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Working Paper 023

Cheaper, cleaner power: De-risking as an anti-collusion strategy in Bangladesh

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June 2020

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Acronyms and abbreviations

ADB	Asian Development Bank
ATT	Average treatment effect on treated
BIPPA	Bangladesh Independent Power Producers’ Association
BPDB	Bangladesh Power Development Board
IDCOL	Infrastructure Development Company Ltd
HFO	Heavy furnace oil
HSD	High speed diesel
IDA	International Development Association
IFI	International financial institution
IPP	Independent power producer
kWh	Kilowatt hour
MW	Megawatt
PRG	Partial risk guarantee
PSM	Propensity Score Matching

Acknowledgments

This work would not have been possible without the valuable time that many entrepreneurs, bureaucrats and sector specialists gave us. We would also like to thank the World Bank office in Dhaka, the Bangladesh Power Development Board (BPDB), the Bangladesh Electricity Regulatory Commission (BERC), the Bangladesh Independent Power Producers' Association (BIPPA), Dr Sultan Hafeez Rahman and Mr Salahuddin Ahmed for their generous assistance.

Executive summary

Collusive contracting with private power plants in Bangladesh has resulted in high power prices that cost the taxpayer around US$1 billion a year in subsidies, as well as the selection of environmentally damaging fuels and technologies. The overpriced plants are also prioritised in dispatch orders and fuel supplies, perhaps because their high mark-ups allow them to corruptly influence these decisions. A World Bank study of gas-fired plants in 2014 found that expensive plants received more orders than cheaper ones, costing the taxpayer US$1.4 billion through this misallocation alone. Other types of preferential treatment of privileged companies are also reported.

These problems emerged after 2010 as contracts began to be signed in closed-door negotiations between the government and individual investors. However, the suspension of competitive procurement rules and of transparency did not happen on a whim. The private sector delivered two of the lowest-priced power plants in Asia in the early 2000s in competitive tenders, but, later that decade, projects stopped attracting investors. At the heart of the problem was the perception of risk in contexts of weak contract enforcement. Private power investments involve large upfront outlays with costs and profits recovered over long periods. If the rule of law could be quickly improved, that would be a way to reduce risks. But otherwise, intermediate solutions have to be found.

To mitigate risks in high-risk contexts, governments have to provide subsidies to change incentives. The Bangladesh experience shows that risk-mitigation subsidies can have competitive effects, but other subsidies can support collusive outcomes. Competitive risk-mitigation subsidies reduce risks for all potential investors interested in a project. They attract competition and can reduce prices by much more than the value of the subsidy. They should arguably be regarded as public investments with a high social return rather than subsidies. The early projects in Bangladesh benefited from such subsidies, including preferential financing from international financial institutions (IFIs) and access to leased government land. Unfortunately, their significance was not understood. The subsidies were withdrawn and only partially reintroduced later. When they were withdrawn, investments dried up. To resolve a severe power crisis, the government resorted to a collusive risk-mitigation strategy, engaging in closed-door negotiations with single investors to mitigate their risks. This solved the investment problem but at a high cost and with much higher subsidies.

Versions of competitive risk-mitigation subsidies continued in a few projects. We use data from 58 private power plants in Bangladesh from 2008 to 2016 to show that even in an overall collusive environment, the provision of relatively small risk-mitigation subsidies resulted in a 62% reduction in plant-level prices in these projects, adjusting for fuel type, generation capacity and age. Our analysis of risk perceptions and potential competition provides a plausible explanation for this huge price effect.

The evidence and analysis suggest a feasible and effective anti-collusion strategy for the power sector. Given the powerful interests at play, we looked for and identified an instrument that is not opposed by powerful players and yet is effective in changing their behaviour. Our analysis also suggests that a full subsidy withdrawal strategy will not solve collusion and corruption problems in developing-country power sectors. In fact, the collusion problem emerged as a result of an untimely withdrawal of some subsidies.

1. Introduction

Despite much progress over the last decade, power generation and distribution capacities remain low relative to the size of the population across South Asia. This is particularly true in Bangladesh. The latest comparative figures for the region show that Bangladesh had the second lowest electricity consumption per capita and the lowest energy use per capita (which includes other forms of energy) (see Table 1). All of South Asia was also well behind the average for low- and middle-income countries.

Table 1. Energy and power use: South Asia 2014

	Energy use (kg of oil equivalent per capita)	Electric power consumption (kWh per capita)
Bangladesh	229.25	320.20
Nepal	434.45	146.47
Pakistan	460.24	447.50
Sri Lanka	515.51	531.09
India	636.57	804.51
Low & middle-income countries	1,331.73	1,934.07

Source: World Bank World Development Indicators (WDI) 2020.

Increasing the supply of affordable electricity is therefore widely recognised as critical for accelerating and sustaining development in Bangladesh (Planning Commission, 2011). However, like many developing countries, Bangladesh has been more successful in increasing generation capacity and less so in containing costs and maintaining environmental quality. This constrains how effectively generation capacity can be expanded in the future. To expand capacity at low cost and with the best technologies, tenders have to attract the widest range of bidders. The problem in developing countries is that investments in power are often very risky because they require large upfront investments with recovery over long periods. In contexts of weak contract enforcement and political risks, the best bidders can stay away, leaving the field to politically connected companies. This can result in the generation of overpriced power and less clean technologies.

The design of de-risking strategies can be critical for determining the price and quality of power. While well-designed subsidies can, in principle, de-risk investments sufficiently to attract competitive investors, badly designed subsidies can significantly raise the price of power.

A *competitive de-risking strategy* is one that reduces risks for all interested investors to a level where multiple investors start engaging in the market, potentially making competitive bids and lowering prices to an extent that pays for the cost of the de-risking strategy. The result may be an enhanced investment flow, lower prices and the ability to set higher technological and environmental standards. The textbook strategy of competitive de-risking is to improve the governance climate. Yet this may not be immediately feasible as a de-risking strategy in many developing countries because policies supporting these improvements may take years to make a difference. Instead, feasible instruments are more likely to involve appropriately targeted de-risking subsidies. To support a competitive de-risking strategy, subsidies have to be *contestable*. They must be potentially available to all competitors who can imagine improving the terms likely to be offered by the parties who are perceived to be bid leaders.

Collusive risk-mitigating strategies, on the other hand, are where governments reduce the risks of particular investors through close involvement in negotiations. Such investors are likely to be politically connected private companies or public-sector companies from countries with close political relationships with the government. This approach can also raise investments, by offering attractive terms in direct negotiations, but the absence of competition makes it more difficult to contain costs or to specify technologies in line with national interests. The potentially higher mark-ups in these contracts also increase the risk of rent-sharing arrangements with public officials. This approach too is likely to involve subsidies, this time to make power affordable to consumers, but the subsidies are likely to be much higher than with competitive risk-mitigation strategies, with a higher total fiscal cost of providing power in this way.

The Bangladesh experience is useful because we find instances of both types of subsidies. In the late 1990s and early 2000s there were two very competitive private power projects supported by competitive risk-mitigating subsidies. These subsidies were later withdrawn and were only available sporadically in a few projects. Facing a severe power crisis, the Government of Bangladesh passed the *Speedy Supply of Power and Energy Act* in 2010 to enable power and energy projects to be implemented without competitive tendering. The new risk-mitigation strategy that emerged was based on the close involvement of government in the selection of investors and closed-door negotiations with them. This collusive risk-mitigation strategy was very successful in raising capacity but at a high cost, and with much higher subsidies.

Interestingly, as the earlier forms of subsidies continued now and then in a few projects, we are able to compare the effects of subsidy design on pricing. Not only were the average prices in projects without competitive risk-mitigation strategies much higher, there was a significant increase in the use of dirtier fuels like diesel and furnace oil. But even with these fuels, prices were lower in the presence of competitive risk-mitigating subsidies. To reduce the over-pricing and the likely corruption and collusion that follow to share these rents, we need to identify feasible de-risking strategies that reduce mark-ups and prices by bringing in a broader spectrum of bidders.

The welfare-enhancing role of risk-mitigating subsidies has been recognised for green investments in power (Waissbein et al., 2013; Newbery, 2014; Sweerts et al., 2019). However, we argue that de-risking subsidies have a more general applicability in enhancing the quality of power-sector investments in developing countries – they should be an important component of competition-supporting strategies to limit collusive pricing and to promote environmentally superior technologies. But we also argue that while some forms of subsidy can reduce investor risk, other forms of subsidy may *increase* risks and may be associated with collusive risk-mitigation strategies. Therefore, the policy concern is to understand how subsidy design can improve power-sector outcomes by lowering the overall cost of power and the propensity for corruption.

Using propensity score matching (PSM), we estimate the average treatment effects on the treated (ATT) where treatments are different combinations of direct subsidies (access to leased land, access to lower-cost financing, or both) and outcomes are plant-level sale prices per kilowatt hour (kWh). This method allows us to control for relevant variables that can affect plant-level prices including the plant's age, generation capacity and fuel type (gas, heavy furnace oil, diesel or high-speed diesel). It allows us to test our risk-adjusted pricing model, which predicts a discontinuous jump in pricing when the withdrawal of direct subsidies raises risks above a critical limit. We test this with data from the Bangladesh Power Development Board (BPDB) for 58 private plants from 2008–2016, which gives us the prices at which each plant sold power over this period, the quantities sold, and the technical characteristics of each plant as fuel type, capacity and age. We also have data from the Bangladesh Independent Power Producers' Association (BIPPA), the World Bank, and power-sector consultants on different types of direct subsidies received by each plant. The two main direct subsidies of interest are the provision of partial funding from international financial institutions (IFIs) at concessionary rates or partial risk guarantees from IFIs, and the provision of leases on government land for the project. The significance of a third direct subsidy, the fuel subsidy, cannot be tested because there is no variation in application across plants.

The evidence shows that relatively limited risk-mitigation support through these direct subsidies reduced plant-level power prices by 62.1%. The evidence and our analysis of competitive risk-mitigation suggests a feasible anti-collusion and anti-corruption strategy in the power sector based on small risk-mitigation subsidies. The optimal level of these subsidies will depend on country- and time-specific risks and how the existing system of price-setting operates. The relevant point for policy is that direct subsidies are an effective tool for reducing power prices by attracting multiple bidders or creating a context of potential entry. If policy can reduce risk sufficiently, even a single or small number of bidders have to offer competitive prices because of potential entry. The level or type of direct subsidies that will have this effect going forward need not be the same as before and is likely to be different in other countries. The optimal level can nevertheless be discovered by incrementally increasing the value of contestable direct subsidies to the point where multiple bidders begin to appear, particularly unconnected bidders, and plant-level power prices fall as a result.

Section 2 of this paper provides further context on the power sector in Bangladesh, highlighting relevant features and describing the transformation that happened around 2010 following introduction of the *Speedy Supply of Power and Energy Act* (henceforth the *Speedy Power Act*). Section 3 sets out our theoretical model of the effect of different combinations of subsidies on power pricing and section 4 presents the estimation results. Section 5 summarises the policy implications of our analysis.

2. Power generation in Bangladesh

2.1. Managing risk for private investors: Bangladesh's subsidy system

Bangladesh was an early adopter of private investments in the power sector in the 1990s and it was understood then that private investors would view this market as risky. They would have to contract to supply power and collect payments over the lifetime of a plant, which could be fifteen to twenty years or longer. These contracts would be complex, specifying the quantity of power each plant had to be ready to deliver, the minimum quantities and capacity charges the power purchaser (the BPDB) committed to, the penalties each side had to pay if contract commitments were violated, and so on. The interpretation and enforcement of these complex agreements in a developing-country context where contract enforcement is generally weak exposes investors to risks. The provision of direct subsidies in the form of leased land and financing at preferential rates aimed to reduce the direct cost of generation and therefore the subsequent risks faced by investors.

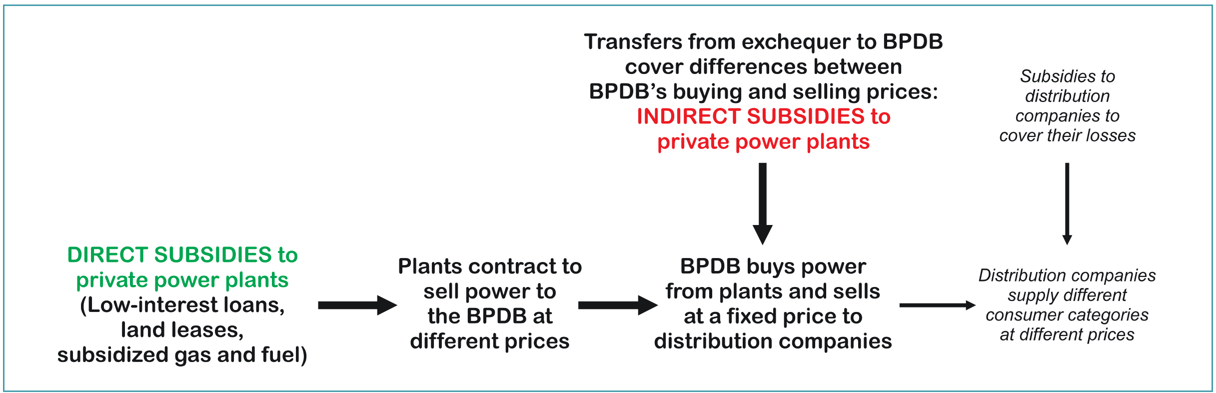
In the first two projects, lower-cost financing came directly from IFIs and from a local non-bank financier, the Infrastructure Development Company Ltd (IDCOL), which was in turn financed by IFIs including the World Bank and the Asian Development Bank (ADB). There were also partial risk guarantees from IFIs, which further reduced the cost of capital. Foreign currency loans from IFIs were a few percentage points cheaper than any alternative sources of funding, and this constituted the subsidy element.

Appendix A describes the financing structure of the two pathbreaking projects at Meghnaghat and Haripur that set some of the lowest power prices in Asia. The projects also had land lease arrangements that freed investors from significant transaction costs in acquiring land. However, savings from both types of support directly contributed at best a few percentage points to the unit cost of power. The effect of financing as much as 60% of the project cost at an interest rate 5% lower than the market alternative for a US$340 million power plant was estimated to reduce the price per kWh by only around 15% (Asian Tiger Capital Partners, 2010). Even the two pioneer projects that received direct IFI financing did not benefit from lower interest rates to this extent.

In later projects with IFI support, the interest rate subsidy was generally much lower and covered a smaller percentage of the project cost. Across projects, financing cost and land lease subsidies can plausibly explain a lower generation cost per unit of electricity of at best 5% to 10% in the plants that got them. Therefore, the much greater reduction in actual plant-level prices that we observe in projects that received these two forms of support has to be explained by factors such as their effect on risk-reduction that helped induce competitive pricing behaviour.

Figure 1 shows how different types of subsidies support private power producers in Bangladesh. Each plant sells power to the BPDB, the public power purchaser, at prices determined at the contracting phase. The BPDB then sells the power on to distribution companies at a fixed policy-determined price, which can be lower than the price paid to many plants. The prices that plants are paid are therefore supported by a mix of what we describe as direct and indirect subsidies.

Figure 1. Direct and indirect subsidies to private power plants



Source: The authors.

Direct subsidies go to power plants. They are set at the time of bidding and, once a winning bidder secures these subsidies, they cannot be easily changed or withdrawn. They include low-interest loans, usually arranged with the involvement of IFIs, and/or partial risk guarantees (PRGs) from them. Both reduce the cost of capital. These are some of the most secure forms of direct subsidy as governments cannot easily renegotiate them later.

Direct subsidies may also include leases on government land that save the investor the transaction costs of acquiring, establishing and protecting land titles. Future rental rates are not entirely watertight as governments may try to change them regardless of contracts, but the major component of the subsidy is the savings in transaction costs, which are gained at the very outset. Finally, direct subsidies include access to subsidised gas and fuel. Fuel for plants is provided by the government at below-market prices, and power purchase contracts in Bangladesh have a pass-through clause so changes in fuel prices do not affect plants. As a result, this direct subsidy is also fairly secure. All private plants using the same fuel get the same subsidy and have similar pass-through contracts, so there is no variation in access to this direct subsidy across plants.

The characteristic of direct subsidies is that they are potentially available to all investors in a particular project if they have the same qualifications. Even if a single investor negotiates these subsidies, they are potentially contestable, since competitors with similar qualifications cannot, in principle, be denied the same package. Direct subsidies attract investors because they lower their risks by reducing the portion of their costs of generation that they have to recover from the BPDB through sales. Variants of direct subsidies can therefore serve as competitive risk-mitigation instruments.

Indirect subsidies, in contrast, are very different. After plants sell their power to a public aggregator like the BPDB, the latter sells on to distribution companies at its policy-determined price. If some plant-level prices are higher than the BPDB's selling price, losses on these transactions have to be recovered in the form of transfers to the BPDB from the exchequer. We describe these as indirect subsidies to the relevant plants. Direct and indirect subsidies imply very different risks. Direct subsidies entail low risks because, once granted, their flow is not easily influenced by governments. In contrast, indirect subsidies have higher risks because they have to be periodically released by government to the BPDB before plants get them. Plants without political connections may perceive even higher risks as they are likely to be placed lower down the queue for payments if the BPDB has deficits financed by transfers from the exchequer. If payments to a plant become too dependent on indirect subsidies, unconnected investors may exit entirely. Connected companies can then further increase prices, with additional increases in indirect subsidies. High levels of indirect subsidies may therefore be indicative of collusive risk-mitigation strategies.

Figure 1 shows there are further subsidies downstream, but these do not affect the determination of plant-level prices and technologies. The downstream subsidies are shown in italics and are triggered after the BPDB sells to distribution companies. Distribution companies supply different types of consumers (domestic, small industry, agricultural, commercial and so on) at different policy-determined prices. There are implicit cross-subsidies at this stage across consumers as well as further transfers from the exchequer to cover distribution and collection losses. These have come down significantly over the last decade and are lower than in comparable South Asian countries (Pargal, 2017). As these small distribution-stage subsidies do not affect plant-level selling prices, we do not look at them further in this paper (Mujeri et al., 2013).

Zhang (2019) argues that removing all subsidies in the power sector in Bangladesh will improve welfare because electricity is being supplied to consumers whose willingness to pay is lower than the generation cost of electricity. There are two main problems with such an argument. The first is that given the already low electricity usage and the low purchasing power of most consumers in Bangladesh, the willingness to pay may seriously underestimate the marginal social benefit of power. The second and much more serious problem is that the generation cost of power is not independent of public risk-mitigation strategies and the efficacy of subsidies that address the market failures that result in high plant-level prices. The price of power depends on risk-perceptions of investors that in turn determine their mark-ups. In a poor country where the effective demand for electricity is income and price constrained, and where contracts are already risky, removing all subsidies may significantly increase investor risks by reducing demand. That, in turn, may result in a vicious cycle of increased mark-ups and higher prices, further demand contractions, and even worse risk perceptions. The withdrawal of *all* subsidies is therefore unlikely to be either politically feasible or economically effective in lower-income countries.

On the contrary, the Bangladesh evidence suggests that direct subsidies provided through IFI support and leased project land reduced risks for investors and generated reductions in power prices much greater than the value of the subsidies. Their removal triggered the emergence of much higher prices as a result of closed-door contracting and associated collusion. We have no reason to believe that policymakers *intended* the exit of unconnected bidders in the late 2000s by withdrawing direct subsidies. Rather, the subsidies that were withdrawn were not perceived to be particularly important at the time. But unconnected investors largely exited the market, nonetheless. Furthermore, with only connected bidders competing for tenders, their internal lobbying delayed and blocked the allocation of any contracts, a problem that eventually led to the *Speedy Power Act*.

Direct and indirect subsidies are not substitutable because of their very different effects on risk perceptions. A reduction in direct subsidies raises risks for power producers and they are likely to raise their mark-ups, resulting in a price increase greater than the reduction in the direct subsidy. If the distribution price is to be maintained, indirect subsidies have to increase by more than the cut in direct subsidies to absorb the higher mark-ups. If the increase in risk results in politically unconnected companies exiting the market, even greater price increases are likely to follow. This logic holds even if the BPDB's distribution price is cost-reflective (equal to the average of plant-level prices). Cost recovery by plants may still require transfers to the BPDB from government, for instance if prices are so high that some consumers fail to pay for power, or their consumption falls which forces the BPDB to pay for unpurchased power in line with purchase agreements. If the potential dependence of plants on indirect subsidies rises, risk premia can again rise and eventually unconnected investors may depart, inducing further price increases. Thus, the real question is not whether to have cost-reflective pricing or not, but rather how to design competitive risk-mitigation strategies that contain plant-level prices.

2.2. The Speedy Power Act and the cost of collusive risk mitigation

In the late 1990s and early 2000s, the first two private power projects in Bangladesh achieved some of the lowest independent power producer (IPP) prices in South Asia (Pargal, 2017). Unfortunately, the role played by competitive risk-mitigating subsidies in supporting this pricing was not fully understood. The subsidies were entirely withdrawn for some time and not systematically available thereafter. By the late 2000s, investor interest dried up, resulting in a severe power crisis. The only interest came from politically connected companies; and lobbying by competing groups blocked or delayed contracts. In the face of this crisis, the government passed the *Speedy Supply of Power and Energy Act* in 2010, which enabled power and energy projects to be implemented without competitive tendering. This collusive risk-mitigation strategy rapidly raised capacity but at a high cost and with much higher indirect subsidies. The higher prices and mark-ups also created huge rents that influenced subsequent decisions and resulted in additional distortions.

For instance, higher-priced power plants were systematically allocated subsidised fuel in preference to cheaper plants whenever there were shortages. They also received priority in dispatch orders for delivery to the grid, selling more power than cheaper plants. A World Bank study of gas-fired plants from 2010 to 2015 found that, adjusted by age and capacity, every 1% increase in a plant's fuel efficiency (the ratio of its power output to gas input) resulted in a 1.2% decrease in its probability of getting gas (Zhang, 2019). Another World Bank study using hourly data for dispatch orders in 2014 found that higher-cost plants were systematically prioritised in getting orders (Nikolakakis et al., 2017). Merit order dispatching requires ordering from the cheapest plants first, then sequentially from more expensive ones, with the most expensive supplying peak loads. The authors estimate that keeping the supply of gas fixed and dispatching by merit order would have saved the government US$1.4 billion or 63% of the payment to gas-fired plants (ibid.).

These systematic anomalies strongly indicate collusive rent-sharing agreements. The US$1.4 billion estimate of unnecessary overpayments for gas-based power is just part of the annual cost of collusion in the sector because it only covers gas-powered plants; and there were other types of anomalies as well. For instance, contracts with high-cost rental power plants often stipulated that if they were not given orders for power, they would still be paid for 60% of the power they could have produced. This created incentives for arranging more than occasional non-production. These attractive terms were repeatedly renewed for some companies while others like the British company Aggreko had their contracts renewed with ‘no power, no payment’ clauses, showing that, here too, some plants were treated differently from others (Byron and Rahman, 2014). Public-sector plants that could supply cheaper power also appeared to remain out of commission for unusually long periods, requiring base loads to be supplied by expensive private plants (Pargal, 2017). As the BPDB’s distribution price could not be increased in line with these plant-level price increases, the result was a massive increase in indirect subsidies. These currently amount to annual transfers of around a billion dollars from the government to the BPDB, limiting the sustainability of this expansion path.

The *Speedy Power Act* did have some justification as an emergency response and was intended to last for no more than two years. However, moving back to open tendering required a strategy to bring back unconnected investors. That did not happen. The Act was extended for a further two years until 2014, again for another four years to 2018, and is currently being extended again until 2021. The legislation makes it illegal to subject decisions under this Act to any legal challenge. The underlying problems were therefore not addressed, and indeed the rents that emerged created interests within government, bureaucracy and investors to prolong these arrangements, exactly as rent-seeking theory would predict.

2.3. Energy supply, transmission and distribution constraints

The expansion of power generation can be constrained by shortages in upstream energy supply and downstream transmission and distribution problems. Both were important in Bangladesh as additional compounding factors.

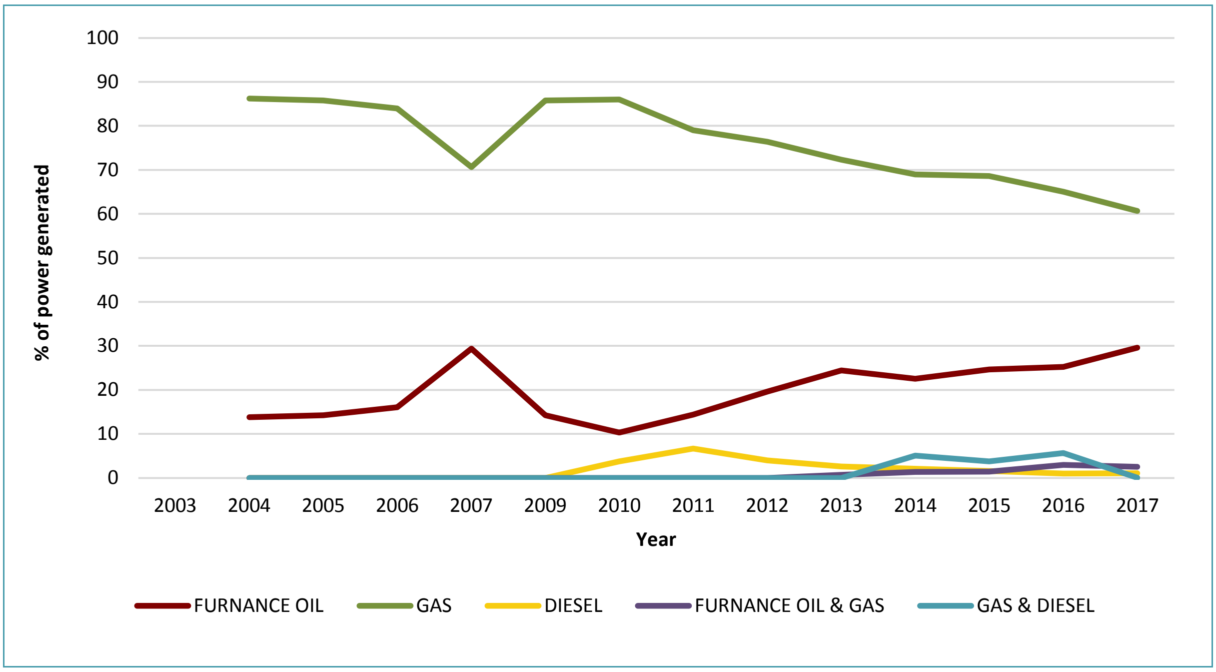
Early power generation was almost entirely based on gas, but by the late 2000s it was clear the government had not invested enough in new exploration or in infrastructure to import gas. A new energy policy emerged in the Power System Master Plan of 2010, which proposed a shift towards coal. The Plan envisaged a dramatic reduction in the share of gas from 89% to 25% between 2010 and 2030 and an increase in the share of coal from less than 4% to 50% (Power Division et al., 2011). Work on a number of large public-sector coal-fired projects began in Rampal, Matarbari and Payra, despite considerable social opposition on environmental grounds. All of them involved government-to-government agreements with a number of countries including India, Japan and China, although none of the projects were operational by 2020.

The long-term feasibility of coal is also questionable in Bangladesh given the huge investments and large land areas that are required for the transportation and storage infrastructure and for the disposal of ash (Pargal, 2017). If the long-run cost of coal-based power turns out to be higher than gas, which is very possible, the huge investments in this infrastructure may turn out to be an expensive mistake (Ichord, 2020). The decision to invest US$11.38 billion in a 2,400 megawatt (MW) nuclear plant at Ruppur with Russian and Indian collaboration is even more questionable. Even this huge investment is set to escalate significantly. Maintaining nuclear safety is also a challenge in a potential earthquake zone and with Bangladesh's weak governance.

The government's strategy of developing infrastructure for the import of liquefied natural gas (LNG), which can feed gas into existing pipelines, is a more comprehensible strategy provided LNG prices remain competitive. In the longer run, offering attractive terms for gas exploration onshore and in the Bay of Bengal is necessary to tap into the most promising source of cheap energy. Gas and renewables are environmentally superior alternatives to furnace oil and diesel, while coal imposes large costs on the lived environment in a land-scarce country. Land scarcity also means that solar photovoltaic (PV) panels have a high opportunity cost. Moreover, the variability of sunlight means that solar power will require large conventional spinning reserves to make it viable, and this makes the economics of solar unattractive at the moment (Nikolakakis et al., 2017). While energy policy questions are being settled, attracting the best investments in gas-based generation is likely to be the most effective strategy for cheaper, cleaner power in the medium term (Ichord, 2020).

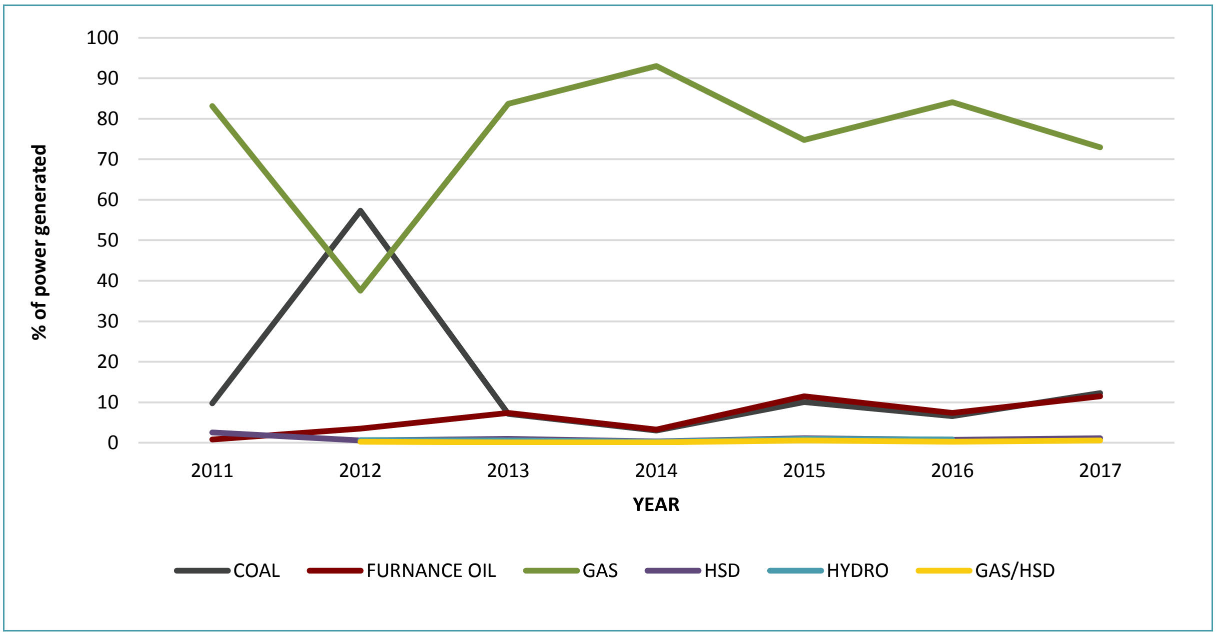
The new risk mitigation strategy that emerged after 2010 had two separate damaging effects. The emergency installation of a few furnace oil and diesel plants to respond to an acute crisis became a sustained strategy of repeatedly renewing expensive contracts. Secondly, unit prices rose across all fuel types when competitive risk-mitigation subsidies were missing. Figure 2 shows the effects on fuel mix in the private sector after 2010.

Figure 2. Fuels used in private-sector plants



Source: BPDB

Figure 3. Fuels used in public-sector plants



Note: HSD = High speed diesel
Source: BPDB

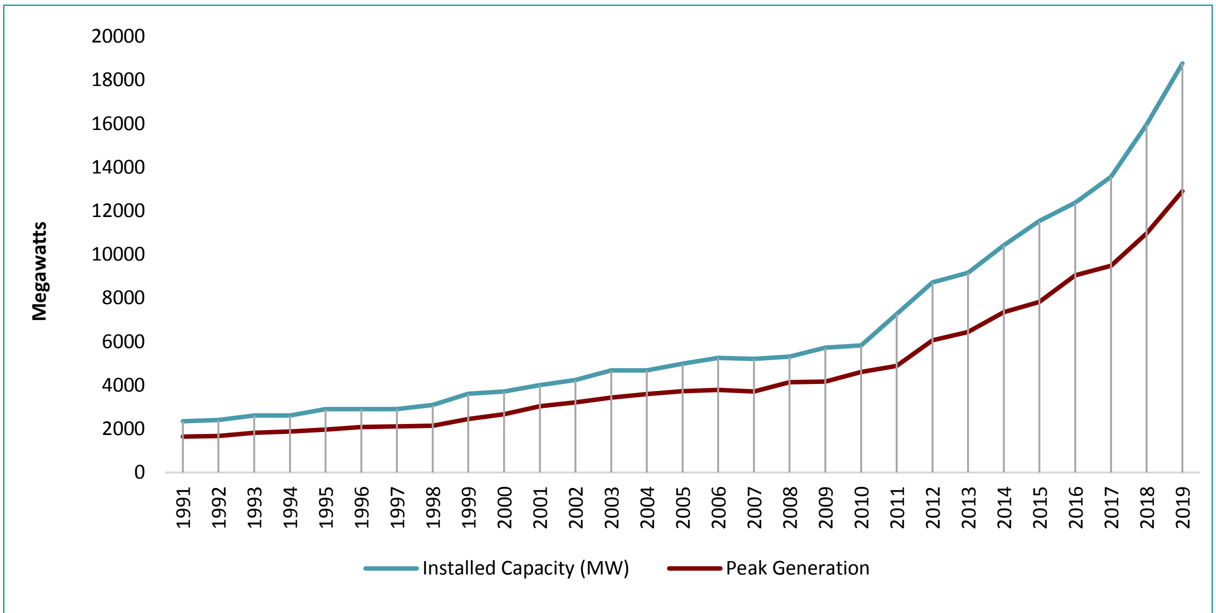
In the public sector gas continued to be important after 2010 (Figure 3), but in the longer term, there may be significant adverse effects on the public-sector fuel mix. As private investments in cheaper gas-based projects declined, the government turned to government-to-government collaborations to implement large coal-fired and nuclear power plants. These may have even more damaging long-term consequences because they are more costly to reverse than the investments in furnace oil and diesel.

Transmission and distribution systems have also been constraints in Bangladesh. Transmission capacity has often lagged generation, holding back distribution. There were also leakages in transmission and distribution, but these were gradually reduced. From 2002 to 2016, distribution losses were reduced from 24% to less than 11% and transmission losses from 4% to 2.6% (Pargal, 2017). While both transmission and distribution contributed to the power crisis of the late 2000s, the problem was primarily a failure to attract bidders in competitive IPP project tenders. The subsequent increase in generation capacity overcame the crisis, but at a high cost. If these costs could be reduced, the savings would make other reforms easier. Over time, of course, improvements in power supplies require addressing the interdependent problems of energy supplies, power generation, transmission and distribution.

2.4. The expansion of generation capacity

Figure 4 shows the development of installed and peak generation capacity in Bangladesh from 1991 to 2019, and the acceleration of installed capacity after 2010. Peak generation accelerated at a slower pace. No doubt the adverse influences affecting dispatch orders, fuel supplies and other anomalies help explain why generation grew more slowly than capacity. The flatlining of generation capacity from 2004 to 2008, coinciding with a period of rapid economic growth, was at the heart of the power crisis. The frequent power cuts and shortages over this period contributed to a political crisis that brought in an emergency caretaker government from 2007 to 2009. The caretaker government introduced short-term 'rental' power contracts as an emergency measure, structured to enable investors recover their investments in small power projects in two to five years. They involved the installation of smaller plants with enhanced capacity charges paid as rents. This proved insufficient to address the problem. The new government elected in 2009 went further by abandoning competitive tendering across the entire power and energy sector in the *Speedy Power Act*, discussed earlier.

Figure 4. Total installed and generation capacity, Bangladesh, 1991–2019



Source: BPDB Annual Reports

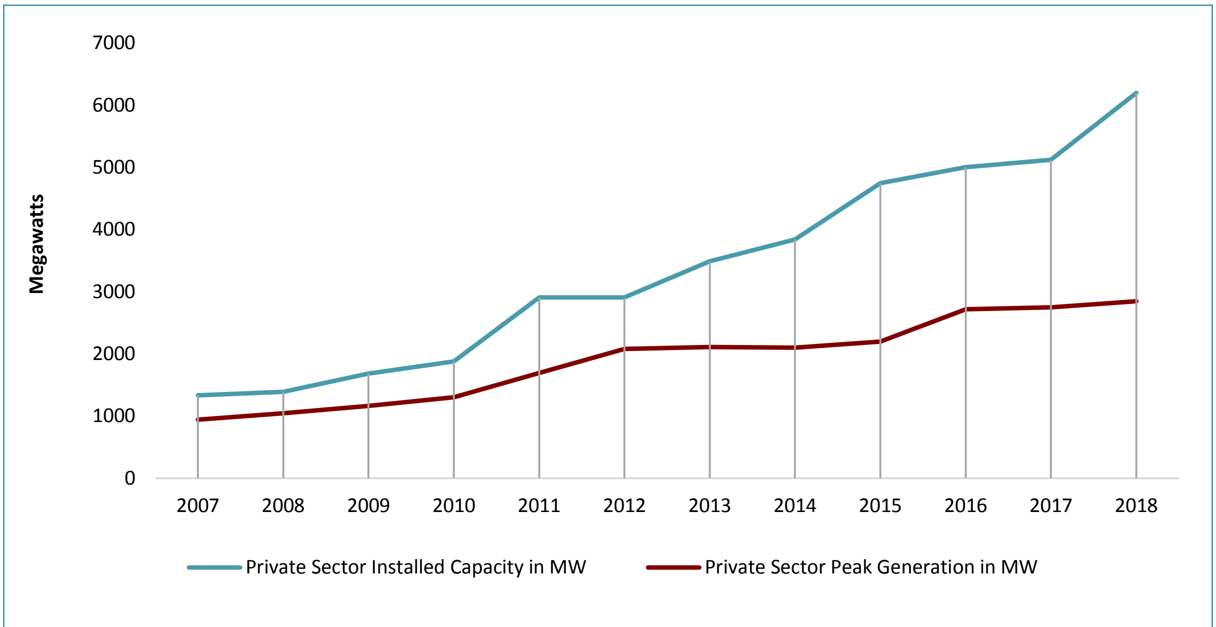
Table 2 shows the rapid growth in the number of private power plants after 2010. Initially these were rental and Small IPP (SIPP) projects. Larger IPP projects began to come on stream from 2014. Figure 5 shows the growth in capacity and generation in private plants and Figure 6 in public plants. Both sectors came under the *Speedy Power Act,* but the acceleration was greater for the private sector with installed capacity growing from 33.6% of the total in 2010 to 41.2% in 2018.

Table 2. Number of power plants (private and public sector)

Year	PRIVATE		PUBLIC
	IPP	Rental & SIPP	
2004	6	0	18
2005	8	0	19
2006	8	0	19
2007	8	0	19
2008	6	2	19
2009	6	10	19
2010	6	17	19
2011	6	33	19
2012	6	38	31
2013	6	38	35
2014	11	35	36
2015	16	37	40
2016	18	39	40
2017	22	36	42
2018	34	36	52

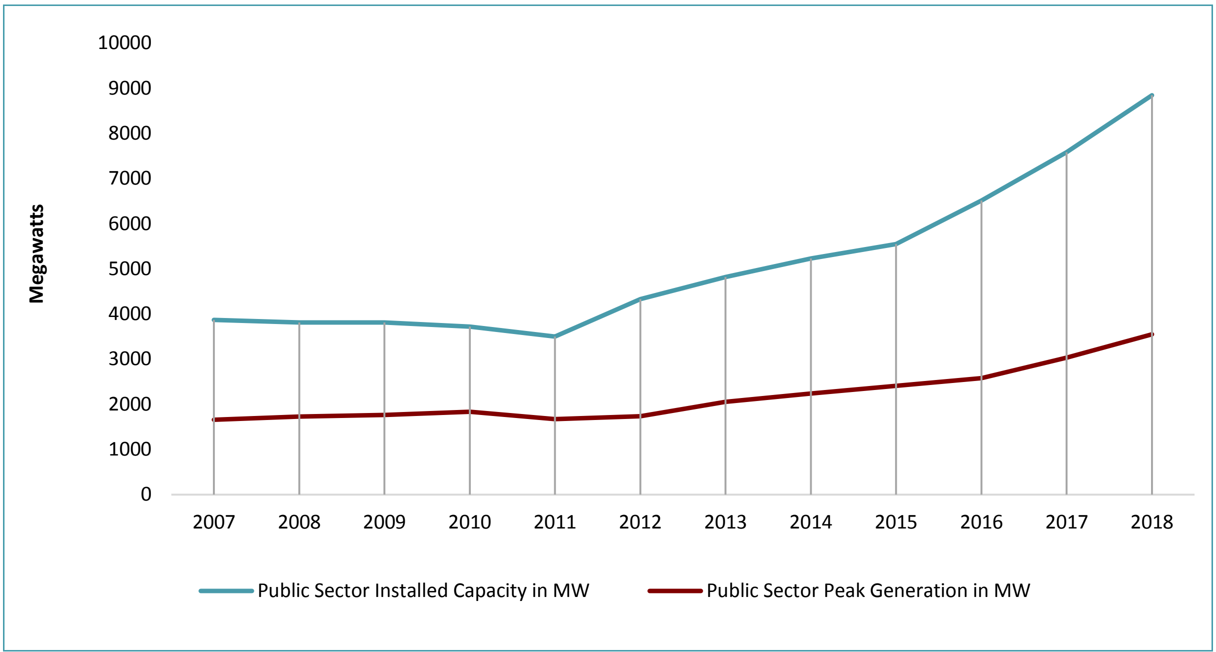
Note: Rental power projects have somewhat different contractual terms than IPPs and SIPPs based on rental payments that are equivalent to a higher capacity charge.
Source: BPDB Annual Reports

Figure 5. Private-sector installed and generation capacity, 2007–2018



Source: BPDB Annual Reports

Figure 6. Public-sector installed and generation capacity, 2007–2018



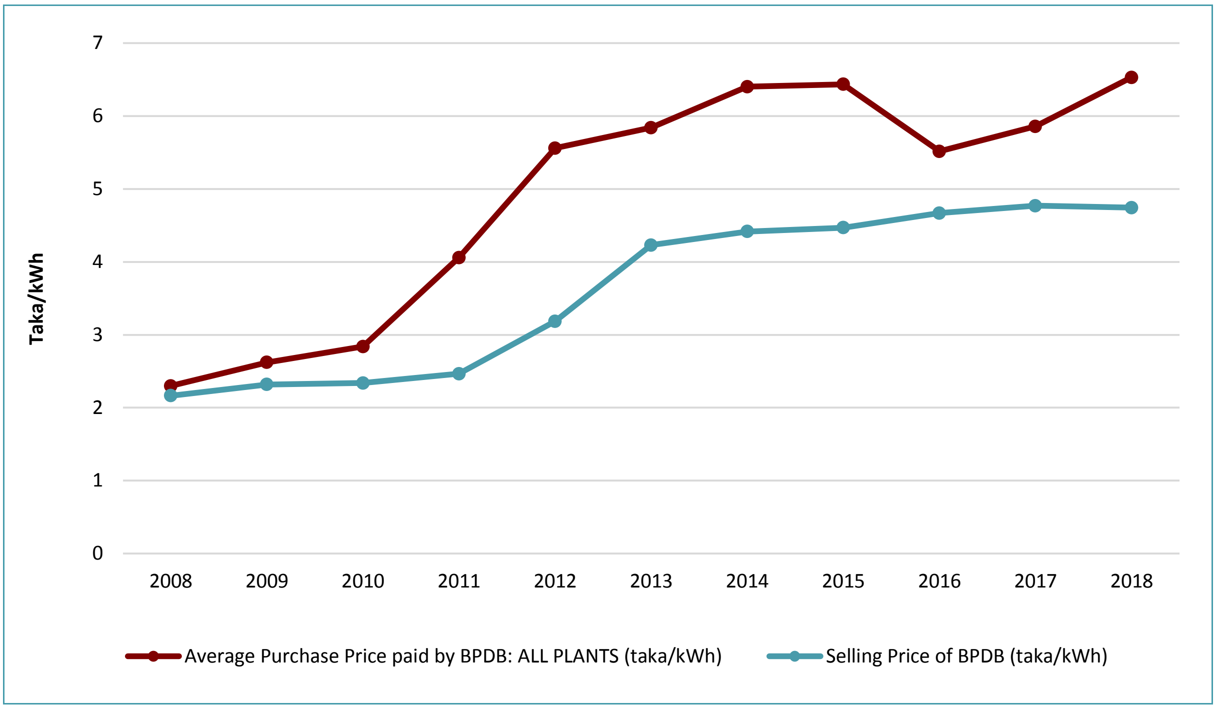
Source: BPDB Annual Reports

2.5. Pricing and indirect subsidies

Figures 7, 8 and 9 show how plant-level prices rapidly escalated after 2010, particularly in the private sector. The average selling price for each plant in Bangladeshi takas per kWh can be calculated from the plant-wise power purchase and payments data in the BPDB's annual reports. The BPDB's own selling price to distribution companies also increased after 2011 but could not be raised as fast as the prices charged by private power plants. The growing gap between the BPDB's buying and selling prices resulted in a growing operating deficit that was covered by transfers from the exchequer, providing indirect subsidies to expensive plants.

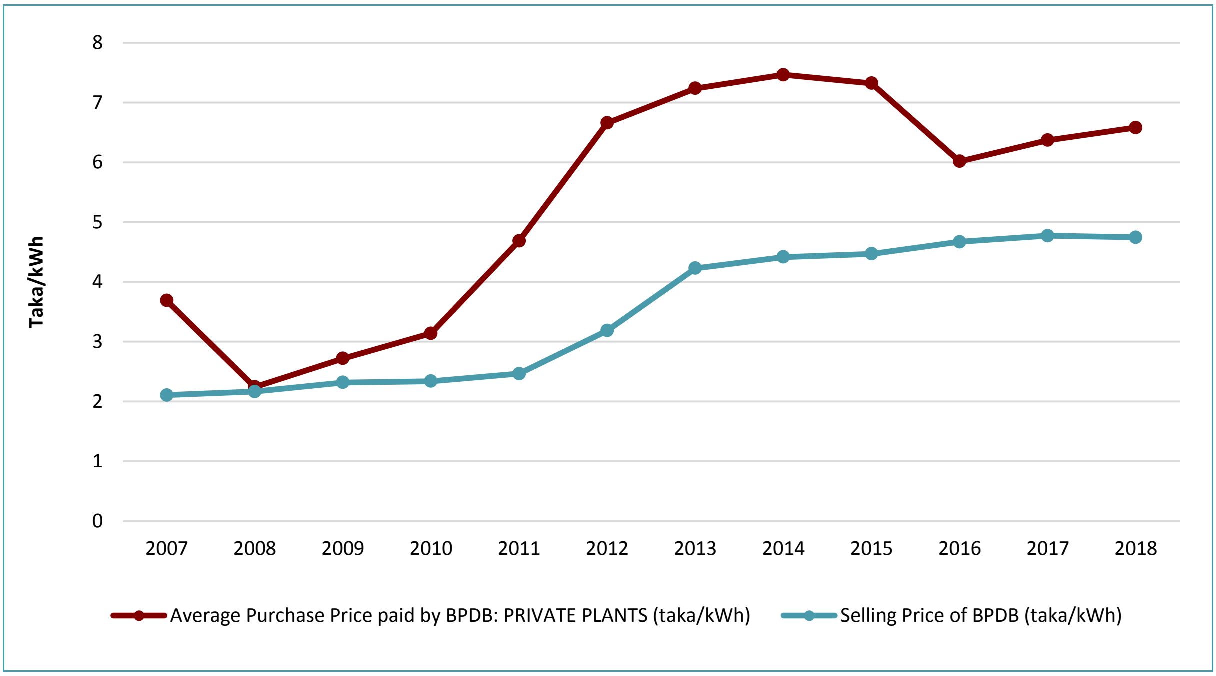
Almost all of the huge growth in the deficit of the BPDB was due to the escalation of prices paid to private-sector plants. The prices paid to public plants closely tracked the selling prices of the BPDB, but the slower growth in public-sector prices does not necessarily mean these plants were more efficient. When private plants are inefficient or capture unwarranted profits, this is usually reflected in higher selling prices. In contrast, in public plants, these can show up in higher prices but can also be hidden in operating losses financed by loans or transfers from the exchequer or other subsidies. To assess if private plants were truly less efficient, adjusted for fuel type and generation capacity, we would need to access data on all other forms of subsidies and loss financing available to public plants. These data are not readily available, however.

Figure 7. BPDB buying and selling prices averaged across all plants



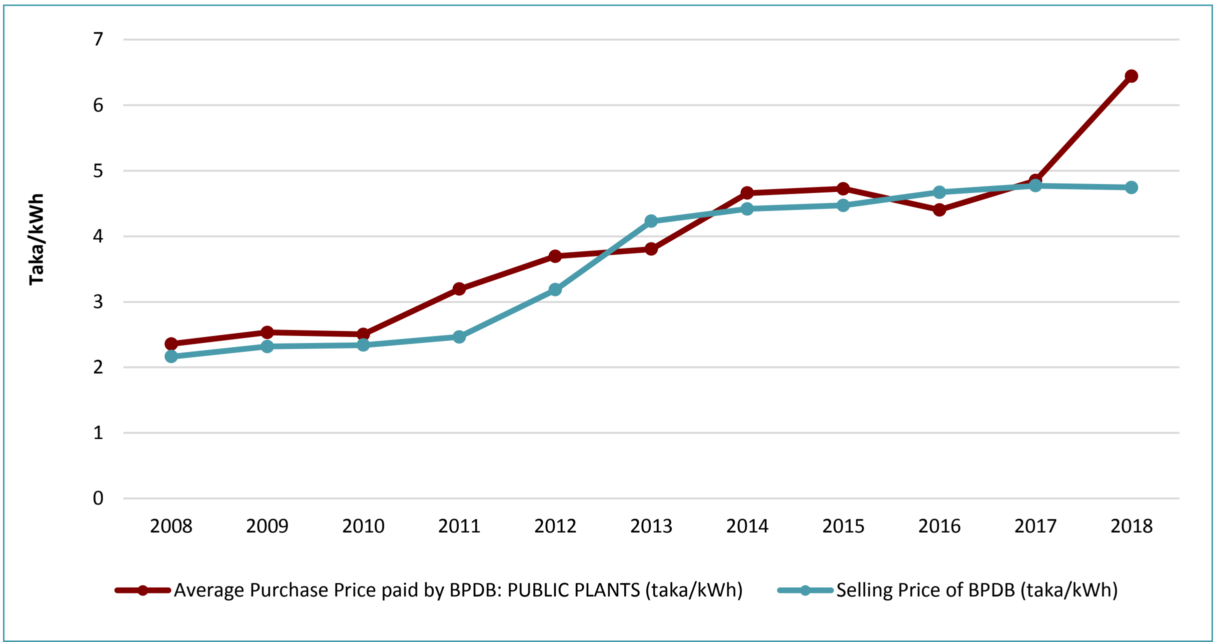
Source: BPDB

Figure 8. BPDB buying and selling prices for private-sector plants



Source: BPDB

Figure 9. BPDB buying and selling prices for public-sector plants



Source: BPDB

The growing operating deficits of the BPDB, covered by transfers from the exchequer, are shown in Table 3, drawing on different sources. According to World Bank sources, the figures from the *Medium-Term Macroeconomic Policy Statements* shown in the first column are the most robust. The BPDB's own estimate of transfers are shown in the second column. They are roughly equal to the cumulative sum of figures in the first column. The last column reports data from the *Seventh Five-Year Plan*. This series is incomplete and not entirely consistent with the first two.

Table 3. Measures of BPDB deficits

Fiscal year	BPDB cash loan and subsidy * (US$ million)	Cumulative budget subsidy to BPDB ** (US$ million)	Power-sector budgetary support *** (US$ million)
2008	87.57	177.08	N/A
2009	145.84	324.42	N/A
2010	143.23	417.94	144.09
2011	542.74	936.29	610.58
2012	778.09	1622.67	734.39
2013	577.49	2271.82	668.81
2014	785.78	3044.74	785.78
2015	1154.24	4218.70	771.21
2016	355.87	4542.91	N/A
2017	483.87	4914.45	N/A
2018	418.16	5156.53	N/A
2019	1088.76	N/A	N/A

Sources and notes: **Medium-Term Macroeconomic Policy Statements, Government of Bangladesh FY2014–FY2016, FY2016–FY2018, and FY2019–FY2021*. The cash loan and subsidy to BPDB covers its transaction losses.

***BPDB Annual Reports*. The cumulative budget subsidy reported by the BPDB is roughly equal to the cumulative total of the first column.

****Seventh Five Year Plan 2016–2020*. These figures appear to be based on backward and forward extrapolations from the 2014 figure.

N/A = not available. All taka figures converted to US$ at mid-year exchange rates. The subsidy escalation in taka is similar in orders of magnitude, and the escalation is not due to currency depreciation.

The data in Table 3 (column one) shows that the annual deficit of the BPDB grew from around US$87 million in 2008 to more than US$1 billion in 2015 and 2019. Both the quantity of power purchased and the deficit per unit of power increased over this period, but most of the growth in the overall deficit was due to the rapid growth in the gap between buying and selling prices from private plants.

In the next section we set out our model to analyse the effect of different combinations of subsidies on power pricing.

3. A rent-seeking analysis: risks, subsidies and collusion

Economic efficiency requires that power is sold at its marginal cost of generation. But with large fixed costs, as is typical in power generation, marginal costs may be lower than average costs, and plants may make losses with marginal cost pricing. Power pricing is therefore typically based on a fixed capacity charge and a variable component corresponding to marginal costs. It does not matter for efficiency whether the capacity charge is passed on to consumers as a standing charge or paid from general taxation (Ramsey, 1927; Hotelling, 1938, 1939; Rhys, 2018). Prices may additionally be adjusted to account for market failures.

The social costs of environmental damage may justify the use of taxes to further adjust the price of power upwards. However, in developing countries prices are likely to already be too high because of other market failures. These may justify price adjustments in the opposite direction. In particular, private investors face significant risks in contexts of weak contract enforcement. If this results in high-risk premia and the marking up of prices of power, the demand for power can shrink with negative consequences for development and welfare. In this case, subsidies to de-risk private investments may be justified to improve welfare. Welfare-enhancing pricing may therefore involve standing charges, different prices for different types of consumers, for different times of usage, and may be further adjusted by taxes, subsidies or cross-subsidisation (Friedman, 2009; Pikk and Viiding, 2013; Borenstein and Bushnell, 2018).

Contracts with power plants usually describe prices as a combination of a fixed charge, a variable charge and supplemental charges. The fixed charge is often described as a capacity purchase charge, the variable or marginal charge as an energy purchase charge, and supplemental charges are specified for additional costs like numbers of start-ups per month (Jones et al., 2008). Given the contracted quantity of power that the plant has to supply, this gives a more or less narrow range of fluctuation for the average price *P* per unit of power from that plant. We are interested in this average purchase price, but we break it down in a different way to focus on the effects of risk perceptions on mark-ups. Our understanding of the significance of risk perceptions draws on earlier research on the power sector in Bangladesh as part of a World Bank mission over 2010–2011, when the importance of risk became clear to us in extensive conversations with stakeholders (Khan et al., 2012).

Equation (1) shows our breakdown of the average price P at which each power plant sells a unit of power to the power purchaser. Plant characteristics relevant for pricing are shown by subscripts T and K, where T stands for technology and K for political connections. The technical characteristics of a plant refer to its fuel specification (gas, furnace oil, diesel etc.), its rated capacity (in MW), its age (as a proxy for the vintage of its technology and any time-specific factors affecting prices). The political connections of the plant, shown by subscript K, takes two values, $K=u$ if the plant is unconnected and $K=c$ if connected. Connected owners have close relationships with bureaucrats and politicians who are sufficiently powerful to sort out delays in payments or other contracting issues affecting them. Plant owners who do not have such relationships are unconnected even if otherwise powerful.

$$P_{TK} = C_{TK} + M_{TK} - DS_T \tag{1}$$

The price, P_{TK}, of each plant is divided into three components: C_{TK}, the average generation cost for the plant, including both fixed and variable costs; M_{TK}, the mark-up per unit of power; and DS_T, the direct subsidy per unit of power to the plant.

The power purchaser buys power at plant-specific prices P_{TK}, but sells to distribution companies at a market or policy-determined price $\bar{P}$, which may be lower than P_{TK} for particular plants. When it is lower, the BPDB makes a loss on the transaction, which has to be covered by transfers. This is the indirect subsidy to the plants in question, shown as IS_{TK} in Equation (2). In the case of Bangladesh, the BPDB has been in overall and growing deficit throughout our period of concern so these transfers have required the release of more and more money from the exchequer. Plants that are more reliant on indirect subsidies face greater uncertainty about payment flows as discussed earlier.

$$If\ \bar{P} < P_{TK}, \qquad \bar{P} = P_{TK} - IS_{TK} \tag{2}$$

Combining Equations (1) and (2), Equation (3) shows that the selling price of the BPDB, $\bar{P}$, can be supported at the plant level by a combination of a direct subsidy DS, and an indirect subsidy IS, given the costs of generation, C, and mark-ups M.

$$\bar{P} = C_{TK} + M_{TK} - DS_T - IS_{TK} \tag{3}$$

Although direct and indirect subsidies appear to be equivalent in Equation (3), they are not. They have different effects on risks and therefore on the *mark-ups* of plants. A cut in the direct subsidy to a plant of one cent can trigger an increase in a plant's unit selling price by more than one cent if the investor perceives greater risks, and as a result increases their risk-adjusted mark-up M. To maintain the BPDB's selling price $\bar{P}$, the indirect subsidy has to increase by more than one cent to compensate for the cut in direct subsidy *and* the increase in the mark-up. The withdrawal of direct subsidies may eventually raise risk to the point that unconnected firms drop out entirely. This can result in a dramatic increase in the mark-ups and prices of connected companies, not because they perceive more risk, but because they can now collude with authorities to set higher mark-ups and prices. These increases also have to be covered by indirect subsidies.

To show the relationships between risks and mark-ups, we define the variable d_{TK} in Equation (4) to measure the *dependence* of a plant on the riskier indirect subsidies. The variable d_{TK} measures the share of generation costs *not* covered by low-risk streams of payments. The part of the generation cost covered by the BPDB's selling price $\bar{P}$ is fairly secure because consumers of electricity are paying this to the BPDB. The part covered by direct subsidies, DS_T, is also fairly secure as discussed earlier. The balance of the generation cost measured by d_{TK} has to be recovered through indirect subsidies that have higher risk, particularly for unconnected investors.

$$d_{TK} = \frac{C_{TK} - DS_T - \bar{P}}{C_{TK}} \tag{4}$$

A higher d_{TK} means that a greater proportion of generation costs depend on the riskier transfers from the exchequer. The risk perception of the investor, r_{TK}, is likely to go up as this fraction increases, as described in Equation (5).

$$r_{TK} = f(d_{TK}, X_1, X_2, \dots X_n) \tag{5}$$

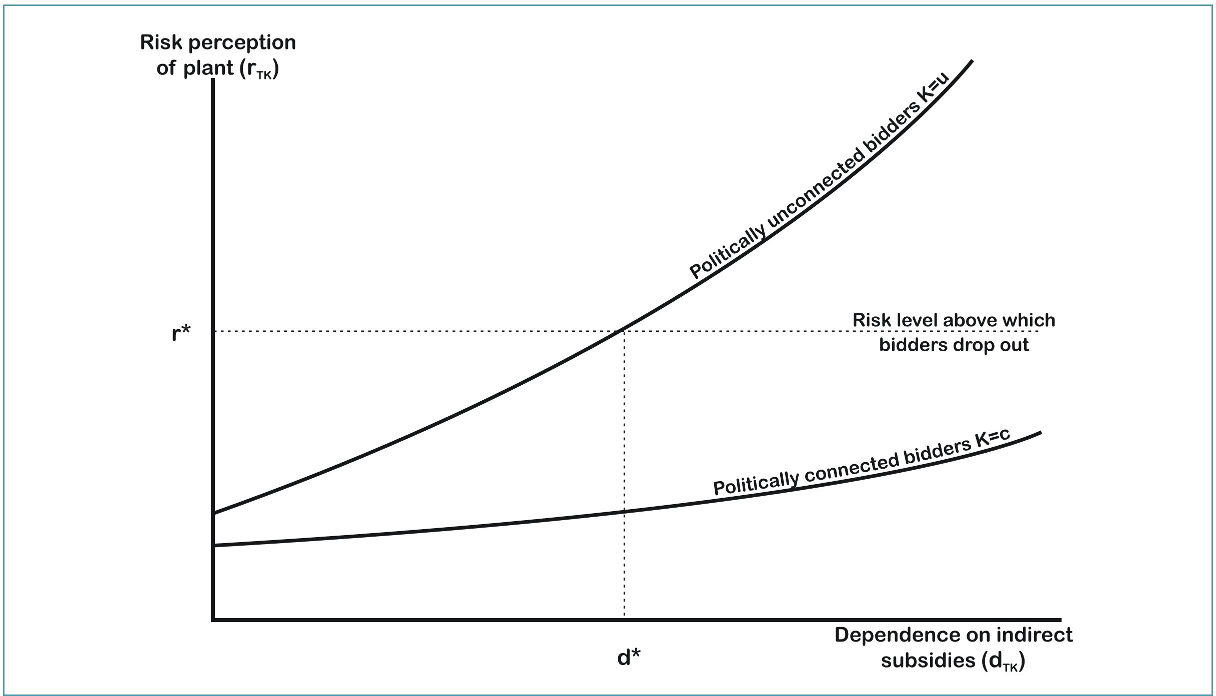
A plant's risk perception is a function of its dependence on indirect subsidies, d_{TK}, and other country- and sector-specific risk factors X_1, X_2, …, X_n. Risks for all firms increase with d_{TK}, but are likely to be higher and rise more steeply for unconnected companies (K=u) relative to connected ones (K=c), as shown in Equations (6) and (7).

$$\frac{\partial r}{\partial d} > 0 \tag{6}$$

$$\frac{\partial r_u}{\partial d} > \frac{\partial r_c}{\partial d} \tag{7}$$

The relationships between risk perceptions and d_{TK} for politically connected and unconnected plants are shown in Figure 10. The critical risk level r^* is the level of risk above which firms desist from bidding for that project. As d_{TK} increases, unconnected investors are therefore likely to exit first, and this happens when d_{TK} reaches d^*.

Figure 10. Indirect subsidies and investor risk perceptions



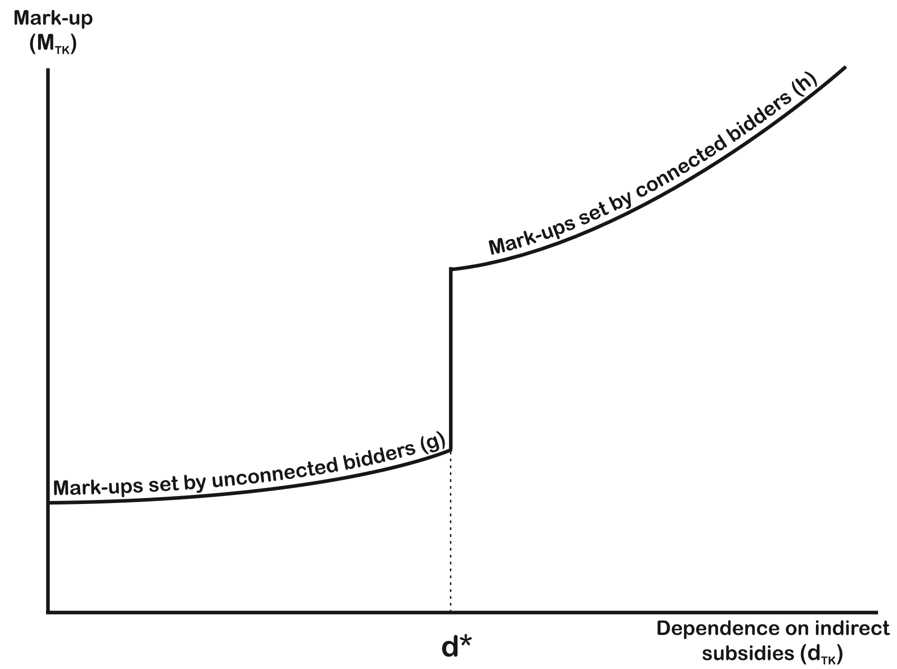
Source: The authors

We can now trace how risk affects pricing through the mark-up. As risks go up, all investors gradually increase their risk-adjusted mark-ups. However, mark-ups also depend on the degree of competition in the market. As risks go up, at some point unconnected investors exit the market. At this point, the mark-ups of the remaining connected investors can display a discontinuous step-change as collusive price-setting becomes possible – and indeed, without collusive risk-mitigating government assurances, investments are unlikely to happen. Equation (8) describes the discontinuity in the rate of increase of the mark-up as dependence, d, increases.

$$M_{TK} = \begin{cases} M_{Tu} = g(r_{TU}, Y_1, Y_2, \dots Y_n, n_u) & if\ d < d^* \\ M_{Tc} = h(r_{TC}, Y_1, Y_2, \dots Y_n) & if\ d \geq d^* \end{cases} \tag{8}$$

When $d < d^*$, the mark-up, M_{TK}, is constrained by the mark-up accepted by unconnected investors. Connected investors cannot set a mark-up much higher than unconnected investors will accept. This is shown in function g where the mark-up is set by the risk perceptions of unconnected investors, r_{TU}, other country- and sector-specific variables $Y_1, Y_2, \dots Y_n$, (which can include rules of competition and procurement, governance variables and so on) and n_u, the number of unconnected bidders in that bid. The last is a critical determinant of effective competition, because for procurement and governance rules to work in these contexts, there must be at least one unconnected bidder with the capability to put together a feasible bid. If such competitors exist, they are likely to protest if they suspect collusion in the granting of contracts. Protests are likely to trigger effective investigations if IFIs or similar organisations are involved in financing projects, if only because they are concerned about their own reputations. As a result, when unconnected bidders are in the running, even if a connected bidder wins a bid, they are likely to have to match or improve on the costs and mark-ups of the former. When *d* is in this range, an increase in *d* will have an incremental effect on risks r_{TK}, and therefore on mark-ups in line with function *g* in the top line of equation (8). However, when $d \geq d^*$, a different function, h, emerges, because after unconnected investors exit, mark-ups are set by the collusive behaviour of connected investors. The number of unconnected bidders, n_u, is now zero and the mark-up can jump to a higher level.

Figure 11. The discontinuity in mark-ups



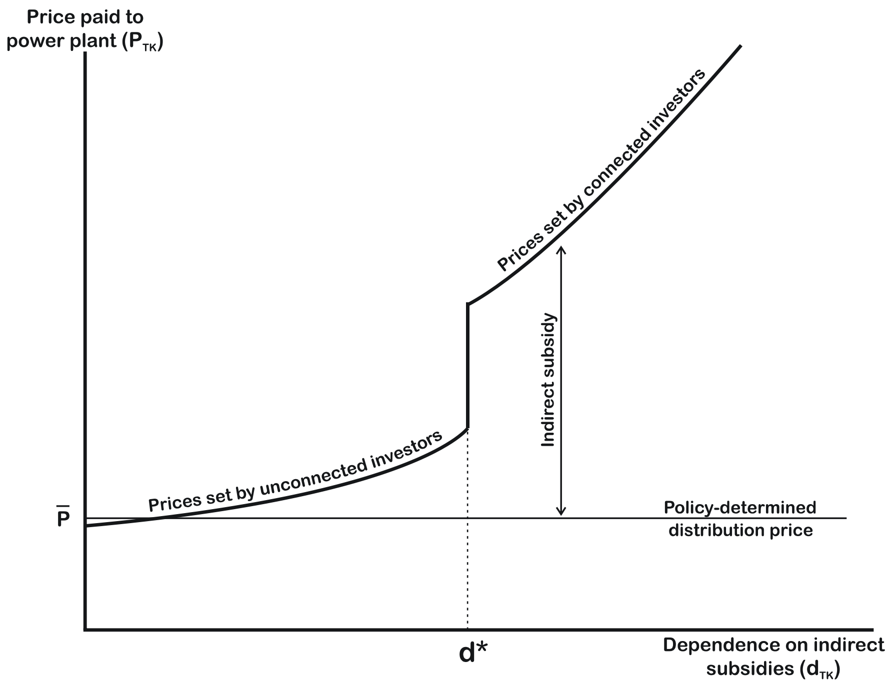
Note: (g) and (h) refer to the functions in Equation (8)
Source: The authors

Figure 11 shows the discontinuity in the mark-up that emerges as d increases. After the exit of unconnected bidders, collusive arrangements are much more difficult to expose or challenge. No bidder is likely to make a complaint to external bodies as investigations are likely to reveal their own collusion. Intense competition is still likely, but it will probably include rent-sharing arrangements. As a result, we expect higher levels of collusion and rent-sharing beyond d^*.

We can now see what happens to pricing in Equation (9), which parallels and accentuates the discontinuity in mark-ups shown in (8). When $d < d^*$, both costs and mark-ups are constrained by what unconnected companies would accept. Beyond d^*, unconnected companies drop out. This has a discontinuous effect on mark-ups, and in addition, the generation costs of connected companies, C_{Tc}, are also likely to rise once unconnected companies exit. Costly technologies with worse environmental implications may be selected if these achieve even faster paybacks or if they are technologies from which connected investors can otherwise profit by supplying.

$$P_{TK} = \begin{cases} C_{Tu} + M_{Tu} - DS_T & if\ \ d < d^* \\ C_{Tc} + M_{Tc} - DS_T & if\ d \geq d^* \end{cases} \tag{9}$$

Figure 12. Power prices and indirect subsidies



Note: Based on Equation (9).
Source: The authors

Figure 12 shows this graphically. As d increases, direct subsidies fall, and this arithmetically raises prices (Equation 1). In addition, mark-ups increase, raising prices further. But most importantly, after d^*, mark-ups jump and generation costs C_{TK} may also increase. As a result, after that point, prices rise faster still. We can now see why direct and indirect subsidies are *not* equivalent. A cut in direct subsidies will not only necessitate an arithmetic increase in indirect subsidies, but also a progressively greater increase to compensate for the growth in risk-related mark-ups (even before the point d^*) and a sharp increase in mark-ups and possibly also in generation costs after the point d^* when unconnected investors exit. Indirect subsidies can therefore be expected to rise rapidly when direct subsidies are cut.

4. Evidence: the effect of competitive risk-mitigation on prices, 2008–2016

We test the effects of direct subsidies on plant-level prices in 58 private power plants in Bangladesh from 2008–2016 for which comparable price and technical data are available. Our analysis predicts that if direct subsidies are large enough to reduce risk to a level that makes unconnected investors interested in a bid, plant-level prices will be substantially lower, much lower than can be directly attributed to the subsidies alone. Furthermore, we should see this effect even if unconnected investors did not bid for a particular project or did not win the bid: their *potential* entry may be sufficient to achieve the beneficial effect on pricing. To test this hypothesis, we can investigate if some combination of direct subsidies results in a significant discontinuity in plant prices after adjusting for fuel type, generation capacity and time-dependent characteristics.

The annual reports of the BPDB record the power purchased from each plant and the amounts paid to each. This gives us the plant-level purchase price per kWh by year and we use the data from 2008 to 2016 to get the average price paid to each plant over this period. As the commissioning agency, the BPDB also provides technical data for each plant including its date of commissioning, installed capacity, current capacity and the type of fuel used. The industry association, BIPPA, helped us by conducting a survey of its members to identify plants that had received leased land from the government or had acquired low-interest credit directly or indirectly from an IFI or had been granted partial risk guarantees. We cross-checked this information and filled in gaps, particularly for IFI support, with the help of power-sector specialists at the World Bank in Dhaka and independent consultants in the power sector.

The mix of connected and unconnected investors who participated in tenders in the past cannot be directly observed. Moreover, many projects changed hands several times after commissioning. We asked a leading financial journalist to identify the owners of plants in our study and trace their political links. Not surprisingly, we found that almost every plant is currently owned by politically connected groups, even if some contracts were originally won by unconnected companies. Fortunately, plant-level prices are bound by original contracts and year-to-year variations are negligible even if ownership changes. Moreover, our hypothesis does not require that contracts should be won by unconnected companies for prices to be low. All that is required is the presence of direct subsidies on a sufficient scale to achieve competitive risk-mitigation. This makes the bid *potentially contestable* and lower prices should follow regardless of the current ownership of plants, and regardless of whether the winning bidder was politically connected or not. Since our hypothesis is about potential competition from unconnected companies at the time of bidding, rather than the identity of the winning bidder, we do not need to identify the political connections of each plant to test our hypothesis.

Of the three direct subsidies referred to earlier, the fuel subsidy with a pass-through benefits all plants using that fuel and there is no variation across plants. However, the other two – leases on government land and access to low-cost financing and IFI PRGs – were available in some projects but not others over the period we are interested in. If a plant does not currently record these subsidies, we assume they were not available at the bidding stage. This is because if a losing bidder with a lower bid price had access to these subsidies, particularly IFI support, they would have triggered a third-party investigation if they were unfairly excluded. And if a bidder with a higher price had access to these subsidies, the winning bidder with lower prices would have asked why they were not eligible. We have no knowledge of such challenges, so it is unlikely that these subsidies were available to a losing bidder and not the winning one. This logic is much more credible for IFI support than for government land leases. If a land lease is available on its own to a politically connected company, unconnected companies may not be able to contest it in the same way. Nevertheless, if land leases are combined with IFI support, this package of direct subsidies does become contestable.

Crucially, we know that access to IFI support is not a function of political connections. There are a small number of players in the power sector and many that have received IFI support in new projects are known connected companies. This is important because if IFIs only extended support to companies without political connections, the lower prices in these projects may simply have reflected a selection bias preventing collusive price-setting. In reality, the same connected companies got IFI support in some projects and not in other similar projects, and their pricing was different across these projects. The factors that determined if one of several agencies would financially support particular projects appear to be linked to the timing of projects, the funding cycles of agencies and the initiative of particular insiders within funding bodies and business groups. The observation that selection was *not* based on the political status of companies allows us to exclude this as a control variable affecting the selection of treatment groups.

The direct financing of power projects by IFIs ended with Meghnaghat and Haripur. After a hiatus, IFI support returned in a number of different forms. All of these did not count as competitive risk-mitigating instruments. For that, support has to fulfil two necessary conditions. First, it must lower the cost of financing, thereby providing an implicit subsidy. Secondly, it has to be ‘contestable’, meaning that the support is in principle available to other bidders. Even if negotiated with a single bidder, the latter’s governance, procurement and pricing should potentially be open to scrutiny by competitors contesting procedures. IFI support that satisfies these conditions reduces risks and attracts unconnected companies either as actual contestants or as potential scrutinisers. In either case we expect an effect on pricing. Appendix B lists the types of financing support currently available from international agencies and the ones that we include because they satisfy our two conditions. As interest rates and shares of project financing from different sources are commercially sensitive data that plants do not share, we cannot estimate the value of the IFI support to each plant. Instead we use a binary variable to label the presence or absence of financial support satisfying our criteria in each plant. A similar binary variable records the presence or absence of leased government land in each plant.

Table 4 is a descriptive summary of the 58 plants. The average plant-level price for a kWh of power over this period was 8.95 takas, ranging from 1.41 to 23.35 takas. Of the 58 plants, 12.1% had access to IFI support satisfying our conditions, 36.2% had leases on government land, and 10.3% had both IFI support *and* leased government land. The average age of plants was 7.3 years and the average generation capacity was 73.5 MW. The usage of different fuels is also shown – for instance, 44.8% of plants were gas-based, 43.8% used furnace oil and the rest used diesel or high-speed diesel (HSD).

Table 4. Summary statistics of 58 private power plants, 2008–2016

Variable	Mean	Standard deviation	Minimum	Maximum
BPDB purchase price (taka per kWh)	8.95	6.54	1.41	23.35
Access to IFI support/partial risk guarantees	0.121		0	1
Access to government land leases	0.362		0	1
Access to both IFI support AND leased land	0.103		0	1
Plant age	7.33	4.18	1	20
Present capacity (MW)	73.47	40.47	0	195
Fuel: gas	0.448		0	1
Fuel: heavy furnace oil (HFO)	0.431		0	1
Fuel: diesel	0.069		0	1
Fuel: HSD	0.051		0	1

Note: Plant purchase prices are weighted averages of prices paid to each plant over the period. Standard deviations are reported for non-binary data.
Source: BPDB, BIPPA, World Bank.

Table 5 summarises the plant-level prices in plants with different combinations of direct subsidies. The averages immediately show that plants with access to both IFI support and land leases, or just IFI support, had lower prices than plants without, adjusting for type of fuel, the most important determinant of plant-level prices. Plants that received only land leases display anomalous results, with the expected effect only visible for diesel plants. This is not surprising given that land leases on their own are not a strongly contestable direct subsidy. Of course, the averages hide much variation within groups and there are other relevant variables affecting price that are not included in the table.

Table 5. Power prices in plants with different direct subsidy combinations (Taka/kWh)

Fuel Type	IFI support AND leased land		IFI support alone		Leased land alone	
	Plants with	Without	Plants with	Without	Plants with	Without
Gas	2.17	3.07	2.41	3.35	3.60	3.01
HFO	9.86	11.64	10.00	12.97	16.44	11.12
Diesel	-	23.89	-	18.00	16.22	23.35
HSD	22.26	-	-	19.98	19.98	-

Note: Blank price cells appear when there are no plants in that category. ‘Plants with’ are treatment plants and ‘without’ are control groups.
Source: BPDB, BIPPA, World Bank.

Simple regression results in Table 6 confirm that leased land on its own has no significant effect on prices, supporting the observation in Table 5. In contrast, IFI support on its own has a significant negative effect on plant-level prices, and the negative effect is highest when plants receive both IFI support and land leases.

Table 6. Regression results

Independent variables	Dependent variable: log price per kWh		
Both IFI support and leased land	-0.329** (0.165)		
IFI support		-0.212* (0.124)	
Leased land			0.065 (0.091)
Log plant age	0.100 (0.087)	0.059 (0.086)	0.076 (0.092)
Log present plant capacity	0.069 (0.060)	0.011 (0.052)	-0.007 (0.058)
Fuel: diesel (reference group)			
Fuel: gas	-1.349*** (0.163)	-1.416*** (0.160)	-1.447*** (0.161)
Fuel: HFO	-0.216 (0.160)	-0.207 (0.163)	-0.259* (0.164)
Fuel: HSD	0.488* (0.261)	0.273 (0.239)	0.290 (0.236)
R-squared	0.850	0.851	0.844

Source: The authors.

However, regression analysis cannot satisfactorily adjust for the possible co-determination of independent and dependent variables. We use Propensity Score Matching (PSM) to address possible selection biases that may lead to a correlation between the receipt of IFI support and/or leased land and plant-level prices. Following Rubin (1974) and Rosenbaum and Rubin (1983), the PSM method allows for the correction of possible selection bias by comparing plants that received IFI support and/or leased land with similar plants that did not, based on their propensity scores. In comparison with other estimation methods, the PSM gives a more accurate non-experimental estimate of the treatment effect (McKenzie et al., 2010).

Let D_i=1 if power plant *i* received the direct subsidy or combination of subsidies, and $D_i = 0$ if not; let Y_{1i} be our outcome of interest (plant-level power prices) for plants with the treatment and Y_{0i} be the outcome for plants without the treatment: the control group. Using PSM, our parameter of interest is the average treatment effect on the treated (ATT), which is calculated by subtracting the average outcomes in the treatment group from those in the control group at a particular propensity score of the balanced covariates or control variables.

$$ATT = E[Y|D = 1, P(X)] - E[Y|D = 0, P(X)] \tag{10}$$

where $E[Y|D = 1, P(X)]$ is the expected value of the plant-level price in plants with the treatment, given the covariates X; and $E[Y|D = 0, P(X)]$ is the expected value of plant-level prices in plants without the direct subsidy or subsidy combination in question, given the covariates X. The PSM estimates are based on the conditional independence assumption, which states that, conditional on *X*, the potential outcomes are independent of the treatment status. After controlling for the observable covariates *X* (plant age, present plant capacity, and fuel type dummies), the treatment assignment is as close to random as we can achieve with observational data (Lechner, 1999). Using the control variables discussed earlier, Table 7 presents the results.

Table 7. Treatment effect using propensity score matching

Treatment variable	ATT on log of plant-level price	Standard error	t-statistic	Percentage change in price due to treatment
BOTH IFI support AND leased land from government	-0.969***	0.199	-4.876	-62.1%
IFI support	-0.204**	0.100	-2.035	-18.5%
Leased land from government	0.020	0.403	0.051	Not significant

Notes: ** and *** indicate significance at 5%, and 1%, respectively. Control variables include plant age, present plant capacity, and dummy variables for fuel types (gas, HFO, diesel, and HSD). The dependent variable is the log of plant-level prices. As the ATT is in logs, the actual percentage change in plant-level prices in the last column is exp(ATT)-1.

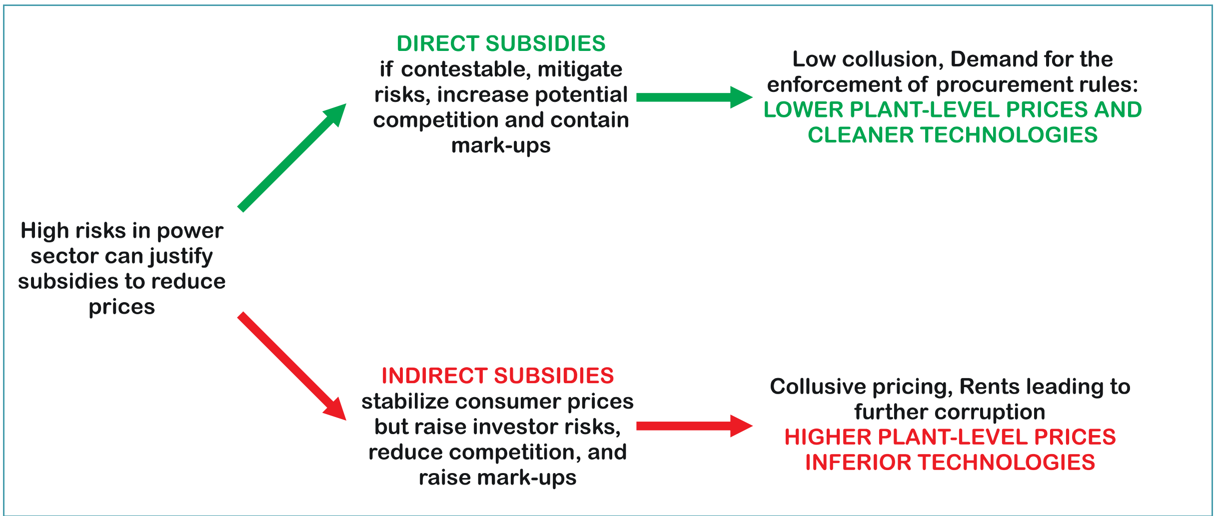
Source: The authors.

The PSM estimates confirm that land leases on their own had no significant effect on plant-level prices. This is consistent with our expectations and confirms that, on their own, land leases are not contestable direct subsidies that can induce competitive bidding. In contrast, IFI support on its own reduced plant-level prices by 18.5%. This is significant at the 5% level and is much higher than any plausible arithmetic effect of lower interest costs on power prices. This is consistent with our explanation of likely effects operating through competitive risk-mitigation on mark-ups and prices. However, the most significant results are achieved when IFI support is combined with land leases, when there is a 62.1% reduction of plant-level prices, significant at the 1% level. The large discontinuous effect here suggests that this combination of direct subsidies had the characteristics of a contestable risk-mitigating subsidy that lowered dependence on risky cost recovery to below the level d^* in Figure 12. The large and significant reduction in prices therefore has a plausible explanation.

5. Conclusion: a feasible anti-collusion strategy

The theory and evidence discussed here shows that contestable direct subsidies can and have functioned as risk-mitigating instruments supporting competitive behaviour. In their absence, collusive relationships between business and government emerged to solve the investment problem in Bangladesh. Mark-ups and prices rapidly increased, and the rents generated supported further corruption that drove anomalies in dispatch orders, the preferential supply of fuel, the preferential renewal of contracts, and so on, which have all been observed in Bangladesh. Different estimates of the social cost of this collusion and corruption consistently value it at much greater than US$1 billion a year.

Figure 13. Subsidies, risks, collusion and corruption



Source: The authors.

The collusion and corruption in the sector can be attributed to many factors, but most of these are not feasible policy variables. For instance, the collusion could be correctly attributed to the absence of competitive tendering and the weak enforcement of procurement rules, but this does not identify a feasible policy response. How do we enforce procurement rules or return to competitive tendering if politically unconnected companies refuse to bid? The deficits of the BPDB are clearly a problem but how do we reduce these deficits without raising the prices of power to economically and politically unsustainable levels? Our search for a feasible policy variable was therefore driven not just by the evidence, but by an understanding of how risk affects investment decisions. That helped to identify feasible policy instruments whose likely effects we then validated with evidence.

An understanding of the powerful groups in the sector, their interests and capabilities – which can be described as the sectoral political settlement – underpins our analysis by suggesting anti-collusion strategies that may be resisted, but not so much that they have a very low chance of success. Clearly, we can expect rent-seeking interests to range against the implementation of a strategy that will have the effect of reducing uncompetitive rents. Nevertheless, the strategy may be feasible to implement, particularly if the fiscal crisis of the sector begins to increase risks for incumbents and slows down the government's plans for expanding power supplies. Our evidence shows that many powerful business groups engaged in the sector have both treated and untreated plants in their portfolio. When policy creates a more competitive environment, even connected companies are able to deliver better prices, and still make sufficient profits. Obviously in the absence of competitive pressures, the same groups take the opportunity to raise prices. However, as competitive generation is sufficiently profitable in the presence of moderate risk mitigation, there is no evidence that the provision of preferential financing, together with government land leases, has been strongly opposed by anyone. Instead, broadening the availability of these incentives to cover most or all projects may work to change the behaviour of existing players in a more productive direction, which many connected firms have already demonstrated is possible in particular projects.

The anti-corruption approach suggested here is one of '*designing for differences*' (Khan et al., 2019). Different types of investors, depending on their political connections, perceive the risks associated with payments from a loss-making public purchaser very differently. The more their payments depend on transfers from the exchequer, the greater their risk, and risk is even greater if they are unconnected companies. By understanding these differences, feasible changes in policy can increase the probability that unconnected investors become potential entrants, which creates competitive pressures that can contain mark-ups, prices and corruption. Relatively small risk-mitigating subsidies can reduce average plant-level prices by more than 60%, and if widely implemented, this would significantly reduce or eliminate the avoidable deficit of the BPDB, which is the most direct measure of the social cost of collusive pricing. In addition, removing the distortionary rents created by overpricing can also reduce the associated corruption that drives anomalies in dispatch orders, gas supplies, the choice of inferior technologies and other decisions that further add to the social cost of the collusive power market. As the reduction in plant-level prices and therefore the savings in the social cost of power is a large multiple of the direct subsidies, the latter may be more usefully regarded as public co-investments in projects, with a high rate of social return, rather than as subsidies.

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Appendix A. Early projects with direct IFI financing

The two earliest projects that received direct IFI financing were Haripur and Meghnaghat. The contract for the 360 MW Haripur gas-fired IPP was won by the American company AES and operations began in 2001. The tariff contracted was US$0.0277/kWh. Debt constituted 63% of project financing.

As Table A 1 shows, the cost of capital was significantly reduced by direct lending by the World Bank at their international lending rates, which are lower than those available in the local market, and a PRG that reduced the cost of other commercial credit.

Table A 1. Financial structure of Haripur power project

	Million USD	
Equity:		
Sponsor equity	31.0	17%
Subordinated sponsor loan	37.0	20%
	68.0	**37%**
Debt:		
Commercial debt*	60.9	33%
IFC direct loan	40.0	22%
IFC syndicated loan	14.0	8%
	114.9	**63%**
Total	**182.9**	**100%**

* guaranteed with the International Development Association's (IDA) US$60.9 million PRG based on government indemnity agreement with IDA, achieving US Libor rate + 2%. International Financial Corporation's (IFC) direct and syndicated loans at international market rates. The IFC and IDA are both part of the World Bank Group.

Source: Asian Tigers Capital Partners (2010)

The 450 MW Meghnaghat gas-fired IPP was also developed by AES Corporation and contracted in 1999. Here, debt was 73% of the project cost. As Table A 2 shows, here too, IFIs provided direct financing and PRGs, including A and B loans from the ADB, a commercial loan tranche covered by a PRG from ADB, as well as loans from IDCOL, which was in turn financed by the IFIs. Pricing on the PRG-backed loan tranche was 200 basis points over LIBOR, while the B loan was priced at 350 basis points over LIBOR.

Table A 2. Financial structure of Meghnaghat power project

	Million USD	
Equity:		
Sponsor equity	80.0	26.7%
	80.0	**26.7%**
Debt:		
ADB Loan	50.0	16.7%
Commercial Banks* (ADB PRG)	70.0	23.3%
Commercial Banks (ADB scheme)	20.0	6.7%
IDCOL	80.0	26.7%
	220.0	**73.3%**
Total	**300.0**	**100.0%**

* guaranteed with US$70 million political risk ADB PRG scheme with government counter guarantee to ADB. LIBOR + spread determined by Interest Rate Committee. IDCOL loan via IDA.

Source: Asian Tigers Capital Partners (2010)

Appendix B. Contemporary financing by IFIs and development banks

Direct financing by IFIs was largely discontinued after the first two projects in Haripur and Meghnaghat that still produce some of the cheapest power in Bangladesh. IDCOL too shifted its attention to other infrastructure projects and later to solar power, though some direct involvement of IFIs and IDCOL continued on a smaller scale in later years. Bidders in power projects had to arrange their own financing to a much greater extent or entirely. From 2006 the World Bank provided funding for power plants as part of its Investment Promotion and Financing Facility (IPFF). This provided interest-free loans to the Bangladesh Bank, which then provided credit to commercial banks, who in turn lent to projects. As the loans are ultimately made by local banks in local currency, the interest rates are the standard commercial rates in local banks. Typically, these loans do not provide any significant element of direct subsidy, though the IPFF funding enhances the lending capacity of local banks. As there is no significant subsidy element, we exclude IPFF loans from our list of competitive risk-mitigating direct subsidies.

We also exclude credit provided by export credit agencies (ECAs). These are agencies in exporting countries that provide financing to importers, in this case importers of power plant equipment. Here, even if there is an interest rate subsidy, the benefit is restricted to a particular supplier from the exporting country and their importing partner. Lowering the cost of this finance reduces risk for the specific exporter and importer, but the benefit is shared between the exporter and importer and may not be passed on as lower power prices. This is because the risk mitigation here is exclusive to the companies involved. Potential competitors, particularly from other countries, do not in principle have access to this ECA credit nor do they have the right to raise questions about procurement processes and possible overpricing of the machinery or of power. This would be very different if the credit had been in the form of an IFI loan. Hence, ECA credit does not have the effect of a competitive risk-mitigating subsidy. The same holds true for exporter's credit organised by the exporter using export-promotion banks in their home country. These arrangements are often used by machinery suppliers, including from China, but do not count as competitive risk-mitigation subsidies.

However, IFIs continue to support particular power projects in new ways that have competitive risk-mitigation effects. PRGs from IFIs were later complemented by guarantees from the World Bank's Multilateral Investment Guarantee Agency (MIGA), which provided guarantees against non-commercial risks like political risks and breach of contract. These are significant risks in developing countries and these guarantees reduce the cost of capital. As they are available to any investor or supplier competing for a tender who satisfies eligibility criteria, the benefits are in principle not limited to a particular investor. The recipients of a MIGA guarantee are therefore open to scrutiny by competitors and adverse procurement or pricing behaviour could trigger World Bank scrutiny if necessary. We include MIGA risk guarantees as an IFI instrument that works as a competitive risk-mitigation strategy.

The International Finance Corporation (IFC) has also recently invested in a number of power projects in Bangladesh with loans and equity. As their investments are linked to international (LIBOR) interest rates and not the high interest rates in domestic banks, IFC investment or financing provides an element of financing subsidy that is also in the public domain and open to competitors to challenge if their own investment package is technically or commercially superior. Therefore, we count IFC financing as a competitive risk-mitigation instrument.

Bilateral development banks have occasionally invested in private power projects in Bangladesh. They include the German Development Finance Institution DEG, (Deutsche Investitions- und Entwicklungsgesellschaft) and the Dutch Development Bank FMO (Nederlandse Financierings-Maatschappij voor Ontwikkelingslanden). Their involvement is still relatively small, but these investments are similar to those by the IFC even if these are not multilateral IFIs. Their investments in equity or financing at interest rates lower than those available in the domestic market lower the cost of capital for a firm that has to then price in a competitive way. Competitors can potentially challenge these financing decisions if the prices offered by the supported company are uncompetitive. Therefore, these types of financing should also count as competitive risk-mitigation instruments.

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Disclaimer: This publication is an output of a research programme funded by UK aid from the UK Government. The views presented in this paper are those of the author(s) and do not necessarily represent the views of UK Government's official policies.

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