

The Research of the Effect of Imported Amount and Price of Bulk Commodity of Coal and Natural Gas on the Profits of Major Thermal Power Enterprises in China—Based on Liner Regression Model

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Abstract--The problem of energy materials' shortage recently drove public attention to the power enterprises. To which extent power enterprises would be affected by the price of coal and natural gas is worthy of investigation. The paper analyzes the tendency towards the change of the amount and price of imported bulk commodity of coal from 2016 to 2021 and further investigates the relationship between the price of coal and natural gas of bulk commodity and the profits of major thermal power enterprises in China by using descriptive analysis, correlation and liner regression model. Enterprises selected are those that not only have more than 75% thermal generators but also with more than 60,000 kilowatts' thermal power installed capacity. Results show that the profit of these enterprises negatively correlates with both the price of coal and natural gas. The extent that the price of coal affects the total profit is far more than that of the natural gas. There is no significant correlation between the profit with the imported amount of coal and natural gas. It is worth mentioning that the price of natural gas is significantly and also positively correlated with its imported amount and the price of coal.

Keywords: natural gas; coal; profits of Chinese thermal power enterprises

1 INTRODUCTION

In recent years, especially during the Covid-19 pandemic, the price of coal and natural gas has witnessed a dramatic increase. The amount of imported coal stayed almost the same in 2020 and 2019 while the demand for electricity increased greatly due to the cold weather and the warming back of China's export. The shortage of raw materials leads to the inadequate supply of electricity. At the end of 2020, some cities in China have limited electricity use while some cities have to suffer complete power cuts. The power industry is of great importance not only for any country's national economy but also for citizens' living conditions. Coal and natural gas are the two major raw materials for electricity production. In China, the price of coal and natural gas is determined by the market while the price of electricity is controlled by the government in [1] and [2], which makes it difficult for power enterprises to maintain profit if the raw materials' prices keep roaring. It hence becomes necessary to investigate the effect of the international bulk commodity price of coal and natural gas on the profits of major power enterprises in China.

In the field, many researchers have investigated how the price of coal or natural gas would affect different aspects or industries in China. For example, Wang & Gao did research on how the price of coal affects the Chinese economy [3]. He & Sun did research on how natural gas prices affect residential consumption and industrial structure in China [4].

In this paper, we mainly focus on investigating how the price or the amount of imported coal and natural gas would affect the profit of Chinese thermal power enterprises. The paper first would summarize the change of the tendencies concerning the amount of imported bulk commodities of coal and natural gas and the price of them in the last five years. Then an analysis based on correlation and multiple liner regressive model would be carried out to investigate the extent to which the prices of international bulk commodity of coal and natural gas would affect the profits of power enterprises.

2 THE TENDENCY DESCRIPTION

Before the investigation of the relationship between the amount, price and the profits, it's necessary to first look at the tendency of the changes in amount and price of imported coal and natural gas in recent years. Since data of the profits of the main power enterprises in China are revealed seasonally, data concerning imported coal and natural gas is also analyzed by seasons.

2.1 The imported amount and price of coal in 2016-2021

The paper investigated both the amount and the price of coal imported from Q1 in 2016 to Q2 in 2021. The price was computed based on the amount and total value in USD of imported coal. The data were sourced from China's General Administration of Customs (CGAC). A study was carried out to manifest the tendency of the amount and price of imported coal in these years.

Through the investigation, we found out that although the price of imported coal increased dramatically in these years, the amount of coal did not decrease but rather increase in most of time. It's worth mentioning that, in the year 2017, the price of imported coal increased to a great extent, in most seasons more than half compared with that in the last year. Such an increase in price surprisingly did not lead to a dramatic decrease of the related imported amount of coal.

As it is shown in the table, the imported amount of coal also increased in the first half of 2017 while it started to decrease only slightly in the second half of 2017. The most severe extent of decrease in amount happened in the third season of 2020. Over 30 percent of decreases made it outstanding among the increasing seasons. A closer look at this phenomenon is taken. Table I displayed China's imported coal from Australia and Indonesia in 2020. This aims at further studying the reason for such a situation. Because according to Wang, these two countries are the top 2 countries for China's coal import [5].

Table 1. 2020 China Coal Import Amount from Australia and Indonesia

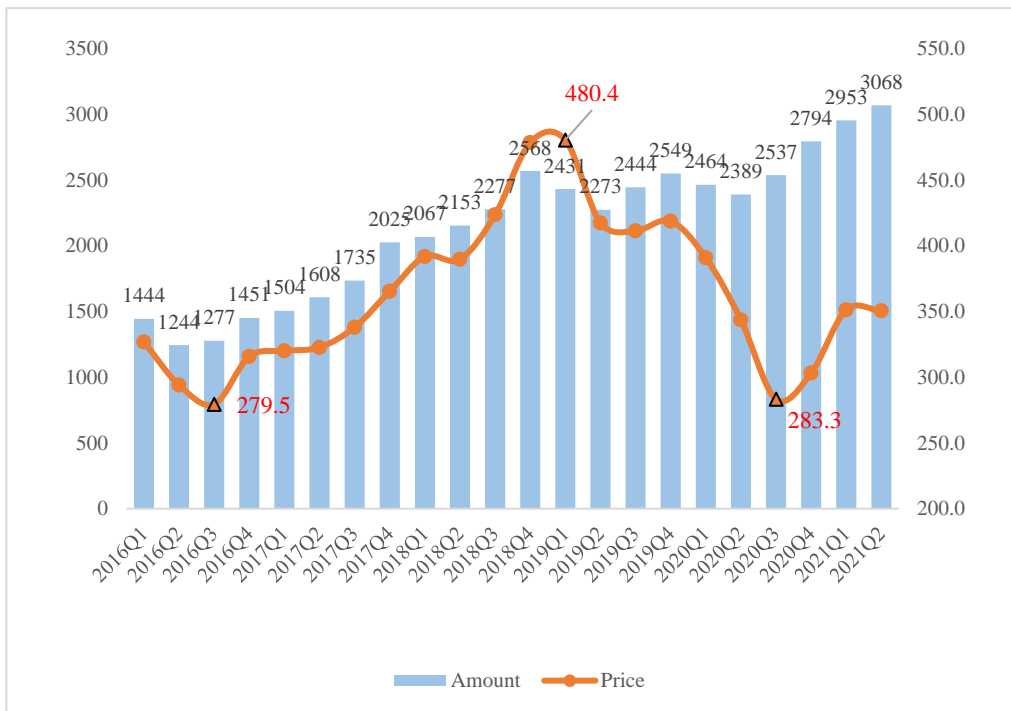
Time	Imported from Indonesia (Value in USD)	MoM (Indonesia)	Imported from Australia (Value in USD)	MoM (Australia)
202001	501089402		1585446994	

202002	304374607	-39.26%	793605554	-49.94%
202003	279578174	-8.15%	1020665357	28.61%
202004	333964200	19.45%	1110180893	8.77%
202005	228636920	-31.54%	524697143	-52.74%
202006	216117174	-5.48%	732098636	39.53%
202007	241624359	11.80%	861926738	17.73%
202008	173738278	-28.10%	565729519	-34.36%
202009	161443434	-7.08%	382159567	-32.45%
202010	79696980	-50.63%	223764350	-41.45%
202011	79150419	-0.69%	49782003	-77.75%
202012	525167680	563.51%	5802570	-88.34%

As shown in Table 1, the amount of imported bulk commodity of coal decreased most of time in 2020 in both countries. This coincided with the above result. However, the decrease in the extent of the amount of coal imported from Indonesia is not that much compared with that from Australia. As it is shown, coal imported from Australia decreased mostly by more than 30%, especially in the last season. The extent of decrease is relatively high at 77.75% in November and 88.34% in December when compared with the last month. It is worth mentioning that at the end of 2020, the total imported amount of coal from Australia is only around 0.37% of that at the beginning of the year. On the contrary to the huge decrease in the amount imported from Australia, in December, the imported amount of coal from Indonesia increased dramatically at 563.51% compared with that in November. Nevertheless, this is only 4.8% increase compared with the amount in January. The total imported amount from these two countries at the beginning of 2020 at 2,086,536,396 is almost four times more than that at the end of the year at 530,970,250. This coincides with the above result when a 94.52% sharp increase of imported amount of coal at the Q1 MoM is captured.

2.2 The imported amount and price of natural gas in 2016-2021

As for natural gas, the price is a little more complicated than that of coal because imported natural gas can be divided into two types—liquid and gas. Here in this paper, we adopted data for general natural gas imports classified by the CGAC to analyze from a general perspective and no longer classify it.



Graph 1. 2021 Imported Amount and Price of Natural Gas

In Graph 1, the amount of imported natural gas is increasing steadily with time, however the price of it fluctuates. In terms of the amount of imported natural gas as a bulk commodity, a clear increase tendency from 2016 to 2018 was shown before it started to decrease slightly in 2019 and maintained quite a long time to Q3 in 2020 until it started to increase again. It is important to note that during almost the same period, from Q3 in 2020 till now, the price of imported natural gas increased as well. The increasing price, as the same situation as that of coal import, does not limit the imported amount of natural gas.

As it can be seen, the price of natural gas reaches the highest point in Q1 in 2019 at around USD 480.4 per ton, which is around 40% more than that in Q4 in 2016 when the price reaches the lowest point at USD 279.5 per ton. Though the price is 40% higher, the amount of imported natural gas at the same time is also around 40% more. When making comparison of data in 2016 Q3 with 2020 Q3 when the price of natural gas is around the same at USD 279.5 and USD 283.3 per ton respectively, the amount of imported natural gas still doubled in these five years.

Therefore, although the price of both coal and natural gas is either roaring or fluctuating in these five years, the imported amount of coal and natural gas is not reduced accordingly. This somehow proves that the price has very little effect on the amount of imported coal and natural gas. The amount of imported coal and natural gas, though witnessed some fluctuations, is generally increasing with time which hence makes it not difficult to say that the demand of coal and natural gas in China is not declining but rather increasing with time, at least in recent five

years. Under the situation of increasing demand of imported coal and natural gas with controlled electricity prices, will the power enterprises suffer relative loss is a question worth investigating.

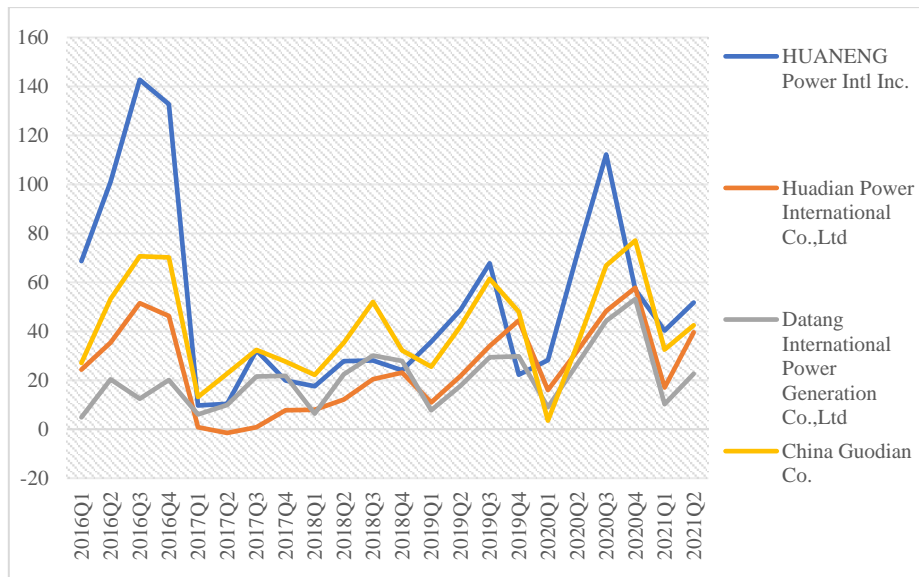
2.3 The major thermal power enterprises selected in China and their profits from 2016 to 2021

An analysis is carried out to investigate the changes in the profits for main Chinese thermal power enterprises. When doing analysis of the power industries, in the field, many researchers tend to select all the listed companies. Like Yuan & Zhao selected all the listed companies that are classified coal and power industries by Sina Finance in China [6]. In this paper, the main thermal power enterprises are selected according to the following criteria:

- Since paper is correlating the price of coal and natural gas with the profit, the enterprises selected must be those whose main focus is on thermal power generation. In this paper, the enterprises whose installed thermal power generation constitutes more than 75% of the whole installed generation are selected.
- Since in this paper, we are emphasizing on main Chinese thermal power enterprises, only those with the scale of more than 60,000 kilowatts thermal power installed capacity enterprises are selected.

It is worth mentioning that, for some enterprises, like SDIC Power Holdings Co., Ltd., even though its scale of thermal power installed capacity is not low, thermal power installed capacity only constitutes around 40% of its whole installed capacity. It may not be representative. Therefore, this kind of enterprise is not selected.

According to the above selection criteria, the following four Chinese thermal power installed capacity enterprises are chosen. They are Huaneng Power Intl Inc., Huadian Power International Co., Ltd., Datang International Power Generation Co., Ltd., and China Guodian Co. The data were sourced from the open financial reports from these listed companies. This sequence is arranged by its thermal power installed capacity.



Graph 2 2016-2021 Top 4 Chinese Power Enterprises' Profits

Graph 2 showed a very clear fluctuation in the profits of these five power enterprises. Especially for each year, Season 1 is the time when the lowest profit is gained. This is maybe because during Season 1, it's usually Chinese lunar new year, many factories and companies are taking a holiday off. The demand for electricity, especially for industrial electricity, is the lowest in the whole year. The declining demand for electricity leads to the reduction of electricity production, which in turn causes low profits.

Besides that, three out of four power enterprises here, including Huaneng Power Intl Inc., Huadian Power International Co., Ltd. and China Guodian Co., the profits are decreasing from 2016 to 2017. Only Datang International Power Generation Co., Ltd. maintained its profit in 2017. From 2017 to 2019, the profits start to increase steady but also slowly until it began to increase more in 2020. In spite of that, the profit for some enterprises, including Huaneng Power Intl Inc., the No. 1 Chinese thermal power installed capacity enterprise, still does not come back to that in 2016.

Since there was a clear increasing tendency above concerning the imported amount and price of coal and natural gas in these five years, it urges an investigation to be taken to examine the relationship between them with the profits of the main power enterprises in China.

3 ANALYSIS AND DISCUSSION

In this chapter, some relevant models would be selected to do analysis, the results would be displayed and discussed.

3.1 Model used

In this paper, a correlation analysis is adopted to first check whether there's any correlational relationship between the 5 main variables: the amount of imported coal, the price of imported coal, the amount of imported natural gas, the price of imported natural gas and the total profit. The profit is calculated based on the total amount of the profit of the above-mentioned four thermal power installed capacity enterprises.

Then, after the correlation analysis, further examination of the relationship would be carried out by running regression analysis. Through regression analysis, the exact correlational relationship and the extent to which one particular variable would affect another can be looked into in more details.

3.2 Results and Discussion

A correlation analysis ran first to investigate the correlational relationship between the amount, price of coal and natural gas and the profit for these top 4 thermal power installed capacity enterprises. As shown below in the Table 2, there is significant negative correlation between the profit with both coal and natural gas prices while there's no significant correlation between it with the imported amount of both coal and natural gas. Moreover, for natural gas prices, there is a significant positive correlation relationship with both coal prices and the imported natural gas amount. This will be further analyzed by regression analysis and the possible reasons are to be discussed.

Table 2. Correlation results for the five variables

		Coal Amt	Coal Price	Natural Gas Amt	Natural Gas Price	Total Profit
Coal Amount	Pearson Correlation	1	.315	.166	.175	-.033
	Sig. (2-tailed)		.154	.461	.437	.885
	N	22	22	22	22	22
Coal Price	Pearson Correlation	.315	1	.317	.566**	-.602**
	Sig. (2-tailed)	.154		.150	.006	.003
	N	22	22	22	22	22
Natural Gas Amount	Pearson Correlation	.166	.317	1	.446*	-.041
	Sig. (2-tailed)	.461	.150		.037	.855
	N	22	22	22	22	22
Natural Gas Price	Pearson Correlation	.175	.566**	.446*	1	-.468*
	Sig. (2-tailed)	.437	.006	.037		.028
	N	22	22	22	22	22
Total Profit	Pearson Correlation	-.033	-.602**	-.041	-.468*	1

	Sig. (2-tailed)	.885	.003	.855	.028	
	N	22	22	22	22	22
**. Correlation is significant at the 0.01 level (2-tailed).						
*. Correlation is significant at the 0.05 level (2-tailed).						

Since the coal price is significantly correlated with the profit at 0.01 level, a further regression analysis about it is carried out to look into more details. The results are displayed below in Table 3. As shown in the table, the Sig=.003<.01 proves a significant difference. The price of coal, coincides with the above result, affects the profit of power enterprises. Furthermore, B=-3.439 shows that this is a negative correlational relationship. When the price of coal increases, the profit of main thermal power installed capacity enterprises would decrease. The formular generated is as follows:

$$Total\ profit = 462.057 - 3.439 \times coal\ price \quad (1)$$

Table 3. Regression analysis results between coal price and total profit

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	392.922	76.690		5.123	.000
	Coal Price	-3.439	1.020	-.602	-3.370	.003

a. Dependent Variable: Total Profit

As for price of imported natural gas of bulk commodity, it shows a significant correlation with the profits as well. As shown below in Table 4, the Sig=.028<.05 which proves a significant difference. The price of natural gas also affects the profit of power enterprises. Furthermore, B=-.616 shows that this is a slightly negative correlational relationship. When the price of natural gas increases, the profit of main thermal power installed capacity enterprises would decrease slightly. The formular generated is as follows:

$$Total\ profit = 362.314 - 0.616 \times natural\ gas\ price \quad (2)$$

Table 4. The Regression analysis results between natural gas prices and the total profit

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	362.314	95.625		3.789	.001
	Natural Gas Price	-.616	.260	-.468	-2.370	.028

a. Dependent Variable: Total Profit

Even though there is a significant correlation between imported natural gas prices with the total profits of these four thermal power enterprises. The extent to which the price of natural gas affects the total profits is not much, especially when compared with that of the coal price. This is maybe because gas generators only constitute a little part of the whole installed generators in major Chinese thermal power installed capacity enterprises. For example, in the No. 1 thermal power installed capacity enterprises, Huaneng Power Intl Inc., gas generators only constitute around 11% in 2021. For other enterprises like Datang International Power Generation Co., Ltd., this number goes down to only around 8%. This would possibly make the profit that gained by gas generators somehow be covered by that gained by coal generators. The extent thus becomes less by comparison.

As for imported coal amount as a bulk commodity, it does not significantly correlate with profit. Because in the first place, as shown in Table 2, the imported amount of coal does not significantly correlate with its prices. To explain more, a regression analysis is done. The result shows that there is no significant correlational relationship between imported coal price and amount. The change in price does not significantly affect the related imported amount. This means that how much coal is going to be imported is not mainly based on its price, in other words, even when the price is high, if there's a need to import coal, the enterprises would do it. Secondly, time when we import coal is actually not time when we use it, in other words, there is time lag in the use of coal. These might be some of the reasons why the coal price does not affect imported coal amount.

Moreover, the amount of imported natural gas does not significantly affect the profit of the profits of these thermal power enterprises neither. The main possible reason would be that in China, not all imported natural gas is used for electricity generation. It is worth mentioning that a large amount of natural gas imported is used in some other industries. Take porcelain factories as an example, they are huge natural gas consumers. Furthermore, a certain amount of natural gas imported is used by citizens in their daily lives.

As for the price of natural gas, it is significantly correlated with the coal price (at 0.01 level) and imported natural gas amount (at 0.05 level). This is further testified by the result of following Table 5 where the coal price significantly affects the price of natural gas.

Table 5 The Regression analysis results between coal price and coal amount

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	
	B	Std. Error	Beta			
1	(Constant)	181.456	60.165		3.016	.007
	Coal Price	2.459	.801	.566	3.072	.006
a. Dependent Variable: Natural Gas Price						

This result coincides with research of Sun & Xie who have investigated the relationship between the price of coal, natural gas and crude oil and concluded a long-term positive correlation relationship in between [7].

Interestingly, it's worth to mention the positive correlation relationship between the price of natural gas and the imported amount. Though the correlational relationship is not so strong, it is still significantly correlated.

Table 6. The Regression analysis results between natural gas price and its imported amount

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	636.519	686.575		.927	.365
	Natural Gas Price	4.159	1.866	.446	2.228	.037

a. Dependent Variable: Natural Gas Amount

As demonstrated in the above Table 6, $\text{sig}=.037 < .05$, the natural gas price significantly affects the imported natural gas amount. This maybe is somehow beyond the normal expectation that the relationship shown is positively correlated but not negatively. Because it means that when the price gets higher, the imported amount of natural gas also increases. When we look back at the Graph 1, it's clearly shown that the amount of imported natural gas is increasing by time even though there have been fluctuations of the natural gas price meanwhile. From 2016 to 2021 in China, the demand for natural gas keeps increasing not just because the gas electricity generators are installed more in these thermal enterprises. For example, in Huadian Power International Co., Ltd., the gas electricity generators only constitute around 9 percent in 2017 while around 15 percent in 2021. But also, under the idea of environmental protection and green development, the use of natural gas in other industries and citizens daily life keeps increasing. Therefore, the imported amount of natural gas may possibly be more affected by its demand not by its price. The increase of price hence does not restrain the demand of natural gas which may possibly lead to this positive correlational relationship to being shown.

4 CONCLUSION

To be concluded, in terms of the tendency of the change concerning the imported amount and price of coal and natural gas, from 2016 till now, there has been a dramatic increase in the coal price which has almost doubled in these years. The price of imported natural gas however fluctuated during this period. It increased from 2016 to 2018 before it reached its peak in 2019 and gradually fell down before it went up again in 2020. Regardless of such change in price, the imported amount of both coal and natural gas increased most of the time. This proves that the price of imported coal and natural gas does not restrain the need for their importation. There is even a positive correlational relationship between the imported natural gas amount and its price.

For the profit of four selected thermal power installed capacity enterprises, for each year, Season 1 is time that the lowest profit is gained. As discussed above, this is maybe because during Season 1, the demand for electricity, especially for industrial electricity, is the lowest among

the whole year. The declining demand for electricity leads to the reduction of electricity production, which in turn causes the low profits.

It is important to mention that from 2016 till now, these enterprises do not seem to maintain a good profit increase. The No. 1 Chinese thermal power installed capacity enterprise, Huaneng Power Intl Inc., still do not come back its profit in 2016. Therefore, the increased price of imported coal and natural gas must somehow affect their profits. This is further testified by the correlation and regression analysis where there demonstrated significant negative correlational relationship between the profit with both the price of coal and natural gas. Nevertheless, according to the result of regression analysis, the extent to which the coal price affects the profit is larger than that of natural gas. As discussed above, this maybe because the gas generators only constitute a small part which may make the profits gained by them be covered by that from coal generators. Therefore, the extent to which the price of natural gas affects the total profit becomes less.

There is no doubt that there have been some limitations in this paper. In the first place, data selected only focused on five years. Furthermore, like mentioned above, the gas generators only constitute a little part of the whole installed generators and not all imported natural gas are for electricity production use. This hence may make the result less representative. In further research, it is recommended to eliminate such affected elements.

REFERENCES

- [1] WangFang, & Zhang Wei. (2018). Study on earnings management behavior of thermal power Enterprises under the combined policy of coal and electricity. *Communication of Finance and Accounting*, p.94-99.
- [2] Song Wei. (2015). Development of thermal power industry and the formation of "electricity shortage"-- Analysis based on the contradiction between "market coal" and "planned electricity". *Research on Financial and Economic Issues*, p. 33-38.
- [3] WangLijie, & GaoZhiyuan. (2015). Research of the Effect on Chinese Economics Due to the Rise in the Price. *Ecological Economy*, p.66-69.
- [4] HeYongda, & SunWei. (2017). The Impact of Price Fluctuations of International Natural Gas on residential. *Journal of Yunnan University of Finance and Economics*, p.72-81.
- [5] WangYaqin. (2018). Prediction of China's coal import and export under SIno-US trade war. *Coal Market*, p.9-13.
- [6] Zhao, & Yuan. (2016). An empirical research on the financial performance relationship between China's coal and electricity industries. *Journal of Arid Land Resources and Environment*, p.19-24.
- [7] SunRenjin, & XieLiang. (2020). Study on the Price Relationship among Crude Oil, Natural Gas and Coal. *Prices Monthly*, p.16-24.