Empirical Research on the Impact of International Trade on Aluminum Supply Security

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Abstract. Aluminum is widely used in various fields because of its good properties. Since the beginning of China's industrialization process, the consumption of aluminum is second only to steel, which is an indispensable basic material in the industrialization process. At present, China's bauxite mainly depends on trade import, international trade has an important impact on the supply security of domestic bauxite. Therefore, in order to ensure the security of national bauxite supply, this paper expects to explore the influencing factors of bauxite supply security and give corresponding risk measures.

Keywords: Bauxite, International trade, Security of supply, Risk warning

1 Introduction

Aluminum is widely used in various fields because of its good properties. Since the beginning of China's industrialization process, the consumption of aluminum is second only to steel, which is an indispensable basic material in the industrialization process. At present, China's bauxite mainly depends on trade import, international trade has an important impact on the supply security of domestic bauxite. Therefore, in order to ensure the security of national bauxite supply, this paper expects to explore the influencing factors of bauxite supply security and give corresponding risk measures. Based on the data of China's aluminum resource trade from 2008 to 2021, this paper uses Eviews data analysis software to create a supply security evaluation index system and corresponding calculation model of international trade, which integrates production concentration, external dependence, import market concentration, stability of import source countries and international price changes. According to the calculation results of supply security, combined with the import and export volume of aluminum resource trade, foreign direct investment, domestic output of bauxite, effective exchange rate of RMB and other data from 2008 to 2021, this paper explores the impact of aluminum international trade on the supply security of aluminum resources. The results show that: From 2012 to 2016, due to the rapid development of domestic industry, the gap between supply and demand of aluminum resources increased, and domestic supply could not

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meet the demand. International trade had a great impact on domestic supply security, and supply security fluctuated greatly during this period.

2 Literature Review

Aluminum is a crucial and indispensable mineral resource of strategic importance. It holds a significant role in the advancement of the country's economy [1]. Aluminum possesses excellent malleability, resistance to corrosion, and electrical conductivity, making it extensively utilized in various sectors such as household appliances, communication, transportation, construction, and durable consumer goods [2]. Aluminum is a vital fundamental material in the field of industrial construction. Copper is the second most often used metal, following iron [3]. Strategic mineral resources are typically marked by a notable disparity between supply and demand. Nevertheless, there is an unequal distribution of resources. Based on data from USGS, the cumulative worldwide aluminum reserve amounts to around seventy-five billion tons [4].

The primary deposits of aluminum ore are primarily found in Guinea, Australia, and Vietnam, located in the regions of Africa, Oceania, and Asia respectively. The regions mentioned hold 64% of the global deposits of aluminum ore. Imports are primarily concentrated in Europe, Asia, and North America [1]. Aluminum is classified as one of the five industries that consume a significant amount of energy, and it is responsible for contributing 2% of the total carbon emissions worldwide [1]. Countries worldwide have implemented policies to restrict high-carbon industries in response to the climate problem [5]. The mining process has resulted in evident pollution, leading to a gradual implementation of restrictions on both mining and the exportation of aluminum ore in several regions. Moreover, as global industrialization advances and the manufacturing industry undergoes upgrades, the annual demand for aluminum is steadily rising [6]. The disparity between the supply and demand of aluminum has heightened the level of rivalry among nations. The sustainable supply of aluminum resources and the sustainable growth of the economy and society are impeded by trade protectionism and the precarious international trade environment [7]. The world's aluminum supply has become more vulnerable due to a variety of issues, including the recent advent of the new coronavirus epidemic [8]. Consequently, nations must guarantee the secure provision of aluminum resources via trade networks. The issue of ensuring secure and reliable access to aluminum resources through trade has been a growing concern for countries around the globe. In the context of international commerce, it is essential for countries to comprehend the competitive attributes and supply vulnerabilities of the aluminum mining industry in order to formulate effective strategies [9].

To summarize, the present research exhibits the following characteristics: Primarily, the primary emphasis is placed on energy resources, including oil and aluminum, whereas research on mineral resources is merely stated and lacks a comprehensive investigation. Furthermore, there is a strong focus on safeguarding national security systems, implementing national policies, and aligning with national strategic orientations. Furthermore, the primary area of study revolves around the influence of geopolitics, supply, demand, and prices on the security of supply. While international commerce is

the common theme in these study directions, there has been limited thorough discourse on the safety model research concerning the direct influence of international trade on supply and the trade-induced risk assessment system [10].

3 Methodology

3.1 Data and Measurement

The paper focuses on the supply security index (F) as the dependent variable. This index is generated from the international trade supply security evaluation system for aluminum resources mentioned earlier. The variable value is derived by selecting five evaluation indicators from the trade security perspective and computing the evaluation index using principal component analysis.

The independent variables included in this study mostly consist of the following four factors: Import the value of bauxite commerce (X1). The quantity of foreign direct investment (X2). China's production of bauxite has increased thrice (X3). The effective exchange rate of the RMB (X4). The chosen independent variables are the effects of global commerce in aluminum resources on the stability of bauxite supply. In order to ensure the reasonableness of the regression coefficients and mitigate the impact of dimensions, this study employs logarithmic transformation on the data of the explanatory variables. The aforementioned explanatory variables primarily impact the security of bauxite supply in our country by influencing the international trade dynamics of bauxite, either directly or indirectly.

3.2 Model

Regression models are a statistical tool used to examine the correlation between numerous independent variables and a single dependent variable. They can be utilized to evaluate the linear correlation between independent and dependent variables, as well as to forecast the value of the dependent variable. This paper employs a multiple regression model to examine the influence of alterations in factor endowments on the security of aluminum resource supply. Thus, the formulated structural equation modeling (SEM) is presented below.

$$Y_t = \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \alpha_0 + \varepsilon$$

3.3 Findings and Results

The descriptive findings of data sample are shown in Table 1.

Table 1. Descriptive statistical results.

	Y	X1	X2	X3	X4
Mean	0	11.59579	7.733527	11.60845	4.738942

Median	0.2585	11.63031	7.821945	11.49601	4.803266
Max	0.662	12.04783	7.969079	13.14001	4.864607
Min	-0.706	10.58124	7.300534	10.96215	4.506454
SD	0.725198	0.38538	0.210943	0.547452	0.120077

Correlation Coefficient Matrix. Multicollinearity can cause inaccuracies and economic implications in the data, perhaps leading to errors in the forecasting algorithms. Hence, it is imperative to perform tests to detect multicollinearity in the dataset. The correlation results in Table 2 indicate a significant correlation between the explained variable of international trade in aluminum resources and the explanatory variables of supply security, aluminum trade import and export volume, foreign direct investment amount, China's bauxite production, and the effective exchange rate of the RMB. Simultaneously, the correlation coefficients between the selected variables in this study are predominantly below 0.8, suggesting the absence of multicollinearity among the explanatory factors.

Table 2. Person correlation coefficient matrix.

	Y	X1	X2	X3	X4
Y	1.0000	0.3373	0.0465	0.2758	-0.1969
X1	0.3373	1.0000	0.8352	0.2585	0.7174
X2	0.0465	0.8352	1.0000	0.3912	0.8569
X3	0.2758	0.2585	0.3912	1.0000	0.3458
X4	-0.1969	0.7174	0.8569	0.3458	1.0000

OLS Estimation. Table 3 clearly displays an R^2 value of 0.6456. A reasonably high R^2 value implies that the model is a good match for the sample data. The model estimation results suggest that, holding other variables constant, a 1% change in the trade import and export volume of bauxite (X_1) results in an average 2.0377% change in the security of bauxite supply. On average, a 1% change in foreign direct investment (X_2) results in a 0.7972% change in the security of bauxite supply. The average annual fluctuation in China's bauxite production (X_3) is 1%, whereas the corresponding shift in the security of bauxite supply is 0.5336%. On average, a 1% change in the effective exchange rate of the RMB (X_4) corresponds to a 5.5226% change in the security of bauxite supply. The outcome exhibits a substantial level of conformity with theoretical analysis and can be evaluated through its economic importance.

With a significance level of α=0.1, the absolute values of the T-test statistics for bauxite trade import and export volume (X1), foreign direct investment (X2), China's bauxite production (X3), and the effective exchange rate of the RMB (X4) all exceed the critical value indicated in the regression parameter estimation table. Indicate that

the t-test is statistically significant at the significance level of α=0.1, given that all other variables remain unchanged. As a result, it greatly affects the supply security of bauxite, which is the variable being described. Using a significance level of α=0.1, we may extract the critical value from the F distribution table by considering the degrees of freedom k-1=3 and n-k=10. The regression parameter estimation table indicates that the value of F is 4.0992. Given that F is bigger than the crucial value, we can confidently reject the null hypothesis, which suggests that the explanatory variables have a substantial influence on the security of aluminum resource supply.

Table 3. OLS estimation results.

Dependent Variable	coef	SE	T value	P value
X1	2.0377	0.6852	2.9739	0.0156
X2	0.7972	0.4216	1.8909	0.0459
X3	0.5336	0.2883	1.8507	0.0972
X4	-5.5227	2.3255	-2.3748	0.0416
C	2.5131	5.8266	0.4313	0.6764
R^2	0.6456	Means of Y		0.0000
SD	0.5188	SD of Y		0.7252
RSS	2.4228	AIC		1.7980
Log likelihood d	-7.5863	SC		2.0263
F value	4.0992	HQC		1.7769

Heteroscedasticity and Correlation test. Table 4 displays the results of the heteroscedasticity test. The test indicates that at a significance level of 10%, the associated P value is 0.8097, which is greater than 0.1. This suggests that there is no heteroscedasticity issue present in this model. The results of the blood glucose (BG) test in Table 5 indicate that the coefficient of determination (nR2) is 0.5816, with a p-value of 0.862. Consequently, the supplemental regression model lacks significance, suggesting the absence of autocorrelation.

Table 4. Heteroscedasticity test.

F value	0.060844	P value under F(1, 11)	0.8097
nR^2	0.071511	Chi-Square(1)-P value	0.7891

Table 5. Correlation test.

F value	0.151726	P value under F(2,7)	0.862
nR2	0.581687	Chi-Square(2)-P value	0.7476

4 Conclusion

The method used in this article is to conduct an econometric analysis of the structural factors affecting the security of aluminum resource supply. The following conclusions are drawn.

Based on the findings, while all other factors remain the same, a 1% rise in the volume of bauxite trade imports and exports and a 1% variation in foreign direct investment will result in an average 0.7972% alteration in bauxite supply security. China's output of bauxite enhances the security of bauxite supply by an average of 0.5336% for every 1% increase. On average, a 1% increase in the effective exchange rate of the RMB leads to a 5.5226% decline in the supply security of bauxite. Through a comparison of the coefficients of different explanatory factors, it has been determined that the trade import and export volume of bauxite and the effective exchange rate of the Chinese yuan have a noteworthy influence on the supply security of bauxite. The influence of China's bauxite production and foreign direct investment on the security of bauxite supply is relatively insignificant. The primary factor contributing to this result is the dependence on imports for the provision of bauxite resources. Hence, variables such as the direct correlation between import and export values and trade circumstances, as well as the direct influence of the RMB exchange rate on import and export volumes, have a more pronounced impact on supply security. Despite a consistent increase in domestic output in recent years, it remains unable to meet the growing demand resulting from the rapid industrialization process. The self-sufficiency rate of domestic bauxite resources has consistently remained low and has exhibited a downward trajectory. Consequently, the production of bauxite in China has minimal influence on supply stability. Simultaneously, foreign direct investment in the aluminum industry primarily impacts the export sector. It directly increases the volume of exports, while its effect on imports is delayed, resulting in a less noticeable impact on imports during a specific timeframe. Hence, in order to conduct a more in-depth qualitative analysis on the factors that impact supply security in international trade, and to identify potential risks and appropriate countermeasures, it is crucial to primarily concentrate on the factors or potential risks that lead to variations in import and export volumes, as well as the effective exchange rate of the renminbi.

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