

# Research on Price Discovery Function of China Pig Futures Market

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**Abstract:** On January 8, 2021, China Pig futures was listed on Dalian Commodity Exchange. Its listing has brought new tools for the risk management of hog prices, and has aroused widespread concern in the community. Research on the price discovery function of pig futures market is of great significance to the price risk management of pigs. This paper takes the China pig futures and spot market as the research object, selects the live pig futures and spot trading data of China from January 8, 2021 to September 28, 2023, and makes a preliminary effectiveness analysis on the price discovery function of the futures market through the trend of spot prices. Secondly, the data are tested for stationarity and cointegration, and then the VAR model is established. Through descriptive statistics, Granger causality test, impulse response and variance decomposition analysis, the price discovery function of China pig futures market is further analyzed. The results show that China pig futures market has played a certain price discovery function, but there is still room for improvement. Based on this, the relevant countermeasures and suggestions are put forward: to improve the relevant rules and systems of pig futures, to strengthen the standardization construction of the over-the-counter market of pigs, and to promote the enthusiasm of enterprises in the pig industry chain to participate in the futures market.

**Keywords:** Pig futures, Price discovery function, Futures prices, Spot price.

## 1. Introduction

Pig breeding industry has been a traditional agricultural industry in China since ancient times. Pork is the largest meat food consumption in China and one of the most important products in the "vegetable basket". It is related to the food security of Millions of people. At the same time, its production and consumption are ranked first in the world. Since the 21st century, the market price of live pigs has been fluctuating and there is a "pig cycle", which brings certain risks to pig farmers. The outbreak of African swine fever in 2018 caused unprecedented price fluctuations in the pig market, which made it difficult to guarantee the income of pig farmers and caused a huge impact on the pig market. On January 8, 2021, live pig futures were officially listed and traded on the Dalian Commodity Exchange. New hedging instruments were introduced into the live pig market, the most important purpose of which was to smooth the drastic fluctuations in the price of live pigs and reduce the price risk in the live pig market, so as to protect the income of pig farmers. Live pig futures can stabilize the spot market price of live pigs to a certain extent. At the same time, we can use the price discovery function of the futures market to anticipate the future market price and help each business entity in the pig industry chain to make reasonable production and sales arrangements based on the forecast results, which is conducive to stabilizing the market supply and demand and promoting the high-quality development of the pig industry.

Related research on the price discovery function of pig futures, Yang Yang (2017) analyzed that the price discovery function of pig futures in China can make the price of pig futures as an early warning indicator of future pork prices and thus carry out price control measures, further improving the price control system of pig in China. Xiuling Sun (2017) studied and analyzed the impact of the perfection of the spot pig market in China on the futures price discovery function,

and believed that more entities in the pig industry chain should be added to the futures hedging, so that the futures price discovery function can be better played. Research by Yanyuan Zhang and Guangwei Ju (2019) suggests that establishing and perfecting the pig futures market in China and giving full play to the price discovery function of futures are also helpful to the design and development of the pig price insurance with the futures price as the trigger price for compensation. Haifeng Zhang et al. (2021) analyzed the price trend of live pigs in China and the future market changes, and considered that the live pig futures in China could not eliminate the price fluctuations brought by the "pig cycle", but the price discovery function of the live pig futures could guide the production and marketing arrangements of relevant pig enterprises, and play a certain role in alleviating the drastic fluctuations of the pig price. After empirical analysis, Tao Wang (2023) believes that China pig futures play a one-way leading role in price discovery. China's pig futures have a certain price discovery function for spot, but the price discovery function still needs to be improved. Kengzheng Xie (2023) believes that pig futures have initially played its functional role and the correlation with spot prices is gradually increasing.

To sum up, although the research on the functional field of pig futures price discovery is quite rich, there are still research breakthroughs: First, the research on pig futures mostly stays in the theoretical link, and the corresponding empirical analysis is less; Second, the live pig futures have a short listing time, and there is less data in the relevant empirical analysis. The conclusion needs to be further verified. Therefore, this paper uses the latest live pig spot trading data to measure the strength of spot price discovery function of live pig futures through empirical analysis, so as to help each subject of the live pig industry to use futures tools to provide theoretical reference for risk management.

## 2. Analysis on the effectiveness of the spot market in the live pig period in China

### 2.1. Status of Pig Market in China

In recent years, the new and old risks and challenges facing the pig industry and the market have been increasing, and problems such as tighter resource constraints, weak international competitiveness and severe epidemic situation have become prominent, resulting in increasing pressure on pig supply and price stability and frequent price fluctuations in the pig market. As shown in Figure 1, there was a certain "pig cycle" in the pig price in China from 2013 to 2018, but

the fluctuation range was limited. The market price began to fluctuate violently after the outbreak of African swine fever in 2018. At the same time, many market control measures were implemented at the national level, but the fluctuation in the pig market could not be effectively ironed out. The pig market price began to rise sharply in 2019, and fell in 2021 after more than a year of adjustment after reaching the peak. The fluctuation range was much higher than before and nearly tripled before. In 2022, the production capacity of live pigs returned to the normal level of the year. The price of live pigs in the country rose steadily. The price fluctuation increased first and then decreased slightly. The price of live pigs decreased slowly from January to February 2023. Since then, the price of live pigs has remained stable with little fluctuation.

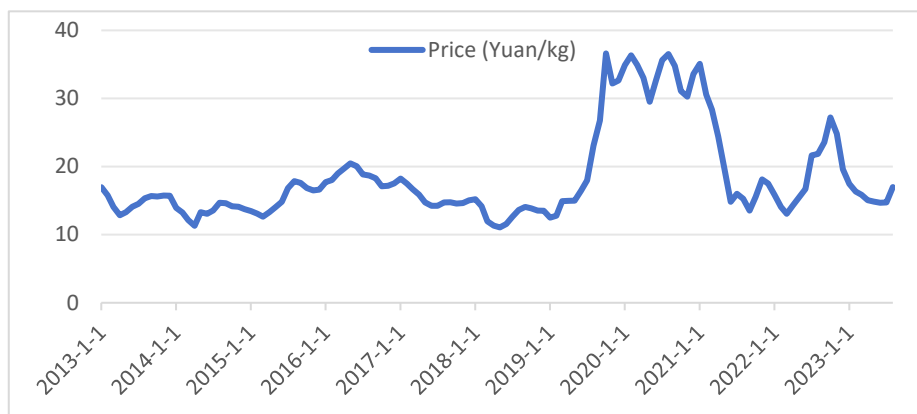


Figure 1. Trend of Pig Price in China from 2013 to 2023  
Source: Ministry of Agriculture of Rural China

### 2.2. Relevant Theoretical Analysis

In the meat consumption structure of China residents, pork consumption accounts for the largest proportion and occupies a very important position. In the past few years, The drastic fluctuations in pig prices have had a huge adverse impact on the pig industry. Pig farmers and industry-related practitioners need to build and optimize pig risk management, build a hedging portfolio using pig futures, and then transfer the risks brought by fluctuations in spot prices of pigs. At the same time, the price discovery function of the pig futures market is used to forecast the future pig price, and according to the forecast results, the industry sector can be helped to formulate reasonable plans in a timely manner to adjust and optimize the structure of the pig industry, so as to mitigate the risk of fluctuations in pig prices.

Hedging refers to when an investor wants to conduct a spot transaction, in order to avoid the risks brought by future price changes, he/she carries out transactions with the same amount and opposite directions in the futures market, locks the transaction price and avoids the time risk. Producers sell certain assets and buy futures assets: when the future transaction price is higher than the current price, the producers will cause some losses in the spot market and gain some profits in the futures market, which will offset each other so as not to cause losses; When the future trading price is lower than the current price, the spot market gains part of the profit, while the futures market causes part of the loss, offsetting each other so as not to generate profit. The essence of this is that producers are afraid of losses caused by future price drops when the market price is high, and then lock in profits. Take pig farmers as an example: suppose that the price of live pigs is relatively high at this time, but the pigs of pig

farmers are not ready for the market, and the farmers are worried that the price of live pigs will fall, so they sell a contract in the futures market, the quantity  $n$  is the same as the quantity on the market, and the price is  $P_0$ . after the pigs are ready for the market, suppose that the spot price will rise and fall simultaneously, the spot price will drop from  $P_1$  to  $P_3$ , and the futures price will drop from  $P_0$  to  $P_2$ . the farmers will sell the live pigs in the spot market, and at the same time, they will close more positions in the futures market, making a profit  $(P_0 - P_2) \times n$ . At this time, the profit of the farmers from selling live pigs is  $(P_3 + P_0 - P_2) \times n$ . When the drop in spot price equals the drop in futures price, i.e.  $P_1 - P_3 = P_0 - P_2$ , the profit of the farmers is  $P_1 \times n$ , which is equivalent to locking the trading price and profit in advance to avoid the risk of price drop.

This paper believes that the price discovery in the futures market is a complex process, and the futures market's own unique trading mechanism determines the authenticity, continuity and authority of the futures price. The exchange collects information about the supply and demand of commodities and their changing trends from a large number of buyers and sellers, forming an open and free competitive market in which prices are adjusted immediately according to changes in supply and demand. As there are some mature institutional investors in the futures market, their investment behavior is more rational, they have more price-related information in the futures market and the spot market, and their reaction to information is reflected in the trading behavior in the futures market, so the futures are more sensitive to market information, and the futures price more accurately reflects the real supply and demand situation and price change trend. The change trend of the futures price will drive the change trend of the spot price, and the spot market

price will be adjusted according to the futures market price. There is a lead-lag relationship between the two prices.

### 2.3. Analysis on the Effectiveness of Live Pig Period Spot Market

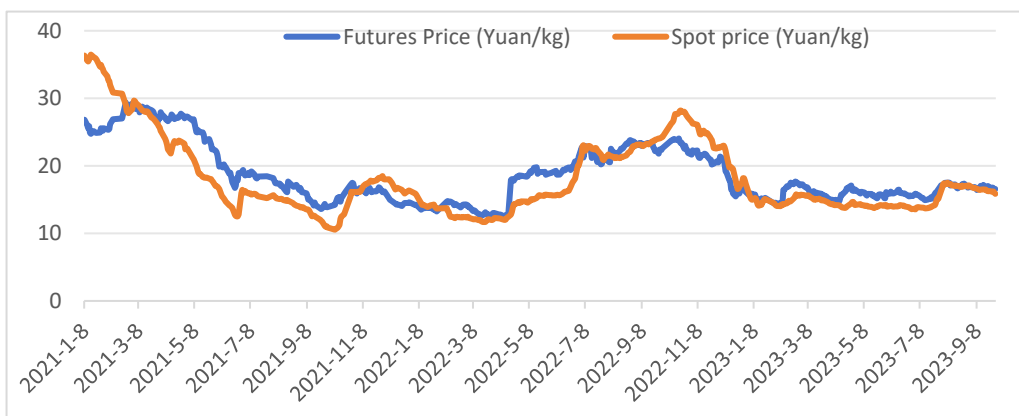


Figure 2. Spot Price Trend of Live Pig Period in China from 2021 to 2023

The trend of pig futures and spot prices in China from January 8, 2021 to October 19, 2023 is shown in Figure 2. The futures data in the figure are the closing prices of major contracts of Dalian Commodity Exchange, which are derived from CSMAR database, and the spot prices are derived from China Rural Agriculture Department. Judging from the early stage of the listing of pig futures in China on January 8, 2021, the price of pig futures in China is not in line with the fluctuation of spot price of pigs. The price of pig futures has shown a slight upward trend, while the spot market price of pigs has dropped all the way. The analysis may be due to the fact that the futures price of live pig futures fell by more than 12% on the day of listing, which was quite different from the spot price. Subsequently, the futures market price showed a trend of correction to the spot price. Until March 2021, futures market prices began to exceed spot market prices. As the spot price tends to be the same, it experienced a small fluctuation for another month, and the fluctuation direction of pig futures price and spot price also tends to be the same, and the futures market began to play its role. As can be seen from fig. 2, from January 2021 to April 2022, China is experiencing a "pig cycle" market in the phase of rapid downward trend of pig prices. the low price of live pigs has seriously affected the profit of farmers and their enthusiasm for breeding. The government's policy of raising the price of live pigs to the bottom has been strengthened. In April 2022, the price of live pigs began to change from low to high. At the same time, due to the increase in the cost of breeding feed and the increase in the demand side of live pigs, the increase in the price of live pigs accelerated significantly after July. Until mid-October, the spot price of live pigs peaked. Subsequently, the momentum of this round of price increase was insufficient. As the price of live pigs rose too much, the price was too high and the accumulated inventory of live pigs in the early period began to release. The imbalance between supply and demand led to the beginning of a new cycle of price decline of live

pigs. The price difference between spot prices of live pigs further narrowed. In February 2023, spot prices of live pigs reached the bottom of the downward trend. Since then, as of September 28, 2023, the spot price of the live pig period has not fluctuated much, the spot price is slightly lower than the futures price, and the fluctuation direction tends to be the same. On the whole, the spot price of live pig period in our country changed from the temporary deviation at the beginning of listing of live pig futures to the trend of price fluctuation. Preliminary analysis: The spot price discovery function of China live pig futures is gradually strengthening, and the expected effect of the futures market on the future price of live pig spot market has begun to appear.

## 3. Empirical Analysis on Price Discovery Function of Pig Futures Market

### 3.1. Data Sources and Descriptive Analysis

The daily transaction data from January 8, 2021 to October 19, 2023 are selected to eliminate the mismatch of the spot and futures data caused by holidays, and 672 sets of data are finally obtained. Among them, the pig futures price is the daily closing price of the main contract of Dalian Commodity Exchange, which is expressed by LHF; The spot price of live pigs is selected from the wholesale price of pork in the Ministry of Agriculture and Rural Affairs, expressed in LHP, and the unit is unified as RMB/kg. Pig futures price data are derived from CSMAR database and spot price data are derived from the Ministry of Agriculture and Rural Affairs of China. As shown in Table 1, the standard deviation, skewness and kurtosis of the fluctuation range of live pig spot price are all larger than the futures price, indicating that the price fluctuation in the live pig spot market is more severe than that in the futures market and the market risk is higher.

Table 1. Descriptive Analysis

	average	median	maximum	minimum	standard deviation	skewness	kurtosis
LHF	18.62834	17.08000	29.38000	12.52500	4.167469	0.811024	2.716037
LHP	17.98016	15.91000	36.47000	10.56000	5.456011	1.295957	4.214565

### 3.2. Stationarity test

In order to eliminate the heteroscedasticity of the series, the two sets of price data are subjected to logarithmic processing, which are respectively represented by lnLHF and lnLHP. The logarithmic price data are respectively subjected to first-order

difference, and the obtained price time series are respectively represented by dlnLHF and dlnLHP. The LNLHF and LNLHP sequences are tested by ADF. From the test results, at the significance level of 5%, the live pig futures and spot logarithms are both unstable sequences, and both are stationary sequences after first-order difference.

**Table 2.** ADF test results

variable	ADF statistics	Threshold (5%)	Adjoint probability p	conclusion
lnLHF	-1.868380	-3.417215	0.6696	unstable
dlnLHF	-25.18282	-3.417215	0.0000	stable
lnLHP	-2.739162	-3.417239	0.2211	unstable
dlnLHP	-21.65075	-3.417239	0.0000	stable

### 3.3. Cointegration test

lnLHF and lnLHP sequences are both integrated of order. The VAR model is established, the optimal hysteresis coefficient is determined to be 4 by the information criterion, and the cointegration relationship between them is determined by Johansen cointegration test. The test results are shown in Table 3. The corresponding P value is less than 0.05

for both trace statistics and maximum feature statistics, which indicates that there is no cointegration relationship hypothesis and at most one cointegration relationship hypothesis is rejected at 5% significance level. The conclusion is that there are at least two or more cointegration relationships between live pig futures and spot, i.e. there is a long-term equilibrium relationship between live pig futures and spot in China.

**Table 3.** Johansen cointegration test results

suppose	eigenvalue	Maximum eigenvalue	Trace test	Threshold 5%	P value
None*	0.0334	-	24.7130	15.4947	0.0016
At most 1*	0.0067	-	4.0676	3.8415	0.0437
None*	0.0334	20.6454	-	14.2646	0.0043
At most 1*	0.0067	4.0676	-	3.8415	0.0437

### 3.4. Granger causality Test

The Granger causality test is performed on the premise that the sequence is stationary, so the sequence after the first-order difference is used for the Granger causality test, and the test results are shown in Table 4. Under the significance level of 5%, the change of pig futures price is the Granger cause of

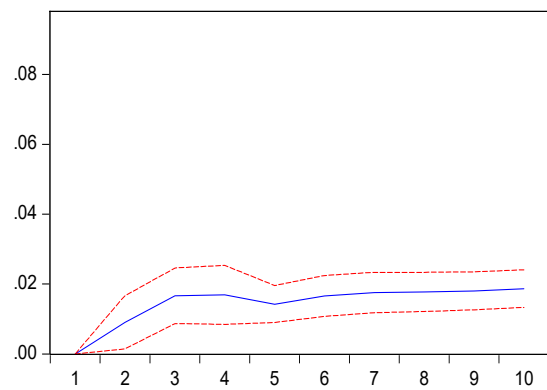
spot price change, while the change of spot price is not the Granger cause of future price change, which indicates that there is only one-way Granger causality between spot prices in pig period, i.e. the fluctuation of pig futures price has a significant impact on the change of spot price of pigs, pig futures play a one-way leading role in price discovery, and the development of pig futures still needs to be further improved.

**Table 4.** Granger Causality Test Results

Variable relation	null hypothesis	variance ratio	P value	conclusion
dlnLHF,dlnLHP	dlnLHF does not Granger Cause dlnLHP	7.9558	0.0000	refuse
	dlnLHP does not Granger Cause dlnLHF	0.1832	0.9471	accept

### 3.5. Impulse response analysis

By establishing the impulse response function, the analysis chart of the impulse response function between the pig futures and spot price is obtained. The results show that lnLHF has a positive impact effect on lnLHP and reaches its maximum value in the third phase, after which it causes continuous and stable impact. lnLHP also has a positive impact effect on lnLHF, but the impact effect is small, reaching a maximum value in the third phase, which is about one tenth of the impact effect of lnLHF on lnLHP, and then causing sustained and stable impact. According to the above analysis, the impact of lnLHF on lnLHP is more intense, indicating that the spot price of live pigs has a greater impact on the spot price change of live pigs, while the spot price of live pigs has a smaller impact on the spot price change of live pigs. Pig futures play a leading role in spot, and the price discovery function has been improved to a certain extent.



**Figure 3.** Response of lnLHP to lnLHF

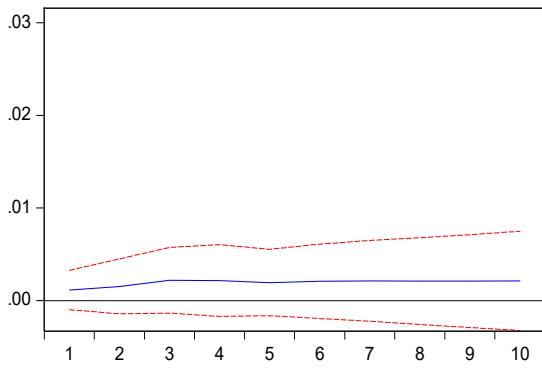


Figure 4. Response of lnLHF to lnLHP

### 3.6. Variance Decomposition

The variance decomposition is used to analyze the contribution rate of factors between the pig futures and spot price of Chinese live pigs, so as to judge and analyze the degree of mutual influence of the pig futures and spot prices of Chinese live pigs. As shown in Table 5, the variance

decomposition results of the first 50 periods of the spot price sequence of the live pig period show that the contribution rate of the live pig futures from itself is 99.82% when the forecast period is 1. With the increase of the forecast period, the contribution rate of the live pig futures to its variance decreases continuously until the contribution rate of the fiftieth period is 99.37%, and the contribution rate of the variance from the spot pig in our country increases until the contribution rate of the fiftieth period is 0.63%. When the forecast period is 1, the contribution rate from the spot pig is 99.13% and the variance contribution rate from the pig futures is 0.87%. With the increase of the forecast period, the variance contribution rate from the spot pig decreases continuously until the 50th period is 48.17%, while the variance contribution rate from the pig futures increases continuously until the 50th period is 51.83%. It is concluded that the contribution rate of China's live pig futures to live pig spot can account for about 50% in the period of 50, which indicates that China's live pig futures have a certain time lag effect on the transmission of live pig spot.

Table 5. Variance Decomposition Table

Lag period	lnLHF		lnLHP	
	lnLHF	lnLHP	lnLHP	lnLHF
1	99.81508	0.18492	99.13482	0.86518
2	99.73611	0.26389	96.64024	3.35976
3	99.59238	0.40762	94.69271	5.30729
4	99.53405	0.46595	93.83177	6.16823
5	99.52507	0.47493	99.13482	0.86518
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46	99.37842	0.62158	50.85461	49.14539
47	99.37743	0.62257	50.15981	49.84019
48	99.37647	0.62353	49.48122	50.51878
49	99.37555	0.62445	48.81846	51.18154
50	99.37465	0.62535	48.17114	51.82886

## 4. Conclusions and Inspiration

Through descriptive analysis, we can draw the conclusion that the price fluctuation in spot pig market in China is more severe than that in futures market; Through the results of cointegration test, it can be seen that there is a long-term equilibrium relationship between China pig futures and live pig spot; The Granger causality test results show that there is only one-way Granger causality between the spot price of live pigs in China, that is, the fluctuation of the price of live pig futures has a significant impact on the change of the spot price of live pigs, and live pig futures play a one-way leading role in price discovery; Through impulse response analysis, it is found that China pig futures has certain price discovery function on the spot market, but there is room for improvement; Through the analysis of variance decomposition, it is found that there is a certain time lag effect on the transmission of live pig spot in China pig futures, and there is a long-term impact relationship between the two. With the steady operation of the live pig futures market in China, there is a certain room for improvement in the price discovery function of live pig futures.

Based on the comprehensive empirical conclusions, the following inspirations are drawn: improve the relevant rules and systems of pig futures, further improve the futures market environment, and enhance the efficacy of pig futures in serving the pig industry; We will strengthen the

standardization of the live pig off-market market and further promote the integration and development of live pig spot market. The over-the-counter market can help enterprises to deliver futures, and the further development of the over-the-counter market can better meet the practical needs of pig enterprises. We should strengthen the all-round construction of live pig on-site and off-site markets to improve the market risk management system and realize better interconnection of live pig spot. Promote the enthusiasm of enterprises in the pig industry chain to participate in the futures market, further play the role of futures price discovery, and encourage and guide large pig breeding enterprises in the pig industry chain to actively participate in the futures market to carry out hedging.

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