Estimating Global Food Waste Across Commodities and Supply Stages

Introduction

Food loss and waste (FLW) is a central challenge for global food security, environmental sustainability, and agricultural markets (U.N., 2019). Reducing FLW has been identified as a promising pathway to ease pressure on food supply, lower food prices, and mitigate environmental impacts. Despite its importance, comprehensive and internally consistent estimates of FLW shares across countries, commodities, and supply-chain stages remain limited (Helander et al., 2021; Sheahan and Barrett, 2017). Existing data sources are fragmented: FAO provides detailed food supply data by country and commodity, while dietary intake estimates are typically available only at aggregated levels, and empirical FLW estimates are sparse, heterogeneous, and unevenly distributed across regions and food categories (Gatto and Chepeliev, 2024). As a result, directly reconciling food supply and waste data often leads to inconsistencies and implausible net intakes. This study develops a statistically disciplined framework to estimate and calibrate global food waste shares that preserves heterogeneity while enforcing aggregate consistency and alignment with available data on net food intakes.

Methods

We employ a two-stage calibration framework. In the first stage, food waste shares are estimated using a hierarchical Bayesian binomial–logit model fitted to nearly 3,000 observations collected from the empirical literature, covering approximately 2% of all region-commodity–stage combinations. The hierarchical structure allows partial pooling across regions, commodities, and supply-chain stages, enabling well-documented cases to inform data-sparse ones without imposing full homogeneity. This approach yields posterior distributions of waste shares by country-commodity-stage and associated uncertainty for each dimension.

In the second stage, we reconcile estimated retail and consumption waste shares with observed national dietary intake data using a cross-entropy (minimum-adjustment) calibration. Net intakes are sourced from the estimates provided by a global health model (Springmann et al., 2025), which empirically estimates net intakes based on Estimated Energy Requirements computed on several biophysical characteristics of different populations. The calibration enforces consistency between supply-implied net intake and observed intake while minimizing deviations from prior waste estimates. Importantly, adjustment penalties are weighted by posterior uncertainty from the Bayesian model, allowing larger revisions where estimates are weakly identified and constraining adjustments where evidence is strong. This uncertainty-informed calibration avoids implausible shifts in waste shares and accepts small residual gaps when underlying data sources are structurally inconsistent.

Results

The hierarchical model indicates a global baseline food waste share of approximately 7%, with substantial heterogeneity across regions, commodities, and supply-chain stages. The calibrated

retail and consumption waste shares display clear income-group–specific patterns and time dynamics. Figure 1 shows that consumption-stage waste is consistently highest in high-income countries and exhibits a mild upward trend over time, while middle-income countries remain relatively stable. In contrast, low-income countries experience a noticeable decline in consumption waste over the 2010–2020 period. Retail-stage waste follows a different trajectory: retail losses decline sharply in low-income regions before stabilizing, whereas middle- and high-income regions show relatively flat or slightly increasing trends. These results highlight that food waste shares are not static, but evolve systematically with income growth and structural change in food systems, underscoring the importance of income- and stage-specific policy interventions.

Next Steps and Policy Simulation

The calibrated waste shares are designed for direct integration into global economy-wide (e.g. computable general equilibrium) and partial equilibrium models. Embedding country-, stage- and commodity-specific waste parameters will enable simulation of policies such as consumer waste-reduction campaigns, retail efficiency standards, cold-chain investments, and income-driven dietary transitions. This integration will allow economy-wide assessment of how waste-targeted policies affect food demand, production, prices, trade, and environmental outcomes, providing a rigorous foundation for policy evaluation in global agri-food systems.

Potential for generating discussion

The analysis provided in this study will be of interest to a diverse group of researchers and decision-makers who are involved in the development of food waste-related and nutritional policies in the U.S. and worldwide. The study will provide a detailed data ground for potential policy solutions for food waste management in the United States and worldwide.

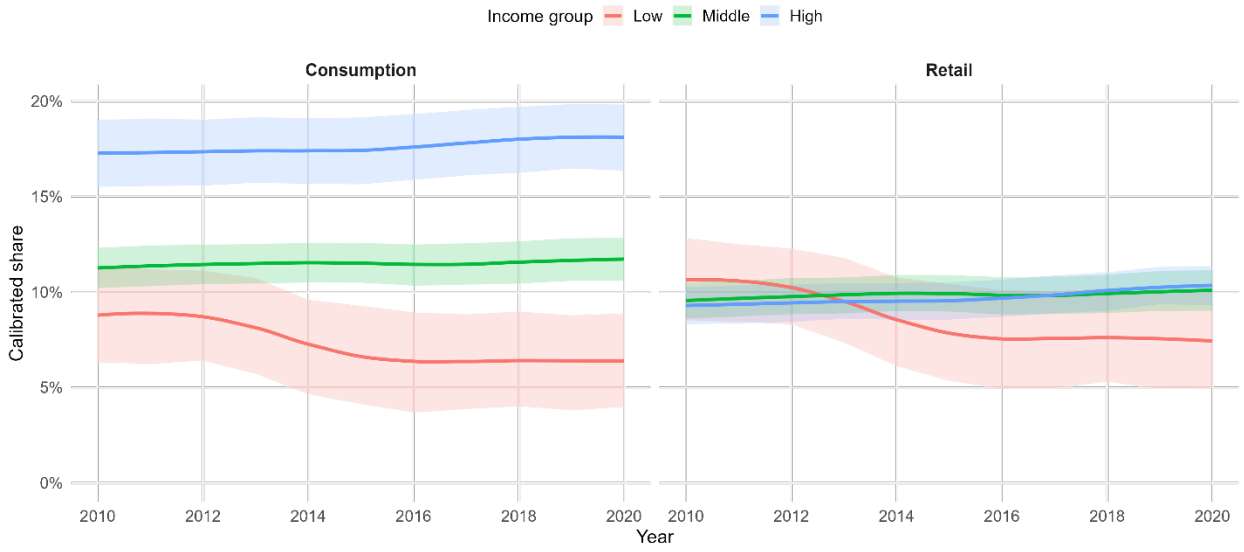

Figure 1. Mean consumption and retail food waste shares by income group (2010–2020).