

MSIASM Approach to China's Exosomatic Energy Metabolism in each Sector: 1995 and 2002

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1. Introduction

During the last decades, China has been one of the fastest growing economies contributing to increased standards of living through massive investments in manufacturing capacity and infrastructure. This has resulted in massive growth in resource use, especially energy consumption. China is also a very diverse economy with economic development occurring in coastal areas while the hinterland has lacked behind. The regional disparity has been growing more recently and may well become a constraint for China's rapid economic development. In order to look closely at China's economic development and the causes of development disparity, this research will focus on the national and regional level to unpack drivers and constraints for regional and national development.

2. Data and methodology

2.1. Data

The data used in this research are mostly from following official government publications and other authoritative sources: China's Statistical Yearbook, the Statistical Yearbook of each Province, China's Energy Statistical Yearbook, Gender Statistics in China (1990-1995), National Bureau of Statistics under the 1995 national sample survey of 1 per cent of the population data.

2.2. Methodology

Multi-scale integrated analysis of societal metabolism (MSIASM) approach is used in this study. This methodology was first developed by Giampietro and Mayumi and finally systematically defined by Giampietro. It is a useful analytical tool to synthetically look at the issues of development and sustainability from different angles by analyzing all kinds of data from different disciplines, which are mainly biophysical variables (ie. human time and energy use) and economic variables (ie. GDP).

There are two types of variables in this MSIASM scheme, extensive and intensive variables.

Extensive Variables in 3 hierarchical levels

THA: Total Human Activity

HA_i: Human Activity in each sector

TET: Total Exosomatic Energy Throughout

ET_i: Exosomatic Energy Throughout in each sector

GDP: Gross Domestic Product

GDP_i: Gross Domestic Product in each sector

Intensive Variables in 3 hierarchical levels

EMR_{SA}: Exosomatic Metabolic Rate of the whole

society

EMR_i: Exosomatic Metabolic Rate in each sector = ET_i/HA_i

ELP_{SA}: Economic Labor Productivity of the whole society

ELP_i: Economic Labor Productivity in each sector = GDP_i/HA_i

3. Results and discussions

The Characteristics of exosomatic energy metabolism and economic development of China at three hierarchical levels

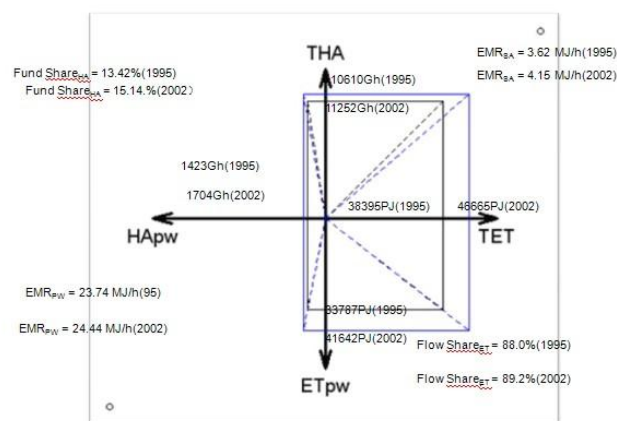


Fig.1-Flow-Fund Representation of MSIASM for China, 1995 and 2002

Figure 1 shows China's exosomatic energy metabolism on level n and level n-1 in 1995 and 2002. From the diagram, we can easily see that the energy use (TET) grows faster than total human time (THA) from 1995 to 2002, which results in an increase of EMR_{SA} from 3.62 MJ/h in 1995 to 4.15 MJ/h in 2002. By combining the result of EMR_{PW} from 1995 to 2002, which increase from 23.74 MJ/h to 24.44 MJ/h, we can know that this energy metabolism improvement in the whole society contributes to increasing the capital accumulation of the paid work sector and the material living standard in the household sector, which means that during the period under the analysis, China not only improves the machinery in the working place but also the quality of people's lives. Regarding the percentage change of energy metabolism rate between 1995 and 2002, one interesting finding is that the percentage change in households 4.87% is bigger than paid work sector's 2.96%, which is mainly caused by the rapid increase in the energy consumption in household sector and massive labor force rush into working places.

Percentage Change	PW	AG	PS	CS	TP	SG
Human Activity	19.7%	5.3%	-2.9%	37.7%	22.8%	56.8%
Energy	23.3%	-21.3%	18.1%	80.6%	110.0%	47.1%
Added Value	97.9%	36.3%	90.1%	73.4%	131.0%	153.4%
EMR	3.0%	-25.3%	21.6%	31.2%	71.1%	-6.2%
ELP	65.4%	29.4%	95.7%	25.9%	88.1%	61.6%

Table.1- Percentage Change of various variables in each sector between 1995 and 2002

Table 1 shows the percentage change of extensive and intensive variable in paid work sector and its sub-sectors between 1995 and 2002. For the paid work sector, all the extensive variables increase with different growth rate, which results in the great improvement of labor productivity and small growth of the amount of energy consumption per hour of working time(EMR_{PW}), the proxy of the capitalization level.

As to the human activity, the time allocated in production sector surprisingly decreases 2.9% while the others all increase, especially service sector with 56.8% growth. This can be interpreted that China's working force is gradually shifting from traditional production sector like manufacturing and mining to service sector, which is consistent with China's structural change policy.

In each sub-sector, it is clear to know that all the added value grow much faster than human time use resulting in the great ELP changes in each sector. This implies that the China's economic is on the rapid development path.

When we look at transportation and construction sectors, we find out that all the variables in these two sectors increase. Especially in transportation sector, the percentage change of its energy use and GDP rank No.1 and No.2 respectively among all the sectors. Therefore, the EMR and ELP changes are very high during the time period. This indicates that the transportation sector develops rapidly with high improvement in capital accumulation and high output.

Another surprising result is that the labor force in the production sector decreases 2.9% while the energy consumption in transportation has the biggest change among all the sub-sectors. This result might be a little bit shocked to some people because it is generally believed that China's manufacturing consumes more energy as its escalation of products exportation to other countries. However, it turns out that the production sector in China maintains its high GDP growth with less human labor, which can also be confirmed by its EMR change 21.6%

4. Conclusions

Through the multi-scale integrated analysis of China's economy by using both extensive and intensive variables in the MSIASM scheme, following conclusions can be found.

1) MSIASM is a useful tool to perform an integrated analysis of China's social metabolism across scales. The MSIASM analyses show that China is on its high development path with improving the level of capital accumulation in paid work sector and people's living standard in household sector.

2) The structure change of China's economy is quite successful. The shift of great number of labor force from traditional production working place to the service sector gives birth to the enormous growth of GDP in service sector while at the same time production sector maintains its high output.

3) On the national level, by looking at the change of exosomatic metabolic rate in each sector from 1995 to 2002, we can know that transportation sector is the main driving force of improvement of China's exosomatic metabolic rate. The second one is the construction sector and then it is the productive sector.

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