance Yojana)	Banks	2,090B INR	1,486B	1.52%	States shall take over 75% of DISCOM debt as on September 30, 2015 over two years. 50% of DISCOM debt shall be taken over in 2015-16 and 25% in 2016-17. States taking over and funding at least 50% of the future losses.	Operational attempts to reduce deficit, such as reducing losses and increasing efficiency.
2012 (Name of Bailout Scheme)	Banks	1,900B INR	1,204B	1.91%	States required to take on 50% of outstanding short-term liabilities up to March 31, 2012. They will be converted into bonds and issued to lenders. With liability falling to the states. The other 50% will be restructured such that there will be a 3-year moratorium on repayments.	Performance incentives issued by Central Government for meeting certain operational and financial targets.
2001-2002[e]	Centrally owned generators/ CPSUs	400B INR	120B	1.84%	50% of the interest on delayed payments was waived and the remaining amount (full principal + remaining interest) converted into bonds by the state government.	APDRP and Electricity Act of 2003 intended to deliver increased profitability for DISCOMs and structural reforms to the power sector, respectively.
Total		5,290B	3,576B			

Table 2: Aggregate Financials of Indian Discoms, 2009-10 to 2021-22

Years	Gross Input Energy (MU)	Gross Energy Sold (MU)	Total Expenditure (in Rs. Crore)	Total Revenue on Subsidy Received Basis (in Rs. Crore)	Revenue (excl. state subsidies & revenue grant under UDAY) (in Rs. Crore)	Loss	Loss (without subsidies and UDAY Grant revenue)	Loss without subsidies & UDAY Grant in constant INR (2022) (in Rs. crore)
	(A)	(B)	(C)	(D)	(E)	(F) = (D) - (C)	(G) = (E) - (C)	G (in 2022 Rupees)
2009-10	7,04,727	5,22,256	2,49,794	2,06,373	1,87,299	-43,421	-62,495	-33,743
2010-11	7,55,933	5,80,996	3,00,681	2,49,552	2,29,214	-51,129	-71,467	-41,958
2011-12	8,10,653	6,24,954	3,69,272	2,93,329	2,67,558	-75,943	-1,01,714	-64,453
2012-13	8,44,767	6,57,312	4,25,274	3,53,907	3,17,809	-71,367	-1,07,465	-72,311
2013-14	8,89,417	6,98,169	4,61,624	3,92,497	3,55,739	-69,127	-1,05,885	-73,621
2014-15	9,67,856	7,53,432	5,03,773	4,47,204	4,01,620	-56,569	-1,02,153	-72,645
2015-16	10,07,997	7,85,132	5,34,783	4,86,401	4,11,887	-48,382	-1,22,896	-90,227
2016-17	10,42,428	8,20,244	5,71,477	5,22,035	4,29,263	-49,442	-1,42,214	-1,08,553
2017-18	11,18,530	8,89,691	6,25,893	5,81,420	4,72,836	-44,473	-1,53,057	-1,21,368
2018-19	12,24,166	9,90,832	7,35,984	6,77,528	5,60,998	-58,456	-1,74,986	-1,42,095
2019-20	12,19,221	10,06,755	7,49,325	7,13,972	5,83,805	-35,353	-1,65,520	-1,40,788
2020-21	12,25,389	9,95,472	7,59,579	6,89,181	5,71,676	-70,398	-1,87,903	-1,73,473
2021-22	13,13,864	10,90,052	8,27,847	8,10,879	6,49,153	-16,968	-1,78,694	-1,78,694

Source: Calculated using PFC Report on Performance of Power Utilities (over multiple years). The data include both state and private discoms. Total Revenue on includes Other Income & Revenue Grants and Regulatory Income.

Table 3: Design Elements of Direct Benefit Transfers for Electricity

Design	Principle	Variant for domestic consumers	Variant for agricultural consumers
Entitlements	Consumers are entitled to a fixed number of discounted units of electricity.	Number of units and per unit subsidy may be dictated by structure of pre-existing tariff.	Number of units based on average consumption or the hours of free power under feeder rationing.
Transfers	State government transfers the value of entitlement to the consumer at the time a bill is issued.		Refundable DBT: if the consumer uses less than entitlement, the value of the difference is refunded.
Billing	Consumer is billed at the full tariff rate.	Bill may be issued only for the net amount owed after deduction of subsidy.	No bill need be issued for exceeding the entitlement if supply is rationed.

Table 4: Illustration of Direct Benefit Transfers for Electricity

Panel A. Domestic Consumer Example

Line items	**Consumption scenarios**		
	(1)	**(2)**	**(3)**
(i) Consumption *(in kWh/month)*	100	200	400
(ii) Cost of supply *(@ Rs 6/kWh) (=6*i)*	600	1200	2400
(iii) Tariff *(@ Rs 6/kWh) (= 6*(i))*	600	1200	2400
(iv) Bill to customer *(in Rs)*	600	1200	2400
(v) Subsidy value *(@ Rs 4 for first 200 kWh)*	800	800	800
(vi) = (iv) - (v) Bill net of subsidy *(Rs/month)*	-200	400	1600
(vii)= max{0,-(vi)} DBT to customer net of power bill *(Rs/month)*	200	0	0

Panel B. Agricultural Consumer Example

Line items	**Consumption scenarios**		
	(1)	**(2)**	**(3)**
(i) Consumption *(in hours/day)*	3	6	9
*(ii) = (i)*5HP*30*0.7457* Consumption *(in kWh/month)*	335.6	671.1	1006.7
(iii) = 6(ii)* Cost of supply *(@ Rs 6/kWh)*	2013.4	4026.8	6040.2
(iv) = 6(ii)* Tariff *(@ Rs 6/hour)*	2013.4	4026.8	6040.2
(v) Subsidy value *(@ Rs 6 up to 9 hours)*	6040.2	6040.2	6040.2
(vi) = (iv) - (v) Net bill to customer *(in Rs/month)*	-4026.8	-2013.4	0
(vii)= max{0,-(vi)} DBT to customer net of consumption charges *(Rs/month)*	4026.8	2013.4	0

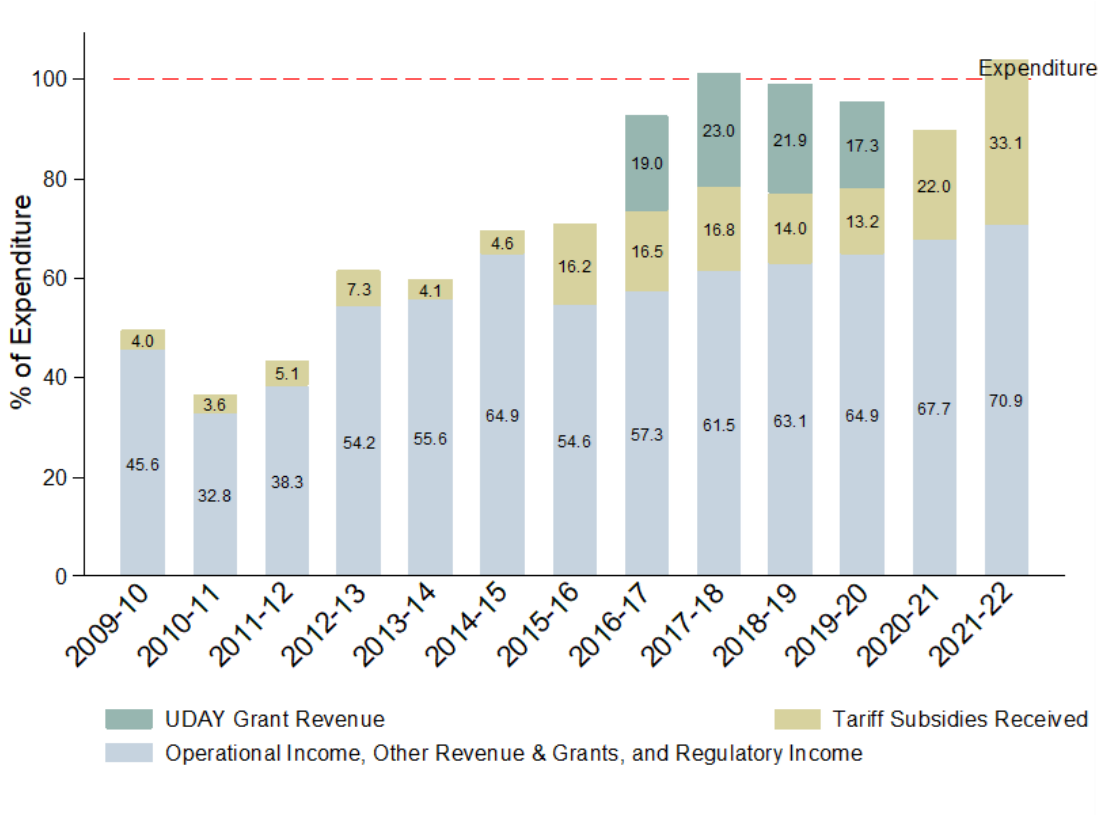
Note: Assuming pumpset capacity of 5HP for agricultural consumer.

Table 5: Direct Benefit Transfers for Electricity Pilots in Rajasthan and Punjab

Design point	Rajasthan	Punjab
Status quo	Meters installed, nominal energy charges net of subsidy (Rs. 0.9 per kWh). Ration of 6 hours power.	No meters installed, free power. Ration of 9 hours power available to agricultural feeders.
Entitlement calculation	Entitlement based on average usage within each sub-division for agricultural users of the same pump capacity	Entitlement based on average of feeder-level specific energy consumption (kWh/HP), scaled by pump capacity
Subsidy payment refundable?	Yes, refundable at Rs 3.85 per kWh rate of subsidy for each unit saved below entitlement	Yes, refundable at Rs. 4 per kWh rate of subsidy for each unit saved below entitlement
Bills issued above entitlement?	Yes, bills issued for consumption above entitlement, as in status quo.	No. No bills issued for consumption beyond entitlement.
Scope of pilot	Farmers in 3 feeders in Bundi district eligible to enroll on voluntary basis	Farmers in select 250 feeders in 11 districts eligible to enroll on voluntary basis
Duration of pilot	September 2017 - March 2020	June 2019 – present

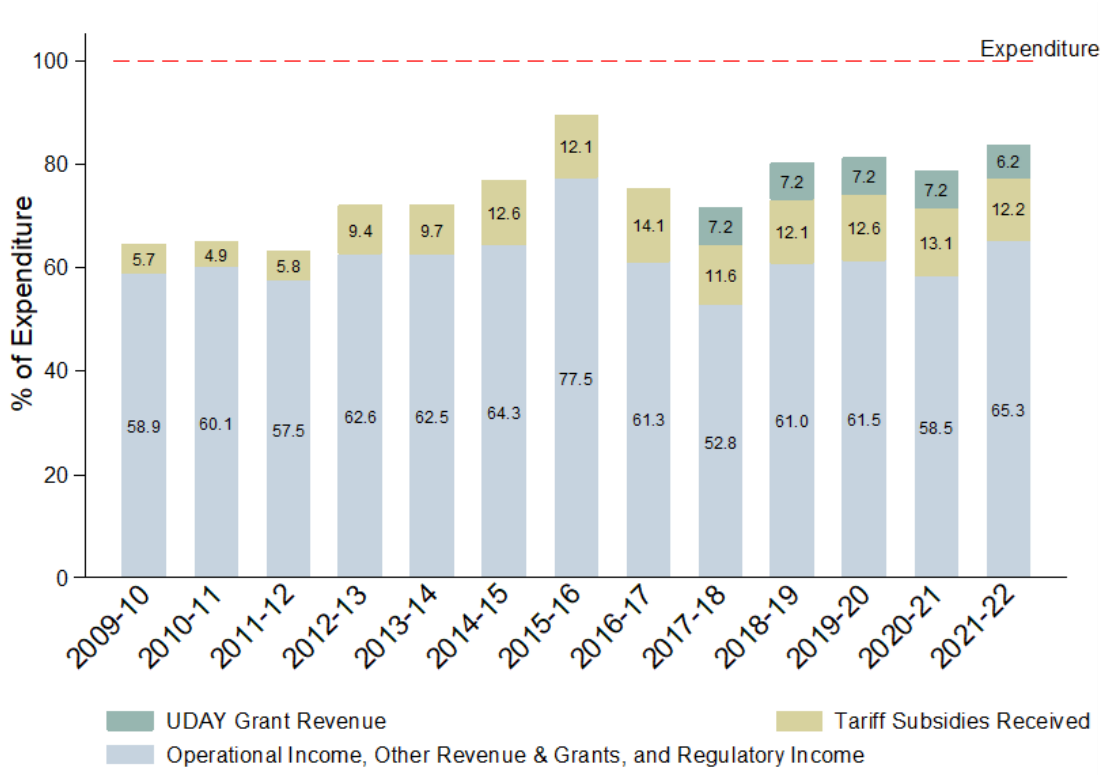
Annexure: Additional Figures and Tables

Figure A1: Revenue Split by Operational, UDAY Grant Revenue and State Subsidies for Rajasthan



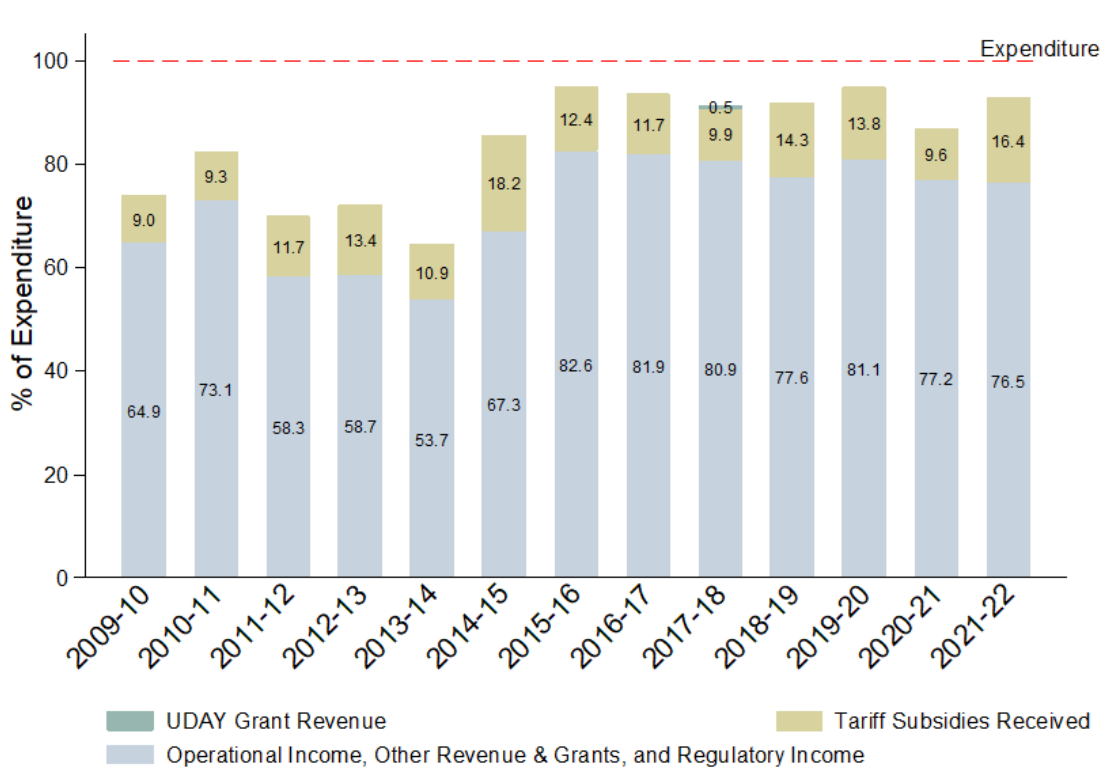
Source: Calculated using PFC Report on Performance of Power Utilities (over multiple years). Other revenues include regulatory income and grant revenues other than under UDAY.

Figure A2: Revenue as a Percentage of Expenditure for Tamil Nadu



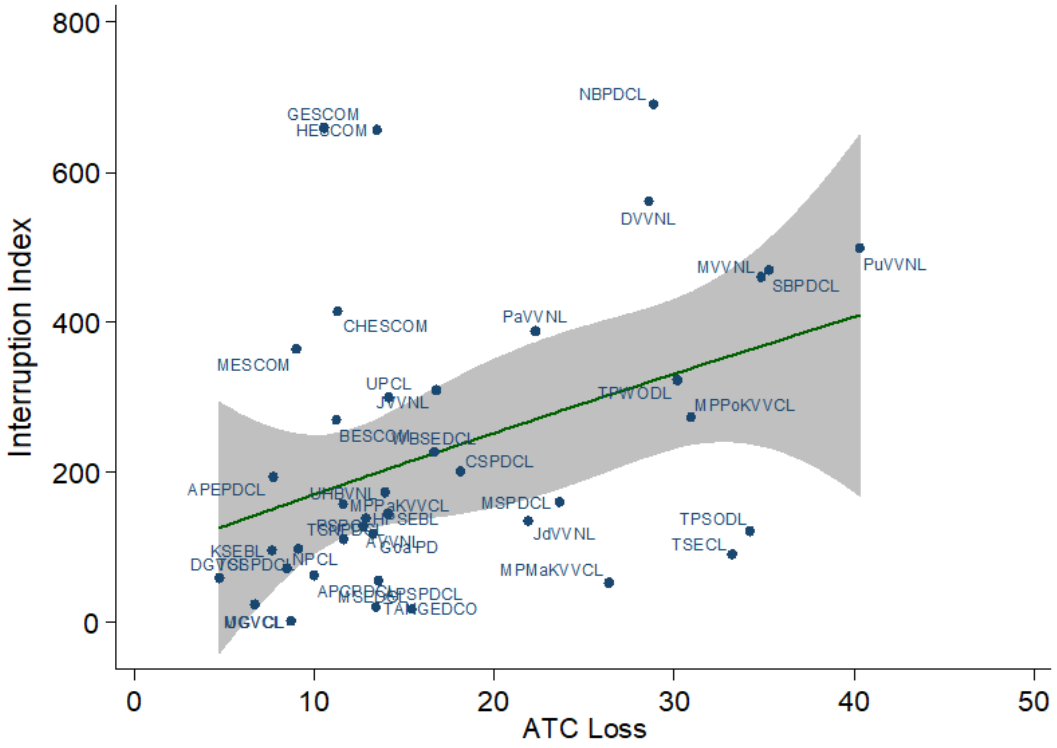
Source: Calculated using PFC Report on Performance of Power Utilities (over multiple years). Other revenues include regulatory income and grant revenues other than under UDAY.

Figure A3: Revenue as a Percentage of Expenditure for Uttar Pradesh



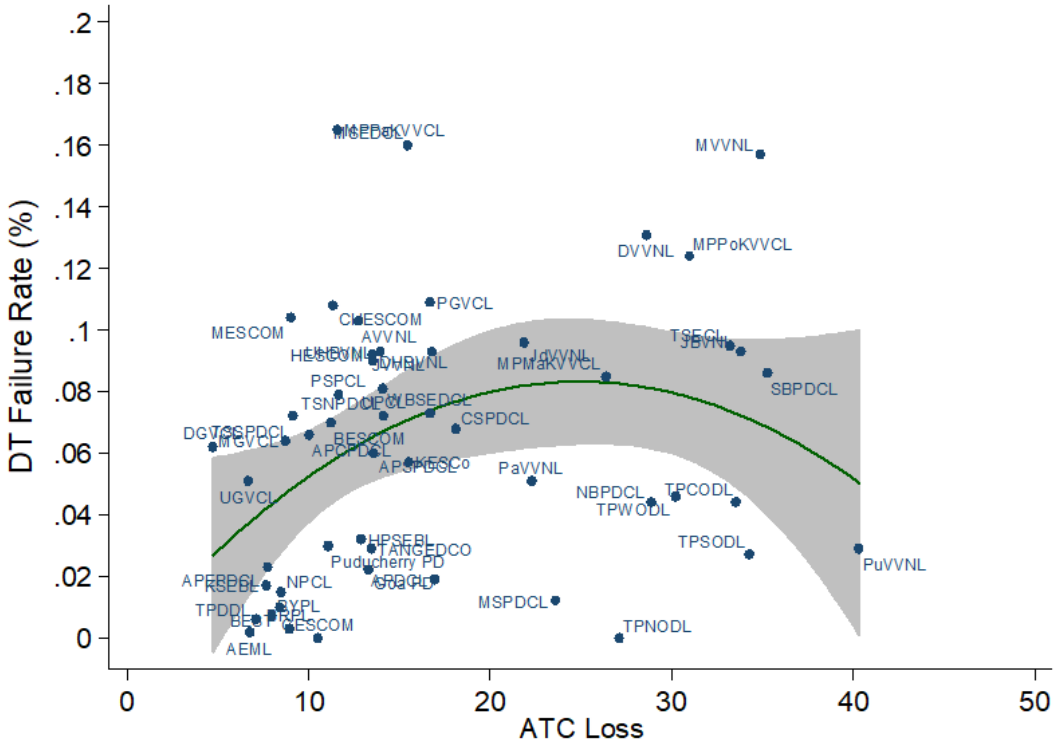
Source: Calculated using PFC Report on Performance of Power Utilities (over multiple years). Other revenues include regulatory income and grant revenues other than under UDAY.

Figure A4: ATC Loss v/s Disruption Index



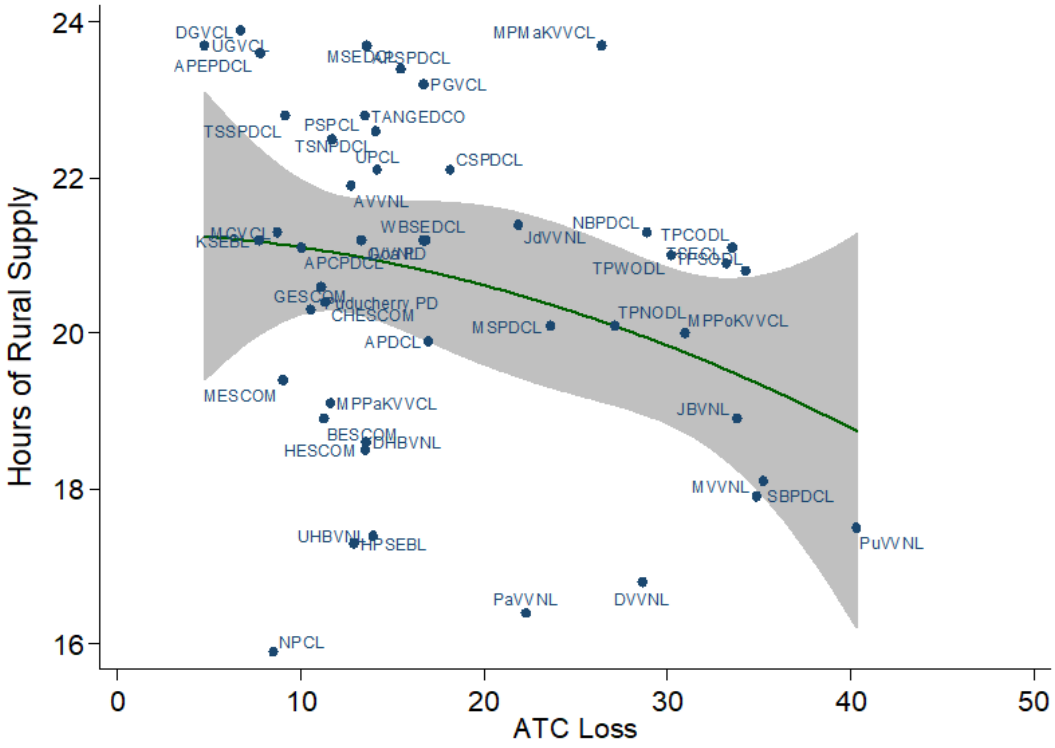
Source: AT&C Losses from the PFC Performance Reports and Disruption Index from REC (CSRD Report, 2020-21).
Note: The Gujarat DISCOM PGVCL was dropped from this graph because of an unusually high interruption index which was skewing the graph.

Figure A5: ATC Loss v/s DT Failure Rate (%)



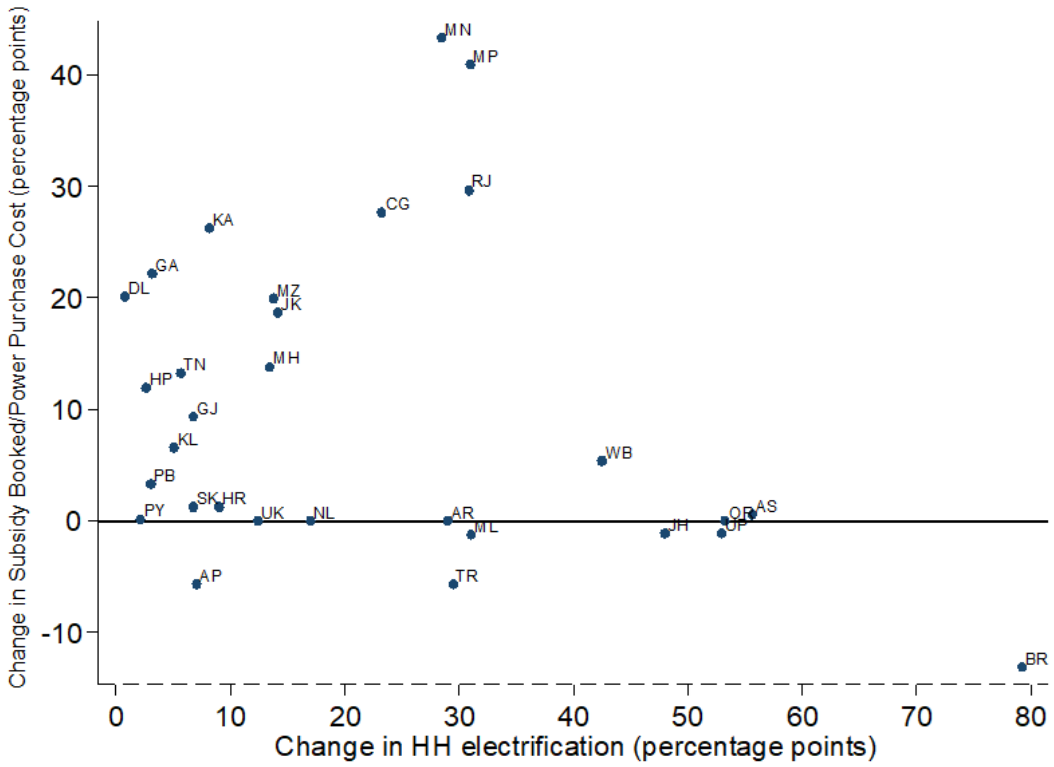
Source: AT&C Losses from the PFC Performance Reports and DT Failure Rate from REC (CSRD Report, 2020-21).

Figure A6: ATC Loss v/s Hours of Rural Supply



Source: AT&C Losses from the PFC Performance Reports and Hours of Rural Supply from REC (CSRD Report, 2020-21).

Figure A7: Change in Household Electrification % v/s Change in Subsidy Booked (% of Power Purchasing Cost) between 2020 and 2011



Note and Source: 2011 CENSUS and NFHS-5 (2021) for household electrification and PFC Performance Reports for Subsidy Booked. Because Telangana was a part of Andhra Pradesh in 2011, for the purpose of this graph we have combined it with Andhra Pradesh in 2020 and the electrification % is an average of the two states.

Table A1: Revenue Breakdown for States with high Agricultural Electricity Consumption (2020-21)

State	Punjab	Rajasthan	Maharashtra	Karnataka	Haryana
Gross Energy Sold (MU) (A)	49,729	66,464	1,05,484	54,783	43,165
Domestic	15,322	13,399	21,413	13,871	11,974
Agricultural	13,049	28,506	33,913	21,091	10,006
Commercial	3,282	3,855	4,831	4,974	4,006
Industrial	16,425	13,339	38,090	8,382	12,665
Others	1,651	7,364	7,236	6,464	4,515
Total Expenses (B)	32,837	58,071	87,023	46,273	28,038
Total Revenue (incl. subsidy & UDAY) (C)	32,885	52,076	83,989	41,100	28,675
Operational Revenue	20,714	34,836	67,077	28,143	22,208
Subsidy Received (D)	9,657	12,767	8,185	11,148	5,566
Regulatory Income	-	-	2,909	246	0
Other Income & Revenue Grants	2,514	4,473	4,826	1,563	901
UDAY Grant	0	0	992	0	0
Agricultural Subsidy (0.9*D)	8,691	11,490	7,367	10,033	5,009
Domestic Subsidy (0.1*D)	966	1,277	819	1,115	557
Net Revenue (C - B)	48	-5,995	-3,034	-5,173	637
Revenue (w/o subsidies & grants) (E)	20,714	34,836	69,986	28,389	22,208
Net Revenue (w/o subsidies & grants) (E - B)	-12,123	-23,235	-17,037	-17,884	-5,830

Note: Calculated using PFC Report on Performance of Power Utilities (over multiple years). PFC in their analysis assumes that 90% of the subsidies are agricultural and 10% of the subsidies are for households. The breakdown of state subsidies here follows the same assumption. Capital expenditures are included as part of total expenses. Revenue & Expenses in Rs Crore, Energy in MU.

Table A2: Tabulation of States by UDAY Status

State did not join UDAY	Delhi, Odisha, West Bengal
States that joined UDAY but did not draw funds	Arunachal Pradesh, Gujarat, Jammu & Kashmir, Karnataka, Kerala, Manipur, Mizoram, Nagaland, Puducherry, Sikkim, Tripura
States that joined UDAY and drew funds	Andhra Pradesh, Assam, Bihar, Chattisgarh, Haryana, Himachal Pradesh, Jharkhand, Madhya Pradesh, Maharashtra, Meghalaya, Punjab, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand

Source: UDAY Portal and CAG Audit Reports.