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Complementarities Between Coal Mining Machinery Industry and Coal Mining Industry: Evidence from China 1991-2006

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Abstract: This study used VAR model to analyze and verify the complementaries between Chinese coal mining machinery enterprises and coal mining enterprises from the perspective of static state and dynamic state, it concluded that: there is a co-integration relationship between the actual output value of Chinese coal mining machinery enterprises and the actual value of Chinese coal mining enterprises, namely, there is a long-term and stable equilibrium; Chinese coal mining machinery enterprises have advanced the development of Chinese coal mining enterprises, while the development of Chinese coal mining enterprises also have played a significant role in promoting Chinese coal mining machinery enterprises; in the short term, the changes of the actual output value of Chinese coal mining machinery enterprises are due to themselves as well as the actual output value of Chinese coal mining enterprises and the changes of actual output value of Chinese coal mining enterprises are also due to themselves and the actual output value of Chinese coal mining machinery enterprises.

Key words: Coal mining machinery enterprises, coal mining enterprises, complementaries

INTRODUCTION

There is a strong symbiosis between Coal Mining Machinery Enterprises (CMMEs) and Coal Mining Enterprises (CMEs), which can be reflected in two aspects: First, the CMEs affect the development of CMMEs through demand effect, the development of CMEs is the precondition of the existence and development of CMMEs, CMMEs can't exist without CMEs and the healthy development of CMEs will lead to the rapid development of CMMEs, on the contrary, the slow development and even backward of CMEs will restrict the development of CMMEs; Second, the level of CMMEs has a direct impact on the modernization level of CMEs, CMMEs are the basis and engine for the sustainable development of CMEs, the basic equipment performance that CMMEs provide to a large extent determines the level of both production and technology in CMEs, as well as their competitiveness, the development and power of CMMEs is a significant feature and symbol to achieve basic modernization for the CMEs and industrialization for the entire country (Ma, 2004). In order to analyze the internal mechanism of symbiotic nature between CMMEs and CMEs in China, this article will introduce the quantitative analysis of multi-variable model based on non-structural method (Yi, 2002).

METHODOLOGY

The traditional structural approaches often use economic theory to describe the relationship among variables. However, the economic theory usually can not provide a strict definition for the dynamic relationship among variables and the endogenous variables may appear on both sides of the equation at the same time which would make estimation more complicated. In order to solve these problems, the non-structural approach in reference to multi-variable model is introduced. The VAR (Vector Autoregression) is a kind of such model, which is usually applied to time-series forecasting system and the dynamic effect analysis of variables system in response to random disturbance.

EMPIRICAL ANALYSIS

Preliminary analysis: The sample space of this analysis is from Year 1991 to Year 2006 where Year 1991 is the base period. The actual output value of Chinese coal mining machinery enterprises is represented by MJ, while the actual output value of Chinese coal mining enterprises is represented by YM. Related data can be found from China Statistics Yearbook 2006 and all the concerned websites (NBSC, 2006).

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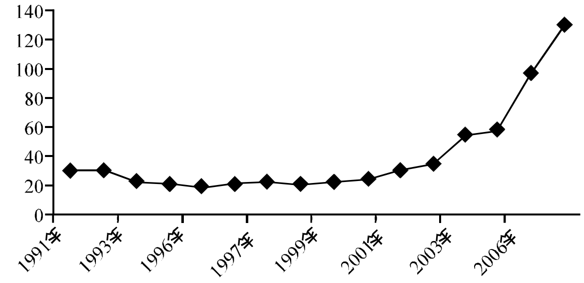

Fig.1: Line graph of the actual CMMEs output

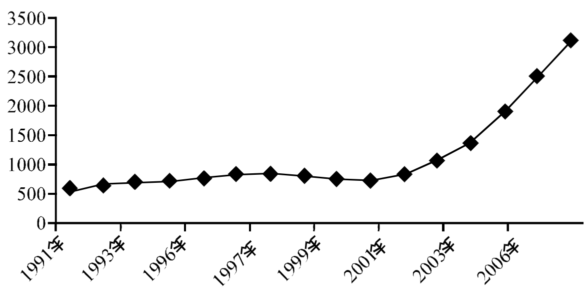

Fig.2: Line graph of the actual CMEs output

In order to remove the price changes in economic variables, this study will use GDP deflator to transform the nominal CMMEs output and the nominal CMEs output into actual CMMEs output and actual CMEs output respectively. To study the two series, their trends can be seen from Fig. 1 and 2:

According to Fig. 1, from 1991 to 2006, the development of Chinese CMMEs can be divided into two phases: the wandering stage from 1991 to 2000 and the high-speed development stage from 2001 to 2006. During the first phase, from 1992 to 1993, actual output value of Chinese CMMEs had a severe landslides, falling from 3.04 billion Yuan in 1991 to 2.9 billion Yuan in 1992, further to 2.21 billion Yuan in 1993 and in the subsequent years from 1994 to 2000, the actual output value of Chinese CMMEs changed slightly around 2 billion Yuan, that is mainly because of the slow development of coal mining industry and thus led to the lack of demand for the products of CMMEs. During the second phase, due to the demand effect of the rapid development of coal mining industry, the actual output value of CMMEs increased sharply since 2001.

And according to Fig. 2, from 1991 to 2006, the development of Chinese CMEs also can be divided into two phases: the wandering stage from 1991 to 2000 and the high-speed development stage from 2001 to 2006. During the first phase, it can be subdivided into the slight rise stage from 1991 to 1997 and the slight decline stage from 1998 to 2000 but in the meantime, the actual output value of Chinese CMEs was always between 50 billion Yuan to 100 billion Yuan, it shows that the Chinese coal mining industry experienced a slow development process. During the second phase, along with the increase in demand for coal and the coal industry's recovery, the actual output value of coal in China increased rapidly since 2001. We should note that Fig. 1and Fig. 2 show the same general trend of development that can explain the symbiotic characteristics between CMMEs and CMEs.

Table 1: Correlation coefficient

	LYM	LMJ
LYM	1	0.92138
1LMJ	0.921381	1

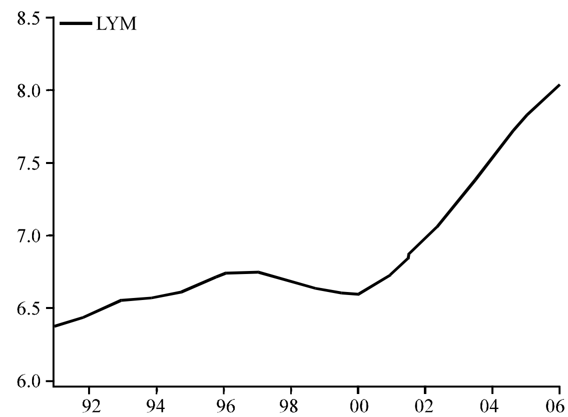

Fig. 3: LYM

In order to remove the heteroscedasticity, this article took the logarithm form of MJ and YM, namely, LMJ = log (MJ), LYM = log (YM). The correlation coefficient can be seen in Table 1:

In Table 1, the correlation coefficient is 0.921381 and that means they are highly interrelated. Therefore, it is appropriate to set two-variable model explaining the symbiosis between CMMEs and CMEs in China.

In reference to YM and its line graph in differential form, the first-order difference series and the second-order difference series of LYM are respectively represented by iLYM and iiLYM. (Fig. 3, 4 and 5, respectively) In Eviews, they are listed as follows:

According to the graphs, the line graph of LYM has significant trend, so it may be non-stationary series. About iLYM, though there is no trend, there is still constant, so it maybe not stationary. But iiLYM is a stationary series after LYM was differentiated for two times. By the same token, the time series MJ also shows the same characteristics. For this reason, a stationarity test is needed.

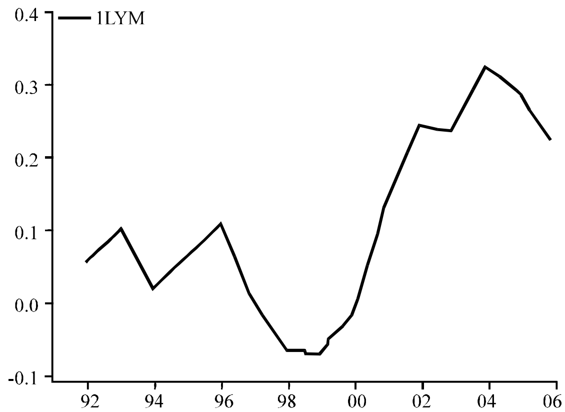

Fig. 4: iLYM

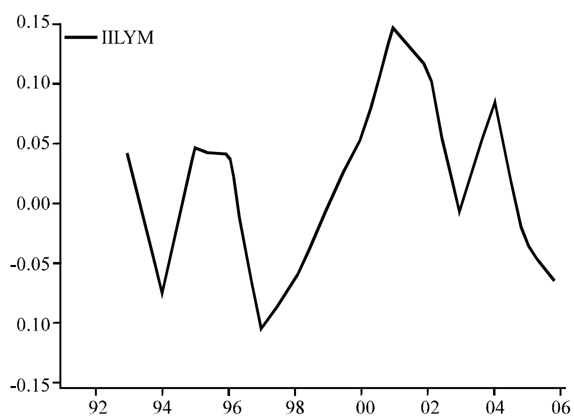

Fig. 5: iiLYM

Stationarity test: This study would use ADF test (Augmented Dickey-Fuller Test) to test the unit root of those series including LYM, LMJ, iLYM, iLMJ, iiLYM and iiLMJ. See Table 2.

Here i represents the first-order difference,ii represents the second-order difference; C, T, L represent the constant, time trend and lag period, * represents the critical value in the 1% confidence level, ** represents the critical value in the 5% confidence level.

The results show that: LYM and LMJ are both non-stationary time series, their first-order difference variables are still non-stationary time series but the second-order difference variables iiLYM and iiLMJ become stationary. Thus, LYM and LMJ are second-order integration series.

VAR model: In order to judge whether there is a cointegration relationship between LMJ and LYM, firstly, we should set VAR model for those two series, in which the model's lag period was determined to be 4 in accordance with the principle of minimizing AIC and SC. The results of the estimated parameters can be written in 1.

Table 2: Results of stationarity test

Variable	ADF	Type (C,T,L)	Critical value
LYM	-1.1240	(C,T,5)	-5.2735*
iLYM	-0.9284	(C,0,0)	-4.0113*
iiLYM	-2.5275	(0,0,0)	-1.9699**
LMJ	1.9103	(C,T,4)	-5.1152*
iLMJ	-1.4307	(C,T,5)	-5.4776*
iiLMJ	-8.6192	(0,0,0)	-2.7760*

Table 3: Results of Johnsen cointegration test

	Likehood	5% critica	1% critica	
Eigenvalue	ratio statistic	value	value	Null hypothesi H0
0.690686	16.846600	15.41	20.04	r = 0*
0.115289	1.592421	3.76	6.65	r = 1

Here r represents the number of cointegration vector

Table 4: Standard cointegration coefficient

LMJ	LYM	C
1.000000	-2.20842	11.83201
	-0.51297	
Log likelihood	36.12279	

$$\begin{bmatrix} LMJ_t \\ LYM_t \end{bmatrix} = \begin{bmatrix} 0.41 & 1.41 \\ 0.66 & 0.98 \end{bmatrix} \begin{bmatrix} LMJ_{t-1} \\ LYM_{t-1} \end{bmatrix} + \begin{bmatrix} 0.95 & -2.36 \\ 0.20 & -1.41 \end{bmatrix} \begin{bmatrix} LMJ_{t-2} \\ LYM_{t-2} \end{bmatrix} + \begin{bmatrix} -0.17 & 0.76 \\ -0.29 & 1.15 \end{bmatrix} \begin{bmatrix} LMJ_{t-3} \\ LYM_{t-3} \end{bmatrix} + \begin{bmatrix} 0.03 & 0.77 \\ 0.24 & -0.73 \end{bmatrix} \begin{bmatrix} LMJ_{t-4} \\ LYM_{t-4} \end{bmatrix} + \begin{bmatrix} -4.39 \\ 4.31 \end{bmatrix} \quad (1)$$

Cointegration test: In view of the above analysis that shows LMJ and the LYM are second-order integration series, therefore, we can continue to conduct cointegration analysis. Here we use Johansen Cointegration Test in the VAR model and the results are shown in Table 3.

Test results show that: an the 1% confidence level, there is no likelihood ratio statistic greater than the critical value, so there is no cointegration relationship between LMJ and LYM; but at the 5% confidence level, only the first likelihood ratio statistic is greater than the critical value, so the first null hypothesis was rejected, namely, there is only one cointegration relationship between LYM and the LMJ.

Meanwhile, Johansen Cointegration Test also shows the following standardized cointegration coefficient in Table 4.

From Table 4, we can get the cointegration function as follows:

$$LMJ = -11.83+2.21*LYM \quad (2)$$

where, there is a long-term equilibrium relationship between LMJ and LYM.

Table 5: Results of Granger causality test

Test variable (ull Hypothesis)	Lag	No. of variable	F statistic	p-value	Conclusion
LMJ $\nRightarrow$ LYM	1	15	4.50912	0.05519	LMJ$\Rightarrow$LYM
LYM $\nRightarrow$ LMJ	1	15	5.52841	0.03663	LYM$\Rightarrow$LMJ
LMJ $\nRightarrow$ LYM	2	12	53.5308	0.00403	LMJ$\Rightarrow$LYM
LYM $\nRightarrow$ LMJ	2	12	3.25504	0.17983	LYM $\nRightarrow$ LMJ

Granger causality test: To further illustrate the causality between the two variables, Granger Causality Test needs conducting. The results are shown in Table 5.

According to Table 5: When the lag period is 1, for the null hypothesis of LMJ does not Granger cause LYM, the probability of committing the first type error as refusing it is 0.05519, it indicates that at 90% confidence level, we can consider LMJ does Granger cause LYM; for the null hypothesis of LYM does not Granger cause LMJ, the probability of committing the first type error as refusing it is 0.03663, it indicates that at 95% confidence level, we can consider LYM does Granger cause LMJ; By the same token, for the null hypothesis of LMJ does not Granger cause LYM, the probability of committing the first type error as refusing it is 0.00403, it indicates that at 99% confidence level, we can consider LMJ does Granger cause LYM; while for the null hypothesis of LYM does not Granger cause LMJ, the probability of committing the first type error as refusing it is 0.17983, we can consider that LYM does not Granger cause LMJ, since the probability is large and we can not refuse the null hypothesis.

VECM model: Vector Error Correction Model (VECM) is a VAR model that exerts a cointegration constraint to all variables, in which the error correction term (vecm) reflects the deviation degree of variables from their long-term equilibrium in the short-term fluctuation. Error Correction Model may well reflect the direction and speed of movement once the above-mentioned variables deviate from the long-term equilibrium. As we have already found the cointegration relationship between the two variables, therefore, the VAR model must be adjusted to Vector Error Correction Model (VECM) with cointegration constraint. In Eviews, we can get the results of estimated parameters and put them into the form of matrixes in 3.

$$\begin{bmatrix}\Delta LMJ_t\\ \Delta LYM_t\end{bmatrix}=\begin{bmatrix}0.04 & 1.11\\ 0.20 & 1.02\end{bmatrix}\begin{bmatrix}\Delta LMJ_{t-1}\\ \Delta LYM_{t-1}\end{bmatrix}+\begin{bmatrix}0.34 & -1.79\\ 0.08 & -0.22\end{bmatrix}\begin{bmatrix}\Delta LMJ_{t-2}\\ \Delta LYM_{t-2}\end{bmatrix}+\begin{bmatrix}-0.37\\ 0.12\end{bmatrix}vecm_{t-1}+\begin{bmatrix}0.16\\ 0.004\end{bmatrix} \tag{3}$$

where, vecm represents the error correction term and its value is the residual of cointegration equation, namely:

$$vecm = LMJ-2.21*LYM+11.83 \tag{4}$$

where, all variables have passed the significance test.

CONCLUSION

From the above analysis in VAR model, this article concludes that:

- First, the Unit Root Test on logarithmic variables including both the actual output value of CMMEs and that of CMEs shows that they are second-order integration series
- Second, the Cointegration Test further indicates that there is a cointegration relationship between the actual output value of CMMEs and that of CMEs, namely, there is a stable and long-term equilibrium relationship between them. At the same time, cointegration equation shows: in the long run, if the actual average output value of CMEs grows a percentage point, the actual average output value of CMMEs may grow 2.21 percentage points. It is clear that the development of CMEs can promote the development CMMEs to a very significant degree, while the CMMEs greatly depend on CMEs
- Third, the Granger Causality Test shows that: when the lag is 1, the actual output value of CMMEs and that of CMEs do Granger cause each other and the probability of the latter is greater, which means that the development of CMMEs has promoted the development of CMEs, while the development of CMEs also has played a more significant role in advancing CMMEs; when the lag is 2, the actual output value of CMMEs still does Granger cause the actual output value of CMEs and it is one way only
- Fourth, the VECM shows: in the process of mutual influence between CMMEs and CMEs and even influences induced by their own, there is always a time-lag effect. In the short run, the one-period lag actual output value of CMMEs will positively affect the actual output value of CMMEs in the current period with ratio of 0.04, when it is two-period lag, the ratio of the positive effect will reach 0.34. The one-period lag actual output value of CMEs will positively affect the actual output value of CMMEs in the current period with ratio of 1.11, when it is two-period lag, the ratio of the effect will enlarge to 0.34 but it is negative. The one-period lag non-equilibrium error will rectify the actual value of CMMEs with a negative ratio of 0.37. By the same token, in the short run, the one-period lag actual output value of CMEs will positively affect the actual

output value of CMEs in the current period with ratio of 1.02, when it is two-period lag, the ratio of the effect will fall to 0.34, but it is negative. The one-period lag actual output value of CMMEs will positively affect the actual output value of CMEs in the current period with ratio of 0.2, when it is two-period lag, the ratio of the effect will fall to 0.08. The one-period lag non-equilibrium error will rectify the actual value of CMEs with a positive ratio of 0.12

In conclusion, there is a strong symbiotic relationship between CMMEs and CMEs.

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