

ANALYSIS

Economic diversity, development capacity and sustainable development of China

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Abstract

China's economic growth over the past several decades has been among the highest in the world. It has been fueled by cheap fossil fuel energy so energy consumption has risen rapidly, but there are signs that negative feedbacks in the form of waste and inefficiency may affect future development. If energy throughput exceeds the capacity of the environment to process the inevitable waste from production then the development may not be sustainable. We calculate economic diversity using an energy flow network analysis method to explore the relationships of development policy, energy use, efficiency and sustainable development. China and its provinces are presented as a case study and the development status of each province in China is presented. China's development policy does not appear to be sustainable over the period 1985–1998 because of unsustainable energy consumption trends and declining economic diversity. An energy consumption tax is proposed for increasing diversity and dealing with increasing energy consumption in China. © 2002 Elsevier Science B.V. All rights reserved.

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1. Introduction

Sustainable development has been used widely as an organizing principle and has become a policy goal throughout the world. As a developing country, economic reform in China has led to remarkable economic growth with its gross domestic product growing at the average annual rate of approximately 10% over the period 1978–1998,

amid many changes in its economic systems. Along with the rapid economic development, many problems have arisen. Since the adoption of a coastal development strategy in 1981, coastal provinces have been positively encouraged to grow faster and become wealthier than inland provinces. This has led to higher income disparities. Simultaneously many environmental problems related to pollution and resource loss have occurred as privatization and market economy reforms were carried out. At the crossroads, we need to assess the situation; is China's development sustainable during this fast development period? And if we are not on the road to sustainable

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development, what can we do? To answer these questions we analyze energy use in China and examine diversity, energy intensity and economic output. A measure of diversity is useful because it give us a means of tracking economic evolution and progress. Ulanowicz's development capacity formula offers a methodologically simple but comprehensive way to investigate the relationship of structure and performance. In this paper, we are following Templet (1999) to investigate economic systems in China. Templet (1999) adopted an energy flow network method and Ulanowicz's (1986) development capacity formula to discuss the relationship between economic diversity, output and development policy, and presented two distinct development strategies.

The relationship between diversity, development and stability has been a topic of debate for nearly a century and an half. Ecology has been a particularly fertile domain for the discussion. Darwin (1859) first realized that productivity was related to diversity in ecological systems. Ulanowicz (1986) developed a general theory of growth and development from the view of ecosystems phenomenology and showed that diversity and capacity are related. Tilman et al. (1996) used grassland ecosystems to show the positive relationship between productivity, diversity and resource utilization efficiency. Development in ecosystems and economic systems is an evolutionary process that results in self-organization and structure change over time as energy is consumed and information increases. Economic systems and ecosystems increase complexity and reduce uncertainty over time, assuming conditions are favorable. This behavior resembles the dissipative structures of Prigogine (1980). Economic diversity refers to the number and equitability of energy flow paths within an economic system. It can be measured by how many different types of economic activities exist within the system and how equitably energy is distributed between them. The Shannon and Weaver (1949) (SW) equation captures both of these properties and is widely used in ecology to calculate ecological diversity.

Economists have broadly discussed the relationship between diversity, stability and development policy since the 1950s, especially the relationship

between diversity and stability. Various theory and methods have been proposed. Measures used to capture the level of economic diversity have ranged from simplistic percentage standards to the complex using portfolio variance analysis. The majority of economic diversity measures tend to fall into one of two groups: energy flow and portfolio variance measures. Templet (1996) estimated diversity in economic systems using broad economic sectors as energy nodes in the SW equation (Eq. (1)) and suggested a significant positive, logarithmic relationship of diversity to GNP/capita across countries. Further empirical results across the 50 US states suggest that higher levels of diversification are associated with higher levels of output (Templet, 1999). Portfolio theory has been adapted by Conroy (1974) and Brown and Pheasant (1985). This approach focuses on the individual industry's net returns, the stability of these net returns, and the covariance of these net returns among industries within the portfolio. Various combinations of portfolio elements provided a measure of diversity. Because the use of the covariance approach is not independent of stability itself, Portfolio theory has been criticized. Wagner and Deller (1998) took the endogenous interindustrial linkages into account and adopted an input–output approach to measure economic diversity. The relationship between economic structure (measured in terms of diversity) and performance (measured as growth or stability of employment or income) has received considerable attention in the empirical literature. Siegel et al. (1995) have suggested using an input–output model that incorporates elements of portfolio theory for the analysis of economic diversity. Because of lack of data availability, attention has not been devoted to investigating the relationship between economic diversity and development policy. Ulanowicz's development capacity formula offers a comprehensive means of analyzing the relationship between an ecological system's structure and other ecological phenomenon (Ulanowicz, 1986, 1997).

The layout of the remainder of the paper is as follows. The next section presents a short exposition of Ulanowicz's development capacity formula. Section 3 uses data from China and its 29

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