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Household carbon footprints in the Baltic States: A global multi-regional input–output analysis from 1995 to 2011

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HIGHLIGHTS

- The Baltic States provide good example of decrease in production-based emissions.
- However, consumption-based emissions at the same time had a tendency to rise.
- There are significant differences among countries in terms of emissions of consumption, production and trade.
- They can be explained by differences in carbon intensity of the energy sector, economic structure and physical infrastructure.
- Countries have to change household behavior, decarbonize energy and transport sectors, reduce trade related emissions.

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ABSTRACT

The paper analyzes consumption related household CO_2 equivalent (CO_{2e}) emissions for the three Baltic States – Estonia, Latvia and Lithuania from 1995 to 2011. The analysis is based on a multi-regional input–output model, which allows us to estimate life-cycle emissions for all major household consumption items. Results demonstrate that household carbon footprints in all the Baltic States significantly increased by 47% in Estonia, 20% in Latvia and 52% in Lithuania during the study period. In 2011 in Estonia expenditures for housing and utility contributed the highest per capita life-cycle emissions – 43%. However, in Lithuania housing accounted only for 16% of per capita emissions, but food and transport were responsible for 31%; whereas in Estonia and Latvia transport accounted for 18% and 21%, respectively. Production processes related to food consumption are responsible for 18% of emissions in Estonia, 31% in Latvia and Lithuania. Most of the indirect emissions are related to imports from Russia and China followed by imports from other Baltic States. If consumption-based emissions are to decrease countries will have to (1) change household behavior, which requires relevant knowledge, infrastructure and resources to facilitate switching to lower carbon-intensive alternatives; (2) decarbonize their own energy and transport sectors; and (3) reduce lifecycle emissions associated with trade, by supporting imports from low carbon regions, including producing locally.

1. Introduction

The literature distinguishes between two major accounting approaches for pollution and thus for assigning responsibility: the production-based approach, allocating pollution to the country of emissions, as used by the UNFCCC for carbon emissions; and the consumption-based approach – allocating pollution to the final consumer rather than the place of production [1]. Therefore, the consumption-based approach takes into account also pollution embodied in imported goods and services, but excludes pollution associated with the production of exports.

Numerous studies have used one or both of these approaches to analyze global, regional and national trends in greenhouse gas (GHG) emissions and other footprints (e.g. water, land, material, and ecological footprints) [2–7]. Typically these studies identify *industrial processes* (combustion processes; solvent use; agriculture; metal extraction and refining; dissipative uses of heavy metals), *final demand product categories* (construction; food & beverages; motor vehicles & trailers; electricity, gas) and *material categories* (animal products; crops; plastics; oil for heating and transport; concrete) with the highest household environmental impacts to serve as a basis for policy intervention. Recently a

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number of studies focused specifically on environmental impacts embodied in trade [8–10] as well as emissions associated with the complex global supply-chain networks [11] showing the link between local consumption and global pollution and resource depletion. A common trend becomes apparent whereby more developed countries tend to have higher consumption related emissions and less developed countries, higher production related emissions [12,13].

Most recent studies on environmental impacts suggest that current unsustainable consumption and production patterns are responsible for a wide range of environmental problems, such as climate change, eutrophication, biodiversity loss, and resource depletion, and in many cases link current global consumption levels to overshoot of the bio-capacity of the planet [6,14–17]. Studies focusing on consumption related emissions demonstrate that the main product categories of concern are housing, transport and food, which along the entire supply chains account for 70–80% of all household consumption impacts [16]. Obviously, effective environmental sustainability efforts should focus on these 3 main clusters to support needed change. However, the potential of other, lower impact, clusters (especially furniture and household equipment, recreation, clothing, hotels and restaurants) should also be taken into account. Studies also show that achieving a significant absolute reduction in the footprint of consumption is possible by making relatively few changes in the consumption practices of households, however, it requires co-operation between end-users and product and service suppliers [18]. There are also other important factors such as changing demographics affecting household emissions. For example, Shigetomi et al. [19] suggest that it is also important to understand how our consumption and emission patterns changes through aging society, which is a fact not only in Japan but also in the EU and the Baltic States.

Over the last 20 years the Baltic States, Estonia, Latvia and Lithuania, have gone through considerable economic restructuring thereby significantly reduced their production-based emissions [20]. Nevertheless, consumption-based emissions can differ from production-based and do not always follow the same trend [1,12,21,22].

Disposable income and gross domestic product (GDP) in the Baltic States has been steadily growing. Since 2000 per capita GDP in the Baltic States has more than tripled. Nevertheless, they are still much below the EU average. According to Eurostat [23] expenditure for food, housing and transport in the Baltic States in 2011 accounted for 60–65% of household disposable income, while in EU28 it was only 53% (see Fig. 1). The structure of household expenditure differs also between urban and rural areas; in urban areas there is a higher share of expenditure for housing, recreation and clothing whereas in rural areas food accounts for a higher proportion of household expenditure, which is mainly the result of lower incomes in rural areas. Although, the Baltic States were hard hit by the Great Recession, they are now some of the fastest growing economies in the EU – between 2010 and 2014 real GDP increased by more than 17% in all the Baltic States, while average GDP in the EU28 in the same period increased only by 2.6% [24]. In 2013 per capita GDP in Estonia, Latvia and Lithuania reached respectively 13,900, 11,600 and 11,700 EUR, but is still much below the EU28 average of 25,700 EUR per capita.

However, there has not been a study looking at household carbon footprints of The Baltic States, but these are usually only analyzed as part of a larger region rather than as countries in their own right [6,12,17,25]. To our knowledge there are only few studies looking at the carbon footprint of consumption specifically in the Baltic States [14,26].

Therefore in this study we are aiming to bridge this gap by looking at changes in the economy and specifically household consumption patterns and calculate annual direct and indirect CO_2 equivalent (CO_{2e}) emissions throughout global supply chains driven by household consumption for the three Baltic States from 1995 to 2011 to see if political, economic and cultural changes in these countries have brought decrease as well in consumption based emissions. In this study, we include 3 main GHGs: CO_2, CH_4 and N_2O.

2. Methodology

Environmentally extended input–output model has been frequently used for consumption-based environmental accounting [27–38]. Since the global multi-regional input–output (MRIO) databases became available over the last few year, many studies have been carried out based on consumption-based environmental accounting along global supply chains [4,12,25,39–41].

In a MRIO framework, different economies and sectors are connected by intra- and inter-regional trade, T^{rs} $(r = s)$ and T^{rs} $(r \neq s)$ respectively. We first convert the intra- and inter-regional sectoral flow matrix $\{T_{ij}^{rs}\}$, to the technical coefficients matrix A consisting

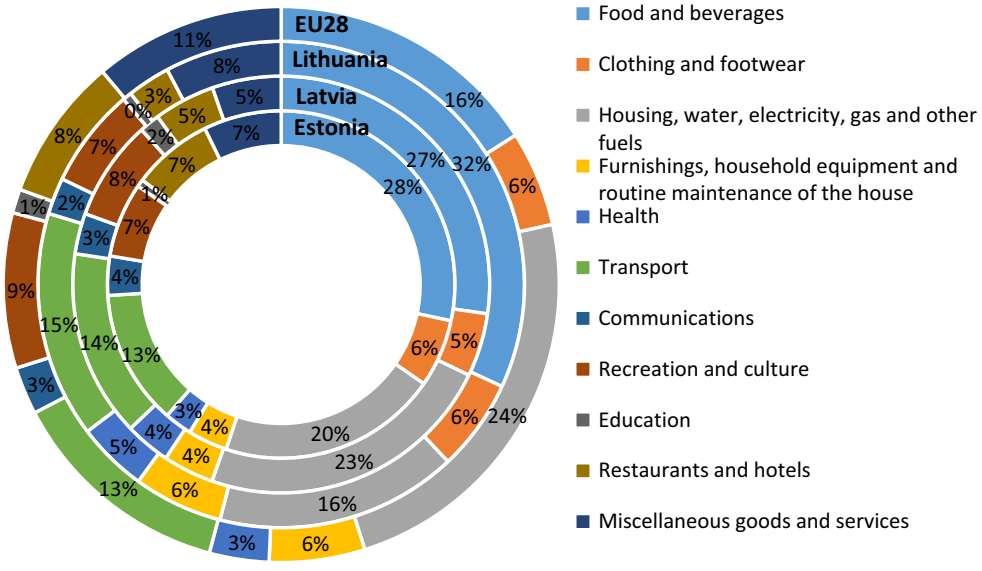

Fig. 1. Shares of household expenditures in the Baltic States – 2011. *Data source:* Eurostat.

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