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Harmony Analysis on Economic Development and Safety Production Level in China's Mining Industry Based on Identity-difference-opposition Dynamic Associated Method

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Abstract: In order to investigate whether the level of development between the mining economy and the national economy and between the safety of mining production and its economic development should be asynchronous or not and exploring the underlying causes for inharmonious development, using identity-difference-opposition analysis method, this study analyzed and evaluated the harmonies that economic development state of mining industry relative to that of industrial and the national GDP and that the safety level of mining production relative to its economic development. We drew the conclusions: The reason of the faster growth rate of mining industrial output value than that of industry is the result of the higher growth rate in purchasing price for raw material, fuel and power than that of producer price for manufactured goods. The economic growth rate of mining is too slow, cannot meet the needs of the development of national economy since the Tenth five-year plan, especially the minerals for life at the present stage. On the surface the growth speed of safety level of mining production is faster than its economic growth at current prices since 1991. But it shows a contrary motion state at constant prices, the safety production level is slower than its economic development in mining industry and can't meet the needs of economic development.

Key words: Mining industry, economic development, safety level of production, dynamic associated analysis, harmonious sustainable development

INTRODUCTION

The mining industry is an important basic industry for development and progress in China's economic and social, there are more than 95% of the energy sources, more than 80% of industrial raw materials, more than 70% of agricultural production supplies and a third of the drinking water all coming from mineral resources (Yang, 2005). Mining is more than 70% support for the thriving of national economy and its relevant departments if all its downstream industries are taken into consideration (Ma, 2009). With the development of human society and the revealing of mineral resource scarcity gradually and with the deepening of financial crisis, various folk capital flow to mining for benefit (Ba, 2012). It is estimated that the number of inflow funds will reach trillions in China from 2013 to 2015 (Zhang, 2012). Therefore, we think that it is necessary to anatomize profoundly the harmony of the economic development of

mining industry. The conclusion can serve as a reference for macroscopic economic layout and investment decisions.

In recent years, there are many studies in this issue of the sustainable exploitation and utilization of mineral resources. They are intended to study the problem of rational approach for the development of mineral resources. However, there have only a few researches on the development level of mining economy and the national economy and on the safety level of mining production and its economic development. These have met with very little empirical support. This paper will put forward to a harmony analysis and evaluation on the development state of mining industry economic relative to that of industrial and the national GDP and on the harmony of safety level of mining production relative to its economic development by identity-difference-opposition dynamic associated method.

MATERIALS AND METHODS

Identity-difference-opposition dynamic associated method has many advantages in terms of grasping correctly the development trend, identifying and evaluating various kinds of social phenomena and economic activity scientifically (Wang, 1998), whose characteristics as flowing (Wang and Wang, 1999): One is that can discriminate the strengths or weaknesses of a economic development process by comparing the development state of studied economy with a more advantage economy proved by practice. Second is that can identify comprehensively the economic process through three key influencing factors, including in displacement, speed and acceleration. Third is that can identify the strengths and weaknesses of running state of the studied object economy relative to a proved standard economy through distinguishing the identity, contrariety or difference between the two.

Concept of identity: The standard function is set to $y_j(t)$ (similarly hereinafter) which complies with the normal operation law of things and the objective function is set to $y_i(t)$, $t \in [a, b] \subset \mathbb{R}$ (field of real numbers).

The displacement between the two functions can be expressed as $|y_i(t)-y_j(t)|$, the smaller value of displacement, the smaller difference of the two functions. When $|y_i(t)-y_j(t)| = 0$, the difference will disappear, namely the difference into an identity. So, the value of $|y_i(t)-y_j(t)|$ can be seen as a measure of the degree of identity between two functions. Identity can be defined as follows (Wang *et al.*, 2005; Wang, 1988):

- When there is:

$$\lim_{t \rightarrow t_0} \frac{y_i(t)}{y_j(t)}$$

and:

$$\lim_{t \rightarrow t_0} \frac{y_i(t)}{y_j(t)} \in [-1,1]$$

so this limit is called displacement identity of $y_i(t)$ relative to $y_j(t)$ at t_0 point which is written as $d_y^{(0)}(t)$ that is:

$$d_y^{(0)}(t) = \lim_{t \rightarrow t_0} \frac{y_i(t)}{y_j(t)} \tag{1}$$

- For the same reason, the speed identity of $y_i(t)$ relative to $y_j(t)$ at t_0 point can be expressed in Eq. 2:

$$d_y^{(1)}(t) = \lim_{t \rightarrow t_0} \frac{y_i'(t)}{y_j'(t)} \tag{2}$$

- For the same reason, the acceleration identity of $y_i(t)$ relative to $y_j(t)$ at t_0 point can be expressed in Eq. 3:

$$d_y^{(2)}(t) = \lim_{t \rightarrow t_0} \frac{y_i''(t)}{y_j''(t)} \tag{3}$$

When the absolute value of the limits Eq. 1, 2, or 3 is above 1 or to 8 which reciprocal will be adopted as the matching identity.

In order to comprehensive analyze the state of identity-difference-opposition between $y_i(t)$ and $y_j(t)$, there is a definition as follows.

$y_j(t)$ is set to the standard function and $y_i(t)$ is objective function, $t \in [a, b]$ (field of definition). If the values of $d_y^{(0)}(t)$, $d_y^{(1)}(t)$ and $d_y^{(2)}(t)$ are all subsistent, so it is called that:

$$D_y(t) = \frac{1}{3}(d_y^{(0)}(t) + d_y^{(1)}(t) + d_y^{(2)}(t)) \tag{4}$$

Equation 3 is the comprehensive identity of $y_i(t)$ relative to $y_j(t)$ at t point.

Considering the integrated identity in the whole movement process is the needs of understanding the overall situation of the objective thing. So, the definition can be given as follows.

$y_j(t)$ is set to standard function and $y_i(t)$ is an objective function. If for any $t \in [a, b]$, $y_i'(t)$, $y_j'(t)$ and $y_j''(t)$ are all exist. And for any $t_0 \in [a, b]$, it is always present the equation below:

$$\lim_{t \rightarrow t_0} \frac{y_i(t)}{y_j(t)}, \lim_{t \rightarrow t_0} \frac{y_i'(t)}{y_j'(t)}, \lim_{t \rightarrow t_0} \frac{y_i''(t)}{y_j''(t)} \in [-1,1]$$

$$D_y^{(0)} = \frac{1}{b-a} \int_a^b \left[\lim_{t \rightarrow t_0} \frac{y_i(t)}{y_j(t)} \right] dt \tag{5}$$

Equation 5 is called overall displacement identity of $y_i(t)$ relative to $y_j(t)$ in the interval of $[a,b]$:

$$D_y^{(1)} = \frac{1}{b-a} \int_a^b \left[\lim_{t \rightarrow t_0} \frac{y_i'(t)}{y_j'(t)} \right] dt \tag{6}$$

Equation 6 is called overall speed identity of $y_i(t)$ relative to $y_j(t)$ in the interval of $[a,b]$:

$$D_y^{(2)} = \frac{1}{b-a} \int_a^b \left[\lim_{t \rightarrow t_0} \frac{y_i''(t)}{y_j''(t)} \right] dt \tag{7}$$

Equation 7 is called overall acceleration identity of $y_i(t)$ relative to $y_j(t)$ in the interval of $[a,b]$:

$$D_{ij} = \frac{1}{3}(D_y^{(0)} + D_y^{(1)} + D_y^{(2)}) \quad (8)$$

And Eq. 8 is called overall comprehensive identity of $y_i(t)$ relative to $y_j(t)$ in the interval of $[a,b]$.

Judging principle: $y_i(t)/y_j(t) = 1$ indicates that there is identity between $y_i(t)$ and $y_j(t)$ and $y_i(t)/y_j(t) = -1$ does an opposition state. When $y_i(t)/y_j(t) = 0$, the identity or the opposition disappear. When the value of $y_i(t)/y_j(t)$ is in the open interval $(0,1)$ or $(-1,0)$, it indicates that there is a certain degree of identity or a certain degree of opposition between $y_i(t)$ and $y_j(t)$. The values of $D_{ij}(t)$ indicate a same determination principle of comprehensive identity.

RESULTS AND DISCUSSION

Identity-difference-opposition dynamic associated analysis on economic development of the mining industry relative to the industrial and the national GDP: The growing demand of social and economic development for mineral resources is driving and stimulating a high-speed development of mining industry in China. From the statistics data of all state-owned and non-state-owned industrial enterprises above designated size, the gross industrial output value in mining increased by more than 75 times from 1986 to 2010 and up from 59.586 billion yuan in 1986 to 4.49507 trillion yuan in 2010, the average annual

growth of 21.28%. But the average growth rate of gross industrial output value in whole industry was 19.87% and the national GDP only 16.62% in the same time period in Fig. 1a. It shows that contribution of mining industry is bigger than the mean of other industries in the whole industrial economy. Cao and Wang (2008) found that there may be two reasons for this. The first is, if the price volatility of mineral products and other industrial products were in the same pace, it shows an enhancement degree of industry economic growth depending on mining industry and a descending level of intensive utilization of minerals and related materials. The use of mineral resources was also stable in high intensity. The second reason is that the price increases of minerals and related energy and raw material were faster than that of industrial product, resulting in the growth of the gross industrial output value in mining was faster than that in the whole industry.

In order to make clear this point, the data of the gross industrial output value in mining, that in industry and the national GDP were deflated by Producer Price Indices (PPI) of mining and industry and the indices of GDP respectively at constant prices in 1985. The gross industrial output value in mining, was 53.012 billion yuan in 1986 and 230.563 billion yuan in 2010, increased by 4.35 times at constant prices, the average annual growth of 7.16% which was slightly higher than that of the national GDP of 6% at constant prices and the annual average growth rate of gross industrial output value in whole industry was 12.88% at constant prices during the same period (Fig. 1b).

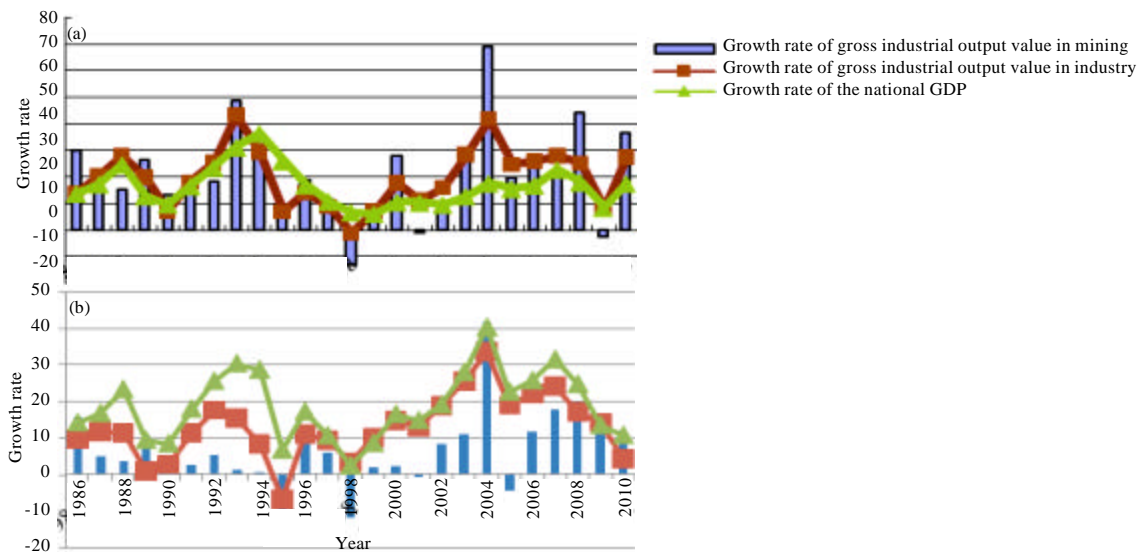


Fig. 1(a-b): Comparing the growth rate of gross industrial output value between in mining and industry and the national GDP in China during 1986-2010, (a) At current prices and (b) At constant prices

The reason of the faster growth rate of gross industrial output value in mining than that in industry is the result of the higher growth rate in purchasing price for raw material, fuel and power than that of producer price for manufactured goods. The economic growth type of mining industry is demand-pull type (Liu, 2010). It can be seen from the comparison of gross industrial output value at current prices and at constant prices in Fig. 1. It is a continuing trend of resources demand with China's economy sustained growth (Liu *et al.*, 2010). But the mining industry product will not meet the needs of the rapid development of national economy at present and in the future. And the development of the mining industry might be conditioned by the reserves, mining and safety technology.

Analysis: It can be seen that mining economic development state is better than that of industry and national GDP at current prices in the overall situation from Fig. 1a. The following analysis will focus on the identity-difference-opposition condition of them at constant prices.

The growth rate of gross industrial output value in mining is as an objective thing and the growth rate of gross industrial output value in industry and national GDP are as standard things. The displacement identity, speed identity, acceleration identity and comprehensive identity of the growth rate of mining industry relative to that of industrial and national GDP for all years from 1986 to 2010 are obtained by Eq. 1-4. Using Eq. 5-8, then, the overall displacement identity, speed identity, acceleration identity and comprehensive identity between the two for all years from 1986 to 2010 are obtained. The results are shown in Fig. 2. Gross industrial output value in mining, industry and the national GDP were deflated by Producer Price Indices (PPI) at constant prices in 1985.

As shown in Fig. 2a and c, the overall comprehensive identity which the growth rate of gross industrial output value in mining relative to that of industry was continuous improvement during 1986-2010. The value of their displacement identity is above 1 in the Seventh five-year plan period and the minus speed and acceleration identities show that the growth trend was slowing down. From the Eighth to Tenth five-year plan period, the values of their displacement identity show that the economic development state of mining industry was an ongoing downward process relative to that of industry. However, their overall comprehensive identity firstly went up in the Ninth five-year plan period and then fell in the Tenth five-year plan period which shows that industrial minerals have failed to meet the development requirement of industrial economy in the next period, so the economic

development in mining industry should speed up. The demand response were obtained in the 11th five-year plan period, the demand propels the economic development of mining industry that is faster than that of industry. The value of displacement identity is above 1 and the values of speed and acceleration identities show that this faster trend is strengthening. So the overall comprehensive identity between the two increased to 0.436 in Fig. 2c.

As shown in Fig. 2b and d, overall comprehensive identity which the growth rate of gross industrial output value in mining relative to the national GDP was a more fluctuant in the 1986-2010 period. The value of velocity identity between the two is above 1, shows that the economic development of mining industry was faster than that of the national GDP and the velocity and acceleration identities show that the growth trend was slowing down. The acceleration identity shows that the economic development state of mining industry was faster than that of the national GDP in the Eighth five-year plan period. And the decreasing overall comprehensive identity between the two indicates that the economic development of mining industry is objective requirement to accelerate development to meet the needs of the development of the national economy. The displacement identity between the two shows that the economic development of mining industry was faster than that of the national GDP in the Ninth and Tenth five-year plan period and the faster development of mining economy was to adapt to the needs of economic development, so the level of their overall comprehensive identity had been increased from 0.061 in Eighth five-year plan to 0.280 in Tenth five-year plan. Their displacement identity shows that the growth of mining economy was slower than that of the national GDP in the 11th five-year plan period, so the overall comprehensive identity was reduced to 0.109.

The above analysis shows that there is uncoordinated the economic development in mining industry between industrial and the national GDP since the Tenth five-year plan. This disharmony is mainly displayed that the growth rate of mining economy is too slowly relative to that of industry and the national GDP. In particular, the minerals for life should speed up as far as right now, to meet the needs of the development of national economy.

Identity-difference-opposition dynamic associated analysis between the safety level of mining production and its economic development state:

In order to reach the harmonious development of mining economy, beyond that it is need to be in accordance with the overall development situation of the national economy, there is a sufficient investment in safety. So, it is necessary for

analyzing the identity-difference-opposition state which the safety level of mining production relative to its economic development level, as shown in Fig. 3 (Gross industrial output value in mining were deflated by Producer Price Indices (PPI) at constant prices in 1990). The data of the set of mining production safety indexes that consists of six 1-level indexes come from literatures 12-14 (Tan *et al.*, 2010, 2012; Chen *et al.*, 2011). The gross industrial output value in China's mining grew by an average of 21.87 during 1991-2010 and the average growth rate of safety level of mining production was 52.86 in the same time period. Overall, the growth rate of safety level of mining production was far higher than that of its economic development level in Fig. 3a. However, the average annual growth rate of gross industrial output value in mining was only 7.16% at constant prices in 1990 and the average growth rate of safety level of mining

production was more than seven times that of gross industrial output value in mining in Fig. 3b. But for all that, we can't decided that the rapid growth of safety level of mining production have already meet the needs of the development of mining production at the present stage. On the one hand, it is the result that the investment in mining safety was extremely weak and a more historical debt before the Eighth five-year plan (Xiao and Shen, 2010; Huang, 2010). On the other hand, with the rapid development of science and technology, the growth rate of production equipment and facilities that is one of the most important parameters of production safety level could be faster than the economic growth of mining industry, such as fixed asset investment is higher than economic growth (Hu, 2010; Yuan, 2005). The bloated safety input level is likely to still cannot meet the needs of mining economic development.

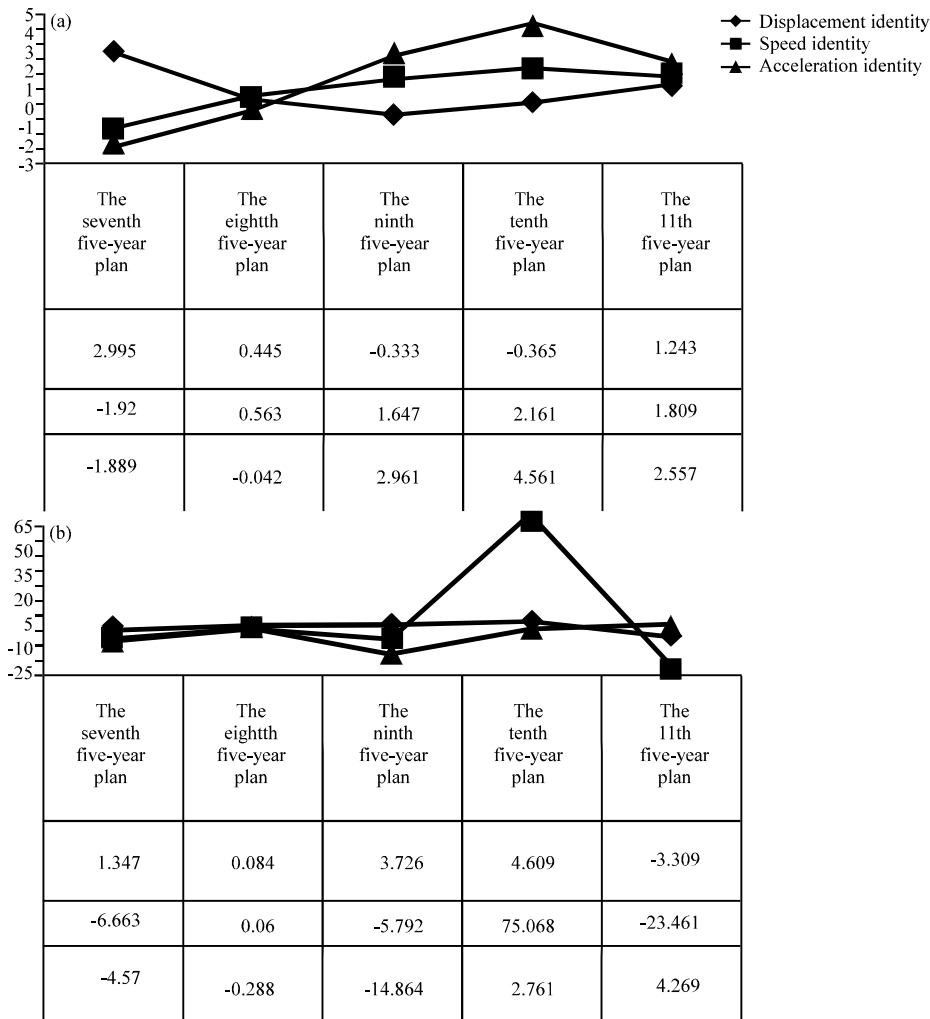


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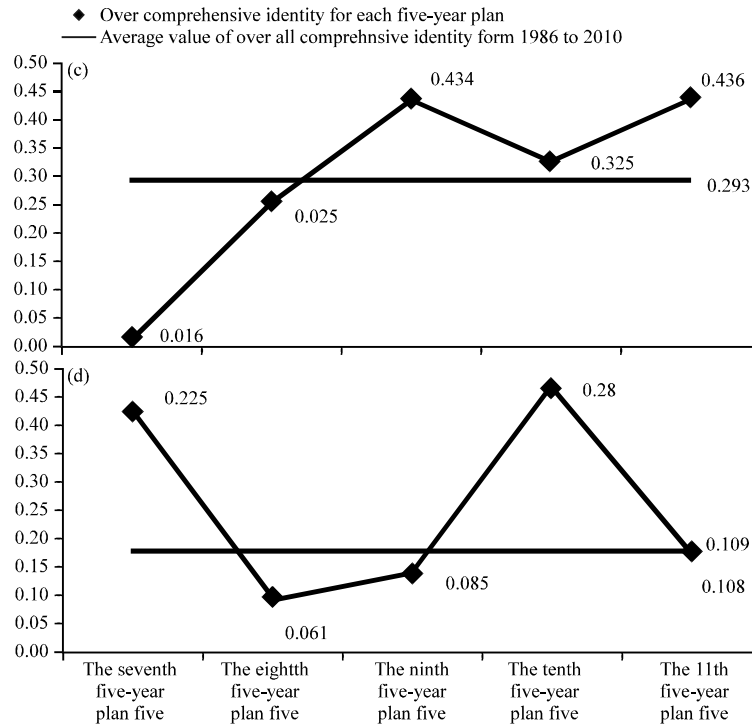


Fig. 2(a-d): Identity-difference-opposition state on the growth rate of gross industrial output value in mining relative to that of industry and the national GDP at constant prices in 1985, (a) Displacement identity, speed identity and acceleration identity of the growth rate of gross industrial output value in mining relative to that of industry for each five-year plan period, (b) Displacement identity, speed identity and acceleration identity of the growth rate of gross industrial output value in mining relative to that of the national GDP for each five-year plan period, (c) Overall comprehensive identity of the growth rate of gross industrial output value in mining relative to that of industry for each five-year plan period and (d) Overall comprehensive identity of the growth rate of gross industrial output value in mining relative to that of the national GDP for each five-year plan period

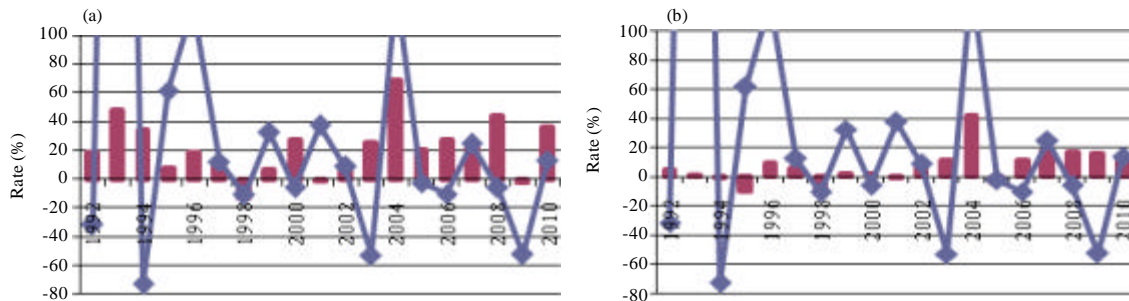


Fig. 3(a-b): Comparing the growth rate of safety level of mining production and gross industrial output value in China's mining from 1991 to 2010, (a) At current prices and (b) At constant prices

Analysis: The growth rate of gross industrial output value in mining is as an objective thing and the growth rate of safety level of mining production are as a standard thing. The displacement identity, speed identity,

acceleration identity and comprehensive identity of the growth rate of safety level of mining production relative to that of gross industrial output value in mining for all years from 1991 to 2010 are obtained by Eq. 1-4. Using

Eq. 5-8, then, the overall displacement identity, speed identity, acceleration identity and comprehensive identity between the two are obtained for all years from 1991 to 2010. The results are shown in Fig. 4. Gross industrial output value in mining was deflated by Producer Price Indices (PPI) at constant prices in 1990.

It showed a weaker identity which the safety level situation of mining production relative to that of its economic development from 1991 to 2010. The overall comprehensive identity was 0.092 at current prices and 0.101 at constant prices in Fig. 4. In terms of displacement identity, the growth rate of safety level of mining production was faster than that of its economic development during the Eighth and Ninth five-year plan period and the speed and acceleration identity show that the growth trend was slowing down. The overall comprehensive identity between the safety level and

economic development in mining industry was 0.14 in the Eighth five-year plan period and was like went up 0.205 in the Ninth five-year plan period. In terms of displacement identity, the growth rate of safety level of mining production lagged behind that of mining economic development during the Tenth five-year plan period and the speed and acceleration identity show that the downward trend was strengthening. Due to the rapid economic development in mining industry in the Tenth five-year plan period, so the overall comprehensive identity between the safety level and economic development was dropped. Influenced by price factors, Fig. 4a shows that the growth rate of safety level of mining production was faster than its economic growth at current prices during the 11th five-year plan period and Fig. 4c shows a contrary motion state and the downward trend was strengthening. So, the overall comprehensive

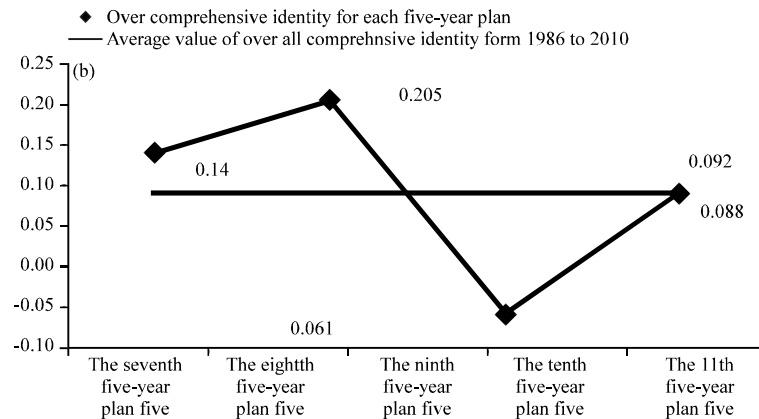
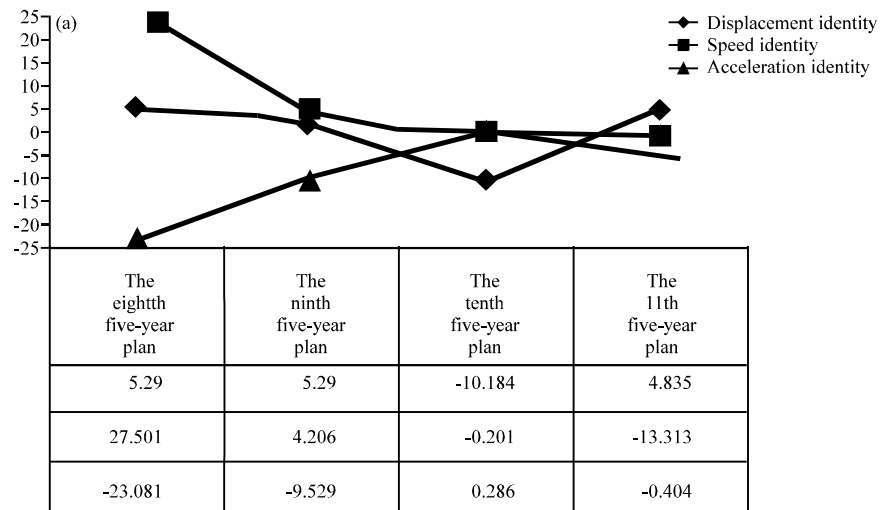


Fig. 4: Continue

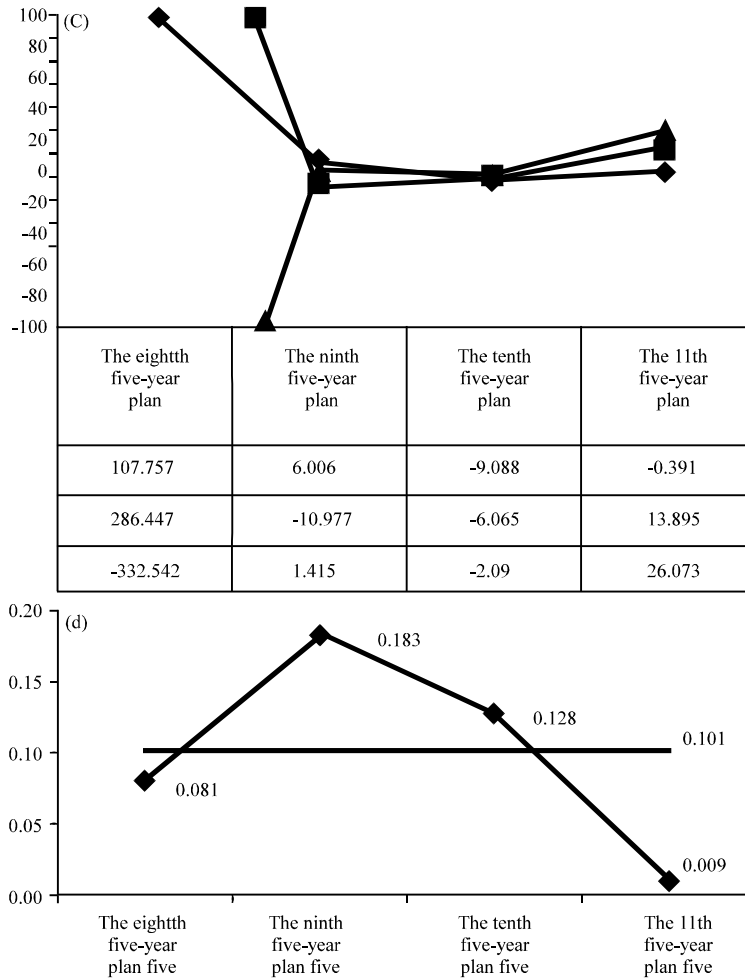


Fig. 4(a-d): Identity-difference-opposition associated state on the growth rate of safety level of mining production relative to that of its economic development, (a) Displacement identity, speed identity and acceleration identity of the growth rate of safety level of mining production relative to that of its economic development at current prices for each five-year plan, (b) Overall comprehensive identity of the growth rate of safety level of mining production relative to that of its economic development at current prices for each five-year plan, (c) Displacement identity, speed identity and acceleration identity of the growth rate of safety level of mining production relative to that of its economic development at constant prices for each five-year plan and (d) Overall comprehensive identity of the growth rate of safety level of mining production relative to that of its economic development at constant prices for each five-year plan

identity between the two was a continuing drop in Fig. 4d, it shows almost no relationship between the growth rate of safety level of mining production and its economic growth. The dropping overall comprehensive identity between safety production level and economic development is one of the important causes leading to the high accident rate in China. We should increase investment in mining safety production to meet the needs of its economic development at this stage.

CONCLUSION

Identity-difference-opposition dynamic associated analysis method not only can be used to analyze instantaneous situation, but also analyze the overall situation, can achieve the combination of qualitative analysis with quantitative analysis by dynamically analyzing the displacement identity, speed identity and acceleration identity which dynamic analysis factors are comprehensive. In the case of the data of all state-owned

and non-state-owned industrial enterprises above designated size, we have made the following evaluation through the identity-difference-opposition dynamic associated analysis on economic development state in mining industry relative to that of industry and the national GDP and on the safety level of mining production relative to its economic development.

- The reason of the faster growth rate of gross industrial output value in mining industry than that of the whole industry is the result of the higher growth rate in purchasing price for raw material, fuel and power than that of producer price for manufactured goods. At constant prices, the economic growth of mining industry cannot meet the needs of national economic development since the Tenth five-year plan, especially in terms of minerals for life. In the current severe financial crisis situation, private capital turning to the mining industry illustrates that the invisible hand of the market is guiding the profit-pursuing operation of capitals
- Although there is a gradual strengthening harmony between economic development situation in mining industry and that of the whole industry during 1986-2010, the overall comprehensive identity of 0.436 between the two still is unsatisfactory during the 11th five-year plan period. This disharmony is mainly displayed that the growth rate of mining economy is too slowly relative to that of industry and the national GDP. Especially, the minerals for life are in short supply at present stage
- On the surface the growth speed of safety level of mining production is faster than its economic growth at current prices since 1991. But it shows a contrary motion state at constant prices, it is mainly displayed that safety production level is slower than its economic development in mining industry and can't meet the needs of economic development. Therefore, the increased investment in mining safety production still is a primary work for ensuring the sound and rapid development of mining economy

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