Toward environmental sustainability: a comparative analysis between Brazil and India

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Abstract

This article performs a comparative analysis between Brazil and India in terms of environmental sustainability over the period 1970 to 2008. To do so, we employed the following selected indicators: the domestic material consumption, the material intensity, the metabolic rate, the ecological footprint and bio-capacity, the ecological deficit/surplus and the adjusted net savings. Prior to this comparison exercise, we briefly describe the socioeconomic performance over the study period, indicating important changes in the economic and social dimensions in both countries, which certainly affected the environmental domain. The indicators utilised in this study suggest that India is performing better than Brazil in a sustainability point of view, with the ecological deficit/surplus indicator as an exception. We also performed a statistical analysis to measure the correlation between economic growth and the selected sustainability indicators. The results revalidate the fact that there is a major compromise, across economies, between economic development and sustainability of an economy. Although through some detailed intra-economic analysis it is shown that Brazil's economy is decarbonizing in the study period, however on a comparative scale Brazil's economy is leaving more externality of its environment. It is also highlighted that policy shifts do not reflect to that extent in sustainability indicators as the stage of development of an economy does. Finally a projection based analysis revealed that India will be achieving the same level of human development as Brazil at a much lower cost of environmental externality. From this it can be established that Indian economy is more sustainable that Brazil's one. As final remarks, some policy recommendations are emphasized in the light of this analysis.

Keywords: sustainability; indicators; ecological scale; Brazil and India, development, Social metabolism, material flow accounting.

1. Introduction

Since the 1980s, when the so-called Brundtland Commission formalised the concept of sustainable development (WCED, 1987)[4], discussions around the idea of sustainability have dominated academic and political arenas. The main message derived from the emergence of this concept is that economic growth and preservation of natural capital are not two conflicting goals. On the contrary, economic growth can and must be achieved and at the same time the environment as a whole needs to be preserved. Moreover, the emergence of the concept of sustainable development reflects a growing recognition that economic progress must respect the limits imposed by the ecosystems resilience.

Notwithstanding the motive of sustainable development as a political goal, it has definitely entered the political agenda of the vast majority of nations, but this concept still remains elusive (Carter, 2001), which greatly compromises the measurement of progress made by nations toward sustainability. This difficulty, however, can be minimised with the use of sustainability indicators, which seek to present a brief outline on what extent a country or region can be considered sustainable. Good examples of this kind of indicators is the ecological footprint and bio-capacity, which are commonly used to reveal whether human consumption compromises the regenerative capacity of the biosphere (Wackernagel and Rees, 1996).

In countries with rapid economic growth and/or intermediate income level, assessment of progress toward environmental sustainability[5] is even more relevant, since the results may indicate the extent to which the trajectory of these countries has been similar to that of currently developed countries, where economic growth was achieved with intense environmental degradation. The focus on these countries is even more relevant if we bear in mind that these nations still must strive for economic growth as to alleviate remaining poverty and to raise general quality of life standards of population. This is the case of Brazil and India, which are experiencing what mainstream economists call the 'catching up'[6] phase.

These countries are part of the group of leading emerging economies and altogether have been attracting great attention from academics and politicians due to their increasing geopolitical and economic importance worldwide. In addition, such countries also host significant portion of the world population that has been increasingly raising their consumption levels. Although this latter fact is unquestionably important for the improvement of living conditions of poor people in these nations, we must keep in mind the inevitable negative externalities generated in terms of environmental degradation throughout this chain of extraction, production, consumption and disposal. It is therefore necessary to monitor and evaluate the negative consequences of the economic rise of these countries employing a sustainability point of view. Moreover, it is paramount to

[4] According to the World Commission on Environment and Development, sustainable development is that one "that meets the needs of the present without compromising the ability of future generations to meet their own needs".

[5] The authors recognise that sustainability is a complex and multidimensional concept (see subsection 2.1). However, the environmental sustainability is the core sense focused on this paper. Even if the word "environmental" is not explicit, the reader should understand that environmental sustainability is being referred to throughout the paper.

[6] In economic theory, the catching up process generally refers to a convergence phenomenon in which developing countries tend to grow at a faster rate than developed countries. As a consequence, all countries will eventually converge in terms of per capita income.

assess whether the current economic growth occurring in these emerging economies has been following the same destructive pattern in terms of environmental deterioration. The question is if and how economic growth of present emerging countries can become qualitatively superior compared to the trajectory experienced by the current developed economies over the last century?

Having this main challenge in mind, this paper is aimed at assessing how much progress toward environmental sustainability that has been achieved in Brazil and India. To do so, we employ traditional sustainability indicators in the period from 1970 to 2008. We aim to perform a comparative analysis between these two countries in order to verify the existence of temporal trends in terms of sustainability. Overall, our main research questions are as follow: i) what are the trends in performance of Brazil and India in terms of key sustainability indicators? ii) are there any trade-offs between economic performance and sustainability indicators in these countries? We intend to provide initial answers for these questions, and we hope our analysis can help policy-makers to better assess the socioeconomic evolution in Brazil and India.

The paper is divided into three sections, besides this introduction and some concluding remarks. In the first section we provide a brief description of the Brazilian and Indian economic policies in the period 1970-2008 as well as an overview of the socioeconomic achievements made in both countries. The second section is intended to present our analysis on the progress achieved in Brazil and India using the following sustainability indicators: Domestic Material Consumption, Ecological Footprint and Adjusted Net Savings. The third section presents a comparative analysis of both countries and we try to devise some policy implications for both the Brazilian and Indian contexts.

2. Economic policies and socioeconomic development in Brazil and India from 1970 to 2008

This section briefly describes the Brazilian and Indian socioeconomic performance over the 1970-2008 period. Major economic changes have occurred in both countries and we intend to present them as a backbone for our sustainability analysis. We believe that progress toward sustainability is mostly influenced by the socioeconomic evolution of a specific country, and comprehending sustainability patterns requires and overall understanding of economic and social choices of a given society.

2.1. The Brazilian socioeconomic performance over 1970-2008

In Brazil the year of 1930 was the dawn of a national developmental phase which would last until the end of the 1970s. The main feature of this period was the pursuit of national industrialisation through an explicit import-substitution policy (Baer and Kerstenetzky, 1964). Not unlike many other Latin American countries (Baer, 1972), Brazil embraced this approach in order to stimulate the growth of its GDP and overcome a perceived sense of social backwardness. As for most of the twentieth century, the Brazilian economy has achieved one of the highest rates of GDP growth in the world, albeit with huge social and environmental costs. In the period between 1920 and 1980, the average annual growth rate in the Brazilian real GDP was 6.2%, whilst real per capita GDP rose by an average annual rate of 3.6% (Barbosa, 1998). The 1970s was certainly the decade when Brazil's

real GDP grew at its faster rate; however, the 1980s started a period of low GDP growth coupled with macroeconomic turbulence.

The pace of real GDP growth was far less vigorous in the period from 1970 to 2008. Throughout these 39 years, Brazil's real GDP increased by 348.9% or at an average annual rate of 4.0%. Over the same period, per capita real GDP grew by 124.9% (from US$ 3,834.3 in 1970 to 8,622.7 in 2008)[7] or at an average annual rate of 2.2% (Figure 1). Some mainstream Brazilian economists regard the last quarter of the twentieth century (with the exception for the 1970s) and the first decade of the 21st century, as disappointing in terms of economic performance (Carneiro, 2007). Moreover, they believe that the low-growth dynamic of the Brazilian economy caused it to 'fall behind' with respect to many other economies over the last three decades – much unlike the 1955-1980 period when Brazil managed to experience what mainstream economists describe as a 'catching up' phase (Arend and Fonseca, 2012).

In Brazil, the population grew at an annualised growth rate of 1.8% over the study period. In 1970 and 2008 the population growth rate was 2.5% and 0.9% respectively (a diminution of 62.6%). The Brazilian Institute for Geography and Statistics (IBGE, 2013) projects that the Brazilian population will reach its maximum in 2042, when it is expected the country will be populated by 228.4 million people. In 2060 the Brazilian population is projected to be 218.2 million inhabitants.

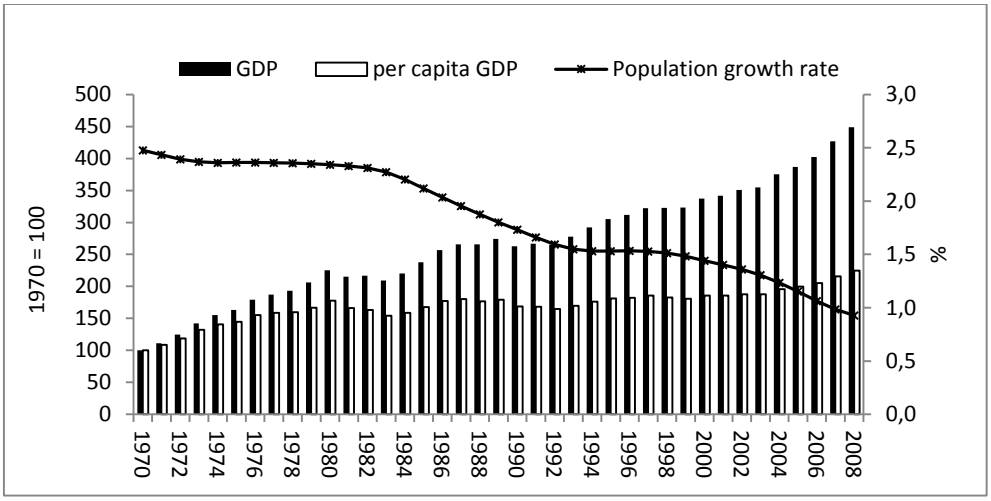

Figure 1: Index of real GDP, real per capita GDP, and population growth rate: Brazil, 1970-2008.

Source: World Bank (2014).

When considering the composition of the Brazilian GDP (Figure 2), it is clear that the services sector has increased its relative importance in the Brazilian economy. In 1970 it accounted for 49.4% of the Brazilian GDP and in 2008 its share rose to 66.2% (a rise of 34.1%). At the same time, agriculture and industry sectors reduced their relative importance (diminution of 52.1% and 27.2% respectively). As for the agriculture, its share dropped from 12.3% in 1970 to only 5.9% in 2008. The same occurred for the industry: in 1970 its share in the Brazilian GDP was 38.3% and in 2008 this figure was 27.9%. The overall reduction in the relative importance of the Brazilian industry has

[7] Priced in constant 2008 US dollars.

raised a debate whether Brazil is suffering from what economists call "early de-industrialisation" (Marconi and Rocha, 2012).

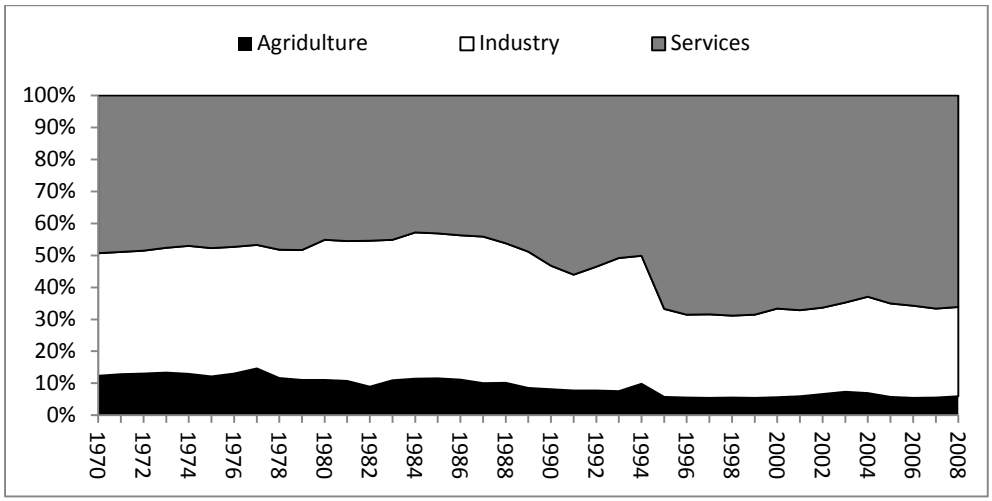

Figure 2: GDP composition: Brazil, 1970-2008.
Source: World Bank (2014).

According to Mortatti (2011), the main conditioning factors behind the growth in per capita GDP in Brazil from 1970 to 2010 were high levels of gross fixed capital formation, human capital improvements, and an increasingly open Brazilian economy with respect to international trade. It is worth mentioning, however, that this 40-year period comprised at least four distinct stages in the Brazilian socioeconomic history, indicating that it is unwise to jump to general conclusions about the GDP growth pattern in Brazil from 1970 to 2008. Each of the four decades within this period had its own particular economic features that should be taken into account when analyzing Brazil's economy[8]. The peculiar characteristics of each decade resulted in a highly fluctuating real GDP-trajectory with similar implications for per capita real GDP growth (Figure 3). Of note are the very low annual growth rates in per capita real GDP in the 1980s and 1990s. Indeed, the Brazilian per capita real GDP in 1999 was only 8.3% higher than its value in 1979.

[8] The overall features of the Brazilian economy over the 1970-2008 period were discussed by several studies, like Malan and Bonelli (1977), Bacha (1977), Valença (1998), Barbosa (1998), Amann and Baer (2000), Cinquetti (2000), Bresser-Pereira (2003), Amann (2005), Carneiro (2007), Baer (2008), and Fonseca et al. (2013).

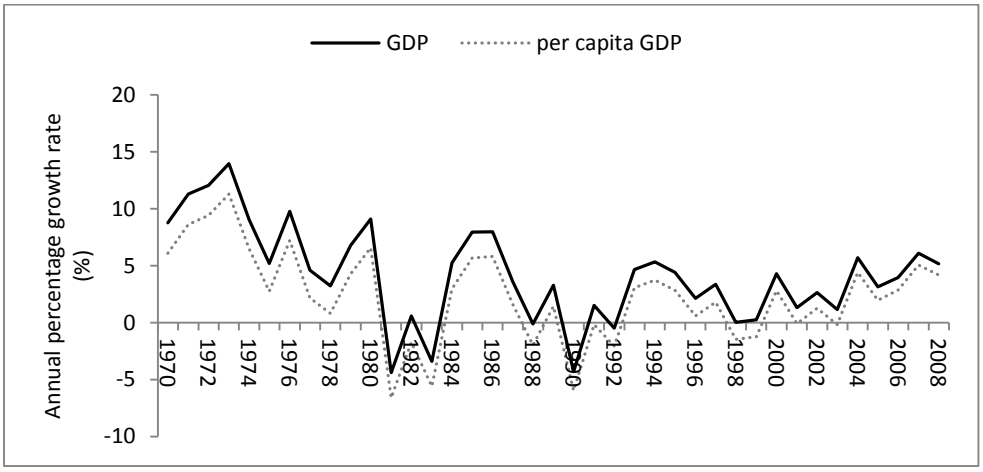

Figure 3: Annual GDP and per capita GDP growth rates: Brazil, 1970-2008.
Source: World Bank (2014)

The most striking feature of the real GDP growth experienced in Brazil is the lack of improvements in the distribution of income among the general population. Despite progress toward a stable macroeconomic environment and remarkable advances in the educational system, income inequality is still very high, ranking Brazil as one of the most unequal societies in the world (Sotomayor, 2008). However, in the last decade of the study period (2000-2008) considerable progress was made toward a more just society. The percentage of the population living under the extreme poverty line dropped from 18.4% in 1976 to 7.6% in 2008. The Gini index also fell from 0.62 in 1976 to 0.55 in 2008 (Ipeadata, 2014). In terms of socioeconomic development, as measured by the Human Development Index (HDI), Brazil has made a significant stride: the Brazilian HDI has increased from 0.52 in 1980 to 0.72 in 2008, which is equivalent to an overall rise of 37.2% (UNDP, 2014).

Regarding economic welfare, the estimates of the Genuine Progress Indicator (GPI) for Brazil (Andrade et al., forthcoming) reveals that genuine progress has been achieved in Brazil, although the rate of the progress was nowhere near as marked as it could have been, and many Brazilians continue to live in abject poverty. Furthermore, by the end of the first decade of the 21st century, the marginal cost of GDP growth in Brazil was very high – so much so, it threatens to undermine Brazil's capacity to boost per capita economic welfare in coming decades.

The social outcomes achieved in Brazil in the first decade of the 21st century were mainly due to improvements in income distribution. In October 2003, the *Bolsa Família* Program (Family Grant Program) was launched as the result of the merger of four pre-existing cash transfer programs. The program is now recognized as the largest conditional cash transfer mechanism in the developing world, and is aimed at reducing current poverty and inequality by providing a minimum level of income to extremely poor families (Lindert et al., 2007).

A recent report issued by the McKinsey Global Institute (Elstrodt et al., 2014) brings to attention the main challenges that Brazil must address if it wishes to deepen the socioeconomic achievements obtained over the last decade. According to Andrade et al. (forthcoming), Brazil needs to enter a new era of development that is capable of delivering broad-based prosperity to the vast majority of its citizens. Regarding sustainability issues,

the authors claim that Brazilian policy-makers should focus on strategies to reduce the environmental costs of GDP growth in Brazil. This can be best achieved by adopting policies aimed at reducing the material and energetic intensity of the Brazilian economy[9].

2.2. The Indian socioeconomic performance over 1970-2008

After independence, from 200 years of colonial rule, on the year 1947 Indian economy was largely agrarian with around 70% of the work force employed in agriculture (Singh et al., 2012). Prevalence of both the state owned and private owned sectors has given it the status of a "mixed economy" (Mukherji, 2010). There was a predominant belief among the policy-makers, that colonialism had harmed Indian industry. To combat that harm, the Indian development strategy was articulated as modernisation through state-led industrialisation. In this case it is particularly state-led as private industrial effort was viewed as inadequate for the task of extracting public good and positive spillovers from the process of industrialisation (Singh, 2009). Public sectors enterprises were created to occupy the leading role in all industrial sectors including steel, chemical, engineering as well as trade and finance.

Another important view of the policy-makers at the time of independence was about the role of international trade and finance. There are two predominant academic arguments for policies to restrict the international trade and finance, in addition to the strong grown negative perceptions about the openness to international trade, formed during colonial times (Singh, 2009). The first argument is of infant industry, which suggests protection of external competition is necessary for full-fledged growth of domestic industries. Expectedly in this case, the role of caring parents was self-assigned on the complete state control over, predominantly, the international import. The next argument is about export restrictions, as exporting goods that are also domestically produced can result in inelasticity of demand and thus does not really contribute in growth (Singh, 2009).

One more vital feature of post-independence Indian economic policies, which can be even considered as the over-arching context, is that of inclination toward socialist ideology as practiced by Russia (Singh et al., 2012). This really promoted moderate consumption as against massive accumulation or use of 'luxury goods'.

Expectedly, these stringent policies on privatization and international trade have not resulted in impressive output in terms of growth. Throughout literature, Indian sluggish growth rate of 3-3.5% has been derogatively described as "Hindu rate of growth" (Mukherji, 2010). Industrial modernisation and green revolution in the last few years of the 1960s could not contribute to any enhancement in the "Hindu rate of Growth" and thus slow growth rate prevailed throughout the period over 1956-1974. Moreover, in addition to the poor performance of Indian economy, the examples of privatisation led rapid growth of East-Asian economies, especially South Korea and Japan, have put immense pressure on Indian policy-makers to consider other obvious alternatives of economic liberalisation. Under these circumstances, 1975 is being marked as the starting of a new era of deregulations of private investment and that further consolidated in the 1980s (Mukherji, 2010). However, these policy shifts remained at the level of mere piecemeal deregulations of various industrial sectors, solely depended on the discretion

[9] This means that Brazil needs to improve the relative decoupling process that would result a higher productivity when it comes to material and energy use.

of political power. Hence, there was hardly any planned reform of the economy, even the Foreign Direct Investment (FDI) and restriction of international trade was very much in place. However, even the encouragement of domestic private investments have managed to push forward the performance of the overall economy in terms of growth and Indian economy started achieving 5% growth rate consistently.

In the literature there is a persistent debate about which change in policy actually managed to direct the fate of the Indian economy and made it into the one of the largest economies of the world. De-Long (2001), Rodrik-Subramaniam (2004), and Kohli (2006) argue that the deregulation phase of 1980s has actually set the stage for massive growth in the economy. On the other hand, Virmani (2004) as well as Panagariya (2004) see 1991's major economic reform towards liberalisation as the trump card behind economic success (Bhalla, 2008). However, it cannot be denied that the root of major financial crisis of 1990-91, that eventually left no option for Indian Government but to liberalise the economy, can be traced back to the decade of 1980s. One of the indications of crisis are rightly pointed by Mukherji (2010) as

> The Indian economy underwent domestic deregulation but did not engage significantly with the global economy after 1975. Its trade as a percentage of GDP, which was 16% in 1980, remained at the same level in 1990. The same figures for China were 22% and 35%, respectively.

Restriction on debt-free FDI (foreign direct investment) from multinational corporations is another important reason behind this crisis. In 1990, the high level of fiscal deficit, international scenario (Gulf War) affecting the oil prices along with this influence of international agencies especially IMF (International Monetary Fund), led the Indian Government to take the radical decision to liberalise the economy. In this package of liberal reforms, restriction on FDI has been taken off along with tariff liberalisation especially in intermediary goods was accompanied with a significant devaluation of Indian Rupee (Mukherji, 2010). In one word, it can be said that at the abovementioned period of time the economic globalisation of the Indian economy had taken place.

During the Post-liberalisation period, Indian economy grew quite strongly and growth rate started crossing 6% consistently. However, after 2003-04 the Indian economy really took off and started growing at the rate of 8%-9%. Bhalla (2008) shows that the decline in the 'real interest rates' is the most likely cause of this late surge in the growth rate of the Indian economy.

Overall, the Indian GDP featured a rise of 585.4% over the 1970-2008 period, which is equivalent to an annual increase rate of 5.2% per annum. The average income of each Indian (the per capita GDP) increased 223.9% (from US$ 340.1 in 1970 to US$ 1,101.7 in 2008)[10] or at an annual rate of increase of 3.1% per annum (Figure 4). Over the study period, the growth in India's population dropped from 2.2% in 1970 to 1.3% in 2008. The average growth rate of the population throughout this 39-year period was 2%[11].

[10] Priced in constant 2008 US dollars.

[11] In 2008 the Indian population reached 1.17 billion people. It is expected that India will be populated by 1.69 billion people in 2050 (UN Population Division, 2010).

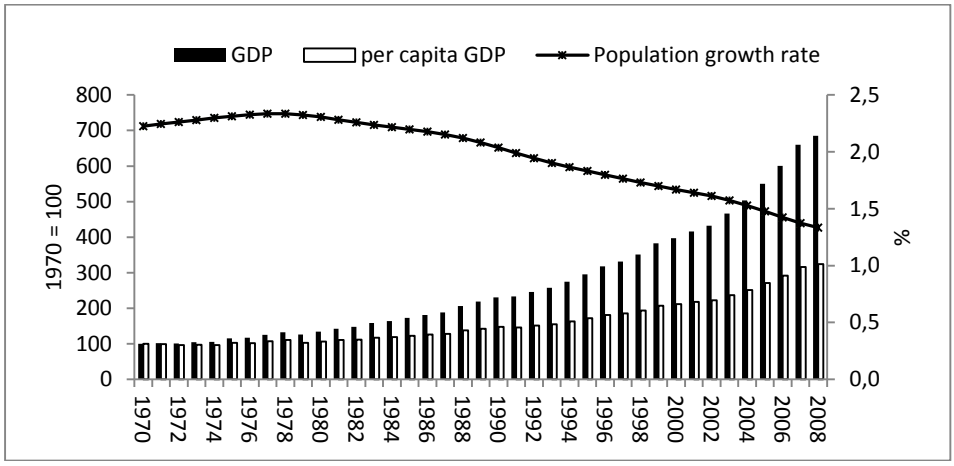

Figure 4: Index of real GDP, real per capita GDP, and population growth rate: India, 1970-2008

Source: World Bank (2014).

Figure 5 displays the composition of the Indian GDP over the study period. The agricultural sector was the only one that reduced its share: from 42% in 1970 to 17.8% in 2008, which is equivalent to a decrease of 57.6%. Both industry and services sectors increased their relative importance in 38.1% and 43.5% respectively over the 1970-2008 period. The industrial sector accounted for 20.5% of the Indian GDP in 1970 and it increased to 28.3%in 2008. As for the services sector, its share rose from 37.6% in 1970 to 53.9% in 2008. Altogether, these figures allow the conclusion that India shifted from an agrarian economy in the beginning of the study period to an economy led mainly by the services sector. It is worth mentioning that – despite some minor fluctuations – the industrial sector in India is still depicting an increasing pattern, which might indicates that India has not completed its industrialisation process[12].

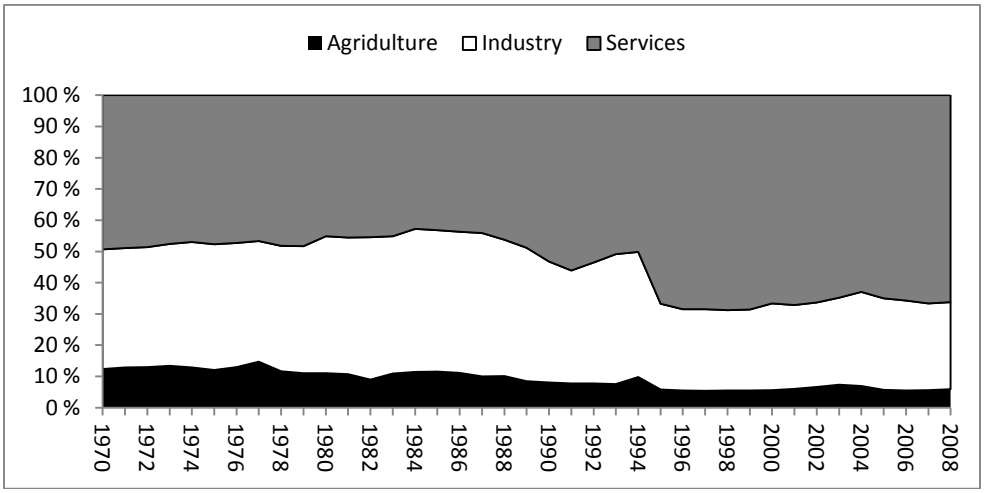

Figure 5: GDP composition: India, 1970-2008.

Source: World Bank (2014).

[12] This is in contrast with the pattern shown by the Brazilian economy. In Brazil the industrial sector has been steadily decreasing its share in GDP in the past years, whist the agriculture and services sectors accounted for 5.9% and 66.2% of the Brazilian GDP in 2008.

Not unlike Brazil, the GDP and per capita GDP in India also presented a fluctuating trajectory over the study period (Figure 6). Of note are the high rates of growth in both GDP and per capita GDP in India after 2003, being the exception the year of 2008 in which both growth rates dropped by 60.3% and 69.7% respectively due to the massive world financial crisis.

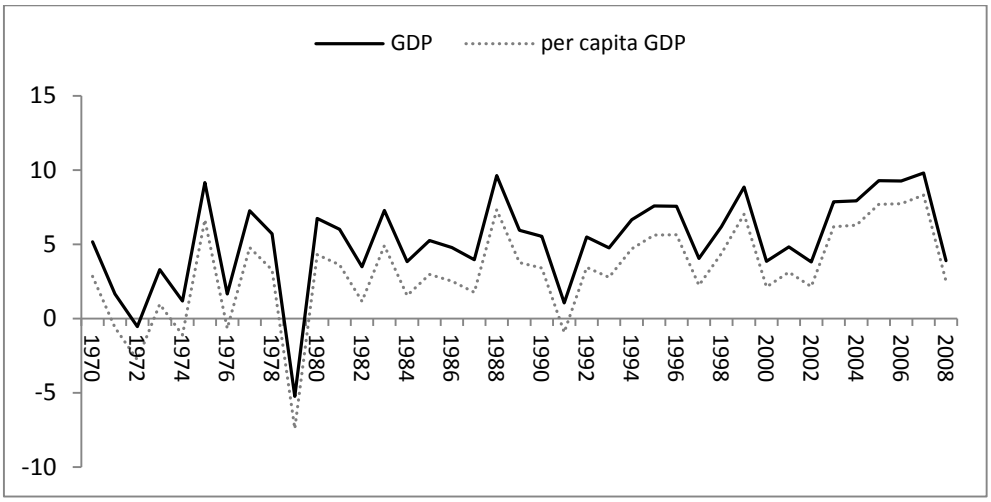

Figure 6: Annual GDP and per capita GDP growth rates: Brazil, 1970-2008.
Source: World Bank (2014).

In terms of human development, the HDI in India has increased from 0.35 in 1980 to 0.53 in 2008, which is equivalent to a rise of 54.5% over the study period. The economic welfare of the Indian population – as measured by the GPI – rose 66.2% between 1987 and 2003 (3% per annum), whilst the per capita GPI in India increased 22% over this same period (1.2% per annum) (Lawn, 2008).

So to summarize in terms of economic policy shifts and subsequent reflection in the economic growth rate of Indian economy, the considered time period (1970-2008) for this paper can be divided into four major parts, i) the slow growth period with complete state control(1970-74)[13], ii) the period of preparing the ground for liberalisation with the declining state control (1975-90), iii) the period of liberalisation (1991-2003), iv) adequate policy shifts to realize uninterrupted high growth rate (2003-08).

3. Sustainability in Brazil and India

This section aims to present the progress towards sustainability that has been achieved in Brazil and India. This is intended to be done by presenting the evolution of some key sustainability indicators in both countries over the 1970-2008 period. Prior to that, we perform a brief literature review on how to measure sustainability.

[13] In the terms of realisation of higher economic growth rates than 'Hindu growth rate' though this period can be extended up to 1980.

3.1. How to measure sustainability: a literature review

The concept of sustainable development is a philosophy of resource consumption that believes it is important to conserve and preserve natural capital for future generations at the same time meeting the needs of human being. In between 1972 and 1992, this concept was progressively evolved with a series of international conferences and initiatives. The first UN (United Nations) Conference on the Human Environment held in1972 in Stockholm was one of the major international gatherings to discuss sustainability at a global scale. The conference prepared several recommendations that led to the establishment of the UN Environment Programme (UNEP) with the creation of different national environmental protection agencies.

In 1980, the recommendations from Stockholm were further elaborated in the World Conservation Strategy (WCS) which collaborated with the International Union for the Conservation of Nature, the World Wildlife Fund (WWF), and UNEP aimed at advancing sustainable development by identifying priority conservation issues and key policy options (IUCN et al., 1980). The foundation of the concept "sustainable development" was first used in the United Nation's Brundtland Commission in 1983 known as the Brundtland report, *popularized in Our Common Future*, a report published by the World Commission on Environment and Development in 1987. The concept "sustainable development" is concerned with the human degradation of the environment and the relationship of this process to the future social and economic challenges facing humankind.

Brundtland's explanation recognises the reliance of human beings on the environment to meet their needs and welfare in a much wider sense than just exploiting environmental and or economic resources at local to international level of development (WCED, 1987; Hopwood et al., 2005). This definition touches three pillars of sustainable development including economic development, social equity and environmental protection. Therefore, sustainability indicators should focus on how far the actual use of resources is away from the aforementioned key domains (Rennings and Wiggering, 1997). To attain sustainable development, a country must acknowledge some challenges toward sustainability indicators. Different types of indicators should be considered to reflect changes in quality of life which are compatible with the current situation of ecological limits (Moran et al., 2008). Achieving sustainable development of a nation should be an ambitious and a primary goal towards sustainability. A nation must improve the welfare of its population along with the quality of life while conserving the natural system to support life in all its diversity. True sustainability is only achieved when progress is realised in the economic, social and environmental domains.

Regarding the measurement of sustainability, the use of indicators is useful not only for policy decision-makers and government officials (Rennings and Wiggering, 1997), but also because they can potentially reflect the economic growth, socioeconomic development and environmental dimensions. They can be used as a tool to illuminate the economic growth, environmental development, socioeconomic development and communication for different functions (Brugmann, 1997). The necessity for these indicators is their usefulness in assessing the sustainability for the future environmental, political and socioeconomic development (Briassoulis, 2001). To meet these, the criteria of policy relevance, analytical soundness and measurability, different indicators as indicated by Moran et al. (2008) can be assed accordingly. They help to communicate

information and provide a signal that is not immediately noticeable (Hammond et al., 1995) about the progress toward sustainable development.

In the following, we have attempted to portray the most traditional indicators employed to measure sustainability. Our goal is to briefly describe these indicators – all of them used at some point in this paper. We do not intend to develop a methodological discussion about them, which does not diminishes the importance of this debate. In doing so, we shall focus or brief review indicators like the Domestic Material Consumption (DMC), Ecological Footprint (EF), Genuine Progress Indicator (GPI), Adjusted Net Savings (ANS), and Social indicators (Gini Coefficient and the Human Development Index (HDI)) that are commonly used to communicate information about progress toward sustainable development in its various dimensions.

3.1.1 Domestic material consumption (DMC)

DMC is the term that indicates the annual total amount of raw materials that is directly used in the economy (used domestic extraction plus imports), minus all the physical materials that are exported (Weisz et al., 2005). It provides an assessment of the absolute level of use of resources, and combined with Gross Domestic Product (GDP). It further provides insight into whether decoupling between the use of natural resources and growth of the economy is taking place. This means that data on material consumption and GDP can indicate the material intensity of a specific country, as well as the metabolic rate[14] when data on population are available.

DMC provides a basis for policies to decouple the growth of the economy (GDP growth) from the use of natural resources so as to achieve a reduction of environmental degradation resulting from primary production, material processing, manufacturing and waste disposal. It is important to take into consideration that the term "consumption" in DMC indicates "apparent consumption" and not "final consumption", and thus refers to "total primary energy supply" as stipulated by Haberl (2001). However, the DMC indicator does not include unused domestic extraction and indirect flows of imports and exports, being only a proxy for the actual total material consumption.

3.1.2 Ecological Footprint (EF)

The concept of Ecological Footprint (EF), introduced by Rees and Wackernagel (1994), measures the biologically productive area necessary to support current consumption patterns, given prevailing technical and economic processes. The EF encompasses the area of biologically productive land appropriated exclusively to produce the resources used and to assimilate the wastes generated by the population (Moran et al., 2008). EF portrays how much the consumption patterns of different populations contribute to this state of affairs (Holmberg, 1999). It is taken as an effective tool for policy-makers to communicate the natural capital reality and potential implications of ecological overshoot, a core driver behind the unsustainable state of the world (Wackernagel et al., 2002). At the same time, this indicator can help people assess their ecological impact and compare this impact to nature's capacity to regenerate (Holmberg, 1999). To understand the sustainability of a given nation, the land area of EF is compared with the actual area of land available (bio-capacity or carrying capacity). That means when EF of a nation is larger than its bio-capacity, the nation has an ecological deficit which means that the

[14] Metabolic rate is the per capita material consumption.

consumption exceeds the bio-capacity of a given area and ultimately the place is unsustainable (Qin-P et al., 2008).

By determining human impact on the planet's limited biological productive area, the EF tool tests a basic ecological condition for sustainability, which ultimately provides the results of its analysis in spatial units and that can easily be communicated. Such analyses provide a benchmark to present ecological performance compared with potential available natural resources and ecosystem services; and identify challenges for lightening an economy's ecological load.

3.1.3 The Genuine Progress Indicator (GPI)

Genuine Progress Indicator (GPI)[15] provides a composite index that imitates GDP but consider the benefits provided for the nonmarket activity that would not be factored into GDP along with social and environmental costs provoked by GDP growth (Thiry and Cassiers, 2010). The use of GDP in the system shows that the more we spend, consume and produce the more the GDP grows. However, the application of the GDP and money based accounts fail to address things that really matter in our lives. It does not account for the physical well-being of people in the society. A system like GPI is beyond the money expressions and closer to measuring "that which makes life worthwhile" is required. It is necessary to use the GPI because it addresses three areas, namely; welfare equivalent income, sustainable income and net social profit. The advantages of employing GPI is that it measures the "welfare a nation enjoys at a particular point in time given the impact of past and present activities" which is more perfect measure of true welfare than GDP (Lawn, 2003). In the social context, the GPI shared principles of sustainable development in the sense that the GPI makes an explicit adjustment to personal consumption expenditures for improvements or declines in distributional equity (Talberth et al., 2007). Such indicator presumes sustainable development must be equitable since a social sustainable system must achieve equitable distribution.

3.1.4 The Adjusted Net Savings (ANS)

Unlike GPI, the Adjusted Net Savings (ANS) is an indicator of sustainability that measures the true rate of savings in an economy. It was initiated by the World Bank in between 1970-2006, and estimated for more than 190 countries due to high visibility (Thiry and Cassiers, 2010). It takes into consideration the investments in human capital, natural assets - depletion of natural resources and damage caused by pollution. The ANS "*seeks to provide national-level decision makers with a clear, relatively simple indicator of how sustainable their country's investment policies are*" (Bolt et al., 2002). The ANS is a good measure of prospects for well-being as it indicates a nation's ability to sustain a consumption stream which is what matters for sustainability, not only being limited to the consumption flow at a particular time as measured in GDP.

3.1.5 Social indicators (Gini Coefficient and the Human Development Index)

The Gini coefficient is a widely accepted measure of inequality and presents the income distribution of the nation. It was established as an ad hoc measure of income inequality (Dorfman, 1979) with standard measurement that varies between zero (0) and one (1).

[15] Refer to Lawn and Clarke (2008) for detailed explanation on theory of the GPI indicator, as well as the methods used to calculate the different items that comprise the GPI.

That means if the Gini coefficient is 0, there is complete equality (when everybody has the same income) whereas 1 indicates a complete inequality (an individual might have all the income while others have none). The use of this standard measurement makes easier to notice if inequality is rising or falling to certain amount of absolute incomes. The concept of inequality is based on the way individuals perceive his position in the society acknowledged as an important aspect of their welfare. However, the growing inequality in income distribution reveals a combination of different factors which ultimately affect the socioeconomic dimension of the nation.

Likewise, the Human Development Index (HDI) is used as an indicator for socioeconomic development (UNDP, 2005). This index overall measures the human well-being that captures individual residents of a nation, how they enjoy long, healthy, and creative lives (Moran et al., 2008) with absolute standards. HDI is a globally available proxy metric for progress toward human development goals, as exemplified in the Millennium Development Goals (MDGs). The HDI accommodate life expectancy at birth, adult literacy rate, gross school enrolment ratio, and GDP per capita (UNDP, 2004). Based on metric progress, when a nation reaches HDI score of 1.0 it means that a nation has attained the maximum value for each sub-index. An HDI value of zero implies that the country is at or below the minimum value for all sub-indices. However, the UNDP set a grade of 0.80 HDI score as the limit between medium and high human development.

Recently the debate of closely related concepts in the field of sustainable development notably the "Green New Deal", "Green Growth" and "Green Economy" have emerged (Brinket al., 2012). These concepts were globally erupted out of its specialist moorings in environmental and ecological economics (UNDESA, 2012) as well as in the mainstream of policy discourse (UNEP, 2011).The mentioned concepts were used in different ways and have different roles and meanings. The first concept – "Green New Deal" – acts as a catalysts and the concept "Green Growth" is an approach toward a "Green Economy", which has an essential meaning of attaining the objectives of sustainable development. The concept of green economy does not only demonstrate the interest on the environment or favour political perspectives over another but the green economy is an economy that enhances human well-being and social equality while significantly reducing environmental harmful and ecological scarcities (UNEP, 2011; 2012). Examples of "green economy" actions range from investments in low carbon technology, less consumption to resource efficient and enhancement of ecosystems quality.

3.2. Measuring environmental sustainability in Brazil and India (1970-2008)[16]

This subsection presents the evolution of key sustainability indicators in Brazil and India over the study period. Here we just describe the trajectory of the following indicators in both countries: the Domestic Material Consumption (DMC), the Material Intensity (MI), the Metabolic Rate (MR), the Ecological Footprint (EF), Bio-capacity (BIO) and Ecological Deficit/Superavit (ED or ES respectively), Ecological Footprint to World Bio-capacity Ratio (EF/BIO_w), and Adjusted Net Savings (ANS). In the next section we will perform a deeper analysis of those indicators as well as devise some policy implications.

[16] As it has been highlighted, this paper focus on the environmental dimension of the sustainability concept. This implies that only indicators connected to this dimension will be used in this subsection, although the early one (subsection 2.1) has described a more comprehensive set of indicators.

In terms of DMC, we can notice that in both the countries there has been a massive increment in domestically-consumed materials (figure 7). In Brazil, the DMC rose from 618.4 million tonnes in 1970 to 2.94 billion tonnes in 2008, whist in India the DMC grew from 1.33 billion tonnes in 1970 to 5.33 billion tonnes in 2008. The Brazilian DMC showed a total rise of 375.8% and the Indian DMC increased 300.8% over the study period, which is equivalent to an annual growth rate of 4.2% and 3.7% respectively.

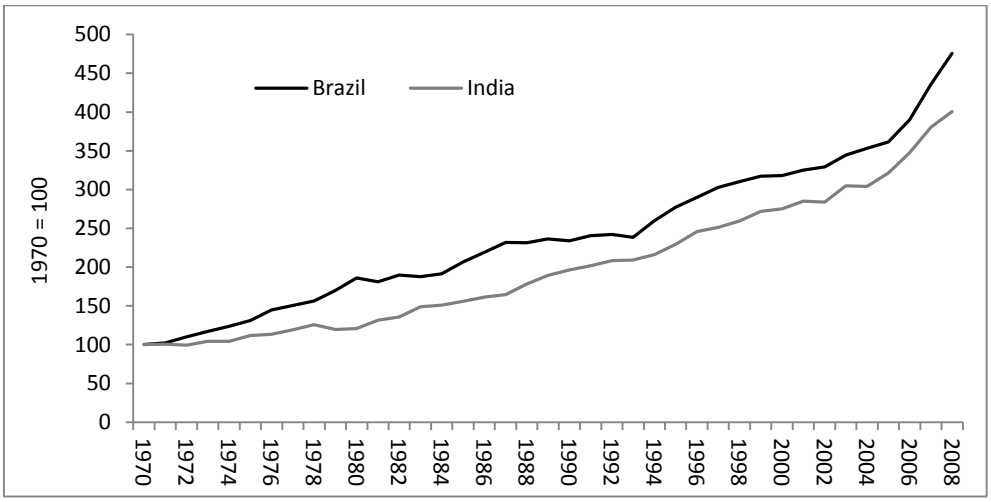

Figure 7: Index values of Domestic Material Consumption: Brazil and India, 1970-2008.
Source: UNEP and CSIRO (2012).

The DMC in India is higher than in Brazil due to the fact that the Indian population was 6.13 times higher than the Brazilian population in 2008. Therefore, the per capita DMC is xx times higher in Brazil as compared to India in that year. Moreover, Brazil has experienced a more intense biophysical growth of its economy than India – see Figure 7. While the Brazilian DMC increased 4.8 times over the study period, the figure for India is only 4. These figures indicate that Brazil increased its ecological-economic scale faster than India; although in 2008 the Indian ecological-economic scale was 1.8 higher than the Brazilian one in absolute terms. In terms of its composition, the most interesting feature of the Brazilian material consumption is the relatively stable share of biomass, construction minerals and fossil fuels, and the increasing share of metal ores and industrial minerals. In India, all the material categories presented are showcasing increasing share in the total domestic material consumption, biomass consumption being the exception. It is worthwhile to mention the massive rise in the fossil fuel share in India, which has grown from 7.3% in 1970 to 14.2% in 2008 (a total rise of 94.8%.

Figure 8 shows the material intensity for Brazil and India from 1970 to 2008. It is clear that India performs better than Brazil in terms of eco-efficiency. While the Indian material intensity dropped from 11.4 Kg/US$ in 1970 to 6.5 Kg/US$ in 2008 (a reduction of 42.7%), the Brazilian material intensity rose from 3.2 Kg/US$ in 1970 to 3.4 Kg/US$ (a rise of 6.4%). This is an important difference between these two countries and this fact has important implications regarding sustainability prospects for both economies. At a first glance, higher the material intensity in a specific country, higher are the environment costs associated with GDP growth. Further analysis will be presented in the following section.

Regarding the metabolic rate (the per capita material consumption), the average Brazilian consumed 6.4 tons of materials in 1970 and 15.3 tons in 2008, which is equivalent to a total rise of 137.9% or to an annual growth rate of 2.3%. Over the same period, the average Indian consumed 2.4 tons of material in 1970 and increased this consumption to 4.7 tons per capita in 2008. This is equal to a total increase of 92.5% in the Indian metabolic rate, or to annual growth rate of 1.7%. Despite of the higher ecological-economic scale in India, Brazil presented a higher metabolic rate (Figure 9) due mainly to its stronger growth in DMC and lower population. If each Indian consumed the same amount of material as an average Brazilian, the DMC in India would have reached a massive amount of 18 billion of tons in 2008, which is 511.9% higher than the Brazilian DMC in this same year. The higher metabolic rate in Brazil can be associated to the fact that Brazil is in a relatively more advanced phase of its 'catching-up' process. In other words, we can infer that Brazil has initiated earlier its transition to an industrial socio-metabolic regime[17] when compared to India.

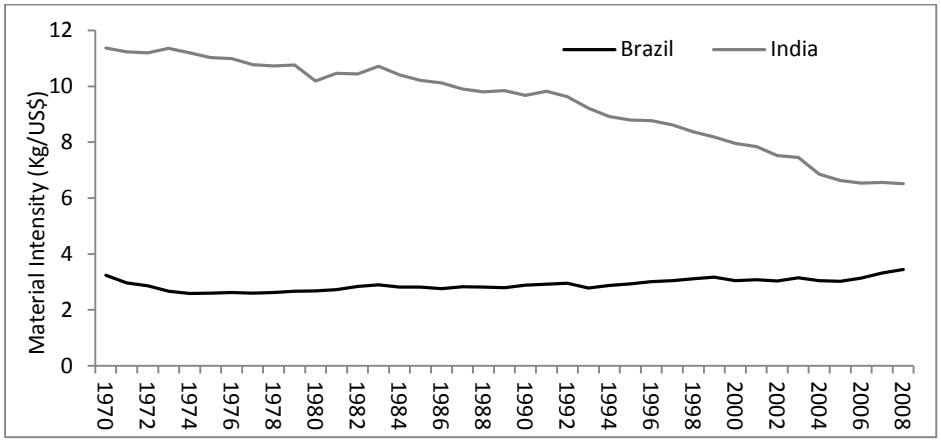

Figure 8: Material intensity: Brazil and India, 1970-2008.

Source: UNEP and CSIRO (2012).

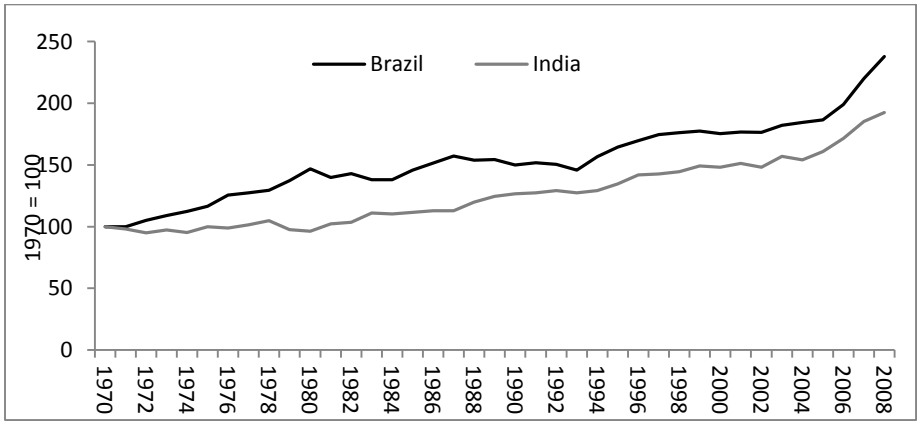

Figure 9: Index values for the metabolic rate: Brazil and India, 1970-2008.

Source: UNEP and CSIRO (2012).

[17] According to Haberl et al. (2011), socio-metabolic regimes are relatively stable configurations that characterise the evolution of socio-ecological systems. Until the present, the authors identify three different socio-metabolic regimes: hunter-gatherers, agrarian societies and industrial societies.

The analysis above explicitly employs a material flow accounting (MFA) approach, and it suggests that India is performing better than Brazil from a sustainability point of view. This perception comes from the slower growth in the Indian ecological-economic scale (biophysical dimension)[18] and its metabolic rate, as well as the stronger reduction in the Indian material intensity.

A different picture, however, emerges when Brazil and India are compared in terms of their ecological footprint, bio-capacity and ecological deficit/surplus[19]. As indicated by figures 10 and 11, over the entire period Brazil had an ecological surplus, although it has been decreasing since the initial year. At the same time, India featured an increasing ecological deficit over the period 1970-2008, which means that in India the country's bio-capacity is not sufficient to provide natural resources that Indian people need[20]. It is worthwhile mentioning that the average Brazilian per capita bio-capacity and per capita ecological footprint are 2,402% and 265% higher than the Indian ones, respectively. In Brazil, the ecological footprint per person increased 24.9% over 1970-2008 whist the same Indian indicator increased 17.6% over the same period. Per capita bio-capacity, in Brazil and India dropped 46.3% and 18% over the study period, respectively. As a consequence, the Brazilian ecological surplus shrank 57% (from 15.6 gha per person in 1970 to 6.7 gha per person in 2008), and the Indian ecological deficit rose 161.6% (from – 0.1 gha per person in 1970 to - 0.4 gha per person in 2008).

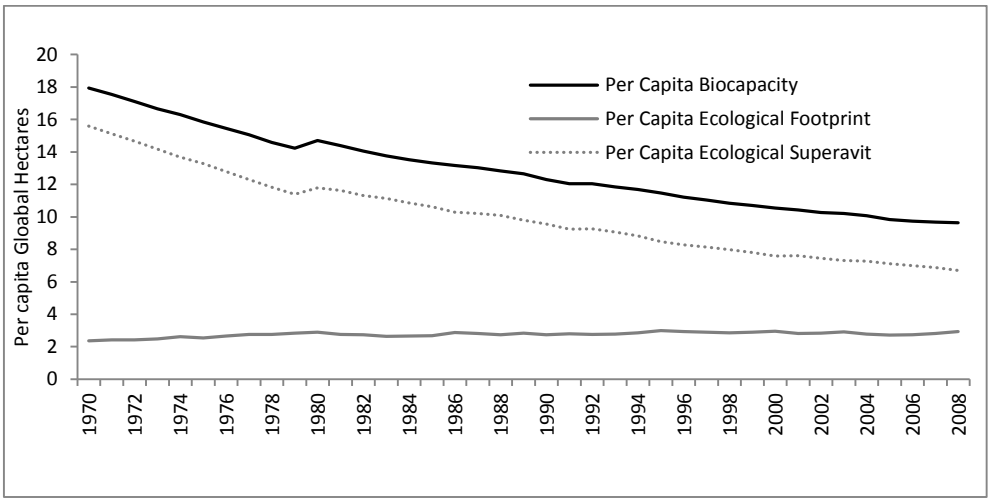

Figure 10: Per capita bio-capacity, per capita ecological footprint and per capita ecological superavit: Brazil, 1970-2008.

Source: Global Footprint Network (2014)

[18] It must be borne in mind, however, that the level of India's ecological-economic scale is larger than the Brazilian scale, which can be associated mainly to the dimension of population in both countries.

[19] Ecological deficit/surplus is given by the difference between ecological footprint and bio-capacity. Note that when ecological footprint is greater that bio-capacity we have ecological deficit. On the contrary (bio-capacity greater than ecological footprint), we have ecological surplus (or ecological superavit).

[20] These results do not change in terms of total ecological footprint and total bio-capacity for both countries.

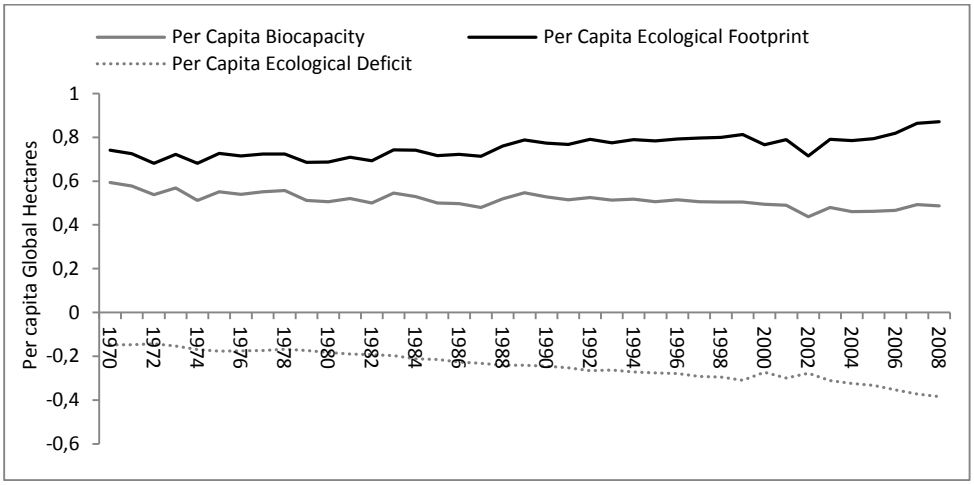

Figure 11: Per capita bio-capacity, per capita ecological footprint and per capita ecological deficit: India, 1970-2008.

Source: Global Footprint Network (2014)

Moran et al. (2008) argue that in order to be partially sustainable, the per capita demand on natural resources in a specific country must be less than the global bio-capacity available worldwide. This per capita ecological footprint to world per capita bio-capacity ratios (*Š*) for Brazil and India are shown in figure 12. Taking this indicator as a sustainability parameter, it can be said that Brazil is not sustainable since 1974 when the ratio *Š* became higher than 1. On the contrary, this same ratio is less than 1 over the entire period in India, which means that the Indian per capita ecological footprint is below the per capita world bio-capacity. It is worth mentioning the increasing trend in *Š* in both countries: in Brazil and India the *Š* ratio rose 94.8% and 83.5% over the1970-2008 period, respectively.

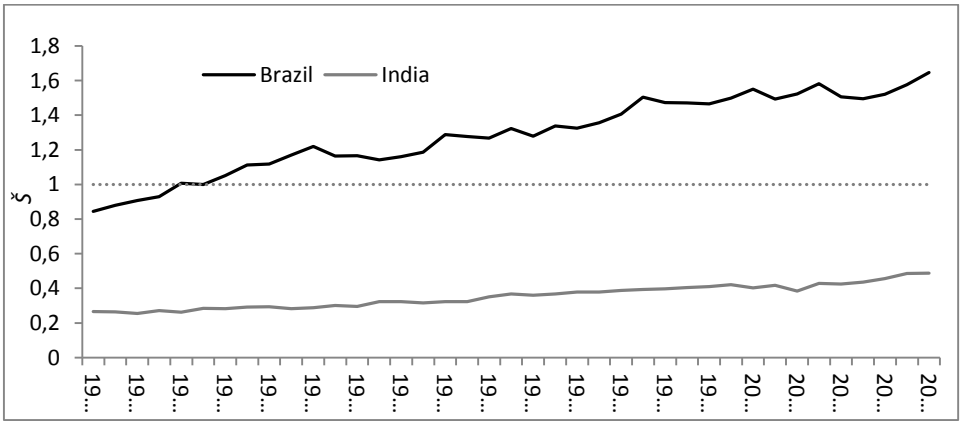

Figure 12: Per capita ecological footprint to per capita world bio-capacity ratio: Brazil and India, 1970-2008.

Source: Global Footprint Network (2014)

In terms of adjusted net savings (ANS) (Figure 13), Brazil performed a very fluctuating trajectory while India had a more consistent increasing path. Although it is difficult to precisely indicate the causes that affected ANS over the study period in both countries, it seems that in Brazil the ANS in the 1980s has increased due to the erratic economic

performance during this decade, which might affected the consumption of fixed capital (one of the items included in the ANS indicator). Relatively low level of education expenditure in Brazil during the 1990s can be one of the causes of the decreasing trend in the ANS indicator between 1994 and 2000. From 2000 to 2008 the ANS rose again in Brazil mainly due to the increase in education expenditures. It is interesting from 1995 onwards the ANS in India became higher than in Brazil as a percentage of GNI (gross national income). This fact can be the result of a more intense increase in the Indian gross national savings and investment in human capital.

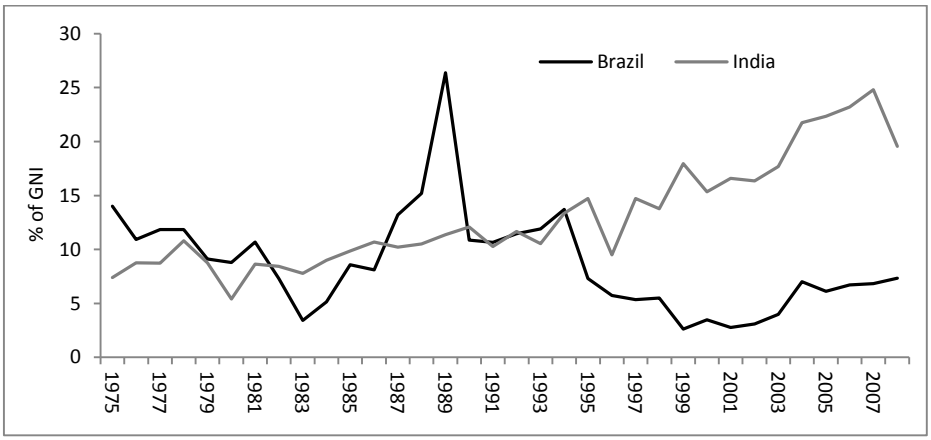

Figure 13: Adjusted net savings: Brazil and India, 1975-2008.
Source: World Bank (2014)

The ANS indicator analysed above suggests that India is performing better in terms of sustainability than Brazil during the last 15 years of the study period. Regarding the five indicators described in this section, the Brazilian performance in terms of sustainability is better than the Indian one only in terms of ecological footprint and bio-capacity as Brazil has an ecological surplus while India has an ecological deficit. Obviously one must take into account the huge stock of natural capital possessed by Brazil, which naturally increases its bio-capacity. The other indicators employed in this study indicate that India can be considered more sustainable than Brazil. However, all indicators have their own limitations and one should bear in mind the immense differences in both countries regarding the population dimension and the current phase of socioeconomic development. Brazil is considered by the World Bank as an upper middle income country and India is still considered a lower middle income nation. However, the Indian economic performance in the 2000s might change this reality in the coming years. It remains unclear though to what extent both countries have incorporated the sustainability view in their economic and social dynamics. This is an important research agenda insofar Brazil and India (as well other BRICS) countries become more relevant in the global scenario.

4. Interfaces between GDP growth and environmental sustainability indicators in Brazil and India

To understand the relationship between economic growth of an economy, especially a developing one, with its sustainability as well as human development potential, both

inter-economy (between two indicators of both the economies over the entire time period) and intra-economy (within two indicators of an economy over various portion of the entire time period) correlation coefficients have been evaluated. The Bootstrapping method[21] is used to evaluate each set of correlation coefficients along with it standard error. As Human Development Index data is available for only seven years for the entire study period, other indicators are reduced to those seven years for evaluation of correlation coefficients between economic growth and sustainability potential with human development potential. To handle the drastic population difference between these two economies all the considered indicators are considered at the per-capita level. As already indicated, the following are different indicators considered to evaluate performance at various fronts.

- Economic Growth: i) Gross Domestic Product per capita (GDPpc)
- Sustainability Potential: i) Domestic Material Consumption per capita (DMCpc), ii) Ecological Footprint upon Bio-capacity (EF/BC), iii) Adjusted Net Savings per capita (ANSpc,) iv) CO_2 Emission per capita (CO_2pc)
- Human Development Potential: i) Human Development Index (HDI)

The general trend obtained from these correlation coefficients will be highlighted and then exception will be discussed to foster more nuanced understanding of possible drivers behind these patterns.

The correlation coefficient between GDP per capita and HDI, DMCpc, EF/BC shows a high positive correlation for both the economies as shown in the figure 14 and there are no significant intra-economy differences; however, correlation coefficients between GDPpc and ANSpc, CO_2pc don't adhere to the same patterns. These patterns very evidently imply that economic growth, especially for large developing economies, significantly undermines the capacity of an economy to be environmentally sustainable. Moreover, the high positive correlation between GDPpc and HDI for both the economies indicates the indispensability of economic growth for developing economies. Hence, both of these insights clearly point to the fact that our economies are completely embedded in a finite biophysical reserve and thus infinite economic growth can't be considered as a recipie for solving issues of poverty and to deliver human development with maintaining sustainability. Rather the entire discourse of development needs a conception of definite threshold and a sense of sufficiency, through which maximum or optimum human development can be achieved with a decent level of sustainability.

[21] Bootstrapping is a *resampling* technique used to obtain estimates of summary statistics

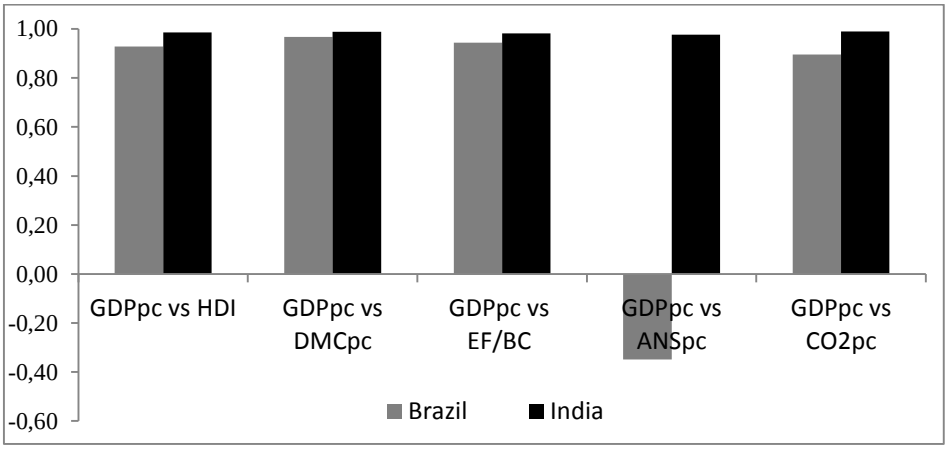

Figure 14: Inter-economy Correlation coefficients over the period of 1970-2008

Source: Own calculation based on World Bank (2014), Global Footprint Network (2014), UNEP and CSIRO (2012).

Now coming to the exception, as already indicated the correlations between GDPpc and ANSpc, and GDPpc and CO_2pc are quite different for both these economies. In this context it is worth mentioning that the difference is extremely significant for the first pair, but for the second it is just enough that it can't be ignored. First the 'just enough' difference will be discussed and then the more significant one will be explored.

For India, there is a strong positive correlation observed between GDPpc and CO_2pc. However, this is not exactly the case for Brazil. Brazil shows rather a comparatively weak positive correlation between the two. The scenario does not change in case of the correlation coefficients between DMCpc and CO_2pc for both the economies. Possible driver behind this difference becomes clear once more intra-economy analysis is devised, especially for Brazil. In the further analysis, it is clearly revealed that over the four decades (1970-79, 1980-89, 1990-99, 2000-08[22]) Brazil's economy is relatively decarbonizing and thus the correlation of CO_2pc with GDPpc and DMCpc is shifting from a very strong positive correlation to an extremely weak positive correlation as shown in the figure 15. The scenario is completely opposite for India as over those decades the correlation has changed from a weak positive correlation to a very strong positive one. This clearly directs to the fact that is already flagged, as though both these economies can be categorized under the same category of 'rapidly emerging economy'[23] still both of these are in two completely different phases of development.

[22] Though it is not a complete decade, still for sake of uniformity it will termed as a decade for the rest of the paper.
[23] Mostly commonly used terms is 'BRICS'.

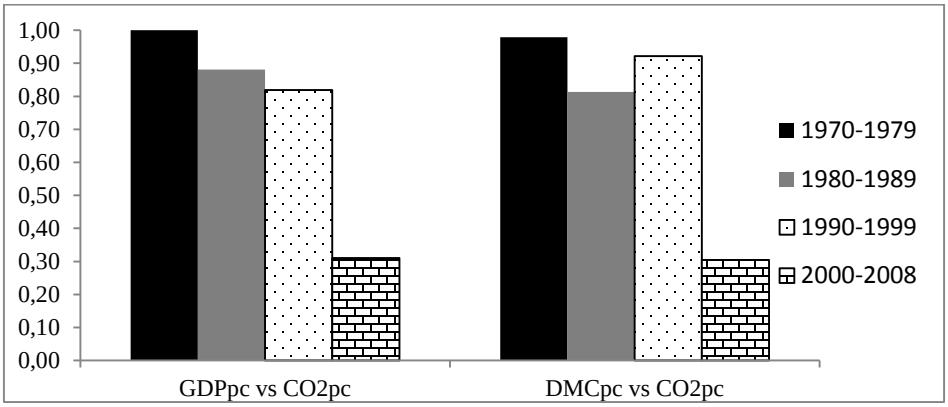

Figure 15: Intra-economy Correlation coefficients for Brazil over the period 1970-2008

Source: Own calculation based on World Bank (2014), Global Footprint Network (2014), UNEP and CSIRO (2012)

Now coming to the other major dissimilarity between these two economies, that is the nature of correlation between ANSpc and GDPpc. It shows a very strong positive correlation for India, where as for Brazil it is a weak negative correlation. Hence according to definition of ANSpc and the weak sustainability[24],with more GDP growth India is achieving more environmental capital resulting in better environmental sustainability; however, the scenario is completely opposite for Brazil. Just like the earlier example, similar intra-economy analysis is carried away for Brazil. The pattern obtained for GDPpc, as shown in the figure 16, is very interesting as it shows an oscillating pattern over the various decades. As in the first decade (1970-79) correlation was moderately negative, but it becomes moderately positive in the second one. In the third decade (1990-99) it becomes again moderately negative and finally in the last decade it shows a strong positive correlation. Following the definition of weak sustainability and the negative correlation of ANSpc and GDPpc for Brazil's economy, it can be concluded that Brazil's economic development is leaving a high negative externality on its society as well as Brazil's development is more at the cost of its natural resources. The second points can be revalidated from the fact, already highlighted earlier, that there is 57% reduction of Brazil's ecological surplus over these four decades, whereas for India it has almost remained same.

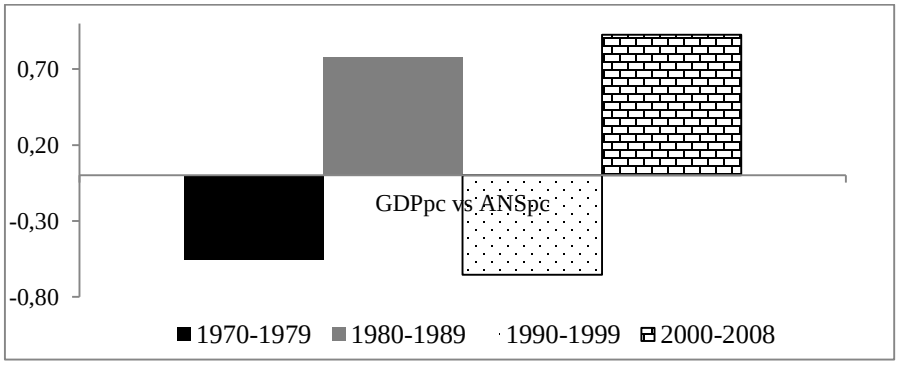

Figure 16: Intra-economy Correlation coefficient for Brazil over four decades

[24] Weak sustainability is the idea within *environmental economics*, which states that *'human capital'* can be substituted by *'natural capital'*

Source: Own calculation based on World Bank (2014), Global Footprint Network (2014), UNEP and CSIRO (2012).

Finally it can be summarized that patterns obtained were quite uniform for both the economies and thus does not leave much scope of formulating causal explanation with the subsequent changes in the economic policies in both the economies. Patterns seems to emerge more from the fact that whether an economy is growing or not, rather than the underlying policy shifts that are responsible for that growth. The following statements will clearly validate the above claim.

- Correlation coefficient between GDPpc with DMCpc, EF/BF and CO_2pc over four decades seems to suggest that there is substantial difference between 1970-79 and 1980-2008 as shown in the figure 17, not between, as generally expected, pre-liberalization (1970-90) and post-liberalization (1991-2008) period. Hence as discussed, beginning of economic growth in India during 1980's immediately started to reflect in sustainability indicators.
- Similarly for Brazil there is considerable amount of difference in the similar correlation coefficients[25] for the period 1970-79 and 1980-2008. Although the difference is completely opposite to the India's case (correlation coefficients are more positive in the first decade and comparatively lower in the rest of the time period), still it is following the same logic about the stage of an economy. As 1970's was the last rapid growing phase for the Brazil's economy and in period of 1980-2008 it was undergoing a low growth stage, trying to recover from the economic crisis of 1980's.

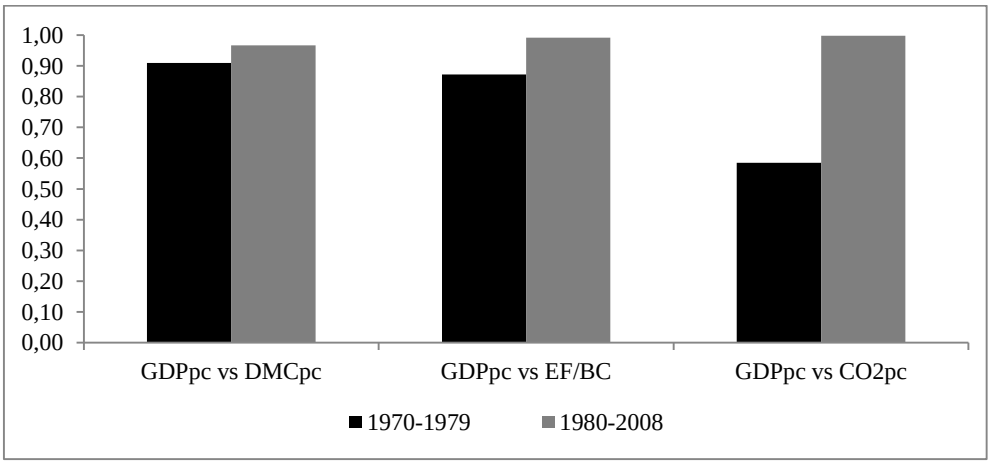

Figure 17: Intra-economy Correlation coefficient for India over1970-1979 and 1980-2008

Source: Own calculation based on World Bank (2014), Global Footprint Network (2014), UNEP and CSIRO (2012)

Another important point to be noted here is that the kind of developmental policies were in place for Brazil during 1970-79 (can be summarized as FDI driven import substitutions policy) was completely different from the ones were in place for India during 1980-2008 (can be characterized as an cascade of changes towards a liberal economy from a very

[25] Especially the correlation coefficient between GDPpc and CO_2pc.

strict state control). Hence, it can be rightly concluded that economic growth for developing economies is generally achieved at the cost of undermining its sustainability. However, it cannot be completely generalized without taking into account, as already it has been pointed out, at what the stage of development the economy is.

Here, both the considered economies clearly are in two stages of development and that has been echoed in most of the indicators, irrespective of whether it is economic, sustainability or human development indicators. Hence, at this stage any relative conclusions, in terms of which economy is comparatively more sustainable or achieving higher human development at a lower environmental cost, are impossible. Thus to overcome this barrier, a projection exercise is conducted with the following assumptions.

- Performance in Human Development Index is taken as the final objective of economic development.
- Value of various indicators (HDI, GDPpc, EF/BC, DMCpc) for Brazil's economy are kept constants at the level of year 2008.
- With the estimated linear trend of last ten years (out of ten years only 5 years is available), HDI of India is projected to reach Brazil's 2008 HDI.
- Similar linear trend for GDPpc, EF/BC and DMCpc for India is estimated to project their level at the year when India's HDI matches Brazil's HDI of 2008.

The result is of quite interesting, as only in the year 2027 India is reaching Brazil's HDI of 2008, i.e. 0.716. However, these projected GDPpc, EF/BC and DMCpc for India are only 23%, 43% and 40% respectively of Brazil's 2008 standard. Hence, it can be justly concluded that India will realize similar human development with better sustainability than Brazil. Proper reason behind this phenomenon needs more in-depth investigation and clearly that is out of the scope of this paper. However one fact should be flagged in this regard is that India's GINI coefficient in the year 2005 is only 59% of the same for Brazil. This indicates that, the comparatively unequal society of Brazil might be the reasons for losing sustainability to achieve the same amount of overall human development.

5. Discussions and Conclusions

Based on our analyses, the following policy recommendations, particularly for developing economies, need to be flagged:

- Firstly, as already indicated, GDP growth at times is extremely necessary for developing economies to cater to the largely unfulfilled needs of its populations. However, considering the indicated strong trade-off between GDP growth and other sustainability indicators, a more sufficiency based approach is necessary. Thus the focus should be more on optimal GDP growth that can help in realising a desired amount of human development at the cost of minimal loss of sustainability. Both countries eventually will need to consider the possibility to make the transition to a qualitatively-improving steady-state economy as it is argued by ecological economists. Endless growth in GDP is not possible in a finite world, so Brazil and India must focus their economic and political efforts to an

economy whose main objective is in the continuous improvement of human life without physical expansion;

- Secondly, the importance of redistribution of wealth is absolutely imperative. This approach is closely linked with the first recommendations as for achieving desired human development, the GDP growth may not be the only solution. Rather more emphasis should be given in terms of more equal distribution of the already appropriated wealth of the nations;
- Thirdly, the improvement on the technology front is undeniably essential as that can help to attain a substantial amount of growth of GDP without compromising the sustainability of an economy to a large extent. Improvement of efficiency and focus on service sectors based industries resulting decarbonizing, is also equally important for rapidly growing economy; as already it might be the case for Brazil;
- Fourthly, the population growth control must be included in the political priorities in both countries. Obviously this issue is relatively more serious in India, where the population is higher than 1 billion people and the basic needs of massive percentage of population are not yet satisfactorily fulfilled. Brazil also needs to deal with the population issue, but in a different manner. The Brazilian population is aging fast and the labour productivity must increase in order to offset the diminution in the supply of workforce. Besides this, the public health system in Brazil in tremendously inefficient and might not be adequate to provide basic health care to the Brazilian elderlies in the near future.

As a very last word, we would like to highlight, completely acknowledging the major limitations of this kind of macro-economic indicators based approach, the importance of this kind macro scaled inter-economic study in providing insights for some alternative developmental models. Especially in the present era of Anthropocene, we need to more such studies to show us some direction for ensuring sufficiency for all without majorly scarifies the sustainability of our life-supporting ecosystems.

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