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SUSTAINABILITY AND GDP: CONVERGING OR DIVERGING? - AN ECONOMETRIC ANALYSIS

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ABSTRACT

The normative context suggests that GDP and Sustainability must complement each other as against the positive theory that brings in the confoundment regarding the two aspects being complement to each other. Sustainability is how a particular system remains diverse and productive. It thrives to make the system long lived and healthy. The underlying principle is to enhance the endurance of the existing processes so as to make proper space for the future requirements. Over last few decades, sustainability has promptly become prerogative issue for the economists, policy makers, environmentalists, and corporates. The main challenge in this embryonic arena is to gauge the impact of sustainability on every aspect of our economy. We have seen exceptionally good GDP figures in the recent years. This paper attempts to understand the linkages between GDP, the most common measure of economic growth and sustainability. The 2005 World Summit on Social Development identified three pillars of sustainable development, such as economic development, social development and environmental protection. For the purpose of our study, around 17 variables from these three different clusters have been analyzed using time series analysis and the variables with most significant impact have been considered to construct a robust economic model to understand the impact of these three pillars of sustainability on GDP. This paper concludes by suggesting that National authorities should endeavor to promote the internalization of sustainability costs so as to make GDP a better measure. Our analysis leads us to the conclusion that a self-sufficient and self-explanatory measure is desirable to ensure incorporation of sustainability and consistent growth in order to reflect true well-being of our economy. With the introduction of Green GDP in the current Five Year Plan, it can be expected that this measure fulfils all expectations.

KEYWORDS: GDP, Sustainability, Green GDP, Economy, Society and Environment.

1. INTRODUCTION

With reference to the World Value Survey, 2014, conducted across 80 countries, there's a strong Indian public opinion amongst half of the people interviewed that India should focus on its economic growth even if it comes at the expense of the environment. This illustrates the lack of concern for environmental protection amongst general populace. There's no denying the fact that same behavior can be attributed to the policy decision makers. In fact, this opinion is the outcome of the *growth versus environment* debate in India. With India's ranking at 155 out of 178 countries on Yale University's Environment Performance Index, it is pretty obvious that there are hardly any measures that have been taken up by the policy makers to improve our condition. Apparently, the whole idea of Sustainability has been subjugated. The main challenge has been to gauge the concept of sustainability in every aspect of our economy. On the contrary, for years and decades sustainability has either been viewed from the economic lens only, ignoring the other two pillars- social and environment perspective or been attributed diverse meanings. Sustainability means managing diligently and ardently, and ensuring that the social, economic and environmental factors are considered in the decisions to fortify long-term success of an economy. Sustainability is how a particular system remains diverse and productive. It thrives to make the system long lived and healthy. The underlying principle is to enhance the endurance of the existing processes so as to make proper space for the future requirements. In no way, only the economic factors are going to make our economy conducive for the coming generations. The economy is one of the "three pillars" by which the aim of sustainable development should be pursued.

With sustainability as the focus of academic as well as national and international level policy research, there still exist divergent viewpoints as to what measures sustainability. In this context, it is imperative to work out the empirical evidences if GDP, the most widely used measure of growth of an economy and sustainability, which ought to be inclusive of social, economic and environmental development are converging or diverging.

2. LITERATURE REVIEW

In the ensuing decades, mainstream sustainable development thinking was progressively developed through the World Conservation Strategy (1980), the Brundtland Report (1987) and the United Nations Conferences on Environment and Development (1992), as well as in national government planning and wider engagement from business leaders and non-governmental organizations of all kinds. The idea of sustainable development has gained prominent importance for academicians, researchers, environmentalists and international organizations forming new grounds for improving the standard of living of people. The concept of sustainability was coined explicitly to suggest that it was possible to achieve economic growth and industrialization without environmental damage

The Brundtland Report (1987) defined sustainable development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. This definition was simple but not very explicit as it cleverly captured only two fundamental issues, the problem of the environmental degradation that so commonly accompanies economic growth, and yet the need for such growth to alleviate poverty.

Thus, the core of mainstream sustainability thinking has become the idea of three dimensions, environmental, social and economic sustainability. The idea of sustainability can be represented visually as the convergence of economic, social and environmental factors below:

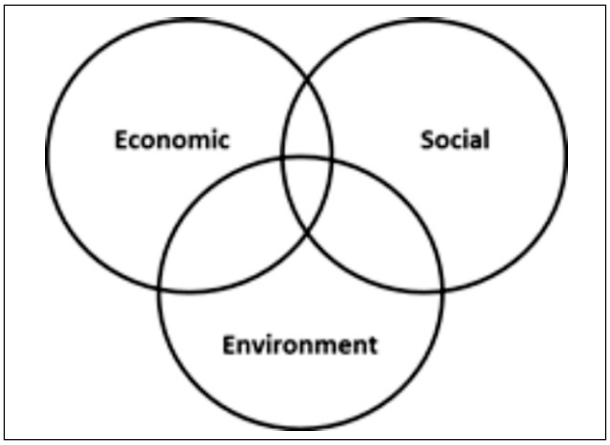

Figure 1: Concept of Sustainability

Although the phrase sustainable development carries a simple message, but has progressed to cover a complex range of ideas and meanings. Environmentalists, governments, economic and political planners and business people use 'sustainability' or 'sustainable development' to express sometimes very diverse visions of how economy and environment should be managed. This wide conceptual acceptance is the reason why even after 30 years of the emergence of the concept, still economist argues about what it actually means. As Solow (2000) puts forth, 'Sustainability is a matter of distributional equity between the present and the future."

In this section we will discuss these existing different visions and their inferences.

Taking the idea of sustainability forward we observe theoretical considerations on the idea of sustainability.

Three seminal contributions to the economic theory of sustainability were provided by Dasgupta and Heal (1974), Solow (1974) and Stiglitz (1974). Their models denoted sustainability to be wellbeing over time in terms of welfare maximisation. The underlying notion of the analysis what to measure the extent to which the economic growth process is restricted with the finiteness of natural resources. Utility can be either constant (Solow 1974; Stiglitz 1974) or declining (Dasgupta and Heal, 1974) over time depending on what is assumed about the capital stock, technological progress, and the rate at which future utility is discounted.

Different dimension to the same topic was advanced by neoclassical economics perspective of sustainability which is rooted with the idea that, 'what is to be sustained is income to be used for consumption of goods and services'. According to Hicks (1946:172) 'the purpose of income calculation in practical affairs is to give people an indication of the amount which they can consume without impoverishing themselves.' What can be inferred from this statement is that he meant sustainable net national income as the amount which can be spent on regular basis without causing impoverishment in some future period.

Another major contribution to the field was bestowed by Hartwick (1977) when he formulated a general rule for sustainability, known as Hatwick Sustainability Rule. The rule was originally formulated as, "Invest all profits or rents from exhaustible resources in reproducible capital such as machines. This injunction seems to solve the ethical problem of the current generation shortchanging future generations by "overconsuming" the current product, partly ascribable to current use of exhaustible resources." Hence the focus of concern is on the prudent use of the return or savings derived from the resources, rather than the depletion of these resources. The rule serves as a useful prescriptive rule for sustainability.

Böhringer and Löschel(2004) computed a general equilibrium models as a methodological tool that is particularly suitable for measuring the impacts of policy interference on the three dimensions of sustainable development. These dimensions are inherently intertwined and subject to trade-offs. The extent to which policy instruments alter sustainable development indicators depends crucially on the responsiveness of supply and demand with respect to price changes. Due to the reliance on exogenous elasticity values and a single base-year observation, comprehensive sensitivity analysis on key elasticities and possibly alternative assumptions on economic incentives should be performed before concrete policy recommendations are derived. According to them even after altering the model and make both strong and weak linkages with different factors, the objective of a sustainable future needs a comprehensive methodology to perform Sustainable development analysis quantitatively.

Adams (2006) in his paper explored the key arguments of International Union for Conservation of Nature and Natural Resources (IUCN) meeting and discussed about the next steps towards rethinking sustainability. According to him, the three pillar concept implies that trade-offs are always be made between environmental, social and economic dimensions of sustainability. He differentiated and enlightened the concept of society and economy. According to him the three 'pillars' cannot be treated as equivalent and the tradeoff emerges because of the different connection of these three pillar with economy and society. The tradeoff emerged because the economy is an institution that emerges from society: these are in many ways the same, the one a mechanism or set of rules created by society to mediate the exchange of economic goods or value. The environment is different, since it is not created by society. The important point here is the environment underpins both society and economy.

Adams (2006) suggests that to make things parallel between these two different concepts and reduction of tradeoff demand a proper matrix which can showcase the linkage and the extent of tradeoff. Since there is no agreed way of defining the extent to which sustainability is being achieved in any policy program, often sustainable development ends up being development as usual, with a brief embarrassment kneeling towards the desirability of sustainability. The important matter of principle therefore becomes a victim of the desire to set targets and measure progress. The present concepts of sustainability and sustainable development are clearly inadequate to drive the transitions necessary to adapt human relations with the rest of the biosphere for the future. As currently formulated they are too loose to drive effective change on the scale required.

Adelle and Pallemaerts (2009) after extensive review of around 40 research projects on sustainable development indicators constructed a set of sustainable development indicators. Recommendations of their study constituted rethinking and restructuring of landscape of sustainable development indicators in certain areas, such as the governmental area as the organization of the existing indicators was highly contestable.

Sustainable development is a broad concept and for measuring it several different indicators have been developed. Tasaki (2010) identified 1790 indicators of sustainability and classified them into 77 sub-categories and further into four headline categories. He suggested creation of time-conscious indicators, measurement of interactions between elements of a system, confrontation of transboundary issues, evaluation of quality and revelation of relation between everyday life and sustainable development.

Few economists argues that the need is to modify the indicator of growth since GDP cannot capture the sustainable development path, and neither GDP nor NDP in the conventional national accounting can be counted upon as a yardstick for the calculation of social welfare (Mobariz, 2013).

3. DATA AND METHODOLOGY:

Taking into account that we intend to investigate the relationship between GDP and sustainability, we consider annual GDP as the dependent variable. We analyze data from 1991 to 2012.

Our first and the foremost step is to frame the hypothesis:

H_0 = GDP and Sustainability are Diverging in nature

H_A = GDP and Sustainability are Converging in nature

Considering that the fundamental purpose of our research i.e. to assess the relationship between GDP and sustainability, we should select a representative and reliable set of sustainable development indicators. Indeed, there is not a general consensus among the researchers as far as the defined set of sustainable indicators is concerned. International organizations and empirical and meta-analytic studies present an array of alternative sustainable development indicators, while in many cases the suggested indicators are hundreds. What is more, in almost all the published research work the need for a defined conceptual framework of sustainability and the determination of an optimal set of representative indicators are noted. We draw our indicators from the Brundtland Report classification of sustainability into three pillars- Economic, Social and Environment. Although many authors assess the theoretical basis and methodological background of the indicators and classification, our study attempts to link the suggested indicators with GDP rates through the application of an econometric analysis.

There were few indicators on which no sufficient data was available and which were thus excluded from our analysis. The data has been collected form the World Bank Database. In order to facilitate the analysis of results, we classify the above indicators into 3 groups as depicted in the table:

Economic Indicators	Industry Value Added (% of GDP), Inflation Consumer Prices, Central Government Debt and Exports of Goods and Services
Social Indicators	Unemployment, Life Expectancy at birth, Mortality Rate(under 5), Death rate, Fertility Rate, Improved Water Resources((% of population with access), Improved Sanitation Resources(% of population with access)
Environmental Indicators	Renewable Electricity Output (% of total electricity output), Renewable Energy Consumption (% of total energy consumption), Total Green House Gases Emissions (kt of CO2 emissions), Adjusted Net Savings, Forest land Area (% of Total Land), Natural resource Depletion (% of GNI)

Considering the data set, since there were 17 variables across three pillars, standardized scores of these variables were developed to construct pillar wise index. As a consequence, three indexes namely, Economic Index, Social Index and Environmental Index were constructed. Thereafter, time series analysis has been done using three models mentioned in the next section. In the present study Dicky Fuller unit root test is performed with the intention to test the stationarity of the examined series. We have also performed the tests for Durbin Watson test for autocorrelation and Breusch-Pagan / Cook-Weisberg test for heteroscedasticity.
The above analysis examined the selection of data used in our sample and clarified the components on which the separation of the models was made. Moreover, the methodology used is briefly analyzed. Subsequently, there is a need to conclude our analysis into the preferable model in order to accept/reject our hypothesis. . In the Section that follows, a brief description of the preferred model will be made and further justification for the models is presented.

4. RESULTS AND ANALYSIS

This section presents the empirical results of the econometric analysis regarding the influence of sustainable development indicators on GDP.

H_0 = GDP and Sustainability are Diverging in nature

H_A = GDP and Sustainability are Converging in nature

In order to understand the relationship and effect of different indicators of sustainability on GDP over the period of time, we have used three models.

Model 1

$$GDP = a_i + b_i\,Social\ Index + c_i\ Environmental\ Index + d_i\,Economic\ Index \quad \text{.....(I)}$$

Here, GDP represents dependent Variable and indicators of sustainability are the independent variable. The table summarizes the results of Multiple Regression.

Table 2: Multiple Regression Model					
Source	**SS**	**df MS**	**Number of obs**	**= 22**	
		F(3, 18)	= 5.16		
Model	42.4917025	3 14.1639008	Prob > F	= 0.0095	
Residual	49.3832993	18 2.74351663	R-squared	= 0.4625	
		Adj R-squared	= 0.3729		
Total	91.8750018	21 4.37500008	Root MSE	= 1.6564	

Gdp	**Coef.**	**Std. Err. T**	**P>t**	**[95% Conf.**	**Interval]**
socialindex	.1485558	.1953516 0.76	0.457	-.2618627	.5589744
environmen~x	.182436	.2670116 0.68	0.503	-.3785345	.7434064
economicin~x	.6938894	.3165376 2.19	0.042	.0288686	1.35891
_cons	6.733143	.3735278 18.03	0.000	5.94839	7.517895

Considering the statistics of the performed equation, we observe low R-squared and Adjusted R-squared values .This implies that the all the three indicators of sustainability together do not have any significant impact on GDP. The p-value of economic index is less than the common alpha value i.e 0.1, this depicts that the economic index has a significant impact on GDP. However in contrast, the other two indicators of sustainability are much higher than the critical value of 0.1 and hence experience insignificant impact on GDP.

The results are in line with our proposition that when we talk about growth and sustainability in calculation of GDP only economic factors holds major consideration with social and environmental factors being ignored to a great extent. As shown in the table coefficients all three indicators are positive as expected and supported by theory, however, the coefficient of economic index is higher than the other two indices.

Model 2

To make the model more robust we use the AR(1) regression model to understand the linkage of sustainability and GDP.

$$GDP = a_i + b_{i1}\,Social\ Index_i + c_{i1}\,Environmental\ Index_i + d_{i1}\,Economic\ Index_i + b_{i2}\,Social\ Index_{i-1} + c_{i1}\,Environmental\ Index_{i-1} + d_{i1}\,Economic\ Index_{i-1}$$

……(ii)

Table 3: Autoregressive Model					
Source	**SS**	**df MS**	**Number of obs**	**= 21**	
		F(6, 14)	= 2.60		
Model	47.4108264	6 7.90180441	Prob > F	= 0.0660	
Residual	42.5548901	14 3.03963501	R-squared	= 0.5270	
		Adj R-squared	= 0.3243		
Total	89.9657165	20 4.49828583	Root MSE	= 1.7435	

Gdp	**Coef.**	**Std. Err. T**	**P>t**	**[95% Conf.**	**Interval]**
Socialindex	.0545595	.4072425 0.13	0.895	-.8188889	.9280079
environmen~x	.5865291	.4102227 1.43	0.175	-.293311	1.466369
economicin~x	.6249413	.3554372 1.76	0.101	-.1373957	1.387278
lagsociali~x	.5013288	.4800628 1.04	0.314	-.5283035	1.530961
lagenviron~x	.3166669	.5197807 0.61	0.552	-.7981519	1.431486
lageconomi~x	.4306245	.4418032 0.97	0.346	-.516949	1.378198
_cons	7.245237	.6262104 11.57	0.000	5.902149	8.588325

Similar to Model 1, this model too has low R-squared and Adjusted R-squared values and hence the result of Model 2 is similar to the result of model 1, the only difference being that the P values of all the independent variables are insignificant and we can strongly accept our null hypothesis that both the variables, GDP and sustainability are diverging with time.

Model 3

However, as we know that a linear regression only works with observed variables while ARIMA incorporates unobserved variables in the moving average part; thus, ARIMA is more flexible, or more general. AR model can be seen as a linear regression model. Meanwhile, MA models do not fit into the OLS framework since some of the variables, namely the lagged error terms, are unobserved, and hence the OLS estimator is infeasible. Hence, to incorporate the unobserved variables into our study we using ARIMA model:

$$GDP = a_i + b_{i1}\,Social\ Index_i + c_{i1}\,Environmental\ Index_i + d_{i1}\,Economic\ Index_i + b_{i2}\,Social\ Index_{i-1} + c_{i1}\,Environmental\ Index_{i-1} + d_{i1}\,Economic\ Index_{i-1} + k_{i1}GDP_{i-1}$$

……(iii)

Table 4: ARIMA Model					
Source	**SS**	**df MS**	**Number of obs**	**= 21**	
		F(7, 13)	= 2.08		
Model	47.5136045	7 6.78765778	Prob > F	= 0.1208	
Residual	42.452112	13 3.26554708	R-squared	= 0.5281	
		Adj R-squared	= 0.2740		
Total	89.9657165	20 4.49828583	Root MSE	= 1.8071	
Gdp	**Coef.**	**Std. Err. T**	**P>t**	**[95% Conf.**	**Interval]**
Socialindex	.0608877	.4236094 0.14	0.888	-.8542648	.9760401
environmen~x	.6143983	.4532852 1.36	0.198	-.3648648	1.593661
economicin~x	.623576	.3684893 1.69	0.114	-.1724967	1.419649
lagsociali~x	.5034799	.4977304 1.01	0.330	-.5718013	1.578761
lagenviron~x	.2978238	.5491203 0.54	0.597	-.8884784	1.484126
lageconomi~x	.4893004	.5648775 0.87	0.402	-.7310431	1.709644
Laggdp	-.05678	.3200538 -0.18	0.862	-.7482141	.6346542
_cons	7.651412	2.379725 3.22	0.007	2.510329	12.79249

Now Table 3 gives us the final robust model after considering both observed and unobserved values. The results are similar to the results of Model 2. All the P values are insignificant with low R squared and Adjusted R Squared values. Hence, we do not reject our null hypothesis: both GDP and Sustainability are diverging.

Last but not the least to assess the model fit, we test autocorrelation and heteroscedasticity:

Table 5: Durbin Watson Statistics

Dwstat	
Durbin-Watson	d-statistic(8, 21) = 1.750907

Since d statistics lies in acceptable range, there is no autocorrelation

Table 6: Breusch-Pagan / Cook-Weisberg test for heteroscedasticity

Hettest
Ho: Constant variance
Variables: fitted values of gdp
chi2(1) = 0.42
Prob > chi2 = 0.5168

As Prob >chi2 = 0.51, is greater than 0.1, thus we will not reject our null hypothesis at 10% level of significance and thus above model does not suffers from problem of heteroscedasticity.

Table 7: Dickey-Fuller test for unit root

dfuller error				
Number of obs = 20				
---------- Interpolated Dickey-Fuller ---------				
	Test 1%	**Critical 5%**	**Critical 10%**	**Critical**
Z(t)	-2.579	-3.750	-3.000	-2.630
* MacKinnon approximate p-value for Z(t) = 0.0974				

Since the Statistical Z values are less than the critical value, no unit root exist. The empirical results of the prevailing model demonstrate the statistical insignificance of indicators of sustainability to GDP growth rate.

5. CONCLUSION

Since economic liberalization sustainable development was not a key priority in India's goals for economic development. It is over time that the need for a sustainable was realized. This paper was an attempt to draw the attention on the relationship between GDP and sustainability.

After employing 3 different models linear regression, AR (1) and ARIMA model our results show that GDP and sustainability are diverging in nature. The value of goods and services which are being produced in our country is increasing but it is coming as a cost on the environment. There is an urgent need to measure the tradeoff between economic development and environmental damage. The issue of sustainability and GDP is not a new topic, it has been in debate for past many years now. The main problem lies with the easy concept of sustainability as the concept is very flexible and wide that every policy maker and analyst tries to adjust its meaning as per their own ease and this is one of the main reasons why no equilibrium has been attained in this field. In this paper we have tried to capture one of the major problems of absence of one variable by making an index and capturing its impact. The idea of sustainable development must be complemented with transparent and participatory mechanisms wherein all the parties affected in the process can participate in decision making. Usages of green products, becoming more energy efficient, reducing wastage, reduced coal dependence, shift to cleaner technologies, increased resource efficiency, environmentally aware consumers are some of the ways of reducing the environmental footprint.

Under country's chief statistician Pronab Sen, an exercise has been started in the year 2015 to adjust India's GDP with economic costs of environmental degradations. India is moving in the direction of greener economy and strengthening India's position as emerging leader in International environmental initiatives as well. Achieving sustainable development is not easy but it is an unavoidable and inescapable responsibility that can be achieved with right mind set, better planning, stronger policies and effective execution. As said my Martin Luther "We must accept finite disappointments, but never lose infinite hope."

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