Data Article

Environmental Loss Assessment using Green Gross Domestic Product (GDP)

ABSTRACT

Numerous factors, such as expanding agricultural activity, altered land use patterns that boosted emissions of methane and nitrous oxide as well as other greenhouse gases, automobile use, etc., are to blame for the wide range of weather conditions in India's climate system. The enormous and underestimated effects of climate change on the natural system must be quantified through changes in extreme weather. The farming community is forced to change planting patterns and seasons due to extreme weather, which has a profoundly detrimental economic impact on the agriculture system. Farmers use more inorganic fertilizers and engage in other activities that would raise methane and nitrous oxide emissions, which are reflected in the damaged environment, in an effort to prevent the fertile land from degrading due to climatic extremes and to improve output. The economic damage brought on by the extreme weather is unprecedentedly great, and its calculation is difficult and uncertain. The Green GDP concept was created by China in 2004 to account for the economic damages to the environment as a result of climate change. The paper's goal is to calculate India's Green GDP and investigate the impact of economic openness on both GDP and Green GDP. The World Bank Database, the Ministry of Statistics and Programme Implementation, the OECD, Energy Statistics India 2021, and the Carbon Disclosure Project, India 2020, were just a few of the sources from which information was gathered for the paper. Multiple linear regression, Growth Rate, Economic Openness Index, and the Green GDP estimation method are employed. In order to compute the Green GDP indicator for the years 2011 to 2020, the GDP measure is subtracted from the costs associated with the utilisation of natural resources and environmental degradation. According to the outcome, the cost of environmental damage will decline from 11% in 2011 to 9% in 2020. Cost of environmental damage growth rate was -3.07 percent. From the estimates of the Green GDP, economic loss due to GHG emission is around 9-11 % of the GDP.

Keywords: Climate Change, Economic Openness Index, Economic loss, Environmental Damage, Green GDP.

INTRODUCTION

~~(~~GDP~~)~~ is a widely used measure to estimate the growth of the economy over a long period and is most commonly called "the monetary value of final goods and services—that is, those that are bought by the final user—produced in a country in a given period of time (say a quarter or a year)". It counts all the output generated within the borders of a country. GDP is composed of goods and services produced for sale in the market and also includes some nonmarket production, such as defense or education services provided by the government (Callen, 2008). India stands in 6th position in terms of nominal GDP and 3rd position in terms of Purchasing Power Parity. Despite having a number of benefits, the old method of calculating economic growth, known as GDP, has a significant drawback in that many of the inputs and outputs that are commonly utilized to produce goods and acquisitions by consumers for satisfaction, such as natural ecosystems, are not included (NRC, 1999)

~~-~~Many scientists have made various attempts to create a new model of economic growth with an emphasis on incorporating a natural accounting system to address the shortcomings of current GDP and have created a number of green national accounts. The proponents of 'green' national accounts believe that new or corrected national accounting aggregates can be used to change both policies with respect to the environment and broader economic policies with environment and broader economic policies with environmental consequences (Reppetto, 1989). Green GDP is an new model of economic measure approach which includes the environemental damage and its cost and environemental value. The strength of these green GDP accounting is considering the ecosystem value in traditional GDP economic measure and to easily recognize the sustainability of our economy. Index of Sustainable Economic Welfare (ISEW) and the Genuine Progress Indicator (GPI) are the two green GDP measuring systems. C~~c~~ountries with ISEW data include Austria, Chile, Germany, Italy etc. W~~w~~hile the United States and Australia are nations addressed by GPI (Neumayer, 2000)~~.~~. t~~T~~he use of these new accounting techniques reveals an increasing disparity between traditional and green GDP, implying that, over time, more and more economic activity may become self-canceling in terms of welfare~~.~~ (Max-Neef, 1995). ~~One of the paper's conclusions is that green accounting aggregates will be key inputs to growth and development policies, although perhaps not in the form initially envisioned.~~

-Acceptance of theoretical concerns and estimating issues, inability to meet the data requirements, and other factors are preventing numerous governments from adopting the Green GDP metric. According to several studies, more open trade regimes have the potential to increase economic growth by enhancing the total factor productivity of the economy , ~~for instance.~~ (Dar and Amirkhalkhali, 2003). There is evidence that increased openness is associated with deteriorating socioeconomic conditions and a higher amount of greenhouse gas emissions, as well as a disparity in income. (Baten and Fraunholz, 2004; Managi, 2004). In this paper, green GDP and its growth rate for India are calculated by using time-series data for 2011-2020. The openness index is also estimated and its effects on Green GDP are tested.

The plan of the paper is: (1) to compute the Green GDP for India and (2) to test the relationship between economic openness on Green GDP per capita.

METHODOLOGY

The following sections describe methods to estimate the green GDP and Openness Index. After characterizing the methods in general form, we used the secondary data collected from various sources and estimated the Green GDP for India. The details of the data and their secondary sources are given in the Table.1

Table.1: Details of variables and their data sources

Variables	Data sources
Gross Domestic Product (GDP)	Ministry of Statistics and Programme Implementation, Government of India
CO_2 Emission	World Bank Database
Gross National Income (GNI)	World Bank Database
Natural Resource Depletion (NRD)	World Bank Database
Population	World Bank Database
Carbon Pricing	Carbon Disclosure Project, India Report 2020 & OECD
Energy production	Energy statistics India 2021

GREEN GDP

By ensuring what is applicable methodology and accurate information for the assessment of economic progress, Stjepanovic suggested a radical change in how we think about sustainability and green development. For assessing and comparing the economies of different countries, they applied a general methodological algorithm. Green GDP is calculated as deducting the cost of natural resource consumption and cost of environmental depletion from GDP measure. But they approached Green GDP by separating the real costs of environmental damage and opportunity costs of a lost turnover. Data unavailability was a major obstacle in achieving more extensive work on green GDP. Calculation scheme in general (presented by Stjepanovic, Tomic, and Skare, 2017) is

$$\text{Green GDP} = \text{GDP} - (Kt CO_2 * P_C) - (\text{Ewaste} * 74\ \text{kWh} * P_{kWh}) - (\text{GNI}/100 * \%\ \text{NRD})$$

Where,

- $K_t CO_2$ - CO_2 emissions expressed as kilo tonnes
- E_{waste} - Total commercial and industrial trash in tonnes
- GNI - Sum of value added by all resident producers plus any product taxes
- NRD - Variable adjusted savings of natural resource depletion
- P_{kWh} - Price in PPP for 1 kilowatt-hour
- P_C - Price for carbon

ECONOMIC OPENNESS INDEX

According to the theoretical literature, trade openness is critical to the process of economic growth in emerging countries. For a variety of reasons, trade openness is an important component of intellectual and policy debate. First, trade openness is an important component of the structural adjustment programmes implemented in many developing nations by the World Bank and the International Monetary Fund. Second, many empirical research have suggested that trade openness is important for economic growth via the exports-led growth hypothesis and the import-led growth hypothesis (see Balassa 1985; Ram 1987; Bhagwati 1978; Greenaway, Nam 1988; Salvatore, Hatcher 1992; Awokuse 2007, 2008; Mishra et al. 2010; Hye, Boubaker 2011; Shahbaz et al. 2011). Non-domestic transactions (imports and exports) have a significant impact on the size and growth of a country's economy. Exports plus imports as a percentage of GDP is used to compute the Economic Openness Index. Economic openness is associated with higher

productivity in countries. Moreover, countries that have improved their economic openness have seen the greatest gains in production.

$$\text{Economic Openness Index} = \frac{X+M}{GDP} * 100$$

RESULTS AND DISCUSSION

Results from Table.2 present the green GDP, cost, and percentage of environmental damage for India from the year 2011-2020. The green GDP for the year 2011 was 161934 US$ and it increased to 237897 US$ in 2020. The cost of environmental damage was increased to 24400 US$ in 2020 from 20370 US$ in 2011. But, the damage cost which is present as per cent of GDP is diminished over the years from 11.17 in 2011 to 9.30 in 2020.

Table.2: Green GDP and Environmental Damage Cost of India *(In Billion)*

Year	GDP (Current US$)	Green GDP (Current US$)	Cost of environmental damage (US$)	Damage Cost(% of GDP)
2011	182304.99	161934.02	20370.97	11.17
2012	182763.78	162149.81	20613.97	11.27
2013	185672.21	164719.18	20953.02	11.28
2014	203912.74	181893.67	22019.07	10.79
2015	210358.78	189224.91	21133.86	10.04
2016	229479.79	207971.41	21508.38	9.37
2017	265147.29	242213.02	22934.27	8.64
2018	270111.17	245475.92	24635.26	9.12
2019	287050.40	261679.70	25370.71	8.83
2020	262298.37	237897.44	24400.93	9.30

The Growth Rate (GR) of GDP, Green GDP, and cost of environmental damage was shown in figure.1. The graph shows that the growth rate of GDP, green GDP, and cost of environmental damage were 5.72, 6.09, and -3.07 respectively. During the recent time period, GDP growth and Green GDP growth haven't differed dramatically. The negative growth of GDP and green GDP in 2020 shows the covid pandemic overall the country. Accordingly, we may conclude that environmental quality has been sacrificed in order to achieve higher economic growth rates and greater benefits.

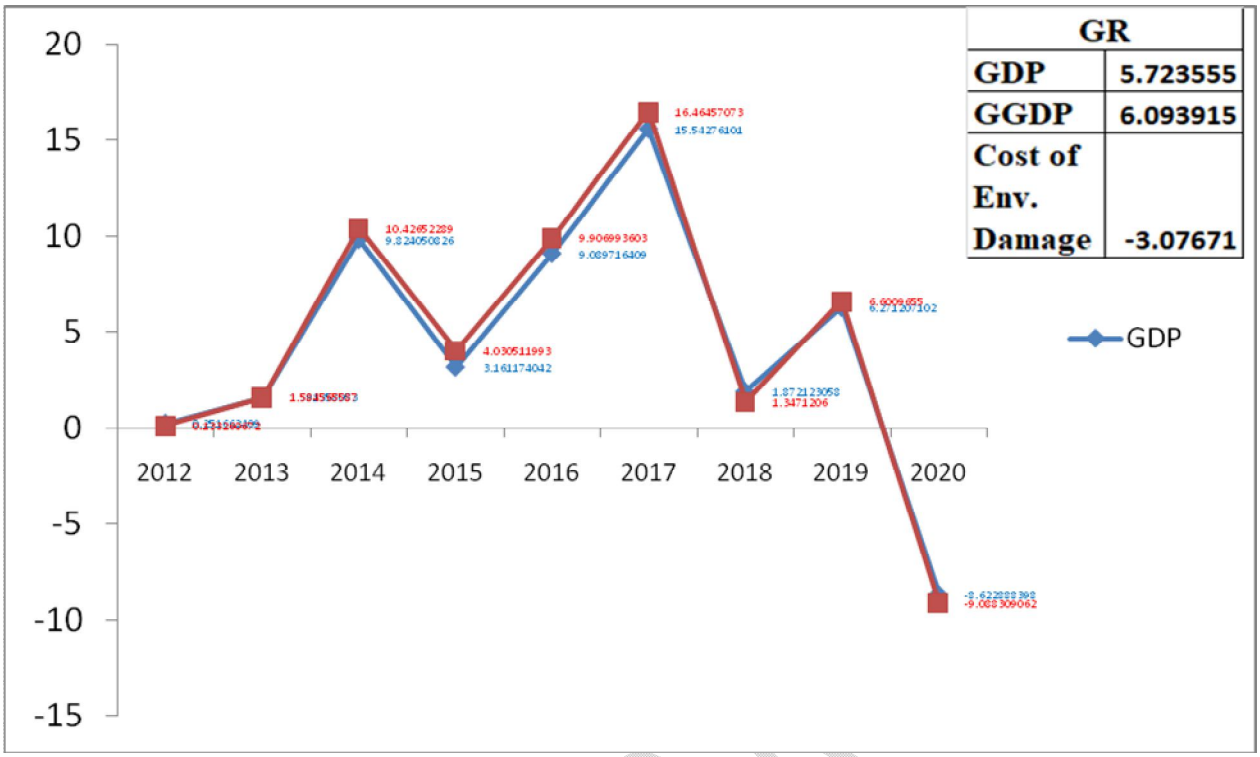


Figure.1: Growth rate of GDP and Green GDP

Table 3: Yearwise Openness index

Year	Openness Index
2011	55.62388001
2012	55.79372173
2013	53.84413195
2014	48.92218575
2015	41.92291387
2016	40.08248571
2017	40.74249695
2018	43.59865716
2019	39.38677104
2020	36.46988337

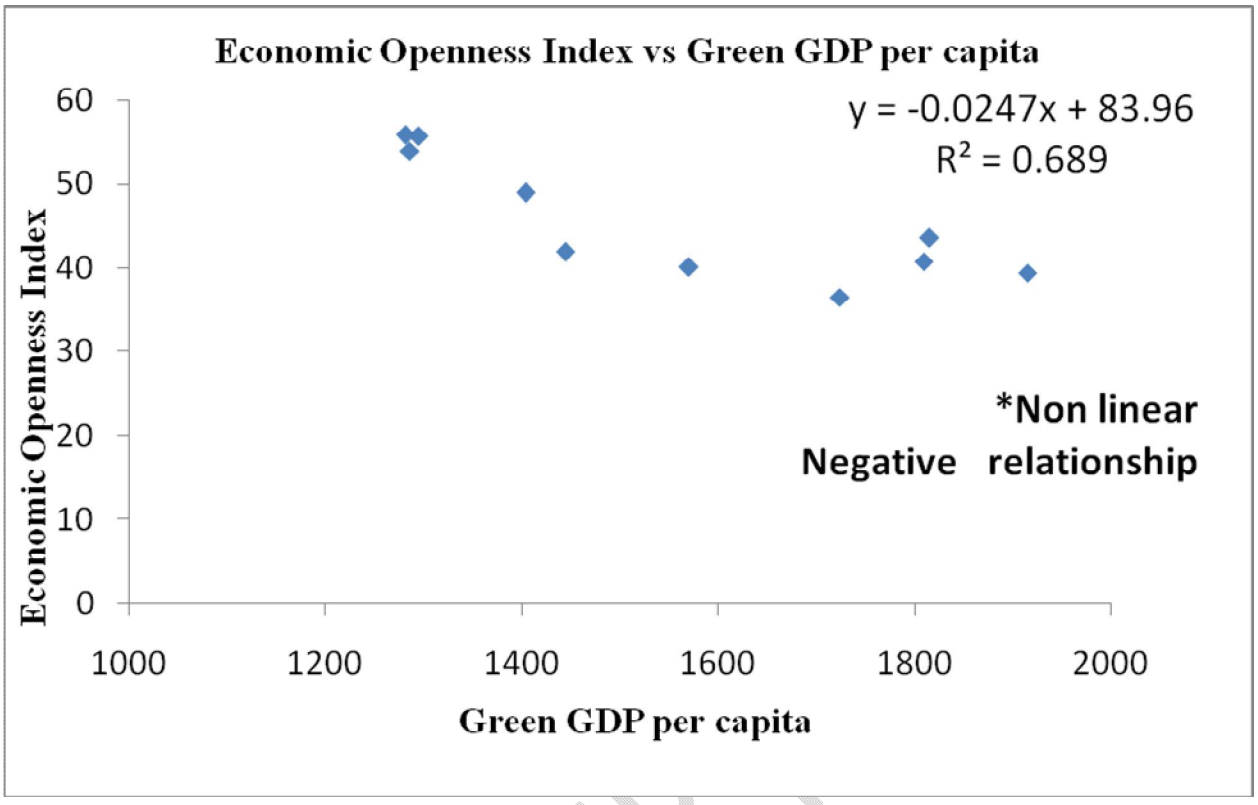
ECONOMIC OR TRADE OPENNESS INDEX

The Economic Openness Index was 55.62 in the year 2011 and it is gradually declining and attained 36.46 in the year 2020. The higher the index, the greater the impact of trade on domestic activities and the more powerful the economy of that country.

RELATIONSHIP BETWEEN OPENNESS INDEX AND GREEN GDP PER CAPIT

The relationship between Economic Openness Index and Green GDP per capita shows a strong, non-linear, negative correlation and relationship. The relationship proves the various past studies' conclusions between the two. The relationship indicates that more and more economic openness will move the green GDP to the diminishing side.

Figure.2: Relationship between Economic Openness and Green GDP per capita



CONCLUSION

By modifying standard GDP metrics for natural resource depletion or pollution, a realistic picture of green growth and development, known as a green GDP assessment, can be obtained. ~~Green GDP cannot replace standard GDP statistics due to methodological constraints and a lack of interpretation. Become a gauge of public awareness via which a slew of public figures attempt to impose new, ecologically oriented policy orientations. Although green GDP accounting is not yet a commonly acknowledged notion due to its methodological complexity and complication, advances in ideas and approaches are continuing. It will be a difficult effort, particularly in the area of statistics, because many industrialised and developing countries still lack important statistics.~~

Due to methodological limitations and a lack of interpretation, green GDP cannot take the place of traditional GDP to become a barometer of popular consciousness via which a host of public leaders try to impose new, environmentally conscious policy philosophies. In addition due to methodological complication, green GDP accounting is not yet a widely accepted concept,

although concepts and techniques are still evolving. It will be a challenging effort, especially in the domain of statistics, as many developed and developing nations still lack crucial statistical approaches and data.

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