An empirical study on soybean meal period and spot market under the influence of the new crown pneumonia epidemic——Based on econometric models

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Abstract. Based on econometric model, this paper studies the dynamic correlation between soybean meal spot market and soybean meal spot market under the influence of Covid-19 epidemic by introducing two variables: soybean meal futures closing price and soybean meal spot price by vector autoregressive model It is found that there is a one-way guiding relationship between soybean meal futures price and spot price before and during the epidemic; During the epidemic period, the positive effect between futures price and spot price is more significant, which provides a reliable empirical basis for regulatory thinking.

Keywords: Time-series model; Econometric models; Soybean meal.

1 Introduction

Soybean meal is widely used and has a low replacement. It is a very important variety of agricultural products and futures transactions[1]. Soymeal futures were launched by the Dalian Commodity Exchange in 2000. In 2007, it ranked first among the world 's agricultural futures. In 2019, my country' s soybean meal futures were sold for nearly 280 million lots a year[2]. Therefore, the function of studying the price of the bean meal and the spot market has important practical significance.

Metrology economics is a branch of Chinese economics disciplines that integrate mathematics statistics and economics[3]. After a series of processes such as sample data collection, model design, parameter inspection, etc., the target decision makers that can analyze the laws involved in social and economic phenomena can be designed as a basis. The application of mathematical models is only a tool, and cannot be used as the essence of research economics theory. But it is this tool that has promoted the development of economic theory[4]. The development of any theory of modern economics is inseparable from mathematical arguments.

By constructing a metrological economy model that is compatible with the financial market situation[5], considering the impact of the new crown pneumonia's epidemic on my country's financial market, analyzing the deep reasons of the soybean meal and the spot market price fluctuations under the new crown pneumonia epidemic, from a statistical perspective exploring the relationship between the soybean meal period and the

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spot market is of great significance for enterprises to quickly make corresponding decisions and government formulation related policies.

2 Methodology

The VAR model is a non-structural equation group model. This model adopts the form of multi -party equations[6]. In each equation of the model, endogenous variables return to the lag of all endogenous self-variables of the model, which is estimated the time series system and the dynamic impact of random disturbance on the variable system[7].

When there is only one variable, the VAR model forms as follows:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_P Y_{t-P} + \varepsilon_t \quad . \tag{1}$$

Among them, Y represents the endogenous variable vector of K Wei, A represents the corresponding coefficient matrix, and P indicates the number of stagnation of endogenous variables. If there are two variables:

$$\begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} A_{11,1} & A_{12,1} \\ A_{21,1} & A_{22,1} \end{bmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}. \tag{2}$$

$$Y_t = \begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix}, c = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix}, A_1 = \begin{bmatrix} A_{11,1} & A_{12,1} \\ A_{21,1} & A_{22,1} \end{bmatrix}, Y_{t-1} = \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \end{bmatrix}, \varepsilon_t = \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}. \tag{3}$$

There are:

$$Y_t = c + A_1 Y_{t-1} + \varepsilon_t . \tag{4}$$

Promoting the VAR model that is lagging behind N variables, including:

$$Y_t = c + A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_P Y_{t-P} + \varepsilon_t . \tag{5}$$

$$Y_t = (y_{1t}, y_{2t}, \cdots y_{Nt})', c = (c_1, c_2, \cdots c_N)', \varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t}, \cdots \varepsilon_{Nt})' . \tag{6}$$

$$A_j = \begin{bmatrix} A_{11,j} & A_{12,j} & \cdots & A_{1N,j} \\ A_{21,j} & A_{22,j} & \cdots & A_{2N,j} \\ \cdots & \cdots & \ddots & \cdots \\ A_{N1,j} & A_{N2,j} & \cdots & A_{NN,j} \end{bmatrix}, \mathrm{j} = 1, 2, \cdots, p . \tag{7}$$

The core idea of the VAR model is to represent the sample data as a linear equation group. Each equation represents a time sequence of a variable, which is associated with other equations. By using the sample data to estimate this equation group, the interaction between each variable and other variables can be analyzed. For example, in a data concentration containing the stock market and interest rates, changes in the stock mar-

ket can affect interest rates, and changes in interest rates may also affect the stock market. The VAR model provides a wealth of structure and can capture more data features. And the model estimation is also very simple, and estimates are consistent and effective.

Futures prices are constantly working on a balanced price by various factors, so the futures price can accurately reflect the supply and demand status of the market, and a complete financial market system should be a good combination of the spot market and the futures market. Therefore, this article is selected to analyze the dynamic connection between the spot during the soybean meal during the spot of soybean meal.

3 Samples and variables

This article selects the daily data of soybean meal from 2017 to 2022 as the research object. It starts with the starting point of the new crown pneumonia epidemic on January 1, 2020, and divides the time sequence as two time periods before the epidemic of new crown pneumonia and the new crown pneumonia epidemic. Observation values that match the soybean meal and spot data and delete the inconsistent transaction time. FP and SP represent the soybean meal period and spot price.

Analysis of the spot price of the soybean meal period, from Table 1: The correlation between the current futures price of soybean meal reached 0.806 and 0.943, respectively. There are strong price discovery functions.

Table 1. Correlation analysis

	I time period		II time period	
	FP	SP	FP	SP
FP	1	0.806	1	0.943
SP	0.806	1	0.943	1

4 Empirical analysis

4.1 ADF test and Cointegration test

The ADF inspection of each time sequence is performed. The test results are shown in Table 2:

Table 2. Stationarity test of variables

	Variable	(C, T, K)	t-Statistic	AIC	SC	HQ	Prob.**	Result
I period	FP	(0,0,1)	-29.651	9.744	9.751	9.747	0.000***	Steady
	SP	(0,0,1)	-24.445	9.244	9.249	9.246	0.000***	Steady
II period	FP	(0,0,1)	-27.648	10.442	10.448	10.444	0.000***	Steady
	SP	(0,0,1)	-21.283	10.574	10.58	10.576	0.000***	Steady

From Table 2, the P value is less than 0.05. the soybean meal period and spot price of I and II periods meet the conditions for co -inspection, indicating that there may be long-term equilibrium relationship between the soybean meal period and the spot price, so the co-inspection is performed.

The optimal lag order needs to be determined during the co-inspection, and the optimal lags are determined by the AIC and SC standards. The result is shown in Table 3 and 4:

Table 3. Optimal AIC, SC, HQ in I time period

Lags	Log L	LR	FPE	AIC	SC	HQ
0	-9608.237	NA	6.09E+08	25.904	25.916	25.908
1	-6900.067	5394.442	416225	18.615	18.652	18.629
2	-6871.548	56.652*	389606*	18.548*	18.611*	18.573*
3	-6868.451	6.136	390556	18.551	18.638	18.585

Table 4. Optimal AIC, SC, HQ in II time period

Lags	Log L	LR	FPE	AIC	SC	HQ
0	-10633.920	NA	1.22E+10	28.902	28.914	28.907
1	-7565.907	6111.022	2958165	20.576	20.613	20.590
2	-7529.692	71.937	2710220	20.488	20.551*	20.512*
3	-7523.657	11.955*	2695275.*	20.483*	20.570	20.517

From Table 3, Table 4: the principle of the minimum AIC. the number of optimal lags in the time period of time I and II is 2 and 3, respectively. Bring the determined optimal lags into the Johansen co-inspection inspection to verify whether there is a coordination relationship between the bean meal and the spot price.

The test results are shown in Table 5:

Table 5. Cointegration test

Statistical methods	Statistical methods	I time period			II time period		
		Trace Statistic	5% Critical Value	Prob.**	Trace Statistic	5% Critical Value	Prob.**
Trace test	None*	18.359	15.495	0.01800	6.744	15.495	0.06076
	At most 1	3.517	3.841	0.06080	0.116	3.841	0.07333
Max-eigenvalue test	None*	14.843	14.265	0.04050	6.628	14.265	0.05341
	At most 1	3.517	3.841	0.06080	0.116	3.841	0.07333

From Table 5: both tests show that there are coordination relationships between the bean meal and the spot market in the time period of I and II. It shows that there is a long -term balanced relationship between the spot market.

4.2 VAR model establishment

The VAR model is established according to the number of optimal lags: I and II time periods:

Modeling in I time period is as follows:

$$Y_t = c + A_1 Y_{t-1} + A_2 Y_{t-2} + \varepsilon_t . \tag{8}$$

$$Y_t = (FP, SP)', c = (c_1, c_2)', \varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t})' . \tag{9}$$

The II time period modeling is as follows:

$$Y_t = m + B_1 T_{t-1} + B_2 T_{t-2} + B_3 T_{t-3} + u_t . \tag{10}$$

$$T_t = (FP, SP)', m = (m_1, m_2)', u_t = (u_{1t}, u_{2t})' . \tag{11}$$

The stable test of the VAR model of I and II time periods is performed. The results are shown in the figure below and the table below:

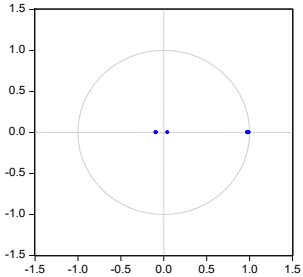

Fig. 1. Round icon of I time period

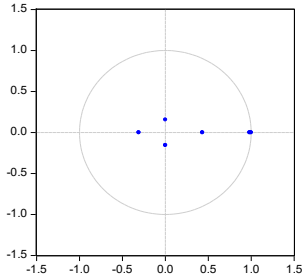

Fig. 2. Round icon of II time period

From Figure 1, 2: The characteristics of the VAR models of I and II time periods are all in the unit circle. Therefore, the VAR models of I and II time periods are stable, and the return results are shown in Table 6 and 7:

Table 6. VAR model results in I time period

Lag period of variables	Estimated value of FP	Estimated value of SP	Standard value of FP	Standard value of SP	T value of FP	T value of SP
FP(-1)	0.9161	0.1515	(-0.0431)	(-0.0331)	[21.2816]	[4.5895]

FP(-2)	0.0674	-0.1385	(-0.0427)	(-0.0328)	[1.5766]	[-4.2201]
SP(-1)	0.0220	1.0045	(-0.0554)	(-0.0425)	[0.3977]	[23.6377]
SP(-2)	-0.0165	-0.0232	(-0.0547)	(-0.0419)	[-0.3011]	[-0.5537]
C	31.5077	17.2232	(-17.1256)	(-13.1371)	[1.8398]	[1.3111]
R-squared		FP 0.9757		SP 0.9874		
Adj. R-squared		FP 0.9756		SP 0.9873		
F-statistic		FP 7614		SP 14863		

Table 7. VAR model results in II time period

Lag period of variables	Estimated value of FP	Estimated value of SP	Standard value of FP	Standard value of SP	T value of FP	T value of SP
FP(-1)	0.9187	0.0743	(-0.0489)	(-0.0523)	[18.7635]	[1.4213]
FP(-2)	0.0542	-0.1446	(-0.0645)	(-0.0689)	[0.8402]	[-2.0981]
FP(-3)	0.0153	0.0765	(-0.0487)	(-0.0519)	[0.3153]	[1.4720]
SP(-1)	0.0893	1.1872	(-0.0456)	(-0.0487)	[1.9591]	[24.3875]
SP(-2)	-0.1020	-0.0897	(-0.0679)	(-0.0725)	[-1.5015]	[-1.2363]
SP(-3)	0.0212	-0.1036	(-0.0441)	(-0.0471)	[0.4809]	[-2.1975]
C	11.3621	3.0091	(-15.0089)	(-16.0271)	[0.7570]	[0.1878]
R-squared		FP 0.9909		SP 0.9954		
Adj. R-squared		FP 0.9908		SP 0.9954		
F-statistic		FP 13348		SP 26601		

From Table 6 and 7, the relationship between the I time period, the II time period, the relationship between the spot price, as shown in the type (12) and (13):

$$\begin{pmatrix} FP_t \\ SP_t \end{pmatrix} = \begin{pmatrix} c_1 \\ c_2 \end{pmatrix} + \begin{bmatrix} 0.916 & 0.022 \\ 0.151 & 1.00 \end{bmatrix} \begin{pmatrix} FP_{t-1} \\ SP_{t-1} \end{pmatrix} + \begin{bmatrix} 0.067 & -0.017 \\ -0.139 & -0.023 \end{bmatrix} \begin{pmatrix} FP_{t-2} \\ SP_{t-2} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} . \tag{12}$$

$$\begin{pmatrix} FP_t \\ SP_t \end{pmatrix} = \begin{pmatrix} m_1 \\ m_2 \end{pmatrix} + \begin{bmatrix} 0.919 & 0.089 \\ 0.074 & 1.187 \end{bmatrix} \begin{pmatrix} FP_{t-1} \\ SP_{t-1} \end{pmatrix} + \begin{bmatrix} 0.054 & -0.102 \\ -0.144 & -0.089 \end{bmatrix} \begin{pmatrix} FP_{t-2} \\ SP_{t-2} \end{pmatrix} + \begin{bmatrix} 0.015 & 0.077 \\ 0.021 & -0.104 \end{bmatrix} \begin{pmatrix} FP_{t-3} \\ SP_{t-3} \end{pmatrix} + \begin{pmatrix} \mu_{1t} \\ \mu_{2t} \end{pmatrix} . \tag{13}$$

From Table 6, 7: I and II periods of the bean meal period and the spot price equation are 0.976, 0.987, and 0.991, 0.995, indicating that the three lags have strong interpretation of its variables in the current value. good.

4.3 Impulse response function

The pulse influence function reflects the dynamic response generated by the "exogenous impact" of a certain variable in the VAR model by its own or other market information. This method uses this method to analyze the impact of changes in the soybean meal period and spot historical price on the current period and the change of the spot market.

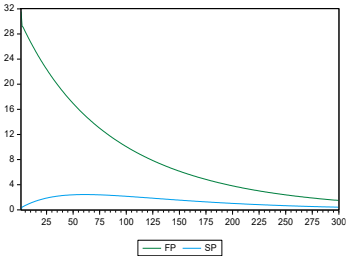

Fig. 3. Response of FP in I time period

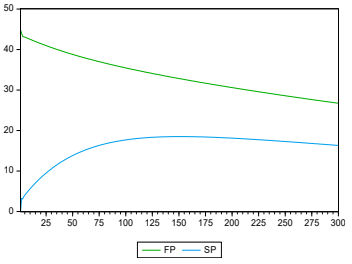

Fig. 4. Response of FP in II time period

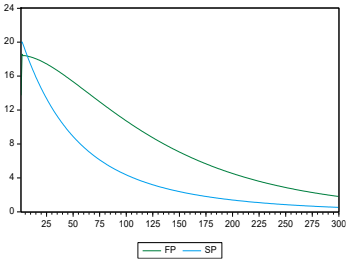

Fig. 5. Response of SP in I time period

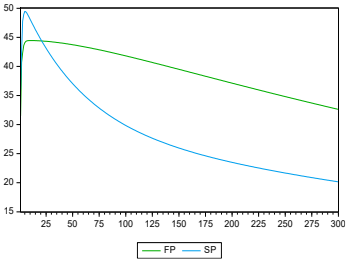

Fig. 6. Response of SP in II time period

From Figure 3—6: the response time of each variable in time during the II time period is longer; the impact strength of futures prices on spot prices is stronger than the

impact of futures prices on futures prices. The futures market occupies a dominant position in the process of long -term information transfer. It is the fluctuation of spot price fluctuations. the main factor of influence.

4.4 Square difference decomposition

This article uses a variance decomposition to describe the relative importance of random disturbance in each variable in the VAR model.

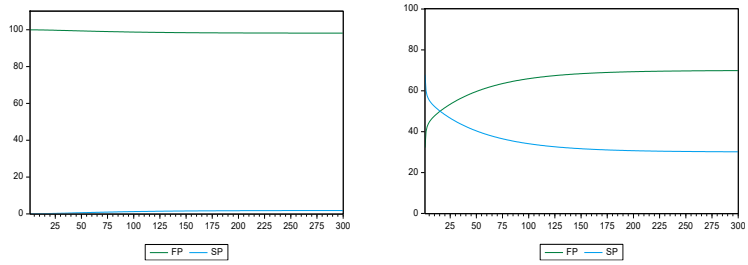

Fig. 7. Variance decomposition in I time period

Table 8. Variance decomposition results in I time period

Lags	Variance decomposition of FP(%)		Variance decomposition of SP(%)	
	FP	SP	FP	SP
1	99.990	0.010	32.197	67.803
100	98.767	1.233	65.908	34.092
200	98.282	1.718	69.322	30.678
300	98.192	1.808	69.859	30.141

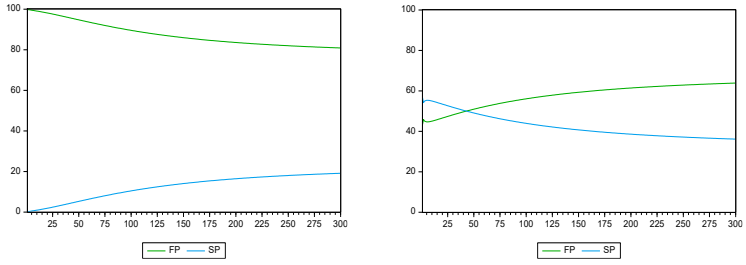

Fig. 8. Variance decomposition in II time period

Table 9. Variance decomposition results in II time period

Lags	Variance decomposition of FP(%)		Variance decomposition of SP(%)	
	FP	SP	FP	SP

1	100	0	43.312	56.688
100	89.560	10.440	56.065	43.935
200	83.574	16.426	61.415	38.585
300	80.877	19.123	63.862	36.138

From Figure 7, Figure 8 and Table 8, Table 9: whether it is the new coronary pneumonia before or during the epidemic period, the contribution rate of spot price is very high, but the changes in futures prices have not been changed by changes in the spot price. A significant impact. It shows that my country's soybean meal futures market has one-way price guidance on the spot market, and price guidance is more significant during the new crown pneumonia epidemic.

5 Conclusion and suggestions

The empirical results show that there is a long -term balanced relationship between the soybean meal and the spot market before the epidemic and the epidemic period, which further verified the existing research conclusions. Whether before the epidemic or during the epidemic, my country's soybean meal futures market has a significant positive price guiding role in the spot market, and in the process of long -term information transmission, the futures market occupies a dominant position and is the main influencing factor of spot price fluctuations. In addition, during the epidemic, the soybean meal futures market has more significant guidance on the positive price of the spot market. Therefore, my country's soybean meal futures market has a strong price discovery function.

The new coronary pneumonia's epidemic directly or indirectly affects my country's soybean meal market. Due to this impact in the short term, the increase in speculative behaviors will lead to significantly increased price fluctuations in the futures market, which is not conducive to the market's role in avoiding risks. Because the price of soybean meal futures is positive to guide the spot price, the price is a stable barometer in the market. Therefore, the stability of futures prices is the basis for promoting the stability of the spot market. Therefore, the following suggestions are made:

The government should strengthen the supervision of the futures market and strengthen the disclosure of information; guide the soybean meal industry to preserve the value of the soybean meal industry, enhance the ability of the futures market to resist risks; enhance the awareness of investors' risk and effectively reduce the abnormal fluctuations in the price of the futures market.

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