Trading Responsibility: navigating national burdens in a globalized world

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Summary

International trade has played a major role in defining the modern global economy. Trade has helped many countries prosper economically and socially by leveraging their comparative advantages leading to local specializations. An important outcome of this trade-centric economy has been the shift of industrial production away from high-income countries to low- and middle-income countries where cheap labor has reduced overall costs of production. The relocation of production, among other aspects of international trade, has raised environmental and social concerns as production in low- and middle-income countries tend to be more environmentally intensive and less socially regulated than in high-income countries. The complexity of modern international trade networks has thus made it difficult to untangle the environmental pressures of various national economic sectors, sometimes giving the illusion of environmental improvements while these environmental pressures have simply been shifted, or even exacerbated, elsewhere.

This dissertation explores the role international trade has on shifting the environmental impacts of two sectors: the food system and the plastic waste system, by answering the following research questions (RQ):

RQ1: How would global agricultural land-use change if countries could reduce their dependence on food trade? (Chapter 2)

RQ2: How does food consumption in the Netherlands contribute to domestic and international plastic pollution? (Chapter 3)

RQ3: How does international trade contribute to global plastic pollution? (Chapter 4)

RQ4: How are international trade policies affecting the contribution of trade to global plastic leakage? (Chapter 5)

Chapter 2 explores the land-use impacts of production under today's trade-centric food system. This is then contrasted to a scenario with no trade, allowing us to understand which countries are currently taking on additional burdens of production. We find that, unlike many other

economic sectors, the food system does not shift the environmental burdens of food production away from high-income countries to low- and middle-income countries, but rather the opposite. Food production is currently largely concentrated within a small number of high-income or industrialized countries. Under autarkic conditions, food production would be more decentralized, relying on increased food production from national systems with lower yields and higher waste fractions, leading to an overall decrease in global food system efficiency. Nevertheless, as such national systems would require a shift to more varied production in order to ensure adequate nutrition, the benefits of switching more in line with local land carrying capacities would result in an overall decrease in global agricultural land use; from 3798 Mha to 3469 Mha. Approximately 50% of the global population lives in countries that would not be limited by land-use if they aimed for autarkic systems, while an additional 45% remove land as the limiting factor through yield improvements, waste reduction, and dietary changes.

In chapter 3, the plastic dimension of the food system is explored to answer RQ2. In addition to land-use, the food system is a major driver of plastic production, and single-use plastic waste generation. To understand how the food system contributes to plastic pollution, this dissertation uses the Netherlands as a case study. Food consumption in the Netherlands generates an average of 2.1 grams of plastic waste per gram of food consumed. With this rate of plastic generation, Dutch food consumption generated 295 kt of plastic waste in 2019. Most of this plastic waste, 200 kt, was sent to incineration, however, 37 kt was exported out of the European Union. Turkey and Indonesia were the primary destinations, taking on 20 kt of Dutch plastic food packaging together, with other Southeast Asian countries importing significant quantities. These countries, however, have high rates of plastic waste mismanagement, which resulted in 5.1 kt of Dutch plastic food packaging being mismanaged and entering the aquatic environment internationally in 2019. In addition to the fraction mismanaged internationally, 1.4 kt of plastic food packaging became unrecovered litter that entered the aquatic environment inside the Netherlands. Therefore, for the Dutch food system, 78% of its contributions to plastic leakage is a result of international trade, while only 22% happens domestically.

Chapter 4 goes beyond the perspective of one country and one sector by analyzing the 2019 global trade of plastic waste to answer RQ3. By total

volume, Japan, Germany, the United States, and the United Kingdom are the largest generators of plastic waste leaked after exports, generating a combined 80 kt of marine plastic debris and nearly 1 Mt of aquatic plastic debris. Relative to the total waste generated domestically, Australia, Norway, and Denmark increased their amount of aquatic plastic debris five-fold highlighting their heavy reliance on plastic waste exports. The most critical importers tasked with managing largely high-income plastic waste exports were found to be Malaysia, Vietnam, Indonesia, Thailand, and India. However, with limited waste infrastructure, these countries were found to leak over 1 Mt of imported plastic waste to the aquatic environment.

Finally, in chapter 5 we focus on RQ4. We expand our analysis of 2019 to an annual estimate from 2013 to 2021. We find that shifting the burden of plastic waste management from high-income to low-and middle-income countries is a systematic problem that emerged towards the end of the 20th century. Until 2017, China was the primary export destination for excess plastic waste of high-income countries, however, due to the environmental pressures caused by the annual leakage of 1.6 Mt of imported waste (from 2012 to 2016), China banned the import of plastic waste halfway through 2017. This unsettled the plastic waste trade network, first causing an increase in plastic leakage of traded plastic wastes to 2.1 Mt in 2018, due to the new destinations having higher rates of mismanagement and trade volumes maintaining previous levels. After 2018 however, we find a continued decrease in leakage due to decreasing trade volumes from 2019 to 2021, although a higher fraction of exported waste is leaked than before China's import ban. The causes of the decrease in trade volumes are unclear however as global economic conditions, in addition to the Covid pandemic, have affected global supply chains. In 2021, plastic waste exports to countries other than China increased for the first time since 2018, indicating that the decreases seen in 2019 and 2020 may have only been temporary, in which case plastic leakage from international trade will likely surpass pre-China ban levels.

From this analysis we now can answer the main question central to this thesis: how has international trade led to structural shifts in environmental impacts across nations, exemplified by the food and plastics systems. International trade's exceptional growth has generated significant environmental issues, notably disconnecting the impacts of consumption from production. Low- and middle-income countries, which

have become major production hubs within modern global supply chains, have increasingly faced the environmental consequences of consumption in high-income countries. These environmental costs have largely become hidden due to the complexity of international trade. This dissertation concludes that in the case of agricultural land-use, international trade does not shift environmental burdens to low- and middle-income countries, but rather centralizes them to a few highly industrialized countries. Nevertheless, international trade does exacerbate the impacts of plastic waste within the food system. In fact, plastic waste generated in high-income countries is an important source of plastic leakage to aquatic environments due to international trade. In the case of both systems, international trade has amplified knowledge imbalances which, over time, contribute to institutional and infrastructural lock-ins, preventing a transition away from trade-centric systems that disconnect environmental and social impacts from consumption.

The export of plastic waste from high-income countries is currently encouraged as it is recorded to be a recycling flow, however, the destinations of the waste make this highly unlikely and impossible to verify. Additionally, many countries have the potential to diversify their local food production to supply their populations with nutritious diets, opening the door for policies to encourage and support such initiatives. In all cases, it should be kept in mind that the international trade of material goods can create knowledge imbalances, that worsen over time. Moving forward trade policies between countries should include stipulations to prevent this to ensure long-term flexibility and development for all parties involved.