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A Comparative Study on the Dynamic Correlation Effect of Foreign and Domestic Gasoline and Diesel Price Fluctuations

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Abstract

This paper uses the law of one price (LOP) and the DCC-GARCH method based on ten-day price sequences. The findings indicate that, compared with the international refined oil markets with mature market-oriented pricing mechanisms, only in the Chinese market do gasoline and diesel prices meet the LOP. This finding shows that, in the context of the gradual integration of the global refined oil market, the international level of China's refined oil price is still quite low. The price reforms pertaining to China's refined oil products still need to be pushed forward in the direction of marketization and internationalization.

Keywords: Gasoline & diesel prices; Correlation effect; Marketization reform**AMS 2010 codes:** 97D10; 91B55.

1 Introduction

The report of the 18th National Congress of the Communist Party of China points out that China should deepen the price and taxation reforms of the country's resource products. A paid-use resource system and an eco-compensation system that reflect market supply and demand should be implemented. The scarcity of resources, ecological value and intergenerational compensation should also be considered, and a multi-energy collaborated price system should be constructed. These steps are necessary to ensure China's energy security. The 18th Third Plenary Session of the Central Committee points out that China should adhere to the aim of ensuring the market plays a decisive role in resource allocation and in deepening economic system reforms. Oil resource's price and taxation reform should also be further promoted. Refined oil is one of the staple goods that affect the national economy and people's livelihoods. Therefore, realizing the marketization of refined oil prices, even on a gradual basis, is a necessary step to achieving the abovementioned reform objectives. With the rapid development of

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the national economy, China's consumption of refined oil has been growing continuously; the dependence on foreign oil has been increasing year-by-year. In terms of international oil trade patterns, China's proportion of refined oil trade is increasing rapidly. Refined oil is becoming one of the international goods circulating the globe. Gradually, a unified international refined oil market is forming. China's marketization reform in terms of refined oil is attracting vast international attention. The basis and core of any market mechanism is the price mechanism. Therefore, the core of China's oil marketization reform is effective price reform. Under the conditions of a market economy, price is the most important economic signal. The timeliness and sensitivity of refined oil price fluctuations directly affect the economic behaviors of the parties involved in supply and demand. In China, the price forming mechanism for refined oil has experienced several stages. In the beginning, there was rigid planned pricing. Then, foreign pricing was passively followed. Finally, oil product prices were independently regulated and controlled by using foreign crude oil prices as a reference point. Now, China's refined oil prices show an increasing degree of marketization and an increasingly stronger ability to reflect the actual supply and demand situation relating to refined oil.

The existing refined oil forming mechanism in China was formed gradually, beginning immediately after China's National Development and Reform Commission (NDRC) issued the *Oil Prices Management Method (Tentative Version)* on May 7th, 2009. On March 26th, 2013, the NDRC further improved the refined oil mechanism. On this occasion, the price adjustment cycle was reduced, and the previous limitations on the range of adjustment were eliminated. Can China's gasoline and diesel markets spontaneously form relatively independent prices (under the guidance of government) in a new price running mechanism? This paper focuses on the price performance of gasoline and diesel after China's refined oil pricing mechanism was improved. Using the mature, market-oriented international refined oil markets as a reference point, this paper researches the price fluctuation correlations between gasoline and diesel. These are the two most important products obtained from crude oil in the refining and decomposition process. Because the production costs of gasoline and diesel are both affected by price fluctuations of the common raw material, crude oil, it is only normal that gasoline and diesel price changes have a high degree of correlation. However, there are different levels of demand for gasoline and diesel in the Chinese market. Specifically, in China, 80% of gasoline is used as automobile fuel, while approximately 50% of diesel is used by the transportation industry; the other half is used in agriculture and industry. Therefore, gasoline has the strong characteristic of being a consumer good, while diesel plays more of the role of an industrial product or means of production.

Our research finds that no standard differences exist between gasoline price changes and diesel price fluctuations in China, particularly as compared with the world's three major refined oil markets. The over-close price fluctuation linkage indicates that China's gasoline and diesel price-forming markets are very dependent on the government's price guidance. However, these markets cannot sensitively reflect the different fluctuations of supply and demand situations in China's gasoline and diesel markets. This situation could ultimately and almost inevitably cause a distortion of the relative prices of gasoline and diesel. This is the sign of the immaturity of China's market mechanism.

Not only that, as the proportion of refined oil in the world's oil market rises rapidly, the world is strengthening the integration of the refined oil market. The world's three major refined oil markets all have very high dynamic relationships between fluctuations in the prices of refined oil. However, in the Chinese market, the dynamic relationship between refined oil price fluctuations is relatively low. This result indicates that the degree of the internationalization of China's refined oil price fluctuations is still low, and this is not compatible with China's increasing dependence on external oil.

2 Research background and China's gasoline and diesel price forming mechanism

China's refined oil price forming mechanism experienced a transformation process that moved from government-planned pricing to market-oriented pricing, albeit under government guidance. The mechanism also moved from using international refined oil prices as a reference point to using international crude oil prices the main refer-

ence point, and from using administrative control and regulation as the primary approach to using various control measures. China's refined oil price evolution can be divided into the following main stages:

2.1 Stage of state-planned pricing according to the development requirements of the domestic economy

From the time China first established its national oil refining industry up to the year 1982, the country's oil industry was a state-owned business, invested in and directly managed by the state. The oil industry was integrated into the overall government administration and was thereby highly monopolized. Corresponding to the planned economy that was being implemented at that time, refined oil (as the main strategic good) followed the same rules of unified state allocation as crude oil. As such, the price of refined oil could and must have been set and adjusted by the government. The prices were also strictly implemented. At that stage of the country's history, there was no refined oil market, let alone any market-oriented pricing of refined oil. During the period from 1982 to 1994, with the implementation of China's economic reform and opening-up policy, the market economy started to develop. Various main goods and materials entered a dual-track pricing stage, during which prices both within and outside the economic plan existed. To adapt to the dual-track system of upstream crude oil prices, refined oil prices also experienced the phenomenon of multiple price forms, including both in-plan and out-of-plan prices. Then, from 1994 to 1998, as China changed from a net exporter of oil to a net importer, the country was suddenly faced with an international oil market dominated by OPEC and large western oil companies. China elected to once again implement unified state pricing of refined oil, after the integration of in-plan and out-of-plan prices. This step was taken in order to avoid the chaos caused by the dual-track system and to better deal with the influence on China of international crude oil prices.

2.2 Stage of state-guided pricing based on international market prices

After 1998, as China's dependence on foreign oil continued to increase, bringing the state price of refined oil in line with international oil prices became an inevitable requirement. On June 3rd, 1998, the original SDPC (State Development Planning Commission) issued the *Reform Plan of Crude Oil and Refining Oil Prices*. The plan changed the way the prices of crude oil and refined oil were formed from the original state pricing method into state-guided pricing. This allowed China to basically achieve the required linkage to international prices. The original SDPC considered refining oil (gasoline and diesel) retail prices and basing them on the import tax-paid costs of gasoline and diesel in Singapore. The SDPC then added the freight costs and miscellaneous charges, calculated according to a reasonable flow direction from the refinery plant to gas stations. Then they added the standard retail price mark-ups in various places, calculated according to the different operational rates between wholesale and retail businesses. Following on from these steps, the SDPC adjusted the prices whenever gasoline and diesel trade prices' cumulative fluctuations exceeded 5% in the Singaporean market. Then, two state-owned oil and gasoline group corporations (CNPC and CPDC) set specific retail prices within the range of $\pm 5\%$. In November 2001, the monthly adjustments of refined oil prices were changed. They became irregular adjustments that were based on the amplitude of oil prices in international markets. The weighted mean of package prices (6:3:1) in the Singapore, Rotterdam and New York markets were considered to be the pricing basis. Then, according to the basic miscellaneous expenses and inland customs dues and adding the refined oil circulation expenses determined by the state, the domestic refined oil's standard retail prices as set by the SDPC were formed. Meanwhile, according to the abovementioned provisions, two state-owned gasoline group corporations could make specific refined oil retail price changes (based on the standard prices) by increasing or decreasing within a range of 8%.

2.3 Stage of state-guided pricing indirectly linked to international oil markets

On March 26th, 2006, the NDRC issued the *Comprehensive Supplementary Reform Plan to Improve the Oil Prices Forming Mechanism*. This plan proposed changing refined oil prices by basing them on international crude oil prices. Refined oil prices began to be indirectly linked to international crude oil prices, rather than

being directly linked to international refined oil prices. Refined oil's guide price benchmarks were changed from the refined oil prices of Singapore, Rotterdam and New York into the crude oil prices of Brent, Dubai and Minas. The refined oil price benchmarks were calculated by the weighted mean of Brent, Dubai and Minas crude oil prices, plus the refining cost and proper benefits, related transportation and circulation expenses and various taxes. When the moving average price of crude oil in international markets exceeded 4% over 22 workdays, China's domestic refined oil prices could be adjusted. On May 7th, 2009, the NDRC officially issued the *Gasoline Prices Management Method (Tentative Version)*. This method changed the policy under which the government set the standard guide price of refined oil into a policy where the government set the ceiling price. The new policy also specified that, when the moving average of crude oil prices in the international market exceeded 4% over 22 workdays, China's domestic refined oil prices could be adjusted correspondingly. On March 27th, 2013, the NDRC reduced the price adjustment cycle for China's refined oil price mechanism to 10 days. They also eliminated the price adjustment range limitation of 4% and adjusted the varieties of crude oil in the international market that were attached to domestic refined oil prices.

Currently, China implements government-guided refined oil prices, except for the oil products supplied to "special users", such as the state reserve or Xinjiang construction corps. The oil prices for these users are still set by the government. The government publishes the ceiling for refined oil retail prices only in the form of draft information. Enterprises that sell refined oil can independently set the prices of refined oil. These prices are generally set according to market competition and supply-demand state, but they do not exceeding the government's ceiling price. The marketization reform of the refined oil pricing mode has basically been completed.

3 Studies of the relationship between gasoline and diesel prices

In the developed countries of Europe and America, a large number of studies have been conducted on refined oil prices in the energy and economic fields. This research tends to focus on the relationship between refined oil prices and crude oil prices, such as the reaction of refined oil price fluctuations to crude oil price fluctuations. Bacon and Robert W. [1] called the phenomenon whereby refined oil prices react to crude oil price rises more sensitively than to price declines the "rock and feather". Borenstein, Severin, Cameron, Colin A., Gilbert and Richard [2] found that the UK's refined oil price fluctuation reactions to crude oil price fluctuations had an asymmetry problem. Kaufmann, R.K. and Laskowski C. [3] proved that the asymmetric transmission of price did exist in the American refined oil market by using an asymmetric error correction model. However, some researchers have also drawn different conclusions when studying the situations in other countries. Rob Godby, Anastasia M. Lintner, Thanssis Stengos and Bo Wandscheider [4] researched the relationship between refined oil prices and crude oil prices in the Canadian market. The results showed that refined oil price reactions to crude oil price fluctuations had no obvious asymmetry. Leon Bettendorf, Stephanie A. van der Geest and MarcoVarkevisser [5] studied the weekly data of the Netherlands gasoline market. They concluded that the research results were different when selecting different data. Some scholars explained the differences in research results. Balke, N. S., S. P. A. Brown, and M. K. Yücel [6] believed that whether or not research results had asymmetry was related to the research methods and models adopted.

Recent studies have focused on the relationship between energy prices and the factors that influencing those prices [7–10], as well as energy price trends and pricing models. Asche et al. [11] researched monthly price data and came to the conclusion that international diesel prices and crude oil prices have a relatively stable price relationship. For many years, China's refined oil prices were strictly controlled by the government. As such, any domestic studies in this field mainly focus on the relative price problems of different varieties of energy. Most of these studies conclude that relatively reasonable energy prices (different varieties of energy) are an important sign of market maturity in terms of the running of the energy market. Ying Fan and Jianling Jiao [12] found no evidence of a stable price relationship between international crude oil prices and Chinese refined oil prices. Hua Liao, Zhishuang Zhu and Yu Zhang [13] empirically tested the market price linkage problem of the three top

regional natural gas markets in the world. The researchers concluded that a globally unified natural gas market was forming. Someone believed that, in developing countries, energy prices generally display a low degree of marketization. The study also found that the relative prices of different energy varieties energy were seriously distorted. Shu Li and Ya'nan Li [14] proved by using an empirical research method that the retail price of refined oil was the most important influencing factor of China's refined oil output. Xiucheng Dong [15] believed that, although the revised *Oil Prices Management Method* reduced the price adjustment cycle and accelerated the frequency of price adjustments, it still failed to meet the requirements of real-time adjustments, according to market supply and demand.

Current studies mainly focus on the problem of the transmission of international crude oil prices to domestic refined oil prices, along with the price linkage of the same variety of refined oil in different areas. Few studies have been conducted that examine the relative independence of China's gasoline and diesel price fluctuations. This is especially true of studies of the relationship between the range of China's gasoline and diesel price changes after the implementation of the new price adjustment mechanism since March of 2013.

4 Data

Currently, there are three refined oil price centers in the world, namely Rotterdam in Europe, New York in America, and Singapore in Asia. These three refined oil markets all adopt a market-oriented pricing mechanism, in which gasoline and diesel prices are fully decided upon by the current state of supply and demand in the market. We therefore use the market data of Rotterdam, New York and Singapore to represent European, American and Asian gasoline and diesel prices as denoted by EP_g , EP_d , MP_g , MP_d , AP_g and AP_d , respectively. The gasoline and diesel price variables in China are denoted by CP_g and CP_d . For comparison purposes, the paper studies the gasoline and diesel price fluctuation data, both in China and in the three international refined oil markets. The ten-day data of gasoline and diesel prices from February 2014, to July 2019, were adopted; blank and invalid data were eliminated. The study covers a total of 129 periods, and the data were collected from the National Bureau of Statistics of China, JLC data center and Wind database.

To eliminate the influence of heteroscedasticity, we first apply the natural logarithm operation to the original price data. This allows us to obtain the logarithmic data sequences of gasoline and diesel prices in the various markets. Then, the different sequences of the logarithmic data of gasoline and diesel prices in each market were obtained. The variables $DLNCP_g$, $DLNEP_g$, $DLNMP_g$ and $DLNAP_g$ are used to represent the gasoline price fluctuations in China, Europe, America and Asia, respectively. The variables $DLNCP_d$, $DLNEP_d$, $DLNMP_d$ and $DLNAP_d$ are used to represent the diesel price fluctuations in China, Europe, America and Asia, respectively.

5 Measurement model

First, on the basis of testing the data's stationarity, we adopt the Johansen co-integration method to test the long-term equilibrium relationship between gasoline price fluctuations and diesel price fluctuations in the different market different areas. Then, on that basis, the LOP is used to test the relative independence between gasoline price fluctuations and diesel price fluctuations in the different market areas. The LOP can be expressed with the following formula:

$$DLNP_{gt} = \alpha + \beta DLNP_{dt} + \varepsilon_t$$

Here, P_{gt} and P_{dt} represent the price time sequences of gasoline and diesel, respectively; t is a time variable, and ε_t is a constant term representing the price variance caused by the difference in transportation and production costs. In addition, β is the correlation coefficient of the prices of two types of refined oil products. If $\beta = 0$, there is no dependence between gasoline price fluctuations and diesel price fluctuations, i.e. gasoline price fluctuations and diesel price fluctuations are somewhat independent. The closer β is to 1, the stronger is the

correlation between the two refined oil price fluctuations. When $\beta = 1$ is valid, $DLNP_g - DLNP_d = \alpha$ is valid. This indicates that gasoline price fluctuations and diesel price fluctuations have a stable proportional relationship, and therefore, the LOP is established. We call the case the relative LOP, and in this study, two refined oil price fluctuations lack the independence. Two markets are, essentially, one fully integrated market. If $\alpha = 0$ at the same time, gasoline price fluctuations and diesel price fluctuations are fully consistent with each other in the market area. We call this case the absolute LOP.

To further study the degree of the internationalization of China's refined oil market, this paper uses the DCC-GARCH method. This method can calculate the time-varying dynamic correlation coefficient between China's refined oil price fluctuations and the price fluctuations of each of the three largest refined oil markets in the world.

Engle and Sheppard [16] extended the CCC-GARCH model and proposed the DCC-GARCH model. Compared with other multivariate GARCH models, the DCC-GARCH model has good computational advantages and can thus be used to estimate large-scale correlation coefficient matrices. In addition, this model can also be used to study the dynamic correlations of many assets in many markets, or the same market under the influences of market information, policy orientation, and other influencing factors in different periods. The bivariate DCC-GARCH meets the following hypothesis (1) - (9):

$$r_t | I_{t-1}(0, H_t) \quad (1)$$

$$H_t = (h_{ij}, t) = D_t R_t D_t \quad (2)$$

$$D_t = (h_{11,t}^{1/2}, \dots, h_{NN,t}^{1/2}) \quad (3)$$

$$R_t = \text{diag}(q_{11,t}^{-1/2}, \dots, q_{NN,t}^{-1/2}) Q_t \text{diag}(q_{11,t}^{-1/2}, \dots, q_{NN,t}^{-1/2}) \quad (4)$$

$$Q_t = (q_{ij,t}) = (1 - \alpha - \beta) \bar{Q} + \alpha \mu_{t-1} \mu'_{t-1} + \beta Q_{t-1} \quad (5)$$

$$q_{ij,t} = (1 - \alpha - \beta) \bar{q}_{ij} + \alpha \mu_{t-1} \mu'_{t-1} + \beta q_{ij,t-1} \quad (6)$$

$$\rho_{12,t} = \frac{(1 - \alpha - \beta) \bar{q}_{12} + \alpha \mu_{t-1} \mu'_{t-1} + \beta q_{12,t-1}}{\sqrt{((1 - \alpha - \beta) \bar{q}_{11} + \alpha \mu_{t-1} \mu'_{t-1} + \beta q_{11,t-1})((1 - \alpha - \beta) \bar{q}_{22} + \alpha \mu_{t-1} \mu'_{t-1} + \beta q_{22,t-1})}} \quad (7)$$

$$h_{11,t} = \theta_{10} + \alpha_{11} \mu_{t-1}^2 + \alpha_{12} \mu_{2,t-1}^2 + \beta_{11} h_{11,t-1} + \beta_{12} h_{22,t-1} \quad (8)$$

$$h_{22,t} = \theta_{20} + \alpha_{21} \mu_{1,t-1}^2 + \alpha_{22} \mu_{2,t-1}^2 + \beta_{21} h_{11,t-1} + \beta_{22} h_{22,t-1} \quad (9)$$

Here, $h_{11,t}$ and $h_{22,t}$ represent the conditional variances of the rate of return of Variable 1 and Variable 2, respectively; α_{11} & α_{22} and α_{12} & α_{21} represent the two variables' self ARCH effect and cross ARCH effect, respectively. Also, β_{11} & β_{22} and β_{12} & β_{21} represent the two variables' self GARCH effect and cross GARCH effect, respectively, and $\rho_{12,t}$ is the dynamic correlation coefficient describing the correlation of two variables'. Finally, α refers to the influence of previous fluctuations in variables on the dynamic correlation coefficient, and β refers to the continuous effect of the close state of correlation between variables.

The price fluctuations in this paper are expressed as follows (10):

$$r_t = DLNP_t = LNP_t - LNP_{t-1} \quad (10)$$

6 Results and discussion

To avoid the spurious regression problem brought about by the non-stationarity of time sequence, we first apply a stationarity test to the time sequence data above, before the parameter estimation.

The test results show that the variables are all stationary time sequences. Table 1 gives the specific unit root test results.

Table 1 ADF stationarity test of variables

Sequence	Test form	ADF	1% Critical Value	Stationarity
DLNCP _g	(0,0,0)	-8.893053	-2.583298	Stationary
DLNEP _g	(0,0,0)	-9.457722	-2.583298	Stationary
DLNMP _g	(0,0,0)	-9.633763	-2.583298	Stationary
DLNAP _g	(0,0,0)	-9.628522	-2.583298	Stationary
DLNCP _d	(0,0,0)	-7.892860	-2.583298	Stationary
DLNEP _d	(0,0,0)	-9.336462	-2.583298	Stationary
DLNMP _d	(0,0,0)	-10.55363	-2.583298	Stationary
DLNAP _d	(0,0,0)	-9.123758	-2.583298	Stationary

The ADF test results show that the above time series data are stationary sequences. Then, we estimate the regression coefficient using the maximum likelihood method and add the constraints condition ($\beta = 1$, $\beta = 1$ & $\alpha = 0$) to the regression coefficient. Then, a significance test is applied to the additional constraint condition, using the Wald statistics (following the asymptotic χ^2 distribution), in order to test whether the law of one valence is valid. Table 2 gives the specific regression coefficient estimation results and the constraint condition test result.

Table 2 Estimation results of regression coefficient and test results of constraint conditions (0.01level)

Explained variable	Explanatory variable	α	β	RLOP	ALOP
DLNCP _d	DLNCP _g	0.000890	0.826145	Accepted	Accepted
DLNEP _d	DLNEP _g	-0.001750	0.612518	Rejected	Rejected
DLNMP _d	DLNMP _g	-0.002504	0.564950	Rejected	Rejected
DLNAP _d	DLNAP _g	-0.000689	0.721256	Rejected	Rejected

From the above results, we can see that in the regression relationships of gasoline and diesel price fluctuations in China, Europe, America and Asia, only in China are both the original hypotheses ($H_0: \beta = 1$ and $H_0: \beta = 1$ & $\alpha = 0$) of the constraint conditions of the regression coefficient of the regression equation between gasoline and diesel prices accepted. Meanwhile, in other areas, the original hypotheses of $H_0: \beta = 1$ and $H_0: \beta = 1$ & $\alpha = 0$ are both rejected. The above results indicate that China's gasoline and diesel price fluctuations have an obvious correlation in the existing pricing mechanism. This is consistent with the previously-mentioned LOP, thereby indicating China's gasoline and diesel price fluctuations do not have the characteristic of independent variation.

Different varieties of refined oil products (such as gasoline and diesel) that are obtained from crude oil at the same time have clearly different purposes. Specifically, 80% of gasoline is used as the fuel of passenger cars, while approximately 50% of diesel is used for transportation; the other 50% is used in agriculture and industry. Gasoline therefore has the nature of being a consumer good, while diesel exists more as an industrial product and a means of production. The situations and demand trends to which gasoline and diesel are subjected are not exactly the same. Gasoline and diesel markets are two mutually independent markets; they do not have the exact same price trends. We should adjust the relative prices of gasoline and diesel continuously, based on

the fluctuations in supply and demand patterns. This would ensure the full use of existing capacity and help maximize the social benefit.

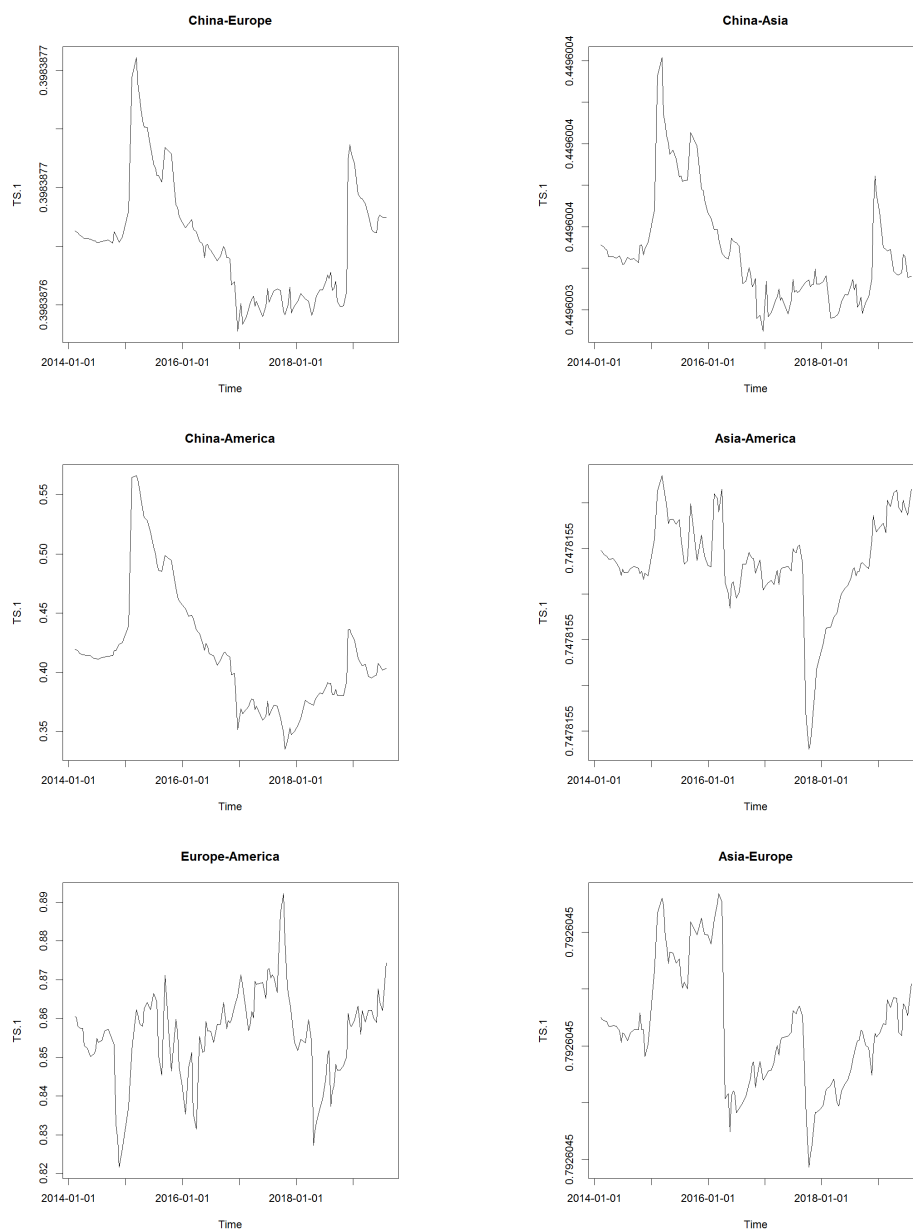


Fig. 1 Dynamic correlation coefficient of gasoline price fluctuations

In order to further investigate the time-varying characteristics of the correlation between Chinese and foreign gasoline and diesel price fluctuations, this paper estimates the dynamic correlation coefficient between Chinese and foreign gasoline and diesel price fluctuations by using a DCC-GARCH model. As can be seen from the above analysis, all time series are stable at the significance level of 1%, and there is no pseudo-regression. The distribution of Q statistics $Q(10)$ and $Q2(10)$ is introduced. That is, Ljung-Box statistics with a lag of order 10 for the original sequence or the square sequence are introduced to test whether the sequence has autocorrelation. In addition, Engle's ARCHTEST is used to test the ARCH effect of the sequence. According to the minimum criterion AIC, the GARCH (1, 1) model is used to obtain the standard residual error of the GARCH model. The

dynamic correlation coefficient is obtained from the standard residual error, as shown in the figures below.

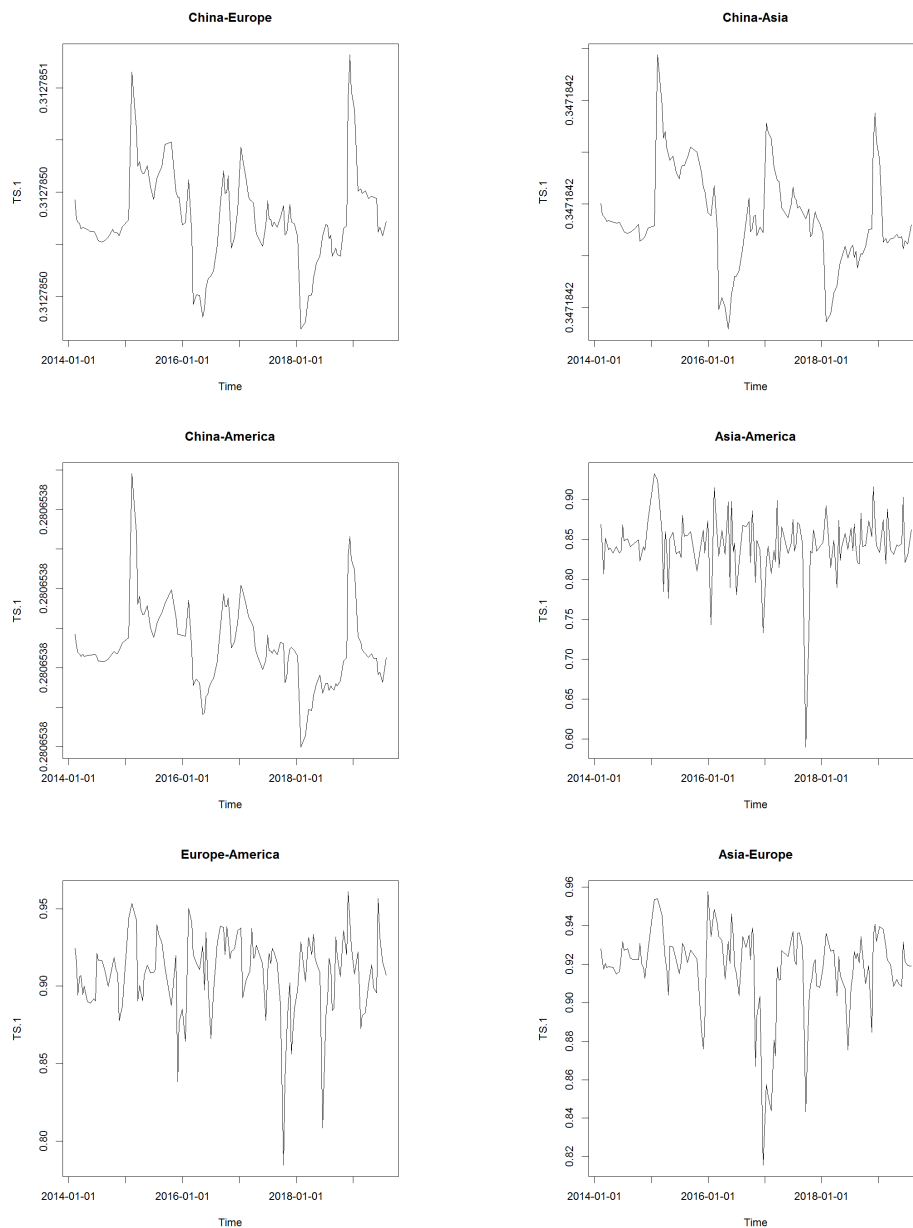


Fig. 2 Dynamic correlation coefficient of diesel price fluctuations

From the perspective of the dynamic correlation coefficient, regardless of whether gasoline or diesel prices fluctuate, the dynamic correlation coefficient between the Chinese market and the world's three main refined oil markets has been relatively low. However, the three global oil markets' price changes of the same product at the same time have maintained a high dynamic correlation coefficient between those three markets. This finding suggests that there is evidence of a global integration of refined oil market characteristics, as the price fluctuations of refined oil all over the world showed consistent price change trends. In addition, China's refined oil market price fluctuations are relatively independent. The degree of connections to other markets is lower, indicating that the internationalization of China's refined oil price level is still low. This lag in integration has been caused by China's long-time implementation of a markup pricing mechanism for refined oil. This type

of sensitive pricing mechanism makes it difficult to accurately reflect the changes in supply and demand in the international refined oil market. As such, China has been unable to effectively ensure the security of its domestic oil product prices. The country cannot give full play to the market price signals provided to producers and consumers and thus cannot play a guiding role.

China's gasoline and diesel markets lack independence compared to the other three international refined oil markets. The existing pricing mechanism maintains the linkage between domestic gasoline and diesel prices and international crude oil prices. Meanwhile, the mechanism also ensures appropriate profit margins for oil refining enterprises, which in turn is good for keeping production stable. In China's existing refined oil pricing mechanism, the country's gasoline and diesel prices follow the same price fluctuation laws. The existing gasoline and diesel price forming mechanism is, essentially, a cost-plus mechanism dominated by the government. Existing gasoline and diesel price signals mainly reflect the price transmission mechanism from international crude oil price fluctuations to domestic refined oil price fluctuations. This also causes crude oil price fluctuations to directly affect refined oil prices. The pricing mechanism cannot fully reflect the differences between the supply and demand of China's gasoline and diesel markets, nor can it reflect in a timely manner the changing trends of the same refined oil supply and demand situation in international markets.

7 Conclusions

The results in this study show that under the existing refined oil pricing mechanism in China, gasoline and diesel prices strictly follow the same price change laws. The existing gasoline and diesel price forming mechanism is essentially a cost-plus mechanism dominated, overseen and implemented by the government. Thus, they fail to fully reflect real-time changes in the supply and demand relationships in China's gasoline and diesel markets.

Thus the Chinese government should adopt differentiated guide price strategies for gasoline and diesel.

First, the government should fully consider the seasonal variations in refined oil consumption. A seasonal factor should be added to the refined oil pricing formula. The price adjustment time of gasoline and diesel should be separated appropriately, and refined oil prices should be raised accordingly in the peak demand season.

Secondly, the government should pay close attention to the fluctuations in supply and demand situations in refined oil markets. They should publish differentiated price guides for different varieties of refined oil, based on fluctuations in the inventory levels of different varieties of refined oil, thus guiding the markets to move in the direction of supply and demand equilibrium.

Thirdly, the government should consider the actual, current situation of urban traffic congestion and seriously foggy and hazy weather in China. Gasoline prices should be raised to proper levels, thus restraining the excessive growth in gasoline consumption. The price ratio of gasoline to diesel should be gradually improved in time. The ratio should be based on the fluctuations in supply and demand in the two markets, as well as the need for environmental protection. The government should also guide people's energy consumption behaviors by collecting differentiated consumption taxes for gasoline and diesel.

All in all, artificial pricing cannot fully reflect the fluctuations of supply and demand in refined oil markets. The forming of equilibrium prices will rely on market-oriented pricing. The Chinese oil market should further expand the opening to the outside world, gradually reducing its reliance on crude oil imports, cultivating more refined oil market suppliers, and gradually completely eliminating the restrictions of refined oil importation and exportation. Let the price changes of refined oil be determined by the market under the guidance of macro policies, such as national taxes and fees. In this way, China's refined oil price reform will continue to advance toward the direction of marketization and internationalization.

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