

Mirela Ionela ACELEANU, PhD (corresponding author)

mirela.aceleanu@economie.ase.ro

Bucharest University of Economic Studies, Bucharest, Romania

Anastasia COSMA, PhD Candidate

cosmaanastasia21@stud.ase.ro

Bucharest University of Economic Studies, Bucharest, Romania

Gina-Cristina DIMIAN, PhD

gina.dimian@csie.ase.ro

Bucharest University of Economic Studies, Bucharest, Romania

Maria Denisa VASILESCU, PhD

maria.vasilescu@csie.ase.ro

Bucharest University of Economic Studies, Bucharest, Romania

Mihaela MAFTEI, PhD

mihaela.maftei@ase.ro

Bucharest University of Economic Studies, Bucharest, Romania

The Synergy between Sustainability and Societal Wellbeing: An Econometric Analysis of the Mediating Effect of Clothing Overconsumption in the EU

Abstract. *Rising living standards in the European Union have gone hand in hand with persistent environmental pressure and with a steady expansion of discretionary household consumption, yet these three developments are rarely examined jointly. Whether material consumption helps translate economic progress into human development, or instead offsets part of its environmental cost, is an open question with direct implications for the design of European sustainability policy. The aim of the study is to investigate the influence of economic and environmental factors on the Human Development Index and to assess the mediating role of overconsumption. The methodology involved the analysis of panel data for the 27 Member States of the European Union and the United Kingdom, covering the period 2000-2023. To ensure the robustness of the results and to address the issues of endogeneity and cross-dependence, advanced econometric models, such as GMM (Generalized Method of Moments) with FOD (Forward-orthogonal deviations) and PCSE (Panel Corrected Standard Errors), were used. The results confirm that per capita CO2 emissions have a significant negative impact on HDI. Furthermore, the results are consistent with a full mediation of the relationship between emissions and human development through clothing expenditure. The heterogeneity analysis highlights clear differences between countries: in countries with above-average consumption, the impact of emissions on HDI is strong and negative, while in countries below average it becomes insignificant. The study contributes to the literature by proposing a unified theoretical framework integrating the three pillars to guide sustainable economic policy decisions at European level.*

Keywords: *wellbeing, sustainability, overconsumption, HDI, CO2 emissions, clothing expenditure.*

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1. Introduction

The last few years have witnessed an increase in the level of interest given to wellbeing both at the personal and societal level, in relation to various influencing factors, including sustainable development and overconsumption. This interest comes from an accelerated economic growth that is supported both locally and internationally. Thus, consumption becomes an accelerator and a reflection of economic development. Improving wellbeing as a result of individual and collective consumption, ensures access to a wide range of goods and services. As a result of diversity and freedom of choice, consumer preferences are constantly changing, which leads to the expansion of demand across market segments (Deputatova et al., 2018). At the same time, globalization is a determining factor in emphasizing the consumption effect. This allows for economic, cultural and technological interconnection at the country level. Hence, digitalization supports easy and fast consumption with the help of technology and online commerce (Apostu et al., 2024). Therefore, wellbeing is affected by the complementarity between the degree of environmental sustainability and overconsumption.

Sustainable development highlights the establishment of a harmony between economic progress, social needs and environmental protection, so that the current wellbeing is ensured, without compromising the wellbeing of future generations (Baysal & Sutton, 2024; Kaklauskas et al., 2020). At the same time, overconsumption is addressed in several areas of interest such as natural resources, food, digital use (Håkansson, 2014). Lately, this topic has been mentioned specifically in discussions on clothing consumption, with “fast fashion” consumption receiving great attention (Fifita et al., 2020).

These key concepts, although they have been addressed individually or as a duo, are rarely discussed in the literature as a synergy of the three. Moreover, the diversity of results presented in different studies indicates the need for a more in-depth exploration in this area. This need motivated the choice of the topic and the purpose of this study. Thus, the European Union represents a starting point in approaching this discussion. It provides a common institutional, economic and digital framework, through which it allows the application of collective measures that aim to recalibrate climate change, sustainable development and wellbeing. Taking this context into account, the purpose of this study is to contribute to the empirical debate on how wellbeing is affected by the level of sustainability, considering the mediating effect of overconsumption.

Therefore, this study proposes the following objectives: a) to investigate how economic and environmental factors influence the evolution of wellbeing, expressed

by the human development index, in European countries, for the period 2000-2023; b) to assess the mediating role of clothing and footwear consumption in the relationship between CO2 emissions and HDI.

The paper contains five dedicated sections. The first section presents, based on the specialized literature, empirical studies of the three pillars: well-being, sustainability and overconsumption. The main hypotheses are also outlined here. The second section covers the methodology, the tools used, the participating variables and the data sources. The next section presents the empirical results and launches a discussion based on them. Finally, the paper concludes with the last section that describes the main conclusions and offers the practical and theoretical implications that emerge from the study results.

2. Literature Review

The concept of sustainable development (the interdependence between the natural environment and human wellbeing – quality of life) depends fundamentally on ecosystem services and natural capital, which requires the integration of environmental sustainability in the definition of societal progress (Baysal & Sutton, 2024). In this sense, wellbeing and the environment are not opposing concepts, but complementary dimensions of development; multi-criteria approach simultaneously assess ecological performance and quality of life, reflecting the three pillars of sustainability (economic, social, environmental) in assessing the prosperity of nations (Kaklauskas et al., 2018).

At the macroeconomic level, wellbeing is frequently reflected through composite indicators, of which the Human Development Index (HDI) occupies a central place, providing a multidimensional assessment of development by integrating the dimensions of health, education and income (Assa, 2021). The HDI emerged from the need to overcome the limitations of Gross Domestic Product (GDP) as the sole benchmark of progress, emphasizing the improvement of people's lives through dimensions that reflect societal wellbeing (Lucia & Grisolia, 2021).

A growing body of research indicates the negative effects of environmental degradation on subjective wellbeing. Regarding EU countries, CO2 emissions per capita have a significant negative effect on the human development index, suggesting that pollution and carbon footprint can undermine social progress and quality of life (Karimi Alavijeh et al., 2024). On the other hand, investments in green technologies and clean energy seem to have the opposite effect: the wider use of renewable energy is linked to increased HDI and improved public health, both in the EU and globally (Karimi Alavijeh et al., 2024; Omri et al., 2022). Overall, a cleaner environment, lower pollutant emissions, and climate change adaptation efforts tend to generate tangible benefits in wellbeing indicators, both by improving health and increasing feelings of security and satisfaction (Ko et al., 2024; Omri et al., 2022).

The level of consumption, in turn, has profound implications for individual wellbeing. The theory "beyond a certain threshold, money does not bring happiness" is supported by numerous studies showing that, once basic needs are met, continued

increases in consumption and income bring diminishing benefits to happiness (Diener & Seligman, 2004). In particular, overconsumption aimed at the accumulation of material goods and social status – often associated with materialism – is negatively correlated with subjective wellbeing (Brown & Kasser, 2005; Lee & Ahn, 2016). Highly materialistic individuals, focused on buying and owning things as their primary source of satisfaction, tend to report lower levels of happiness and life satisfaction (Brown & Kasser, 2005).

Overconsumption of goods and services has direct consequences for environmental sustainability, being recognized as a major factor in the current climate and ecological crisis. Contemporary consumption patterns, especially in developed economies, exert enormous pressure on natural resources and generate high levels of greenhouse gas emissions. Quantitative studies show that consumption-intensive lifestyles – fuelled by the massive production and purchase of non-essential goods – translate into a significantly higher carbon footprint per capita (Ivanova et al., 2020; Pandey et al., 2020). Behavioural changes such as buying fewer clothes, reducing food waste, or using low-emission transportation can substantially reduce household emissions, highlighting the overwhelming role of household consumption in determining total emissions (Ivanova et al., 2020). An emblematic sector of overconsumption with disproportionate environmental impact is the fashion and textile industry. “Fast fashion” – the rapid and cheap consumption of clothes, often worn for a short period of time – has created a hyper-sized production cycle, with high CO₂ emissions and pollution along the supply chain, from textile production to transport and storage (Fifita et al., 2020). Impulsive buying habits and frequent wardrobe renewal, encouraged by aggressive marketing, lead to clothing and footwear overconsumption, a category that has seen considerable increases in household spending as disposable incomes in the EU have increased over the last two decades. Thus, overconsumption – defined as the purchase of goods beyond real needs, for the sake of novelty or status – is closely linked to environmental degradation and increased emissions: the more and the more inefficiently we consume, the more difficult it becomes to achieve sustainability targets (Sandberg, 2021; Touchette & Nepomuceno, 2020).

3. Model Specification

3.1 Model Description and Hypothesis

The main aim of the empirical analysis was to investigate the link between well-being, as measured by the Human Development Index (HDI), and sustainability, as quantified by the Carbon dioxide emissions per capita (CO₂) indicator, considering the mediating effect of overconsumption, as measured by Household final consumption expenditure, clothing and footwear (HFCE_C). The research was conducted based on data extracted from sources such as Eurostat and the World Bank and refers to the 27 Member States of the European Union, plus the United Kingdom. The data cover a period of 24 years, namely 2000-2023 (Table 1).

Table 1. Variables, Measurements, and Sources

Variable	Definition	Source
HDI	Human Development Index (value)	World Bank (WDI)
CO2	Carbon dioxide emissions per capita (production) (tonnes)	World Bank (WDI)
FOOT	Material footprint per capita (tonnes)	World Bank (WDI)
HFCE_C	Household final consumption expenditure by purpose (COICOP 1999) Clothing and footwear (constant 2015 US\$)	Our processing using Eurostat and World Bank (WDI)
GDP	GDP per capita (constant 2015 US\$)	World Bank (WDI)
MOB	Mobile cellular subscriptions (per 100 people)	World Bank (WDI)
URB	Urban population (% of total population)	World Bank (WDI)
LFE	Labor force with advanced education (% of total working-age population with advanced education)	World Bank (WDI)
REGUL	Regulatory Quality: Estimate (from Worldwide Governance Indicators-WGI)	World Bank (WGI)

Sources: Eurostat and World Bank (WDI and WGI) (2025).

Therefore, we consider the following hypotheses:

Hypothesis 1. Per capita carbon dioxide (CO₂) emissions negatively influence the human development index (HDI) in the European Union and United Kingdom.

Hypothesis 2. Household final expenditure on clothing and footwear (HFCE_C) mediates between carbon dioxide (CO₂) emissions per capita and human development index (HDI) in the European Union and the United Kingdom.

3.2 The Analysis

The econometric procedure involved several steps. In a first stage, it was necessary to assess cross-dependence, given that this is a group of countries characterized by significant economic and financial integration that determines close links between territorial units.

There are several types of tests that can be used to assess cross-sectional dependence. Among them are the Pesaran CD test and the LM test proposed by Breusch-Pagan. While the first test is suitable for panels with a cross-sectional dimension larger than the temporal dimension ($N > T$), the second is recommended for panels with a temporal dimension larger than the cross-sectional dimension ($T > N$). Both tests test the null hypothesis of the lack of cross-sectional dependence in the weighted residuals and are calculated based on the estimate of the pairwise correlation of the residuals, $\hat{\rho}_{ij}$ obtained by estimating regressions with panel data (De Hoyos & Sarafidis, 2006).

$$\hat{\rho}_{ij} = \hat{\rho}_{ji} = \frac{\sum_{t=1}^T \hat{u}_{it} \cdot \hat{u}_{jt}}{\left(\sum_{t=1}^T \hat{u}_{it}^2\right)^{\frac{1}{2}} \cdot \left(\sum_{t=1}^T \hat{u}_{jt}^2\right)^{\frac{1}{2}}} \quad (1)$$

Panel data also contain a temporal dimension, and the analysis of the existence of the unit root is important. Two of the widely used tests for unit root detection are Im, Pesaran and Shin (IPS) and the Im, Pesaran and Shin Cross-Section Test (CIPS). Since stationarity is a characteristic of a stochastic process, its testing is based on the generation of a first-order autoregressive process (Burdisso & Sangiácomo, 2016):

$$y_{it} = (1 - \varphi_i)\mu_i + \varphi_i y_{i,t-1} + \varepsilon_{it}, \quad (2)$$

where $i = 1, \dots, N$ and $t = 1, \dots, T$

and testing the null hypothesis of the existence of the unit root: $\varphi_i = 1$ for each unit i .

The Im, Pesaran and Shin cross-sectional test (CIPS) proposed by Pesaran (2007) adds to the initial model the means of the dependent variable Δy_{it} and the regressor, y_{it} , for the units $i=1, \dots, N$ (Burdisso & Sangiácomo, 2016).

One of the key assumptions of regression analysis (including that with panel data) whose validation ensures the obtaining of unbiased and consistent estimates is the uncorrelation between the explanatory variable and the error term, a condition known as exogeneity. Violation of this assumption, namely endogeneity, has important consequences on the statistical analysis because it leads to the obtaining of biased and inconsistent coefficients, which further influence the results of the applied statistical tests.

The occurrence of endogeneity can lead to false conclusions regarding causal relationships (Roberts & Whited, 2012), which raises the question of possible remedies for such a problem. First, in the case of omitting variables, the simple use of the fixed-effects estimator ensures unbiased results. Regarding endogeneity caused by simultaneity or measurement errors, the use of Instrumental Variable Regression (IV) is recommended. In most cases, in panel data analysis, in dynamic models, the Generalized Method of Moments (GMM) is preferred to solve the endogeneity problem.

In 1995 Arellano and Bover proposed “Forward-orthogonal deviations”-FOD as an alternative to the difference transformation in terms of the GMM (Generalized Method of Moments) estimator. The advantages of the FOD transformation are related to the increase in robustness in the conditions of series with missing data, but also to ensuring the uncorrelation of the residuals (Kripfganz, 2019; Roodman, 2009):

$$\omega_{i,t+1}^\perp \equiv c_{it} \left(\omega_{it} - \frac{1}{T_{it}} \sum_{s>t} \omega_{is} \right) \text{ where } c_{it}, \text{ is } \sqrt{T_{it}/(T_{it} + 1)} \quad (3)$$

Thus, the main regression model is as follows:

$$\ln HDI_{i,t} = \alpha + \beta_1 \ln HDI_{i,t-1} + \beta_2 \ln CO2_{i,t} + \beta_3 \ln GDP_{i,t} + \beta_4 \ln MOB_{i,t} + \beta_5 \ln URB_{i,t} + \beta_6 \ln LFE_{i,t} + \beta_7 \ln REGU_{i,t} + R_i + T_t + u_{i,t} \quad (4)$$

The evaluation of the mediation effect was carried out according to the procedure proposed by (Q. Xu et al., 2022) and detailed by (Dimian et al., 2025). Thus, three regression models were estimated. The first model had HDI as the dependent variable, and CO2 as the independent variable, retaining the regression

coefficient. The second model had HFCE_C as the dependent variable, and CO2 as the independent variable. It is checked whether the influence of the CO2 factor is significant. The third model had HDI as the dependent variable, CO2 as the independent variable, and HFCE_C as the mediating factor. If the influence of the mediating factor is significant, and the coefficient of the independent variable becomes insignificant, the mediation effect is total. If the coefficient of the independent variable remains significant in the third model but is smaller than that retained in the first model, the mediation effect is partial. The regressions with mediation effect are as follows:

$$\ln HFCE_C_{i,t} = \alpha + \beta_1 \ln HFCE_C_{i,t-1} + \beta_2 \ln CO2_{i,t} + \beta_3 \ln GDP_{i,t} + \beta_4 \ln MOB_{i,t} + \beta_5 \ln URB_{i,t} + \beta_6 \ln LFE_{i,t} + \beta_7 \ln REGUL_{i,t} + R_i + T_t + u_{i,t} \quad (5)$$

$$\ln HDI_{i,t} = \alpha + \beta_1 \ln HDI_{i,t-1} + \beta_2 \ln HFCE_C_{i,t} + \beta_3 \ln CO2_{i,t} + \beta_4 \ln GDP_{i,t} + \beta_5 \ln MOB_{i,t} + \beta_6 \ln URB_{i,t} + \beta_7 \ln LFE_{i,t} + \beta_8 \ln REGUL_{i,t} + R_i + T_t + u_{i,t} \quad (6)$$

where R_i and T_t control for country-specific heterogeneity and time-related shocks common to all countries, such as global economic crises.

4. Results and discussion

4.1 Testing for the Presence of Unit Root and Cross-Dependence of Residuals

The stationarity test (Unit Root Test) was based on the null hypothesis of the existence of a unit root (Table 2). The results of the IPSW and CIPS tests, which mostly present small p-values (<0.01 or <0.05), lead to the conclusion of rejecting the null hypothesis. The test result indicates that, by taking the logarithms from the data series, most of them became stationary, eliminating the risk of obtaining “false” regressions (spurious regression). However, in some cases such as $\ln CO2$ and $\ln GDP$, the test results can be considered inconclusive (differences between CIPS and Truncated CIPS) and draw attention to the need to test the robustness of the estimates also with the help of methods that allow combining stationary and non-stationary variables (ex ARDL).

The Pesaran CD test evaluates the null hypothesis of cross-sectional independence of the weighted residuals (Table 2).

Table 2. Unit Root Test and Cross-Sectional Dependence of Residuals

Variables/ Test	Unit root test					
	IPSW	P-value	CIPS	P-value	CIPS Truncated	P-value
$\ln HDI$	-2.76065	0.0029	-2.80085	<0.01	-2.35760	<0.01
$\ln CO2$	-3.34517	0.0004	-69.00997	<0.01	-1.57211	≥ 0.10
$\ln FOOT$	-2.51590	0.0059	-33.13689	<0.01	-2.63287	<0.01
$\ln HFCE_C$	-4.31195	0.0000	-2.25348	<0.05	-2.25348	<0.05
$\ln GDP$	-2.28446	0.0112	-4.00799	<0.01	-2.19447	≥ 0.10
$\ln MOB$	-12.5175	0.0000	-4.63661	<0.01	-2.25416	<0.05

Variables/ Test	Unit root test					
	IPSW	P-value	CIPS	P-value	CIPS Truncated	P-value
lnURB	-6.53473	0.0000	-2.85419	<0.01	-3.12126	<0.01
lnLFE	-2.50391	0.0061	-1.99634	>=0.10	-2.74558	<0.05
lnREGUL	-3.11426	0.0009	-16.20174	<0.01	-3.40041	<0.01
Cross-sectional dependence test						
	OLS		FE		RE	
lnHDI (dep)	lnCO2 (indep)					
Pesaran CD	43.51946 (0.000)		11.91927 (0.000)		11.92339 (0.000)	
Cross sections	28					
Period	2000-2023					

Note: 1. the null hypothesis of the IPSW test and the CIPS test is the unit root; 2. the models contain a constant, or a constant and a trend, and a maximum lag of 6 according to the Schwarz criterion; 3. the null hypothesis of the Pesaran CD test is the lack of cross-sectional dependence in the weighted residuals.

Source: Own processing using Eurostat and World Bank data.

For all types of estimation models (OLS/FE/RE) very small p-values lead to the conclusion that the null hypothesis is rejected and the hypothesis that the countries in the sample are interconnected is confirmed. In this case, the estimation of the regression models should be carried out using methods that take this dependence into account, such as GMM or PCSE.

4.2 Estimation of Main Regression

Table 3 shows the effect of human development expressed by HDI. The main regression models were estimated with OLS, DIF-GMM and FOD-GMM, but the method that best responds to the restrictions imposed by the size and characteristics of the panel data series is FOD-GMM (suitable for relatively large T and the existence of missing data).

Table 3. Main Model Results

Method	OLS	DIF-GMM	FOD-GMM
Model	M1	M2	M3
LlnHDI	-	0.686793***	0.740695***
lnCO2	-0.023650***	-0.009128***	-0.008043**
lnGDP	0.056889***	0.028088***	0.020466***
lnMOB	0.042339***	0.006576*	0.005205**
lnURB	0.015491**	0.091889***	0.057058***
lnLFE	-0.154749***	0.000718	-0.015466
lnREGUL	0.012854***	-0.000989	-0.000702

Method	OLS	DIF-GMM	FOD-GMM
C	-0.244438**	-	-
R2	0.798225	-	-
Sargan Test	-	26.63 (0.23)	24.60 (0.26)
AR(1)	-	-4.36 (0.000)	-0.39 (0.000)
AR(2)	-	-0.98 (0.325)	-0.95 (0.340)
Cross sections - fixed	-	YES	YES
Cross sections	28	28	28
Period	2000-2023	2000-2023	2000-2023

Note: 1***, **, * represent the mean significance at the 0.01, 0.05 and 0.10 levels; 2. the null hypothesis of the Hausman test is represented by the cross-sectional random effects; 3. the null hypothesis of the Sargan test is that the overidentification restrictions are valid; 4. number of instruments in FOD-GMM: 7 (5 in M7), consisting of the available lags of the instrumented variables, i.e. the lagged dependent variable and the endogenous regressors (including $\ln HFCE_C$ in M7); the instrument count is well below the number of cross-sections (28), as recommended by Roodman (2009) in order to avoid instrument proliferation.

Source: Own processing using Eurostat and World Bank data.

The FOD-GMM estimates highlight the persistence of the HDI over time, with the lag coefficient being 0.741, significant at a significance level of 1%. It is observed that the HDI index prior to the reference period largely explains the HDI index of the reference period.

The CO2 variable has a significant impact on the HDI. Its coefficient is negative and significant at a significance level of 5%, which implies that a 10% increase in CO2 induces a decrease of approximately 0.08% in the HDI. The effect is small but significant. The effect of this predictor factor also retains its significance in the GMM estimates, indicating the influence that environmental degradation has on human development. These results are consistent with observations in the specialized literature that show a consistent influence of environmental degradation on human development and implicitly on the wellbeing of the society (Karimi Alavijeh et al., 2024; Mohammed et al., 2024; Porcher et al., 2025; Wang et al., 2025).

The impact of GDP on HDI is positive and significant, at a significance level of 1%. A 1% increase in GDP leads to an increase in HDI of approximately 0.02%. A stable relationship is identified that directly influences the human development index. These results, in turn, are consistent with other findings in the literature (Karimi Alavijeh et al., 2024; Porcher et al., 2025). The variables MOB and URB also have a significant impact on HDI. For example, with a 1% increase in URB, HDI increases by 0.06%. Both urban development and mobile subscriptions have an effect on the level of human development. Thus, these observations go in line with

other findings from the literature (Alnafrh & Belyaeva, 2024; Karimi Alavijeh et al., 2024).

Contrary to the results observed in the literature (Ferrara & Nisticò, 2019; Karimi Alavijeh et al., 2024; Wang et al., 2025), LFE and REGUL are not significant in the FOD-GMM model, as demonstrated by the significance tests. The behaviour of lnLFE differs across specifications: it is insignificant in the dynamic GMM models, but negative and significant in the PCSE and ARDL estimates. A plausible explanation lies in the partial overlap between this variable and the dependent variable, since the HDI incorporates an education dimension that is strongly correlated with the share of the working-age population with advanced education. In the dynamic specifications, the lagged HDI (0.741) absorbs most of this slow-moving variation, leaving little independent variation for lnLFE; in the specifications without a lagged dependent variable, lnLFE captures the between-country association in levels, conditional on GDP, urbanisation and mobile penetration, in a sample in which the HDI is close to its upper bound for most countries. For this reason, lnLFE is treated as a control variable and its coefficient is not interpreted as a causal effect. The Sargan test indicates that the instruments used in the GMM estimates are valid (p-value=0.26).

4.3 Testing for Heterogeneity

The heterogeneity analysis was performed on two groups of countries, separated according to the HFCE_C average in the most recent available year (2022): 15 countries with consumption above the general average (Austria, Belgium, Cyprus, Denmark, Finland, Germany, Ireland, Italy, Luxembourg, Malta, Portugal, the Netherlands, Slovenia, Sweden, the United Kingdom), and 13 countries below the general average: Bulgaria, Croatia, Czech Republic, Estonia, France, Greece, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Spain. The grouping is a time-invariant classification of countries based on a single cross-section (the level of HFCE_C in 2022), and the models in Table 4 do not include HFCE_C among the regressors. The split therefore acts as a structural label for the consumption regime of each country, and the results are descriptive of the differences between the two groups rather than a formal test of the equality of the CO2 coefficients across groups.

In this case, given that the temporal dimension is larger than the cross-sectional dimension ($T > N$) and to solve the cross-sectional dependency problem, PCSE models were estimated (Table 4).

Table 4. Heterogeneity Analysis

Sample	ABOVE (AVERAGE) CONSUMERS	BELOW (AVERAGE) CONSUMERS
Method	PCSE	PCSE
Model	M4	M5
LnCO2	-0.044368***	0.000176
lnGDP	0.050664***	0.063219***

Sample	ABOVE (AVERAGE) CONSUMERS	BELOW (AVERAGE) CONSUMERS
lnMOB	0.023511***	0.041755***
lnURB	0.009678***	0.018276***
lnLFE	-0.308244***	-0.013592***
lnREGUL	0.024743***	-8.48E-05
C	0.647566***	-0.977311***
R2 (unweighted)	0.669	0.854
Pesaran CD Test	1.145 (0.252)	1.028 (0.304)
Cross sections	15	13
Period	2000- 2023	2000- 2023

Note: 1. ***, **, * mean significance at 0.01, 0.05, and 0.10 level; 2. null hypothesis of Pesaran CD Test is no cross-section dependence in weighted residuals. 3. R2 is the unweighted R-squared; 4. the two models are estimated separately for each group of countries, without country fixed effects, so the reported constants are the intercepts of two distinct regressions and not group-specific fixed effects.

Source: Own processing using Eurostat and World Bank data.

The results demonstrate differences between above-average and below-average consumers. In the case of the first category of countries, for example, CO2 has a significant, negative and strong effect (-0.044***) on HDI, while in the case of group 2 of countries CO2 becomes insignificant. The REGUL variable has a positive effect on HDI in the first group of countries, while in the group of below-average consumers the REGUL effect is negative but insignificant. In both groups of countries GDP, MOB and URB show a positive relationship with HDI, while LFE has a negative effect on HDI. These results confirm other conclusions (Karimi Alavijeh et al., 2024; Porcher et al., 2025; Wang et al., 2025).

4.4 Estimating Mediation Effects

Table 5 presents the mediation effects of consumption on the relationship between economic predictors and the level of human development. In both models M6 and M7, a high persistence of both variables is observed (0.601*** - M6 and 0.648*** - M7). Thus, a strong inertia in consumption dynamics is observed and the autoregressive effect of HDI is confirmed. The mediation analysis demonstrates that HFCE_C has a total mediation effect in the relationship between HDI and CO2. First, the link between HFCE_C and CO2 is a direct and significant one, as demonstrated by the coefficient in model M6 (0.252***). When HFCE_C is introduced into the main model, the impact of CO2 becomes insignificant, as does the impact of GDP (model M7). Although GDP has a strong and positive influence on consumption, its effect on HDI is weak and insignificant. Thus, the effect on HDI is mediated by the presence of consumption, not directly. At the same time, the results suggest an

improvement in the significance of URB, which indicates that urbanization does not contribute to the level of human development through consumption. LFE and REGUL have no significant effect in either M6 or M7. Thus, the two variables do not influence either consumption or the level of human development.

Table 5. Estimating Mediation Effects

Dependent variable	HFCE_C	HDI
Model	M6	M7
LlnHDI	-	0.647614***
LlnHFCE_C	0.600548***	-
lnHFCE_C	-	0.015084**
lnCO2	0.251673***	-0.009118
lnGDP	0.429421***	0.011324
lnMOB	0.186489***	0.011156***
lnURB	0.309049	0.009910***
lnLFE	0.073636	0.219040
lnREGUL	-0.039896	-0.010302
Sargan Test	23.30 (0.33)	68.27 (0.27)
Cross sections - Fixed	YES	YES
Cross sections	28	28
Period	2000-2023	2000-2023

Note: ***, **, * represent the average significance at the 0.01, 0.05 and 0.10 levels; the null hypothesis of the Sargan test is that the overidentification restrictions are valid; number of instruments in FOD-GMM: 7 (5 in M7), consisting of the available lags of the instrumented variables, i.e. the lagged dependent variable and the endogenous regressors (including lnHFCE_C in M7); the instrument count is well below the number of cross-sections (28), as recommended by Roodman (2009) in order to avoid instrument proliferation.

Source: Own processing using Eurostat and World Bank data.

4.5 Testing the Robustness of Estimates

The robustness analysis was performed by changing the predictor (CO2 was replaced by FOOT) in model M8, respectively by changing the estimation method (FOD-GMM was replaced by ARDL) in model M9. Regardless of how sustainability is measured, or by which method, the main relationships are maintained: the impact of CO2, respectively FOOT on HDI is negative and significant, while the main economic and social factors retain their sign of connection with HDI (Table 6).

Table 6. Robustness Analysis

The groups	Changing the variable FOOT	Changing the method Panel-ARDL
Model	M8	M9
LlnHDI	0.735796***	-
lnCO2	-	-0.014329***
lnFOOT	-0.009849***	-
lnGDP	0.026926***	0.016814**
lnMOB	0.005526***	0.003117
lnURB	0.059814***	0.525879***
lnLFE	-0.005301	-0.104145***
lnREGUL	-0.002105	0.000545
Sargan Test	25.38 (0.23)	-
Cross sections - Fixed	YES	-
Cross sections	28	28
Period	2000-2023	2000-2023

Note: 1. ***, **, * represent the average significance at the 0.01, 0.05 and 0.10 levels; 2. the null hypothesis of the Sargan test is that the overidentification restrictions are valid; 3. number of instruments in FOD-GMM: 7 (5 in M7), consisting of the available lags of the instrumented variables, i.e. the lagged dependent variable and the endogenous regressors (including lnHFCE_C in M7); the instrument count is well below the number of cross-sections (28), as recommended by Roodman (2009) in order to avoid instrument proliferation.

Source: Own processing using Eurostat and World Bank data.

It should be noted that the Panel-ARDL coefficients are long-run coefficients, whereas the GMM coefficients are short-run effects estimated in a specification that includes the lagged dependent variable. The comparison between the two methods should therefore be made in terms of the sign and the significance of the relationships rather than in terms of the size of the coefficients.

5. Conclusions

Wellbeing, sustainability and overconsumption are three pillars that need to be addressed more often in discussions on economic and sustainable development. The present study proposed an exploration of the synergy between the three key elements. Wellbeing was explained using the human development index, since it provides an objective understanding of societal wellbeing, talking about health, education, income and other material and social aspects that shape the quality of life (Assa, 2021). Sustainability or sustainable development is known to be a debated topic in the literature, as a need to balance economic and social objectives with environmental protection has been identified (Baysal & Sutton, 2024; Kaklauskas et al., 2018). This is represented by carbon dioxide emissions per capita and has often

been tested at the EU level in relation to the HDI (Karimi Alavijeh et al., 2024; Omri et al., 2022; H. Xu et al., 2024). The third pillar, overconsumption, has implications for both the wellbeing of the society (Vita et al., 2020) and sustainability (Inês & Moreira, 2025; Ivanova et al., 2020). This is often seen in terms of final household expenditure, particularly on clothing and footwear.

This research aimed to investigate the dynamics between these dimensions, expressed through macroeconomic indicators. It also verified the mediation relationship between sustainability and the wellbeing of the society, through the lens of overconsumption.

Based on the empirical results obtained from the analysis of panel data, the first hypothesis is confirmed. This suggests a negative relationship between carbon dioxide emissions per capita and the human development indicator. Thus, it is understood that there is a negative effect between environmental pressures (CO₂ emissions) and HDI that remains stable over time. The observation is supported by the findings presented in the literature that identified a decrease in the HDI indicator in relation to CO₂ emissions (Karimi Alavijeh et al., 2024; Wang et al., 2025). The second hypothesis is, in turn, confirmed. The results are consistent with a full mediation of the relationship between emissions and human development through clothing expenditure. These are in line with the empirical debates presented in the specialized literature that highlight the impact of overconsumption on sustainable development, which in turn has direct effects on human development (Fifita et al., 2020; Inês & Moreira, 2025; Ivanova et al., 2020; Karimi Alavijeh et al., 2024; Wang et al., 2025). At the same time, the results suggest that an influence of GDP in relation to HDI is achieved through increased spending. This change, in turn, ensures access to a better quality of life. Thus, the observations found in the literature showing how overconsumption has an indirect effect on improving the human development coefficient are highlighted and confirmed (Kaklauskas et al., 2020; Karimi Alavijeh et al., 2024).

From the perspective of heterogeneity, the results suggest the divergence of aggregate studies, a characteristic often observed in panel studies (Dimian et al., 2025). This result makes a first contribution in terms of theoretical implications, as it supports and contributes to the differences observed between European countries (Fifita et al., 2020; Inês & Moreira, 2025; Kaklauskas et al., 2018; Omri et al., 2022). A second theoretical contribution is validated by the robustness of the results, which reinforces this study's credibility. The tested relationships, as well as the synergy between the three key concepts, remained stable, even when subjected to different model specifications. This suggests that the study observed effects that reflect mechanisms anchored in economic reality. The most important theoretical implication lies in the integration of the three concepts into a single theoretical framework, with the hope of highlighting the mechanism of shaping the objective wellbeing of the society, explained by the HDI, through the lens of sustainability explained by CO₂ emissions, and using the mediation effect on this relationship through household final expenditures on clothing and footwear.

The study has several limitations, which also outline directions for future research. First, the mediation effect was assessed through the sequence of dynamic panel models proposed by Xu et al. (2022) and applied by Dimian et al. (2025); complementing this procedure with a formal test of the indirect effect - a Sobel test or bootstrap confidence intervals adapted to dynamic panels estimated with internal instruments and characterised by cross-sectional dependence - would allow a more precise quantification of the consumption channel, and the results reported here should be read as evidence consistent with such a channel rather than as a point-identified indirect effect. Second, the heterogeneity between the two groups of countries was analysed through separate estimations; a specification including interaction terms would allow a formal test of the difference between the coefficients. Third, overconsumption was proxied by household final consumption expenditure on clothing and footwear, which captures only one segment of material consumption.

Several practical implications that are extracted based on the results specifically address the synergy between the three key concepts. First, the empirical results demonstrate the need to introduce policies that integrate economic objectives with environmental and social ones. Thus, the HDI coefficient is optimized over a long period of time. Second, the implementation of policies that refer to solving environmental degradation represents a direct investment in human development performance. Reducing CO₂ emissions has a direct effect on the HDI coefficient. This action represents an essential tool in increasing the societal wellbeing. Third, the mediating role of household final expenditures on clothing and footwear must determine the decision-making factors in adopting policies that discourage overconsumption and propose a consumption that enhances the wellbeing of the society, without stimulating environmental degradation. Last but not least, a practical implication consists in the need to implement policies based on the level of development. The result of heterogeneity encourages policymakers to create for countries in the below-average consumption category a set of policies aimed at increasing and improving the environmental quality coefficient. For countries in the above-average consumption category, it would be advisable to introduce a set of policies dedicated to optimizing sustainable development that would maintain this synergy.

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