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Sustainable Consumption in the Baltic States: The Carbon Footprint in the Household Sector

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Abstract: Sustainable consumption is one of the main aspects while implementing sustainable development goals. The main feature of sustainable consumption is the reduction of environmental impact. Thus, it is vital to understand and evaluate the environmental impact caused by consumption. In this paper, carbon footprint analyses of the Baltic States for the period of 2000–2019 were used to study sustainable consumption and pro-environmental behavior development. The results show not only how carbon footprint changes in different consumption categories (e.g., mobility, housing, food, and services), but whether it is related to changes in pro-environmental behavior as the promotion of sustainable consumption is crucial to reduce the consumption-based carbon footprint. The results from multi-regional input-output analyses show that in the Baltic States 62–71% of all the household carbon footprint is attributed to the three main consumption categories—transport, food, and housing. These categories are also responsible for 53–56% of the household expenditure. Consequently, changes in our mobility, food consumption, and housing management practices can significantly reduce the household environmental impacts. However, to minimize carbon footprints, behavioral changes are not enough; structural changes in the agro-food, housing, energy, and transport systems are also needed.

Keywords: sustainable consumption; pro-environmental behavior; carbon footprint; mobility; food consumption; housing

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1. Introduction

Sustainable consumption and production is the 12th goal among the other sustainable development goals, and it is an essential precondition for the implementation of international and also national sustainability strategies [1–3]. The main aim of this goal is to achieve economic growth and better quality of life at the same time minimizing the use of natural resources, air, water, and waste pollution [4]. In the literature, these two in many cases competing aspects have been considered and vastly analyzed [5–12]. Sustainable production encompasses efficient production based on technological improvement and innovations, while sustainable consumption considers the volume, mode, and distributional issues related to consumption level [10,13,14]. Policymakers often focus on the production side and the tools for how to reduce environmental impact [15]. However, efficient production itself does not guarantee sustainability [10,16]. Furthermore, the practice of sustainable development principles is too complex [17]. Thus, businesses and industries could not deal with it alone [18,19]; the same applies also to governments and other sectors [20,21]. Particularly, it is important to focus on sustainability-oriented innovations and product-service systems [22–24].

In the literature, scholars used to analyze production [25–29] and consumption aspects [30–41] distinct from each other. However, the promotion of sustainable consumption

can enhance environmentally-friendly production processes [42,43]. Therefore, focusing on sustainable consumption also means stimulating sustainable production. When seeking to implement sustainable consumption aspect, it is vital to understand and evaluate the environmental impact caused by consumption [44,45]. The changes in environmental impact occur due to the changes in purchasing and use patterns [13,36,46]. Lukman et al. [47] referring to the Brundtland Report declared that sustainable production and consumption patterns have improved. However, better indicators measuring the environmental impacts of household consumption are particularly important [48,49]. A quantitative assessment of environmental impact could reveal whether countries achieve targets of sustainable consumption or not [50]. Furthermore, considering sustainability aspects, it is important to analyse separate sectors and their progress [18].

Scholars evaluating the impact of consumption in the household sector usually used the footprints' indicators [6,51,52]. The carbon footprint is mostly used, whereas it could reveal both the tendencies of sustainable consumption and achievement of the climate change policy targets [53–57]. In recent years, this indicator was used in various countries or country groups e.g., the United States [58,59], Norway [60,61], China [62–67], Japan [68,69], Nordic countries [70], and also separate European Union countries [71–75].

The Baltic States (Lithuania, Latvia, and Estonia) is a specific country group in the European Union (EU), which for a half-century survived the foreign occupation, facing a centralized economy instead of market-based, but around thirty years regained independence and almost twenty years ago joined the EU. Despite the fact that these countries have a rather common recent history, the economic development, as well as the environmental policy situation, is rather different. Brizga et al. [6], analyzing the household carbon footprint during the period 1995–2011, found the different changes and tendencies of carbon footprint in the household sector of these countries. However, the question remains whether the renewed EU Sustainable Development Strategy (2009), where the goal of sustainable consumption and production emerged, and further developments of EU environmental and climate policies framework and national planning documents, are sufficient.

This paper aims to respond to this question by discussing the main problems of consumption and pro-environmental behavior in the Baltic States from 2000 to 2019, analyzing not only how carbon footprint changes in different consumption categories (e.g., shelter, services, mobility, manufactured goods, food, construction, and clothing), but also looking at the related changes in pro-environmental behavior as the promotion of pro-environmental behavior is crucial to reduce the consumption-caused carbon footprint [76–78].

2. Methodology

This study looks at the household carbon footprint and pro-environmental behavior in the Baltic States, and it is built on the environmentally extended multi-regional input–output (MRIO) analyses accounting for direct and indirect (embodied) household CO_{2e} emissions [79,80] and additionally analyzes the results from several representative public opinion surveys done in the Baltic States over the last few years.

The MRIO model was used to assess consumption-based climate impacts of national consumption activities throughout their supply chains. It combines economic data on the sectoral structure of the economy linked to bilateral trade data and environmental accounts of CO_{2e} emissions related to the production of commodities. In this study, the MRIO model, which is based on a global harmonized set of input–output (IO) tables, was taken from EXIOBASE 3.8 [81]. This model covers a time period of 2010–2019 and includes 163 industries and 44 countries and regions, including all the EU (EU-27) member states, biggest global economies, and four world regions, including aggregated data for the countries not covered by the country model.

EXIOBASE 3.8 provides data for the main greenhouse gas (CO_2, CH_4, N_2O, SF_6, HFC, and PFC) emissions attributed to intermediary consumption, thus covering all the main greenhouse gas (GHG) emissions of the global economy. These emissions were recalculated into carbon dioxide equivalents (CO_{2e}) using per-emission weighting factors

for the 100-year global warming potential provided by the International Panel of Climate Change (IPCC). Additionally to the indirect household emissions calculated using MRIO analyses, direct household emissions from energy use were obtained from EUROSTAT and added to the total household carbon footprint.

In this model, the total consumption-based CO_{2e} emissions were calculated using the following equation:

$$c = f\,(I - A) - 1 \times Y \quad (1)$$

where c represents total supply chain GHG emissions for each of the industrial sectors; f is row vector representing direct CO_{2e} emission intensities of industrial sectors; I is the identity matrix; A is the technological coefficient matrix showing monetary relationships between industrial sectors within the economy; Y is a matrix of final household demand.

The bridge matrix was used to move from the Classification of Products by Activity used in the EXIOBASE to aggregate products in bigger consumption groups (see Annex 1). Based on this aggregation, the results were analyzed in the following consumption groups: shelter, services, mobility, manufactured goods, food, construction, and clothing.

3. Results and Discussion

3.1. Household Income and Consumption Level in the Baltic States

During the analyzed period, the economy in the Baltic States increased very fast. Even though the Baltic States were hard hit by the recent economic recession in 2008–2009, they recovered quickly and were some of the fastest-growing economies in the EU—in 2019, before the SARS-CoV pandemic, real gross domestic product (GDP) increased by 5% in Estonia, 2.1% in Latvia, and 4.3% in Lithuania, while average GDP in the EU27 increased only by 1.5% [82]. In 2019, per capita GDP in Estonia, Latvia, and Lithuania reached 15,760, 12,510, and 14,010 EUR, respectively, but is still much lower than the EU27 average (28,610 EUR) [83]. Therefore, from an economic perspective, consumption growth is welcomed. However, economic growth is closely linked to household income. Thus, over recent years, household consumption in the Baltic States increased by around 20% annually. Meanwhile, from the environmental perspective, it is crucial to ensure decoupling of the economic growth from the environmental impacts. So far, technological progress and changes in economic structure are the main strategies used seeking to reduce this impact [84,85].

Considering the different consumption categories, in 2019, food accounted for 18–20%, housing for 15–21%, and mobility for 12–16% of the Baltic States household expenditures. These three consumption categories jointly accounted for 52.8–55.5% of household disposable income, while, in EU27, it was only 49.7%. The amount and the structure of household expenditure significantly differ depending on the place of living, age, gender, and other factors.

Different consumption categories have different carbon intensities, e.g., shelter, construction, mobility, and manufactured products have some of the highest carbon intensities (see Figure 1). The increasing expenditures for mobility are not a good signal for climate change as it will lead to an increased carbon footprint. Meanwhile, increasing the share of expenditure for services or clothing could slightly offset the environmental impact. The current SARS-CoV pandemic will also have an impact on the structure of the household expenditures and environmental impact, but it is too early to judge.

The habits or patterns of purchasing behavior are also important factors for sustainable consumption [86]. During the last several years, there have been significant changes in consumer shopping habits—most people have become more price-sensitive, chasing discounts, postponing purchases, and switching to cheaper alternatives [87]. However, some of the best ways to reduce the environmental impact of consumption are the consumption of environmentally friendly, local, seasonal, durable, and second-hand goods. Liobikiene et al. [88] showed that, in Lithuania, the level of green purchases was the smallest among the EU countries and the Baltic States. On the contrary, in Estonia, people more often state that they choose green products. Furthermore, the determinants also differed.

In Lithuania and Latvia, the interaction of environmental knowledge and confidence of green products in addition to subjective norms significantly influenced the green purchase behavior. Meanwhile, in Estonia, subjective norms and the importance of green product prices were the main factors.

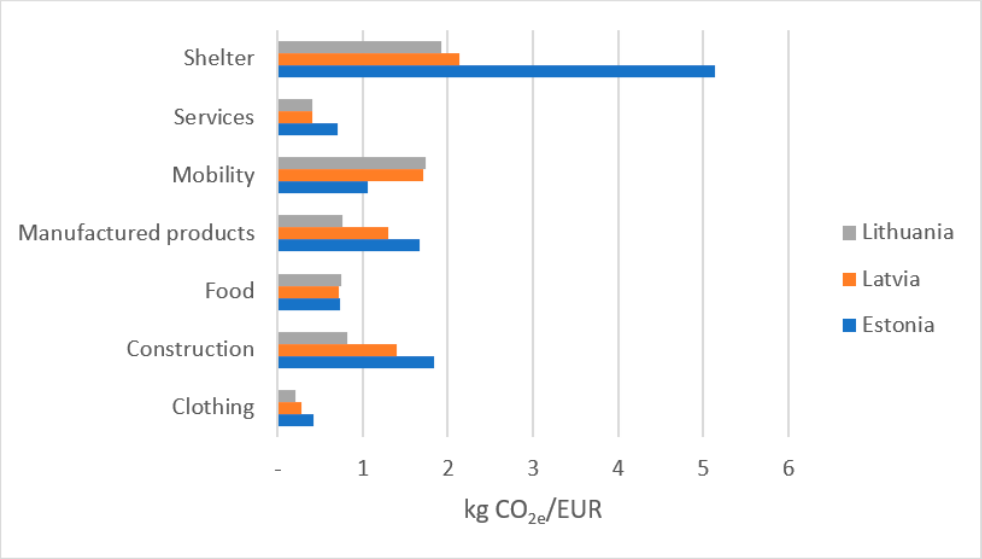

Figure 1. Carbon intensity of consumption expenditures in the Baltic States (2019).

3.2. Consumption-Based Carbon Footprint in the Baltic States

Focusing on the general impact of consumption on the environment and climate change, the carbon footprint was measured. The results demonstrate that the per capita household carbon footprint in Lithuania and Latvia is much lower than in Estonia (see Figure 2). In 2019, in Estonia, it was 13.4 t CO_{2e}, while in the other Baltic States only 9.1 t CO_{2e} per capita. These differences between the countries can be mostly described by a significantly higher carbon intensity of the Estonia energy sector where the primary energy source is lignite, while energy sectors in Lithuania and Latvia have much lower carbon intensity (share of renewable energy in the final consumption is the highest in Latvia, 40.3%) [89].

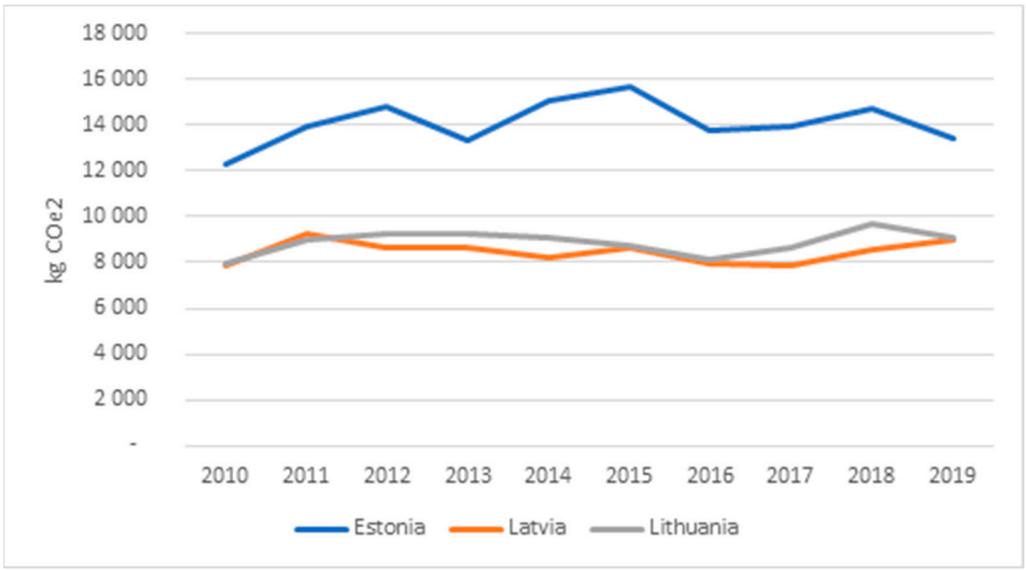

Figure 2. The consumption-based per-capita carbon footprint of the Baltic States (2010–2019).

Carbon footprint in all the Baltic States over the last ten years has been rather stable with a slight tendency to increase. Jakucionyte-Skodiene and Liobikiene [90] revealed that, in 2019, people in Latvia and Estonia were less concerned about climate change. However, the level of climate-friendly behavior was higher in these countries rather than in Lithuania. Particularly in Latvia and Estonia, the bigger share of respondents acknowledged that they have purchased more energy-efficient cars or household appliances. Despite the increasing number of energy-efficient appliances and cars, households consume more and more energy, which is directly leading to an increase in carbon footprint. This effect in the literature is defined as a rebound effect [91–93]. How the structure of carbon footprint changed and how is it linked to pro-environmental behavior in different consumption clusters is discussed in the following paragraphs.

3.3. Carbon Footprint According to Consumption Categories

The structure and the changes in consumption-based carbon footprint differed in the Baltic States. In 2019, shelter was the consumption cluster with the highest per capita CO_{2e} emissions in all the Baltic States (30–42% of total), but between 2010 and 2019 Lithuania has managed to decrease its shelter-related footprint by 37%. In Estonia, shelter accounts for 5 t CO_{2e} per capita or 37% of all household footprints. However, in Lithuania, mobility-related carbon emissions account for 2.9 t CO_{2e} per capita (32% of the total carbon footprint). In Estonia and Latvia, mobility accounts for 9% and 22% of CO_{2e} emissions, respectively. Food is the third most important consumption category, accounting for 15% of emissions in Estonia, 19% in Latvia, and 22% in Lithuania. Another important consumption cluster is services, which account for 17% of emissions in Estonia, 14% in Latvia, and 15% in Lithuania (see Figure 3).

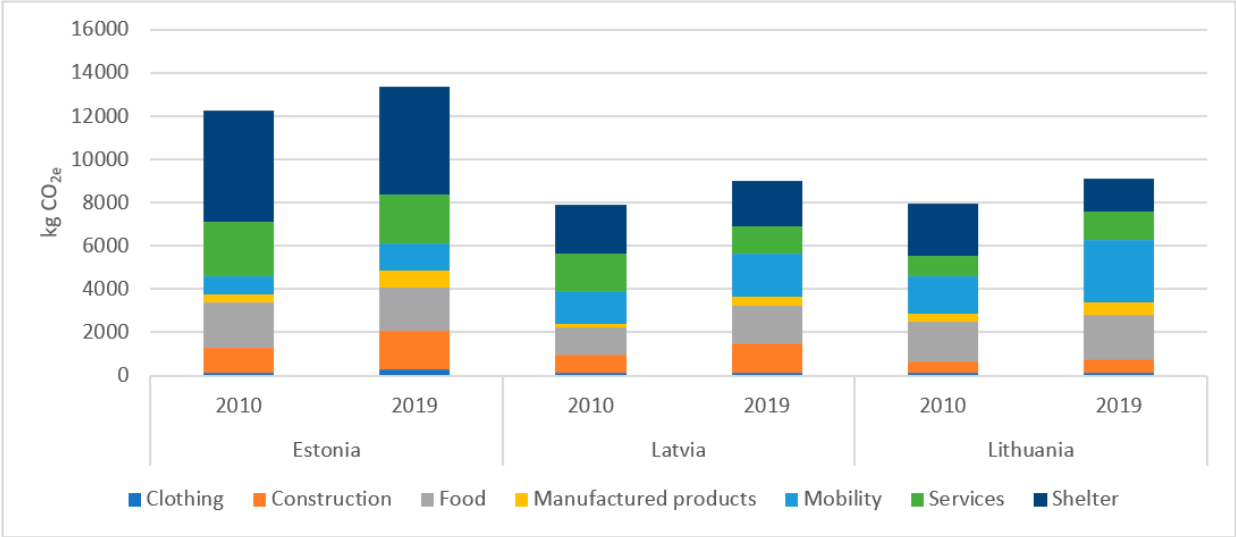

Figure 3. Structures of the consumption-based carbon footprint of the Baltic States in 2010 and 2019.

3.3.1. Food

Food consumption is one of the main consumption clusters which contribute to climate change. Authors assessing the impact of food consumption stress the importance of the agriculture sector, production, transportation, and consumption phases [94]. Zhang et al. [52] stated that the food sector is mostly responsible for GHG emissions in China. Furthermore, the impact of food consumption is bigger in developing countries, where the share of food expenditure is proportionally higher. Considering the Baltic States, between 2010 and 2019, the amount of calories consumed has not changed significantly; nonetheless, there are significant changes in the structure of food consumed—increasing consumption of meat (especially poultry), milk, eggs, and processed products and fruit and decreasing consumption of bread, potato, and fish products [95]. Therefore, in Lithuania

and Latvia, the impact of the food consumption category slightly increased from 2010 to 2019. Meanwhile, in Estonia, the food-related carbon footprint has remained rather stable (Figure 2).

Consumers in the Baltic States are exceedingly price-sensitive. In the recent survey, around 90% of respondents said the price was the primary factor when choosing food, but 70% believe healthy eating to be an important factor as well [96]. However, food surveys show that people consume too much meat, products with high fat and salt content, significant amounts of bread, but insufficient amounts of vegetables, fruit, and dairy products, demonstrating a significant value–action gap in this respect [97]. Furthermore, prefabricated food consumption is also gaining popularity in the Baltic States. Increasing income and lifestyle changes drive an increase in the consumption of prefabricated products to save time but are not good for reducing carbon footprint. However, the organic farming and supply in the Baltic States slightly increase [98], and it can contribute to the reduction of environmental impact and carbon footprint in the longer term.

3.3.2. Mobility

The share of the carbon footprint caused by mobility in 2019 was the biggest in Lithuania and Latvia. Furthermore, in all the Baltic States, the footprint increased over the years, particularly in Lithuania (Figure 1). The main reason could be that the number of passenger cars during the last 10 years has been increasing, but in Latvia, it is still one of the lowest in the EU (369 cars per 1000 inhabitants) [99]. The car fleet in the Baltic States is very old—in 2018, 41% of the cars in Estonia were more than 10 years old, in Latvia, 58%, and in Lithuania 64% (in Germany only 33% of cars are older than 10 years). CO_2 emissions from the new passenger cars purchased in the Baltic States (130 g CO_2/km in Estonia, 128 g in Latvia, and 132 g in Lithuania) are also above the EU average (123 g CO_2/km). Furthermore, the main fossil fuel source is diesel, which has a significant adverse effect not only on the climate but also air pollution. However, in all the Baltic States, diesel fuel is subsidized, making it financially attractive for people to choose diesel cars. Electric and hybrid cars are still not widespread due to the lack of government support and undeveloped charging infrastructure. However, this situation might change as governments are investing in the infrastructure and setting up subsidy schemes to boost the purchase of electric cars. People are also encouraged to change old cars to environmentally friendly alternatives: electric scooters, bicycles, and tickets for public transport.

Cycling and the use of electric scooters are gaining popularity in the Baltic States. Studies show that cycling in 2030 could cover 5.5% of commuting ensuring 2.3% CO_2 emission reduction within the transport sector [100]. However, the main mode of transportation remains a car—51% of respondents mention a car as a dominant mode of daily transport in Estonia, 42% in Latvia, and 48% in Lithuania [101].

Minelgaitė et al. [102] showed that, in Latvia, people more often used public transport rather in Lithuania and Estonia. This is also reflected in the transport-related per capita carbon footprint (see Figure 4). In Latvia, 45% of the transport-related footprint is from the use of public transport, while, in Lithuania, private cars account for 65% of the carbon footprint. However, due to the SARS-CoV pandemic, people starting to commute less and choose other more isolated modes of transport. The most recent public survey shows that the use of public transportation, including urban rail, over the last five years, has decreased by 5% in Estonia, 8% in Latvia, and 1% in Lithuania [101].

To reduce transport-related carbon footprint, public transport is the most environmentally efficient choice [103–106]. However, the Baltic States should stimulate the use of public transport. According to Minelagaite et al. [102] in Lithuania, the main tools could be the improvement in frequency and reliability of the public transport service and lower prices of the tickets; meanwhile, in Estonia, only the amenity and density of stations as a free public transport did not increase the usage of public transport as was expected [107].

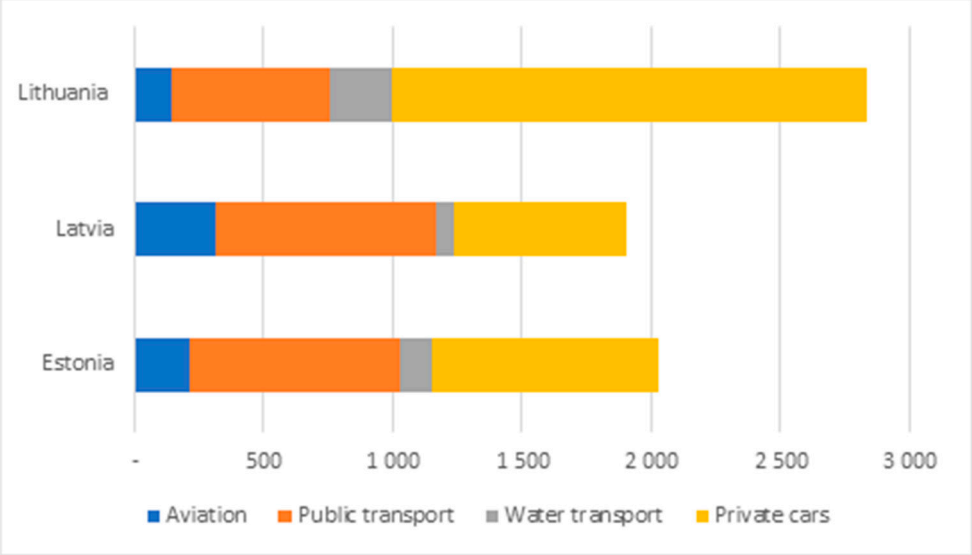

Figure 4. Transport-related per capita carbon footprint of the Baltic States (2019).

In the context of SARS-CoV, the authors found a great reduction of GHG emissions in the transport sector due to the quarantine introduction [108,109]. However, it is expected that this pandemic should have an impact on our habits related to mobility. Virtual conferences and meetings can be some of the best platforms for researchers and some other professions to communicate and reduce mobility-related environmental impacts.

3.3.3. Shelter

The carbon footprint of the shelter category from 2010 to 2019 decreased in all the Baltic States (Figure 1). However, in Estonia, it is still responsible for the biggest share of the household carbon footprint. Some of the drivers decreasing shelter footprint could be linked to the increased thermal efficiency of the housing, improvements in the energy distribution networks, and climate change (decreasing number of heating degree days). At the same time, the average household size in the Baltic States has been decreasing in 2019 reaching 2.1 people per dwelling (dw) in Estonia, 2.3 in Latvia, and 2.2 in Lithuania (EU28—2.3) [110]. However, according to Eurostat, 43% of people in Latvia still live in overcrowded households (at the same time 13.3% of elderly people in Latvia live in dw with too many rooms), but, in Lithuania and Estonia, these numbers are lower, 23% and 13%, respectively [111]. These figures demonstrate significant housing inequality in the region and are also linked to energy poverty as many households experience arrears on utility bills (in Estonia 6.5% of households, in Latvia 11.6%, in Lithuania 9.2% [89]).

Residential energy consumption over the last 10 years has decreased only in Latvia (by 22.6%), but in Estonia and Lithuania, it has not changed much. However, there is some fuel shift observable. Electricity consumption has been growing in all the Baltic States, but especially in Lithuania where it increased by 26% over the last 10 years. Between 2010 and 2019 in all the Baltic states, energy consumption per dw decreased—in Estonia by 10.4% in 2019 reaching 1.48 toe/dw, in Latvia by 6.5% (1.57 toe/dw), but in Lithuania by 3.7% (1.05 toe/dw). Between 2000 and 2019, significant reductions in all the Baltic States have also been observed in terms of household heating energy consumption: −22.5% in Estonia (in 2019 reaching 14.1 koe/m^2), −42.2% in Latvia (15.5 koe/m^2), and −19.9% in Lithuania (11.3 koe/m^2) [112]. These positive changes can be caused by an increasing number of renovations and energy efficiency improvements. Furthermore, even people living in flats have a possibility to choose renewable electricity suppliers due to the liberalization of the EU energy market. The promotion of renewable energy consumption is particularly important in order to mitigate climate change. Furthermore, there are various incentives available in the Baltic States to minimize housing-related climate impacts, for example,

the financial mechanisms to establish solar collectors, renew heading systems, and energy efficiency measures. Most of these measures are funded via EU funds.

3.3.4. Services Sector

The service sector, despite the low carbon intensity, also is one of the main consumption categories where the level of carbon footprint is high. In Estonia and Latvia, the share of carbon footprint during the analyzed period decreased; meanwhile, in Lithuania, a slight increase was observed (Figure 1). These results can be driven by the fact that people's spending on services keep increasing. Service sectors with the highest per capita carbon footprint are Recreation and tourism (12–31%), Health, education, and research (14–31%), and Business and financial services (14–23%). However, differences among countries are significant (see Figure 5). Literature shows that the carbon intensity of the energy system and domestic economy, as well as household expenditure, explain most of the differences in the per capita carbon footprint of services [113]. This could be true also for the Baltic States as the highest carbon footprint of the service sector is in Estonia whose energy sector is highly carbon-intensive, thus leading to the increasing emissions of the service sector.

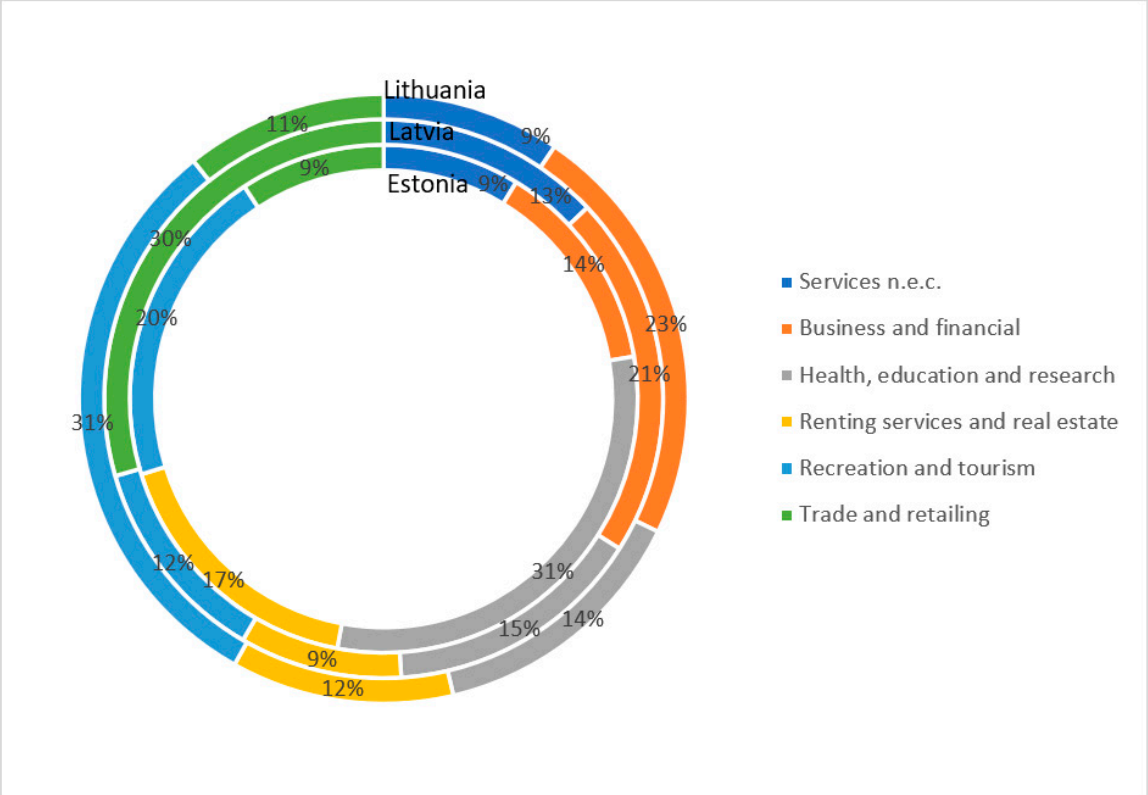

Figure 5. Service-related per capita carbon footprint (2019).

3.3.5. Other Sectors

More than half of the household carbon footprint of consumption of manufacturing products is from the consumption of Appliances, machinery, and electronics (467 kg CO_{2e} in Estonia, 194 kg CO_{2e} in Latvia, and 339 kg CO_{2e} in Lithuania). The second most important consumption category is Media and Communication accounting for 18–37% of the carbon footprint of manufacturing products. Some of the best strategies to reduce the carbon footprint of the manufactured products are a circular economy aimed at reduction of the ownership, an extension of the replacement cycle (more durable goods and better repair possibilities), and policies targeting inter-linkages between durables and complements [114,115]. The environmental certification also could help people to choose more environmentally friendly products seeking to reduce the environmental impact caused by

consumption. Companies also should widen the green supply chain management seeking to improve their environmental performance [16,116–118].

The smallest carbon footprint was observed for the clothing category. The changes over the years in this consumption category were also negligible in all Baltic States (Figure 1). The positive is that green fashion has become more popular among young individuals. Meanwhile, the older people are more conservative and usually are not linked with following fast-fashion. The clothes-sharing platforms and second-hand shopping has also become more and more popular. It can be related to increasing environmental awareness and popularity of the zero-waste movement where people are encouraged to be creative and always be fashionable not only with new clothes.

4. Conclusions and Policy Implications

The results of this study show that, despite the increasing policy support for sustainable consumption, carbon footprints of the Baltic States between 2010 and 2019 significantly increased. In addition, 62–71% of all the entire household carbon footprint can be attributed to the three main consumption categories—mobility, food, and shelter. These categories are also responsible for 53–56% of the household expenditure. Consequently, changes in our mobility, food consumption, and housing management practices can significantly reduce the household environmental impacts. Some general and common suggestions requiring social innovation that changes people's attitudes and social practices can be drawn:

1. Changes in the diet to balance calories and minimize consumption of animal-based products;
2. Consumption of seasonal and local-organic products;
3. Energy efficiency improvements and usage of renewable energy resources in the housing sector;
4. Switching to public transport and non-motorized means of transportation;
5. Decreasing consumption of energy-intensive products and services;
6. Extending the lifespan of the manufactured products;
7. Encouraging companies through subsidies to produce more environmentally friendly products;
8. Educating people to behave in a more environmentally friendly mode not only in private life but in the work place as well [119,120].

These innovations show different ways to eliminate unsustainable practices as well as different forms of sustainable alternatives. However, there are significant differences among the Baltic States in amounts of the carbon footprint. The results demonstrate that the per capita household carbon footprint in Lithuania and Latvia is much lower than in Estonia. These differences between the countries can be mostly described by the significantly higher carbon intensity of the energy sector. The structure of the carbon footprint differed in the Baltic States as well. These differences can be partly explained by differences in mobility patterns, energy consumption, behavior patterns, household income, and consumption structure.

However, political, economical, technological, and societal structural factors, e.g., infrastructure, culture, urbanization, and economic structure, also play a significant role in shaping the household carbon footprints. Some of the important structural factors differentiating carbon footprints in the Baltic States are differences in the carbon intensity of energy production systems, housing structure, mobility patterns, and urbanization differences among the countries, which can help explain some of the differences in carbon footprints.

Therefore, to minimize one's carbon footprint, awareness-raising and behavioral changes are not enough. There is also a need for structural changes in how the agro-food systems, housing and energy systems, as well as transport systems are organized. Differences in these systems also mean different approaches to be implemented in each of the Baltic States to minimize the carbon footprints, e.g., Estonia has to decarbonize its energy sector, Latvia has to improve housing energy efficiency, while Lithuania has to

decarbonize the transport sector. These are just some of the tasks these countries have to take up to ensure the implementation of the decarbonization strategies.

To implement the necessary structural changes in these systems leading to the decarbonization of agriculture, energy, and transport, there is a need for broad stakeholder involvement on different levels involving municipalities, businesses, science, and other stakeholders.

The government in the Baltic States should also be more proactive in integrating sustainable consumption and production aspects in national policy frameworks as well as be actively involved in transnational processes like Sustainable development goals (goal 12 is specifically aimed at sustainable consumption).

5. Limitations and Avenues for Future Research

In this paper, we analyzed how the carbon footprint changed in different consumption categories (e.g., shelter, services, mobility, manufactured goods, food, construction, and clothing) from 2010 until 2019. However, for revealing the main factors which determined the growth of greenhouse gas emissions in the Baltic States, more elaborate analysis is needed. Future researchers should focus on separate consumption categories and analyze the factors of how to reduce environmental impact in separate categories. Furthermore, in this paper, we theoretically analyzed how changes in pro-environmental behavior can influence the reduction or increase in environmental impact in separate consumption categories. Thus, in the future, more studies are needed to analyze how various programs as the choice of green supplier, ecolabelling, cost of public transport (or fuels), increase green products supply, etc. could influence the changes in pro-environmental behavior and environmental impact caused by consumption.

In this study, the particular attention was paid to the Baltic States. Future research should analyze and compare sustainable consumption trends in more EU countries considering the roles of different structural factors e.g., cultural aspects, economic, technological, and infrastructure development dimensions. The impact of the SARS-CoV pandemic on sustainable consumption is also an interesting aspect which future researchers should address to reveal the positive and negative effects on the pro-environmental behavior and environmental impacts.

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