Resources, Conservation & Recycling 126 (2017) 1–11

Contents lists available at ScienceDirect

Resources, Conservation & Recycling

journal homepage: www.elsevier.com/locate/resconrec

Full length article

Regional disparities in the Chinese economy. An emergy evaluation of provincial international trade

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ARTICLE INFO

Keywords:
Emergy
International trade
Resources
China

ABSTRACT

Due to different resource endowment, geographical features, culture and population sizes, different regions are facing different challenges and therefore need to adopt different strategies toward sustainable development. China's Eastern, Central and Western provinces are taking different policies on international trade in order to boost their economy. This paper tries to investigate to what extent a province receives a trade advantage and the corresponding environmental resource flows by employing an emergy accounting method for the period of 1993–2012. Three emergy trade indicators (Exchange Emergy Ratio, Emergy Benefit Ratio and Opportunity Ratio) were calculated along with conventional monetary indicators, to describe the benefits and losses in trade over the investigated period. The results show that the total trade volume of each province increased, but the trajectory of growth has a clear regional disparity. Eastern provinces gained economic advantages during the investigated period, while western provinces did not. The key finding is that benefits in terms of resource availability and work potential are not always in line with monetary advantages. Foreign trade partners received more advantages than their Chinese counterparts although Eastern Chinese provinces performed much better than both Central and Western Chinese provinces. Policy suggestions are then raised so that more sustainable trade policies can be prepared by considering the local realities.

1. Introduction

International trade has been a very important driver of booming Chinese economy. After China entered the World Trade Organization (WTO) in 2001, China's international trade has experienced unprecedented growth due to its export-oriented economy (WB, 2014), only recently partially re-orienting towards increased domestic consumption (NBS, 2015). However, underneath the surface of a flourishing economy, a succession of environmental and resource use problems also occurred (Bi et al., 2011; Chen and Han, 2015; Chen and Chen, 2013; Fu et al., 2007; Liu et al., 2015). International trade can certainly be seen as a whole, in that import and export flows may be lumped together and the performance of national economy can be assessed, without going into the details of local performances in the different areas. While providing a picture of the country as a whole system, the national outlook hides provincial differences and imbalances that affect the present and may also destabilize the future wellbeing of some less favored areas. China's international trade is a provincial epitome, that is to say that commodities which are exchanged in international trade are deeply characterized by and deeply affect the development of each Chinese province. Under such circumstances, international trade heavily impacts on provincial economies, environment and resource use, and further influences their sustainable development, increasing instead of smoothing China's regional disparities.

Since the reform and opening-up policy announced at the end of the 1970s, although China has made great progresses in both social and economic well-being, China's regional disparities still accompany this rapid development. This is mainly due to geographic locations always associated with diversified advantages in access to natural resources, capitals, labor forces, and technologies, leading to different economic growth speeds and industrial structures. As a consequence, under the

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http://dx.doi.org/10.1016/j.resconrec.2017.07.017
Received 17 March 2017; Received in revised form 12 July 2017; Accepted 13 July 2017
Available online 20 July 2017
0921-3449/

macro development policy of China, regional disparities became more and more evident and need to be addressed (Mischke and Xiong, 2015; Tian et al., 2014; Zhang, 2009). In order to identify the trends and seek solutions to China's regional disparities, a huge research effort was displayed, mainly exploring issues as energy consumption, carbon and air pollutants emission, economic development and related social aspects, by means of a variety of tools and methods such as input and output analysis (IO), regression analysis, co-benefit analysis, computable general equilibrium model (CGE), Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS)-Model (Chen, 2010; Dong and Liang, 2014; Fan et al., 2011; Guo et al., 2012; Huang and He, 2011; Kanada et al., 2013; Li et al., 2012; Qi et al., 2013; Su and Ang, 2014; Xu and Masui, 2009; Zhang et al., 2016). The main conclusions from these research activities can be summarized that the problem of inter-regional disparities is a long-standing one in the process of China's economic development, that the developed regions such as Jiangsu, Shanghai and Guangdong provinces obtained more economic, environmental and resources advantages, while the undeveloped regions such as Yunnan, Qinghai and Ningxia provinces only suffered from the associated disadvantages (Dong et al., 2015, 2016; Li et al., 2014; Sheng et al., 2014). To the best of our knowledge, regional disparities issues due to international trade were only assessed looking at conventional monetary flows and trade statistical tools, while important underlining and not-so-evident aspects (environmental support, natural capital extraction, ecosystem services, and renewability) were fully disregarded. Looking at production and consumption processes from the point of view of the amount of economic benefit they can provide is indeed a very partial perspective that needs to be complemented by the point of view of the environmental support from biosphere mechanisms that make them possible and sustainable. A biosphere perspective view reflects the surrounding environmental dynamics (i.e. the time and patterns of natural capital generation by nature as well as the extent unpaid ecosystem services support social and economic processes), and also points out that resources may be used up too quickly, inefficiently and without adequate matching of resource quality to use (Tian et al., 2016a,b). Under such a circumstance, this study aims to fill this gap, and also to answer a few fundamental questions about the problem of regional disparities:

- From an economic perspective, what are the advantages and disadvantages of each province in terms of local trade volume and gross domestic product?
- From an environmental perspective, what are the advantages and disadvantages of each province (in terms of access to resources and their support to local well-being)?
- From a future development perspective, what are the options that are available for appropriate use of resources for locally sustainable production and consumption activities?

Keeping the above mentioned questions in mind, this study uses the emergy accounting approach to assess the environmental value of resource exchanges at provincial international trade level from 1993 to 2012, to design a picture of the link of resources to the economic development in each province, to identify regional disparities in term of access to resources and growth potential, and finally to raise the attention to appropriate resource use and better understanding of its relation to China's regional disparities.

This paper is structured as follows. After this introductory section, Section 2 presents research methods, including detailed introduction to emergy accounting and data sources used in this study. Section 3 presents and discusses the research results from economy and resources use points of view. Finally Section 4 summarizes the main results achieved by the study and proposes related policy implications.

Table 1
The abbreviated name of each province.

Abbreviation	Provinces	Area	Abbreviation	Provinces	Area
BJ	Beijing	Eastern	EN	Henan	Central
TJ	Tianjin		UB	Hubei	
HB	Hebei		UN	Hunan	
LN	Liaoning		SC	Sichuan	Western
SH	Shanghai		CQ	Chongqing	
JS	Jiangsu		GZ	Guizhou	
ZJ	Zhejiang		YN	Yunnan	
FJ	Fujian		XZ	Xizang	
SD	Shandong		SA	Shaanxi	
GD	Guangdong		GS	Gansu	
HN	Hainan		QH	Qinghai	
HJ	Heilongjiang	Central	NX	Ningxia	
JL	Jilin		XJ	Xinjiang	
SX	Shanxi		GX	Guangxi	
AH	Anhui		IM	Inner Mongolia	
JX	Jiangxi				

Footnote: in this study, only 31 provinces of China are listed. Taiwan, Hong Kong and Macao are not included.

2. Materials and methods

2.1. Provinces in China

China is organized with 34 provinces totaling 9.60 million square kilometers of land. Their economic development and cultures are, very different among each other due to geography, resource endowment, population density, infrastructures, culture, languages, among other factors. Mainland China can be divided into three large areas, namely Eastern, Central and Western regions (Table 1), according to their geographical positions and economic development levels. The Eastern area includes those provinces whose economic development levels are highest. These provinces are the pioneers of implementation of the coastal opening-up policy; the Central area includes those provinces whose economic development levels are intermediate; finally, the Western area includes those provinces whose economic development levels are still very low. The areas, populations, and resource ranking of provinces are shown in Fig. 1 (according to (CESY, 2011), where brown, blue and gray colors identify respectively Western, Central, and Eastern areas as above specified); in addition, the green color identifies Taiwan, Hong Kong and Macao, which are not included in this study. The abbreviations of names of the investigated provinces are indicated in Table 1.

2.2. The emergy accounting approach

Emergy is defined as the available energy (exergy) of one kind (usually of the solar kind) required directly and indirectly to make a product or provide a service (Odum, 1996). The emergy concept of cumulative embodiment over a product supply chain supports the idea that something has a value according to what was sustainably invested into making it. In order to quantify the cumulative investment of solar equivalent available energy, the emergy accounting method converts different energy and mass inflows to a system or process into a common basis (solar equivalent Joules, or solar emjoules, sej). The calculation procedure brings into the assessment of the past work performed by the biosphere to generate primary resources over time. By applying the emergy accounting method, it is possible to quantify how much environmental support is therefore needed to provide a unit of a product or service or economic wealth within a country (Geng et al., 2017; Odum, 1996; Sevegnani et al., 2016; Tian et al., 2016a; Viglia et al., 2017; Yu et al., 2016; Zhong et al., 2016). The method was applied to a variety of processes and systems, including agricultural and industrial production, transport, household, waste management, and energy (Franzese et al., 2008; Geng et al., 2017; Lou and Ulgiati, 2013; Tian