How do price caps in China's electricity sector impact the economics of coal, power and wind? Potential gains from reforms

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Executive summary

China's past reforms have moved its electricity sector to the middle ground between fully functioning markets and a command system. The price formation mechanism in particular is still heavily regulated with the government capping the prices at which generators sell power to regional grids, which are termed "utilities" in China. These price caps, which differ by region and generation technology, are designed to cap electricity costs while reflecting market conditions and promoting or restricting a particular technology or fuel type. However, the caps increase costs because of the difficulty of paying for plants that meet peak loads and have high per kWh capital costs. Also, the frequency of the price cap adjustments do not always match movements in fuel markets. This is especially problematic given the deregulated domestic coal sector.

Chinese utilities remain the sole buyers of power in their regions, making them monopsonists. They can lessen the effect of the on-grid tariff caps by using their market power to redistribute the number of generation hours among contracted power plants and consequently, price more capacity below the caps. Often such a redistribution does not match the least-cost solution that would have been available without the caps.

A power plant meeting peak demand can have costs that exceed the price cap. In this case, the grid operator can offer a contract for a bundle of plants owned by the same generator where the payment covers all costs plus a fair rate return for the plants in the bundle. In this contract, each plant is nominally paid a price that falls below the corresponding price cap for that plant, with some plants paid below cost and others paid above cost. This cross-subsidization between power generation plants incentivizes market concentration.

The risk of volatile coal prices due to the deregulation of coal in association with capped coal-fired generation tariffs encourages vertical integration to alleviate fluctuations in fuel costs and ensure uninterrupted supply. These measures further decrease market competition and efficiency. However, the losses incurred by power generators as well as various subsidies received from national and provincial governments suggest that cross subsidization is insufficient to mitigate distortions caused by the price caps.

In order to assess the effect of the on-grid tariff caps, we built a mixed-complementarity-problem (MCP) model that represents the Chinese coal and power sectors and minimizes the total costs of the system with and without caps. We calibrated the model based on 2012 data and developed a set of scenarios to illustrate the impact of China's price-control policies on power generation within the current energy system and under a range of wind capacity targets.

We found that removing the caps would have resulted in at least 45 billion RMB of cost savings in 2012, equal to 4 percent of the power system costs. Removing the caps eliminates generators' losses and the need for cross-subsidization among power generation technologies, reducing the advantages of market concentration. The need for vertical integration to control fuel costs is also reduced. Therefore, lifting the price controls would promote improvements in the market structure, lowering the barriers to entry for new participants and expanding competition.

Abolishing price caps also facilitates grid integration because regions no longer need to hoard base-load generation that cross subsidizes peak generation to stay below the caps, raising interregional electricity trade by 234 terawatt-hours. This increased power transmission eliminates 6 percent of physical coal transportation, reducing the required investment in coal railway infrastructure.

Repealing restrictive tariff caps on coal-fired generation does not increase coal consumption because the utilization rate of peak-shaving coal plants drops. On the other hand, forcing significant wind capacity into the market does not substantially reduce coal use due to coal's cost competitiveness. These findings suggest that a substantial reduction in coal use in China's power sector requires additional policy interventions.

Usually, adding a non-dispatchable technology like wind with feed-in tariffs increases expenditures on subsidies. However, wind ameliorates the problems created by the price caps. By slightly lowering the demand for coal, added wind capacity significantly lowers the coal price, relaxing the revenue constraint and lessening the distortions due to the caps. Thus, the cost of subsidies for the feed-in tariffs is partially offset by the efficiency improvements from relaxing the caps. This conclusion holds true as long as the Chinese regulators do not reduce the caps in response to lower coal prices.