



Measurement of the ocean wealth of nations in China: An inclusive wealth approach

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ABSTRACT

Ocean GDP has been the dominant indicator for measuring ocean wealth and ocean economy development in China since the implementation of the *Ocean GDP Accounting System* in 2006. However, ocean GDP has indicated plenty of limitations over time, such as expressing excessive concern about material production rather than resource and environmental costs. Further, it is an income-based flow concept rather than a wealth-based stock accounting concept. This paper explores a new metric of measuring China's ocean wealth from the perspective of sustainable development. The inclusive wealth approach is introduced in the national ocean wealth measurement of China based on the expansion of the scope of the traditional concept of ocean wealth. In addition, the ocean manufactured capital, ocean human capital, ocean natural capital, the total value of ocean inclusive wealth, and the wealth composition are calculated. The results show that China's ocean inclusive wealth decreased over the years except for a slight growth in 2013 and 2014, and it is unsustainable as a whole. The value of ocean natural capital far exceeded ocean manufactured capital and ocean human capital. Although ocean manufactured capital and ocean human capital experienced an absolute growth, ocean natural capital declined notwithstanding its value, proportion or per capita value. Ocean inclusive wealth of China dropped at a higher rate when both CO₂ damage and demographic growth were taken into account. As compared to ocean GDP, the ocean inclusive wealth is much larger, but relatively stable.

1. Introduction

As one of the meta-problems of economics, early studies of the origin of national wealth can be traced back to Adam Smith's "*An Inquiry into the Nature and Causes of the Wealth of Nations*." [1] Gross domestic product (GDP) has been the benchmark of national wealth accounting since after World War II as suggested by Simon Kuznets. In 1953, the United Nations System of National Accounts (SNA) was established, which uses GDP as the fundamental indicator of the progress and economic performance of the nation. In 1993, China switched to the system of national accounts. However, GDP accounting has been indicating many limitations and thus, it is being challenged. First, it mainly focuses on market-based activities and excludes non-market aspects, such as natural capital, ecosystems, human capital, and health. Second, GDP measures short-term income flows and not long-term capital stock, which contradicts with the theory that wealth is a stock. All of these indicate that GDP cannot account for a country's real wealth. Moreover, GDP describes the size of an economy based on monetary value, which is susceptible to price fluctuations and excludes income

distribution, thus neglecting equity and sustainability. Later, many other indicators, such as the Human Development Index (HDI), green GDP and Happiness Index have emerged to fill the gaps in GDP. However, for various reasons, these indicators suffer from their own specific limitations in national wealth accounting.

In view of the limitations of traditional indicators, efforts have proliferated to develop new methods for national wealth accounting. The United Nations Statistics Division incorporated the environmental accounting to the national income accounting. The System of Environmental-Economic Accounts (SEEA) in 1993, and three of its revisions in 2003 and 2012, and in 2013 the SEEA Experimental Ecosystem Accounting (SEEA-EEA) were published. The SNA accounts are extended to include the natural resource assets in both physical and monetary terms. Then, the World Bank proposed the comprehensive wealth, that is, wealth is the sum of produced capital, natural capital and intangible capital [2,3]. This concept expanded the scope of traditional wealth. However, total wealth is estimated as the present value of future consumption by the World Bank, which is also a flow accounting method. Arrow and Dasgupta (e.g., [4,5]) presented the concept of inclusive wealth, which defines

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wealth as the shadow value of all capital assets (manufactured capital, human capital, natural capital, etc.). In other words, it is the weighted sum of a society's capital assets and their shadow prices. This conceptual framework captures all the capital assets a country can accumulate, which is called the productive base of the nation. Further, compared with other indicators, inclusive wealth is advantageous as it is a stock wealth. Therefore, it has gradually been accepted and widely used as a new measure of wealth accounting.

Ocean GDP was first developed in the United States in the 1970s with the purpose of measuring the value of the national ocean economy [6]. In 2006, China's State Oceanic Administration implemented the "Ocean GDP Accounting System." Since then, ocean GDP has been the dominant indicator used for measuring ocean economy development in China. However, in recent years, with the over-exploitation of marine resources and the damage to the marine environment, the sustainability of ocean economy is being increasingly challenged. Ocean GDP is claimed to exhibit flaws in the form of excessive attention to production and consumption activities and the consequent incapability of assessing the resource and environmental costs of ocean economy development. Additionally, as a flow concept, ocean GDP is mainly focused on short-term production and service values, with little consideration toward long-term development. Accordingly, this measurement provides no concrete answers to whether a country's ocean economy has great potential for development and whether it is sustainable for future generations. In view of this, it is imperative to overcome the limitations of the ocean GDP accounting framework and find a new metric for measuring ocean wealth values based on a long-term perspective of sustainable development.

Early research on inclusive wealth dates back to the relationship between sustainability, welfare, and wealth, which American economists Kenneth Arrow and Partha Dasgupta, professor of economics at the University of Cambridge have been working on to construct a theoretical framework since the early 21st century. The book *Human Well-Being and the Natural Environment* by Dasgupta [7] and two papers titled "Evaluating projects and assessing sustainable development in imperfect economics" (also known as the ADM model) by Arrow, Dasgupta and Mäler [8] and "Are We Consuming Too Much?" by Arrow et al. [4] are significant advances in the field of inclusive wealth. In 2007, Dasgupta formally put forward the term inclusive wealth for the first time [5].² Then, *Inclusive Wealth Report 2012* and *Inclusive Wealth Report 2014* were issued, led by Professor Dasgupta [10,11]. As regards the research on inclusive wealth, besides critiques and methodological considerations [12–15], a number of recent studies have pursued issues related to inclusive wealth, its theories and extensions, accounting methods, comparisons with other indicators, and policies for improving the national inclusive wealth. First, with regard to the categories of inclusive wealth, scholars have reached the consensus that inclusive wealth should be an aggregate measure of a society's productive base, which is defined as the stocks of all capital assets by Arrow et al. [4]. However, there have been great disputes and disagreements on the types of capital assets. A majority was inclined toward categorizing them into manufactured capital,³ human capital, and natural capital, while the remainder insisted that its scope can be extended to include social capital [9,16,17], health capital [18,19], financial capital [20,21], knowledge [22,23], institutions [22,23],⁴ population [23,24] and time

[18,23,25]. Second, as regards the theoretical foundations of inclusive wealth accounting, Arrow et al. [18] and Dasgupta and Duraïappah [23] put forward a formal model of inclusive wealth based on the sustainability criterion of intergenerational well-being to assess the shadow values of manufactured capital, human capital, and natural capital, with the shadow prices of various capital assets as their weights. Other studies extended the theory to incorporate the total factor productivity (TFP) [18,25–27], ecosystem services [28], resilience [29–32],⁵ health capital [25], linkages between capital stocks [33], population change and age distribution [18,24,34], transnational externalities [8,18,25,34], and future uncertainty [8,34]. Third, with regard to the empirical analysis of inclusive wealth, *Inclusive Wealth Report 2012* examined 20 countries for the period from 1990 to 2008, and then extended the study in the *Inclusive Wealth Report 2014* to include 140 countries in the period from 1990 to 2010 [10,11]. Moreover, based on the methodology of Arrow et al. [35], Ollivier and Giraud [36] explored Mozambique's inclusive wealth accounting for the period from 2000 to 2005 to assess the sustainability of the national development path. At a regional scale, Harris and Pearson [9], Walker et al. [31,32], and Pearson et al. [37] all applied the inclusive wealth approach in the Goulburn-Broken Catchment, Australia. The difference between these studies lies in whether or not resilience is focused. After that, a number of case studies were carried out at regional and sub-regional scales, such as in Nova Scotia's protected areas [38] and the state of West Virginia in the US [39]. Further, inclusive wealth and two other separately developed approaches, Satoumi and ecosystem services approach (ESA), were integrated as a new sustainability assessment framework in the regional-scale integrated coastal zone management of the Seto Inland Sea in Japan [40,41]. Furthermore, as compared to these measurements mentioned above, other studies tend to focus on the contributions of some important factors in maintaining an increase in inclusive wealth. Sato, Tanaka and Managi [27] focused on total factor productivity and proposed an IW-based TFP approach measuring the contribution of TFP to inclusive wealth. Yamaguchi and Shin [42] demonstrated how institutions can foster inclusive wealth with corruption control as an example. Meanwhile, the role of satoyama landscapes in Japan as well as the international mining firms in deterring the increase in inclusive wealth was investigated empirically [20,43]. Fourth, empirical comparisons with other indicators were also given considerable attention, such as comparison between GDP, human development index (HDI), and inclusive wealth (IW); comprehensive wealth (CW) accounting by the World Bank and inclusive wealth accounting; and GDP-based TFP and IW-based TFP [10,11,27,44]. Finally, some researchers argued that the inclusive wealth framework can be applied as a tool in policy planning and evaluation, including investment policies of the United Nations [45], water and energy infrastructure policy of the Kingdom of Saudi Arabia [46], and electricity infrastructure policies of oil-exporting countries [47]. Moreover, Yamaguchi and Managi [48] proposed that inclusive wealth-linked bonds can be a new financing instrument for sustainable development.

On the other hand, in terms of national ocean wealth accounting, the first measurement of the ocean's contribution to the U.S. economy based on ocean-GDP was by the Bureau of Economic Analysis (BEA), which also estimated the gross product of ocean-related activities and its contribution to the gross national product (GNP) [6]. Pontecorvo et al. [49] and Pontecorvo [50] also conducted similar studies on the contribution of the ocean sector based on 66 industrial sectors in the national income accounts. After the 1990s, national income accounting gradually became the benchmark in the measurement of ocean wealth. The academia and many governmental organizations specifically focused on the quantitative estimation of the values of ocean sectors and

² Inclusive wealth is referred to comprehensive wealth in Arrow and Dasgupta's early works (e.g., [4,8]). Despite the same name, the definition of the term differs from "comprehensive wealth" as defined by the World Bank. In fact, the term "inclusive wealth" first appeared in Harris and Pearson [9]. However, the first formal definition of inclusive wealth is generally accepted from Dasgupta [5].

³ Manufactured capital is also called as reproducible capital or produced capital.

⁴ Dasgupta [22] believed that institutions and capital assets comprise an economy's productive base, but institutions are different from capital assets. In contrast, Dasgupta and Duraïappah [23] demonstrated that institutions themselves are capital assets (called institutional capital).

⁵ Resilience is "the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks" [30].

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