

A WIOD Input-Output Analysis of Germany and Japan: Emissions of Chocolate Consumption. PHAN Thanh Truc 3225B921-3

1 Introduction

This paper is part of the course *Industrial Ecology* and applies input–output analysis to quantify environmental burdens of products and services. It quantifies the embodied carbon dioxide (CO₂) emissions associated with chocolate consumption in Germany and Japan. These two countries differ substantially in their energy systems, trade structures, and production technologies, making them an interesting case for comparison. The analysis applies an environmentally extended input–output (EEIO) framework based on the World Input–Output Database (WIOD) Timmer et al. (2015) and Groningen Growth and Development Centre (n.d.) to trace emissions along the entire supply chain induced by final demand for chocolate.

2 Method and Material

The analysis is based on national input–output tables from WIOD Release 2013 for the year 2009, the latest year with full data availability, which provide comprehensive environmental satellite accounts for food- and agriculture-related sectors relevant to chocolate production. Chocolate consumption is mapped to the *Food, beverages and tobacco* sector in the WIOD national input–output tables. Sectoral carbon dioxide (CO₂) emissions are taken from the WIOD environmental accounts, reported in gigagrams (Gg), and matched to the national input–output structures of Germany and Japan. For product-level interpretation, emissions are converted to kilograms of CO₂.

The calculations follow an environmentally extended input–output (EEIO) framework as presented in Lecture 10 and were implemented using the

corresponding MATLAB script. CO₂ is selected as the environmental indicator due to its relevance for climate change and its consistent availability across countries and sectors in WIOD.

Switzerland and Japan were initially considered; however, Switzerland is not included in WIOD Release 2013 and was therefore replaced by Germany. Chocolate is used as a representative food product, and retail prices from online listings for Lindt (Germany) and Meiji (Japan) are used to approximate final demand. Prices are scaled to a consumption quantity of ten one-kilogram chocolate bars to ensure cross-country comparability.

3 Results

For clarity of presentation, the analysis focuses on the four sectors with the highest emissions, while the remaining 31 sectors are aggregated into a single category.

Table 1 reports sectoral emissions in Japan. Electricity, gas and water supply represent the largest source of emissions, accounting for approximately 27% of total emissions. Food, beverages and tobacco as well as agricultural activities also contribute substantially. Total emissions associated with the production of ten 1-kg chocolate bars in Japan amount to 71.97 kg.

Table 2 presents the corresponding results for Germany. Emissions are more strongly concentrated in electricity, gas and water supply, which accounts for over 40% of total emissions. Food, beverages and tobacco represent the second-largest category, while agriculture contributes comparatively little. Total emissions associated with the production of ten 1-kg chocolate bars in Germany amount to 58.76 kg.

4 Discussion and Conclusion

The three highest-emitting sectors are identical in Japan and Germany, indicating broadly similar supply-chain structures for chocolate production.

Sector	Emissions (kg)	Emissions (%)
Electricity, Gas and Water Supply	19.31	26.82
Food, Beverages and Tobacco	16.59	23.05
Agriculture, Hunting, Forestry and Fishing	10.22	14.20
Basic Metals and Fabricated Metal	3.99	5.54
All other sectors	21.87	30.38

Table 1: Top 4 sectoral emissions and all other sectors in Japan

Sector	Emissions (kg)	Emissions (%)
Electricity, Gas and Water Supply	24.15	41.10
Food, Beverages and Tobacco	18.07	30.76
Agriculture, Hunting, Forestry and Fishing	5.35	9.11
Other Non-Metallic Mineral	1.41	2.41
All other sectors	9.77	16.63

Table 2: Top 4 sectoral emissions and all the others sectors in Germany

However, the relative importance of these sectors differs substantially between the two countries.

In both cases, electricity, gas and water supply constitute the largest source of emissions, underscoring the central role of energy production in embodied carbon footprints. This sector is considerably more dominant in Germany, accounting for over 40% of total emissions, compared to approximately 27% in Japan. Despite this difference in composition, total emissions associated with chocolate consumption are higher in Japan in absolute terms.

Beyond energy production, emissions in Japan are more evenly distributed across sectors. Food, beverages and tobacco as well as agricultural activities contribute relatively larger shares than in Germany, suggesting a stronger role of primary production and food-related supply chains. In contrast, Germany’s emissions are more concentrated, with a smaller contribution from agriculture and mining-related sectors and a larger share attributable to energy-intensive upstream processes.

Overall, the analysis highlights how differences in economic structure and energy systems shape the environmental footprint of comparable consumption bundles. The results demonstrate the usefulness of environmentally extended input–output analysis for identifying sectoral emission hotspots and informing targeted mitigation strategies.

References

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