Carbon footprint analysis of beverage packaging alternatives: a case study for Brazil

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Executive Summary

Long neck beer bottles pose significant waste management challenges globally, particularly in cities like Rio de Janeiro, Brazil, where improper disposal contributes to sewer blockages and flooding, disproportionately affecting marginalized communities.

This report examines the reduction in carbon emissions resulting from decreased glass consumption, driven by the shift towards aluminium cans. While emissions decreased notably in glass manufacturing, increased aluminium production offset some gains. However, secondary aluminium processing showed promise for emissions reduction.

Limitations include the inability to quantify glass waste reduction and lack of data on bottle consumption. Opportunities for increased earnings for can collectors exist, but enhanced waste management policies and renewable energy utilization in packaging production are crucial for further emissions mitigation.

1. Introduction

The long neck beer bottles are considered worldwide a highly problematic waste, as after beverage consumption, they are simply discarded, treating the material as waste, taking up space at the final destination, and generating other problems when improperly discarded on the streets. In the specific case of the city of Rio de Janeiro, Brazil, improper disposal on the streets is one of the causes of sewer blockages, which combined with heavy rains, contributes to flooding that affects thousands of people, especially those with lower income levels.

Additionally, to remain competitive against aluminium, the glass industry removed certain chemicals that added weight to the packaging, compromising its strength and preventing reuse for a second filling. Therefore, it becomes an environmental problem as it is discarded in the trash (funverde.org.br). Waste pickers, cooperatives, or recycling associations reject collecting these bottles because this packaging has little value, which does not compensate for the effort to carry them. Thus, after product use, they are thrown away and taken to landfills or waste dumps.

On the other hand, the use of other packaging such as aluminium cans generates employment and income for recyclers through cooperatives, ensuring a supplementary source of revenue. According to the Brazilian Aluminium Association, in the year 2022, 100% of aluminium cans used in Brazil were recycled. Aluminum recycling uses 5% of the energy compared to primary aluminium production.

Based on the above, this report aims to simulate the effects in terms of CO2 emissions of a policy aimed at reducing the consumption of beverages packaged in "long neck" bottles in favour of the use of aluminium cans in Brazil.

2. Methodology

The tool utilized to carry out this empirical study was Input-Output-based Life-Cycle Assessment using MARIO (Multifunctional Analysis of Regions through Input-Output), an open-source python-based platform designed to handle and process input-output models (Tahavori et al., 2023). This quantitative model is aimed at assessing the prospective environmental impacts resulting from the application of the policy interventions consisting of the reduction of consumption of “long neck” bottles by Brazil population, including supply chain effects in a Life Cycle perspective.

The database used for this study comes from Exiobase, a detailed Multi-Regional Environmentally Extended Input-Output Table, for a large number of countries (including Brazil), estimating emissions and resource extractions by different industries (Stadler et al., 2018). The year selected for this empirical study is 2022, as it is the more recent version of Exiobase.

In order to facilitate the processing and the exposition of the data from the input output table, I performed a sectoral and regional aggregation, from 163 to 13 sectors, and from 49 to 2 regions (Brazil and Rest of the World).

To simulate the impact of a policy aimed at reducing the consumption of beverages in long neck bottles, it was assumed a reduction in the final demand coming from households affecting the sector “Manufacture of glass and glass products”, and an increase in the final demand of the sectors “Aluminium production” and “Re-processing of secondary aluminium into new aluminium”, assuming that the decrease in the consumption of long neck bottles would reflect in a decrease in the demand of glass, and an increase in the demand for aluminium.

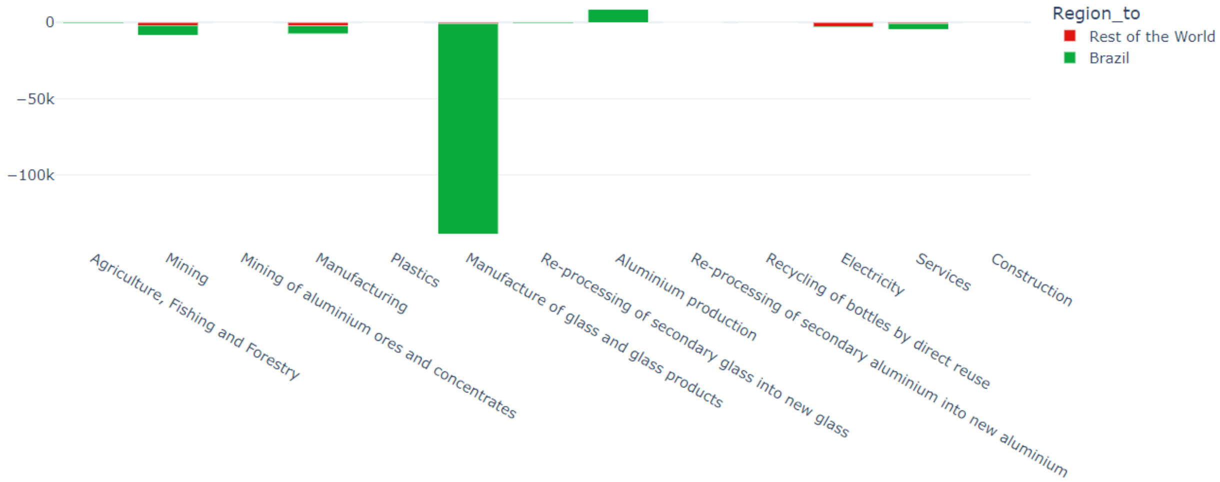
Since 80% of the aluminium can production is made out from recycled cans, and the other 20% from primary aluminium production, I took this proportions to for the assumptions of the shock in final demand of each of the sectors related to aluminium production. Since the glass used for a long neck bottle weights around 7,7 times more than cans, I took account of this proportion to scale the shock of the increasing aluminum demand.

There was not available data on physical units, thus I had to perform the shock over monetary values.

3. Results

Figure 1 exhibits the results of the simulation of a reduction in consumption of glass derived from the hypothetical scenario where long neck bottles are taxed by a policy aimed at reducing the use of this type of packaging.

Figure 1: sectoral contribution in CO2 variation between scenarios (kg of CO2)

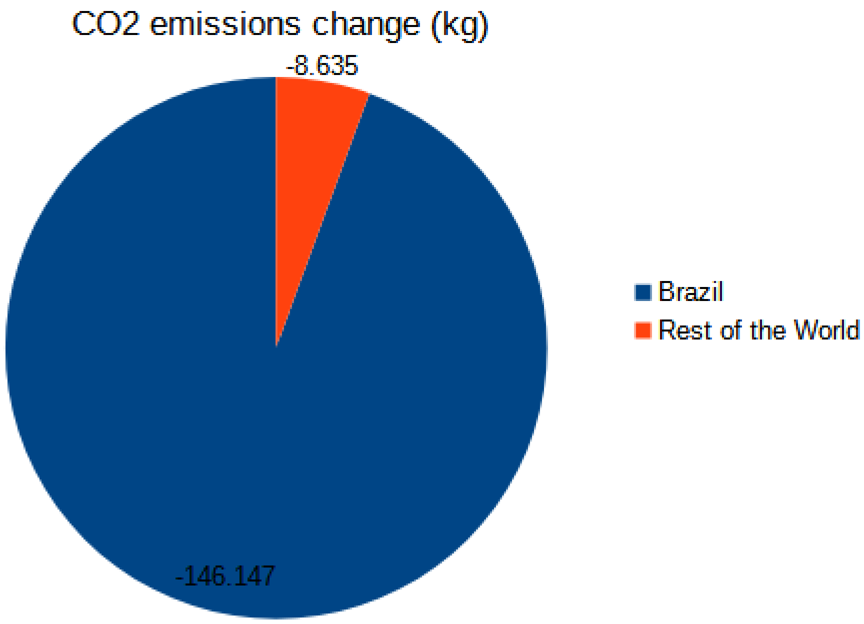


Source: own elaboration using MARIO and Exiobase.

From figure 1 we have that most of the reduction in emissions (-137,691 kilograms of CO2) come from the Manufacture of glass sector, as it was the most shocked, with a reduction in 10% final demand coming from households. The impact of this sector is mainly explained by the fact that glass production is a high energy consuming production process. Another sector contributing to reducing carbon emissions was the mining sectors, which is due to the reduced inter sectoral demand stemming from the manufacture of glass. In this sense, it is worth noting that every additional kilogram of aluminium recycled prevents the extraction of 5 kilograms of bauxite mineral extraction, hence the reduction in emissions due to the mining sector.

On the opposite way, Aluminium production contributed to growing carbon emissions with 8,516 kilograms, due to the increased final demand for this product, as glass became substituted by this packaging for beverage consumption. Re-processing of secondary aluminium into new aluminium sector contributed marginally to growing emissions, as this type of production demands significantly less energy than primary aluminium production, representing 5% of the total energy for primary aluminium production, according to https://industriaverde.com.br.

Figure 2: Regional contribution to Cow emissions change



Source: own elaboration.

Figure 2 exhibits the regional distribution of carbon emission change between Brazil and the Rest of the World. From this figure it can be seen that most of the emissions reduction (96%) came from Brazil. The sectors that contributed the most for emissions reduction in the Rest of the World were Electricity (-2,554 kg), Manufacturing (-2,218 kg), and Mining (-2,066 kg).

4. Discussion

The findings of this study highlight the reduction in carbon emissions resulting from decreased glass consumption, primarily attributed to the reduced use of long neck bottles for beverage consumption, in favor of aluminum cans. While this constitutes a positive outcome revealed by the study concerning the impacts of a policy targeting bottle reduction, additional favorable aspects could not be explored due to insufficient available data.

Firstly, this model cannot quantify the effects related to the reduction in glass material waste resulting from the implementation of a policy aimed at reducing the consumption of long neck bottles, as there are no satellite accounts available to measure this effect.

Future research efforts should prioritize expanding the available data from satellite accounts to encompass these effects. Additionally, the lack of data on the quantity of long neck bottle consumption prevented the accurate assessment of the shock resulting from the reduction in household final demand for glass. This limitation restricted our ability to precisely account for the amount of glass consumed for this packaging. Nevertheless, the analysis of the reduction in carbon emissions under the scenario of a 10% decrease in final demand for glass remains applicable and adaptable to other parameters. While changes in these parameters may alter the results, the analysis consistently demonstrates that emission reductions would result from the implementation of such a policy.

Given Brazil's 100% rate of aluminum can recycling, the transition from glass to aluminum packaging would not result in increased aluminum-related waste. Moreover, the reduction in glass bottle waste would help mitigate flooding incidents caused by obstructed drainage systems in cities facing such challenges. Nevertheless, multiple factors influence these phenomena, including extreme weather events such as heavy rainfall. Therefore, a future research agenda could prioritize conducting more localized studies to assess the impacts of policies targeting waste reduction and disposal management.

Another significant impact of this policy is the potential increase in earnings for can collectors. According to data from Abralatas.com, aluminum can recycling in Brazil generates approximately 1.2 billion USD in revenue for collectors. With an increase in aluminum can usage, earnings for collectors would likely rise accordingly. It is important to note that glass collection is not financially viable, leading to a low glass recycling rate in Brazil, estimated at around 25%. Despite glass's recyclability, inadequate selective collection in many cities and improper disposal by the public hinder the circular economy of glass in Brazil. Therefore, in addition to the policy analyzed in this report, another effective approach to reduce glass disposal would involve raising awareness and educating the public on waste separation, as well as expanding the number of collection points for glass waste.

To further mitigate emissions associated with packaging production, both in primary and secondary aluminum production, as well as glass manufacturing, it is advisable to implement policies targeting increased utilization of low-carbon renewable energy sources in the industrial processes of these energy-intensive sectors. By transitioning towards renewable energy sources, such as solar or wind power, these industries can significantly reduce their carbon footprint and contribute to overall emissions reduction efforts.

5. Conclusion

The results of this study underscore the reduction in carbon emissions stemming from decreased glass consumption, primarily driven by the diminished use of long neck bottles in favor of aluminium cans. The emission reduction was predominantly observed in the

Manufacture of glass sector, given its high energy-intensive production processes. Additionally, the mining sectors experienced a notable decrease in emissions due to reduced intersectoral demand resulting from glass manufacture.

Conversely, the production of aluminium contributed to a rise in carbon emissions due to increased demand resulting from the substitution of glass packaging. However, it is noteworthy that the re-processing of secondary aluminium into new aluminium played a minor role in emissions growth, given its significantly lower energy requirements compared to primary aluminium production.

While this study highlights the positive outcomes of reducing glass consumption, certain limitations, such as the inability to quantify the reduction in glass material waste and the lack of data on long neck bottle consumption, warrant further investigation. Additionally, the transition to aluminium packaging presents opportunities for increased earnings for can collectors. Finally, it is highlighted the need for enhanced waste management policies and increased utilization of low-carbon renewable energy sources in packaging production processes to further mitigate emissions.

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https://industriaverde.com.br

https://www.euromonitor.com/

Appendix

CO2 emissions difference between simulated scenario and Baseline

Sector	Brazil	Rest of the World
Agriculture, Fishing and Forestry	-559	-144
Aluminium production	8.516	7
Construction	-4	-7
Electricity	-765	-2.554
Manufacture of glass and glass products	-137.691	-752
Manufacturing	-5.194	-2.218
Mining	-6.236	-2.066
Mining of aluminium ores and concentrates	-34	2
Plastics	-96	-102
Re-processing of secondary aluminium into new aluminium	278	1
Re-processing of secondary glass into new glass	-564	-63
Recycling of bottles by direct reuse	0	-3
Services	-3.795	-736

Source: own elaboration from EXIOBASE