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A Characteristic Analysis and Countermeasure Study of the Hedging of Listed Companies in China Stock Markets*

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Abstract

Due to COVID-19, the risk of price volatility in commodity and equity markets increases. The research and application of hedging is the most effective way to reduce the market risk. Hedging is a risk management strategy employed to offset losses in investments by taking an opposite position in a related asset. We use *K*-means and hierarchical clustering methods to cluster companies and futures products respectively, and analyze the relationship between the number of hedging firms, regional distribution, nature of firms, capital distribution, company size, profitability, number of local Futures Commission Merchants (FCMs), regional location, and listing time. The study shows that listed companies with large scale and good profitability invest more money in hedging, while state-owned enterprises' participation in hedging is more likely to be affected by the company size and the number of local futures commission merchants, and private enterprises are more likely to be affected by the company profitability and the regional location. Listed companies are more willing to choose long-listed and mature futures products for hedging. We also provide policy advice based on our conclusion. So far, there is no study on the characteristics of hedging. This paper fills the gap. The results provide a basis and guidance for people's investment and risk management. Using clustering analysis in hedging study is another innovation of this paper.

Keywords: Characteristic Analysis, Countermeasure Study, Hedging, Listed Companies, China Stock Markets

JEL Classification Code: G14, G24, P43

1. Introduction

Futures perform two major functions: price discovery and hedging (Li, 2019). Hedging is referred to as buying an asset designed to reduce the risk of losses from other assets. Hedging in finance is a risk management strategy that deals with reducing and eliminating the risk of uncertainties. It helps to restrict losses that may arise due to unknown fluctuations in the price of the investment. Without the realization of the hedging function, physical enterprises will not be able to reduce the risk of spot price fluctuations. Therefore, a study on hedging characteristics of physical enterprises is important for promoting the use of futures hedging and reducing enterprises' risks.

This study takes China's listed companies as research objects, uses the *K*-means clustering method to cluster China's listed companies that participate in hedging, and uses the hierarchical clustering method to cluster hedging products that China's listed companies used. This study finds each cluster's internal similarity and the difference among the clusters based on the result of the cluster analysis. This reveals the essential characteristics of China's listed companies using futures for hedging, and provides policy advice to expand the usage of hedging, and promotes a steady, healthy, continuous, and fairly fast development of spot enterprises and even the national economy.

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2. Literature Review

Rahman et al. (2019) studied the impact of audit characteristics on firm performance. Tran et al. (2020) studied the influence of board characteristics on the risk of commercial banks. There are many studies on hedging focusing on hedging theory, hedging strategies, hedging effectiveness, and hedging portfolio. Smith and Stulz (1985) developed a positive theory of hedging behavior to show that a value-maximizing firm can hedge for three reasons: taxes, costs of financial distress, and managerial risk aversion. Chang et al. (2011) used dynamic multivariate Garch to study crude oil hedging strategies and found that the hedging effectiveness indicates that diagonal BEKK (BEKK) is the best (worst) model for OHR calculation in terms of reducing the variance of the portfolio. Arouri et al. (2012) made use of VAR-GARCH to analyze hedging effectiveness and found that making oil assets part of a well-diversified portfolio of sector stocks improves its overall risk-adjusted performance and that it permits to hedge the oil price risk more effectively. Buehler et al. (2019) used modern deep reinforcement machine learning methods to consider the problem of hedging a portfolio of derivatives in a generic market environment with all sorts of frictions.

Cluster analysis has been widely used in studying financial markets. Sopranzetti and Datar (2002) documented the price clustering in the foreign exchange spot market. Schwartz et al. (2004) documented the price clustering for S&P 500 futures contract. Tola et al. (2008) showed that the use of clustering algorithms can improve the reliability of the portfolio in terms of the ratio between predicted and realized risk. Di Lascio et al. (2018) applied a clustering procedure to partition a risk portfolio into independent subgroups of positively dependent risks. Liu (2019) used *k*-means to disclose the categories and characteristics of technical traders' strategies in the China rebar futures market.

This study contributes to the extant literature by making use of cluster analysis to discuss the hedging characteristics of Chinese listed companies. One of the main advantages of cluster analysis is that it cannot only classify samples but also classify variables, which can more comprehensively reveal the characteristics.

3. Methodology

3.1. Data

The data in this study has two parts:

(1) The data of listed companies using hedging in China included company name, region, industry type, the futures products used for hedging, hedging capital, total asset, and basic earnings per share (EPS). All data is from Shanghai Stock Exchange (SSE) and Shenzhen Stock Exchange (SZSE). All data is for the years from 2015 to 2019 except total assets and basic EPS, which are for the year 2018.

(2) The data of futures products include the number of Futures Commission Merchant (FCMs) by province, transaction data by futures products including trading volume, positions, and delivery quantity. All data is provided by 'China Securities and Futures Statistical Yearbook 2019'. Trading volume and positions are single-counted, and delivery quantity includes Exchange of Futures for Physical (EFP) transactions. EFP is a transaction between two parties in which a futures contract on a commodity is exchanged for the actual physical good. This transaction involves a privately negotiated exchange of a futures position for a corresponding position in the underlying physical.

3.2. Statistical Analysis

To investigate the essential characteristics of China's listed companies using futures for hedging, we conduct cluster analysis with *R* software version 3.6.1. Cluster analysis can sort similar objects into groups, to find out their intrinsic differences and connections. We cluster listed companies that use hedging and hedging futures products respectively. According to the characteristics of the two data sets and the characteristics of different clustering methods, we use *K*-means and hierarchical clustering methods respectively.

Before clustering, we use Hopkins statistic to measure the clustering tendency of the data set. If the data is d dimensional, let $X = \{x_i \mid i = 1, 2, \ldots n\}$ be a set of n data points, let $Y = \{y_j \mid j = 1, 2, \ldots m\}$ be m sampling origins placed at random, $m << n$. Two distance types are defined: u_j as the minimum distance from y_i to its nearest pattern in X and w_j, as the minimum distance from a randomly selected pattern in X to its nearest neighbor, then the Hopkins statistic in d-dimensions is defined as:

$$H = \frac{\sum_{j=1}^{m} u_j^d}{\sum_{j=1}^{m} u_j^d + \sum_{j=1}^{m} w_j^d}$$

A value close to 1 indicates that the data is highly clustered, random data will tend to result in values around 0.5, and uniformly distributed data will tend to result in values close to 0.

We use Euclidean distance to measure the distance (similarity) of object i and object j, the distance d_{ij} is defined as (He, 2008):

$$d_{ij} = \sqrt{\sum_{k=1}^{p} (x_{ik} - x_{jk})^2}$$

The basic idea of the *K*-means clustering method is to assign each object to the cluster that has the nearest centroid (mean). First, partition the objects into *K* initial clusters, then modify them one by one, assigning an object to the cluster whose mean is the nearest. Recalculate the mean for the cluster receiving the new object and for the cluster losing the object. Repeat the calculation until no more reassignments take place.

Assume there are *n* objects, hierarchical clustering method starts with calculating every two objects' distance (similarity). Thus, there are initially *n* clusters, every cluster has only one object. The two most similar objects are first grouped as a new cluster, then we calculate the distance from such cluster to others. Eventually, all objects are merged into a single cluster.

We use Ward's method (Ward Jr, 1963), which idea came from variance analysis. If clustering is correct, the sum of squares of deviations of the objects in the same cluster should be small, otherwise, the sum of squares of deviations between the clusters should be large.

Let G_k denotes cluster k, x_{it} denotes the ith object in cluster G_t, n_t denotes the number of objects in cluster G_t, $\bar{x}_t$ denotes the centroid in cluster G_t, thus the sum of the squared deviations of the objects in cluster G_t is defined as (He, 2008):

$$L_t = \sum_{i=1}^{n_t} (x_{it} - \bar{x}_t)'(x_{it} - \bar{x}_t)$$

The sum of squares of the whole cluster is defined as:

$$L = \sum_{t=1}^{k} \sum_{i=1}^{n_t} (x_{it} - \bar{x}_t)'(x_{it} - \bar{x}_t) = \sum_{i=1}^{k} L_t$$

When k is given, pick the cluster that minimizes L.

4. Results

4.1. China's Listed Companies Cluster

With the increasing number of futures products listed in China, futures hedging as an effective tool has gradually penetrated the industry chain, including production, supply, sales, and storage. The concept of risk management has gradually penetrated the real economy, and China's listed companies have increasingly extended the use of hedging.

We will observe the characteristics of listed companies when using hedging from multiple perspectives to determine the variables indicators for cluster analysis, and then use the *K*-means clustering to investigate China's listed companies participating in hedging, to classify and find out the internal laws.

4.1.1. Listed Companies' Participating Number

The data shows that the number of China's listed companies participating in hedging has increased year by year from 2015 to 2019. According to the year, there were 94 in 2015 and 106 in 2016, with an increase of 13%; 148 in 2017, with an increase of 40 %; 209 in 2018, with an increase of 41%; 223 in 2019, with an increase of 7%.

From Figure 1, on the Shanghai Stock Exchange, 22 listed companies participated in hedging in 2015 and 23 companies in 2016, with a growth rate of 5%. In 2017, the data sharply rose to 32 companies with an increase of 40%. Subsequently, the data continued rising in 2018, with the number of companies reaching 45 and the growth rate reaching 38%. However, there are no new listed companies that participated in hedging in 2019. On the Shenzhen

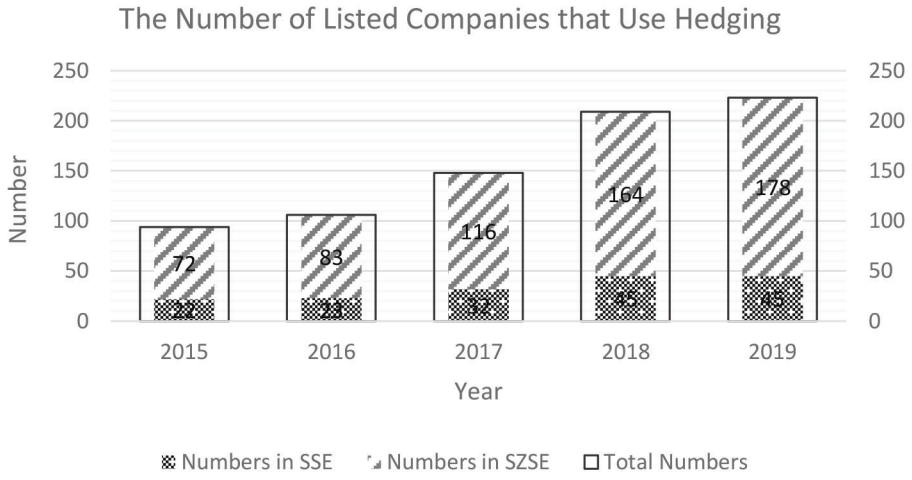

Figure 1: Number of China's Listed Companies Participating in Hedging

Stock Exchange, there were 72 listed companies engaged in hedging in 2015 and 83 in 2016, with an increase of 16%. The number of participating companies in 2017, 2018, and 2019 were 116, 164, and 178, respectively, and the growth rate peaked in 2018 at 42%.

4.1.2. Listed Companies' Regional Distribution Characteristics

Based on regional distribution (see Table 1) of the 223 listed companies that participated in hedging in 2019, we found that 105 listed companies are based in East China accounting for 47% of the total companies participating in hedging. 55 listed companies are based in South China, accounting for 25% of the total companies participating in hedging. However, the northwest region only has 7 listed companies participating in hedging.

Of the 45 listed companies on the Shanghai Stock Exchange, 28 companies are located in East China, accounting for the largest percentage, up to 62%. Among the 28 listed companies, Jiangsu province has the highest number of the listed companies (a total of 9 listed companies) participating in hedging.

With regard to Shenzhen Stock Exchange, East China and South China accounted for the largest proportion, 77 listed companies (43%) and 55 listed companies (31%), respectively. Zhejiang Province ranked number one in East China, with 28 enterprises participating in hedging, while Guangdong Province ranked number in South China, with 48 participating in hedging.

The Pearl River Delta region, called the world's factory floor, is one of the world's largest manufacturing bases. The Yangtze River Delta region is the most comprehensive economic center in China, and the most important international gateways in the Asia-Pacific region, as well as, a significant manufacturing base globally. Based on collated data, we found there are 50 corporate headquarters located in the Yangtze River Delta and 53 corporate headquarters located in the Pearl River Delta. Thus, these two important economic regions play an extraordinary role in the economic structure transition. They have successfully introduced futures business in enterprise risk management. Hedging, as a risk management tool, has been effectively applied to enterprises' routine management operations.

4.1.3. Listed Companies' Business Nature Characteristics

From Table 2, the number of listed companies engaged in hedging is 223. Classifying them according to their business nature, there are 36 state-owned enterprises (SOE) taking part in the hedging (11 listed on the Shanghai Stock Exchange, 25 listed on the Shenzhen Stock Exchange) accounting for 16% of the total companies participating in hedging;

Table 1: Regional Distribution of China's Listed Companies Participating in Hedging in 2019

Regional Distribution	Number of Listed Companies Participating in Hedging					
	SSE		SZSE		Total	
	Number	Percentage of SSE	Number	Percentage of SZSE	Number	Percentage of Total
East China (Shanghai, Jiangsu, Zhejiang, Anhui, Jiangxi, Shandong, Fujian, Taiwan)	28	62%	77	43%	105	47%
South China (Guangdong, Guangxi Zhuang Autonomous Region, Hainan, Hong Kong SAR, Macao SAR)	0	0%	55	31%	55	25%
Central China (Henan, Hubei, Hunan)	4	9%	18	10%	22	10%
North China (Beijing, Tianjin, Shanxi, Hebei, Inner Mongolia)	2	5%	10	6%	12	5%
Northeast China (Heilongjiang, Jilin, Liaoning)	1	2%	8	5%	9	4%
Southwest China (Chongqing, Sichuan, Guizhou, Yunnan, Tibet)	6	14%	7	4%	13	6%
Northwest China (Shanxi, Gansu, Qinghai, Ningxia, Xinjiang)	4	9%	3	2%	7	3%
Total	45		178		223	100%

Table 2: Business Nature of China's Listed Companies Participating in Hedging in 2019

Business Nature	Number of Listed Companies Participating in Hedging					
	SSE		SZSE		Total	
	Number	Percentage of SSE	Number	Percentage of SZSE	Number	Percentage of Total
SOE	11	24%	25	14%	36	16%
Private enterprise	34	76%	153	86%	187	84%
(Sino-foreign Joint Venture)	（10）	（22%）	（30）	（17%）	（40）	（18%）
Total	45		178		223	100%

187 private enterprises participating in hedging (34 listed on the Shanghai Stock Exchange, 153 listed on the Shenzhen Stock Exchange), accounting for 84% of the total companies participating in hedging. Among the 187 private enterprises, there are 40 Sino-foreign Joint Ventures (10 listed on the Shanghai Stock Exchange, 30 listed on the Shenzhen Stock Exchange).

If we analyze by exchange, the Shanghai Stock Exchange has 45 listed companies participating in hedging while the Shenzhen Stock Exchange has 178 companies participating in hedging (76% of Shanghai Stock Exchange, 86% of Shenzhen Stock Exchange). The figure from both exchanges reflects private enterprises mainly participate in the futures market compared to SOEs. Private enterprises rely on their flexible mechanism and unique advantages in hedging and risk management business.

4.1.4. Listed Companies' Hedging Capital Characteristics

Listed companies pay different attention to risk management and hedging. The above-listed companies are quite different in many respects, including the hedging proficiency level, the ability to obtain certain guaranteed benefits while resisting risks of the operation, exposure, and different futures market phases (Table 3).

In 2019, four listed companies' hedging investments exceeded 10 billion RMB, seven companies had hedging investments between 5 billion RMB to 10 billion RMB, thirteen companies had hedging investments between 2 billion and 5 billion RMB, and fifteen companies had hedging investments below 2 billion RMB.

4.1.5. Cluster Result

We use the *K*-means method to classify 223 listed companies. These companies are classified based on eight variables: total asset, basic earnings per share (EPS), and hedging capital, whether they use foreign exchange, futures companies, region, business nature, and industry (see Table 4).

After deleting the missing data, we get 187 observations. We standardize the data, and Hopkins statistic results = 0.85, indicating the data is clustered. Figure 2 and Table 5 show the classification result.

According to the cluster analysis result, we cluster 187 listed companies that participate in hedging into four clusters, and their performance characteristics are as follows:

The first cluster contains only private enterprises that participate in hedging. In general, companies' scale is the main factor of hedging investment. A company with a larger scale is likely to invest more in hedging.

In the second cluster of listed companies, SOEs' hedging investment is related to companies' scale. For private enterprises, besides companies' scale, geographic location, and the number of local FCMs also have an impact on hedging investment. If a private enterprise is large or located in East or South China, or there are many local FCMs, it is likely to invest more in hedging. The hedging investment of Sino-foreign Joint Venture is affected more by its profitability.

The third cluster contains only the private enterprises that participate in futures hedging. Companies in East China invest more in hedging in general. Companies located in Central and North China are more likely to be affected by their profitability. A company with higher profitability will invest more in hedging.

In the fourth cluster, SOEs' participation is affected by the company scale. Private enterprises are non-manufacturing, like agriculture, business support, environmental protection, etc., and there are only one or two samples of each industry in this cluster, hence, the comparability is weak.

4.2. Hedging Products Cluster

4.2.1. Hedging Products' Characteristics

Of all China's listed companies that participate in hedging in 2019, Zheshang Development used the most types

Table 3: Hedging Capital of China's List Companies in 2019 (Billion RMB)

Hedging Capital	Companies Number	Companies Name (Hedging Capital in Parentheses)
Large than 10	4	CIMC Group (63); Lifan (52.5); Wuming Kangde(10.5); Guanghui Automobile (14)
5–10	7	Xingdawang (6), Satellite Petrochemical(5), Ganfeng lithium industry (5), Tianqi lithium industry (6.23), Jinfeng Technology (7), Hikvision (6.3), Omar Electric Appliances (9.4)
2–5	13	Western Gold (2.269), Xinao shares (2.1), Long Python Baili (3), Xinwei Communication (2.8), Xinhecheng is (2), Zhongding Shares (2.1), Jerry (2.5), CV source (3.5), Yutong Technology (3.5), Wanhe Electric (3.69), Dahua shares (4.9), Ocean Electric (2.8), Zheshang Development (3.5)
Less than 2	15	Tongwei shares (1.4), Hailier (1.2), Wanshun new materials (1.1), Aoshikang (1), Lepu medical (1.2), Rifa Precision Machinery (1.45), Qianfang Technology (1.05), Gree Electric Appliances (1.2), Radio and Television Express (1.21), Ningde Times (1.3), Zhongji Xuchuang is (1), Rongsheng Petrochemical (1), Haida Group (1.5), Costa (1,75), Zhongli group (1.06),

Table 4: Cluster Variables of China's Listed Companies

Variables	Descriptions
Total Asset	Company's total asset in 2018, indicates its scale
Basic EPS	Company's basic EPS in 2018, indicates its profitability
Hedging Capital	The hedging capital that the company using for hedging in 2018
If use foreign exchange	If the company use foreign exchange for hedging in 2018
Futures Companies	The number of FCMs in the province that the company based 1
Region	The region that the company based 2
Business Nature	The company's business nature 3
Industry	The company's industry 4

of futures, including 17 products such as ferrous metals, non-ferrous metals, chemicals, energy, etc.; Xiamen Port ranked second, and used 13 products including metals, chemicals, oils, oilseeds, energy, etc.; Yuntianhua and Jinyuan both used 9 products, and were ranked third; Yuntianhua used chemicals & energy, grains, oils, oilseeds, etc. and Jinyuan used precious metals, non-ferrous metals, rare metals, etc. 181 companies only use one product for hedging, and the most prevalent product is foreign exchange, followed by copper, aluminum, nickel, bitumen, Chinese jujube, polypropylene, fiberboard, glass, methanol, steel rebar, hot-rolled coils, gold, thermal coal, urea, white sugar options, wood pulp, ethylene glycol, etc. (See Figure 3).

There are a total of 121 listed companies that participated in foreign exchange hedging. Some companies participate in hedging only in one/two product(s). Yueyang Forest & Paper participates in wood pulp and polypropylene hedging; Xiamen Port participates in wood pulp hedging; Silver Age Sci & Tech participates in polypropylene and PVC hedging; Donghua Energy participates in polypropylene hedging; Inovance and Hailide participate in PVC hedging. Sbs Co., Zheshang Development, Hailide, Rongsheng Petrochemical, Oxiranchem, Eastern Shenghong, and Hengtong Optic-electric participated in PTA hedging.

We found that the listed company's participation in foreign exchange hedging is because they have a large share of foreign business and investments. Under the financial market environment with two-way fluctuations of RMB exchange rate and marketization of interest rate, to avoid exchange rate and interest rate risks in imports and exports business and corresponding foreign currency borrowings, combined with capital management requirements and daily business needs, companies participate in foreign exchange derivatives transaction including forward foreign exchange trading against RMB, RMB and other foreign exchange swaps, forward exchange transactions, foreign exchange swap, foreign exchange options, interest rate swap, and interest rate options.

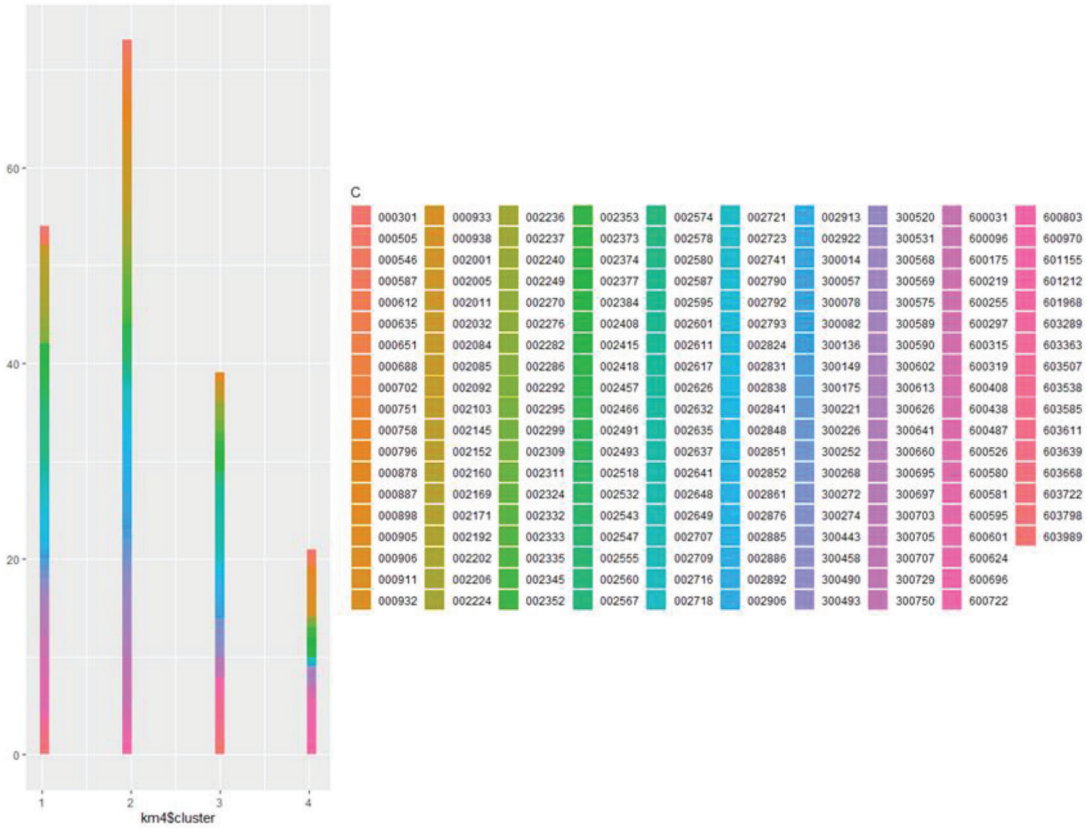

Figure 2: *K*-means Histogram of 187 China's Listed Companies

Table 5: *K*-means Result of China's Listed Companies

Cluster	Companies' Stock Code
1	002169, 002192, 002240, 002741, 002824, 300252, 000612, 002171, 002286, 002377, 002408, 002457, 002560, 002567, 002578, 002580, 002716, 002838, 002852, 300082, 300175, 300490, 300569, 300705, 600219, 600255, 600319, 600408, 600595, 603363, 603668, 603798, 000301, 002085, 002160, 002206, 002224, 002276, 002418, 002491, 002532, 002547, 002574, 002617, 002641, 002718, 002793, 300626, 300660, 300697, 600487, 600526, 600580, 603611
2	000505, 000587, 000635, 000688, 000702, 000751, 000758, 000796, 000898, 000932, 000933, 002005, 002011, 002032, 002084, 002092, 002103, 002152, 002202, 002236, 002237, 002249, 002292, 002295, 002311, 002324, 002332, 002333, 002345, 002466, 002493, 002518, 002543, 002587, 002611, 002709, 002721, 002723, 002792, 002831, 002841, 002851, 002876, 002885, 002886, 002906, 002922, 300014, 300057, 300136, 300149, 300221, 300226, 300272, 300458, 300493, 300531, 300568, 300575, 300589, 300602, 300641, 300695, 300729, 300750, 600031, 600096, 600175, 600315, 600438, 600581, 600722, 601212
3	000887, 002001, 002145, 002270, 002282, 002309, 002335, 002353, 002373, 002384, 002555, 002595, 002601, 002626, 002632, 002635, 002637, 002648, 002649, 002790, 002848, 002861, 002892, 002913, 300078, 300268, 300274, 300443, 300520, 300703, 300707, 600803, 603289, 603507, 603538, 603585, 603639, 603722, 603989
4	000546, 000651, 000878, 000905, 000906, 000911, 000938, 002299, 002352, 002374, 002415, 002707, 300590, 300613, 600297, 600601, 600624, 600696, 600970, 601155, 601968

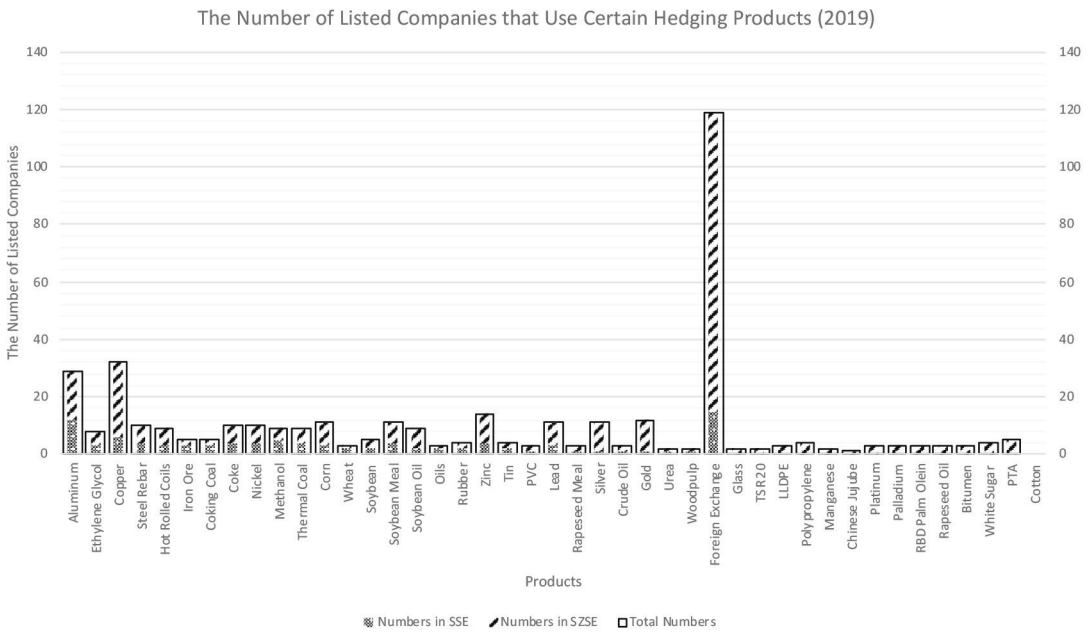

Figure 3: The Number of Listed Companies that use Certain Hedging Products

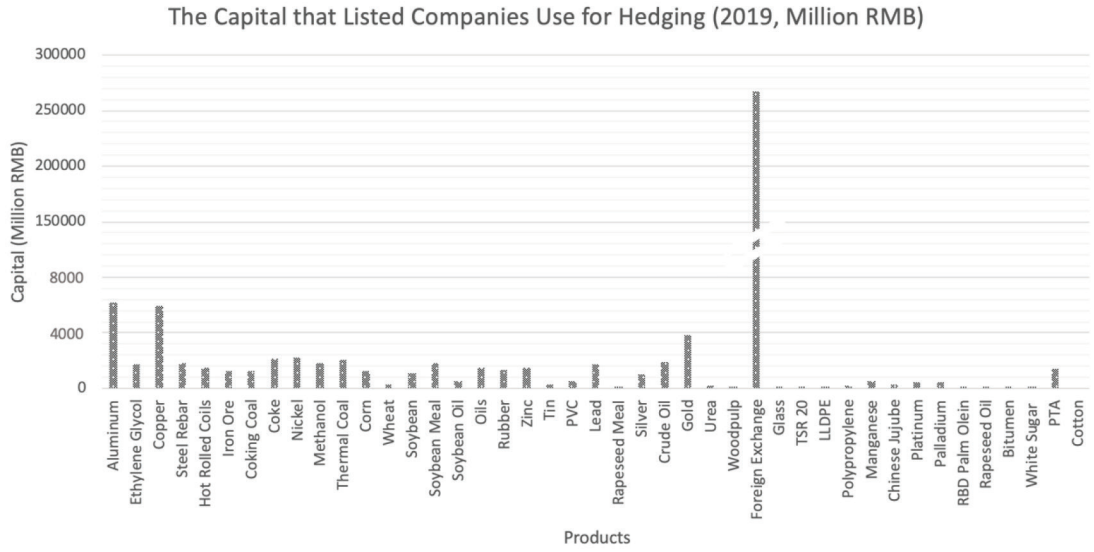

Figure 4: The Capital that Listed Companies use for Hedging

4.2.2. Hedging Products' Characteristics of Capital Investment

Figure 4 shows the capital that China's listed companies participating in hedging in 2019. China's listed companies invest the most capital in foreign exchange hedging, a total of 267.28 billion RMB (85.18 billion RMB from companies listed on the Shanghai Stock Exchange and 182.10 billion RMB from companies listed on the Shenzhen Stock Exchange). The second is aluminum, a total of 7.68 billion RMB

(3.20 billion RMB from companies listed on the Shanghai Stock Exchange and 4.48 billion RMB from companies listed on the Shenzhen Stock Exchange). The third is copper, a total of 7.42 billion RMB (1.82 billion RMB from companies listed on the Shanghai Stock Exchange and 5.06 billion RMB from companies listed on the Shenzhen Stock Exchange).

Except for foreign exchange and non-ferrous metals such as copper and aluminum, other products have a large potential for hedging.

4.2.3. Cluster Result

We use the hierarchical clustering method to classify 38 hedging products. These products are classified based on five variables: listed companies, hedging capital, trading volume, and delivery quantity. All the variables data are in 2018.

After deleting the missing data, we get 32 observations. We standardize the data, and Hopkins statistic = 0.76, indicating that the data is clustered. Figures 5 and 6 and Table 6 show the classification results.

According to the cluster analysis result, we cluster 32 hedging futures products into four clusters, and their performance characteristics are as follows:

The first cluster includes aluminum and copper. The numbers of listed companies that use these two hedging products are the maximum, and their hedging investments are significant (high). The delivery quantity of these two products ranked first and third respectively, but there are not many speculative behaviors, and trading volume is normal. Copper and aluminum are relatively developed since they were launched a long time back, and combined with China's weak pricing power, China's listed companies participate in these hedging products to reduce the spot price risk.

The second cluster is nickel, hot rolled coils, bitumen, coke, white sugar, rubber, polypropylene, coking coal, RBD palm olein, LLDPE, PVC, rapeseed oil, crude oil, manganese, tin, ethylene glycol, and wheat. The number of hedging companies in this cluster is relatively small, the amount of the hedging investment is moderate, and there is a large difference in delivery volume, indicating that the industry is highly centralized, and only a few companies participate in the hedging market. Their trading volumes have a large gap because of industry differences.

The third cluster is steel rebar. Steel rebar is the most active futures product among the 32 products with the largest trading volume. The number of listed companies participating in steel rebar hedging is considerable. However, due to speculative behaviors, the delivery quantity is normal.

The fourth cluster is PTA, iron ore, soybean meal, methanol, corn, soybean oil, soybean, silver, zinc, lead, rapeseed meal, gold. The hedging capital invested in this cluster is above average. Hedging investments are relatively

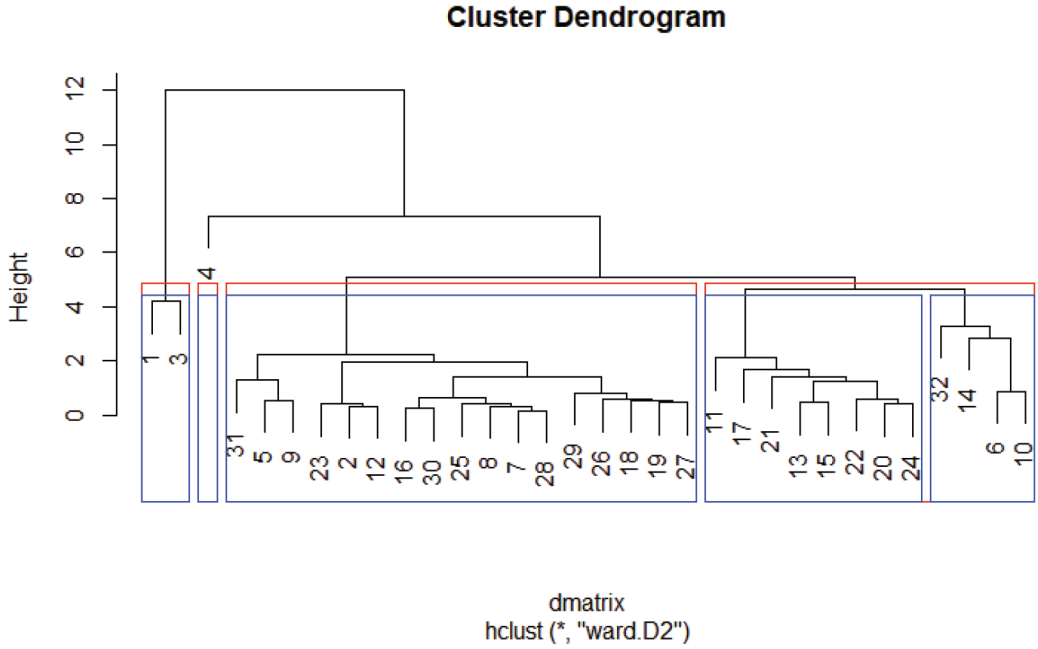

Figure 5: Hierarchical Clustering Dendrogram of 32 Hedging Products

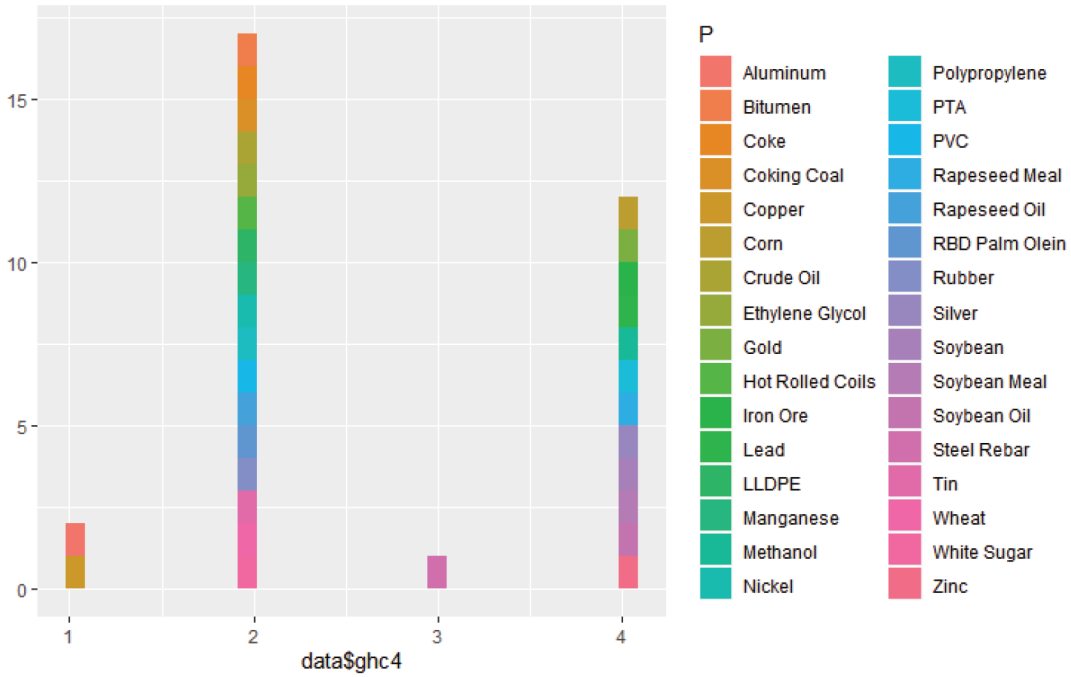

Figure 6: Hierarchical Clustering Histogram of 32 Hedging Products

Table 6: Hierarchical Clustering Result of Hedging Products

Cluster	Product
1	aluminum, copper
2	nickel, hot rolled coils, bitumen, coke, white sugar, rubber, polypropylene, coking coal, RBD palm olein, LLDPE, PVC, rapeseed oil, crude oil, manganeses, tin, ethylene glycol, wheat
3	steel rebar
4	PTA, iron ore, soybean meal, methanol, corn, soybean oil, soybean, silver, zinc, lead, rapeseed meal, gold

small while their delivery quantities are high, which is basically due to their high trading volume thus attracting companies to participate.

5. Discussion and Policy Recommendations

5.1. Discussion

Lee et al. (2016) pointed out that business needs, social expectations, ease of use, and usefulness are important factors in explaining the behavioral willingness of enterprises to use social media. Lee and Mendlinger (2011) showed that the operational capabilities of mobile service providers play a central role in increasing the use and adoption of *m*-commerce. These seem to be very close to the truth that enterprises use hedging.

The number of listed companies participating in hedging has increased year by year. In economically developed areas (along the southeast coast, such as East China and South China), a great number of companies participate in hedging because they have a vibrant economic system and stronger innovation capacity and risk management awareness. The proportion of listed companies in East China and South China that engage in hedging account for 74% and 72% respectively of the companies listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange. Furthermore, the percentage of SOEs participating in hedging accounts for 16%, while the percentage of private companies reached 84%.

This data shows that in Central China, Western China, Northeast China, and other regions, many potential SOEs can participate in hedging. Hedging as a tool should play

a greater role in less developed regions and maintaining or increasing SOEs' state capital value. Currently, it is estimated that nearly 300,000 SOEs in China need hedging, and the successful hedging experience and models of listed companies are worthy of their reference.

In the area with a large number of local FCMs, there will be more listed private enterprises participating in hedging. This means futures institutions play an active role in promoting hedging knowledge and guiding advanced risk management methods for listed companies. Among the listed companies that participate in hedging, manufacturing companies invested a lot of money, and their experience is worthy of reference for other industrial companies such as construction, agriculture, etc.

Some listed companies participate in hedging with more than ten products, including spanning ferrous metals, nonferrous metals, energy & chemical industry, and so on. It is undeniable that doing good hedging can effectively help companies achieve the goal of diversified operations, reduce operational risks, and help managers focus on innovation and effectively save time in risk management.

China's listed companies have a strong awareness of foreign exchange risks, hence, more than 120 listed companies have participated in foreign exchange hedging. However, many companies participate in hedging in only one product. Also, there are some hedging products that have only one or two companies participating. This is partly because of their short listing time, and partly because there are few conferences on such hedging products and companies thus companies have little knowledge about such hedging products. Copper and aluminum are the most popular hedging products and have a large number of listed companies investing and participating.

5.2. Policy Recommendations

We suggest encouraging the maintaining or increasing SOE's state capital value and related risk management business through tax policies, fiscal policies, and evaluation policies for SOE managers and allowing for reasonable mistakes when companies use hedging instruments, to maintain or increase their assets. This helps to effectively stimulate SOEs' enthusiasm and creativity in using hedging in asset risk management. Private enterprises have a lead in the use of hedging instruments, hence, we should encourage SOEs to learn from private enterprises how to use the hedging tool in an accurate, efficient, and flexible way.

In a knowledge-based economy, we suggest optimizing capital industry configuration and establishing a reasonable and orderly mechanism of personnel flow, promoting the movement of hedging talents and capital from East China and South China coastal areas to the Central and Western regions of China. We suggest promoting companies' officers and capital operators from Central, Western, Northeast, North China, and other regions to take temporary posts on the listed companies located in the economically developed regions such as Yangtze River Delta, Pearl River Delta, etc., to learn how to use hedging. In such a way we think it can promote enterprises to gradually become large-scale under the premise of controlling operational risks. Enterprises should learn from Fortune 500 Companies to be first-class modern enterprises globally.

We recommend that small and medium-sized enterprises, especially private enterprises, follow advanced risk management concepts and improve their business operation level, and be modern, scientific, systematic, standardized, and long-term developing enterprises. We suggest establishing more futures institutions in listed companies' locations, including FCMs or FCMs branches. Besides, we should encourage listed companies to participate in futures hedging through buying/setting up an FCM and futures private equity funds, etc. We should encourage futures institutions to host various product hedging forums with the listed companies who have successful hedging experience, to promote hedging business.

6. Conclusion

This study statistically analyzes the hedging data of China's listed companies and clusters China's listed companies and hedging futures products using *K*-means and hierarchical clustering method respectively, finding out China's listed companies' characteristics of participation, regional distribution, business nature, hedging capital, etc.

(1) China's listed companies have gradually deepened the use of hedging. On the whole, companies with a larger scale and higher profitability generally invest more money in hedging. The number of listed companies participating in hedging has increased year by year, and the average annual growth rate is more than 7%. The growth rate in 2017 and 2018 was around 40%. The number of companies listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange participating in hedging keeps growing every year.

(2) In terms of the regional distribution, East China has the highest percentage of listed companies participating in hedging, followed by the South China, then Central and North China, and the hedging participation of companies located in Central and North China are in direct proportion to their profitability. Companies located in the Yangtze River Delta region and the Pearl River Delta region are at the forefront of participating in futures hedging. In terms of industry, listed companies from the manufacturing industry has the

highest hedging participation and invests relatively more in hedging.

(3) From the perspective of companies' business nature, private enterprises more actively participate in hedging, accounting for 80% of the total listed companies participating in hedging, and their hedging investment is related to companies' scale, geographic location, and the number of local FCMs. For SOEs, their hedging investment is affected by companies' scale. The hedging investment of Sino-foreign joint ventures is affected more by its profitability, but the participation of Sino-foreign joint ventures is overall not high.

(4) In terms of hedging products, China's listed companies use a variety of hedging products, and listed companies are more likely to choose products that have been in the hedging market for a very long time and much more developed. Foreign exchange is the most popular product for hedging. Copper and aluminum are the second-most popular products for hedging with many listed companies investing a lot of money in these two products. But there are not many speculative behaviors. The number of companies hedging in products such as hot rolled coils, bitumen, coke, white sugar, rubber, polypropylene, LLDPE, PVC, crude oil, wheat, etc. is relatively small, their industries are highly centralized, and there is a large difference in delivery volume. Steel rebar has many speculative behaviors, and its delivery quantity is not much, but it is the most active hedging product. For PTA, iron ore, soybean meal, etc., their high trading volume attracts companies to participate.

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