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Unintended consequences of China's coal capacity cut policy

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Abstract

In early 2016, China introduced additional capacity cut policies to rebalance supply in the coal market to match demand that had been reduced by slow economic growth and strict environmental regulation. Ensuing disruptions to the coal market caused these policies to be revised and, subsequently, discarded as decision makers tried to find a balance between efficient supply, economic and social stability and environmental sustainability. This paper explores the causes of these unintended consequences using an extended version of the KEM-China model. The results reveal that full and partial compliance with the capacity cut policies result in a significant gap between supply and demand. This suggests that implementation of the policy was technically infeasible, even allowing for a significant increase in coal prices and economic costs. Besides, significant differences in coal prices and output profiles are registered across the country. We argue that the heterogeneous nature of the Chinese coal market and policy compliance was a major factor leading to the unintended consequences. We propose that the capacity cut policy should be differentiated across regions and even types of coalmines, market approaches would be preferable to the command-and-control instruments, and policy distortions that cause excess capacity should be removed.

Key Words: China; coal; excess capacity; over capacity; capacity cut; KAPSARC Energy Model

JEL: C63; Q48;

1. Introduction

Economic expansion, industrial policies and generous subsidies led to substantial overcapacity in various sectors of China's economy, including coal industry, which poses significant problems under the 'new normal growth model' (Hao et al., 2015). In the short run, it puts significant pressure on coal prices and, hence, profitability of domestic producers, their ability to service their debt and pay their employees on time. In the long-run, a bigger share of coal consumption would contravene China's energy development and environmental targets, as well as its international commitment to peak CO2 emissions by 2030. As the most carbon intensive energy source, coal will also be affected by the national emission trading scheme (ETS). Substitution of coal with lower emission energy sources is also the key measure to combat air pollution issues in China. These environmental policies can add constraints on coal demand and further justify the need for capacity cuts to balance the market in the future. Therefore, policies to tackle overcapacity issues have been gradually escalated in the past few years (State Council, 2010, 2013, 2016) but the implementation has not been linear.

One of the additional coal capacity cut policies, the working day limit (State Council, 2016), went through all major phases of its life cycle in 2016, from design to enforcement, revision and eventually, retirement. The objective of this policy was to address the detrimental effects of the overcapacity on the coal market since the Chinese government believed that the issue would not be sufficiently resolved by market forces alone (Shepherd, August 19, 2016). However, major disruptions to the coal market caused by the capacity cut initiative demonstrated the difficulty of balancing competing priorities in a complex system of economic, social and environmental goals subject to both administrative measures and market forces.

The unintended consequences arising from this policy initiative present an opportunity for a compelling case study in the domains of China's energy policy, public policy and governance in general. In this specific case, contradictory mandates, strong support of mining operations by local authorities to protect jobs, and complaints of high coal prices, caused decision makers to think again. As observed in 2016, the collision between policies and market dynamics led to an upwards shock in coal prices, undermining the elimination of inefficient production capacity.

Since the Chinese coal industry accounts for a half of global production and consumption, studying China's overcapacity issue is significant for the global community. Due to strong economic growth, China's energy demand has increased consistently since the 1980s and experienced a surge in the 2000s. Consequently, China's share of global coal consumption rose from about 30 percent in the early 2000s to 50.5 percent in 2015 (BP, 2016), and accounts for around 15-25 percent of global imports (ITC, 2017). Variability in China's coal production is likely to have great impact on the world coal market. More generally, the excess capacity indicates that other producing countries are unlikely to gain additional market share in the Chinese market (Huw McKay and Song, 2010).

To our knowledge, no study has explored the 2016 coal capacity cut polices and its repercussions and there is no quantitative assessment of the impact of any overcapacity issue in China. A number of studies have examined China's overcapacity issues in various sectors including coal, heavy chemical, refinery, steel and power generation in the past two year, but none of them addresses this important case study. There are primarily focused on the outlook for the power generation capacity (Yuan et al., 2016); overall review of the overcapacity situation of China's thermal power industry (Zeng et al., 2017); measurements for over-capacity of refining industry (Pan et al., 2017); estimation of the impacts of policy mix for resolving overcapacity in heavy chemical industry (Li et al., 2017); the measurements or reasons of overcapacity in the coal industry (Zhang et al., 2016; Zhang et al., 2017).

The paper examines why the capacity cut policies and remedial policy interventions in 2016 did not have the intended effect, how the coal market responded to these interventions and what lessons can be learned more generally about the transition from planned/mandated to competitive/liberalized markets. It intends to make contributions to several strands of research by: 1) Studying an important policy experiment and drawing conclusions that can inform international policy makers; 2) Identifying the unintended consequences of the policy, which may support calibration of future capacity control policies in coal and other industries; 3) Revealing the impact of regional and compliance heterogeneity due to information asymmetry - using the KAPSARC Energy Model of China (KEM-China); and 4) Deepening the understanding of energy policy and governance in China.

The paper proceeds as follows: The next section introduces the issues and the hypotheses. Section 3 briefly describes the model and extensions added for the purpose of this study. Section 4 presents the model results and analysis. Regional heterogeneity, information asymmetry due to a lack of reliable statistics, implementation problems and heterogeneous agent behaviour are explored in this section. Section 5 concludes the paper and summarizes the key policy implications.

2. Background and hypotheses

2.1. Excess capacity and its causes

The issue of excess capacity has been explored for several decades in the literature. It has been described as a common phenomenon of the market economy due to the presence of business cycles (Stiglitz, 1999). It can also occur under monopoly conditions as a deterrent to prevent potential entrance of competitors (Barzel, 1970). Chamberlin (1938) found that excess capacity is a common phenomenon in a monopolistic market. Excess capacity has also been revealed in market economies and less concentrated industries, such as European car manufacturing (Jullien, 2015).

However, the main reasons for excess capacity in China are different from those observed in market economies. These include government distortions, such as inappropriate industrial policies and a vast array of subsidies (Anderlini, 16 June 2013). Haley and Haley (2013) find that subsidies, in a broad sense, including cheap land and credit, discounted utilities and tax breaks, account for about 30 percent of industrial output and represent the major driving factor for excess capacity. The overcapacity problem has become prominent in recent years due to over reaction by the Chinese government to the global financial crisis. This has been shown to drive down profits and even threaten the growth dynamics, with recent efforts to slow down demand further exacerbating the problem (Anderlini, 16 June 2013). Local government support is another important driver of overcapacity. Local government tends to distort mines' economic behaviour to increase their popularity by increasing jobs, GDP and deferring bankruptcy (Shi, 2009). The overcapacity of Chinese industries also causes significant problems outside China, as it produces nearly half of the world's coal, aluminium and steel, and about 60 percent of global cement.

Despite significant progress in liberalizing the Chinese economy in general, and the coal industry in particular (Shi, 2009), the government often resorts to policy interventions as a means of sectoral regulation (Shi, 2013). The coal capacity cutis a recent intervention by the Chinese government, gradually targetting stricter controls after 2008.

The objectives of the policies have changed over time, as have the instruments used. Initially, elimination of excessive and less efficient capacity was regarded as a step towards achieving strategic goals of transforming economic development, adjusting economic structure and promoting energy conservation and emission reduction (State Council 2010). In 2010, the State Council strengthened the elimination of backward production capacities and issued specific targets for more than ten key industries, including coal (State Council, 2010). As the issues surrounding overcapacity became more serious , the focus shifted to specific problems and their consequences. The Guiding Opinions issued by the State Council in 2013 and 2016 emphasized the need to rectify misallocation of resources in order to prevent industry losses, non-performing loans, safety problems, unemployment and environmental degradation (State Council 2013, 2016). In 2013, the capacity cut policy was institutionalized through supply-side reforms ('*Gonggeice Gaige'*) (Acheson et al., 2015; State Council, 2013).

Nowadays relveant policy documents stressthe importance of market mechanisms (supported by administrative measures) in resolving the overcapacity issue, as it extends its detrimental effect on the coal market. However, China's policymakers grew distrustful of the ability of the market to resolve this issue. Lian Weilang, the deputy minister of National Development and Reform Commission (NDRC), argued that government intervention was needed to avoid "bad money driving out good money" (Shepherd, August 19, 2016).

Indeed, the market has been not effective enough in driving out inefficient or failed companies, often referred to as 'zombie enterprises'. They rely on 'life support' received from a combination of local governments (reliant on these enterprises for economic growth, taxation and employment indicators) and banks (not wanting to write off or make provisions for bad debts) (Shi, 2009). Companies, that are *de jure* or *de facto* controlled by local governments, tend to be driven by both economic efficiency, to protect the interest of investors, and by imposed social obligations. This makes divestment, scaling down operatoins or closure less likely (Hao et al., 2015). Moreover, the regulatory uncertainty can prevent the firms from exting a market if they expect government intervention tosend prices back up.

However, past experience suggests that despite being initiated in good faith, such interventions often lead to outcomes that diverge from original intentions causing significant economic loss and damaging the credibility of the government (Andrews-Speed, 2004; Andrews-Speed et al., 2003; Shen and Andrews-Speed, 2001; Shen et al., 2009; Shi, 2013). The track record of past policy interventions in China's coal industry suggests that there are significant challenges in the choice of policy tools, enforcement mechanisms, estimation of policy outcomes and balancing economic, social and environmental needs (Andrews-Speed, 2004; Shi, 2009; Yuan et al., 2016; Zhang et al., 2017).

2.2. Evolution of the 2016 capacity cut policies

At the start of 2016, the Chinese coal industry was in a critical stage. China's coal prices plummeted from May 2013 until the end of 2015 (see Figure 1). According to a survey (sxcoal.com, 2017a), only 10 out of 265 sampled mines in Shanxi, Shaanxi and Inner Mongolia, the three key coal producing provinces, were able to make a profit from supplying coal to Bohai-rim ports in January 2016. More than 35 percent of coal mining enterprises recorded losses in the first quarter of 2016 (CEIC, 2017). The economic distress in the coal industry also had a negative impact on the socio-economic stability in key mining regions. The well below national average GDP growth of 3.1 percent recorded in Shanxi province in 2015 fell to a quarter of its 2011 level, when coal prices were peaking. The number of workers in coal mining dropped by 10 percent in the first quarter of 2016 compared to the same period of the previous year (CEIC, 2017).

The immediate economic and social consequences urged Chinese policymakers to intervene, with the hope to boost coal prices to desirable levels. In February 2016, the State Council issued the policy stating that China will cut up to 1000 million tons (MMt) of coal production capacity in the next 3-5 years starting from 2016 and ordered all coal producers to reduce the number of annual working days from 330 to 276 (State Council, 2016). This working day limit effectively reduced coal production capacity by an additional 16 percent. Subsequently, the capacity reduction target for 2016 was set at 250 MMt and was reportedly achieved later in the year (Xinhua, 24 Nov 2016).

These capacity cut measures reversed the trend in the Bohai-rim port coal price (see Figure 1), which was used as a gauge by policymakers. The coal prices rebounded in February 2016 and skyrocketed in July 2016, which, was not expected by the government.

To stablize coal prices the NDRC implemented a three grade response mechanisms for thermal coal using the national FOB Bohai rim benchmark port price (incl. VAT): *Grade 3*: Above 460 yuan/t – 53 mines in Coal Country (Shanxi, Shaanxi, Ningxia and Inner Mongolia provinces) increase output by 0.2 MMt/day. *Grade 2:* Above 480 yuan/t – 66 mines in Coal Country, Shandong, Henan, Anhui and Jiangsu increase output by 0.3 MMt/day. Response called off below 470 yuan/t. *Grade 1:* Above 500 yuan/t – 74 advanced mines nationally increase output by 0.5 MMt/day. Response called off below 490 yuan/t (Zhang, 24 Oct 2016).

Figure 1 Daily coal price 25/1/2013-25/5/2017, Qinghuangdao port, 5500 kcal/kg

Source: CEIC (2017)

However, as shown in Figure 1, the mechanism failed to stabilize soaring coal prices as all the benchmarks were exceeded in a short time period, leaving no time for the government to respond. The capacity cut policy experienced a reluctant U-turn in September 2016, when the NDRC gradually softened its standpoint amid a surge in coal prices and concerns over peak winter demand. Having exhausted its policy options, at the end of October 2016, the NDRC suspended the 276 annual working-day limits for all coalmines. The annual capacity cut policy was also softened by allowing efficient coalmines to increase their capacity.

In early 2017 the fixed capacity cut target of 250 MMt, announced in 2016, was reduced to 150 MMt (Platts, 6 Mar 2017). In October 2017, Heilongjiang became the first province that officially announced to further reduce its capacity cut target due to increasing supply shortage (Li, 26 Oct 2017). Furthermore, the government has taken various policy measures, such as approval of new coal mines (Wang, 19 Aug 2017) and legalization of unsanctioned production capacity of 400-500 MMt (Wu, 3 July 2017) to add more capacity. Despite achieving 85% of the 2017 capacity cut targets by the end of July with the closing of existing mines (Su, 15 Sep 2017), the net national capacity is expected to increase by 200 MMt by the end of 2017 (Wang, 19 Aug 2017).

2.3. Hypotheses

Success of the 2016 capacity cut policies would only have been likely if several strong assumptions had held true. First, there is full compliance with the capacity cut and working day limit policies among different levels of government and different kinds of mines. Second, the benchmark price reflects the market fundamentals in all regional and sub-regional markets. Third, there is a well-defined supply and demand curve to calculate the precise amount of production needed to stabilize the desirable price levels. The market response and subsequent U-turn in policy suggest that at least some of these assumptions were wrong.

The history of coalmine policies (Andrews-Speed, 2004; Andrews-Speed et al., 2003; Shen and Andrews-Speed, 2001; Shen et al., 2009; Shi, 2009, 2013) suggests that incomplete (or inadequate) information on production capacities, consumption patterns and policy implementation can be a major impediment to an effective intervention. There is a lack of reliable statistics due to varying capacities and motivations across local governments. For example, the national competition to reduce energy intensity may encourage local governments to under report consumption. ‘Zombie enterprises’ also distort the industry’s cost curve causing prices to deviate from true production costs.

Policy implementation can also vary due to the large size of the country and varying local conditions. While the central government is putting efforts to curtail excess capacity, the local governments may have opposite interests that undermine the policy (Andrews-Speed et al., 2005; Andrews-Speed et al., 2003). There is a consensus that local governments are accountable for the unsanctioned production capacity (Wu, 3 July 2017). Local officials are often keen to spend government money to advance industries whose success can further their own careers (Anderlini, 16 June 2013). Most of the subsidies to industries were provided by local and provincial governments (Anderlini, 16 June 2013). Zhang et al. (2017) incorporate coal enterprise and local government in a three-stage dynamic game model, and demonstrate that local government is accountable for overcapacity in the coal industry.

In this paper, we test two hypotheses to explain the unintended outcomes of China’s coal capacity cut policies in 2016:

Compliance heterogeneity hypothesis: the heterogeneity in coalmine ownership will cause distortions in governance and policy implementation. According to the literature on compliance in the coal industry, there is a significant divergence among producers of different ownership types. Key State Owned Enterprises (SOEs) are more likely to adhere to the capacity cut policy because failing to do so would put the managers' careers at risk. To certain extent, the TVEs (local or small coalmines) will ignore the policy in pursuit of profits from higher production and prices. The local state owned coalmines could be assumed to demonstrate compliance levels somewhere between the two groups (Andrews-Speed et al., 2005; Andrews-Speed et al., 2003; Braithwaite, 1985; Shi, 2009). On the other hand, SOEs tend to have softer budget constraints and other advantages (Tian and Estrin, 2007), which can help them expand their production by upgrading existing or constructing new mines (Shi, 2010; Shi and Grafton, 2010).

This data also indicate a gradual compliance with the capacity cut policy up until June 2016. The National Bureau of Statistics reported in February 2017 that the total coal production in 2016 was 3.41 billion tons (bt), a 9 percent year-on-year (yoy) decline. The monthly output (compared to the same month of the previous year) declined on average by 10 percent from April to November 2016, whereas in June it dropped to a 10-year low of 16.6 percent (NBS, 2017a).

Regional heterogeneity hypothesis: Chinese coal resources are mainly located in the Northwest region, specifically, Shaanxi, Shanxi, Inner Mongolia and Xinjiang, while the major demand centers are located in the costal Eastern region (NDRC, 2016). Due to the mismatch in resource distribution and consumption, supplemented by the transportation costs and constraints, the Chinese coal market can be deemed to be fragmented (Ma and Oxley, 2012; Sheng et al., 2014). While there might be an overall overcapacity, some regions may face shortages. This regional heterogeneity will likely cause regional markets to respond differently to the capacity cut policies, including varied regional price shocks and production patterns.

Data presented in Figure 2 shows dissimilarities in provincial coal production trends in 2016. Guizhou, a representative of the Southwest market, did not notably reduce its output but rather recorded a production surge in June. Xinjiang, in the northwest, and Shanxi (Major coal exporting province) demonstrated a similar production pattern. While Guizhou increased production to bridge an increasing gap between supply and demand (sxcoal.com, 2016), the surge in Xinjiang's output resulted from a high relative price increase (see Figure 4) that may have pushed the government to relax the policy constraints. In Shanxi, all dominant and large local producers, are categorized as 'advanced capacity' and allowed to gradually increase production according to the national policy response to skyrocketing prices in the second half of 2016 (Zhang, 24 Oct 2016). On the other hand, during this period Shandong (East China market) experienced significant production decline, while the output levels of Heilongjiang (Northeast market) and Hunan (Central China market) remained relatively stable.

Figure 2 Monthly coal production in major regional markets, MMt

Source: CEIC (2017)

3. Model description and scenario design

To study the impact of the China's coal capacity and working day cut we have developed a new version of the coal supply module of the KAPSARC Energy Model (KEM) of China. The module is constructed as a linear problem, minimizing total supply costs, including annualized investment, variable production, transportation and import costs, to satisfy a fixed demand for thermal and metallurgical coal. The regions and regional nodes used along with demand are listed in Table 1.

The model provides a detailed representation of existing coal production and transshipment infrastructure (rail, truck, river and seaports) in a competitive market structure. It was previously used to study rail congestion in China's coal supply industry (Rioux et al., 2016). Please refer to this document for further description of the model equations and calibration. The present version has been re-calibrated to replicate the supply conditions in the year 2016, including revised regional coal transportation infrastructure to account for new coal port and rail lines completed in 2015. Figure 3 maps the regions (right), and the production capacities and rail infrastructure connecting each node (left).

Figure 3 Model regions (left), aggregate production and rail infrastructure (right).
Source: Authors' own work

The impact of capacity cut policies on the coal supply market is simulated in the short run with no new investment in production or transportation infrastructure. Coal demand is calibrated to the year 2016, using the provincial levels reported in 2015 (NBS, 2016) and applying a demand reduction of 4.7 percent as reported by the NDRC (NBS, 2017b). Coal import licenses are capped to the aggregate 2016 values reported by Fenwei (sxcoal.com, 2017a): 86 MMt metallurgical coal (coking coal and anthracite), 170 MMt other thermal coal, with average import prices set to 561 RMB/ton and 396 RMB/ton, respectively[1].

Two modifications were made to the original module to address shortages in coal supply encountered when enforcing the 2016 capacity cut policies with capped imports. First, excess metallurgical coal supplies can be used to fill a thermal coal supply gap. Second, the fixed coal demand assumption was relaxed by allowing for substitution with fuel oil, as otherwise the model would not converge due to gaps between production and demand. We calibrate the cost of demand substitution as the average price of Heavy Fuel Oil (HFO 180cst) in China in 2016 (CEIC, 2017). Excluding VAT, the price is estimated at 2092 RMB/ton, or a Standard Coal Equivalent (SCE 7000 kcal/kg) of 1431 RMB/ton.

The regional coal production structure and costs are based on data from the IHS Coal Rush study (IHS CERA, 2013) that defines 102 different aggregate suppliers with production broken down by mining method, calorific value and coal processing. The production units presented Table A1 (see Appendix) are categorized by four producer types: State Owned Enterprises (SOE), local provincial enterprises, small Town & Village Enterprises (TVE), and All Others. The 2011 production costs reported in the IHS study are adjusted to the year 2015 using a cost index of 87.7 percent derived from cost of sales data from the CEIC (2017). The total aggregate provincial production capacity in 2015, before capacity cuts were implemented, was estimated at 4.29 billion tons based on (CEIC, 2017) and KAPSARC analysis. The provincial capacity estimates are used to rescale the production structure from the IHS Coal Rush data.

[1] For thermal coal, we use an API 8 index for 5,500 kcal/kg NAR (Net As Received) coal delivered to South China.

Table 1: Model regions and transhipment nodes

Source: National Bureau of Statistics (2016), KAPSARC Analysis

The first scenario represents the hypothetical coal market in 2016 if no capacity cuts had been implemented the *Business As Usual (BAU)* case. Next, we simulate the impact of full compliance by all producers under the 16 percent working day reduction, assuming a proportional drop in the 2015 capacity levels, in addition to a fixed capacity reduction of 125 MMt: the *New Baseline* policy scenario. The fixed capacity reduction was calculated from the nominal capacity cut of 290 MMt (Xinhua, 5 March 2017) multiplied by a 43 percent effectiveness factor sourced from a survey of coal enterprises, which, revealed that idle mines and 'zombie' enterprises accounted for a substantial share of capacity cuts (China Bond Rating, 2016). In order to further analyzing the sensitivity of the market response, the working day and fixed capacity cuts are simulated in isolation, and under an alternate 2015 demand assumption. The breakdown of the regional and aggregate SOE fixed cuts is detailed in the appendix in the Table A2.

Finally, we simulate three additional policy cases that imply either non-compliance with the working day cut, or advanced capacity release, by different producer categories and regions. We simulate a scenario with a 100 percent non-compliance by regions with a net import of coal: *Importers* non-compliance. In the next scenario, we simulate the *TVE and Local* non-compliance assuming a 100 and 50 percent non-compliance by the respective producer categories. In the *SOE (Advanced) Capacity Release* scenario, the working day cut is lifted for advanced state owned enterprises, representing a response by the government to the observed price spike. The scenarios are summarized in Table 2.

Table 2. Summary of scenarios setting

Source: Authors' assumption

In this study, the model is solved as a static partial equilibrium in the year 2016. Therefore, it does not consider time varying dynamics and impacts beyond production and transportation optimization. In practice, policies are implemented gradually over time with induced changes in consumption and reactions by market participants. Although the scenarios do not capture all effects of the policies, they do highlight key outcomes and ways to improve their design and implementation.

4. Results and discussion

4.1. Effects of the capacity cuts

The capacity cut policies applied to the *New Baseline* scenario have a profound impact on the key indicators when compared to the *BAU*. Total systems costs, average national prices, the thermal coal supply gap (filled by either metallurgical coal or fuel oil), total supplies by producer category and coal transportation are shown in the Table 3. The price response is primarily driven by shifts in the supply curve that result in a significant increase of its slope and the cost of marginal production units. Compared to the *BAU*, average production cost (before transportation) increases 27 percent in the *New Baseline*, while the average production cost of the last 200 MMt increases 67 percent.

Table 3. Effects of the coal capacity cut policy: total costs, average price, production and transportation statistics

Source: Modelling results

The combination of the permanent capacity cut and working day restrictions result in a domestic thermal coal supply gap of 72 MMt SCE, in addition to 53 MMt SCE of excess metallurgical coal supplies used as thermal coal. This result showcases that this policy combination is not technically feasible when applied to publicly available capacity data and consumption profiles. In reality, this balance can be closed by one, or a combination, of the following factors: unreported capacity or production, partial noncompliance with the policy and stock depletion. While it is difficult to obtain the data on unreported production or compliance levels, evidence suggests that stock withdrawals of thermal coal from January to October 2016 reached 100 MMt (sxcoal.com, 2017b).

Though the coal market, to some extent, alleviated the impact of the capacity control policies, it is evident that this policy mix is unsustainable from a supply perspective. Comparison of the prices and total costs under the *BAU* and *New Baseline* scenarios further confirms this. The policy intervention caused the national average coal price to increase 138 percent from the *BAU* level. Note that the reported average price reflects our assumption on the value of fuel used to substitute coal demand (1431 RMB/ton SCE). It is not intended to mirror the actual coal prices observed in the market, because, actual prices are also affected by a number of factors not captured by the model. The scenarios highlight the observed trends and illustrates issues with the original design. In Section 4.3 we demonstrate that the price volatility can persist in under the non-compliance scenarios, even when eliminating the supply gap filled by fuel oil.

Concerning the measures proposed by the NDRC (Grade-3, Grade-2 and Grade-1) to stabilize the Bohai rim port price, the model output suggests that it would be insufficient. Even the highest (0.5 MMt) daily output increase specified in the Grade-1 response mechanism would not be enough to cover the supply deficit and increased marginal cost due to substitution for metallurgical coal and heavy fuel oil.

Finally, the capacity cut policy, if fully implemented, would result in a 12 percent increase of total system costs (RMB 138 billion), which include both production and transportation costs. The working day cut essentially limits the optimal production level within and across regional mines, reducing their aggregate efficiency. It also puts additional strain on the rail transportation system increasing the ton-kilometer coal freight by 11 percent.

4.2. Uncertainties from the permanent capacity cut and demand

The output of the *New Baseline* scenario indicates that the combination of the permanent capacity cut of 125 MMt and significant working day reduction (~690 MMt of raw production capacity) is unsustainable, even under the assumption that demand fell 4.7 percent in 2016. This assumption, however, may not entirely represent the reality due to a lack of reliable statistics. In this sub-section, we explore the isolated effects of the two capacity cut initiatives and show how scenarios are affected by demand fluctuations.

We introduce two new policy scenarios applying only the 16 percent capacity cut under the 276 working day policy (*IIIa. New Baseline 16% cut*) and only the fixed 125 MMt cut (*IVa. New Baseline 125 MMt cut)*, summarized in Table 4. A comparison of the scenarios (IIIa vs. IVa) demonstrates that the working day reduction is the main driver of the supply gap and associated price volatility. The simulations show that the permanent capacity cut initiative, on its own, would have had a moderate impact on the market: a 1.4 percent increase in total systems costs and price hike of 11 percent.

In combination with the fixed capacity cut the permanent cuts causes much more serious shocks. This result supports the argument made by Zhang Xiaoqiang, former Deputy Minister of the NDRC, that the NDRC policy to simultaneously close down capacity and limit work to 276 days is wrong (Zhou, 8 March 2017). The systems costs increase is also much more pronounced in case of the working days reduction[2].

Table 4. Comparison of the coal capacity cut policies

Source: Modelling results

To assess the impact of the demand assumption, the scenarios in Table 4 are rerun while increasing demand by 4.7 percent to the 2015 level. Table 5 shows the impact of the *Revised* demand scenarios on the prices and supply gap. The average price levels under the four baseline scenarios (*Ib*-*IVb*) demonstrate the acute sensitivity of the coal price to demand fluctuations. The average price surge and the total supply gap exceed 110 percent and 190 MMt SCE, respectively, under both *IIb* and *IIIb*. The prices under the revised demand assumption increase by 35 percent for the *New Baseline* (*IIa* vs *IIb*) and 51 percent under the *16 % Cut* (*IIIa* vs *IIIb*). Considering the prevailing underreporting of coal consumption (Buckley, 3 NOV. 3 2015), similar demand shocks could have contributed to the unexpected price surge in 2016 and high price level observed in 2017.

Table 5. Revised coal policy scenario results under the 2015 (higher) demand assumption

[2] It should be noted that such reduction is not permanent, because the fixed factors that determine capacity have not been changed.

Source: Modelling results

4.3. Compliance assessment

The significant supply gap found in the full compliance scenarios highlights the market disruption potential of these policies, providing an explanation for the persistent coal price increase in 2016. To address the compliance heterogeneity hypothesis (variations in governance and policy compliance), we report results from the three non-compliance scenarios (*Importers, TVE & Local , SOE Capacity Release)* scenarios under the 2016 demand assumption (Table 6).

Table 6. Partial compliance and advanced SOE capacity release scenarios

Source: Modelling results

Under the three compliance scenarios, significant price increases are still observed, even as the supply gap is reduced. They range from 20 percent under the *SOE* advanced capacity release (non-compliance), to 60 percent under the *Importers* non-compliance scenario. These results suggest that the SOE advanced capacity is essential to recover prices. However, the capacity release proposed by the NDRC in its three-tier policy response mechanism would result in at best a price surge of more than 20 percent and, thus, would not reach its intended goal.

In both the *Importer* and *TVE & Local* non-compliance scenarios, average prices remain high under increased production from units with higher costs, and a persistent supply gap. Increased production from the TVEs also requires additional transportation costs, as those mines are typically further from major demand nodes. These scenarios suggest that under the conditions reported in 2016, even under high non-compliance, a significant price volatility is expected.

It should be noted that our estimation of price levels could be deemed as conservative due to data limitations in representing the coal supply curve. The aggregated supply structure of the model is based on a smooth regional supply curve that likely underestimates the marginal cost of increased production. Furthermore, the cost curve does not replicate the cost differential of the same coalmine at different production levels.

4.4. Regional heterogeneity

The *regional heterogeneity hypothesis* implies that dissimilarities across regions impede implementation of the capacity cut policy causing it to deviate from intended outcomes, both at the regional and national levels. In Figure 4 we illustrate the impact of the *Importers non-compliance*, *SOE capacity release*, and *New Baseline* scenarios (Table 2) on the regional price, including the percent change compared to the *BAU* case. Regions are sorted according to the coal price levels, decreasing from left to right.

Figure 4 Regional prices and percent difference compared to BAU under various scenarios

Source: Modelling results

The results confirm the findings in the literature that no single price can reflect national market fundamentals (Ma and Oxley, 2012; Sheng et al., 2014). Therefore, using FOB Bohai rim port prices as a key indicator in making the capacity cut policy is not always appropriate. For example, Hebei province in the Northern region, where the Bohai rim ports are located, does not display the most significant price spikes observed in Henan, West, Coal Country and, most notably, – up to a threefold increase – in Xinjiang.

In general, the regions with the largest difference between coal production and consumption, either positive or negative, are most vulnerable to the price shocks triggered by the capacity cut policy. The top net coal importing regions (Southwest, Northeast, Central and East) observe the highest absolute price levels, while the largest net exporters (e.g. Coal Country, Xinjiang) record the largest relative increase in price. The latter phenomenon can be explained by increased arbitrage opportunities for domestic producers, who can potentially redirect supplies to the provinces with higher prices, increasing the cost of marginal supplies for local consumers.

Another group of provinces that may be dissatisfied with this policy experience the largest percent increase in prices. Those provinces that had high prices will likely be significantly impacted by the capacity restriction policies, despite the moderate increase in relative terms. For the *Importer* non-compliance scenario this falls in the 50 percent range for most regions, however, several north western regions encounter much higher price shocks. Xinjiang prices increases between 65 and 218 percent even under the relaxed *SOE* capacity release scenario. Henan, West, and the Coal Country regions are also an exception exceeding 70 percent in the Importers non-compliance scenario. The combination of regional supply heterogeneity with non-compliance in regions with supply deficits significantly disadvantages industries in regions that adhere to the policy.

Since the provincial and regional governments have the power of enforcing regulations, the capacity cut policy in such provinces is unlikely to be fully implemented and complied. For example, Guizhou, a part of the Southwest region, had the second highest price in the country before the policies were applied. The subsequent prices spike magnified the panic and prompted the government to undercut the policy implementation. In December 2016, the Guizhou provincial government went even further by subsidizing local coal output and imports from other provinces (sxcoal.com, 2016).

The findings of this study, along with the observed regional mismatch in demand and resource distribution, and transportation capacity limit, pose a question—does China have a national coal market. This thesis has been discussed in the literature (Ma and Oxley, 2012; Sheng et al., 2014). Our finding that there is a lack of national coal market is in in line with the current 13th Five Year Plan which specifies four regional markets (NDRC, 2016). This defies the 'one fit all' approach to policy interventions, which would likely result in local resistance to such measures, even if the national average outcomes turn out to be acceptable.

5. Conclusion and policy implications

The life cycle of the Chinese coal capacity cut and working day limit policies in 2016 present an interesting case study of how government interventions can fail. These policy measures did not address the underlying causes behind misallocation of resources in the coal market and, therefore, did not resolve any of the fundamental market inefficiency problems. However, they led to a number of unintended consequences including supply shortages, abrupt price spikes and distortions in the industry cost curve, thus, increasing the system costs, market volatility and regulatory uncertainty. To our knowledge, no existing study has applied a detailed sectoral model to investigate why these policies did not have the intended effect or what caused the unexpected response in the coal market.

This study has both academic, industrial and policy implications, within and beyond China's economy. We propose that different levels of compliance due to ownership difference and prevailing heterogeneity complicate the implementation of policies designed by the central government. The two hypotheses, based on information asymmetry, are investigated using the extended version of the KEM-China Model.

The results demonstrate that the policy was technically infeasible: full compliance with the proposed measures would cause a significant gap between supply and demand, thereby forcing fuel switching to coal's alternatives. The persistent gap also suggests that the capacity cut and subsequent remediate policies were poorly designed. This implies that either production statistics, the level of compliance, or both were compromised. The simulations also show that capacity cuts result in a significant increase in coal prices and economic costs.

Our results demonstrate that the government's intervention through stepwise release of 'advanced capacity' proved to be insufficient to alleviate the price shocks since there is no way to calculate a link between supply and price. Linking the policy response mechanisms to the national benchmark, the Bohai rim ports price, is inappropriate due to the fragmented nature of the coal market and significant variations in regional price patterns. Using the national benchmark price as a signal ignores regional heterogeneity issues and does not account for the diverse regional interests, which is likely to lead to local enforcement and compliance problems.

The failure of the capacity cut measures was primarily caused by the inappropriate choice and calibration of the policy tools. Moreover, the initial working day limit and subsequent attempts to stabilize the coal prices ignore the problem of information asymmetry. The fact that all the three price targets were broken in a short amount of time indicates that the targets were poorly set. It is not possible to know the exact characteristics of the national supply and demand curve, which is hypothetical in nature. The lack of reliable statistics on coal production and demand effectively make the policy price targets arbitrary.

We can draw the following policy implications and suggestions from our analysis:

First, the capacity cut policy should be differentiated across regions due to the fragmented coal markets, unbalanced distribution of resources and a mismatch between production and demand centres. Given the sheer size of the country, the diversified interests of provincial governments and firms with different ownership, nation-wide policy interventions tend to be inefficient and costly – if not impossible – to enforce. While it is reasonable to limit the production capacity that relies on outdated technologies, the artificial caps on technologically advanced and efficient mining units result in a net warfare loss and decline in safety and productivity performance. Designing capacity cut targets for specific regions or even producers could help ensure better efficiency and feasibility, as demonstrated by the implementation of the permanent capacity cuts in 2016. Besides, a detailed plan coordinated with local governments, released in advance and implemented gradually, would give the market a better opportunity to adjust and alleviate supply and price shocks. However, information availability and compliance enforcement problems would still hinder the effectiveness of such a policy.

Second, market approaches would be preferable to command-and-control instruments. In its August 2016 notice (NDRC et al., 2016), the central government agencies encourage local governments to establish platforms for capacity quota trading, but so far no specific progress has been made. ZHANG Xiaoqiang, the former Deputy Commissioner of NDRC, suggests that capacity cuts should be designed and implemented on a mine-by-mine basis (Zhou, 8 March 2017). This would be cost prohibitive without a market instrument. The coal industry could adapt a ‘cap-and-trade’ approach that has proved to be effective in the fishing industry and, more recently, in the emission trading schemes in many countries. First proposed by John (1968), the usage of cap and tradable permits has a long history in practice and research. The ‘cap-and-trade’ approach would allow the capacity cut quotas to be redistributed to those mines with the lowest compliance costs and thus will reduce enforcement costs. The prices of such permits can be used as an indicator of the level of production capacity at the regional and, potentially, national level. The market-based approach is recommended for future studies on this topic.

Other market based strategies to alleviate the supply and price shocks of these and other policy interventions may include: development of hedging instruments, relaxing the fixed prices along the value chain for more equal price risk distribution and facilitating vertical integration and strategic alliances / partnerships between producers and consumers. Demand side market instruments targeting consumption would also help alleviate the impact of supply fluctuations.

Finally, rather than focusing on overcapacity itself, the policies should target the underlying factors that distort the behaviour of participants and investors. Potential measures may include: strict enforcement of safety, environmental and technological standards, cramping unlicensed capacity and illegal operations, limiting amount of debt that companies can assume and reducing the level of subsidies and other local government support measures. In parallel, local authorities should receive proper incentives and resources to develop welfare and reemployment programs in order to alleviate the hardships of the transition period and relieve coal producers from non-core activities and social burdens. If these hurdles were addressed, the issue of excess capacity – a normal phenomenon in business cycles – and its repercussions for the coal industry, its value chain and socio-economic development of mining regions, would probably be resolved by the market itself. However, these initiatives require addressing a number of complex issues, such as revising the evaluation process of provincial officials, which is beyond the scope of this study.

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6. Appendix

Table A1 Production units with supplier type

Source: IHS CERA (2013), KAPSARC analysis

Table A2 Distribution of fixed regional capacity cuts

Source: Authors collected capacity cut achievement by provinces from various media sources. The data in this table has been multiplied by the 43 percent effectiveness factor from the original report data due to the finding that idle mines and ‘zombie’ enterprises accounted for a substantial share of capacity cuts (China Bound Rating, 2016).

Figure(s) 1

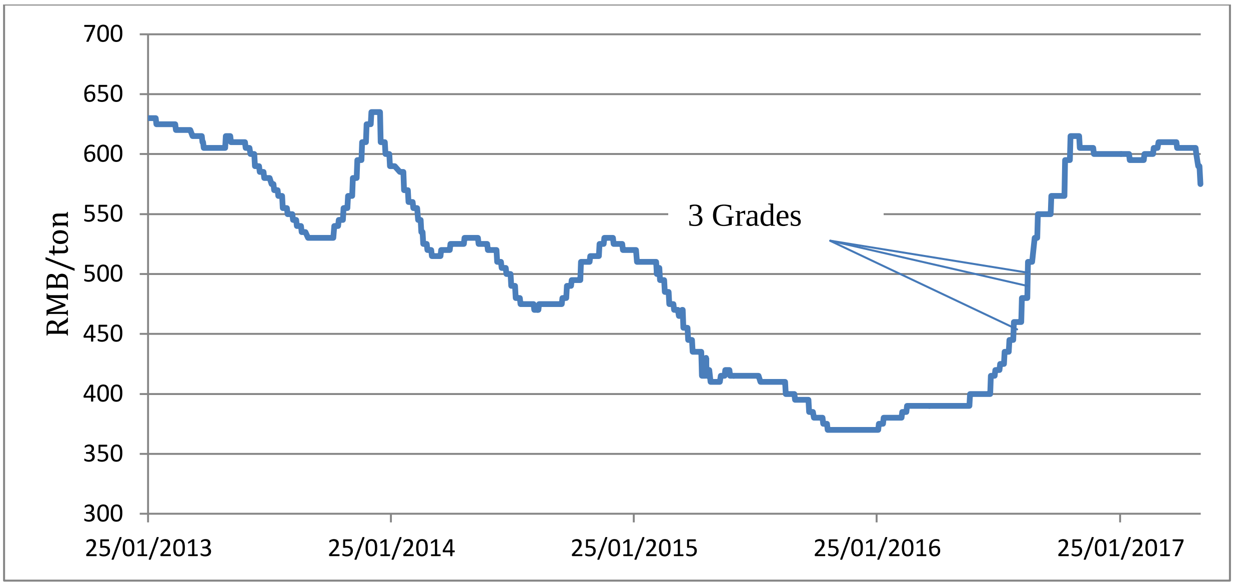

Figure 1 Daily coal price 25/1/2013-25/5/2017, Qinghuangdao port, 5500 kcal/kg

Source: CEIC (2017)

Figure(s) 2

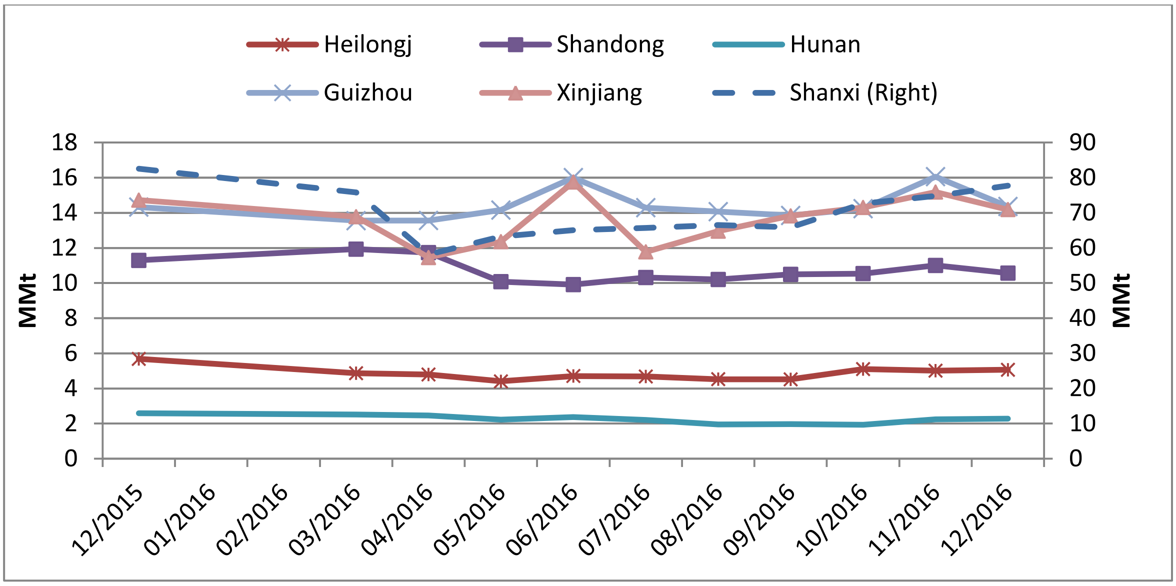

Figure 2 Monthly coal production in major regional markets, MMt

Source: CEIC (2017)

Figure(s) 3

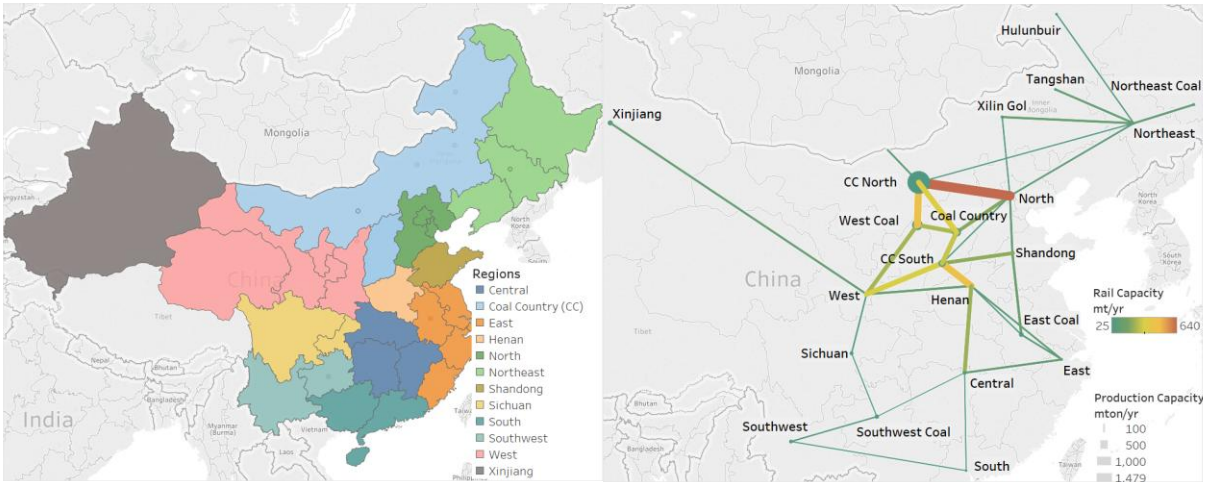

Figure 1 Model regions (left), aggregate production and rail infrastructure (right).

Source: Authors' own work

Figure(s) 4

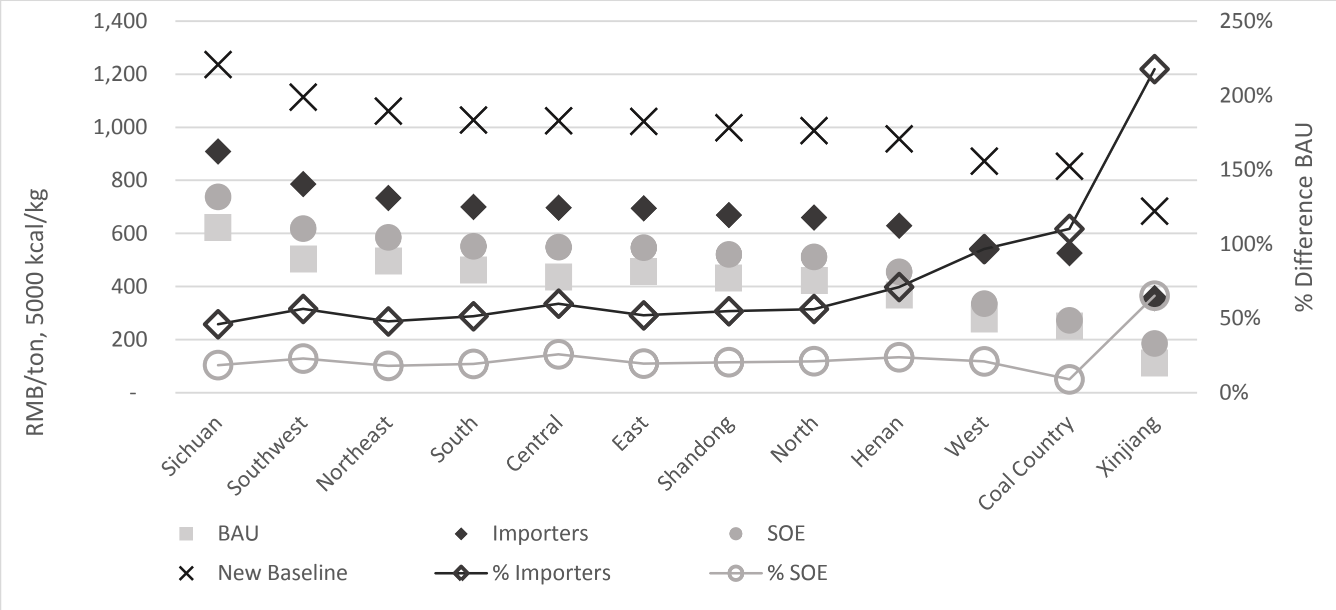

Figure 3 Regional prices and percent difference compared to BAU under various scenarios

Source: Modelling results

Table(s) 1

Table 1: Model regions and transhipment nodes

Region	Provincial Coverage	Demand		Regional Nodes
		Thermal Coal, MMt SCE	Metallurgical Coal, MMt	
Central	Hubei, Hunan, Jiangxi	179	37	Central
Coal Country	Shanxi, Wester Inner Mongolia	236	65	Coal Country Central North Coal Country Region South Coal Country Region
East	Anhui, Fujian, Jiangsu, Shanghai, Zhejiang	379	179	East Eastern Coal Region (Huaibei, Huainan)
Henan	Henan	121	14	Henan
North	Beijing, Hebei, Tianjin	166	41	North
Northeast	Heilongjiang, Inner Mongolia East, Jilin, Liaoning	263	31	Northeast Hulunbuir Coal Region Tangshan Coal Region Xilin Gol Coal Region Heilongjiang and Jilin Coal Regions
Shandong	Shandong	203	20	Shandong
Sichuan	Chongqing, Sichuan	89	129	Sichuan
South	Guangdong, Guangxi	147	42	South
Southwest	Guizhou, Yunnan	104	23	Southwest Southwest Coal Region
West	Gansu, Ningxia, Qinghai, Shaanxi	139	48	West Western Coal Region (Ningxia, North Shaanxi)
Xinjiang	Xinjiang	56	3	Xinjiang

Source: National Bureau of Statistics (2016), KAPSARC Analysis

Table(s) 2

Table 2. Summary of scenarios setting

Scenarios	Level of compliance (reduction)	Remarks
New Baseline	16% reduction	
Importers	Importers 0%	Non-compliance with working days cut in regions with supply deficit
TVE and Local	TVE 0%; Local 8%	Non-compliance with working days cut by small and local producers
SOE	SOE 0%	Advanced capacity release, including SOEs and large private companies

Note: all the policy scenarios include 125 MMt permanent capacity cut.

Source: Authors' assumption

Table(s) 3

Table 3. Effects of the coal capacity cut policy: total costs, average price, production and transportation statistics

		BAU	**New Baseline**
Total Systems Cost, Billion RMB (% diff BAU)		1,169	1,308 (+12%)
Average Coal Price, 5000 kcal/kg, RMB (% diff BAU)		419	998 (+138%)
Thermal Coal Supply Gap in MMt SCE	Metallurgical coal	-	53
	Fuel oil/supply gap	-	72
Total Supplies after processing, MMt	TVE	425	357
	Local	701	642
	SOE	1,448	1,465
	Others	613	665
Transport, billion ton-km	Rail	1,419	1,570
	Sea/River	855	823
	Truck	11	-

Source: Modelling results

Table(s) 4

Table 4. Comparison of the coal capacity cut policies.

Scenarios		**Ia**	**IIa**	**IIIa**	**IVa**
		BAU	New Baseline	New Baseline 16% cut	New Baseline 125 MMt cut
Total Systems Cost, Billion RMB		1,169	1,308	1,258	1,185
Average Coal Price, 5000 kcal/kg, RMB (% diff BAU)		419	998 (+138%)	683 (+65%)	462 (+11%)
Thermal Coal Supply Gap in MMt SCE	Metallurgical coal	-	53	-	-
	Fuel oil	-	72	90	-

Source: Modelling results

Table 5. Revised coal policy scenario results under the 2015 (higher) demand assumption

Scenario		**Ib**	**IIb**	**IIIb**	**IVb**
		Revised BAU	Revised New Baseline	Revised New Baseline 16% Cut	Revised New Baseline 125 MMt cut
Average Coal Price, 5000 kcal/kg, RMB (% diff BAU)		480	1,346 (+180%)	1,028 (+114%)	491 (+2%)
Thermal Coal Supply Gap in MMt SCE	Metallurgical coal	-	183	117	-
	Fuel oil	-	50	73	-

Source: Modelling results

Table(s) 6

Table 6. Partial compliance and advanced SOE capacity release scenarios.

		BAU	New Baseline	Importers	TVE and Local	SOE Capacity Release/non-compliance
Total Systems Cost, Billion RMB (% diff BAU)		1,169	1,308 (+12%)	1,255 (+7%)	1,234 (+6%)	1,224 (+5%)
Average Coal Price, 5000 kcal/kg, RMB (% diff BAU)		419	998 (+138%)	670 (+60%)	618 (+47%)	504 (+20%)
Thermal Supply Gap in MMt SCE	Metallurgical coal	-	53	-	-	-
	Fuel oil	-	72	77	12	-
Total Supplies after processing, MMt	TVE	425	357	402	425	357
	Local	701	642	666	695	630
	SOE	1,448	1,465	1,373	1,441	1,657
	Others	613	665	749	656	559
Transport, billion ton-km	Rail	1,419	1,570	1,454	1,708	1,454
	Sea/River	855	823	888	877	888
	Truck	11	-	14	20	14

Source: Modelling results

Supplementary Material

Click here to download Supplementary Material: Table A1.docx

Supplementary Material
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