

Regulating Ultra-Processed Foods: How Fiscal and Informational Policies Shape Product Composition and Marketing Strategy

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Regulating Ultra-Processed Foods: How Fiscal and Informational Policies Shape Product Composition and Marketing Strategy

This study examines how fiscal and informational regulations influence product composition and marketing strategy in the ultra-processed food (UPF) sector, comparing Portugal's sugar tax with Brazil's front-of-pack (FOP) warning labels. A cross-sectional sample of 119 products was collected in supermarkets in Porto and São Paulo, focusing on sugar-sweetened beverages and breakfast cereals. A two-way ANOVA tested whether taxation is associated with lower sugar levels, using cereals as a control group. Additional analyses examined Nutri-Score in Portugal and sugar alerts in Brazil. Results show no significant reduction in sugar levels in taxed beverages in Porto relative to São Paulo. In contrast, FOP sugar alerts identified higher-sugar cereals, while Nutri-Score was not associated with lower sugar content. Findings suggest informational regulation better signals nutritional risk, while fiscal incentives alone may not induce reformulation.

Keywords: ultra-processed foods; sugar regulation; front-of-pack labeling

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1. Introduction

Global dietary patterns have shifted dramatically in recent decades, driven by the accelerated penetration of ultra-processed foods (UPFs) into everyday consumption. UPFs—industrial formulations containing additives, flavor enhancers, colorants, and preservatives—have increasingly replaced minimally processed foods across the world (Monteiro et al., 2019a; 2019b). Their high energy density, low nutritional quality, and engineered palatability have been linked to rising rates of obesity, diabetes, and other diet-related chronic diseases (Baker et al., 2020). Evidence from Brazil shows a substantial increase in UPF consumption across all age groups, including extremely high prevalence among young children (Louzada et al., 2015; 2018; Lacerda et al., 2023), contributing to concerning public health trends (Castro et al., 2023). As UPFs become central to household diets—especially in emerging markets—their influence on consumer well-being and vulnerability becomes increasingly salient (Hill & Sharma, 2020).

In response to these health challenges, countries have adopted different regulatory mechanisms aimed at curbing UPF consumption. Two major approaches have gained prominence: fiscal regulation and informational regulation. Portugal represents the fiscal route, implementing a tiered sugar tax on beverages intended to discourage high-sugar formulations by increasing their cost. Brazil, by contrast, has implemented front-of-package warning labels (FOPL) that signal when products are “high in” added sugar, sodium, or saturated fats. This system, introduced in 2020, is inspired by Chile’s pioneering labeling law (Dintrans et al., 2020) but adapted to Brazilian cultural and political contexts (Guerreiro et al., 2024). Both regulatory models aim to reduce information asymmetry and guide consumers toward healthier choices, yet they differ in the mechanisms through which they influence both consumers and manufacturers.

Because these regulatory designs operate through distinct behavioral levers, they create different incentives and constraints for companies. In fiscal systems, firms respond to economic pressures, reformulating products only when taxes materially affect profitability. In informational systems, firms face perceptual pressures: warning labels may deter consumers, incentivizing producers to adjust nutrient levels so they remain just below regulatory thresholds or to deploy counterbalancing marketing elements. Prior work shows that manufacturers often compensate for negative labeling cues through healthwashing—the strategic use of nutrient claims, added vitamins, and appealing characters to neutralize negative impressions (Hastak & Mazis, 2011; Pulker, Scott, & Pollard, 2018; Pereira, de

Angelis-Pereira, & Carneiro, 2019). These strategies are especially prevalent in UPFs marketed to children, where branding elements and emotional appeals interact strongly with low nutritional literacy (Hill & Sharma, 2020; Popkin et al., 2021).

Taken together, these developments suggest that regulation does not simply shape consumer decisions—it also shapes marketing strategy and product composition, influencing how companies engineer formulations and construct packaging communication to comply with, circumvent, or strategically adapt to policy requirements. Understanding these responses is crucial for assessing the real impact of regulation on food environments and consumer vulnerability.

Based on this discussion, the objective of this paper is to analyze how fiscal and informational regulation influence marketing strategy through their effects on product composition, comparing Brazil and Portugal as contrasting regulatory contexts. By examining how firms adapt to taxation and to front-of-package warnings, we contribute to a deeper understanding of the interplay between regulation, product design, and consumer well-being.

2. Theoretical Background

2.1 Ultra-Processed Food in Brazil and Portugal

Ultra-processed foods (UPFs) have become central to dietary patterns in many emerging markets, where rapid urbanization, aggressive marketing, and affordability accelerate their adoption. In Brazil, UPF consumption has risen significantly across all age groups. Studies show that between 2008 and 2018, the share of UPFs in the national diet increased consistently, with particularly high prevalence among children and adolescents (Louzada et al., 2015; 2018; Louzada et al., 2023). Infants and young children are increasingly exposed to sugary snacks, powdered beverages, and processed dairy products, often at the expense of minimally processed alternatives (Lacerda et al., 2023; Castro et al., 2023). These patterns contribute to deteriorating diet quality, reduced intake of fiber and essential nutrients, and rising rates of obesity and other non-communicable diseases.

To mitigate these risks, front-of-package labeling (FOPL) has emerged as a key policy tool in emerging markets, aimed at reducing information asymmetry and enabling consumers to quickly identify products high in sugar, salt, and saturated fat. Evidence from Chile demonstrates that clear warning symbols effectively influence consumer choices (Dintrans et al., 2020). However, the implementation of FOPL often faces strong industry resistance, citing costs, trade barriers, and the potential impact on sales (Guerreiro et al.,

2024). Furthermore, consumer comprehension can be limited when labels contain technical language or when packaging includes competing claims and promotional cues (Latino et al., 2020). As studies have shown, companies frequently respond to labeling initiatives by emphasizing micronutrient fortification or by using child-oriented branding to maintain product appeal (Hastak & Mazis, 2011; Pulker et al., 2018; Pereira et al., 2019). Thus, while labeling can increase transparency, it also triggers strategic adaptive behaviors by firms, especially in markets characterized by lower nutritional literacy.

Recent evidence shows that ultra-processed food (UPF) consumption has become a significant component of the Portuguese diet, particularly among younger age groups. National survey data indicate that UPFs account for nearly 24% of total energy intake, with the highest consumption observed among children and adolescents (Magalhães et al., 2021). Dietary sources vary by sociodemographic group: children and adult women consume high amounts of industrialized yogurts, adolescents and young men show elevated intake of soft drinks, and lower-educated men consume more cold meats and sausages (Magalhães et al., 2021). Broader European comparisons also position Portugal within a region marked by substantial and rising UPF intake, although generally below the levels observed in Northern Europe (Mertens, Colizzi, & Peñalvo, 2022). Complementary analyses of food availability trends reveal that UPF options have become more accessible across retail environments, contributing to a gradual displacement of minimally processed foods and potentially reshaping traditional dietary practices in Portugal (Araújo et al., 2024).

Growing scientific evidence links the increased availability and consumption of UPFs to adverse health outcomes in Portugal. Analyses of national dietary data show that higher UPF intake is associated with poorer nutritional profiles—higher energy density and lower intake of fiber and essential micronutrients—which contribute to elevated risks of obesity and related non-communicable diseases (Magalhães et al., 2021; Araújo et al., 2024). Longitudinal cohort data deepen this picture: a study following Portuguese children from ages 4 to 13 found that those with consistently high UPF consumption experienced faster increases in body weight, BMI z-scores, waist circumference, and body fat percentage, along with slower height growth, compared to peers with lower UPF intake (Magalhães et al., 2024). These findings align with broader European research indicating that UPF consumption among adults is associated with unfavorable cardiometabolic outcomes, reinforcing concerns about the long-term health implications of UPF-dominant diets in Portugal (Mertens, Colizzi, & Peñalvo, 2022).

2.2 Regulatory Frameworks for Sugar, Salt, and Fat: Brazil and Portugal in Comparative Perspective

Brazil and Portugal represent two contrasting approaches to regulating unhealthy nutrient profiles in packaged foods. Brazil has adopted an informational approach centered on mandatory warning labels. Implemented through Normative Instruction No. 75/2020, the system requires triangular icons on products exceeding thresholds for added sugar, sodium, or saturated fats. The Brazilian system—while inspired by the Chilean model—was adapted to sociocultural and political conditions, including negotiations among regulators, industry associations, and public health advocates (Guerreiro et al., 2024). The objective is to empower consumers through clear risk signaling, with an expectation that firms will reformulate to avoid warnings. However, early evidence shows widespread borderline reformulation, where nutrient levels are positioned just below regulatory thresholds, allowing manufacturers to comply without substantially altering product profiles.

Portugal, on the other hand, employs a fiscal framework, most notably a tiered sugar tax on sugar-sweetened beverages. This tax increases the cost of high-sugar formulations and is intended to encourage reformulation by imposing direct financial penalties. Fiscal measures operate through economic incentives rather than consumer-facing information, and their effectiveness depends on tax magnitude, consumer price sensitivity, and firms' willingness to modify formulations. While sugar taxes have produced modest reformulation in some European contexts, results are uneven, particularly when thresholds are low or easily circumvented.

Comparing these approaches highlights key differences in how regulation shapes the strategic environment faced by manufacturers. Informational regulation affects consumer perceptions directly and thus prompts firms to manage reputational and perceptual risks, often through labeling strategies or healthwashing. Fiscal regulation affects profitability and cost structures, encouraging reformulation only when financial incentives are strong enough to outweigh technological or sensory constraints. Together, these frameworks demonstrate how policy design influences not only consumer behavior but also the composition and marketing strategies deployed by food companies.

3. Method

3.1. Data collection and sample

This study employed a cross-sectional observational design to compare sugar content across product categories and cities operating under two distinct regulatory environments: a fiscal sugar tax in Portugal and front-of-pack nutritional warning labels in Brazil. Data were collected in Porto/Portugal and São Paulo/Brazil to capture real-world product variation in retail environments. A total of 119 products were photographed using a convenience-based sampling strategy in large supermarket chains. In Porto, data were collected in two supermarkets, while in São Paulo, three supermarkets were visited.



Figure 1. Example of photo

All data collection occurred in-store, ensuring that only products available to consumers at the point of purchase were included. The sample consisted of sugar-sweetened beverages (juices) and breakfast cereals, categories selected due to their differential regulatory treatment across countries. In Portugal, fruit-based beverages are subject to a progressive sugar tax tied to sugar concentration, whereas cereals are not taxed. In Brazil, neither category is fiscally regulated; however, breakfast cereals are subject to front-of-pack (FOP) warning labels when sugar levels exceed national thresholds. Products were eligible if they contained a complete nutritional information panel. When duplicates appeared across retailers, only one instance was retained.

3.2. Variable construction

Nutritional information was manually extracted from product photographs and entered into a structured database. The primary dependent variable was sugar content, standardized as: grams per 100 g for cereals and grams per 100 ml for juices. And independent variables included: Product category (0 = cereal, 1 = juice); City (0 = São Paulo, 1 = Porto). Two binary variables captured labeling characteristics: Nutri-Score presence (1 = yes, 0 = no); Front-of-pack sugar alert presence (1 = yes, 0 = no). Nutri-Score labels appeared only in Portuguese products, reflecting voluntary adoption by manufacturers. FOP sugar alerts appeared only on Brazilian cereals, in line with Brazil's mandatory warning label policy.

3.3. Analytical strategy

A two-way analysis of variance (ANOVA) was conducted to examine whether Portugal's sugar taxation is associated with lower sugar levels in taxed categories. The model specification was: Dependent variable: Sugar content per 100 g/ml; Factors: Product category (cereal vs. juice), City (Porto vs. São Paulo). This factorial design allows identification of: Main effect of product category; Main effect of city; Interaction effect (Category $\times$ City)—interpreted as evidence that taxation influences sugar content in juices relative to cereals. Cereals, untaxed in both contexts, served as an internal control group, enabling an indirect estimate of the taxation effects.

To explore the influence of labeling systems, additional analyses were conducted within each subsample. Regarding the Nutri-Score (Porto), a descriptive comparison was performed between products with vs. without Nutri-Score, focusing on mean sugar levels. Because Nutri-Score is voluntary in Portugal, these results are interpreted cautiously as potential indicators of firm positioning strategies. Regarding Sugar Alert Labels (São Paulo cereals), a Welch's t-test compared sugar levels between products with vs. without Brazil's mandatory sugar alert symbol. Welch's test was selected due to unequal variances and group sizes.

4. Analysis

To assess whether Portugal's sugar taxation is associated with reduced sugar levels in sugar-sweetened beverages (SSBs), we conducted a two-way analysis of variance (ANOVA) with sugar content per 100g/ml as the dependent variable and two independent variables: product category (cereal vs. juice) and city (São Paulo vs. Porto). This design enables a comparison of taxed (juices in Porto) versus untaxed products, using cereals—untaxed in both contexts—as an internal control group.

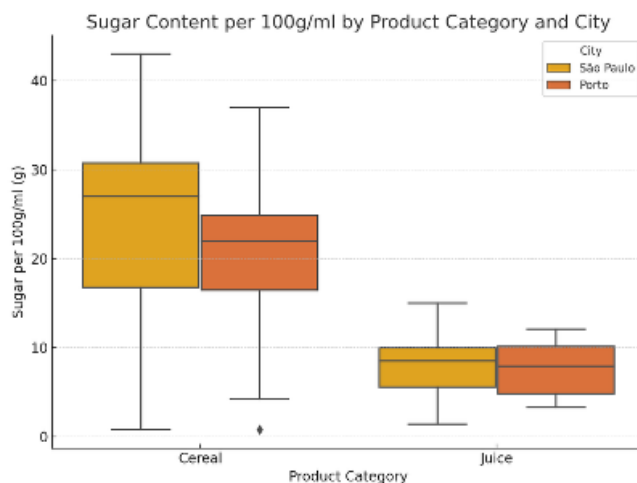
Descriptive statistics were first examined for the four product–city combinations. As expected, juices contained substantially more sugar than cereals across both cities. Cereals displayed comparatively stable sugar content across regions, while juices in Porto showed a slight decrease in sugar concentration relative to those in São Paulo. However, this difference appeared modest and required inferential testing to determine its significance.

The results of the ANOVA revealed a significant main effect of product category, $F(1, 115) = 80.80, p < .001$, indicating that juices are consistently higher in sugar than cereals regardless of city. The main effect of city was not significant, $F(1, 115) = 2.42, p = .123$,

suggesting that overall sugar content does not differ meaningfully between Porto and São Paulo when categories are combined.

Crucially, the interaction between product category and city was not significant, $F(1, 115) = 1.83$, $p = .179$, indicating that the effect of city does not vary by product type. In practical terms, the sugar content of taxed juices in Porto does not differ statistically from that of juices in São Paulo when contrasted against the stable sugar levels observed in cereals. Figure 1 presents a boxplot showing the distribution of sugar content for each category–city cell. While Porto’s juices have a slightly lower median sugar content compared to São Paulo’s, the distributions largely overlap. Cereals, as anticipated, exhibit narrow and consistent distributions across cities.

Figure 1. Sugar Content per 100g/ml by Product Category and City



An exploratory analysis revealed that 17 products (14%) displayed the Nutri-Score label, all of which were from Porto. Products with Nutri-Score had a higher average sugar content ($M = 20.41$, $SD = 6.94$) compared to those without ($M = 14.47$, $SD = 10.61$), suggesting that Nutri-Score presence does not necessarily indicate lower sugar levels in the sample analyzed.

Among the sampled cereals from São Paulo, 16 products (72.7%) featured a sugar alert, while 6 products (27.3%) did not. A comparison of average sugar content per 100g between these two groups reveals a striking difference. Cereals with a sugar alert had a substantially higher mean sugar content ($M = 30.94$ g, $SD = 5.99$) compared to those without the alert ($M = 4.95$ g, $SD = 5.76$).

This difference was statistically significant, as confirmed by an independent samples t-test (Welch’s t-test due to unequal sample sizes and variances), yielding a t-value of 9.32 and

a p-value < 0.001 ($p = 4.85 \times 10^{-6}$). This strongly suggests that the presence of the sugar alert label is associated with markedly higher sugar content in the sampled São Paulo cereals.

This result reinforces the utility of front-of-pack alerts in highlighting nutritionally critical information and aligns with regulatory intent. Unlike the case of the Nutri-Score, where the presence of the label did not correlate with lower sugar levels, the sugar alert in São Paulo does appear to be effectively identifying higher-sugar products within its category.

5. Conclusions and Discussion

The results of this study indicate that fiscal regulation—specifically the sugar tax applied to SSBs in Porto—was not associated with a statistically significant reduction in sugar content when compared to similar products in São Paulo, where no tax exists. Although descriptive patterns suggested slightly lower sugar levels in Porto’s juices, the difference was not statistically significant and did not vary by product category. In contrast, informational regulation in São Paulo, particularly mandatory front-of-pack sugar alerts, showed a clear association with nutritional profiles: cereals bearing sugar alerts had substantially higher sugar content than those without, demonstrating the label’s effectiveness in differentiating high-sugar products.

Cereals, untaxed in both contexts, served as a consistent control group. Their stable sugar levels across cities reinforce the idea that, without targeted fiscal policies, product formulation tends to remain unchanged. This highlights that any policy-driven nutritional improvements would need to be category-specific and enforcement-sensitive to be effective.

These findings raise broader considerations for public health policy design. The absence of significant differences in juice sugar content suggests potential limitations in the strength or enforcement of sugar taxes, or the possibility that manufacturers absorb tax costs rather than reformulate. Meanwhile, the strong link between sugar alerts and sugar content underscores the value of front-of-pack labeling in supporting consumer awareness and potentially influencing market dynamics over time. The contrast between fiscal and informational tools suggests that combined regulatory approaches may yield greater impact. Finally, the results emphasize the importance of tailoring policies to the specific characteristics of product categories, which differ in sugar profiles, price structures, and consumption patterns.

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