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HOW SOCIAL INEQUALITY AFFECTS SUSTAINABLE DEVELOPMENT: EVIDENCE FROM A CROSS-COUNTRY ANALYSIS OF THE COEFFICIENT OF HUMAN INEQUALITY AND THE SUSTAINABLE DEVELOPMENT GOALS INDEX

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ABSTRACT

Rising inequality is an urgent global issue and this is because of its implications for sustainable development in the world economies. In this paper we estimate the relationship between social inequality as measured by the Coefficient of Human Inequality and sustainable development which was measured by the Sustainable Development Goals Index. Using panel data for 142 countries over the period 2010 to 2019, we found evidence of a negative relationship between social inequality and sustainable development in both the long run and short run and this relationship seems to be robust to different specifications, the inclusion of control variables and the country's level of development. Furthermore, our analysis also found different associations between social inequality and the different dimensions of sustainable development. In particular, a negative relationship with the Human Development Index and Real Gross Domestic Product per capita but a positive one with Total Greenhouse Gas Emissions. These results are important for formulating and implementing policies aimed at promoting sustainable development, especially in highly unequal societies.

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INTRODUCTION

The impact of inequality on development has occupied a prominent position in a wide range of research and despite the acknowledgement in the literature that development encompasses much more than income, the study of the effects of inequality on development has been concerned largely with income inequality and its impact on economic growth. Over the years however, there has been a gradual shift in the analysis of how inequality affects development with many researchers highlighting the importance of other dimensions of inequality such as wealth (Piketty & Goldhammer, 2014), education (Mayer, 2010), health (Wilkinson & Picket, 2009b) and the environment (see Bullard, 2004; Pellow & Park, 2002). And in recent times, there has been an increasing call for more multidimensional inequality analysis since it is believed that unidimensional inequality measures do not capture the true nature and extent of inequality in society (Costa *et al*., 2017).This paper aims to contribute to the literature on how social inequality, which is multidimensional in nature, affects sustainable development. In particular, we empirically analyzed the impact of social inequality as measured by the Coefficient of Human Inequality (CHI) on sustainable development as measured by the Sustainable Development Goals Index (SDGI), in a panel of 142 countries over the time period 2010-2019. We distinguished between the long run and short run association and we evaluated the Kuznets Hypothesis with our data. We also compared our results with other research that utilize different measures of inequality and sustainable development. In relation to the existing literature on the relationship between inequality and sustainable development, previous studies have analyzed the complexity of this relationship and several of these studies which are reviewed in the next section have identified both positive and negative channels through which inequality influences sustainable development. Further, some of these channels are connected to the other dimensions of development beyond income, like health and education as well as the environment. This therefore suggests that there is a need to consider the impact of multidimensional measures of inequality on a broader definition of development that is beyond income and wealth. However, while previous works have analyzed the impact of inequality on economic growth, we are yet to identify any research that have examined this association using a comprehensive framework such as the SDGI framework. On the issue of inequality, the literature has largely been dominated by income based unidimensional analyses (see for instance, World Bank 2005;

Easterly, 2007; Marrero & Rodriguez, 2013; Castells-Quintana & Royuela, 2017) and even though income in most case is a socially desired good, it is not the only one since individuals in society also value other collective goods such as security, participation and autonomy, knowledge and education along with good health and a comfortable environment (Góngora-Mera, 2015). Over the years however, there has been a gradual shift towards more multidimensional analyses of inequality and thishas been supported by writers such as Therborn 2006, 2013; Boyce, 2008 and Binelli *et al.,* 2015 who have argued that examining inequality in several dimensions better informs our understanding of the influence it is having on both individual and society's progress and this is because inequality in different dimensions tend to move in the same direction and reinforce each other. Our paper therefore sets out to answer the question of how social inequality affects sustainable development in both the short run and long run and in this regard, we relied on the CHI and SDGI as our main variables since in our view, they offer a new perspective on the inequality-development relationship. The reminder of this paper is organized as follows: In the rest of this section, we reviewed and merged the literature on social inequality with that of sustainable development. In Section 2, we discuss our data and our empirical model. The main results, along with some robustness checks are presented and discussed in Section 3. Finally, our concluding remarks are outlined in Section 4.

Sustainable Development: The concept of Sustainable Development gained increasing attention during the 80s and this was attributed to the work done by the World Commission on Environment and Development (WCED). In 1987, the Commission published a comprehensive report titled Our Common Future and it lists the most serious threats facing humanity among which were the persisting poverty situation and the looming environmental crisis. For the Commission, the solution to these threats was sustainable development which it came to defined as "a development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (WCED 1987).Sustainable development is therefore thought of comprising three interdependent pillars of sustainability which are the environment, the economy and society. For environmental sustainability, the concerns are centered around the natural environment, that is, it focuses on things like the integrity of ecosystems and the diversity of species and how it endures and remains diverse and productive (Harris 2002). In line with this argument therefore, the ecological integrity is not only important for economic productive activities but also for social well-being in terms of health and social prosperity. Regarding economic sustainability, this refers to the improvement of economic conditions such as income and wealth and material well-being of people to a preferred level of standard of living. However, economic sustainability cannot be referred to as sustained growth only. In fact, it must encompass other dimension and specific types of economic activities that can promote a stable and dignified local livelihood for individuals in society but at the same time it must not harm the environment. This therefore suggest that the economic dimension of sustainability has a vital role to play in achieving environmental and social sustainability by providing the necessary material resources needed to address poverty and inequality and achieve social prosperity or to redress environmental degradation. In essence, economic sustainability is all about giving people what they want without compromising the quality of life of individuals and societies around the world especially in developing countries.

On the other hand, the social dimension of sustainable development is perceived by many authors as the most important pillar of the three because it acts as a mediator between the other two dimensions. Economic well-being and ecological integrity can only be achieved by social actions that lead to the formulation and implementation of adequate and binding rules (Boyer *et al*. 2016). Grießler and Littig (2005) defined social sustainability as the "quality of societies" and for these authors, "it signifies the nature-society relationships, mediated by work, as well as relationships within the society" (Grießler and Littig, 2005, p.72). In this regard, social sustainability is achieved when people improve their livelihoods and fulfil their human needs in terms of social justice, human dignity and participation with some degree of ease. Social sustainability therefore ensures equitable access to economic resources and opportunities and a comfortable environment for all. Furthermore, the 17 Sustainable Development Goals (SDGs) collectively embodied a shared global vision of how to combine the dimensions of sustainable development into action at the local, national, and international levels and progress on these goals is measured by the Sustainable Development Goals Index (SDGI). The Bertelsmann Stiftung along with the support from the Sustainable Development Solutions Network has published the index annually in their SDG Index and Dashboards Global Report since 2016 (Sachs *et al.,* 2016). The emergence of the SDGI as a measure to track a country's achievement across the 17 SDGs can be thought of as part of the extensive and still ongoing discourse and criticism of conventional measures of economic prosperity and development. Despite its robustness and its impact on policy and the academic community, the SDGI has been subject to several critiques. One such criticism is that the scarce availability of information for many countries generally results in about 60% of the SDGs indicators being disregarded in the SDGI (Diaz-Sarachaga *et al.,* 2018). Nonetheless, analyses of the SDGI can produce more insights on the study of the impact of social inequality on sustainable development.

Social Inequality: Prior to the 90s, most of the research on the issue of inequality was limited to studies conducted by economists and focused largely on economic inequality, whichis the unequal distribution of income and wealth in society, (see for example Atkinson 1980, 1983; Kuznets 1955). In recent years however, many scholars have shifted to a more comprehensive notion of inequality referred to as social inequality which is multidimensionalin nature (for an overview see Costa *et al*., 2017, Bashi-Treidler and Boatcă2016, Guidetti and Rehbein 2014). Thisapproach towards examining inequality is rooted in other individual wellbeing aspects apart from income and wealth as it includes adifferential access to power resources (see also Kreckel 2004). This is arguably the case since income and power inequalities tend to reinforce each other (Therborn, 2006 & 2013; Boyce 2008). In addition, it is worth noting that income and wealth are in most cases socially desired goods, but they are not the only ones. Individuals in society also value other collective goods such as security, participation and autonomy, knowledge and education along with good health and a comfortable environment but they may differ significantly in their possibilities to access these goods (Góngora-Mera, 2015). Given the multidimensional and interdependent characteristics of social inequality, Costa *et al.,* 2017 defines it as the "distance between positions which individuals or groups of individuals assume in the context of a hierarchically organized access to relevant social goods (income, wealth, etc.) and power resources (rights, political participation and positions)" (Costa *et al*., 2017, p.6).

A deeper exploration into the issue of social inequality reveals that establishing conceptual clarity is rather challenging and not as straightforward as one might think and this is because there has never been just one way of examining a social issue; rather, different concerns and interests lead to different questions and answers. However, one cannot deny that analysis of inequality in several dimensions is more likely to provide richer insights as to what is happening with inequality and more importantly how it is affecting a country's sustainable development progress. In the next section, we discussed three important channels through which inequality affects sustainable development, and these are economic development, the environment and health and social problems.

The effects of inequality on sustainable development: A vast majority of the literature on the effects of inequality on sustainable development has focused mainly on its impact on economic development and in particular economic growth, but the evidence unearthed to date is not completely unanimous. In this regard, traditional writers such as Lewis (1954), Kaldor (1955), Baldwin (1956), Murphy (1989) and Forbes (2000) supported the hypothesis that inequality is beneficial for economic growth in the post

industrialization period. Interestingly, most of the studies relied on panel data, focusing on variation within countries over time, and relate to a short-run effect. The positive mechanisms circled around (a) higher savings rates (Kaldor, 1956) and (b) imperfect capital markets with investment indivisibilities (Aghion, *et al*., 1999) in physical and human capital. On the other hand, modern writers such as Alesina & Rodrik, 1994; Easterly, 2007; Herzer & Vollmer, 2012; Oechlin & Zweimüller, 2014; Ostry, Berg, & Tsangarides, 2014; Persson & Tabellini, 1994; Galor & Zeira, 1993and Aghion & Bolton, 1997 argued that inequality has an adverse effect on the process of economic development by limiting human capital investment**. T**hese studies were based on cross-country variation and focused on long-run effects and the negative mechanisms were linked to (a) greater sociopolitical instabilityandrisk of social conflict and unrest, implying uncertainty of property rights and reduction of investment (Alesina & Perotti, 1996) and (b) higher redistributive pressure that creates economic distortions and disincentives (Alesina & Rodrik, 1994; Persson & Tabellini, 1994). Regarding the environment channel, research on the relationship between the environment and inequality is fairly extensive and many researchers support the claim that social and power inequalities may serve to deteriorate the environment through multiple channels. In examining this relationship, the spatial pollution scale is considered to be an important characteristic for the link between inequality and the environment. As Boyce (2008) notes, many environmental pollution types are localized and are disproportionately shared by the communities at the margin of society. This localized nature of the environmental pollution insulates the rich people from the harm caused by its effect on health. In essence, the poorest and most vulnerable groups in society are often those who are affected in a significant way by local pollutions.

Torras and Boyce (1998) were among the first to provide an empirical analysis of the relationship between inequality and the environment. Relying on data drawn from the GEMS database for pollutant concentrations throughout the 1977-1991 period in 18-52 cities in 19-42 countries, they demonstrated that inequalities interact with per capita GDP levels in explaining pollution. Their results were similar to Grossman and Krueger (1995) which confirmed the Environmental Kuznets Curve for most of the pollutants. A similar paper is Baek and Gweisah (2013). Baek and Gweisah (2013) confronts the inequality environment relationship by utilizing a logarithmic linear regression equation along with annual time series data from the US spanning the period 1967 to 2008. Their findings suggest that inequality measured using income distributionand environmental degradation measured by per capita CO_2 emissions shares a positive relationship both in the short and long run. As a result, they conclude that the greater equality of income in the US has a beneficial effect on environmental quality. In addition to the cited literature above, other studies have shown that as the gap between rich and poor people widens, the extent of environmental damage increases. One such analysis is Gates *et al*. (2002) which found an underlying significant and negative relationship between social inequalities and the preservation of ecosystems through their negative impact on political freedoms. With respect to the impact of inequality on health and social problems, there have been several major studies, including the Whitehall Studies (Marmot, *et al*., 1978; Marmot, *et al*., 1984; Marmot and Shipley., 1996), along with some major reviews of the social determinants of health (Department of Health and Social Security, 1989: Townsend, *et al.,* 1986; Acheson, 1998; Marmot, 2010), which have clearly demonstrated the linkages between the socio-economic background of individuals and health. Where causation is concerned however, one of the most recent, and major studies to establish causation is that of Kondo, *et al.,* (2009), who carried out a meta-analysis of 9 cohort studies and 19 cross-sectional studies involving over sixty million subjects worldwide and their overall conclusion was that income inequality has an independent effect on health. In a similar vein Wilkinson and Pickett (2009a) argued that income inequality causes health and social problems due to 'status anxiety'. They suggest that income inequality is harmful because it places people in a hierarchy which increases status competition and this in turn contributes to poor health and other negative outcomes. In this regard, Wilkinson and Pickett (2009a) notes that the situation under which people live has a psycho-social impact on their lives, over and above their own individual circumstances. Drawing on the work of Marmot (2004), they posit that anxiety about social status is the mechanism by which income inequality causes social problems (see also James, 2007). The preceding discussion on the impact of inequality on development has unearthed an important finding which is that emerging research on the impact of inequality on sustainable development has begun to focus on other dimensions of development beyond income. However, none of these papers have examined the effects of multidimensional inequality on a broad definition of development. We are unaware of any paper analyzing the effects of social inequality as measured by the CHI on sustainable development, measured by the SDGI. However, in their paper Castells-Quintana *et al.,* 2018 examine the inequality-sustainable development relationship using a panel of 117 countries for the period 1970-2010. For their analysis, they relied on income inequality measured by the Gini Coefficient and they approximate sustainable development using the Human Development Index (HDI). In this paper therefore, we do something complementary yet different, which is to analyze the association between inequality and sustainable development using the CHI and the SDGI and we identify a causal effect using different estimation techniques.

RESEARCH METHODOLOGY

Data: This analysis relied onpanel data for 142 countries over the time period 2010-2019. The dependent variableis sustainable development and is measured by the SDGI. The index allows each country to compare itself with other countries in its region, with other counterparts at similar levels of overall economic development, and with the entire world, including the best and worst performers. The index was first published in 2016 by Sachs *et al.,* 2016 in the SDG Index and Dashboards- Global Report. However, it is available from 2000-2021 covering 177 countries which account for over 90% of the world's population. The index is computed using data from a mix of official and non-official sources on the indicators and targets for the 17 SDGs. Most of the data which are at the country level are drawn from the databanks of international organizations (FAO, ILO, OECD, UNICEF, WHO, World Bank and other sources) which follow extensive and rigorous data-validation processes. Other data sources include less traditional statistics such as household survey (Gallup World Poll), civil society organizations and networks (including Oxfam, Tax Justice Network, World Justice Project, or Reporters sans Frontières), peer-reviewed journals (for example, to track international spillovers) and geographic information systems (GIS) (see Sachs *et al.,* 2022).

The SDGI ranks countries regarding their initial status on the 17 SDGs. The Index allows each country to assess its current state of progress relative to its peers, to the SGD targets, and to the best possible scores on the various indicators. In addition, to compute the SDGI, the data for each indicator was ordered from worst to best and for each country an adjusted indicator score that lies between 0 and 100 was created. This adjusted indicator score marks the placement of the country between the worst (0) and best cases (100). A score of 70, for example, signified that the country is 70% of the way from the worst score to the best score.

The main independent variable is social inequality, and we rely on the CHI. The index was first published by the United Nations Development Programme (UNDP) in the 2014 Human Development Report, and it combines inequality in income, education and health for 191 countries. The index is available from 2010 to 2021 and it draws on the Atkinson (1970) family of inequality measures with the inequality aversion parameter Ɛ set equal to 1. The CHI ranges between 0 (perfect equality) and 1 (perfect inequality) (see UNDP, 2020 for more details). The index is selected because of the availability of data, its robustness and the fact that it captures inequality on several important dimensions of human development. However, it is not without its flaws, one of which is that it excludes dimensions that are considered to be important for analyzing human wellbeing and these include the wealth and environmental

dimensions. This analysis also utilized control variables and the literature on the determinants of cross-country differences in economic development was followed to identify these variables. These controls included Real GDP per capita (Constant 2017 international$), Government Expenditure on Education (as percentage of GDP), Life Expectancy (years) and Per capita Annual production-based emissions of carbon dioxide (tons of CO_2 per person). We also include a continent dummy variable to control for different continent effects. The data for these variables were obtained from a number of official sources. We work with annual data, as standard in the literature, between 2010 and 2019. Further, the descriptive statistics for our main variables are summarized in *Table 1* and from this table, we observegreat variations in both the SDGI and the CHI. Using our data, we constructed a scatter plot between SDGI and CHI which is presented in Figure 1, and we also computed the correlation coefficient for these variables. As shown in Figure 1, there is a strong negative correlation between the SDGI and CHI and this is confirmed by the correlation coefficient which is -0.90. This value highlights the fact that many countries with high levels CHI had low SDGI values which include countries such as Denmark, Norway and Switzerland. On the other hand, countries with a high CHI are observed to have a low SDGI, and these include Central African Republic, Niger and Chad.

It is worth noting that the overall correlation between the CHI and the SDGI did not change when controlling for time fixed effects (-0.903). The value however changed but remained negative when controlled for country fixed effects (-0.993) and both time country fixed effects (-0.998) suggesting that social inequality and sustainable development share a negative relationship.

Empirical Model: The descriptive analysis conducted indicates a negative overall correlation between social inequality and sustainable development. Does this negative relationship hold when we consider certain control variables and other determinants of sustainable development?

Is this relationship different for different groups of **countries**? And is there a causal effect of social inequality on long-run sustainable development? To answer these questions, we follow the literature on the determinants of sustainable development in the long run to investigate if social inequality can help us predict levels of sustainable development. In this regard, the model specification becomes:

$$Log(SDGI_{it}) = \beta_0 + \beta_1 log(CHI_{it}) + \beta_2 log(Co2Em_{it}) + \beta_3 log(RGDPPer_{it}) + \beta_4 log(GovExpEdu_{it}) + \beta_5 log(LifeExp_{it}) + \mu_{it} \quad (1)$$

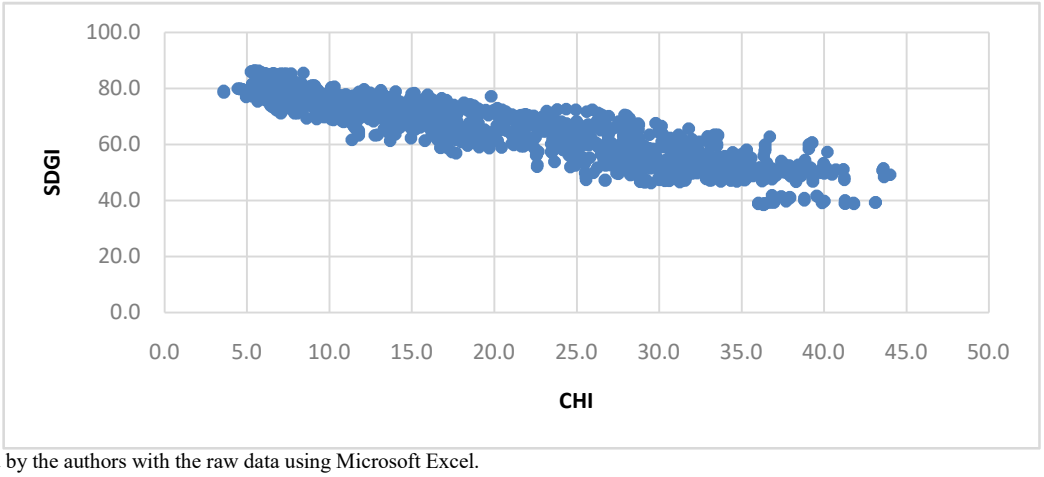
where $SDGI_{it}$ is the Sustainable Development Goals Index in country i and time *t*, CHI is the Coefficient of Human Inequality which is our measure of Social Inequality for the main independent variable. Annual CO_2 emissions per capita (Co2Em), RGDP per capita (RGDPPer), Government Expenditure on Education (GovExpEdu), and Life Expectancy (LifeExp) are our main controls, and μ_{it} is the random error term. $\beta_0$represents the intercept for the model and β_1-β_5 are the elasticity values. We define our time dimension annually from 2010 to 2019 and the decision on the time length was motivated by the availability of data as the CHI is only available from 2010. The log-log functional form was used for three main reasons. Firstly, we are interested in comparing our results and findings to Castells-Quintana *et al.,* 2018 and they used the log-log functional form in their estimation. Secondly, we are interested in estimating elasticity values between our dependent variable and the independent variables. Thirdly, based on the Kuznets Hypothesis, we believe that the relationship between social inequality and sustainable development is non-linear, and this made the log-log approach more applicable to our data. We estimate the main underlying model for SDGI specified in Equation (1) as well as for different dimensions of sustainable development and different groups of countries and we did thisusingdifferent estimation techniques. For our Panel EGLS and Fixed Effects (FE) approaches, we cluster standard errors by country and include time and country fixed effects to control for global shocks and for unobserved country-specific characteristics.We also perform some robust checkson the model.

Table 1. Descriptive Statistics for the Main Variables and Controls

	SDGI	CHI	CO2EM	GOVEXP	RGDPPER	LIFEEXP
Mean	65.45	20.31	4.05	4.43	18650.39	71.13
Median	67.43	19.05	2.37	4.34	11625.85	72.99
Maximum	86.41	44.00	70.69	11.78	116518.30	84.63
Minimum	38.45	3.58	0.03	0.47	751.66	45.10
Std. Dev. Overall	10.77	10.27	5.44	1.76	19463.96	8.62
Observation	1420	1420	1420	1420	1420	1420
# of Countries	142	142	142	142	142	142
# of Years	10	10	10	10	10	10

Source: Computed by the authors using EViews 12. Note SDGI and CHI are measured in % and data collected from Sachs *et al.,* 2022 and UNDP (2022), CO2EM is Per Capita Annual Production-based Emissions of Carbon Dioxide (tons of CO_2 per person) and the data was gathered from the Global Carbon Project (2022). GOVEXP represents Government Expenditure on Education (as percentage of GDP) with the data coming from Our World in Data based on UNESCO (via World Bank). RGDPPER is Real GDP per capita (Constant2017 international $) and this data was obtained from World Bank and OECD. Finally, LIFEXP is Life Expectancy (years) and the data was obtained from UN WPP (2022); Zijdeman*et al*., (2015); Riley (2005).

Figure 1. A Scatter Plot of the Relationship Between SDGI and CHI, 2010-2019



Source: Constructed by the authors with the raw data using Microsoft Excel.

Table 5. Social Inequality vs Sustainable Development forHigh andLow Income Countries

	High Income (Linear)	High Income (Log-Log)	Low Income (Linear)	Low Income (Log-Log)
Dependent Variable: SDGI				
CHI	-0.431*** (0.0219)	-0.079*** (0.003)	-0.326*** (0.037)	-0.171*** (0.014)
Co2_Em	-0.047* (0.025)	-0.016*** (0.003)	-1.001*** (0.361)	0.009 (0.007)
RGDPPer	3.82E-0.5*** (1.17E-0.5)	0.039*** (0.004)	0.001*** (0.0002)	0.042*** (0.012)
Gov_ExpEdu	0.549*** (0.078)	0.030*** (0.005)	0.513*** (0.079)	0.034*** (0.005)
Life Exp	0.477*** (0.042)	0.345*** (0.027)	0.422*** (0.032)	0.394*** (0.037)
R^2	0.935	0.948	0.873	0.894
F-stat	2401.295*** (0.000)	3019.816*** (0.000)	786.714*** (0.000)	964.651 (0.000)
Observations	840	840	580	580
# of Countries	84	84	58	58
# of Years	10	10	10	10

Source: Computed by the authors using EViews 12. *Note*. Table reflects Panel EGLS for all estimatesand includes cross-section weights. Standard errors were clustered by country and are presentedin parentheses. ***p<0.01, **p<0.05, *p<0.1. Data in the previous year was carried forward for years with missing data.

Table 2. Different Estimation Approaches for the Main Variables and Controls

Dependent Variable: log (SDGI)	(1) Panel EGLS	(2) RLS	(3) Pooled OLS	(4) FE1	(5) FE2	(6) FE3
log(CHI)	-0.063*** (0.005)	-0.062*** (0.005)	-0.068*** (0.006)	-0.023*** (0.009)	-0.076*** (0.013)	-0.001 (0.006)
log(Co2Em)	0.001*** (0.003)	0.006** (0.002)	0.014*** (0.003)	0.019** (0.008)	0.015* (0.007)	0.019** (0.008)
log(RGDPPer)	0.029*** (0.004)	0.034*** (0.004)	0.026*** (0.004)	0.042** (0.017)	0.029** (0.013)	0.022* (0.012)
log(GovExpEdu)	0.036*** (0.005)	0.040*** (0.003)	0.035*** (0.004)	0.008 (0.007)	0.034** (0.016)	0.013** (0.006)
log(LifeExp)	0.485*** (0.028)	0.433*** (0.024)	0.482*** (0.028)	0.608*** (0.121)	0.541*** (0.077)	0.181* (0.092)
Fixed effects	No	No	No	Yes	Yes	Yes
R^2	0.983	0.730	0.904	0.993	0.898	0.996
Observation	1420	1420	1420	1420	1420	1420
# of Countries	142	142	142	142	142	142
# of Years	10	10	10	10	10	10

Source: Computed by the authors using EViews 12. *Note*. Panel EGLS includes cross-section weights. Standard errors were clustered by country for Panel EGLS, FE1, FE2 and FE3. A continent dummy was included for Panel EGLS, RLS and Pooled to control for different continent effects. Standard errors presented in parentheses. ***p<0.01, **p<0.05, *p<0.1. Data in the previous year was carried forward for years with missing data.

Table 3. SocialInequality vs the Different Dimensions of Sustainable Development

	(1) Dependent Variable: log(HDI)	(2) Dependent Variable: log(RGDP)	(3) Dependent Variable: log(TGGE)
log(CHI)	-0.047*** (0.005)	-0.154*** (0.024)	0.239*** (0.068)
log(Co2Em)	0.036*** (0.002)	0.491*** (0.011)	0.663*** (0.026)
log(RGDP)	0.078*** (0.003)	-	-0.127*** (0.040)
log(GovExpEdu)	0.005 (0.004)	-0.138*** (0.028)	-0.835*** (0.067)
log(LifeExp)	0.636*** (0.022)	3.307*** (0.155)	0.507 (0.314)
R^2	0.996	0.983	0.898
F-stat	29167.590***	8162.226***	1131.418***
Observation	1420	1420	1420
# of Countries	142	142	142
# of Years	10	10	10

Source: Computed by the authors using EViews 12. *Note*. Table reflects Panel EGLSfor all estimates and includes cross-section weights and continent dummy. Standard errorswere clustered by country and are presented in parentheses. ***p<0.01, **p<0.05, *p<0.1. Data in the previous year was carried forward for years with missing data. Finally, data for HDI and TGHG were gathered from UN Human Development Reports 2014-2020 and Climate Watch. 2020 respectively.

Table 4. Inequality vs Economic Growth for High and Low Income Countries.

	High Income (Linear)	High Income (Log-Log)	Low Income (Linear)	Low Income (Log-Log)
Dependent Variable: RGDPPer				
CHI	-377.215*** (45.976)	-0.165*** (0.019)	48.749*** (11.128)	0.268*** (0.090
Co2Em	935.909*** (146.231)	-0.165*** (0.019)	2811.377*** (302.733)	0.523*** (0.020)
GovExpEdu	361.265 (229.691)	0.009 (0.027)	14.983 (52.214)	-0.119*** (0.024)
Life Exp	2415.474*** (112.392)	6.028*** (0.185)	95.183*** (13.868)	0.870*** (0.155)
R^2	0.942	0.980	0.804	0.928
F-stat	3379.972*** (0.000)	10019.09*** (0.000)	588.532*** (0.000)	1845.802*** (0.000)
Observations	840	840	580	580
# of countries	84	84	58	58
# of Years	10	10	10	10

Source: Computed by the authors using EViews 12. *Note*. Table reflects Panel EGLS for all estimates and includes cross-section weights. Standard errors were clustered by country and are presented in parentheses. ***p<0.01, **p<0.05, *p<0.1. Data in the previous year was carried forward for years with missing data.

RESULTS AND DISCUSSION

Sustainable Development and Social Inequality: *Panel and Cross-section Estimates:* The main results are presented in *Table 2*and column's 1, 2, 3,4 ,5 ,6 refers to Panel Estimated Generalized Least Squares (Panel EGLS), Robust Least Squares (RLS), Pooled Ordinary Least Squares (Pooled OLS), Country Fixed Effects (FE1), Time Fixed Effects (FE2), and Country and Time Fixed Effects (FE3) respectively.Panel EGLS is presented in column 1 and for this approach cross-section weights are included to address the issues of autocorrelation and heteroskedasticity. We observe from this column that social inequality and sustainability development share a negative relationship that is significant. Also, all the controls had positive coefficients and were statistically significant and this was expected. These results tell us that a 1 percent increase in a country's level of socialinequality, holding everything else constant, leads to approximately 0.07 percent decline in its sustainable development progress. The results for the RLS, Pooled OLS and FE2 aresimilar to our Panel EGLS with marginal differences in the coefficients. Further, the results in column 4are derived using country fixed effects and the main difference in these results and the other approaches is that our control variable for Government expenditure on education was insignificant.Finally, the results when we included both country and time fixed effects is presented in column 6 and the highlight of this column is that even though our main variables share an inverse relationship, the relationship is insignificant.

In addition to the results presented in *Table 2*, we checked for multicollinearity using the Variance Inflation Factor and these statistics revealed that multicollinearity is not a concern for the model. Further, the insignificance of our country and time fixed effects estimate in Column 6 of *Table 2* does not necessarily mean that social inequality and sustainable development are unrelated. In fact, the coexistence of two opposing association between social inequality and different dimensions of sustainable development may explain this non-significance (See Castells-Quintana*et al.,* 2018). In addition, fixed effects estimates only consider variation within countries over time, so results can be interpreted as related to the short run (seeCastells-Quintana*et al.,* 2018;Partridge, 2005) while RLS and Panel EGLS can be considered as capturing a long run association (see for example Castells-Quintana*et al.,* 2018; Baltagi& Griffin, 1984; Pirotte, 1999). Therefore our results in *Table 2* indicate a negative and significant association between social inequality and sustainable development in both the short run and long run. However, it is worth noting that Castells-Quintana*et al.,* 2018 found a negative long run relationship between inequality and sustainable development but a positive short run association. Our results pertaining to the short run therefore seem to contradict Castells-Quintana*et al.,* 2018 and other research on the effects of inequality on sustainable development.

For ourresults when we separately regressed social inequality on the three dimensions of sustainable development using the Panel EGLS approach are presented in *Table 3*. In this regard, we use the HDI to measure social sustainability and this was adopted from Castells-Quintana*et al.,*2018, RGDP per capita was used for economic sustainability (see Aras & Filiz, 2020) and environmental sustainability is estimated using Total Greenhouse Gas Emissions (TGGE) as guided by Alola *et al.,* 2020.The results in *Table 3* show that social inequality shares a negative relationship with HDI (column 1) and RGDP per capita (column 2) but a positive relationship with TGGE (column 3). The negative relationship that social inequality shares with RGDP per capita contradicts previous studies that relied on panel estimates (see Forbes, 2000; Li & Zou, 1998). The negative association with HDI is explained by the fact that social inequality creates barriers for human capital accumulation (i.e., Easterly, 2007 and Galor & Moav, 2004).On the other hand the positive association between social inequality and TGGE is in line with the idea that inequality contributes to environmental degradation through greater pollution as identified byTorras &Boyce (1998) and Baek &Gweisah (2013).

The literature highlights that the overall association betweeninequality and development differs for different groups of countries and this was actually hypothesized by Simon Kuznets (see Kuznets, 1955).To investigate whether the social inequality-sustainable development relationship differs for different groups of countries or more importantly whether the Kuznets Hypothesis holds, we sort our data using the 2019 HDI value and countries were classified as either High Income or Low Income. In this regard, we define High Income countries as those attaining a high or very high human development index which means an HDI of 0.7 or above. We then estimate several regressions, first with RGDP per capita as the dependent variable (see Table 4) and then with the SDGI as the dependent (see Table 5). Table 4displaysthe Panel EGLS estimates for the two groups of countries using RGDP per capita and the resultsare consistent with the Kuznets Hypothesis.In this regard, we observe a positive relationship between social inequality and RGDP per capita for low-income countries but a negative relationship for the high-income countries and these relationships hold irrespective of the functional form. Our findings arealso consistent with Castells-Quintanaet al., 2018 and it reinforces the idea of Galor and Moav (2004) who argued that in the early stages of development, when physical capital accumulation is the driver of economic growth, inequality is growth enhancing but it becomes irrelevant for growth in developed countries.This finding however contradicts Barro (2000) whosuggests that inequality is negatively correlated with growth in less developed nations but is positively related to growth in developed countries. According to Barro (2000), inequality has a negative effect on development in developing countries through higher fertility rates and low investment in education.

Further, when the SDGI was used as the dependent variable which represented a broader measure of development, the Kuznets Hypothesis no longer holds (see Table 5). In this regard, we saw that the estimated coefficients for social inequality for both groups of countries remained negative and were statistically significant. Therefore, given the countries in our sample and the time period under consideration, the level of development has no effects on the negative relationship between a country's social inequality level and its sustainable development progress. This finding however, stood in sharp contrast to Castells-Quintana*et al.,* 2018 who found that the estimated coefficient for inequality in developing countries was positive when the HDI was the dependent variable.In summary, our resultssuggest that with the inclusion of our controls and differentiating by levels of development, a negative and statistically significant relationship exists between social inequality and sustainable development in both the short run and long run. However, our findings run in a sharp contrast to Castells-Quintana*et al.* 2018 who found a short run positive relationship between inequality and sustainable development as well as different associations based on the level of development. This is not surprising since their paper measures sustainable development using the HDI and their inequality measurement was the unidimensional Gini Coefficient.

CONCLUSION

Building on past research that examined the linkages between inequality and its impact on development, this paper tackled a somewhat neglected relationship in the literature, that is, the relationship between social inequality and sustainable development. To achieve this, we perform several econometrictechniques, relying on a cross-country panel data on social inequality measured by the CHI and sustainable development measured by the SDGI, from 2010 to 2019. By relying on the CHI and SDGI, we were able to consider other societal dimensions of development that is beyond income. In this regard, we are better able understand the effects of social inequality on both individual and society's progress and this has important implications for policy. It is our conclusion that in the short run as well as the long run, social inequality has a negative impact on sustainable development and this effect seems to be robust to several controls, estimation techniques, and a country's level of development.

Further, our results indicate that the negative relationship exists because higher levels of social inequality leads to greater greenhouse gas emissions which contributes to environmental degradation, it lowers a country's economic growth by reducing its RGDP per capita and it presents challenges for the attainment of greater human development, all of which are important for the achievement of sustainable development. In other words, social inequality perpetuates unsustainable development. Therefore, to advance sustainable development, countries need to identify and address their context specific drivers of social inequality. This paper has some limitations but it offers directions for future research. Firstly, we have used the SDGI as the measure for sustainable development and even though this is a comprehensive measure, it is not widely known and as such, there have been few empirical research papers that have actually relied on this index. In light of this, other indices of sustainable development such as the Sustainable Society Index and the Living Planet Index should be considered to see if the results would be consistent. Secondly, the comprehensiveness of the CHI as a measure of social in equality is called into question since it does not include other important dimensions such as wealth and the environment.

Asargued by Beck (1986), environmental problems are intricately linked to how human society is organized (Mohai & Kershner, 2002) and as a result, there is a connection between the exploitation of the environment and the exploitation of human populations (See also Bullard (2004), Pellow & Park (2002)). And where wealth is concerned, Piketty & Goldhammer (2014) demonstrated that even though income is a significant inequality dimension, it pales in comparison with wealth inequality today and that wealth inequality during 1914-1970 was more destabilizing to democracy than income inequality. As a result, including the wealth and environmental dimensions in any measure of social inequality would certainly add value to inequality research. With all of this considered, there is clearly the need for future research towards understanding the relationship between social inequality and sustainable development.

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