The Eco-Wellbeing Performance in China

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After rapid development in recent decades, China has laid a strong economic foundation and established material conditions. Despite this, the country still confronts a range of challenges that impede higher-quality economic and social development. To measure high-quality regional development, eco-wellbeing performance (EWP) has become an important tool that seeks to strike a balance between economic development, human wellbeing, and environmental protection.

eco-wellbeing performance | three-stage network model | directional distance function

1. Introduction

Today's world is undergoing significant and unprecedented changes. Global climate change, social unrest due to the growing inequality between certain countries, and the impact of the fourth technological and industrial revolution on the labor market are all severe obstacles to humanity's goal of a better life [1]. At the same time, China, as the world's most populous country, has quietly changed its main social contradictions, and its unbalanced and inadequate development can no longer meet the people's growing demand for a high quality of life [2]. Providing a better ecological environment, high-quality public services, safeguarding people's welfare, and achieving sustainable development will be important elements in satisfying people's demands for a wonderful life. After over 40 years of rapid growth through reform and opening up, China has laid a good financial foundation and material conditions. However, its development still faces a series of challenges, some of which constrain China from achieving higher quality and a more sustainable society.

Environmental degradation poses a major challenge in China today. Continuous economic development, since its implementation of reform and openness, has exerted considerable stress on the ecological surroundings, energy, and resources. As observed, the Soil Pollution Prevention and Control Action Plan, which was reissued in 2016, expresses China's worrisome situation regarding soil pollution [3]. Furthermore, 70.7% of China's 338 urban centers, at the prefecture level and higher, had inadequate ambient air quality in 2017 [4]. The total volume of China's water resources was only 2876.12 billion cubic meters in 2017, indicating a per capita possession of 2075 cubic meters, which represents just one-third of the world's per person possession in 2014 [5]. Public service remains to be another major challenge for China. Initially, in 1978, China's urban population was under 20%, however, by late 2018, the urbanization rate for the resident population was 59.6%, showing a large increase of 40 percentage points [6]. As more residents migrate to cities, resulting in soaring demand for public services, this growing demand exceeds the limits of urban public resource services. China's economic growth is also a crucial challenge for the future. From 1978 to 2017, GDP experienced an average annual growth of 9.5% at fixed prices

which is significantly faster than the world economy's average annual increase of about 2.9% over the same time, positioning it among the world's major economies. However, since 2015, China's economic growth has slowed, with a yearly average of less than 7% [7].

The Chinese government has introduced a variety of policies and initiatives to address the challenges, including the promotion of social equality and environmental protection. In 2017, the State Council released the "13th Five-Year Plan for Promoting Equalization of Basic Public Services". The plan aims to achieve a more equitable and better basic public service system by 2020 [8]. The following year, the Chinese government introduced the Three-Year Action Plan for Winning the BlueSky Battle [9]. The plan intends to mitigate air pollutants and greenhouse gas emissions by reorganizing the industrial layout, energy, transportation, and land use structure. Since the 13th Five-Year Plan, China has voluntarily forsaken its rapid economic growth strategy to promote a more sustainable economic outlook [10].

Despite various central government policies on ecology and public services, there is still an open question of whether municipal governments have taken effective action, and more significantly, whether these measures help to improve the wellbeing of people. Eco-wellbeing performance (EWP) seeks to balance economic progress with environmental protection and social welfare by prioritizing the sustainable exploitation of natural resources and the protection of the earth and is an effective indicator of the ability of regions to develop sustainably [11][12]. As a result, EWP has gained increasing popularity in China [13][14][15][16][17], and the state of EWPs in China has profoundly influenced the process of sustainable development in the world.

However, there are some shortcomings in the existing studies. Firstly, most studies are stuck in a one- or two-stage research paradigm. Due to this limitation, natural resource consumption, economic growth, science and technology innovation, and people's wellbeing have not been well linked to measuring the stages of sustainable development in urban areas. Secondly, most studies on EWP have focused on the national or provincial level, and due to the overly large data compilation and collection, very little research has been conducted on prefecture-level cities in China.

2. Eco-Efficiency

The notion of eco-efficiency was proposed in 1992 by the World Business Council for Sustainable Development (WBCSD), to create more worth using fewer resources while minimizing the environmental effect of economic activities by optimizing natural resource use, minimizing waste and pollution [18]. Following the adoption of China's sustainable development policy, the focus of eco-efficiency studies shifted rapidly from provinces to city clusters, and ultimately to prefecture-level cities. In provincial eco-efficiency studies, key areas of concern entail industrial restructuring, technological innovation, improving resource utilization efficiency, and promoting sustainable development. These studies aimed to measure eco-efficiency levels and investigate relationships between variables such as industrial structure, technological innovation, and resource use efficiency in individual provinces [19][20][21]. For example, Zhou et al. [22] estimated the eco-efficiency levels in Guangdong Province and found that the average eco-efficiency was low, mainly attributable to low resource use efficiency and unfavorable industrial

structure. However, technological innovation had a beneficial impact on eco-efficiency levels in Guangdong Province. In urban clusters, the research focus is on urbanization and regional coordination. Several studies aim to determine the best allocation of resources between different regions to achieve regional eco-efficiency [23][24][25]. For instance, Ren et al. [26] evaluated the efficiency in urbanization and eco-efficiency levels in seven urban agglomerations in the Yellow River Basin of China between 2006 and 2019 and found a significant spatial correlation between the two variables. Thus, effective policies and interventions are needed to achieve the coordinated development of eco-efficiency and urbanization. In cities, the research focus revolves around green urbanization, low-carbon development, and sustainable urban development. Studies have investigated various eco-efficiency indicators, such as carbon emissions, energy consumption, and water use, concerning assessing eco-efficiency levels of different prefecture-level cities in China [27][28][29][30]. For instance, Liu et al. [31], Bai et al. [32], and Ren et al. [33] all examined eco-efficiency levels in prefecture-level cities in China by evaluating resource consumption, economic output, and pollution emissions.

3. Innovation Efficiency

Innovation efficiency is another crucial indicator of the sustainable development potential of a nation or area [34]. According to Vollebergh and Kemfert [35], sustainable development is not feasible without technological innovation and progress. Innovation plays a crucial role in the development of China's green economy while driving the country's economic, ecological, and social sustainability, as emphasized by Liu and Dong [36] and Ke et al. [37]. As such, innovation efficiency in China has been a popular research subject, with scholars investigating it from various viewpoints. Studies have revealed that innovation efficiency in many Chinese cities is generally low and polarized, with a noticeable spatial aggregation effect [38][39]. In contrast, a few scholars have found the innovation efficiency of Chinese urban areas to be on the rise, even though some urban areas in the northeast, northwest, and southwest regions are an exception to this trend [40][41]. Nonetheless, the regional disparity in green innovation efficiency among Chinese cities is undeniably narrowing, as indicated by Zhao et al. [42] and Liao and Li [43], which suggests the gradual emergence of a spatially synergistic innovation division of labor with "R&D in the East + transformation in the in the Southwest and Northeast". Effective environmental regulation is an essential factor that could enhance innovation efficiency in China, according to Zhang et al. [44] and Fan et al. [45]. Meanwhile, external factors, such as R&D financing, knowledge diversity, and transport infrastructure, also boost innovation efficiency, leading to the sustainable development of the region [46][47][48]. Additionally, urban innovation is not solely dependent on local innovation activities but also on the geographical position of cities in their intercity co-invention network [49][50].

4. Eco-Wellbeing Performance

Eco-wellbeing performance (EWP) was introduced by Daly [51] in 1974 and defined by Zhu et al. [52] as the enhancement of human welfare per unit of ecological depletion. EWP upgrades eco-efficiency, bringing it closer to the goal of sustainable development [53][54]. Many scholars have studied EWP in different cities and regions of China. Some studies have focused on the space-time evolution and drivers of EWP in Chinese cities [55][56].

Scholars generally agree that EWP is low in Chinese cities and performs better in the east than in the center and west [11][57]. However, the EWP of cities is now improving [11]. Specific regions, for instance, the Yangtze River Delta [58], the Middle Yangtze River Urban Agglomeration [59], the Yellow River Delta [15], and Beijing-Tianjin-Hebei Agglomeration [60], have also become popular targets for EWP studies. At the inter-provincial level, studies indicate that the general level of EWP in China is declining, and the spatial gap may increase further [16][17][61]. In contrast, Deng et al. [13] reported that EWP improved nationally, with greater improvements in the east.

5. The Connection of Ecology, Economy, Innovation, and Wellbeing

All of the above studies take ecological inputs to cities as a starting point and measure their efficiency in translating into economic output, innovation output, and people's wellbeing, respectively. However, the correlation between the economy, innovation, and people's wellbeing has been ignored. What is certain is that innovation efficiency is an upgrade of eco-efficiency and eco-wellbeing performance is an upgrade of innovation efficiency. The emergence of innovation efficiency has led to a shift away from a focus on crude economic growth, and the introduction of eco-wellbeing has anchored the purpose of development in human beings themselves. Today, there is a consensus that cities are complex mega systems [62]. Therefore, the depletion of natural resources, economic development, technological innovation, and the wellbeing of people in cities can never exist separately from this system. It was not until Kiani Mavi et al. [63] used the two-stage network DEA to measure eco-efficiency and eco-innovation that a new way of thinking was opened to clarify this connection. Since then, many scholars have started to conduct studies using this approach, for example, Hou et al. [64] and Xia and Li [60] decomposed EWP into ecological economic efficiency and economic welfare efficiency. However, they usually only remain in a two-stage research paradigm [65][66][67][68]. The closest to the idea of this study is that of Zhang et al. [69], who measured eco-efficiency, eco-technological innovation, and eco-welfare performance in 102 countries, however, they still failed to link all three into the same framework. The final objective of urban development is the welfare of the people, while technological progress and innovation are only an intermediate process.

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