International Scholars Journals

Global Journal of Business Management ISSN 6731-4538 Vol. 12 (5), pp. 001-007, May, 2018. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Regional sustainability assessment based on long periods of ecological footprint: A case study of Zhejiang Province, China

Haijun Bao*, Huixiong Chen, Shuli Jiang and Yanhong Ma

College of Business Administration, Zhejiang University of Finance and Economics, Hangzhou, China.

Accepted 23 August, 2017

China has experienced unprecedented economic growth for three decades since the implementation of economic reform. This paper argued that the capitalization of environment and resources fuel the economic growth. It was documented through a case of Zhejiang Province based on long periods of ecological footprint analysis. It concluded that: (1) ecological footprint per capita and ecological deficit from 1990 to 2006 in Zhejiang Province is increasing year by year; (2) ecological footprint per 10000 GDP tends to decline and the economic capability grows in the past 17 years; (3) however, the economic capability growth mainly depends on the expands of ecological footprint per capita, while diversity index tends to decline. Furthermore, it is demonstrated that the rapid economic growth of Zhejiang Province relies on the capitalization of environment and resources. The Janus-faced nature of industrial development indicated that ecological civilization should be given priority over industrial civilization in China and other developing countries.

Key words: Sustainability, ecological footprint, Zhejiang Province.

INTRODUCTION

Market-oriented reforms in China were undertaken at the end of 1978; they were multi-phased, started in rural areas and were highly decentralized. Reforms began in the rural economy followed by urban state-owned sector reforms, which led greater opening to the global economy. They were also characterized by provinces having a great deal of autonomy in experimenting with policies that altered the incentive structures of an administered economy to those that are oriented toward profit and efficiency (Yao and Yueh, 2009). Despite the different growth rate within provinces, China has experienced unprecedented economic growth for three decades since the implementation of economic reform in 1978. One of the enduring puzzles surrounding China's rapid economic growth is how it was achieved within an incomplete legal system and under-developed financial markets- both of which are thought to be crucial in enabling the workings of an efficient market economy (Allen et al., 2005). Many literatures interpret this puzzle by institutional innovations which provided incentives that would normally be generated through well-defined property rights and informal institutional arrangements which stimulated market exchange (Riskin, 1987; Huang and Rozelle, 1996; Lin, 1992; Lau et al., 2001; Allen et al., 2005; Clarke, 2003; Pei, 2001; Pistor and Xu, 2005; Knight and Yueh, 2008; Yao and Yueh, 2009).

To some extent, these documents may be true. However, they are merely got from the aspect of economy itself. In fact, the rapid economic growth has altered the physical landscape and brought about tremendous challenges to the environment and the human society (Alipour, 2009; Oloruntegbe et al., 2010). Industrial wastes contaminated soil and polluted air and water, compromising human health and the quality of life. Rapid economic growth destroyed natural habitat and diminished biodiversity (Chen et al., 2010). These sustainability issues revealed the Janus-faced nature of development (Antrop, 2004). Therefore, it raises doubts about the stability of sustained economic growth of China.

*Corresponding author. E-mail: baohaijun@zufe.edu.cn. Tel: 86 057186735803.

Furthermore, this paper argued that the capitalization of environment and resources fuel the economic growth. It will be demonstrated through a case of Zhejiang Province, China.

Zhejiang Province, located on the Delta of Yangtze River, has a population of 46.47 million, ranking 11th in the country. However, the composite index of natural resource per capita ranks the last but two, the cultivation land per capita is the last in the whole country. The water resource per capita is about 2100 m^3, which is nearing the water shortage alarm line. The market oriented economic and social reform made Zhejiang a strong economy Province. From the 1990s, Zhejiang economy witnessed a rapid development with an increase of about 13% in GDP each year which is higher by 4% than the average increase of the whole country (Zhejiang Province Statistic Bureau, 2007).

The rapid economic development attracted much attention throughout the country. But what has happened to the relationship between the ecological footprint and ecological carrying capacity and whether the economy in Zhejiang Province could be developed in a sustainable way in the future have aroused people's wide concern nowadays.

METHODOLOGY

Ecological footprint (EF) is a group of quantitative index based on the land area, which consists of forest, meadow land, cultivated land, water area, the fossil fuel land and construction land. The concept of ecological productive land being put forward and the equalization of different ecological land make it possible for the analytical method of ecological footprint to provide a unified analytical framework and basis for various ecological capital measurements. For the relatively strong operability, EF analytical method has become an effective tool to analyze the ecological change and the evaluation of capability in sustainable development (Binningsbo et al., 2007; White, 2007; Lenzen and Murray, 2001; Chen et al., 2007; Senbel et al., 2003).

The calculation steps of ecological footprint are as follows (Wackernagel and Ree, 1996):

(1) The consumption items should be divided into parts and the consumption of major items should be calculated with the quantum of trade adjustment considered. (2) The consumption of different items should be converted into the land area needed for the production by using the data of average output. (3) By applying the equilibrium factor, the productive land area of living beings should be converted into land area of equivalence productivity, thus the ecological footprint could be calculated. (4) The ecological carrying capacity could be worked out by applying output factor.

Comparing ecological footprint and ecological carrying capacity, the degree of sustainable development could be analyzed.

The commonly used formula for ecological footprint is:

$$EF = N[EF = \sum(AA_I) = \sum(C / P_I)] \quad (1)$$

In Formula 1, *i* refers to different items of consumer goods; P_i is the average productivity for the *i*th consumer goods; C_i is the consumption per capita of the *i*th consumer goods; aa_i is the converted land area per capita from the *i*th consumer goods; N stands for population size; ef stands for ecological footprint per capita, EF is the total ecological footprint.

From formula (1), we know ecological footprint is a function between the population size and material consumption per capita. Due to the dynamic change in the capacity of human being's utilization of resource and the population size, the ecological footprint is also a dynamic index. In the ecological footprint model, the consumption of biological resources and energy is mainly concerned. The consumption of biological resources consists mainly of farm product, animal product, forest product, fruit and timer, etc. while the consumption of energy takes into consideration the consumption of raw coal, clean coal, coke, gas, kerosene oil, diesel oil, fuel oil, liquefied petroleum gas, thermal power and electric power, etc.

SUSTAINABILITY ASSESSMENT

The evolution of Ecological Footprint from 1990 to 2006 in Zhejiang Province

Based on the data collected from "Zhejiang Province yearbook (1991-2007)", the investigation of Zhejiang Provincial Economy and Trade Commission and Zhejiang Province Statistical Bureau, this paper calculated the ecological footprint in Zhejiang Province in the past 17 years. The calculating results are shown in Figure 1. From Figure 1, the evolution of ecological footprint in Zhejiang Province from 1990 to 2006 could be divided into five stages. The first stage ranges from 1990 to 1993, during which the ecological footprint in Zhejiang Province is basically within the range of ecological carrying capacity. The second stage stems from 1993, during which the macro economy in China is developing and the national consumption is improving all the time. Thus the ecological footprint in Zhejiang Province is increasing all the way to a peak till 1996. During these years, the ecological carrying capacity remains almost steady except for a slight decline. The ecological deficit is increasing year by year and reaches 0.8470 gha by the year 1996. The third stage ranges from 1997 to 2000. In this period of time, the economic development in Zhejiang Province made a soft landing because of China's implementation of deflation dominated macro control and the influence of Southeast Asian Financial Crisis. The national consumption and ecological footprint is decreasing at the same time. In this period of time, the ecological carrying capacity in Zhejiang keeps steady and the ecological deficit is fixed around 0.8 gha. The fourth stage ranges from 2001-2005, during which time China has joined the WTO, and the duty for cars is decreasing so that Zhejiang residents could afford cars. Additionally, influenced by the active fiscal and monetary policy and the policy of urbanization, the real estate in Zhejiang Province is rising rapidly. All these led to the increase in ecological footprint. With the advance of urbanization, a large amount of cultivated land is taken up, resulting in the decrease of ecological carrying capacity and increase of ecological deficit which reached 1.2372 gha by the year 2005. The last stage ranges from 2006 to now,

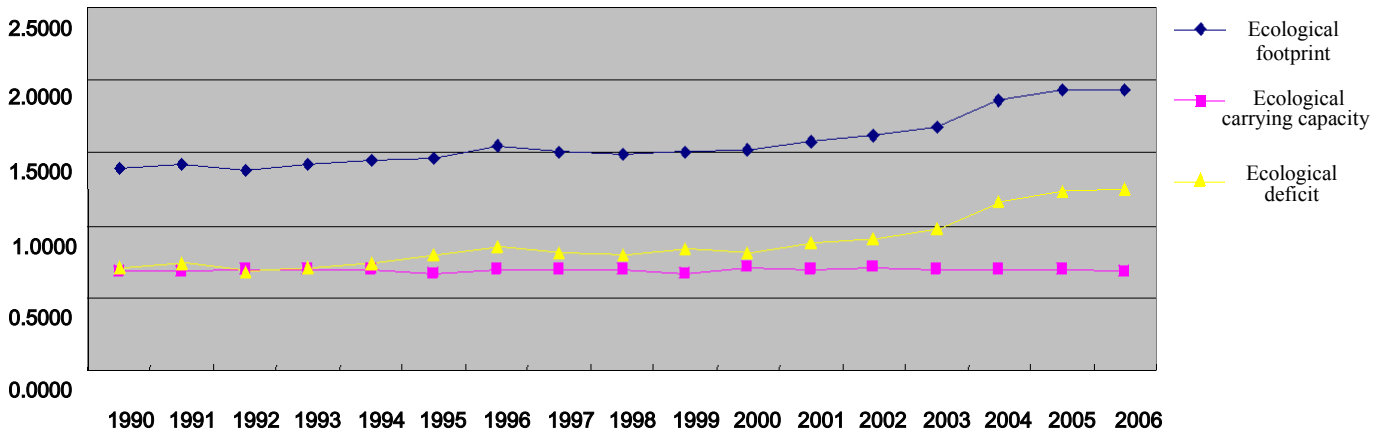

Figure 1. The evolution of ecological footprint from 1990 to 2006 in Zhejiang Province.

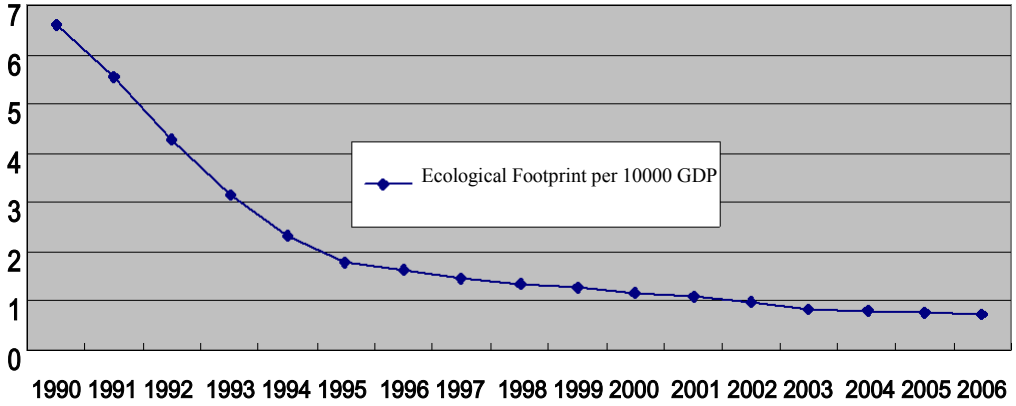

Figure 2. The ecological footprint per 10000 GDP from 1990 to 2006 in Zhejiang Province.

during which the rising rate of ecological footprint in Zhejiang Province is slowing down because of a series of macro-control measures in China.

Ecological footprint per 10000 GDP and resource utilization efficiency

The more the need for ecological footprint per 10000 GDP, the lower the resource utilization efficiency is, but on the contrary, the higher the resource utilization efficiency is. According to the GDP data from Zhejiang Province yearbook in the past years and the ecological footprint data above, this paper made a calculation of ecological footprint per 10000 GDP from 1990 to 2006, as illustrated in Figure 2. From Figure 2, we can know the ecological footprint per 10000 GDP is decreasing each year; before the year 1995, the ecological footprint per 10000 GDP is declining in a large degree and thereafter a slight decline.

Comparing the calculating data of ecological footprint per 10000 GDP in the whole country by Xu Zhongmin and Liu Yuhui in the years 1999 and 2001, the ecological footprint per 10000 GDP in Zhejiang Province is about 60% of the national average level (Table 1). Thus the ecological footprint per 10000 GDP in Zhejiang Province is relatively low. The decline of ecological footprint per 10000 GDP is considered primarily as due to the improvement of resource utilization efficiency and the more application of technological factors to the economic production process (Liu and Peng, 2004), which reduced the consumption of the resources and transferred the worry for regional ecological safety into a beneficial signal for sustainable development in Zhejiang Province. But the prominent increase in ecological footprint indicates the spreading trend of ecological deficit in Zhejiang and calls for great attention. Reducing ecological footprint becomes a difficult task for regional economic and social

Table 1. Comparison of ecological footprint per 10000 GDP between Zhejiang Province and the whole country.

Year	Zhejiang (gha)	Average in the whole country (gha)
1999	1.261	2.037[a]
2001	1.079	1.870[b]

[a]Cited from Xu and Chen (2003); [b]Cited from Liu and Peng (2004).

development.

The diversity of ecological footprint in Zhejiang Province and its capability of development

The diversity index of ecological footprint could be calculated by applying Shannon—Weaver's formula (Shannon and Weaver, 1949):

$$H = -\sum_{II}[P \ln P] \quad (2)$$

In Formula (2), H represents diversity index, P_i refers to the ratio of i types of land to the total ecological footprint, that is the degree of abundance. $\ln P_i$ is the distributing mode of i types of land in the whole ecological footprint, that is the degree of fairness. In a word, the diversity of ecological footprint in formula (2) is made up of the following two parts: (1) the degree of abundance (the quantity for the utilization of different types of land); (2) the degree of fairness (an evaluation of the distributing mode of ecological footprint). The Shannon—Weaver formula is not a monotonic function, implying that the fairer the distribution of ecological footprint in ecological economic system, the higher the diversity for the fixed group of systems.

The development capacity could be obtained from the multiplication of ecological footprint by the diversity index deduced from the aspect of systematic organization. According the Ulanowicz formula, the development capacity could be described by the following formula (Ulanowicz, 1986):

$$C = EF \cdot (-\sum_{II}[P \ln P]) \quad (3)$$

In formula (3), C is the development capacity and ef stands for the ecological footprint for a country or a region.

From Formulae (2),(3) and the data collected above about the ecological footprint in Zhejiang Province in the last years, the index of diversity and development capacity in Zhejiang Province from 1990 to 2006 is shown in Figure 3.

Formula (3) indicates that the eco-economic development capacity has a positive correlation with both diversity index and ecological footprint per capita. Though the land use structure improves its degree of richness year by year, the footprint of fossil fuel land increased almost 1.5 times from 1990 to 2006, that is from 0.3804 (1990) to 0.9499 gha (2006). The degree of imbalance in land footprint distribution surpassed the degree of richness in land use structure, thus the diversity index in Zhejiang Province ET decreased from 1.3551 (1990) to 1.1617 gha (2006) while the eco-economic development capacity increased by 24.16% from 1.8952 (1999) to 2.3498 gha (2006). The ecological footprint and diversity index, decreasing in cultivated land and forest land, keeping balance in meadow land, and increasing in construction land and fossil fuel land, resulted in the increasing development capacity of Zhejiang Province. Hence, the improvement of eco-economic development capacity in Zhejiang Province resulted from the increase in EF per capita (especially that of construction land and fossil fuel land) and the decrease in diversity index which represents the stability of ecological economic system. This, to some extent, indicates that there is something unsustainable in the eco-economic development capacity in Zhejiang Province which calls for considerable attention.

The comprehensive analysis in the capacity of sustainable development in Zhejiang Province

The capacity of sustainable development is closely related to the ecological deficit per capita, ecological footprint per 10000 GDP and diversity index. The greater the ecological deficit per capita, the weaker the capacity of sustainable development is. The decrease in EF per 10000 GDP encourages the capacity of sustainable development, whereas the decrease in diversity index discourages it. Figure 4 shows the dynamic evolvement status of three indexes in influencing the capacity of sustainable development. From Figure 4, we know that except the ecological footprint per 10000 GDP has been in the right path, the other two was not on the way. So the economic development of Zhejiang Province is still contrary to its ecological protection. According to the Cask Theory, the capacity of sustainable development in Zhejiang Province is determined by the weakest factor. Hence, only the three factors could be in the right path can Zhejiang Province continue the sustainable development.

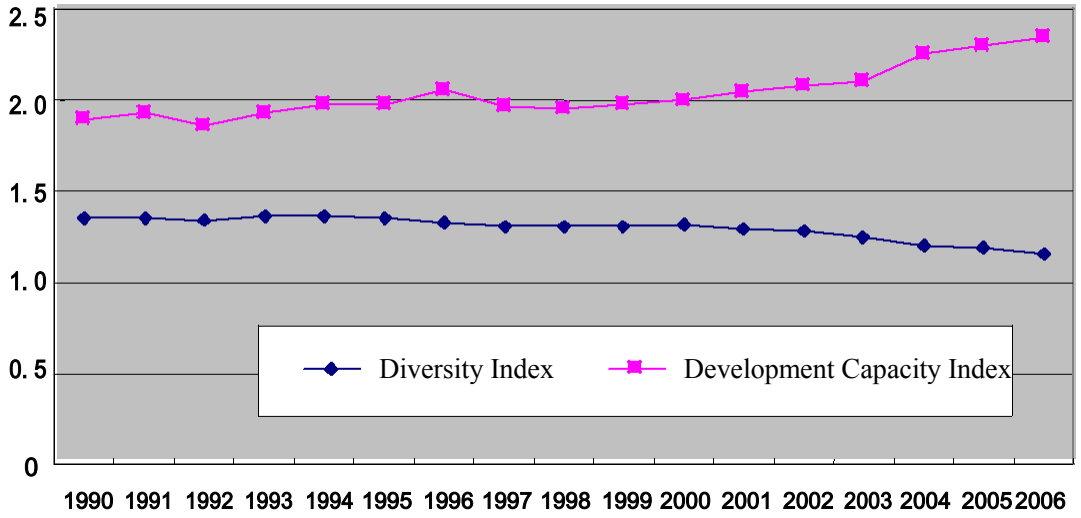

Figure 3. The diversity index and development capacity index in EF in Zhejiang Province from 1999 to 2006.

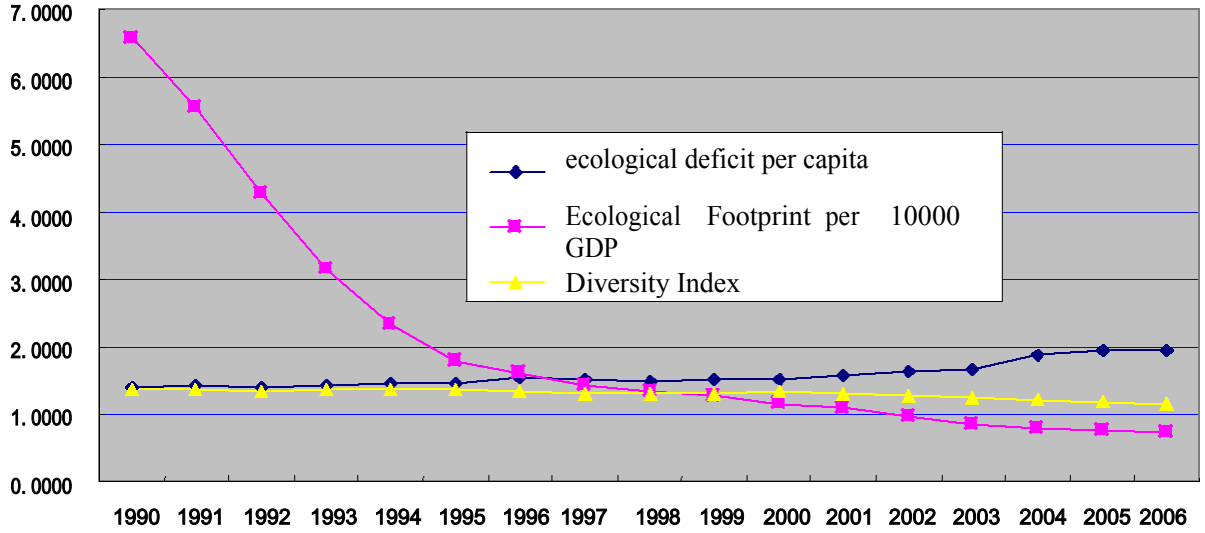

Figure 4. The dynamic evolvement status of three indexes influencing the capacity of sustainable development.

CONCLUSIONS AND RECOMMENDATIONS

The calculation and analysis in the above indicate that the EF per capita increased by 38.336% from 1.3966 (1990) to 1.9319 gha (2006). The ecological deficit is increasing year by year. In 2006, it increased to 1.2463 gha, 74.74% more than that of 1990. This shows that in the past 17 years, though the economy in Zhejiang Province is increasing dramatically, the ecological safety is decreasing. The ecological development is restricted by the ecological carrying capacity year by year. Transition from the industrialization to a new mode which is more energy-saving through system planning is a way out for the future modernization and development of Zhejiang Province in its urbanization process.

The ecological carrying capacity per capita is kept basically steady. In 2006, it only increased by 0.34% compared with the year 1990. This indicates that in the past 17 years in Zhejiang Province, there is little done actively to improve the ecological carrying capacity by improving the production in every land unit. There is much to do in this respect to lessen the negative influence caused by the persistent expansion of ecological footprint in Zhejiang Province.

Though the ecological deficit in Zhejiang Province increases each year and the ecological carrying capacity

per land unit remains the same, the ecological footprint per 10000 GDP is decreasing year by year. In 2006, it decreased 8.91 times than that of 1990. The ecological footprint per 10000 GDP is 60% that of the average national level in 1999 and 2001. Thus it can be seen that the resource consumption in Zhejiang Province is decreasing while the resource utilization efficiency is increasing. With the quality of economic growth improving, Zhejiang Province is developing in an energy saving path. The decrease in resource consumption per 10000 GDP is partly due to the promoting of industrial structure, partly due to the technological advancement and the improvement of energy efficiency ratio by system innovation. This shows that the technology innovation, changes of resource management system and industrial structure promotion is a basic way to change the status of severe ecological deficit and keep the sustainable development in China. It can also be of significant importance to promote the sustainable development nationwide.

The eco-economic development capacity in Zhejiang Province increased by 24.16% from 1.8925 (1990) to 2.3498 gha (2006), which shows that the ratio of increase in GDP far surpassed that of eco-economic development capacity. It is obvious that Zhejiang Province has obtained an ideal economic development by marketing reform, giving full play to the system priority, and overcoming the shortcoming of poor resource. This is of positive significance for the sustainable development in Zhejiang Province. However, due to lack of resources in the future, this mode is not sustainable. The decrease in cultivated land, the forest land and the diversity index warns people that it is time for Zhejiang Province to transfer the mode of economic growth.

In order to increase sustainability, the following suggestions should be taken into consideration. First, develop the economy by continually relying on the market economic system and making clear the property right for ecological resource protection, including various types of ecological compensation system. In this way, the ecological resource could be protected and the production per land unit could be increased. Second, the capacity of sustainable development should be improved by continually adjusting the industrial structure and technological structure, decreasing the energy consumption by exploration of high technology and promotion of industrial structure. Third, gradually control the increase of GDP within the range of ecological carrying capacity. Fourth, use land resource economically and intensively to improve the diversity index and utilization efficiency of cultivated land, forest land and meadow land. Through changing the mode to improve the quality of economic growth, thus the eco-economic development capacity in Zhejiang Province can be improved.

Furthermore, it was demonstrated that the capitalization of environment and resources fuel the economic growth through a case of Zhejiang Province
based on long periods of ecological footprint analysis. The conclusion contributes to the understanding of the puzzle of China's rapid economic growth within an incomplete legal system and under-developed financial markets. The Janus-faced nature of industrial development has led to many environmental problems and altered the physical landscape. The ecological civilization should be given priority over industrial civilization in China and other developing countries. The firms need to take on social responsibility by cleaner production, low carbon act, etc. for sustainable development.

REFERENCES

Alipour H. (2009). Effective factors on economic development in East Azerbaijan, Iran. Afr. J. Bus. Manage. 3(12): 826-830

Allen F, Qia, J, Qian M. (2005). Law, financ. and econ. growth in China. J. Finan Econ., 77(1):57-116

Antrop, M. (2004). Landscape change and the urbanization process in Europe. Landsc. Urban Plann., 67(1-4):9-26.

Chen, B. Chen GQ, Yang, ZF, Jiang, MM (2007). Ecological footprint accounting for energy and resource in China. Energy Policy, 35:1599-1609

Binningsbo H. de Soya I Gleditsch N. (2007). Green giant or straw man? Environmental pressure and civil conflict, 1961–1999. Population and Environ., 28:337-353

Chen YH, Chen CY, Lee SC. (2010). Technology forecasting of new clean energy: the example of hydrogen energy and fuel cell. Afr. J. Bus. Manage., 4(7): 1372-1380

Clarke DC (2003). Economic development and the rights hypothesis: The China problem. American J. Compar. Law, 51: 89-111.

Huang J, Rozelle S. (1996). Technological change: The re-discovery of the engine of productivity growth in China's rural economy. J. Dev. Econ., 49:337-369

Knight J, Yueh L. (2008). The role of social capital in China's urban labour market. Econ. Transit., 16(3): 389-414.

Lau LJ, Qian Y, Roland G (2001). Reform without losers: An interpretation of China's dual-track approach to transition. J. Polit. Econ., 108(1):120-143.

Lenzen M, Murray SA (2001). A modified ecological footprint method and its application to Australia. Ecol. Econ., 37:229-255

Lin J Y (1992). Rural reforms and agricultural growth in China. Am. Econ. Rev., 82(1): 34-51.

Liu YH, Peng XZ (2004). Time Series of Ecological Footprint in China Between 1962˜2001: Calculation and Assessment of Development Sustainability. Acta Ecologica Sinica (in Chinese), 24(10):2257-2262

Oloruntegbe KO, Akinsete, AM, Ayeni EO, Odutuyi MO, Gazi Mahabubul Alam. (2010). Rethinking development and sustainability of African economy: the roles of science education. Afr. J. Bus. Manage., 4(6):811-819

Pei MX (2001). Does legal reform protect economic transactions? Commercial disputes in China. In: Peter Murrell (Ed.), Assessing the value of law in transition countries (pp. 180–210). Ann Arbor: University of Michigan Press.

Pistor K, Xu C (2005). Governing stock markets in transition economies: Lessons from China. Am. Law Econ. Rev., 7(1): 1-27.

Quan, B., Chen, J. F., Qiu, H. L., RÖmkens, M. J. M., Yang, X. Q., Jiang, S. F., Li, B. C. (2006). Spatial-temporal pattern and driving forces of land use changes in Xiamen, Pedosphere. 16(4): 477-488.

Riskin C. (1987). China's political economy: The quest for development since 1949. Oxford: Oxford University Press.

Senbel M, McDaniels T, Dowlatabadi H. (2003). The ecological footprint: a non-monetary metric of human consumption applied to North America. Global Environment. Change. 13:83-100.

Shannon CE, Weaver W (1949). The Mathematical Theory of Communication. University of Illinois Press, Illinois, 102-104

Ulanowicz RE (1986). Growth and Development: Ecosystems Phenomenology. Springer-Verlag. New York, 203-205

Wackernagel M, Ree W. (1996). Our Ecological Footprint: Reducing

Human Impact on the Earth. New Society Publishers, Gabriola Island. 132 Senbel.
White T (2007). Sharing resources: the global distribution of the ecological footprint. Ecol. Econ., 64: 402-410
Xu ZM, Chen GD(2003). The calculation and analysis of ecological footprints, diversity and development capacity of China. J. Geogr. Sci., 13(1):19-26
Yao Y, Yueh L (2009). Law, Financ and Econ Growth in China: An Introduction. World Dev., 37(4):753-762
Zhejiang Province Statistic Bureau. Zhejiang province yearbook. Beijing, China: Chinese Statistics Publishing House (in Chinese). 1991-2007.