

Structural Path Analysis of Sugar Embodied in Food Consumption in the United States

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Excessive sugar consumption is a major driver of non-communicable diseases (WHO, 2015). The WHO recommends that free sugar intake remain below 10% of total energy intake. However, consumption in the United States exceeds this threshold by 5% (FAO, 2024), requiring urgent reduction strategies.

Addressing U.S. sugar consumption requires integrating two perspectives: industrial supply chains and consumer behavior. Sugar flows through multi-tier supply chains via direct paths (e.g., sugar production to cookie manufacturing) and indirect paths (e.g., sugar to chocolate production used in cookies). Consumers ultimately ingest sugar embodied in processed food systems. Moreover, although household characteristics strongly influence dietary patterns, U.S. policies have not fully incorporated these demographic differences.

This study addresses excessive U.S. sugar consumption by jointly analyzing consumer and industrial perspectives. The novelty lies in constructing a mixed-unit input-output table based on U.S. accounts, converting the “sugar and confectionery” sector from monetary values (in USD) to physical quantities (in tons). Using this model, the study aims to: (1) identify supply chain paths through which food demand triggers sugar production; and (2) examine how household characteristics shape dietary expenditure patterns to inform targeted health recommendations. Based on these results, the paper proposes evidence-based policies for healthier diets.

The core of this methodology involves two primary analytical steps. First, Structural Path Analysis (SPA) identifies supply chain paths through which food demand triggers sugar supply across sectors. Second, mixed-unit IO analysis calculates embodied sugar input per dollar of final consumption (i.e., the sugar consumption unit) for specific sectors.

Furthermore, this study incorporated detailed household characteristics—specifically income and age—using expenditure data for single-person households from the 2017 Consumer Expenditure Survey (CES) to reveal divergent food expenditure patterns across demographics. Data on industrial sugar use was sourced from the United States Department of Agriculture for 2017, and the domestic input-output table was obtained from the Bureau of Economic Analysis published in 2017.

The results revealed that single-person households in the U.S. consumed 47 grams of sugar per person per day in 2017. The top three sectors for sugar intake were bread and bakery product manufacturing (8.5 grams), limited-service restaurant (8.4 grams), and cookie, cracker, pasta, and tortilla manufacturing (6.0 grams). These sectors accounted for 49% of total sugar consumption. The analysis indicated that excessive sugar intake from processed food industries was driven by high sugar consumption units, whereas intake from the restaurant industry was driven by high consumer expenditure.

To identify the industrial structure of this consumption, SPA was employed to map the U.S. sugar supply chain. The results showed that 99% of domestically used sugar is supplied through direct inputs from the “sugar and confectionery” sector to final products. The three main supply paths were sugar and confectionery product manufacturing to bread and bakery product manufacturing (660 kilotons), sugar and confectionery product manufacturing to cookie, cracker, pasta, and tortilla

manufacturing (473 kilotons), and sugar and confectionery product manufacturing to limited-service restaurants (412 kilotons). These findings indicate that the U.S. sugar supply chain is relatively simple. These findings indicate that the U.S. sugar supply chain is relatively simple. Consequently, the government should consider implementing a "sugar tax" targeting downstream processed food industries (e.g., bread manufacturing) to incentivize producers to reduce sugar content during production.

Furthermore, additional analysis controlling for income and age examined expenditure patterns at limited-service restaurants. The results showed a positive correlation between income and annual expenditure; the highest income group (\$40,000 and more) spent \$1,180 annually—1.6 times the average (\$733). This suggests that higher-income individuals may prioritize dining out over home cooking due to financial flexibility and demanding lifestyles. By age group, younger consumers spent more, with those aged 25–34 spending \$1,085—1.5 times the average. This pattern likely reflects busy schedules, limited cooking experience, or frequent social interactions.

Given these results, the government should prioritize sugar reduction policies targeting the working-age population. According to the CES, frequent use of limited-service restaurants for lunch accounts for about 40% of total expenditure in that sector. Therefore, promoting employee cafeterias and expanding healthy, quick-prep lunch box options could significantly reduce national sugar intake.