Equilibrium Effects of Food Labeling Policies

R&R Econometrica

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Motivation

Question: What are the products front-of-package labels (FoPL) Chilean act demand, supply, nutritional and welfare effects?

What this paper does:

(a) Estimate and unpack sugar and calorie intakes effects of the FoPL act.

(b) Build and estimate a demand-supply model for food and nutrients (Breakfast cereal).

(c) Compute consumer welfare changes.

(d) Use the model to perform counterfactuals to analyze equilibrium forces and optimal police design.

(e) Compare FoPL and tax policies effectiveness.

Key take away: Information interventions at the food and nutrients market might reduce inefficiencies by improving consumers choices and incentivize the production of healthier goods.

Front-of-package labels (FoPL) Chilean act

Table 1: Law 20.606 thresholds for Stage 1

	Solids	Liquids
Sugar (g/100g[ml])	22.5	6
Energy (kcal/100g[ml])	350	100
Sodium (mg/100g[ml])	800	100
Saturated fat (g/100g[ml])	6	3

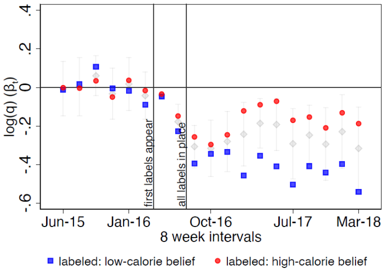
Data

- **Product scanner-level**: Provided by Walmart-Chile (40% market share). All transactions between May 2015 and March 2018. Variables: price, revenue, product name, brand name, and discounts. 524,000 consumers that visited Walmart store at least once every 8 weeks during the study period
- **Product Nutritional Information**: Provided by University of Chile and USDA. Aloud to recover if a product will get a Front-of-package label.
- **Consumer beliefs**: Ad hoc survey relative levels of believed nutritional content of different cereals.
  $\Longrightarrow$ Consumers have accurate beliefs about sugar concentration on cereals, but NOT in calories concentration.

Food act effects on breakdast cereal demand

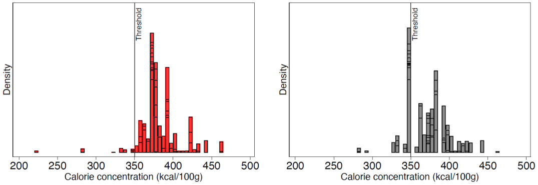
94 unique cereal products orresponding to 14 different producers. 55 received a high-in-calories label and 21 additional high-in-sugar label.

$$\underbrace{\log\left(q_{jst}\right)}_{\substack{\text{grams of product } j\\ \text{sold in store } s \text{ in time } t}} = \underbrace{\beta_t}_{\substack{\Delta Q \text{ of labeled}\\ \text{vs unlabeled.}}} \underbrace{L_j}_{\text{n labels } \mathbb{1}} + \gamma \underbrace{\log\left(p_{jst}\right)}_{\substack{\text{product's price per}\\ \text{100 grams of cereal}}} + \underbrace{\delta_{js} + \delta_t}_{\text{Fixed effects}} + \varepsilon_{jst}$$



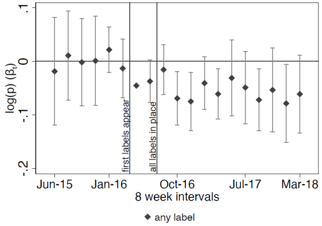
- Consumers decrease demand for labeled products relative to unlabeled ones.
- Labels are especially effective for products where consumers are more misinformed.

Changes in supply: breakfast cereal



(a) Distribution of calorie content in 2016 (b) Distribution of calorie content in 2018

Event study for cereal prices: $\log\left(p_{jst}\right) = \beta_t \cdot L_j + \delta_{js} + \delta_t + \varepsilon_{jst}$



$\implies$ Suppliers responded to the policy by reformulating their products and changing prices.

Model: Demand

Continuum of risk neutral consumers ($i \in I$) that buy products ($j \in J$) at store (market) t produced by firms ($f \in F$). Based on her beliefs, consumer i chooses the product j that maximizes her expected utility:

$$\mathbb{E}_{\pi_{ji}}[u_{ijt}] = \underbrace{\delta_{ijt}}_{\text{experience/taste}} - \underbrace{\alpha_i p_{jt}}_{\text{price paid}} - \underbrace{\mathbb{E}_{\pi_{ji}}[w_{jt}|L_{jt}]'\phi_i}_{\text{health consequences}}$$

where $\mathbb{E}_{\pi_{ji}}$ denotes the expectation operator over prior beliefs, and $L_{jt} \in \{\text{pre-policy, no, yes}\}$ denotes the label status of product j in market t.

The set of consumers that choose product j in market t is $\Theta_{jt} = \left\{ i \in \mathcal{I}_t : \mathbb{E}_{\pi_{ji}}\left[u_{ijt}\right] \geq \mathbb{E}_{\pi_{ki}}\left[u_{ikt}\right], \quad \forall k \in \mathcal{J}_t \right\}$ and its market share is $s_{jt} = \int_{i \in \Theta_{jt}} di$. ($\mathcal{J}_t$ includes the outside good option).

Model: Supply

To produce a given product j, firms use two types of inputs: critical nutrients w_{jt} (e.g. sugar), and other inputs m_{jt} (e.g. sacralose, polyols). The taste of a product is given by a product-specific production function $\delta_j(w_{jt}, m_{jt})$ ($\bar{\delta}_j$ can be invariant to reformulation). The marginal cost of producing product j is:

$$c_{jt}\left(w_{jt}\right) = p_w w_{jt} + p_m \underbrace{m_j\left(w_{jt}, \bar{\delta}_j\right)}_{\text{Inverse of } \delta_j(w_{jt}, m_{jt})} + \underbrace{\vartheta_{jt}}_{\text{cost shifter}}$$

Let ν_j , which we will call the "bliss point" of product j, be the value of w_{jt} that minimizes marginal cost. The bliss point is the concentration of critical nutrients to achieve taste $\bar{\delta}_j$ at minimum cost.

With the FoLP policy, the demand function becomes discontinuous and firms have incentives to reduce the nutritional content of products whose bliss points are to the right of but close to the threshold.

Model: Demand estimation assumptions

1. Split consumers into two bins defined by being above or below median household income.
2. Product quality is parametrized.
3. Consumers (b) make their beliefs by using the observed labels (or lack of them) and applying Bayes rule, not taking into account firm behavior.

$$\begin{aligned}\log\left(s_{jtb}\right)-\log\left(s_{0tb}\right)=-\alpha_b p_{jt}-\mathbb{E}_b\left[w_{jt}\mid L_{jt}\right]'\phi_b+\\ \rho\log\left(s_{j|g,tb}\right)+\delta_{jb}+\delta_{T(t)b}+\delta_{S(t)b}+\underbrace{\xi_{jtb}}_{\text{demand shock}}\end{aligned}$$

Model: Demand estimation key results

1. α: Average own-price elasticity of -3.66 (close to Nevo, 2001)
2. ϕ_b: consumers are willing to pay 11% of the average price of cereal to reduce the sugar or calorie concentration of products by 1 standard deviation , while keeping the taste constant.
3. ρ: intra-nest correlation of 0.9919, there is little substitution from inside goods to the outside good.

Model: Supply estimation key result

What would be the value of optimal level of sugar/calories (λ_j^n) that would make a firm indifferent between choosing a given bliss point or having the product bunching at the threshold, keeping all other products' nutritional fixed:

- **Sugar**: Average reduction in sugar concentration among products bunching in sugar is 8.2 gr/100gr.
- **Calories**: Average reduction in calorie concentration among products bunching in calories is 24.9 kcal/100gr.

$\implies$ the average expected increase in marginal cost for products bunching in any nutrient is 4 cents per 100gr (or 6.4% of the average price of cereal)

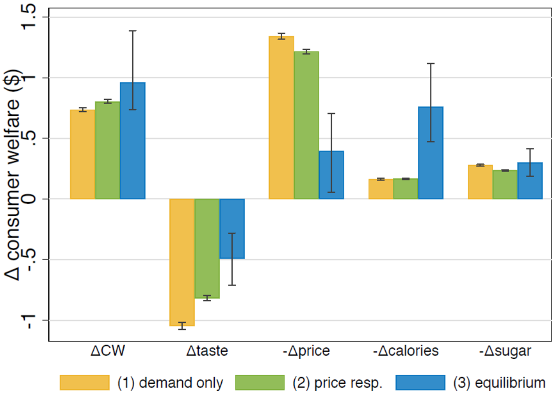
Counterfactuals (1)

Counterfactual	Description
(0) *no intervention*	No intervention
(1) *demand only*	Labels at place but no supply responses
(2) *price response*	(1) + firms choose prices optimally (p_{jt})
(3) *equilibrium*	(1) + (2) + firms choose nutritional content optimally (w_{jt})

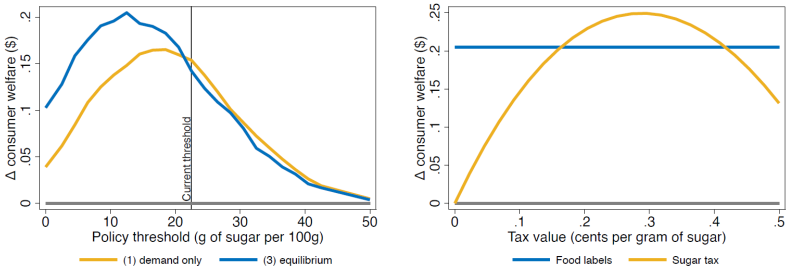
$$\Delta CW^t(x) = \sum_b \frac{1}{\alpha_b} \sum_j \{ \underbrace{\int_{\Delta\Theta_{bjt}^{(x)}} \delta_{ijt} di - \left(\alpha_b p_{jt}^{(x)} + w_{jt}^{(x)} \phi_b \lambda\right) \Delta s_{jt}^{(x)}}_{\text{substitution-effects}}$$

$$\underbrace{- \left(\alpha_b \Delta p_{jt}^{(x)} + \Delta w_{jt}^{(x)} \phi_b \lambda\right) s_{jt}^{(0)}}_{\text{supply-effects}} \}$$

Counterfactuals (2)



Optimal policy design



(a) Food labels

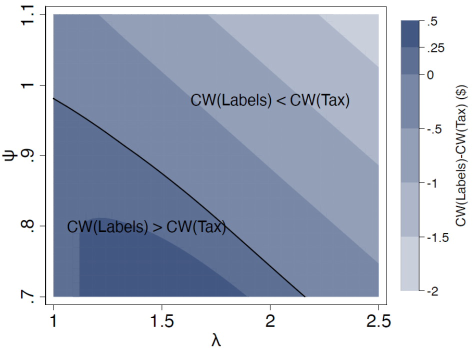
(b) Sugar taxes

- Naive policymaker (ignores equilibrium effects, C1) would set the policy threshold at 18.5g/100g.
- C3, however, is maximized at 12.5g/100g (12% larger than C1).
- Optimal sugar taxes are 12.5% larger than C FoLP optimal policy with equilibrium effects.

Food labels vs. sugar taxes

- λ: market imperfections.
- ψ: marginal value of public funds

A high λ favor taxes, however tax, impose a large burden on consumers who end up spending up to 7% more on cereal. If ψ is small, tax collection will not contribute much to the total welfare.



Also, taxes might be regressive in this feature, generating income inequality effects.

Proposed discussion

Amazing paper!

Enrich consumer information usually improves their welfare, but the equilibrium consequences that arise might generate ambiguous aggregate results on market power:

- FoPL is alternative way to gain efficiency at the food industry, where firm markups might end up decreasing for high market power firms with above nutrient threshold products.
- FoPL might help firms differentiate their products (with not clear increase in costs) and raise their markups.