Exploring Challenges in SDGs with Focus on the Complementarity of Sustainable Growth, Equality, and Consumption

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Abstract: The urgency of achieving the United Nations Sustainable Development Goals (SDGs) is evident, yet progress remains insufficient in key areas such as decent work and economic growth, reducing inequality, and responsible consumption and production. This paper explores the systemic obstacles hindering progress in these areas, with a focus on factors such as low wages, constrained consumption, and inefficient resource allocation. The study seeks to examine these barriers through an analytical framework aimed at identifying their root causes and implications. The findings underscore the interconnectedness of economic and social dimensions of inequality, consumption, consumption footprint and circularity and offer insights for addressing these challenges. By synthesizing the results, the paper provides a foundation for future policy recommendations and highlights the need for targeted interventions to ensure sustainable development.

Keywords: Sustainability, Economic Growth, Inequality, Consumption, SDGs
JEL Classification: D12, I32, O44, Q56

1 Introduction

Although relationships between sub-objectives can be neutral, such neutrality is rare in the economic, and especially socio-economic, sphere. Most objectives are therefore rather complementary, though some sub-objectives may be mutually exclusive. However, it is not possible to determine ex-ante what the relationships between the sub-objectives will be. This paper thus aims to examine the relationships between SDG sub-goals, with a focus on growth, consumption, and equality. The assessment will consider these relationships not only from an environmental-economic perspective but also from a socio-economic perspective, accounting for the sustainability of production, consumption, and the impacts of income inequality.

The environmental impacts of production and consumption are examined either in relation to the life cycle of products, where impacts are allocated to final consumers (Sanye Mengual and Sala, 2023), or in relation to the production process itself, where impacts are allocated to producers (Li et al., 2023).

To assess the environmental impacts of household consumption, a consumption footprint indicator covering five consumption domains was proposed. Castellani et al. (2021) evaluated its values using the Environmental Footprint 3.0 method. Razzaq et al. (2021) further analysed the relationship between material footprint and infrastructure development through green innovation, globalization and resource depletion. Adewumi et al. (2024) chose institutional influences as another aspect of evaluation, using data from 27 EU member states between 2014 and 2023, they concluded that while circularity-based entrepreneurial activities can improve economic welfare, effective management of the consumption footprint is essential for optimization. However, the assessment and partial conclusions may differ following the use of European or national data due to the so-called outsourcing of environmental impacts, as found by Nuss et al. (2023) based on an analysis of European and German consumption statistics from 2010-2018. Moreover, based on beta- and sigma-convergence values obtained from the analysis of data from 2014-2018 in EU countries, Markowski et al. (2023) conclude that CEE countries are moving away from other EU countries in most indicators in terms of sustainable production and consumption or their negative environmental impact.

Based on the current indicators of circular economy or circularity in general, Muñoz et al. (2024) propose a holistic approach to assess circular strategies through the construction and use of the so-called 9R circularity index. In doing so, they respond to the lack of harmonisation of the growing number of tools developed for assessment and subsequent decision-making, e.g. following Valls-Val et al. (2022). Similarly, Colasante et al. (2022) also proposed a new index

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under the name of the New Circularity Index following the processing of data from 28 EU countries from 2014-2018. As a further level of circularity assessment, Okumura (2022) developed a model of product reuse efficiency, based on optimal product durability, end-of-life collection rates, and the number of reuse cycles. Recycling scenarios in relation to landfilling in the context of EU directives have also been addressed by Agovino et al. (2024). Based on an analysis of the literature, Kapoor et al. (2023) concluded that progress in monitoring circularity in cities and regions will require stakeholders to test only a very small number of indicators and sets of indicators in the context of circularity, which are both relevant and practical for effective monitoring.

2 Methods

This paper aims to analyse Challenges in achieving so-called sustainable development goals (SDGs) while focusing mainly on growth, equality and consumption. Given one of the goals was to assess sustainability, the rate of circularity was also included in the analysis. There are many ways to express the circularity rate, in this paper, it is presented as circular material use rate. It measures the proportion of materials that are recovered and fed back into the economy, thus conserving primary raw materials within the overall material usage. It is important to mention what form of other data was used. There are many methods to measure and express inequality. For example, the Gini coefficient, however, in this paper the method top20down20 ratio was used. For which, from now on in the paper, the general term "inequality" is used. Simply put the top20down20 measures, how many times is the income of the top 20 % greater than the one of the bottom 20 %. The consumption footprint indicator is very complex and has many forms, in this paper the single weighted score is used. It calculates the consumption footprint by summing the environmental impacts of various categories, adjusting each by a global normalization and weighting factor to create a single composite score. It is expressed as a value per inhabitant. As for housing expenditure, it is measured as a percentage of household total expenditure on the final consumption, broken down according to the Classification of Individual Consumption by Purpose (COICOP). To be exact, specifically category 04 - Housing, water, electricity, gas and other fuels.

To assess the relationship between these variables, data for all 27 countries from the European Union were used. The time period used for this paper is 2010 – 2022. All the data except the Gross National Income (GNI) per capita in purchasing power parity (PPP), were taken from Eurostat. The GNI per capita (PPP) data were taken from the World Bank database. The whole statistical analysis was conducted in the statistical software R. Mainly using a linear regression model, which was used to assess the relationship between all the variables. To further understand these relationships, we then included the lagged variables in these models. Using lag 1 and lag 2, we were able to assess the direction of the relationship and the behaviour of these relationships deeper. In other words, using lagged variables allowed us to explore whether past values of one variable impact other variables in subsequent years and vice versa.

$$reg\_model \; <- \; lm(variable\ 1 \sim variable\ 2, data \; = \; data\_combined) \tag{1}$$

$$model\_lag \; <- \; lm(variable\ 1 \sim lag(variable\ 2, 1), data \; = \; data\_combined) \tag{2}$$

The example of the difference in a linear model with and without using lagged variables can be observed in formulas (1) where there is no lag included and in formula (2), where is lag of value 1 used. The value 1 represents the lag of 1 year and in this example the model_lag tests whether variable 2 in year n has any impact on variable 1 in year n+1. After conducting the first part of the analysis, the relationship between the explanatory variables—inequality and housing expenditure—and the dependent variable, consumption footprint, was analysed using a multivariate linear model. An interaction term was included to investigate how the level of inequality moderates the effect of housing expenditure on the consumption footprint, revealing that higher inequality is associated with lower housing expenditure. Before the paper focuses on the hypotheses themselves, brief attention needs to be devoted to the properties of the variables being examined in the paper. These properties are summarized in the descriptive statistics table, which includes values such as mean, median, standard deviation, or minimum and maximum values.

Table 1 Descriptive statistic of variables analysed in the paper

Variable	Mean	Median	Std. Deviation	Min	Max
Inequality	4.76	4.36	1.17	3.03	8.32
Housing Expenditure	22.39	22.5	4.03	12.0	31.5
Consumption footprint	0.94	0.94	0.20	0.54	1.42
Circularity	8.66	7.0	6.32	0.6	29.0
GNI per capita	46 486	43 028	15 819	21 515	95 715

Source: Authors calculations

Authors of the paper formed three hypotheses that were all tested using the methods mentioned. Linear model in software R provided a needed test to assess whether there is a relationship and if there is one, then whether this relationship is statistically significant. To assess whether the relationships are statistically significant, standard measures were used, specifically a 5% significance level, which corresponds to a 95% confidence level. All three hypotheses were conducted as null hypotheses that typically assume no relationship exists. The first null hypothesis was conducted as follows:

(1) Null hypothesis (H0): *"There is no significant relationship between housing expenditure and inequality."*

The reason for testing this relationship was to determine whether housing expenditure constitutes a larger share of income in countries with higher or lower levels of inequality. This analysis was then extended to examine whether the countries with the lowest levels of inequality are those with the highest or lowest GNI per capita. This relationship between inequality and GNI per capita can be observed in Figure (1) – see results. The second hypothesis focuses on the relationship between consumption footprint and the rate of circularity. The second null hypothesis stands as follows:

(2) Null hypothesis (H0): *"There is no significant relationship between the consumption footprint and the rate of circularity."*

This relationship is especially interesting to analyse because the results may not come as expected. One might anticipate that a higher rate of circularity would correspond with a reduced consumption footprint. It is however much more complicated relationship because the level of circularity is determined by the manufacturers while the consumption footprint depends on the consumers. Their level of responsible consumption determines the level of consumption footprint. In addition, it should be mentioned that despite the efforts of some companies to increase circularity, the consumption footprint may also increase until consumers realise the importance of responsible consumption. It is therefore important to believe that this positive relationship will tip into a negative one in the future, with increasing levels of circularity and decreasing consumption tops. As for the third and last hypothesis tested in this paper, this hypothesis again revolves around circularity, this time with inequality. The third null hypothesis stands as follows:

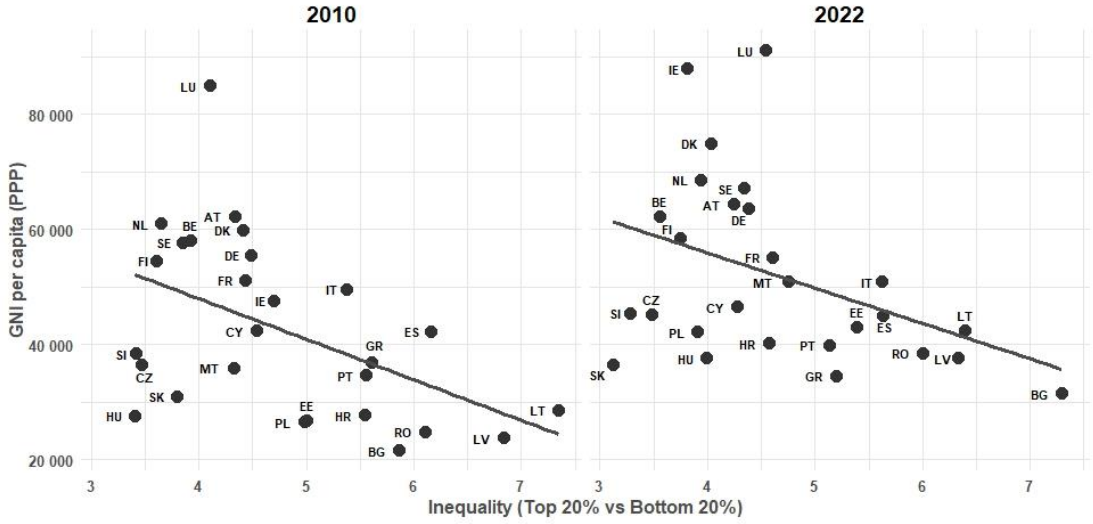
(3) Null hypothesis (H0): *"There is no significant relationship between the rate of circularity and inequality."*

The possible connection between inequality and the rate of circularity is as important as interesting to analyse, because of the importance of both variables. Circularity is gaining more and more attention and importance nowadays. Similarly, there is an emphasis on reducing inequality, so that if, for example, lower inequality is shown to promote higher levels of circularity, this could be considered a very interesting finding. All three hypotheses were developed with reference to the Sustainable Development Goals (SDGs), with a focus on equity - represented in the data as inequality, consumption - represented by housing expenditure, responsible consumption - using the consumption footprint, and sustainability through the circularity rate.

3Research results

Based on the established hypotheses mentioned in the methods, an analysis was conducted. The first hypothesis tested deals with the relationship between housing expenditure and inequality. The results of testing this hypothesis show a statistically significant negative relationship between these two variables. In other words, the analysis suggests that lower inequality is associated with a higher percentage of household income spent on housing expenditure. This conclusion might seem logical, as one could assume that less developed countries are less unequal because there are fewer entities whose income significantly surpasses that of others. At the same time, we might also expect that these countries would logically need to spend a larger portion of their income on housing.

Figure 5: GNI per capita (PPP) and inequality (Top20% down20%), 2010 and 2022



Source: Authors calculations

However, what is surprising is that when we look at the inequality structure of the countries in the analysed dataset in relation to income per capita, we see that countries with lower inequality are, in fact, among those with the highest income per capita (see Figure 1). Moreover, this relationship remains consistent over the entire period between 2010 and 2022. This finding shifts the interpretation of the original findings, suggesting that in the countries with lower inequality in the dataset, there is higher income per capita and likely a higher standard of living. Consequently, in these countries, higher housing demand could lead to higher prices, meaning that residents need to allocate a larger portion of their income to housing expenditure. However, it is important to point out that the countries in the dataset are all relatively highly developed countries, all from the European Union. The results may differ when developing countries with very low income are included. The exact results of the data analysis concerning not only this first hypothesis can be seen in Figure 2, which also includes the results of the analysis for hypotheses 2 and 3. To conclude on hypothesis 1, it should not be missed that the coefficient of the effect of inequality on housing expenditure increases with the use of lags 1 and 2, which in other words means that the effect of inequality in the following two years persists and may even become stronger with a longer time lag, since, for example, the value of the coefficient for inequality in year n and housing expenditure in year n+2 is -0.6474.

Table 2 Overview of the results from testing hypotheses

Relationship	Coefficient	Std. err.	p-value	R-squared
Housing expenditure ~ Inequality	-0.5480	0.1780	0.00223	0.02485
Consumption footprint ~ Circularity	4.860	1.690	0.00429	0.02314
Inequality ~ Circularity	-0.0597	0.0092	3.57e-10	0.1067

Source: Authors calculations

As for the second hypothesis, the results of testing relationship between consumption footprint and the rate of circularity are very interesting to say the least. As already indicated in the methods section, this relationship appears to be very complicated however the analysis finds statistically significant strong positive relationship between the two variables. Again, using lag 1 and lag 2, the results show that the effect of the consumption footprint on circularity persists even after two years, but this effect gradually decreases, where compared to the model without lag with a coefficient value of 4.860 (see Table 2) for the model with lag 2, i.e. with a two-year lag, the coefficient value is only 3.956. This finding may appear strange to some as it could be expected that higher circularity rates bring the consumption footprint down, it is however not the case. This may be due to the fact that countries with higher GNI per capita and their companies are more focused and concentrated on the circular economy than countries with lower GNI per capita, as confirmed by this analysis, where the association between GNI per capita and the level of the circular economy shows a statistically significant positive relationship. However, consumers in these countries are likely to spend more and somewhat without concern for sustainability. Whether this is a matter of mindset or a matter of price, where sustainable and more environmentally friendly goods may be more expensive, should be the subject of future research as it is a very interesting question. Not only higher GNI per capita is connected with higher rates of circularity. Testing the third hypothesis showed

a statistically significant negative relationship between the circularity rate and inequality. In other words, lower inequality was found associated with higher rates of circularity.

Figure 2 Diagram of connectivity between analysed variables

Source: Authors creation

If we link these results together, this creates at least a partial picture of how the relationships between these variables may work. In an attempt to connect all variables that were analysed in this paper in joint dependence and continuity, the connection may look something like Figure 2.

4Conclusions

As already mentioned, higher GNI per capita is associated with lower inequality. Both lower inequality and higher housing expenditure have been found to be positively related to a higher consumption footprint. Moreover, using a multivariate linear model, the significance of both relationships persists, and higher inequality was found to be associated with lower housing expenditure, thus reducing its effect on a higher consumption footprint. All these results can be interpreted as suggesting that lower inequality in higher-income countries is associated with more expensive goods and other services, with housing being no exception. Moreover, consumers with low sustainability concerns spend more and on unsustainable goods, thus generating a higher consumption footprint. On the other hand, a higher consumption footprint promotes a higher level of circularity, either because companies are more aware of the need for a circular economy or because these higher-income countries focus on sustainability. Either way, the result is increased circularity. This offers great scope for future research to determine whether, in the long term, the initially increased consumption footprint will start to decrease as the level of circularity reaches even higher values. The increase of circularity rate is however only a part of the solution, for this to happen, consumers must, among other things, become responsible and help societies achieve sustainable development. This suggests some similarities to the Kuznets curve, which speaks about an initial increase of pollution and eventual decline as the country's income countries to rise.

The results confirm that it is necessary to examine individual phenomena in their interconnectedness if the partial findings are to be the basis for design and measures to influence real phenomena and processes, not only economic but also social and environmental. The limit of the research is the available data and the related research horizon. Future research could be supplemented with additional variables, which could not only provide economic policymakers with more comprehensive information for their decision-making.

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