

Article

The Elusive Phenomenon: Unveiling Deconsumption in the EU

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Abstract: This article analyzes the phenomenon of deconsumption, which is relatively new and insufficiently researched or defined. Based on a review of the literature on the subject, it was found that there was little interest in deconsumption compared with sustainable consumption. Moreover, the number of scientific publications was negligible as the concept of deconsumption was rarely studied as a phenomenon. In addition, it should be noted that deconsumption can play a role in sustainable development and care for the environment and natural resources. Our study on this phenomenon sought to determine whether the phenomenon has spread to a noticeable degree, despite the deconsumption trend, which is important for its effective popularization in societies. Therefore, the aim of this study was to analyze whether the deconsumption phenomenon was reflected in macroeconomic data on consumption in selected European Union countries prior to the COVID-19 pandemic. The analysis of macroeconomic data on per capita consumption in the years 2000–2019 did not reveal a clear phenomenon of deconsumption; however, changes in the consumption structure were identified. In some countries, consumption fluctuated or decreased in certain sectors, suggesting the possible emergence of deconsumption. The computation method used in this study was fuzzy c-means clustering (FCM).

Keywords: consumption; deconsumption; fuzzy c-means; European Union; consumption structure



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1. Introduction

Sustainable development is one of the main objectives of the European Union (EU). During this time of rapid climate change and increasing demand for energy and resources, the EU has introduced a number of policies and initiatives aimed at sustainable consumption and production. Within the framework of the European Green Deal, and in particular, the Action Plan on a Closed Economy, a legislative initiative on sustainable product policy was announced with the aim of adapting products to a climate-neutral, resource-efficient, closed-loop economy.

There is an urgent need for a public debate about encouraging all economic actors to adopt more sustainable consumption patterns. To achieve Sustainable Development Goal 12, it will be necessary to use resources much more efficiently. This requires, among other things, a reduction in waste in general with a particular reduction in wasted food. The world's population currently consumes more resources than ecosystems can provide. Therefore, fundamental changes are needed in the way societies, companies, and individuals produce and consume goods and services. Interest in sustainable development is heterogeneous and evolves over time. This is important from the perspective of this research as it refers to analyzing consumption-related behaviors in a broader scope. At the same time, the literature on the subject indicates that a frequently analyzed scientific

research topic of sustainable consumption relates to textiles, electronic equipment, cars, and modern services. In its direct and macroeconomic meaning, the topic of deconsumption is extremely rarely discussed in scientific works; therefore, the analyses in question are critical to understanding the essence of this phenomenon. Therefore, our research goal was to verify the research hypothesis that the deconsumption phenomenon emerged in macroeconomic data in the 2000s and 2010s.

2. Literature Review

One of the first studies that referred to the phenomenon of deconsumption was published by Gregg [1], who used the phrase “voluntary simplicity” in the context of reducing consumer spending. It referred to the voluntary reduction in spending on consumer goods and services and the promotion of lifestyles that involved increased consumption of intangible goods [1]. Other researchers, such as Etzioni [2], Shaw and Newholm [3], Huneke [4], and McDonald et al. [5], also used the term in their papers. However, these articles did not define the phenomenon of deconsumption directly [6].

In the context of desk study that attempts to define the phenomenon of deconsumption, it can be said that there are many studies that use the word “deconsumption” but do not define the phenomenon itself. This prompted the authors of this study to take a closer look at the definitions of deconsumption, their characteristics, and their mutual connections. Accordingly, a table was compiled that organized the articles chronologically, part of which is devoted to the definition of deconsumption itself (Table 1). The common elements of each definition are marked with colors (the same color indicates a common element).

The yellow color indicates the characteristics of each definition related to a conscious, voluntary reduction in consumption in favor of higher-quality goods, as well as a reduction in material consumption in favor of immaterial consumption. At the same time, based on one of the definitions (the feature marked in black), the authors emphasize that deconsumption is not necessarily a predictable process. The orange color indicates the environmental aspects appearing in the definitions. These primarily concern deconsumption in terms of limiting the use of natural resources and supporting zero-waste activities. On the other hand, the aspects of the definitions that deal with changing consumer lifestyles and habits are circled in green. An interesting aspect that appears in terms of defining the phenomenon of deconsumption is the concept of sharing, which is marked with purple. Ideological elements also appeared in the definitions (marked in red).

Please note that in this study, the most important features of the various definitions were those related to the macroeconomic perspective (indicated in blue). They indicate that deconsumption can have the effect of reducing current consumption, as reflected by reduced direct and indirect costs. This also indicates that a decline in consumption in an area, sector, or country can be evident and that the phenomenon of deconsumption can emerge during situations of economic uncertainty.

Table 1. A summary of selected features of deconsumption definitions in chronological order, according to the publication date of each study.

Year of Publication	Author(s) of the Publication	Conscious, Voluntary Reduced Consumption in Favor of Higher-Quality Goods, as Well as Limited Material Consumption in Favor of Immaterial Consumption					Deconsumption in the Context of Limiting the Use of Natural Resources and Supporting Zero-Waste Activities			Change in Lifestyle and Consumer Habits	Deconsumption as a Sharing Concept	Deconsumption as an Ideology	Deconsumption in the Economic Aspect	Deconsumption as an Unpredictable Process																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
		Consumption Disorder	Giving up Consumption Behavior	Limiting Material Consumption	Limiting the Amount of Goods Consumed	Improving the Quality of Consumed Goods	Increasing Immaterial Consumption	Rationalization of Consumption and Consumer Behavior	Assumes the Use of the 3R Principles (Reduce, Reuse, Recycle)						Responsibility for the Long-Term Effects of Consumer Decisions	Protection of Natural Resources	Reducing Waste of Resources While Meeting Individual Needs	Assumes the Use of the 6R Principles (Rethink, Refuse, Reduce, Reuse, Recycle, Recover)	A Lifestyle Based on Simplicity and Frugality	Consumption of Ecological Products and Services	Consumer Is Not Guided by Fashion and Trends	Alternative Lifestyle	Emphasis on Social Identity	Restricting Hedonistic Behavior	Connecting People Who Prefer a Simplified Lifestyle	Creating Cooperation Networks and Developing the Sharing Economy to Allow Access to Products without the Costs of Ownership	Deconsumption as a Value in the Long Term	A Form of Resistance to Attempt Limiting Consumers' Ability to Consume	Tries to Change Consumer Behavior	It Uses the Same Mechanisms of Influence as the Ideology of Consumerism	Prioritizing Local Consumption over International Consumption	Limiting Current Consumption (Reducing Direct and Indirect Costs)	A Decline in Consumption in a Given Area, Sector, or Country	Limiting Consumption Because of Economic Uncertainty	Unpredictability of Consumer Decisions																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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Table 1. *Cont.*

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		Consumption Disorder	Giving up Consumption Behavior	Limiting Material Consumption	Limiting the Amount of Goods Consumed	Improving the Quality of Consumed Goods	Increasing Immaterial Consumption	Rationalization of Consumption and Consumer Behavior	Assumes the Use of the 3R Principles (Reduce, Reuse, Recycle)	Responsibility for the Long-Term Effects of Consumer Decisions	Protection of Natural Resources	Reducing Waste of Resources While Meeting Individual Needs	Assumes the Use of the 6R Principles (Rethink, Refuse, Reduce, Reuse, Recycle, Recover)	A Lifestyle Based on Simplicity and Frugality	Consumption of Ecological Products and Services	Consumer Is Not Guided by Fashion and Trends	Alternative Lifestyle	Emphasis on Social Identity	Restricting Hedonistic Behavior	Connecting People Who Prefer a Simplified Lifestyle	Creating Cooperation Networks and Developing the Sharing Economy to Allow Access to Products without the Costs of Ownership	Deconsumption as a Value in the Long Term	A Form of Resistance to Attempt Limiting Consumers' Ability to Consume	Tries to Change Consumer Behavior	It Uses the Same Mechanisms of Influence as the Ideology of Consumerism	Prioritizing Local Consumption over International Consumption	Limiting Current Consumption (Reducing Direct and Indirect Costs)	A Decline in Consumption in a Given Area, Sector, or Country	Limiting Consumption Because of Economic Uncertainty	Unpredictability of Consumer Decisions	
2012, 2016, 2018	Wilczak [24–26]				X		X		X						X																
2012	Szul [27]												X																		
2013	Séré De Lanazue, Siadou-Martin [28]																											X		X	
2013, 2019	Patrzałek [29,30]	X		X	X	X	X									X															
2015	Michałowska, Danielak [31]			X			X																								
2016, 2017	Byłok [32,33]														X	X															
2019	Trzęsiok, Słupik [34]						X				X		X																		
2019	Lemanowicz, Szwacka-Mokrzycka [35]								X	X	X		X																		
2020	El Amri [36]										X												X	X	X						
2020	Balcerowicz-Szkućnik and Szkućnik [37]						X	X					X																		
2021	Szwacka-Mokrzycka [38]		X	X		X																								X	
2021	Mysona-Byrska [39]						X		X		X		X																		

Table 1. Cont.

Year of Publication	Author(s) of the Publication	Conscious, Voluntary Reduced Consumption in Favor of Higher-Quality Goods, as Well as Limited Material Consumption in Favor of Immaterial Consumption	Deconsumption in the Context of Limiting the Use of Natural Resources and Supporting Zero-Waste Activities			Change in Lifestyle and Consumer Habits	Deconsumption as a Sharing Concept	Deconsumption as an Ideology	Deconsumption in the Economic Aspect	Deconsumption as an Unpredictable Process
		Consumption Disorder Giving up Consumption Behavior Limiting Material Consumption Limiting the Amount of Goods Consumed Improving the Quality of Consumed Goods Increasing Immaterial Consumption Rationalization of Consumption and Consumer Behavior	Assumes the Use of the 3R Principles (Reduce, Reuse, Recycle) Responsibility for the Long-Term Effects of Consumer Decisions Protection of Natural Resources Reducing Waste of Resources While Meeting Individual Needs Assumes the Use of the 6R Principles (Rethink, Refuse, Reduce, Reuse, Recycle, Recover)	A Lifestyle Based on Simplicity and Frugality Consumption of Ecological Products and Services Consumer Is Not Guided by Fashion and Trends Alternative Lifestyle Emphasis on Social Identity Restricting Hedonistic Behavior	Connecting People Who Prefer a Simplified Lifestyle Creating Cooperation Networks and Developing the Sharing Economy to Allow Access to Products without the Costs of Ownership	Deconsumption as a Value in the Long Term A Form of Resistance to Attempt Limiting Consumers' Ability to Consume Tries to Change Consumer Behavior It Uses the Same Mechanisms of Influence as the Ideology of Consumerism	Prioritizing Local Consumption over International Consumption Limiting Current Consumption (Reducing Direct and Indirect Costs) A Decline in Consumption in a Given Area, Sector, or Country Limiting Consumption Because of Economic Uncertainty	Unpredictability of Consumer Decisions		
2022	Borin et al. [40]		X	X						
2023	Ciechomski [41]		X		X					
2023	Szuskiewicz [42]	X	X			X	X			

Source: our study, May 2024.

Some researchers emphasize that the post-pandemic reality can be an opportunity to change lifestyles that require large amounts of energy and materials. Please note that the COVID-19 pandemic had a significant impact on consumption patterns, including changing some consumer behaviors and the frequency of consumption practices. Changes in consumption in Europe were reflected in lower demand for entertainment products and services [43]. Phenomena related to limiting consumption, including deconsumption became observable and thus, researchable.

The observability of macroeconomic changes in deconsumption is indicated by the elements of its definition (marked in blue in Table 1). The elements of the definition of the deconsumption phenomenon (Table 1) indicate that it is an important and beneficial phenomenon in the context of sustainability and care for the environment and natural resources. At the same time, the authors investigated whether, despite the emergence of deconsumption trends, this phenomenon has spread to a noticeable extent. This is important for the effective popularization of the deconsumption trend in societies [44]. Therefore, in connection with the desire for a deeper understanding of the processes influencing the spread of deconsumption, the aim of this study was to analyze the possibility that this phenomenon was present in macroeconomic data on consumption in selected European Union countries before the COVID-19 pandemic.

The phenomenon of deconsumption has not yet been thoroughly researched or defined. Analyses that touch on this concept are carried out mainly regarding the sustainable consumption of textiles, food, electronics, and services. However, the phenomenon of deconsumption itself has been analyzed to a very limited extent. For example, simple English queries in Google Scholar, conducted on 30 June 2023, show that the largest number of publicly available scientific publications since 2019 pertain to the research topic concerning the concept of “sustainable consumption”. Compared with sustainable consumption, there is little interest in deconsumption, anti-consumption, and minimalist consumption (Table 1). The ratio of scientific publications on deconsumption to those on sustainable consumption was approximately 0.003 (see item 8/item 5, Table 2). At the same time, the analysis of the literature on the subject showed that no research has been conducted to explain deconsumption in detail.

Table 2. The number of search results for publicly available scientific publications based on queries pertaining to the phenomenon of sustainable consumption, deconsumption, anti-consumption, and minimalist consumption.

ID	Google Scholar Query	Results (Approx.)
1	“sustainable consumption” “clothes” filetype:pdf	1390
2	“sustainable consumption” “fashion” filetype:pdf	2460
3	“sustainable consumption” “food” filetype:pdf	8550
4	“sustainable consumption” “electric” filetype:pdf	2350
5	“sustainable consumption” filetype:pdf	12,400
6	“anti-consumption” filetype:pdf	584
7	“anticonsumption” filetype:pdf	101
8	“deconsumption” filetype:pdf	36
9	“minimalistic consumption” filetype:pdf	6

Source: our study, March 2023.

As shown, the research relating to deconsumption was carried out mainly when explaining sustainable consumption in various aspects. For example, the phenomenon of sustainable consumption in fashion has been studied in recent years by many researchers. The study by Park and Lee [45] demonstrated that purchasing is only a partial behavior of the entire consumption process. The actual stages of consumption are more complex. They involve consumer awareness and behavior in different areas and stages of consumption.

Moreover, Armstrong and Park [46] noted that a consumer’s environmental awareness has a significant impact on the decision to engage in shared consumption. The relevance of

the issue of consumption and deconsumption is highlighted by the UN Agenda for Goal 12, pointing to the need for sustainable consumption and production patterns [47].

In his research on the textile industry, Muthu [48] outlined what consumers can do about fast fashion, as well as the important aspects that need to be addressed for fast fashion to be sustainable. Hasbullah et al. [49,50] investigated the factors influencing perceived value, which certainly had an impact on sustainable fashion consumption.

Research related to the topic of sustainable clothing consumption was conducted in the context of business models aimed at sustainable consumption and transitioning to a circular economy. It was shown that comprehensive changes to business models are required to transform unsustainable consumption patterns [51]. Also, sustainable consumption and anti-consumption were studied for electronic and electrical appliances, electric cars, and modern services.

On the other hand, Dutta and Hwang [52] showed that an individual's concern for the environment is an important type of personal belief. Thus, consumers' beliefs on environmental care are a potential factor shaping their decision to use green products. Moreover, Zorn and Suni [53] proved that economic and psychological reasons help explain why consumers engage in environmentally friendly behavior. They maximize their personal utility, so personal benefits motivate them. When the benefits of purchasing green products outweigh their costs, consumers are more likely to buy them. Gontarz and Sulich [54] pointed out that a sustainable economy can provide a clear impetus for socially and ecologically responsible actions in terms of the social motivation of the economy and sustainable use of resources. Chang et al. [55] emphasized that consumer cognition and personal factors have a key influence on responsible environmental behavior and intentions. Consumers who care about the environment are inclined to buy green products. Islam et al. [56] provided evidence that sustainable consumption can be facilitated by redesigning e-commerce platforms. In turn, de Silverira et al. [57] proposed a theoretical–empirical model that explains the relevance of sustainable collaborative practices through bike sharing. The largest group of publications on sustainable consumption since 2019 pertained to the food market. Authors who have discussed this issue include Goryńska-Goldmann [58]; Zalega [59], Kutty and Abdella [60], and Haque, Yamoah, and Sroka [61]. Their research focused on food waste management in a closed food supply chain and on information management systems able to address common challenges. The analysis of the literature on the subject shows that an attempt has been made to reveal factors relevant to consumer involvement in sustainable consumption for a broad range of product types and services associated with environmental protection [62]. In conclusion, based on the literature study, deconsumption can be defined as a conscious reduction in consumption to a rational size, resulting from the natural, individual, physical, and mental characteristics of the consumer. It is an alternative trend to consumerism, promoting moderate consumption [40]. This phenomenon also refers to changing consumption habits to obtain products that cause less harm or consume fewer resources.

3. Materials and Methods

To study the deconsumption phenomenon, figures were obtained to demonstrate the various components of per capita consumption (in euros), covering the period from 2000 to 2019 in each country [63]. Data on shares of consumption components (food and non-alcoholic beverages; alcoholic beverages, tobacco, and narcotics; clothing and footwear; housing, water, electricity, gas, and other fuels; furnishings, household equipment, and routine household maintenance; health; transport; communications; recreation and culture; education; restaurants and hotels; and miscellaneous goods and services) were converted into percentage shares. The classification covered 25 European Union countries (Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Greece, Spain, the Netherlands, Ireland, Lithuania, Latvia, Luxembourg, Malta, Germany, Poland, Portugal, Slovakia, Slovenia, Hungary, and Italy) in 20 periods. Based on the data review, 2 countries were excluded from the analysis—Romania and Sweden. The

consumption structure in these countries was incomplete—the database had significant deficiencies in individual components. Additionally, the period of the COVID-19 pandemic (from 2020 to 2022) was excluded from this study. Because of governmental restrictions, the pandemic had a significant impact on the consumption structure [64–67].

Differences in the structure of consumption indicate that its level was non-uniform in these European countries during the period under study.

The introduced time factor was of particular importance for the fuzzy c-means method used. It allowed for tracking changes in structure over time in individual countries based on the analysis of their migration between individual clusters.

Cluster analysis performed using the fuzzy c-means method is widely used in the study of macroeconomic data [68–71] and many other types of data. Developed by Bezdek in 1973 [72], fuzzy c-means clustering allows for dividing records into clusters based on probability [73]. This algorithm solves problems related to recognizing patterns occurring within a phenomenon. To correctly present the research procedure, we provide the following detailed explanations of the symbols used:

x_n —set of n objects;

x_k — k^{th} vector of the base data of the training set;

n_v —number of input (base) variables in the data set;

T —transposition;

μ_{ik} —value of the k^{th} input vector's membership in the i^{th} cluster;

J —value of the objective function;

c —number of clusters;

n —number of observations in the training data set;

m —optimal fuzziness level;

$d^2(x_k, v_i)$ —distance between the k^{th} object and the i^{th} cluster center (Euclidean distance was adopted as the distance measure);

v — n_v dimensional vector;

t —iteration index;

$\mu_{ik}^{(t)}$ —value of the k^{th} input vector's membership to the i^{th} cluster identified during the t^{th} iteration;

v_i —cluster center;

$v_i^{(t)}$ —vector of the center of the cluster identified in the t^{th} iteration of the algorithm;

$v_j^{(t)}$ —vector of the center of the cluster of the j^{th} variable identified in the t^{th} iteration of the algorithm;

x_{ij} — j^{th} vector variable of the k^{th} data vector.

The c-means fuzzy clustering procedure implemented in this study was enriched with a time factor. The set of n objects was represented by $X = \{x_1, x_2, \dots, x_n\}$, and each k object ($k = 1, 2, \dots, n$) was represented by an n_v dimensional vector $x_k = [x_{1,k}, x_{2,k}, \dots, x_{n_v,k}]^T \in \mathbb{R}^{n_v}$. The cluster of n vectors was represented by an $n \times n_v$ data matrix [74].

$$X = \begin{bmatrix} x_{1,1} & x_{1,2} & \dots & x_{1,n_v} \\ x_{2,1} & x_{2,2} & \dots & x_{2,n_v} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n,1} & x_{n,2} & \dots & x_{n,n_v} \end{bmatrix} \quad (1)$$

Clustering was performed for data with an assigned time stamp. Therefore, the columns of the X matrix contained individual observations over time, and the rows contained the components of the consumption structure. The fuzzy clustering algorithm divides the data set X into c overlapping clusters, creating a partition matrix U . It is composed of the membership degrees of objects x_k ($k = 1, 2, \dots, n$) to each cluster i ($i = 1, 2, \dots, c$).

The membership degree of the vector k to the cluster is represented by $\mu_{ik} \in U$, and the partition matrix takes the form [75]:

$$U = \begin{bmatrix} \mu_{1,1} & \mu_{2,1} & \cdots & \mu_{c,1} \\ \mu_{1,2} & \mu_{2,2} & \cdots & \mu_{c,2} \\ \vdots & \vdots & \ddots & \vdots \\ \mu_{1,n} & \mu_{2,n} & \cdots & \mu_{c,n} \end{bmatrix} \quad (2)$$

Each cluster is represented by a vector called the “cluster center” or the “cluster prototype”, which can be used to represent cluster structures in the entire set X [76].

The fuzzy clustering algorithm identifies the number c of cluster center vectors in a data set X composed of nv dimensional vectors, $V = \{v_1, v_2, \dots, v_c\} \in \mathbb{R}^c \times nv$, where each cluster center $v_i \in \mathbb{R}^{nv}$ is also an nv dimensional vector. The cluster center is usually represented as the center of nv objects. For example, it could be represented as the average of all data for the cluster [77]. Fuzzy c -means clustering assumes that the number of clusters is known. The algorithm divides the data set $X = \{x_1, x_2, \dots, x_n\}$ into c clusters.

The fuzzy c -means clustering algorithm tries to minimize the objective function with two pieces of information including the number of clusters c and the fuzziness parameter m , as follows:

$$\min J(X; U, V) = \sum_{i=1}^c \sum_{k=1}^n (\mu_{ik})^m d^2(x_k, v_i) \quad (3)$$

The objective function will take the value 0 if all data objects are clusters in centers ($c = n$). However, when data objects are located further from the cluster centers (v_i), the objective function will be larger. Therefore, the partition matrix is restricted as follows:

$$\sum_{i=1}^c \mu_{ik} = 1, \forall k > 0 \quad (4)$$

$$0 < \sum_{k=1}^n \mu_{ik} = n, \forall i > 0 \quad (5)$$

They result in at least one observation being assigned to each cluster [78]. The optimal centers can be obtained by solving the optimization problem using the Lagrange multipliers method [75]:

$$v_i^{(t)} = \frac{\sum_{k=1}^n (\mu_{ik}^{(t)})^m x_k}{\sum_{k=1}^n (\mu_{ik}^{(t)})^m}, \forall i = 1, 2, \dots, c \quad (6)$$

The equation for calculating the fuzzy share value is defined by:

$$\mu_{ik}^{(t)} = \left[\sum_{j=1}^c \left(\frac{d(x_k, v_i^{t-1})}{d(x_k, v_j^{t-1})} \right)^{\frac{2}{m-1}} \right]^{-1} \quad (7)$$

where $v_{\text{and}}^{(t)}$ represents the cluster center vector obtained in the $(t - 1)$ iteration and $\mu_{ik}^{(t)}$ stand for optimal share values calculated for the t^{th} iteration. The share values and cluster centers are interdependent. The objective function J^t in each iteration is measured by [74]:

$$J^t = \sum_{i=1}^c \sum_{k=1}^n (\mu_{ik}^{(t)})^m d^2(x_k, v_i^{(t)}) \quad (8)$$

The fuzzy c -means clustering algorithm stops after a certain number of iterations or when a previously set stopping criterion is met. The study of the consumption structure was supplemented by the analysis of two-dimensional Flexplot charts.

4. Results and Discussion

According to the Eurostat classification, the consumption structure consisted of aggregates such as food and non-alcoholic beverages; alcoholic beverages, tobacco, and narcotics; clothing and footwear; housing, water, electricity, gas, and other fuels; furnishings, house-

hold equipment, and routine household maintenance; health; transport; communications; recreation and culture; education; restaurants and hotels; and miscellaneous goods and services. The main aim of this study was to analyze changes in the consumption structure in countries over time. JASP software (JASP 0.17.3, 2023) was used for the cluster analysis. Fuzzy c-means clustering was used to identify groups of EU countries in the years 2000–2019. The appropriate number of clusters was determined using the elbow technique [79] and the homogeneity in the clusters was assessed using the t-Distributed Stochastic Neighbor Embedding (t-SNE) plot [80]. The procedure assumed the following training settings: maximum number of iterations—17, blur parameter—2, and optimization of the number of clusters (according to the BIC criterion).

4.1. Determining the Number of Clusters

The number of clusters was determined using the elbow technique, considering the BIC criterion. Figure 1 shows elbow plots that consider AIC, BIC, and WSS criteria. As a result of grouping, five clusters were obtained.

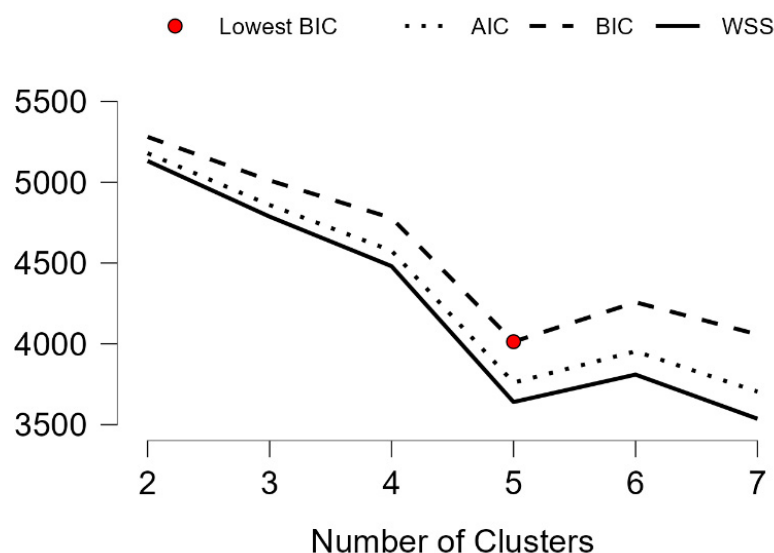


Figure 1. Elbow plots for AIC, BIC, and WSS criteria. Source: our study, 2023.

The elbow technique allows for determining the number of clusters to be used with various metrics. The measures of model performance are the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and the Within-Cluster Sums of Squares (WSS), which are responsible for measuring the distance of observations from the cluster center [81,82]. If the number of clusters is higher than the elbow point (the lowest BIC), it will not significantly reduce the AIC, BIC, or WSS coefficients. The first knee point was observed with five clusters, which means that the adopted solution was optimal for the batch data.

4.2. Cluster Validation

Figure 2 presents a t-SNE cluster plot for data from 2000 to 2019. An unsupervised machine learning algorithm revealed the probability distribution of the data points, from which clusters were created. The results indicated that the cluster observations were well grouped, which confirms the choice of a five-class solution.

Table 3 presents the AIC, BIC, and Silhouette indexes for the adopted fuzzy c-means clustering in the years 2000–2019. These measured the appropriate fit of data within designated clusters.

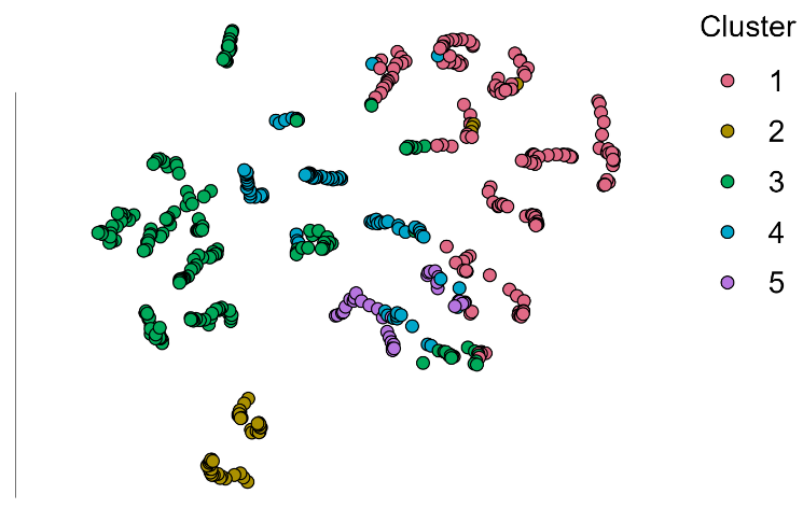


Figure 2. t-SNE cluster plot. Source: our study, 2023.

Table 3. AIC, BIC, and Silhouette indexes of the fuzzy c-means clustering for observations from 2000 to 2019.

Clusters	N	R ²	AIC	BIC	Silhouette
5	500	0.540	3768.430	4021.310	0.160

Source: our study, 2023.

4.3. Cluster Comparison

The grouping of objects with structural similarity was performed using the fuzzy c-means clustering method. The analysis used data on per capita consumption in the studied countries in the years 2000–2019. Data on individual consumption components were converted into percentage shares. In total, 25 countries were classified in 20 periods, which produced five clusters with a significant degree of diversity. The number of clusters was as follows: 156—cluster 1 (approximately 31% of the population), 45—cluster 2 (approximately 9% of the population), 179—cluster 3 (approximately 36% of the population), 86—cluster 4 (approximately 17% of the population), and 34—cluster 5 (approximately 7% of the population) (Table 4).

Compared with the remaining groups, cluster 1 (156 observations) was distinguished by the share of the “food and non-alcoholic beverages” variable, which amounted to approximately 19%. This was the highest average share among all the clusters. This cluster was also characterized by the lowest values for the components “recreation and culture” (approximately 7%), “furniture, household appliances, and routine household maintenance” (approximately 4.8%), and various goods and services (approximately 8%).

The second cluster comprised 45 objects. In relation to the first cluster, it was characterized by a quite high (amounting to approximately 17%) but still lower share of the “food and non-alcoholic beverages” variable (by approximately 2.6%). At the same time, this cluster was characterized by the highest average values of variables such as “housing, water, electricity, gas, and other fuels” (approximately 27%) and “alcoholic beverages, tobacco, and narcotics” (approximately 6.8%). The lowest shares were those of “health” (approximately 2%), “transport” (approximately 8.6%), “clothing and footwear” (approximately 4%), and “restaurants and hotels” (approximately 7%).

The third cluster consisted of 179 objects and was characterized by the highest average shares in the consumption structure, such as recreation and culture (approximately 9%) and various goods and services (approximately 12%). The third cluster was also distinguished by the lowest average values of components, such as food and non-alcoholic beverages (approximately 12%), means of communication—communication (approximately 2.6%), and education (approximately 0.8%).

Table 4. Consumption per capita—characteristics of clusters selected using the fuzzy c-means clustering method.

Cluster 1												
	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12
$\bar{x}$	19.24	6.75	4.76	19.23	4.75	4.21	12.89	3.41	7.32	1.35	8.40	7.69
V	0.19	0.20	0.25	0.12	0.21	0.18	0.15	0.23	0.18	0.44	0.50	0.22
Cluster 2												
	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12
$\bar{x}$	16.64	6.77	4.19	27.22	5.48	2.32	8.55	3.25	9.26	1.05	6.88	8.38
V	0.11	0.18	0.15	0.11	0.12	0.35	0.20	0.12	0.09	0.44	0.23	0.14
Cluster 3												
	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12
$\bar{x}$	12.03	4.78	4.88	23.42	5.72	4.10	13.37	2.61	9.41	0.76	6.97	11.94
V	0.19	0.39	0.11	0.12	0.14	0.28	0.11	0.24	0.18	0.49	0.35	0.15
Cluster 4												
	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12
$\bar{x}$	13.54	4.22	6.14	19.06	6.27	3.80	13.29	2.65	8.02	1.17	11.48	10.36
V	0.22	0.27	0.10	0.15	0.12	0.18	0.10	0.16	0.19	0.36	0.25	0.10
Cluster 5												
	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12
$\bar{x}$	13.98	4.47	5.57	12.81	6.00	3.99	13.80	3.12	8.14	2.02	17.19	8.91
V	0.10	0.13	0.08	0.13	0.23	0.17	0.14	0.13	0.19	0.25	0.12	0.11

V1—food and non-alcoholic beverages; V2—alcoholic beverages, tobacco, and narcotics; V3—clothing and footwear; V4—housing, water, electricity, gas, and other fuels; V5—furnishings, household equipment, and routine household maintenance; V6—health; V7—transport; V8—communications; V9—recreation and culture; V10—education; V11—restaurants and hotels; V12—miscellaneous goods and services. $\bar{x}$ —arithmetic mean, V—coefficient of variation. Source: our study, 2023.

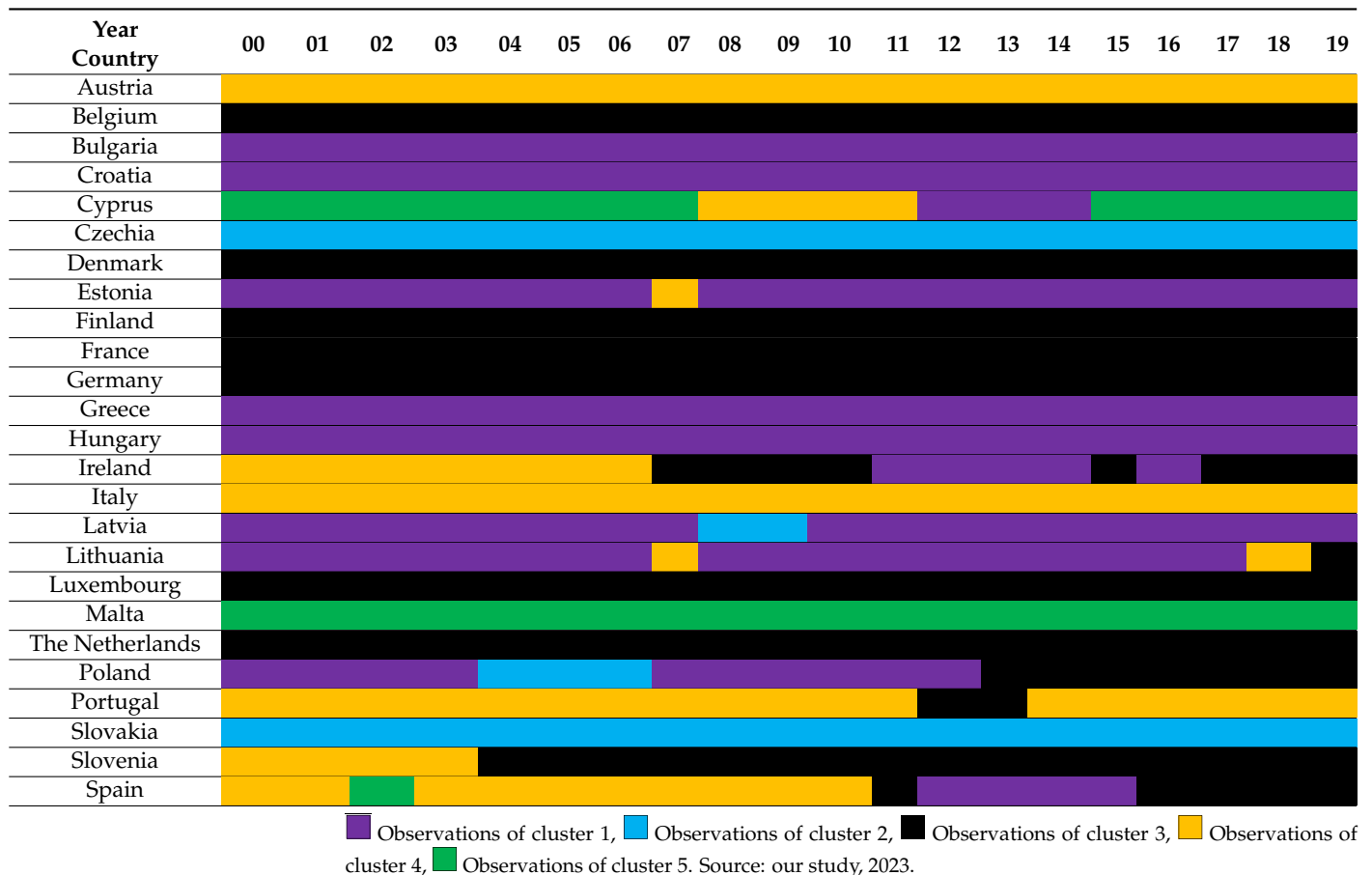
Cluster 4 consisted of 86 objects, which were characterized by the highest average expenditure in the consumption structure on clothing and footwear (approximately 6%) and furniture, household appliances, and routine household maintenance (approximately 6.3%). At the same time, the average percentage of expenses for means of communication was relatively low in cluster 4 (approximately 2.6%). A similar situation was observed for the “alcoholic beverages, tobacco, and narcotics” component—it accounted for approximately 4.2% of the consumption structure.

In cluster 5, the characteristic feature was high average values of the following variables: transport (approximately 14%), education (approximately 2%), and restaurants and hotels (approximately 17%). This cluster, in relation to cluster 4, had similar shares of the following components: “food and non-alcoholic beverages”, “alcoholic beverages, tobacco, and narcotics”, “clothing and footwear”, “furniture, household appliances, and routine household maintenance”, and “health, recreation, and culture”. At the same time, the average share of the variable “housing, water, electricity, gas, and other fuels” was the lowest in cluster 5 and amounted to approximately 13%.

The surveyed countries included those that underwent changes in the per capita consumption structure (Table 5). Two sets of areas were distinguished. The first included countries whose per capita consumption structure was stable—it did not change over time, or the transformations were insignificant and occurred in the middle periods of this study. It included countries such as Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Luxembourg, Malta, the Netherlands, and Slovakia. The second set included countries that changed their

consumption structure including Cyprus, Ireland, Latvia, Lithuania, Poland, Portugal, Slovenia, and Spain.

Table 5. The change in qualifying the results into clusters using the fuzzy c-means clustering method.



In the group of countries that changed their consumption structure, we note the area of Cyprus. Over time, it shifted from cluster 5 in 2008 to cluster 4. From 2012 to 2014, the consumption structure in the country changed once again—it migrated to cluster 1. Finally, in 2016, Cyprus returned to cluster 5 and remained in this cluster in subsequent study periods.

Similarly, Ireland experienced changes in its consumption structure as many as five times. This country was balanced among clusters 4, 3, and 1. In 2007, Ireland shifted from cluster 4 to cluster 3 and remained there until 2010. From 2011 to 2014, it was classified in cluster 1, and in 2015, it migrated to cluster 3, only to return to cluster 1 in 2016. Ultimately, from 2017 to 2019, Ireland was included in cluster 3.

Latvia and Lithuania experienced minor shifts among clusters over the study period. In 2008–2009, Latvia migrated from cluster 1 to cluster 2. This shift, however, was temporary—in 2010, the country returned to cluster 1 and remained there for the remaining periods of this study. However, Lithuania experienced three changes in the per capita consumption structure. For most of the study period, this country belonged to cluster 1, but in 2007, it shifted temporarily (for one period) to cluster 4. Lithuania's migrations among clusters were also observed in 2018–2019. In 2018, the country shifted to cluster 4, and in 2019, to cluster 3.

The consumption structure in Poland was characterized by quite large and long-lasting changes. This country moved from cluster 1 to 2 in 2004–2006. In 2007, Poland returned to cluster 1 and remained there until 2012. In 2013, the country migrated to cluster 3 and remained there for the rest of the study period. Portugal experienced structural changes in

consumption, and in 2012–2013, it belonged to cluster 3. In the remaining periods of this study, Poland belonged to cluster 1. Changes in consumption structure were also observed in Slovenia. This country shifted from cluster 4 to cluster 3 in 2004; however, from 2004 to 2019, the consumption structure did not change significantly—Slovenia remained assigned to cluster 3 over this period.

Consumption in Spain was characterized by multiple changes within clusters determined by the fuzzy c-means method. In 2000–2001, the country belonged to cluster 4, in 2002, it shifted to cluster 5, and in 2003, it returned to cluster 4 and remained there until 2010. Spain experienced a sudden shift to cluster 3 in 2011, while from 2012 to 2015, it belonged to cluster 1. From 2016 to 2019, Spain was a member of cluster 3.

The observed movements of countries among individual clusters over time allow for determining the countries in which the consumption structure changed. According to economic theory, human needs are constantly growing, but within the consumption structure, a decline in the value of its individual components can be observed, with simultaneous growth in other variables. This means that the deconsumption phenomenon can be observed in selected sectors. Changes in structure, which indicate lower consumption of material goods, are a particularly interesting phenomenon. Therefore, analyzing the diagram of variability in cluster membership allowed for selecting countries in which the consumption structure changed in the recent study periods. Two-dimensional Flexplot charts were used to present changes in the selected consumption components in selected countries. The Loess regression algorithm was used to generate the graphs and delineate a smooth curve along the scatterplot points. This can help reveal trends and cycles that are difficult to detect with parametric curve modeling [83]. If one of the studied countries experienced changes in the consumption structure only in the middle periods of this study, and in the final periods the observations returned to the original clusters, these changes were classified as fluctuations in the consumption structure. Such fluctuations concerned countries such as Cyprus, Lithuania, and Portugal. It is possible that these fluctuations represent the beginning of a change that will lead to a permanent transformation of the consumption structure in these countries in the coming years. On the other hand, shifts to other clusters in the final periods of this study in relation to initial group membership were recorded in the following countries: Ireland, Lithuania, Poland, Slovenia, and Spain. Characteristic changes in individual components of the consumption structure of the above countries over time were illustrated on Flexplot charts.

In Ireland (Figure 3), there were clear fluctuations in per capita consumption from 2010 to 2016 in the following structure components: “alcoholic beverages, tobacco, and narcotics”, “clothing and footwear”, “furnishings, household equipment, and routine household maintenance”, “communication”, “recreation and culture” and “miscellaneous goods and services”. Only in the case of the “clothing and footwear variable” did the 2019 levels of consumption return to the level of 2000–2007.

In Lithuania (Figure 4), the per capita expenditure on education stabilized in the years 2007–2016. Starting in 2016, an increase in expenditure in this respect was observed.

In Poland (Figure 5), a slowdown in per capita consumption was observed in 2010–2016 in sectors such as “food and non-alcoholic beverages”, “alcoholic beverages, tobacco, and narcotics”, “housing, water, electricity, gas, and other fuels”, “communications” and “education”. Then, after 2015, the above-mentioned variables (except for education) showed an increasing trend.

Per capita consumption in Slovenia (Figure 6) slowed down in 2010–2016 for variables such as “alcoholic beverages, tobacco, and narcotics”, “clothing and footwear”, “furnishings, household equipment, and routine household maintenance”, “communications”, and “recreation and culture”. It was observed that in the case of structure components such as “alcoholic beverages, tobacco, and narcotics”, “communications”, and “furnishings, household equipment, and routine household maintenance”, per capita consumption did not return to high values after 2016. At the same time, as part of the analysis of the variable

“furnishings, household equipment, and routine household maintenance”, it was observed that its values increased from 2016 to 2019.

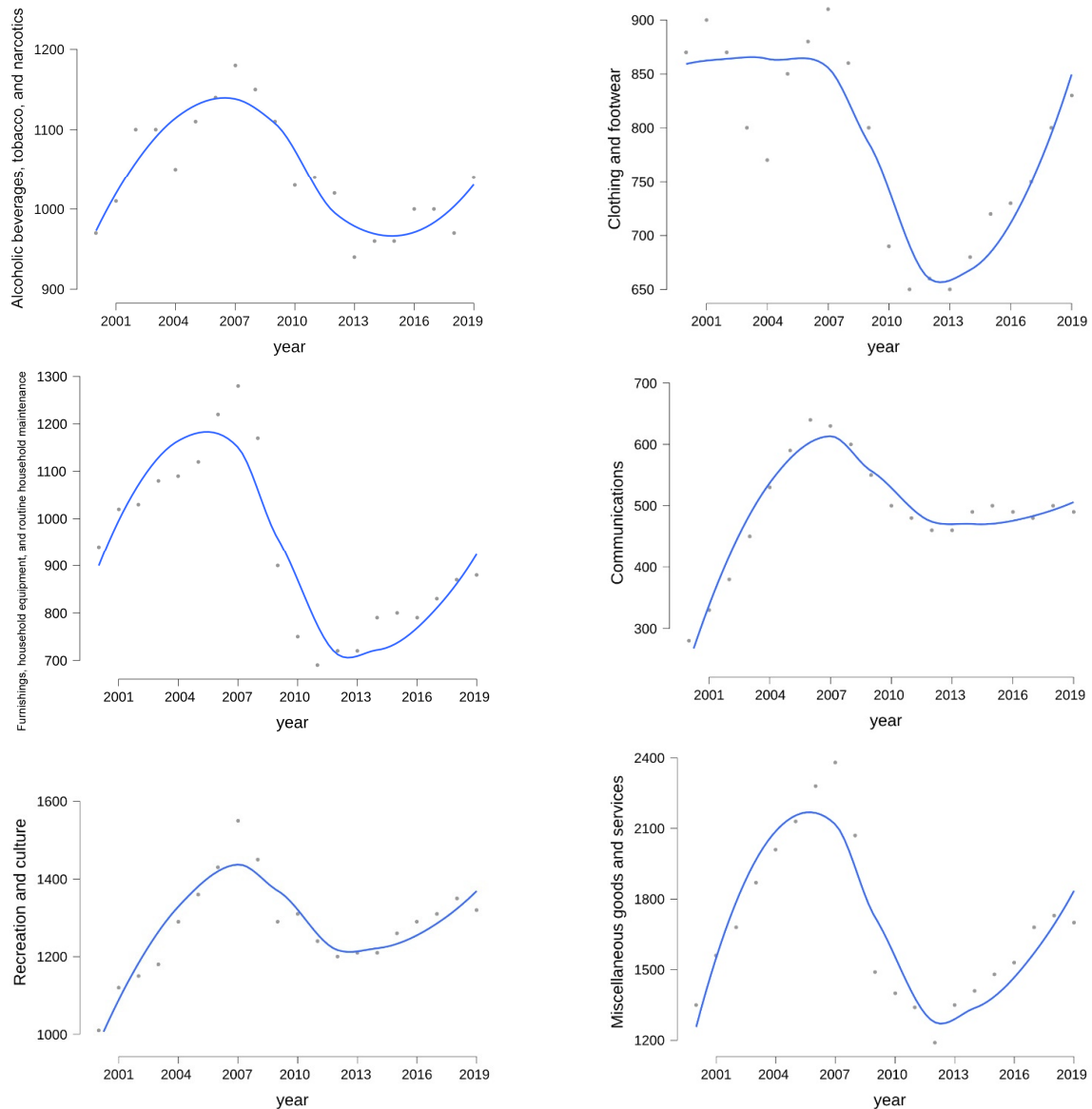


Figure 3. Flexplot charts for selected components of consumption in Ireland in euro per capita in the study period. Source: our study, 2023.

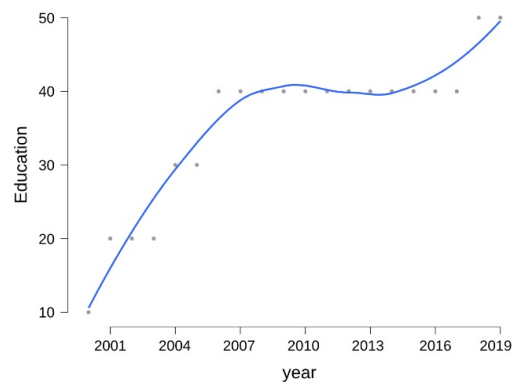


Figure 4. Flexplot charts for selected components of consumption in Lithuania in euro per capita in the study period. Source: own study, 2023.

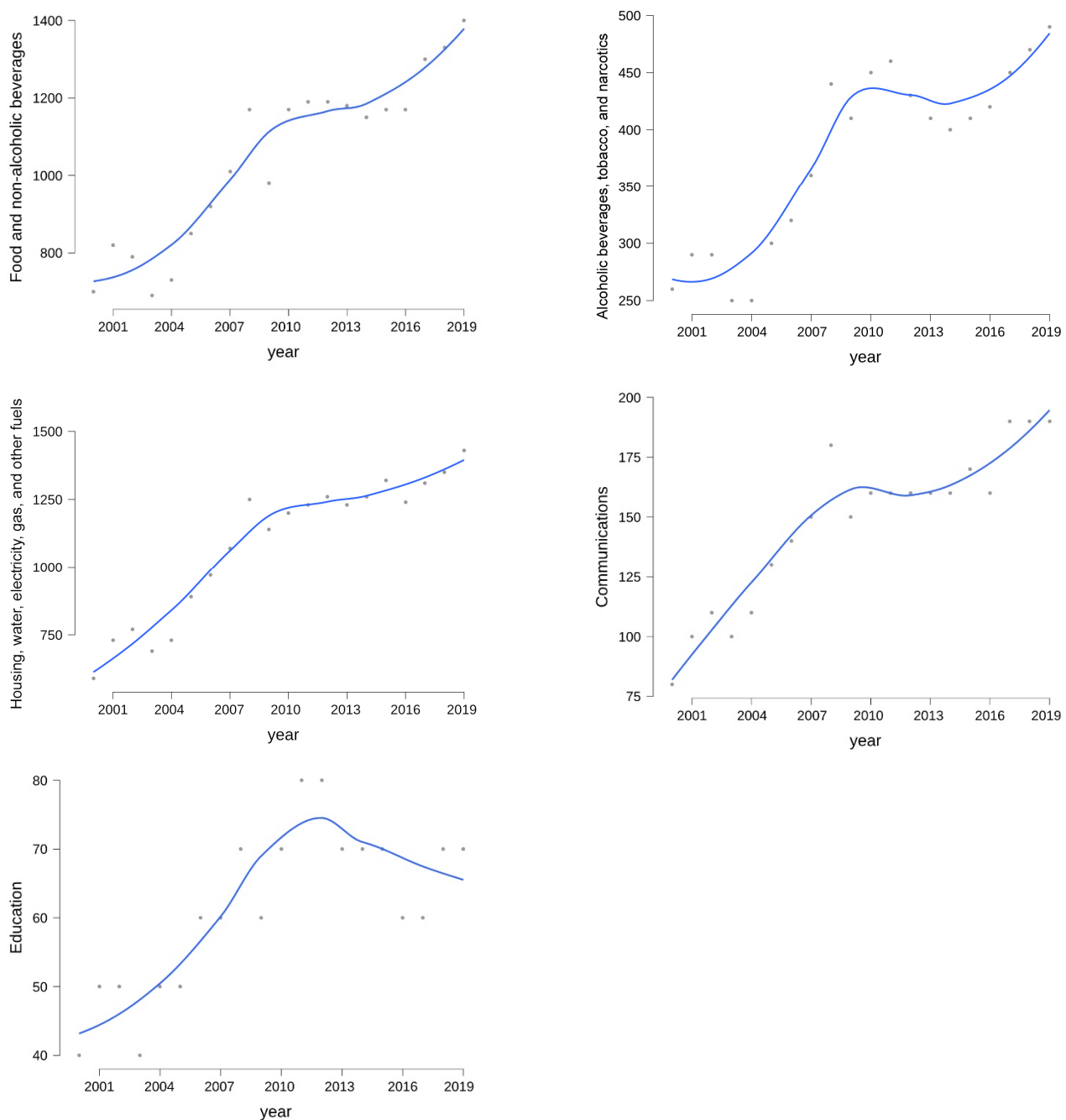


Figure 5. Flexplot charts for selected components of consumption in Poland in euro per capita in the study period. Source: our study, 2023.

In Spain (Figure 7), a clear collapse in per capita consumption occurred in three periods. From 2007 to 2013, no growth or declines in consumption were observed for the following structure components: “food and non-alcoholic beverages”, “alcoholic beverages, tobacco, and narcotics”, “recreation and culture”, “restaurants and hotels” and “miscellaneous goods and services”. The slowdown in per capita consumption also concerned the years 2010–2016 for variables such as “alcoholic beverages, tobacco, and narcotics”, “housing, water, electricity, gas, and other fuels”, and “communications”. Consumption per capita also declined in 2007–2016 for the following components: “furnishings”, “household equipment and routine household maintenance”, and “clothing and footwear”. At the same time, the level of per capita consumption did not return to previous values for the variable “clothing

and footwear”, and the increases in consumption from 2013 compared with 2000–2013 were smaller for the “housing, water, electricity, gas, and other fuels” component.

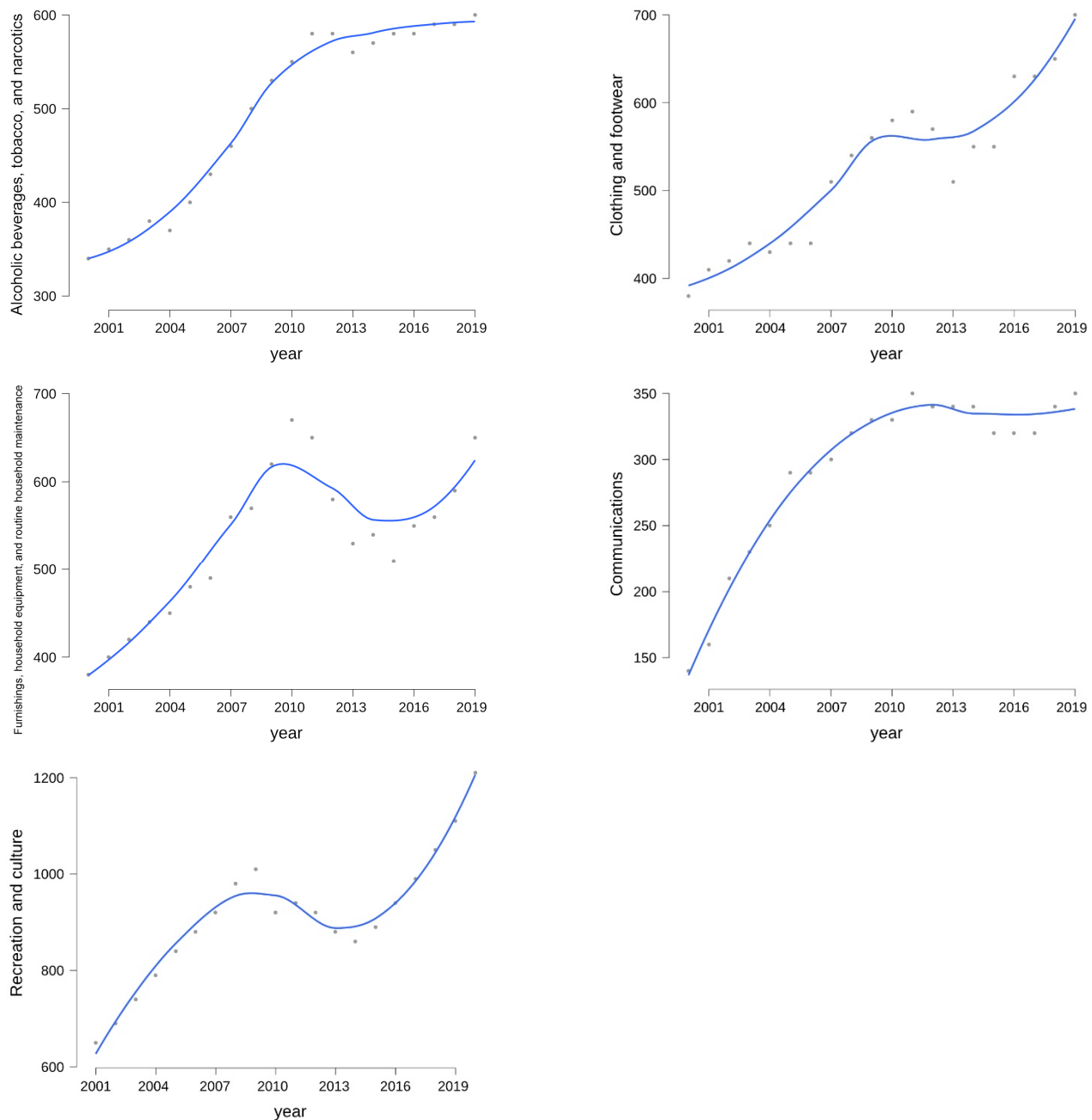


Figure 6. Flexplot charts for selected components of consumption in Slovenia in euro per capita in the study period. Source: our study, 2023.

Deconsumption research is often carried out in qualitative forms that involve survey groups, in which people answer questions about their consumption behavior. In this context, one research paper comes to mind, in which the authors aimed to understand new knowledge about the factors impacting the role of students in increasing food savings coming from reducing food waste. This is a behavior that fits into the definition of the deconsumption phenomenon [84]. The results of the 2022 survey indicated that there were differences in the behavior of consumers (students) in the process of food management, which were less favorable for saving food during the lockdown than during the threat of a pandemic. Based on these results, it can be pointed out that the lockdown did not force frugal behavior among students.

Another qualitative study that is interesting in the context of deconsumption analysis is a paper that analyzed the consumption behavior of seniors in Poland [21]. Its author showed that the level of deconsumption was influenced by demographic and social characteristics of people aged 65+, such as age, gender, education, income, and place of residence. Female seniors showed greater interest in deconsumption compared with male seniors. On the other hand, according to the author of the publication, seniors who were college and high school graduates and residents of large cities, with monthly income above PLN 3000 (~EUR 700) per capita were highly influenced by the deconsumption trend. This could represent an increasingly common way of life for seniors.

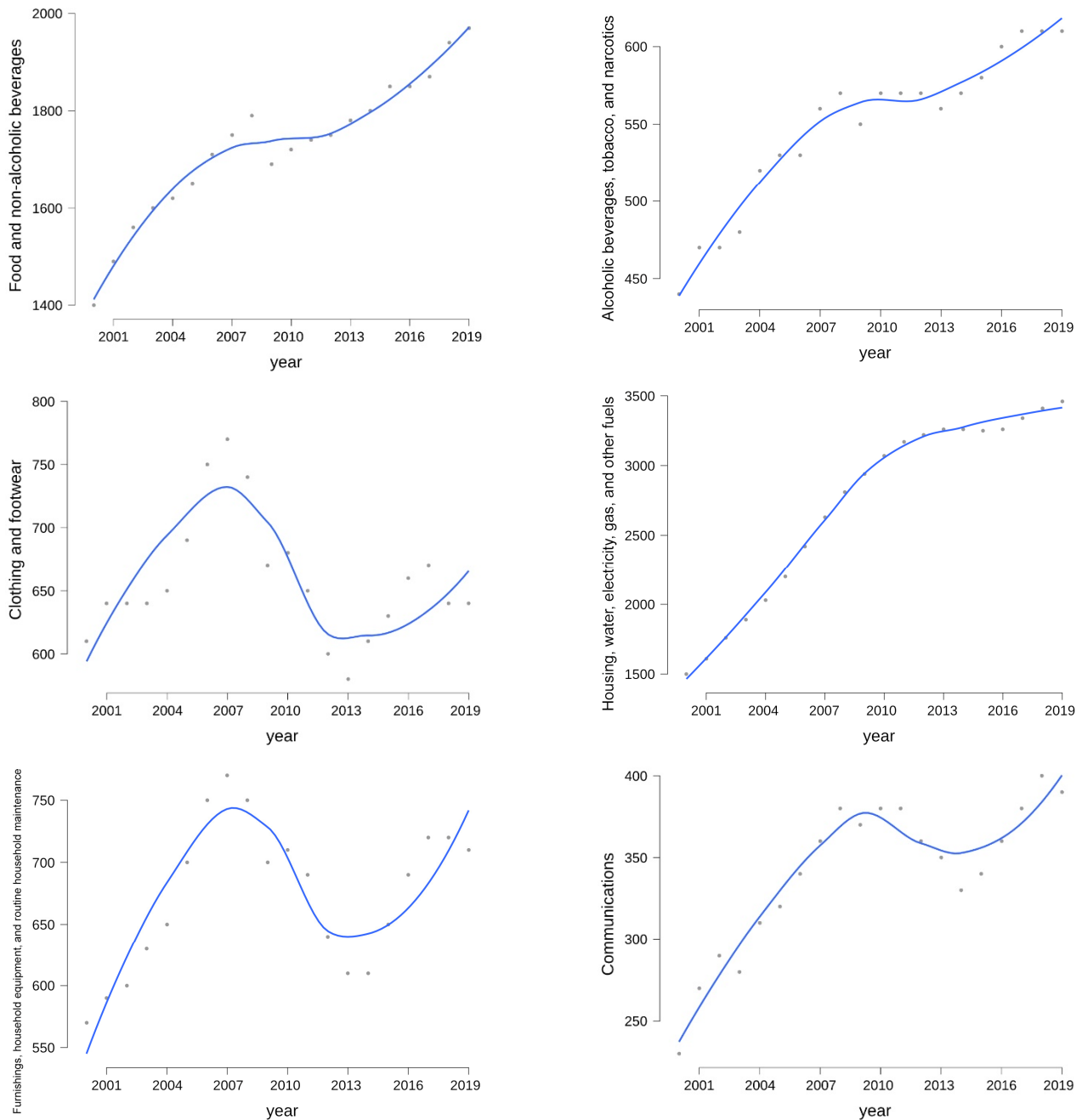


Figure 7. Cont.

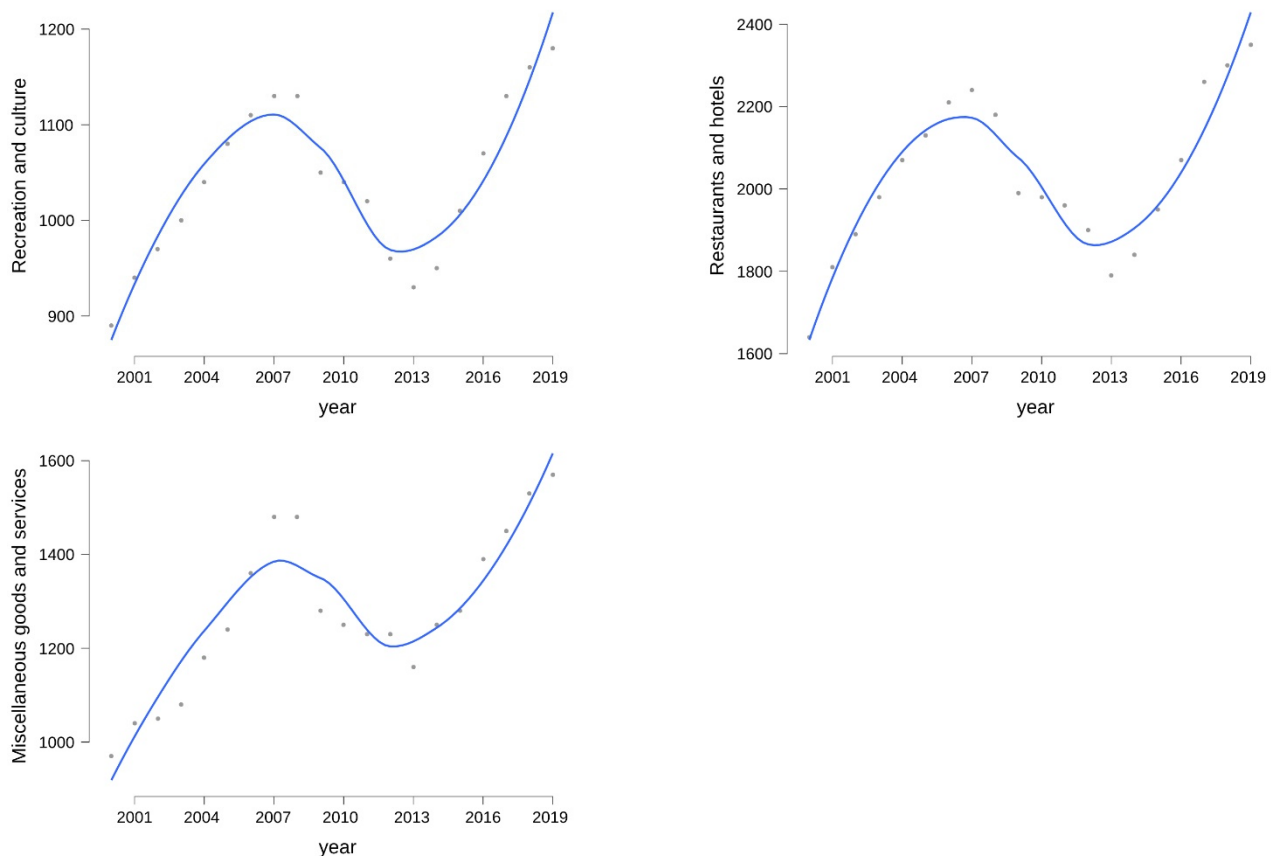


Figure 7. Flexplot charts for selected components of consumption in Spain in euro per capita in the study period. Source: our study, 2023.

Qualitative research on consumption is also being conducted in the tourism sector. The work of Manczak et al. [85] is worthwhile in this regard. Based on the opinions of experts participating in interviews, it attempted to outline changes in tourism after the COVID-19 pandemic. The results of the analysis indicated that the pandemic intensified the virtualization of tourism, which could have been reflected in the slow recovery of this sector. This is why the tourism sector can be an interesting subject in deconsumption analysis.

Elements of the study of deconsumption also appeared in the work presented by Zywiółek et al. [86]. Although the studied households declared that they were saving energy, the percentage of their expenditures on energy actually increased. The authors emphasized that the dissonance between declarations and consumer behavior may be due to the subjective assessment of a household's financial situation or the overall economic condition of the country [86]. This is an important finding because it indicates the need to reduce the element of subjectivity in studies that cover the extent of the real incidence of deconsumption. It suggests that quantitative research in the area of deconsumption analysis makes sense.

In terms of quantitative and qualitative research, the work published by Szwacka-Mokrzycka [38] is worth mentioning. The author showed that in terms of the formation of consumption of food products in Poland, there was a significant variation depending on the category of products consumed. However, in the case of basic products, the author noted a slight increase in consumption, while the demand for highly processed products remained at a relatively high level. This could confirm the absence of the phenomenon of deconsumption in this sector. In addition, the author emphasized the occurrence of qualitative changes in the consumption of food products, which were due to the intensification of substitution processes among product groups, changes taking place in the consciousness of consumers, and the transformation of consumer preferences [38]. The

phenomenon of substitution itself could be part of changes in consumption patterns but does not necessarily indicate the occurrence of deconsumption.

In the pre-pandemic period, Swietlik [87] conducted quantitative research on trends in the behavior of modern food consumers in Poland. It showed that in 2013–2017, upward trends in the economy were reflected in the increase in demand for food. Moreover, consumption of the most basic food groups increased. On the other hand, studies of budgets showed that changes in consumer preferences occurred in the form of the amount of food consumed in terms of basic products (low-processed) in favor of more processed products with a higher unit price. The author of the article called this phenomenon deconsumption, but in the opinion of the authors of this study, this does not fit the definition of the phenomenon of deconsumption as per its characteristics indicated in the Introduction of this article, based on the analysis of the subject literature.

5. Conclusions

This study demonstrated how the consumption structures of only a few EU countries have undergone significant and lasting transformations. This is undoubtedly a phenomenon that can be monitored over time using the fuzzy c-means method. It allows for isolating extensive clusters of observations and identifying shifts in individual objects within them. Intergroup migration of objects over time was observed for eight countries. However, 17 of 25 countries studied experienced no changes in their consumption structure, or only minor ones. At the same time, in the remaining eight countries, there were ambiguous changes that suggest fluctuations or reductions in consumption in individual sectors.

In countries where there were observable changes in the per capita consumption structure as part of inter-cluster shifts, no common pattern was detected in terms of transformations in the value of the per capita consumption variables over the study period. This means that different variables in different countries showed declines or minor changes in per capita consumption.

Macroeconomic data on per capita consumption did not highlight the occurrence of deconsumption in the years 2000–2019. At the same time, it was found that there were changes in the consumption structures of individual countries. The study of variables over time also showed that in countries that experienced changes in the consumption structure, the values of individual variables fluctuated over time. At the same time, consumption within some of its components showed decreasing or slightly increasing trends. This could indicate the emergence of the phenomenon of deconsumption, which was still in its initial stage in the period under study.

The analysis of the per capita consumption structure in EU countries highlighted yet another important aspect. In 17 out of 25 surveyed countries, there were no significant changes in the per capita consumption structure in the 2000s and 2010s. Stabilization of the structure could indicate the existence of the phenomenon of deconsumption in at least some of the studied countries. At the same time, a preliminary review of the data showed that in most countries, per capita consumption increased over the years. Therefore, the authors of this study believe that only an inflation-adjusted data analysis can show deconsumption changes that are visible directly. Therefore, this work can serve as an inspiration for further research on deconsumption. This article investigates a fragment of reality, allowing for drawing theoretical conclusions and constructing a specific model of the support environment for the processes under study—in this case, deconsumption. The results highlight the timeliness and validity of the issues raised in theoretical, cognitive, methodological, and utilitarian areas. This work also has utilitarian qualities, i.e., it formulates arguments for decision-makers, practitioners, managers, and consultants who diagnose the industry regarding the direction and formulation of models of deconsumption for sustainable development. The above considerations do not undermine the research results presented in this article because the subject of the analysis was the structure of consumer spending, which will not differ significantly even after inflation correction. It should

be added that deconsumption is a relatively new and not yet widespread phenomenon; hence, its visibility in macroeconomic data in the examined period could have been limited.

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References

1. Gregg, R.B. *The Value of Voluntary Simplicity*; Pendle Hill Essays: Wallingford, UK, 1936; Volume 3.
2. Etzioni, A. The post affluent society. *Rev. Soc. Econ.* **2004**, *62*, 407–420. [\[CrossRef\]](#)
3. Shaw, D.; Newholm, T. Voluntary simplicity and the ethics of consumption. *Psychol. Mark.* **2002**, *19*, 167–185. [\[CrossRef\]](#)
4. Huneke, M.E. The face of the un-consumer: An empirical examination of the practice of voluntary simplicity in the United States. *Psychol. Mark.* **2005**, *22*, 527–550. [\[CrossRef\]](#)
5. McDonald, S.; Oates, C.J.; Young, C.W.; Hwang, K. Toward sustainable consumption: Researching voluntary simplifiers. *Psychol. Mark.* **2006**, *23*, 515–534. [\[CrossRef\]](#)
6. Niklewicz-Pijaczyńska, M.; Stańczyk, E.; Gardocka-Jałowiec, A.; Gródek-Szostak, Z.; Niemczyk, A.; Szalonka, K.; Homa, M. A Strategy for Planned Product Aging in View of Sustainable Development Challenges. *Energies* **2021**, *14*, 7793. [\[CrossRef\]](#)
7. Cova, B. Community and consumption: Towards a definition of the “linking value” of product or services. *Eur. J. Mark.* **1997**, *31*, 297–316. [\[CrossRef\]](#)
8. De Young, R.D. Expanding and evaluating motives for environmentally responsible behavior. *J. Soc. Issues* **2000**, *56*, 509–526. [\[CrossRef\]](#)
9. Senda, J. Trendy zachowań konsumenckich w rozwiniętych europejskich gospodarkach rynkowych. *Handel Wewnętrzny* **2000**, *46*, 16–25.
10. Bywalec, C.; Rudnicki, L. *Konsumpcja*; PWE: Warszawa, Poland, 2002; p. 143.
11. Bywalec, C. *Konsumpcja a Rozwój Gospodarczy i Społeczny*; Wydawnictwo CH Beck: Warszawa, Poland, 2010.
12. Woś, J. (Ed.) *Zachowania Konsumenckie: Teoria i Praktyka*; Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu: Poznań, Poland, 2003.
13. Marchand, A.; De Coninck, P.; Walker, S. La consommation responsable: Perspectives nouvelles dans les domaines de la conception de produits. *Nouv. Prat. Soc.* **2005**, *18*, 39–56. [\[CrossRef\]](#)
14. Grinstein, A.; Nisan, U. Demarketing, minorities, and national attachment. *J. Mark.* **2009**, *73*, 105–122. [\[CrossRef\]](#)
15. Kieźel, E. (Ed.) *Konsumenci i Jego Zachowania na Rynku Europejskim*; Polskie Wydawnictwo Ekonomiczne: Warszawa, Poland, 2010.
16. Kieźel, E. Konsumpcjonizm i dekonsumpcja w zachowaniach polskich konsumentów. In Kieźel, S. *Smyczek (Red.), Zachowania Konsumentów*; Procesy unowocześniania konsumpcji; Oficyna Ekonomiczna Grupa Wolters Kluwer: Warszawa, Poland, 2014.
17. Grzega, U.; Kieźel, E. Trendy w zachowaniach konsumentów. In M. Bartosik-Purgat (Red.), *Zachowania Konsumentów. Globalizacja, Nowe Technologie, Aktualne Trendy, Otoczenie Społeczno-Kulturowe*; Wydawnictwo Naukowe PWN: Warszawa, Poland, 2017.
18. Botsman, R.; Rogers, R. *What’s Mine Is Yours: The Rise of Collaborative Consumption*; Harper Business: New York, NY, USA, 2010.
19. Zalega, T. *Konsumpcja: Determinanty, Teorie, Modele*; Polskie Wydawnictwo Ekonomiczne: Warszawa, Poland, 2012.
20. Zalega, T. Nowe trendy i makrotrendy w zachowaniach konsumenckich gospodarstw domowych w XXI w. *Konsumpcja Rozw.* **2013**, *2*, 3–21.
21. Zalega, T. Deconsumption in consumer behaviour of Polish seniors. *Zesz. Nauk. Szkoły Głównej Gospod. Wiejskiego. Ekon. Organ. Gospod. Żywnościowej* **2018**, *124*, 29–49. [\[CrossRef\]](#)
22. Burgiel, A.; Zralek, J. Is sustainable consumption possible in Poland? An examination of consumers’ attitudes toward deconsumption practices. *Acta Sci. Polonorum. Oeconomia* **2015**, *14*, 15–25.
23. Zralek, J. Dekonsumpcja jako przejaw proekologicznych zachowań konsumentów. *Handel Wewnętrzny* **2012**, *2*, 135–136.
24. Wilczak, A. Współkonsumpcja jako wyzwanie dla współczesnego marketingu. In *Aktualne Problemy Zarządzania—Teoria i Praktyka*; Wiatrak, A., Ed.; Wyd. Naukowe Wydziału Zarządzania UW: Warszawa, Poland, 2012; pp. 199–210.

25. Wilczak, A. Dekonsumpcja jako przejaw odpowiedzialnej postawy i styl życia konsumenta w świetle analizy jakościowej. *Handel Wewnętrzny* **2016**, *362*, 388–402.
26. Wilczak, A. Between consumerism and deconsumption—attitudes of young poles as a challenge for marketers. In *Proceedings of the Economic and Social Development: Book of Proceedings*, Warsaw, Poland, 26–27 September 2018; pp. 297–305.
27. Szul, E. Dekonsumpcja—Moda czy sposób na kryzys. *Nierówności Społeczne A Wzrost Gospod.* **2012**, *24*, 316–328.
28. Séré de Lanauze, G.; Siadou-Martin, B. Pratiques et motivations de déconsommation: Une approche par la théorie de la valeur. *Rev. Française Gest.* **2013**, *1*, 55–73. [[CrossRef](#)]
29. Patrzalek, W. Between consumerism and deconsumption—In search of a new model of society. *Pract. Nauk. Uniw. Ekon. We Wrocławiu* **2019**, *63*, 221–234. [[CrossRef](#)]
30. Patrzalek, W. Dekonsumpcja—Racjonalny wybór czy ekonomiczny przymus? *Forum Socjol.* **2013**, *4*, 15–29.
31. Michałowska, M.; Danielak, W. The impact of globalization on consumer behavior in Lubuskie province in the light of the research. *Ann. Univ. Mariae Curie-Skłodowska Sect. H—Oeconomia* **2015**, *49*, 135. [[CrossRef](#)]
32. Bylok, F. Intricacies of modern consumption: Consumerism vs. deconsumption. *Annales. Etyka W Życiu Gospod.* **2017**, *20*, 61–74. [[CrossRef](#)]
33. Bylok, F. Meandry konsumpcji we współczesnym społeczeństwie: Konsumpcjonizm versus dekonsumpcja. *Annales. Etyka W Życiu Gospod.* **2016**, *19*, 55–69. [[CrossRef](#)]
34. Trzesiok, J.; Słupik, S. The identification and analysis of the factors affecting energy consumer behaviour. *Pract. Nauk. Uniw. Ekon. We Wrocławiu* **2019**, *63*, 113–126. [[CrossRef](#)]
35. Lemanowicz, M.; Szwacka-Mokrzycka, J. Identification of leading consumer trends on the food market. In *Proceedings of the 2019 International Conference “Economic science for rural development”*, Jelgava, Letonia, 9–10 May 2019; Volume 51, pp. 291–297. [[CrossRef](#)]
36. El Amri, D. Why do consumers turn a deaf ear to calls for reducing home energy consumption? *Rev. l’Organisation Responsable* **2020**, *15*, 29–38. [[CrossRef](#)]
37. Balcerowicz-Szkutnik, M.; Szkutnik, W. Consumption model and current globalization problems—An attempt to asses existing relationships. In *Proceedings of the 14th International Scientific Conference Analysis of International Relations 2020, Methods and Models of Regional Development*, Katowice, Poland, 9 January 2020; Summer Edition; Szkutnik, W., Sączewska-Piotrowska, A., Hadaś-Dyduch, M., Acedański, J., Eds.; Publishing House of the University of Economics: Katowice, Poland, 2020; pp. 29–35.
38. Szwacka-Mokrzycka, J. Changes in Food Consumption of Polish Households in the 21st Century. *Eur. Res. Stud.* **2021**, *24*, 686–698. [[CrossRef](#)]
39. Mysona-Byrska, J. Dekonsumpcja—droga do wyzwolenia z konsumpcjonizmu. *Kult. Wartości* **2021**, *31*, 23–41. [[CrossRef](#)]
40. Mishra, A.; Borin, N.; Lindsey-Mullikin, J.; Krishnan, R. Understanding Consumers’ Motivations and Product Preferences for Deconsumption. *CSU J. Sustain. Clim. Chang.* **2023**, *2*, 4. [[CrossRef](#)]
41. Ciechomski, W. *Contemporary Consumer Trends*; Naukowe Politechniki Śląskiej. Organizacja i Zarządzanie; Scientific Publications—Katowice: Katowice, Poland, 2023; Volume 173. [[CrossRef](#)]
42. Szuszkiewicz, A. Sustainable Consumer Trends in B2C Enterprises’ Marketing Strategies: An Example of Deconsumption. In *International Business from East to West: Global Risks and Opportunities*; Czarnecka, P., Ed.; SGH Publishing House: Warsaw, Poland, 2023; pp. 115–120.
43. Degli Esposti, P.; Mortara, A.; Roberti, G. Sharing and Sustainable Consumption in the Era of COVID-19. *Sustainability* **2021**, *13*, 1903. [[CrossRef](#)]
44. Sesini, G.; Castiglioni, C.; Lozza, E. New trends and patterns in sustainable consumption: A systematic review and research agenda. *Sustainability* **2020**, *12*, 5935. [[CrossRef](#)]
45. Park, S.; Lee, Y. Scale development of sustainable consumption of clothing products. *Sustainability* **2020**, *13*, 115. [[CrossRef](#)]
46. Armstrong, C.M.J.; Park, H. Online clothing resale: A practice theory approach to evaluate sustainable consumption gains. *J. Sustain. Res.* **2020**, *2*, 1–24. [[CrossRef](#)]
47. Gardetti, M.A.; Muthu, S.S. *The UN Sustainable Development Goals for the Textile and Fashion Industry*; Springer: Berlin/Heidelberg, Germany, 2020.
48. Muthu, S.S. *Fast Fashion, Fashion Brands and Sustainable Consumption*; Springer: Berlin/Heidelberg, Germany, 2019.
49. Hasbullah, N.N.; Sulaiman, Z.; Mas’od, A. The effect of perceived value on sustainable fashion consumption in the era of COVID-19: A proposed conceptual framework. *J. Acad. Res. Bus. Soc. Sci.* **2020**, *10*, 895–906. [[CrossRef](#)]
50. Hasbullah, N.N.; Sulaiman, Z.; Mas’od, A. The influences of parasocial relationship and sources credibility in promoting sustainable fashion in social network sites. *Int. J. Eng. Adv. Technol.* **2020**, *9*, 1642–1648. [[CrossRef](#)]
51. Tunn, V.S.; Bocken, N.M.; van den Hende, E.A.; Schoormans, J.P. Business models for sustainable consumption in the circular economy: An expert study. *J. Clean. Prod.* **2019**, *212*, 324–333. [[CrossRef](#)]
52. Dutta, B.; Hwang, H.-G. Consumers purchase intentions of green electric vehicles: The influence of consumers technological and environmental considerations. *Sustainability* **2021**, *13*, 12025. [[CrossRef](#)]
53. Zorn, S.; Suni, J. An Investigation of Sustainable Self-Drive Tourism in Florida. *J. Fla. Stud.* **2019**, *1*, 21.
54. Gontarz, M.; Sulich, A. The sustainable transportation solutions: Smart shuttle example. *Vision* **2019**, 10833–10840.
55. Chang, T.-W.; Chen, Y.-S.; Huang, S.Y.B. How to weigh in on sustainability trends? Sustainable consumption by electric scooter customers and its implications for green marketing. *Corp. Manag. Rev.* **2021**, *41*, 39–79.

56. Islam, M.S.; Proma, A.M.; Wohn, C.; Berger, K.; Uong, S.; Kumar, V.; Korfmacher, K.S.; Hoque, E. SEER: Sustainable E-commerce with Environmental-impact Rating. *Clean. Environ. Syst.* **2023**, *8*, 100104. [\[CrossRef\]](#)
57. da Silveira, A.B.; Levrini, G.R.D.; Ertz, M. How digital platforms materialize sustainable collaborative consumption: A Brazilian and Canadian bike-sharing case study. *J. Int. Consum. Mark.* **2022**, *34*, 51–71. [\[CrossRef\]](#)
58. Goryńska-Goldmann, E. Barriers to the development of consumption sustainability: The consumers,, perspective on the food markets. In *Hradec Economic Days*; Jedlicka, P., Maresova, P., Soukal, I., Eds.; University of Hradec Kralove: Hradec Kralove, Czech Republic, 2019; Volume 9, pp. 243–251.
59. Zalega, T. Sustainable consumption in consumer behaviour of young Polish consumers. *Stud. Ekon.* **2019**, *383*, 82–107.
60. Kutty, A.A.; Abdella, G.M. Tools and techniques for food security and sustainability related assessments: A focus on the data and food waste management system. In Proceedings of the 5th NA Conference on Industrial Engineering and Operations Management, Detroit, MI, USA, 10–14 August 2020; pp. 10–14.
61. Haque, A.; Yamoah, F.A.; Sroka, W. *Willingness to Reduce Food Choice in Favour of Sustainable Alternatives: The Role of Government and Consumer Behaviour*; Perspectives on Consumer Behaviour: Theoretical Aspects and Practical Applications; Springer: Berlin/Heidelberg, Germany, 2020; pp. 31–51. [\[CrossRef\]](#)
62. Piligrimienė, Ž.; Žukauskaitė, A.; Korzilius, H.; Banytė, J.; Dovalienė, A. Internal and external determinants of consumer engagement in sustainable consumption. *Sustainability* **2020**, *12*, 1349. [\[CrossRef\]](#)
63. Eurostat. Final Consumption Expenditure of Households by Consumption Purpose (COICOP 3 Digit). 2023. Available online: https://ec.europa.eu/eurostat/databrowser/view/NAMA_10_CO3_P3_custom_5970730/default/table?lang=en (accessed on 20 November 2023).
64. Cabral, S.; Mantey, C.; Serra, S.; Silva, C. Consumption expenditure during the COVID-19 pandemic: An analysis based on Portuguese card transaction data. *Banco Port. Econ. Stud.* **2021**, *13*, 27–40.
65. Grzega, U. Savings and debts as a sources of financing consumption of Polish households. In Proceedings of the Economic and Social Development: Book of Proceedings, Dubai, United Arab Emirates, 19–20 October 2022; pp. 357–359.
66. Zhao, B.; Jiang, X. Research on The Statistical Measurement of Consumption Quality during the COVID-19 Pandemic. *Int. J. Nanotechnol. Nanomed.* **2021**, *6*, 56–57.
67. Chen, J.L.; Kitingern, K. A case study of factors affecting the performance of the hotel industry of Chiang Mai in Thailand and the impact of COVID-19: Taking de chai hotel group as an example. *Adv. Manag. Appl. Econ.* **2020**, *10*, 73–74. [\[CrossRef\]](#)
68. Bublyk, M.; Kowalska-Styczeń, A.; Lytvyn, V.; Vysotska, V. The Ukrainian Economy Transformation into the Circular Based on Fuzzy-Logic Cluster Analysis. *Energies* **2021**, *14*, 5951. [\[CrossRef\]](#)
69. Aryandani, A.I.S.Y.A.H.; Solimun, N.; Rinaldo Fernandes, A.A.; Efendi, A.C.H.M.A.D. Implementation of Fuzzy C-Means in Investor Group in the Stock Market Post-COVID-19 Pandemic. *WSEAS Trans. Math.* **2022**, *21*, 420–422. [\[CrossRef\]](#)
70. Ansari, A.; Riasi, A. Customer clustering using a combination of fuzzy c-means and genetic algorithms. *Int. J. Bus. Manag.* **2016**, *11*, 62–64. [\[CrossRef\]](#)
71. Giles, D.; Draeseke, R. *Econometric Modelling Based on Pattern Recognition via the Fuzzy c-Means Clustering Algorithm*; Working Paper EWP0101; University of Victoria: Victoria, BC, Canada, 2001. [\[CrossRef\]](#)
72. Bezdek, J.C.; Ehrlich, R.; Full, W. FCM: The fuzzy c-means clustering algorithm. *Comput. Geosci.* **1984**, *10*, 191–203. [\[CrossRef\]](#)
73. Kim, M.S.; Choi, E.S.; Lee, J.Y.; Kang, M.S. A study on the analysis of stability indicators in financial statements using fuzzy c-means clustering. *Int. J. Appl. Eng. Res.* **2017**, *12*, 9864.
74. Celikyilmaz, A.; Türksen, I.B. *Modeling Uncertainty with Fuzzy Logic: With Recent Theory and Applications*; Springer: Berlin/Heidelberg, Germany, 2009; pp. 62–64. [\[CrossRef\]](#)
75. Gokten, P.O.; Baser, F.; Gokten, S. Using fuzzy c-means clustering algorithm in financial health scoring. *Audit. Financ. J.* **2017**, *15*, 385. [\[CrossRef\]](#)
76. Cannon, R.L.; Dave, J.V.; Bezdek, J.C. Efficient implementation of the fuzzy c-means cluster-ing algorithms. *IEEE Trans. Pattern Anal. Mach. Intell.* **1986**, *2*, 248–255. [\[CrossRef\]](#)
77. Basri, Z.A.; Mohamad, N. A new hybrid of Fuzzy C-Means Method and Fuzzy Linear Regression Model in Predicting Manufacturing Income. *Int. J. Eng. Technol.* **2018**, *7*, 474–476. [\[CrossRef\]](#)
78. Destia, B.; Kartikasari, M.D. Comparison of fuzzy c-means and fuzzy Gustafson-Kessel cluster-ing methods in provincial grouping in Indonesia based on criminality-related factors. *Barekeng J. Ilmu Mat. Dan Terap.* **2023**, *17*, 1095–1104. [\[CrossRef\]](#)
79. Bholowalia, P.; Kumar, A. EBK-means: A clustering technique based on elbow method and k-means in WSN. *Int. J. Comput. Appl.* **2014**, *105*, 18–21.
80. Van der Maaten, L.; Hinton, G. Visualizing data using t-SNE. *J. Mach. Learn. Res.* **2008**, *9*, 2579–2587.
81. Tian, Y.; Wu, J.; Wang, Z.; Lu, D. Fuzzy clustering and Bayesian information criterion-based threshold estimation for robust voice activity detection. In Proceedings of the 2003 IEEE International Conference on Acoustics, Speech, and Signal Processing, Hong Kong, China, 6–10 April 2003; Proceedings. (ICASSP '03). pp. 444–447. [\[CrossRef\]](#)
82. Gan, G.; Lan, Q.; Sima, S. Scalable clustering by truncated fuzzy c-means. *Big Data Inf. Anal.* **2016**, *1*, 247–259. [\[CrossRef\]](#)
83. Poniak, R. O możliwości wykorzystania regresji LOESS w analizie szeregów czasowych. *Przeszłość Demogr. Pol.* **2016**, *38*, 104–115. [\[CrossRef\]](#)
84. Skawińska, E.; Zalewski, R.I.; Wyrwa, J. Students' Food Consumption Behavior during COVID-19 Lockdown. *Sustainability* **2023**, *15*, 9449. [\[CrossRef\]](#)

85. Manczak, I.; Gruszka, I.; Drozdowska, M. Changes in Tourism after the COVID-19 Pandemic: Results of Qualitative Research. *IBIMA Publ. Commun. Int. Proc.* **2022**, *2*, 1–9.
86. Żywiołek, J.; Rosak-Szyrocka, J.; Mrowiec, M. Knowledge management in households about energy saving as part of the awareness of sustainable development. *Energies* **2021**, *14*, 8207. [[CrossRef](#)]
87. Świetlik, K. Trends in behaviour of modern food consumers in Poland. *Zesz. Nauk. SGGW Polityki Eur. Finans. Mark.* **2020**, *23*, 191–207. [[CrossRef](#)]

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