

Research On the Impact of Aluminum Metal Futures Prices on The Stock Prices of Aluminum Enterprises- Based on The Perspective of Upstream and Downstream

Siyue Wang

School of Economics, Wuhan University of Technology China

45371596@qq.com

Abstract. This paper takes aluminum metal futures as an example to explore the impact of fluctuations in non-ferrous metal futures prices on the stock price performance of related listed companies. Firstly, the basic situation of aluminum futures is introduced, and then further discussion is conducted on how aluminum futures affect the stock prices of upstream and downstream enterprises related to aluminum. Then, empirical analysis is conducted. This article uses methods such as ADF, EG-ADF, ECM model, and Granger test to explore the impact of aluminum metal futures prices on the weighted stock prices of upstream and downstream enterprises related to aluminum. The research results indicate that the impact of aluminum metal futures prices on the stock prices of aluminum enterprises varies with different positions in the industry chain. There is a one-way guiding relationship for the weighted stock prices of upstream aluminum enterprises, while there is no leading and lagging guiding relationship for the weighted stock prices of downstream enterprises. Based on the upstream and downstream perspectives, this article selects four representative listed companies in the aluminum industry to weight their stock prices according to their market value ratios, and explores their relationship with aluminum futures prices. This study helps investors evaluate stock price trends and make wiser investment choices; Adjusting business plans and coordinating stock prices for aluminum enterprises has positive significance; At the same time, it helps regulatory authorities to gain a deeper understanding of market information and further understand the price discovery function of futures markets

Keywords: aluminum futures, aluminum futures price, stock price, enterprises.

1. Overview Of Aluminum Metal Futures

1.1. The Role of Non ferrous Metal Futures Market

With the continuous development of the economy, futures have gradually become an important financial derivative product. In recent years, China's non-ferrous metal futures have further developed, and the futures market has also been continuously improved and matured. The non-ferrous metal futures market in China has become one of the commodity futures markets with high degree of marketization and internationalization, and good market function. (Wang Yanli, Fu Shuixing, Tian Jinchuan et al., 2021 [3]) The futures market has functions of price discovery, risk management, and resource allocation, playing an important role in stabilizing prices and maintaining the security of the industrial and supply chains (Yang Yi, 2023 [5]).

The non-ferrous metal futures market has played an important role at different levels: from a macro perspective, the non-ferrous metal futures market provides decision-making basis for macroeconomic regulation, and the government can further formulate relevant industrial policies by monitoring price fluctuations and trading in the futures market. From a meso perspective, the development and growth of the futures market directly support and promote the development of China's non-ferrous metal industry. From a micro perspective, China's large and medium-sized non-ferrous metal enterprises can use hedging in the futures market to avoid operational risks. This means that companies can lock in future prices through futures contracts, thereby reducing the risk of price fluctuations in raw material procurement and production processes.

1.2. Aluminum metal futures

1.2.1 Contract Content

Table 1 Aluminum futures contract content

Trading instrument	aluminum
Transaction unit	5 tons/hand
Quotation unit	Yuan (RMB)/ ton
Minimum moving price	5 yuan/ton
Limit range	The settlement price of the last trading day was up or down three percent
Contract month	From January to December
Trading hours	9:00-11:30 am, 1:30-3:00 PM and other trading hours specified by the exchange
Last trading day	15th of the contract month (postponed in case of national holidays, the last trading day such as the Spring Festival month can be adjusted and notified)
Delivery date	Two consecutive business days after the last trading day
Delivery grade	Standard product: Aluminum ingot, in line with the national standard GBTT1196-2017AL99.70, the aluminum content is not less than 99.70%.
	Substitute:1, aluminum ingot, in line with the national standard GBT1196-2017AL99.80, AL99.85 provisions. 2, aluminum ingot, in line with P1020A standard.
Delivery point	Exchange designated delivery warehouse
Minimum margin	5% of the contract value
Delivery mode	Physical delivery
Delivery unit	25 tons
Transaction code	AL
Listed exchange	SHANGHAI Futures Exchange

Note: Amended in accordance with Announcement [2023] No. 2 issued by the Shanghai Futures Exchange on January 17, 2023

The trading of aluminum futures began in the early 1980s, primarily trading on the London Metal Exchange (LME). With the development of the market, the main aluminum futures trading markets now include LME, Chicago Mercantile Exchange (CME) in the United States, and Shanghai Futures Exchange (SHFE) in China. The specific details of the contract are shown in Table 1.

1.2.2 Development of Futures

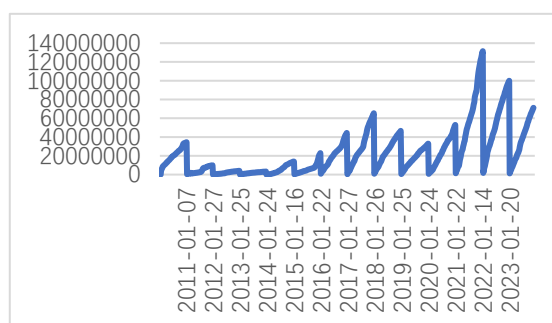


Figure 1 2010-2023 aluminum futures volume of Shanghai Futures Exchange

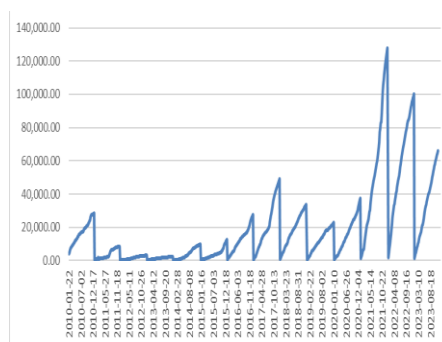


Figure 2 2010-2023 Shanghai Futures Exchange aluminum futures transaction amount

From Figures 1 and 2, it can be seen that the trading volume and amount of aluminum futures have been increasing year by year in recent years, indicating that aluminum futures trading is becoming increasingly active and the aluminum futures market is constantly improving and developing. The existence of the aluminum futures market enables producers, consumers, and investors to manage future price fluctuations. Producers can lock in future sales prices by selling futures contracts, consumers can lock in future purchase prices by buying futures contracts, and investors can speculate on future price changes by buying and selling futures contracts. At the same time, the aluminum futures market also provides an important reference for the spot price of aluminum.

2. Theoretical Relationship Between Aluminum Metal Futures And Stock Prices Of Aluminum Enterprises

2.1. Influence stock prices through industrial policies

Aluminum futures further affect corporate stock prices through price fluctuations affecting industrial policies. The price of aluminum futures usually causes the government to re-evaluate and adjust macroeconomic and industrial policies. The government usually takes into account the signals of the futures market and the potential impact of futures prices on the real economy and society when taking action. Political investors usually pay close attention to changes in industrial policy, and adjust their investment portfolios according to the expectations of the future business and earnings of the enterprise to further affect the stock price of the enterprise, and this factor has the same impact on upstream and downstream enterprises in aluminum.

2.2. Influence stock price through spot price

There is a two-way guiding relationship between aluminum futures and spot prices, that is, there is a long-term stable relationship between futures and spot prices. (Qu Hongtao, Zhuang Xintian, Su Yanli et al. 2011[1]). Therefore, the aluminum futures price affects the profitability of aluminum enterprises by affecting the price of aluminum spot, further affecting investors' forecasts for the company, and ultimately affecting its stock price.

For listed companies, especially those that use spot non-ferrous metals as commodities, their performance is very sensitive to the price of related resources, and the change of spot price will endanger the profit margin of many related companies. The change of futures price reflects the change of supply and demand of spot commodities through the spot market, which affects the production cost or product selling price of upstream and downstream aluminum listed companies, affecting the production and operating performance of these listed companies, such as net profit, net asset profit margin. Through the analysis of the company's publicly disclosed statements, investors realize the fact that the company's performance changes, form the expectation of the listed company's stock price, and ultimately affect the stock price of the listed company in the stock exchange. Under this mechanism of action of futures, the position of the listed company in the supply chain determines how the company is affected.

In general, for enterprises upstream of the supply chain of the aluminum industry, the signal of rising futures prices will be transmitted to the spot market, causing the price of products of enterprises in the industry to change in the same direction. Without considering other factors, such signals are expected to improve the performance of upstream companies, which may lead to higher stock prices of listed companies. For enterprises downstream of the supply chain, rising futures prices lead to rising spot prices, even though production costs increase, which slows down the profitability of enterprises to a certain extent. This causes investors to expect its stock price to fall, if investors make investment decisions based on this, it may lead to the trend of lower stock prices of downstream listed companies.

3. Empirical test

3.1. Data Selection

3.1.1 Selection of futures price data

The aluminum futures settlement price of Shanghai Futures Exchange from January 5, 2009 to December 8, 2023 (continuous) is selected for the demonstration of aluminum futures prices and upstream enterprises' weighted stock prices, with a total of 3569 data. The aluminum futures settlement price of Shanghai Futures Exchange from July 18, 2012 to December 8, 2023 (continuous) was selected for the empirical analysis of aluminum futures prices and weighted stock prices of downstream enterprises. A total of 2716 data were obtained from Flush iFinD.

3.1.2 Stock price data selection

The top 15 main businesses of listed aluminum enterprises in terms of total market value are sorted out according to the data of Flush, as shown in Table 2.

Table 2 Main business of the top 15 enterprises in the total market value of aluminum industry

Ranking	Enterprise name	Main business	Market value (billion)
one	Aluminum Corporation Of China Limited	Exploration and mining of bauxite, coal and other resources, production, sales, technology research and development of alumina, primary aluminum, aluminum alloy and carbon products, international trade, logistics industry, firepower and new energy power generation.	819.11
two	Yunnan Aluminium Co.,Ltd	Bauxite mining, alumina, green aluminum, aluminum processing and aluminum carbon production and sales	409.22
three	SHANDONG NANSHAN ALUMINIUM CO., LTD	From thermal power, alumina, electrolytic aluminum, melting casting, aluminum profile/hot rolling - cold rolling - foil rolling, scrap aluminum recycling (recycling) complete aluminum processing industry chain	331.35
four	Inner Mongolia Dian Tou Energy Corporation Limited Inner Mongolia Dian Tou Energy Corporation Limited	Coal and aluminum, power, new energy business. The company's main products are coal, electrolytic aluminum and power products	326.37

five	Tianshan Aluminum Group Co.,Ltd	Upstream and downstream integration from bauxite, alumina to electrolytic aluminum, high-purity aluminum, and aluminum deep processing, and supporting the complete aluminum industry chain layout of self-provided power plants and self-prepared pre-baked anodes 276.32	276.32
six	Innovation New Material Technology Co.,Ltd.	Aluminum alloy and its products research and development and production processing.	209.44
seven	Guangdong Hec Technology Holding Co.,Ltd.	Electronic components, high-end aluminum foil, chemical new materials, energy materials four sectors of business.	201.03
eight	Shanghai Huaфон Aluminium Corporation	Research and development, production and sales of aluminum sheet and foil	160.06
nine	Henan Zhongfu Industrial Co.,Ltd	Aluminum and aluminum deep processing, supporting coal mining, thermal power generation, carbon and other industries	134.33
ten	Henan Mingtai Al.Industrial Co.,Ltd.	Plate and foil, aluminum profiles, comprehensive utilization of renewable resources.	133.68
eleven	Jiangsu Dingsheng New Materials Joint-Stock Co.,Ltd	Research and development, production and sales of aluminum sheet and foil	112.45
twelve	Xinjiang Joinworld Co.,Ltd.	Research and development, production and sales of aluminum electronic new materials and aluminum and alloy products	95.85
thirteen	Jiangsu Asia-Pacific Light Alloy Technology Co.,Ltd.	Automotive thermal management system aluminum business, automotive lightweight system aluminum business, emerging areas of business	79.76
fourteen	Jiaozuo Wanfang Aluminum Manufacturing Co.,Ltd.	The main business is aluminum smelting and rolling processing, supporting thermal power generation.	66.52
fifteen	Yinbang Clad Material Co.,Ltd.	R&d, production and sales of aluminum alloy composite materials, multi-metal composite materials and aluminum alloy structural materials	65.59

According to the data in the above table, four listed companies with high market value and most influence in aluminum mining and smelting in the A stock market are selected: Aluminum of China, Cloud Aluminum Shares, Nanshan Aluminum, and Xinjiang Zhonghe. The downstream companies selected are three listed companies with greater influence in the A stock market engaged in aluminum-related deep processing: Zhongfu Industry, Mingtai Aluminum, Asia-Pacific Technology and Yinbang Shares. The upstream stock price data are also selected from 2009 to 2023, and the downstream stock price is selected from 2012 to 2023 due to incomplete data, and the final stock price results are calculated according to the weighted calculation of relative market value. Therefore, the weighted numbers of upstream enterprises are 49.5%, 24.7%, 20% and 5.8% respectively. The

analysis that both aluminum futures price and weighted stock price of aluminum upstream enterprises are first-order monointegrals, so the regression residual of the two is tested by ADF, and the test results are as follows.

```
. reg gus qi
```

Source	SS	df	MS	Number of obs	=	3,622
Model	2809.14031	1	2809.14031	F(1, 3620)	=	385.27
Residual	26395.0111	3,620	7.29143952	Prob > F	=	0.0000
Total	29204.1514	3,621	8.06521717	R-squared	=	0.0962
				Adj R-squared	=	0.0959
				Root MSE	=	2.7003

gus	Coefficient	Std. err.	t	P> t	[95% conf. interval]
qi	.000354	.000018	19.63	0.000	-.0003187 .0003894
_cons	1.341377	.2789313	4.81	0.000	.7944989 1.888255

Figure 7 Aluminum futures price and aluminum upstream enterprises weighted stock price regression results.

H0: Random walk without drift, a = 0, d = 0

Test statistic	Dickey-Fuller critical value			
	1%	5%	10%	
Z(t)	-2.329	-2.580	-1.950	-1.620

Figure 8 Test of co-integration relationship between aluminum futures price and weighted stock price of aluminum upstream enterprises.

As can be seen from the test results in Figure 8, there is a long-term equilibrium relationship between aluminum futures prices and the weighted stock prices of aluminum upstream enterprises at the 5% level, and according to the regression results in Figure 9, the long-term equilibrium formula between the two is $gus=0.000354qi+1.341377$

3.2.3 Establishment of Error Correction Model (ECM)

The short-term equilibrium relationship between qi and gus was further analyzed by error correction model (Zhang Yanfang,2023[6]). In this paper, the formula is set as $dgus=\beta_0+\beta_1dgus_lart+\beta_2dqi+\lambda ecmt-1+\mu$, where dgus_lart represents the lag term of dgus. The result after regression is shown in Figure 9.

```
. reg dgus dgus_lar dqi elcm
```

Source	SS	df	MS	Number of obs	=	3,620
Model	1.36889082	3	.456296939	F(3, 3616)	=	10.77
Residual	153.265905	3,616	.042385483	Prob > F	=	0.0000
Total	154.634796	3,619	.042728598	R-squared	=	0.0089
				Adj R-squared	=	0.0080
				Root MSE	=	.20588

dgus	Coefficient	Std. err.	t	P> t	[95% conf. interval]
dgus_lar	.0542366	.0165763	3.27	0.001	-.0217367 .0867366
dqi	.000096	.0000239	4.01	0.000	-.0000491 .000143
elcm	-.002965	.0012684	-2.34	0.019	-.0054518 -.0004783
_cons	-5.774-06	.0034221	-0.00	0.999	-.0067151 .0067036

Figure 9 Aluminum futures price and aluminum upstream enterprises weighted stock price error test model regression results.

According to the test results, at the 5% confidence level, b1, b2 and λ are significant, and only the constant term is not significant. From the estimated value of coefficient 0.0012684, when the short-term fluctuation deviates from the long-term equilibrium, the unbalanced state will be pulled back to the equilibrium state with the adjustment force of 0.0012684.

3.2.4 Granger causality test

After the above analysis, it can be seen that there is a certain equilibrium relationship between aluminum futures price and the weighted stock price of aluminum upstream enterprises. Finally, Granger test is used to analyze the temporal causal relationship between aluminum futures price and the weighted stock price of aluminum upstream enterprises. Since both are non-stationary, we use their first-order differences as variables to test. According to the results in FIG. 10, we select a lag order of 2 for Granger test, and the test results are shown in FIG. 11.

According to the test results, at the level of 5%, aluminum futures prices are non-stationary time series data and stable after first-order difference. Similarly, at the 5% level, the weighted stock price of aluminum downstream enterprises is non-stationary time series data and stable after first-order difference.

3.3.2 Co-integration relationship Test

Next, the co-integration relationship between aluminum futures price and the weighted stock price of aluminum downstream enterprises is tested. Test whether there is a long-term equilibrium relationship between them. EG-ADF method was also adopted to test the residual of regression between the two, and the test results were shown in Figure 16.

H0: Random walk without drift, a = 0, d = 0				
Test statistic	Dickey-Fuller critical value			
	1%	5%	10%	
Z(t)	-2.322	-2.580	-1.950	-1.620

Figure 16 Test results of co-integration relationship between aluminum futures price and weighted stock price of aluminum downstream enterprises.

As can be seen from the test results in Figure 16, there is a long-term equilibrium relationship between aluminum futures prices and weighted stock prices of aluminum downstream enterprises at the level of 5%.

3.3.3 Error correction model

The short-term equilibrium relationship between qi2 and gux is further analyzed by the error correction model, and the formula is $dgux = \beta_0 + \beta_1 dgux_{lar} + \beta_2 dq_{i2} + \lambda ecmt - 1 + \mu$, where $dgux_{lar}$ represents the lag term of $dgus$. And regression is carried out, and the regression results are shown in Figure 17.

```
. reg dgux dgux_lar dq12 e1cm
```

Source	SS	df	MS	Number of obs =	2,763
Model	3.83375837	3	1.27791946	F(3, 2759)	= 15.63
Residual	225.626132	2,759	.081778229	Prob > F	= 0.0000
Total	229.459891	2,762	.083077441	R-squared	= 0.0167
				Adj R-squared	= 0.0156
				Root MSE	= .28597

dgux	Coefficient	Std. err.	t	P> t	[95% conf. interval]
dgux_lar	.0576502	.0189236	3.05	0.002	-.0205444 .0947561
dq12	.0002027	.0000373	5.44	0.000	.0001296 .0002759
e1cm	-.0041657	.00159	-2.60	0.014	-.0074795 -.0008519
_cons	-.0020675	.0054406	-0.38	0.704	-.0127356 .0086006

Figure 17 Aluminum futures price and aluminum downstream enterprises weighted stock price error correction model regression.

According to the test results, at the 5% confidence level, b1, b2 and λ are significant, and only the constant term is not significant. From the coefficient estimate of -0.0041657, when the short-term fluctuation deviates from the long-term equilibrium, the disequilibrium state will be pulled back to the equilibrium state with the adjustment force of -0.0041657.

3.3.4 Granger causality test

Finally, Granger test is used to analyze the temporal causal relationship between aluminum futures price and weighted stock price of aluminum downstream enterprises. They are also tested using their first-order differences as variables. According to the results in FIG. 18, we select a lag order of 2 for Granger test, and the test results are shown in FIG. 19.

```
. vwrsc d.gux d.q12
```

Lag-order selection criteria

Sample: 6 thru 2765 Number of obs = 2,760

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-18140.1				1755.77	13.1404	13.148	13.1507
1	-18063.7	152.8	4	0.000	1666.03	13.094	13.0936	13.1068*
2	-18021.9	24.114*	4	0.000	1656.35*	13.081*	13.0959*	13.1096
3	-18031.2	.8383	4	0.933	1660.64	13.0907	13.1016	13.1081
4	-18049.8	2.8362	4	0.580	1663.75	13.0926	13.1065	13.1312

* optimal lag
Endogenous: D.gux D.q12
Exogenous: _cons

Figure 18 Aluminum futures price and aluminum downstream enterprises weighted share price Granger test order selection.

vargranger

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
D_gux	D_qi2	.00194	2	0.999
D_gux	ALL	.00194	2	0.999
D_qi2	D_gux	3.8093	2	0.149
D_qi2	ALL	3.8093	2	0.149

Figure 19 The Granger test results of aluminum futures price and weighted stock price of aluminum downstream enterprises.

According to the test results, whether dgux or dq12 is the explained variable, the p value is large, indicating that neither of them is Granger cause, that is, aluminum futures price has no obvious guiding relationship to the weighted stock price of aluminum upstream enterprises.

4. Conclusion

Based on the above discussion and empirical analysis, the conclusion is summarized:

1. In recent years, the non-ferrous metal futures market has been developing continuously and its influence has been deepening. Aluminum futures trading is also more and more active, price discovery function is more and more mature. Theoretically, aluminum futures prices affect the stock prices of aluminum enterprises through the impact on industrial policies and corporate performance, and have different impacts on upstream and downstream enterprises.

2. Through the empirical analysis of aluminum futures prices and weighted stock prices of aluminum upstream enterprises, it can be found that both of them are non-stationary time series at the 5% level, and they are stable after first-order difference, that is, first-order monointegration. At the 5% confidence level, there is a cointegration relationship between aluminum futures prices and the weighted stock prices of aluminum upstream enterprises, and the long-term equilibrium expression is, indicating that there is a positive correlation between the two.

3. It is found that when the short-term fluctuation deviates from the long-term equilibrium, the disequilibrium state will be pulled back to the equilibrium state with the adjustment force. After that, the lag order is selected as 2 to conduct Granger test on the first-order difference components of the two, and it is further found that aluminum futures price does have a one-way guiding relationship with the weighted stock price of aluminum upstream enterprises

Through the ADF test of aluminum futures price and weighted stock price of aluminum downstream enterprises, it is found that both are non-stationary time series, which is stable after first-order difference, that is, first-order single integer. At the confidence level of 5%, there is a cointegration relationship between aluminum futures price and the weighted stock price of aluminum downstream enterprises.

4. It is found that when the short-term fluctuation deviates from the long-term equilibrium, the disequilibrium state will be pulled back to the equilibrium state with the adjustment force. However, after Granger test, it is found that there is no guiding relationship in time sequence between the two, and the conclusion remains unchanged after multiple tests of other orders, indicating that although there is a co-integration relationship between the two, aluminum futures prices have no leading and lagging guiding relationship with the stock prices of downstream deep processing enterprises, so further research is still needed.

5. Through the empirical comparison of aluminum futures prices on the weighted stock prices of aluminum upstream enterprises and aluminum downstream enterprises, the influence of aluminum futures prices on the stock prices of aluminum enterprises varies with different positions in the industrial chain. It can be seen that aluminum futures prices have a one-way guiding relationship with the weighted stock prices of aluminum upstream enterprises, while there is no leading and lagging guiding relationship with the weighted stock prices of downstream enterprises.

References

- [1] Qu Hongtao, Zhuang Xintian, Su Yanli et al. An empirical study on the price discovery function of commodity futures [J]. Journal of Northeastern University (Natural Science),2011,32(09):1364-1368
- [2] ZHANG Xiaodong. Fundamentals of Econometrics [M]. Tianjin: Nankai University Press,2001:337.
- [3] Wang Yanli, Fu Shuixing, Tian Jinchuan et al. Research on the present situation of nonferrous metal ore futures market in China [J]. Mineral Exploration,2021,12(04):1085-1089.
- [4] Fan Yawen. Research on Several Kinds of statistical Testing Problems in Time Series Models [D]. Jiangxi University of Finance and Economics,2023
- [5] Yang Yi. The function of "stabilizer" in futures market is fully displayed [N]. Financial Times,2023-09-13(007).
- [6] Zhang Y F.Research on the relationship between technology trade and economic growth in China: An analysis based on Co-integration and error correction model [J]. Journal of Technology and Economics, 2023,42(12):97-108.