Efectos de Equilibrio de la Ley de Etiquetados

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La batalla contra la obesidad

- Prevalencia de obesidad en el mundo se ha **triplicado** desde 1975
  - Chile: 30% de la población es obesa
- **Mala alimentación** es una de las causas principales de la obesidad
- Distintos gobiernos están buscando medidas para mejorar la ingesta nutricional de las personas
- Una política cada vez más común es implementar **etiquetados de alimentos**

Pregunta de investigación

1. ¿Ayudan las etiquetas a mejorar la alimentación y bienestar de las personas?

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1. ¿Ayudan las etiquetas a mejorar la alimentación y bienestar de las personas?

2. ¿Cómo afecta la respuesta de los productores de alimentos estos resultados?
   - Cambios en **precios** debido a cambios en el poder de mercado
   - Incentiva el uso de **ingredientes más sanos** para evitar recibir etiquetas

Pregunta de investigación

1. ¿Ayudan las etiquetas a mejorar la alimentación y bienestar de las personas?

2. ¿Cómo afecta la respuesta de los productores de alimentos estos resultados?

3. ¿Cómo se comparan políticas de etiquetado con instrumentos alternativos?

La ley de etiquetados en Chile

- Respondemos estas preguntas en el contexto de Chile, en donde desde 2016
  - productos que superen ciertos niveles de **azúcar**, **calorías**, **sodio**, y **grasas saturadas** deben llevar un sello de advertencia

Datos

1. Precios y compras
   - Datos de compra de **Walmart-Chile** (2015-2018)

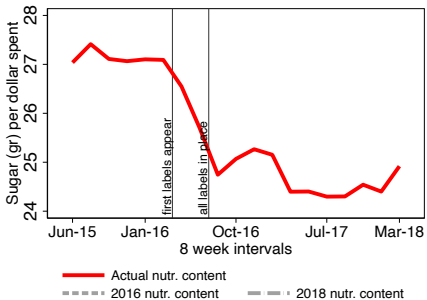
2. Contenido nutricional
   - Datos colectados a mano - dos levantamientos: **antes (2016) y después (2018)**

3. Percepción sobre contenido nutricional de productos

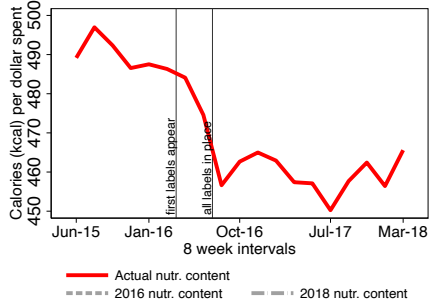
details

Evidencia: Cambios totales en la ingesta nutricional

- Ingesta de azúcar y calorías por peso gastado disminuyó 9% y 7% respectivamente



(a) Ingesta de azúcar



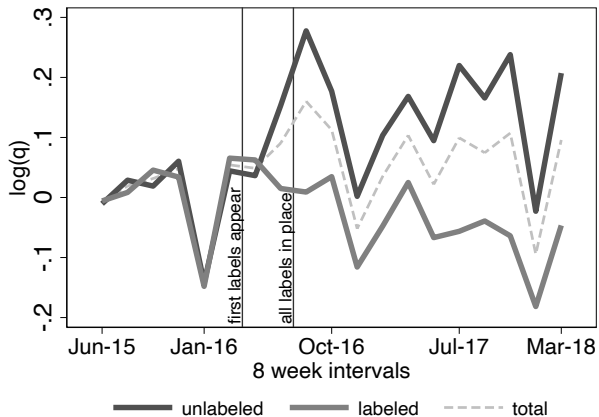
(b) Ingesta de calorías

additional details | alternative specification | between-category substitution

Cereales de desayuno

Evidencia: Cambios en demanda

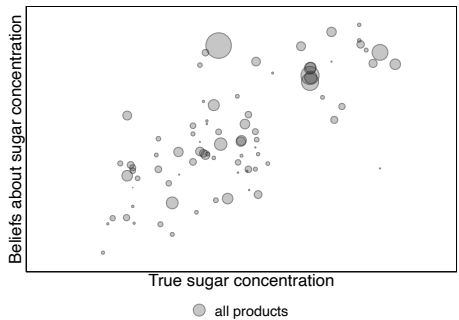
- Importante sustitución de productos con sello a productos sin sello



regression

Evidencia: El rol de la información

- Correlación entre creencias del consumidor y verdadero contenido de azúcar es 0.73
- Correlación entre creencias del consumidor y verdadero contenido de calorías 0.28



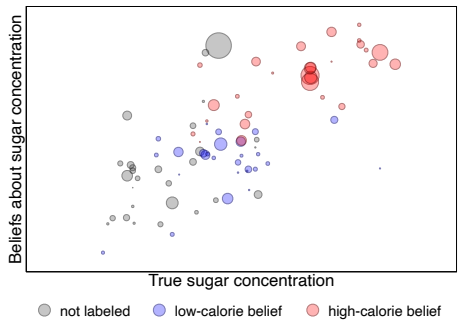
(a) Creencias sobre azúcar

(b) Creencias sobre calorías

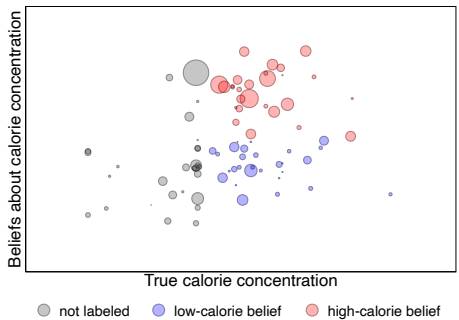
survey details

Evidencia: El rol de la información

- Dividimos productos entre aquellos con y sin etiqueta
- Y que son considerados como altos y bajos en contenido de calorías



(a) Creencias sobre azúcar

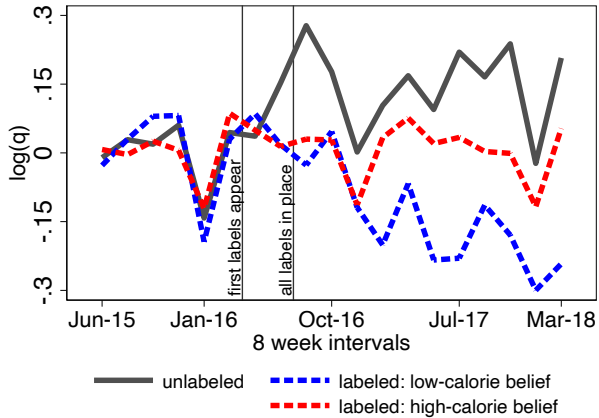


(b) Creencias sobre calorías

survey details

Evidencia: El rol de la información

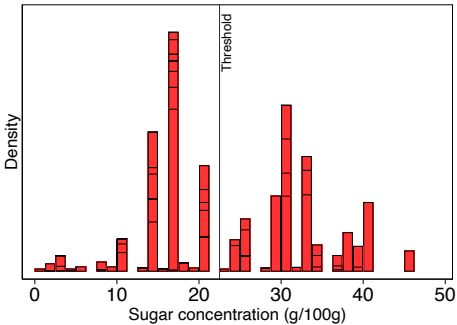
- Productos considerados sanos pero que reciben sello son los más afectados



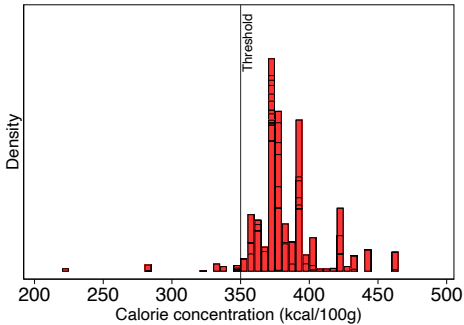
discussion non-parametric version

Evidencia: Oferta - reformulación de productos

- Firmas reformularon productos para evitar tener sellos
- 33% y 23% de productos "alto-en" azúcar y calorías respectivamente cruzaron el límite



(a) Sugar content - 2016



(b) Caloric content - 2016

other nutrients | distribution in 2020 | scatter plot | changes in prices

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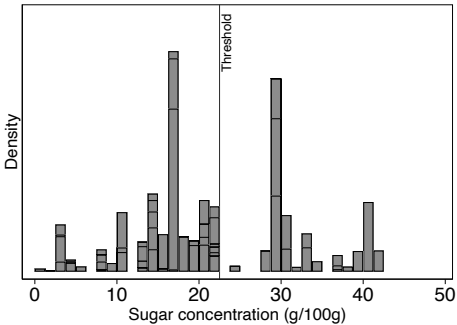
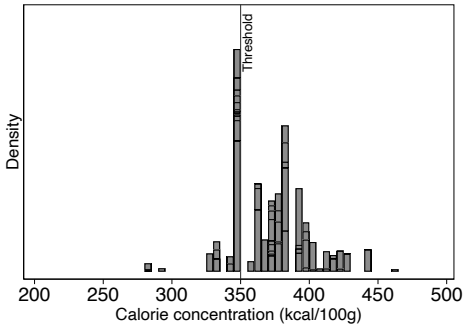


(a) Sugar content - 2018



(b) Caloric content - 2018

other nutrients | distribution in 2020 | scatter plot | changes in prices

Evidencia: Resumen

- Demanda por productos con sello disminuyó 26% relativo a productos sin sello
  - Las creencias de los consumidores cumplen un rol fundamental
- Las firmas reaccionan cambiando los precios y reformulando los productos
  - Concentración promedio de azúcar y calorías disminuyó en 12% y 3%
  - Precio promedio de productos sin sello aumentó en 5.5% relativo a otros

other categories

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- Desarrollamos un modelo de oferta y demanda para:
  - Cuantificar los resultados recién presentados
  - Separar los efectos de oferta y de demanda
  - Estudiar el diseño de política óptima y compararla con políticas alternativas

other categories

Modelo

- Consumidores: Les importa el precio, el sabor, y lo saludable de los productos, pero tienen **creencias incorrectas** sobre el contenido nutricional
  - Los sellos proveen información a los consumidores que los ayudan a tomar mejores decisiones

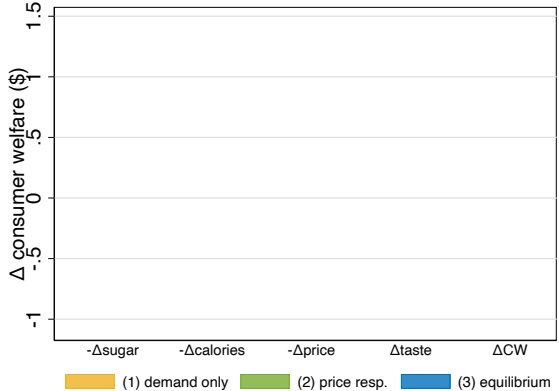
- Firmas: Eligen el **precio** y el **contenido nutricional** de sus productos para maximizar utilidades
  - Cuando aparecen los sellos, las firmas tienen incentivos a reducir el contenido nutricional justo debajo del límite

Decomposición de la política: Contrafactuales

- Estimados bienestar del consumidor en cuatro escenarios distintos:

Contrafactual	**Descripción**
(0) no intervention	Sin internvención
(1) demand only	Sellos sin reacción de firmas
(2) price response	(1) + firmas eligen precios
(3) equilibrium	(1) + (2) + firms eligen contenido nutricional

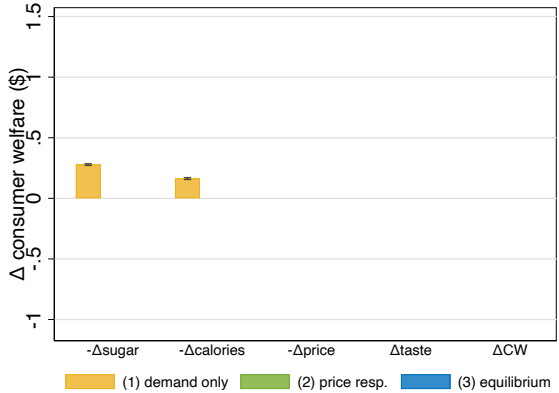
Decomposición de la política: (0) No intervention



skip subjective welfare effects decomposition mechanisms

Decomposición de la política: (1) Demand only

- Consumidores sustituyen a productos más saludables



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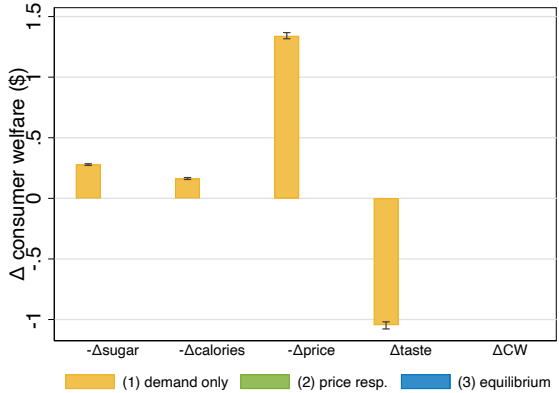
Decomposición de la política: (1) Demand only

- Productos saludables son más baratos pero con menor sabor



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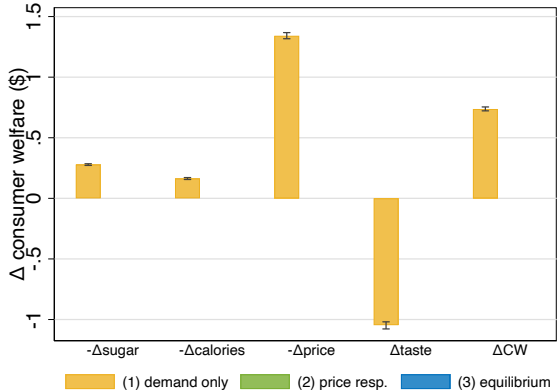
Decomposición de la política: (1) Demand only

- Aumento en bienestar del consumidor de 3% del gasto total



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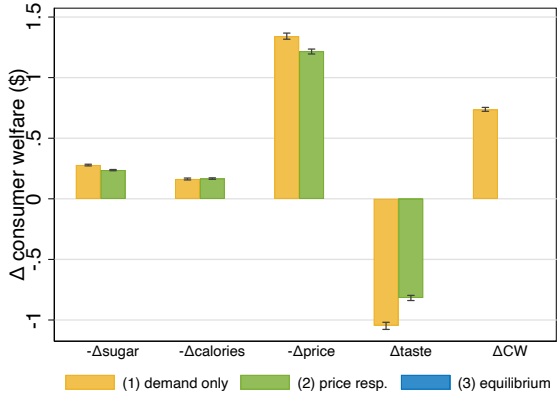
Decomposición de la política: (2) Price response

- Firmas responden aumentando (disminuyendo) los precios de productos sin (con) sellos



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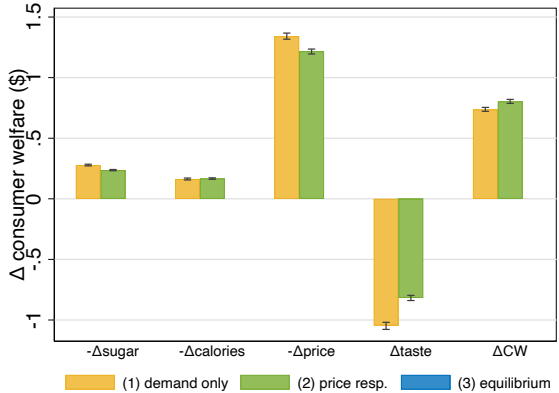
Decomposición de la política: (2) Price response

- Ganancias en bienestar son mayores que bajo (1)



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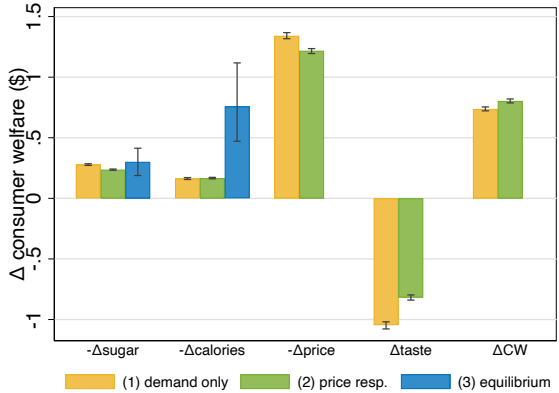
Decomposición de la política: (3) Equilibrium

- Firmas responden reduciendo la concentración de nutrientes críticos



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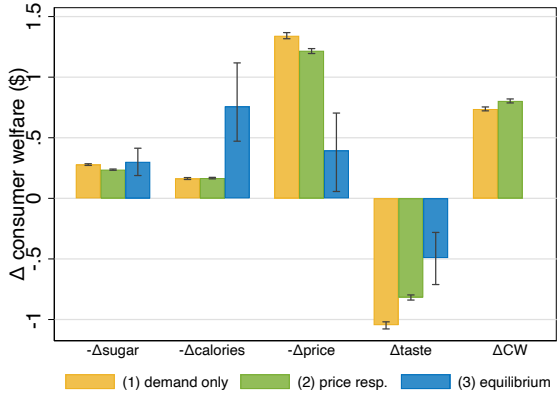
Decomposición de la política: (3) Equilibrium

- La reformulación aumenta los costos, lo que se transmite en mayores precios



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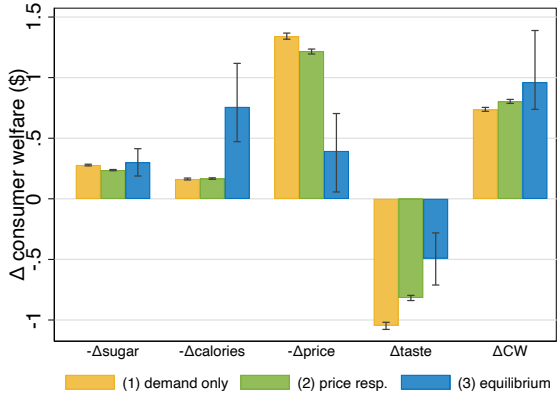
Decomposición de la política: (3) Equilibrium

- Ganancias en bienestar del consumidor son 30% más grandes que en (1)



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Política óptima

- Estudiamos diseño de política óptima cambiando los límites regulatorios
  - Regulador elige límites que maximicen la información entregada por los sellos
  - Considerando efectos de equilibrio, es conveniente disminuir los límites para aumentar reformulación

- Comparamos ley de etiquetados con impuestos al azúcar
  - Sellos presentan ventajas distributivas con respecto a los impuestos al azúcar
  - Impuestos al azúcar lidian mejor con fricciones no informacionales (adicción, impulsividad, etc)

back beyond cereal

Más allá de cereales

- Con nuestro modelo podemos aprender sobre los efectos de la ley en otras categorías
- Determinantes de respuesta en demanda:
  - Sustituibilidad $(+)$
  - Informatividad de etiquetas $(+)$
- Determinantes de respuesta en oferta:
  - Distancia al límite $(-)$
  - Costos de reformular $(-)$
- Miramos otras categorías para testear estas hipótesis
  - Bebidas vs. cereales
  - Líquidos vs. sólidos

Soft drinks vs cereal | Liquids vs solids

Concluding remarks

1. Ley de etiquetado es una política **efectiva** para mejorar nutrición

2. **Efectos de equilibrio** son importantes
   - Respuestas en precio puede afectar los beneficios
   - La reformulación hace productos más sanos pero más caros

3. Comparado con impuestos al azúcar, sellos presentan **ventajas** y **desventajas**
   - Más progresivos y mejor focalizados
   - Menos efectivos ante otras imperfecciones de mercado

4. Esperamos ver más de estas políticas implementadas en el resto del mundo

Appendix: Regulatory thresholds

- The regulation is gradually tightened in three phases: June 2016, June 2018, June 2019

	Solids			Liquids		
Stage	S_1	S_2	S_3	S_1	S_2	S_3
Energy (kcal/100g)	350	300	275	100	80	70
Sodium (mg/100g)	800	500	400	100	100	100
Total Sugars (g/100g)	22.5	15	10	6	5	5
Saturated fats (g/100g)	6	5	4	3	3	3

- Some examples as reference:

per 100 gr	Energy (kcal)	Sodium (mg)	Sugar (gr)	Fat (gr)	# of labels
Frosted Flakes	369	468	35	0.5	2
Cheetos	468	904	0.8	4.8	2
Snickers	488	189	47	13	3
Coca-Cola	44	10	10.5	0	1

back

In Sweeping War on Obesity, Chile Slays Tony the Tiger

New regulations, which corporate interests delayed for almost a decade, require explicit labeling and limit the marketing of sugary foods to children.

"Nutrition experts say the [Chilean] measures are the world's most ambitious attempt to make a country's food culture what it should be and a model for how to turn the tide on a global obesity epid

In Sweeping War on Obesity, Chile Slays Tony the Tiger

New regulations, which could affect nearly a decade, require explicit labeling and limit the marketing of sugary foods to children.

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This Paper: Related literature

1. Consumer choice in settings of imperfect information
   - Hastings and Weinstein (2008), Abaluck and Gruber (2011), Woodward and Hall (2012), Handel and Kolstad (2015), Allcott and Knittel (2019)

2. Policies to improve consumers' diet quality
   - FoPL: Sacks et al. (2009), Kiesel and Villas-Boas (2013), Zhu et al. (2015) Araya et al. (2019), Taillie et al., (2020).
   - Information on Menus: Elbel et al. (2009), Wisdom et al. (2010), Bollinger et al. (2011), Finkelstein et al. (2011), Courtemanche et al. (2020).
   - Advertising: Ippolito and Mathios (1990,1995), Dubois et al. (2017).
   - Taxes: Allcott et al. (2019), Aguilar et al. (2019).

3. Quality disclosure and certification
   - Dranove et al. (2003); Jin and Leslie (2003); Greenstone et al. (2006); Dranove and Jin (2010); Roe et al. (2014)

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Appendix: Walmart-Chile

- About Walmart-Chile:
  - 42% of market share
  - +22,000 food products; divided in 101 categories and 524 subcategories
  - Categories: cereals, soft drinks, juice, bread, cheese, flour, pasta, rice, seeds, soups...

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  - +22,000 food products; divided in 101 categories and 524 subcategories
  - Categories: cereals, soft drinks, juice, bread, cheese, flour, pasta, rice, seeds, soups...
- The data:
  - May 2015 - March 2018
  - Detailed data at the transaction level by UPC: includes price, quantity, rebates, packaging details, etc.
  - Identifies consumer through Walmart's loyalty program
  - +9 billion transactions, +5 million identified consumers

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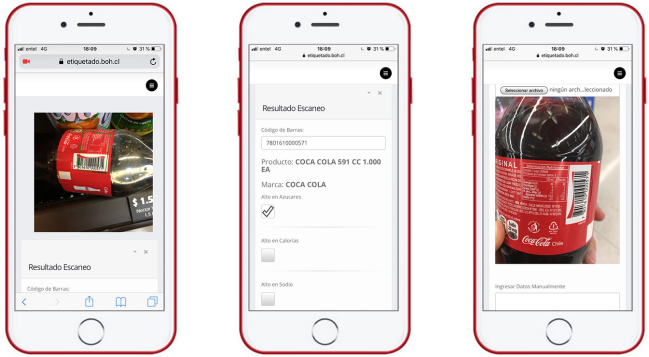
Appendix: Nutritional Content

- Two snapshots of data: pre and post policy nutritional composition (2016 and 2018)
  - We developed an app to take pictures of nutrition fact tables in supermarkets and link them to the Walmart data
  - Agreement with INTA (Institute of nutrition and food technology)



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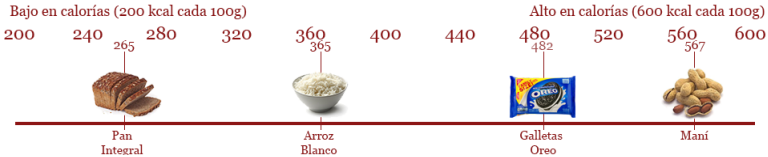
Appendix: Beliefs Survey

- We asked consumers to insert cereal products between these reference products:

- Calories:



- Sugar:

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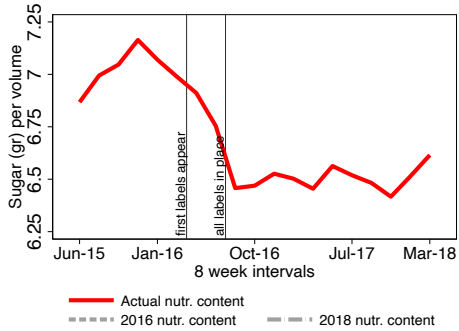
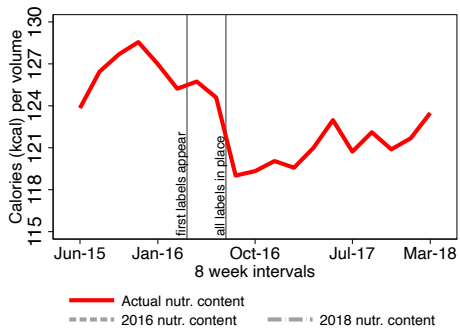
Appendix: Changes in nutritional intake (per volume)



(a) Sugar intake



(b) Calorie intake

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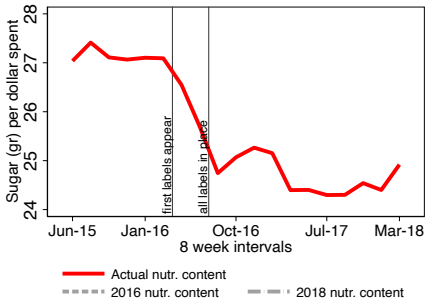
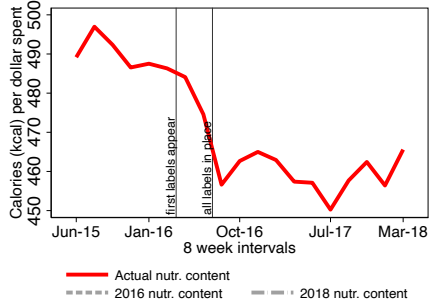
Appendix: Overall changes in nutritional intake

- Sugar and calorie intake per dollar spent decreased 9% and 7% respectively
- **Channels**: 1. between-category subs., 2. within-category subs., 3. product reformulation



(a) Sugar intake



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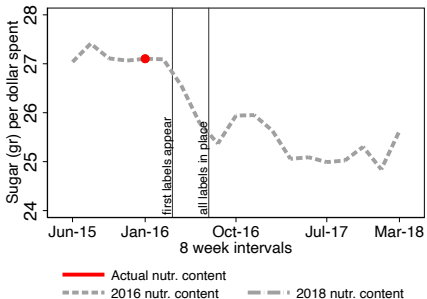
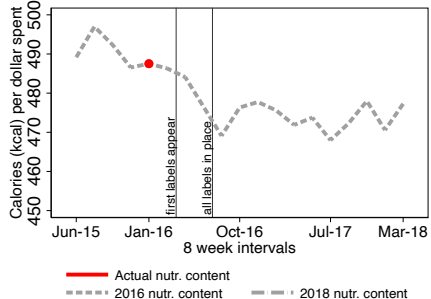


(a) Sugar intake



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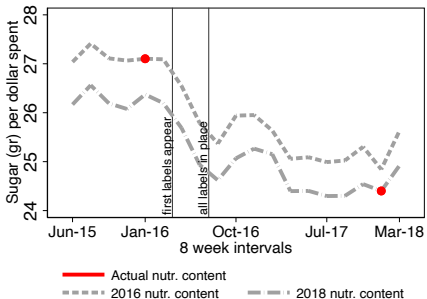

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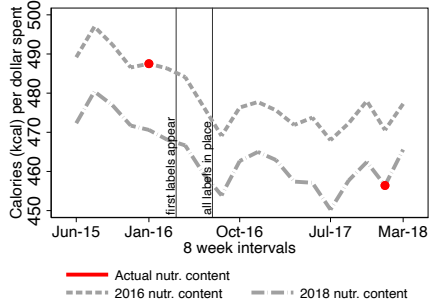

(b) Caloric intake

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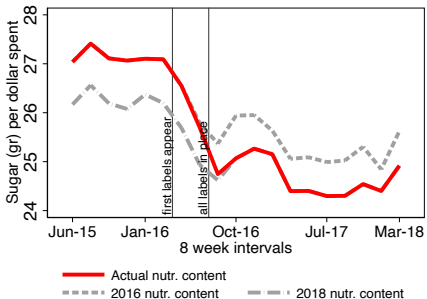

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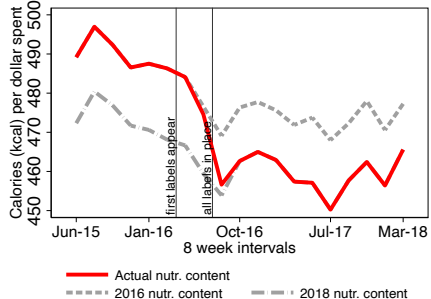

(b) Caloric intake

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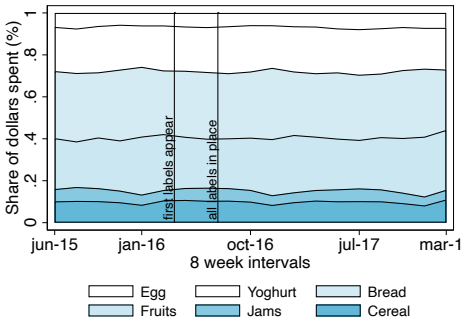
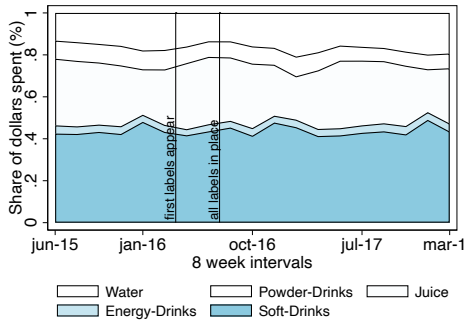
Appendix: Between-category substitution



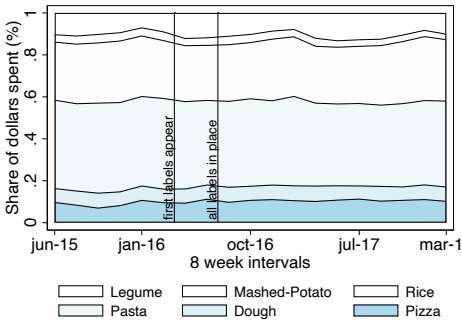
(a) Breakfast



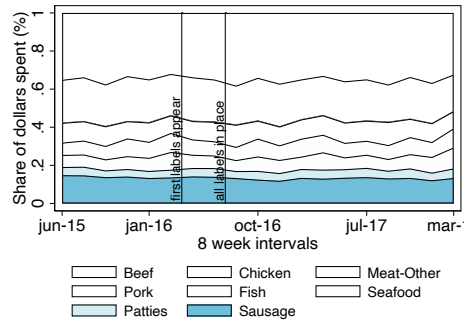
(b) Drinks

back

Appendix: Between-category substitution



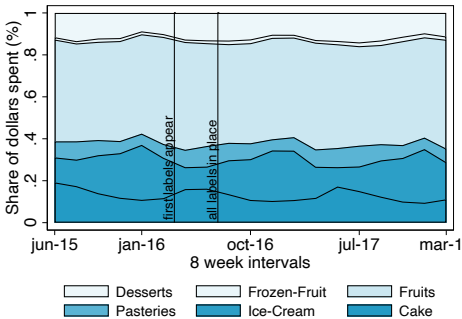
(a) Carbs



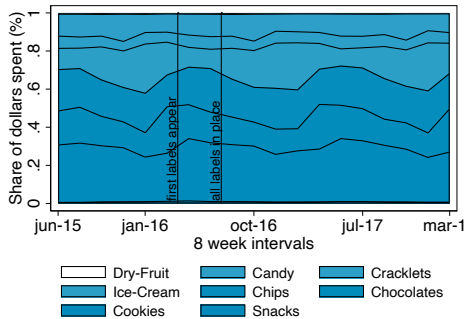
(b) Meat

back

Appendix: Between-category substitution



(a) Desserts



(b) Snacks

back

Evidencia: Cambios en demanda

- Product: all bar codes with same name and brand (e.g. "Honey Nut Cheerios")

- We estimate the following regression

$$\log(q_{jst}) \quad = \quad \sum_k \beta_k L_j \mathbb{1}_{\{k=t\}} + \gamma \log(p_{jst}) + d_{js} + \delta_t + \varepsilon_{jst}$$

where

  - q_{jst} are total grams of product j sold in supermarket s in period t (8 weeks long)
  - L_j is defined as whether the product gets any label (as in 2018)
  - Observations are weighted by pre-policy revenue
  - Standard errors clustered at the product level

Evidencia: Changes in equilibrium quantities

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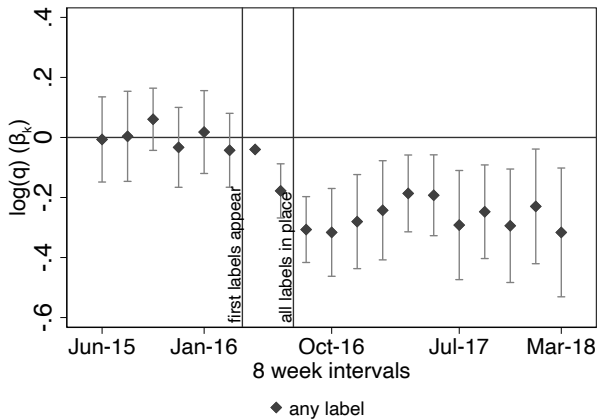
- L_j is defined as whether the product gets any label (as in 2018)
- Observations are weighted by pre-policy revenue
- Standard errors clustered at the product level

Evidencia: Changes in equilibrium quantities

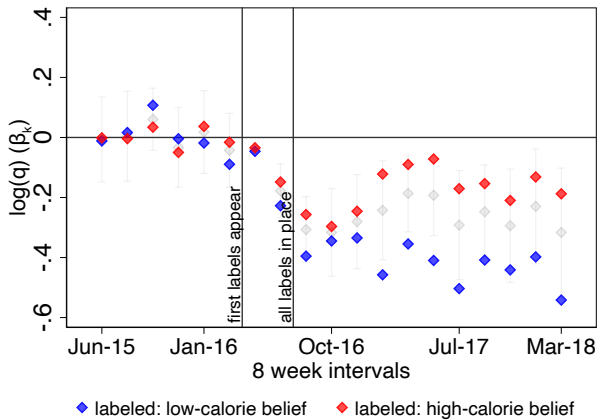
- Relative decrease in demanded quantities for labeled products of 26.4% on average



raw data | robustness | excluding prices | estimates by labels | consumer-level heterogeneities

Evidencia: The role of beliefs

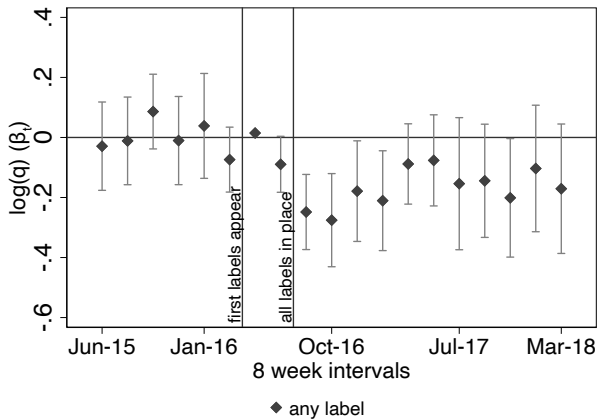
- Products perceived as healthy that received a label were more affected



discussion non-parametric version

Appendix: Robustness

- Results are robust to exclude oats from analysis



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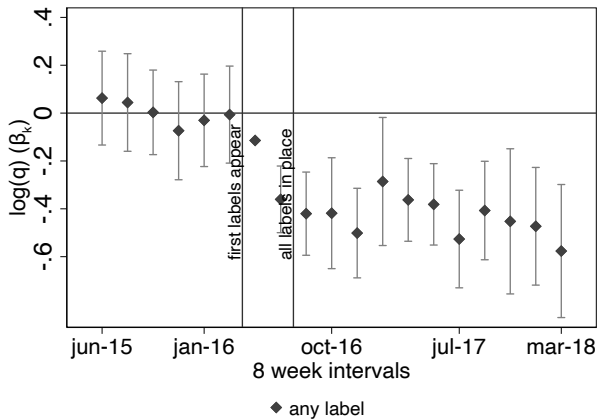
Appendix: Robustness

- Results are robust to exclude reformulated products



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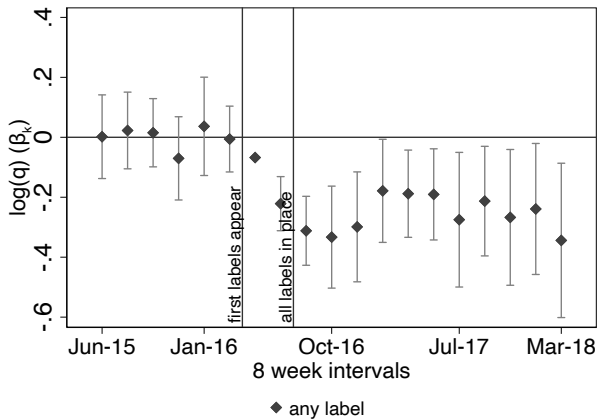
Appendix: Robustness

- Results are robust to instrument for labels using pre-policy nutritional content



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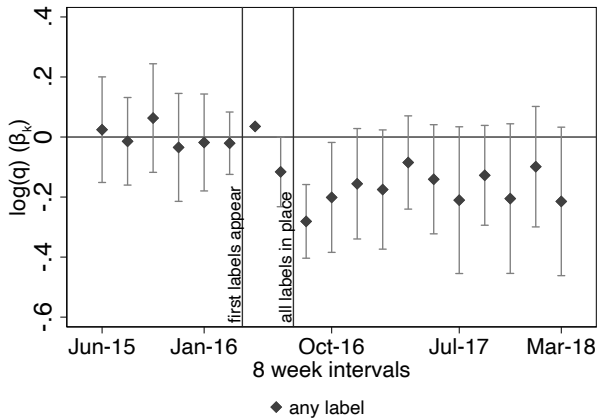
Motivating evidence: Not controlling for prices

- Results are robust to not including prices



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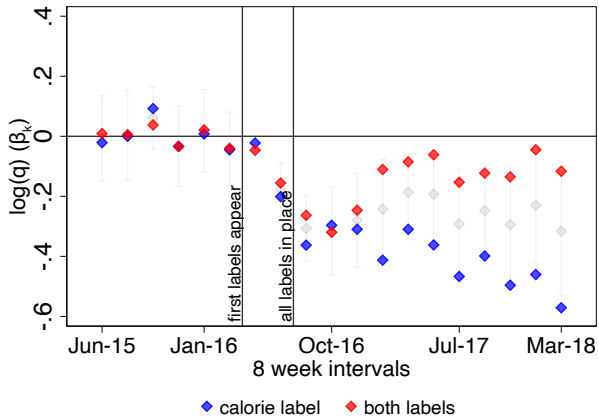
Appendix: Changes by regulatory label



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Appendix: Consumer heterogeneity

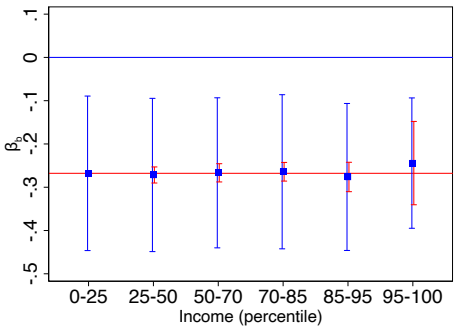
- To test for heterogeneous responses across consumers, we estimate

$$\log(q_{bjst}) = \beta_b L_j \mathbb{1}_{\{t>t_0\}} + \gamma_b \log(p_{jst}) + d_{bjs} + \delta_{bt} + \varepsilon_{bjst}$$

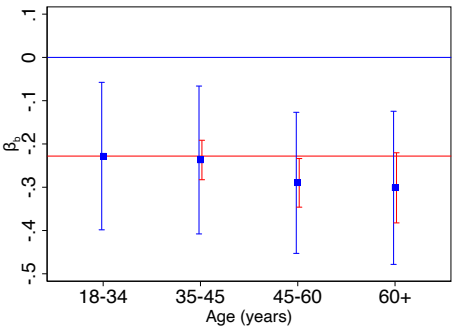
  where q_{bjst} are grams of product j sold in store s in period t to consumers of type b

- We present results for household income and age

Appendix: Consumer heterogeneity



(a) Income heterogeneity



(b) Age heterogeneity

- Blue confidence intervals test against the null $\beta_b = 0$
- Red confidence intervals test against the null $\beta_b = \beta_1$

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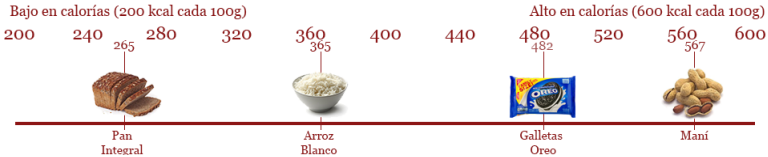
Appendix: Beliefs Survey

- We asked consumers to insert cereal products between these reference products:

- Calories:



- Sugar:

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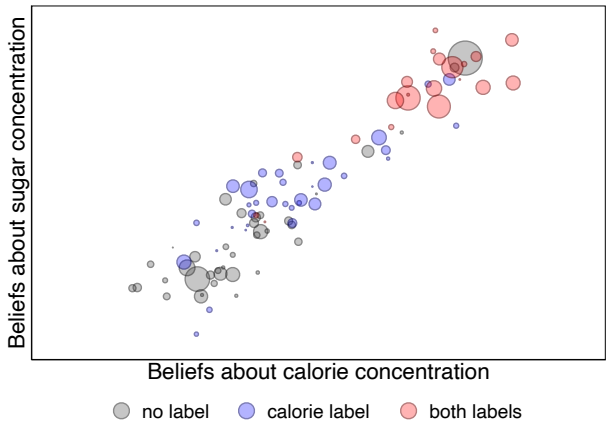
Appendix: Beliefs survey results

1. Calories and sugar beliefs are very correlated, while true values are not



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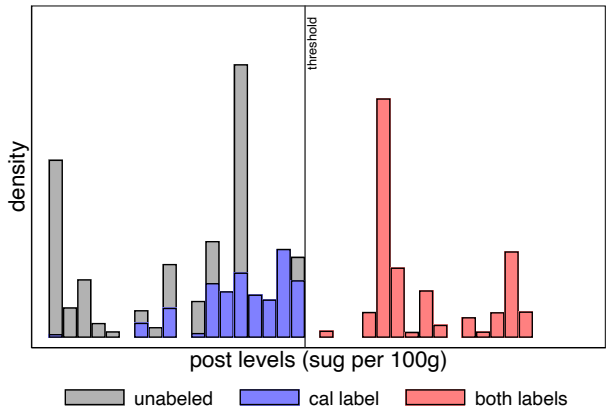
Appendix: Beliefs survey results

2. Sugar beliefs are highly correlated with the truth



Notes: 73 different products. Weigthed by pre-policy revenues.

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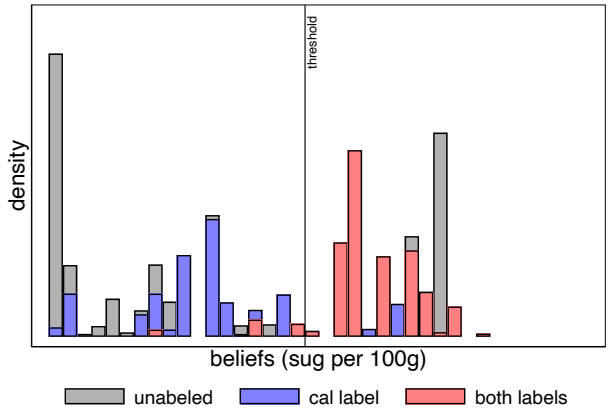
Appendix: Beliefs survey results

2. Sugar beliefs are highly correlated with the truth



Notes: 73 different products. Weigthed by pre-policy revenues.

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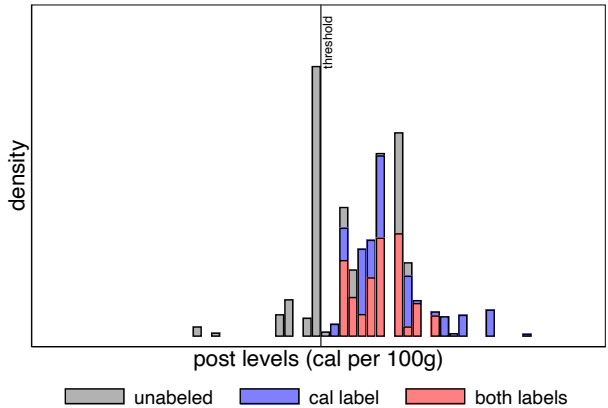
Appendix: Beliefs survey results

3. Calories beliefs are not very correlated with the truth

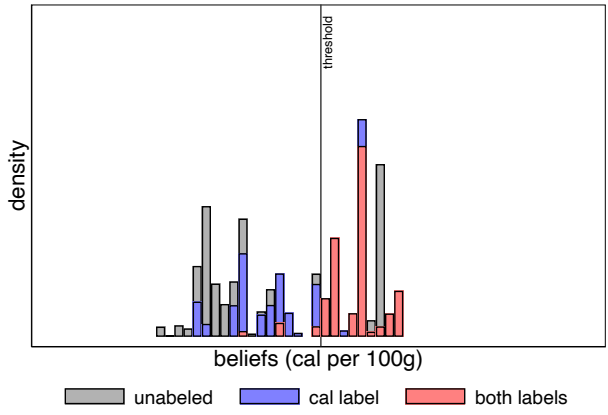


Notes: 73 different products. Weigthed by pre-policy revenues.

back

Appendix: Beliefs survey results

3. Calories beliefs are not very correlated with the truth



Notes: 73 different products. Weigthed by pre-policy revenues.

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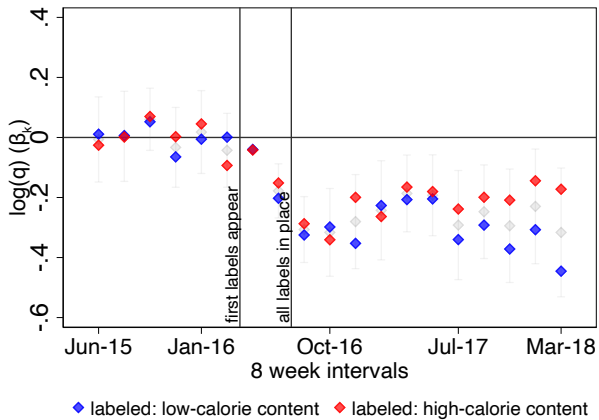
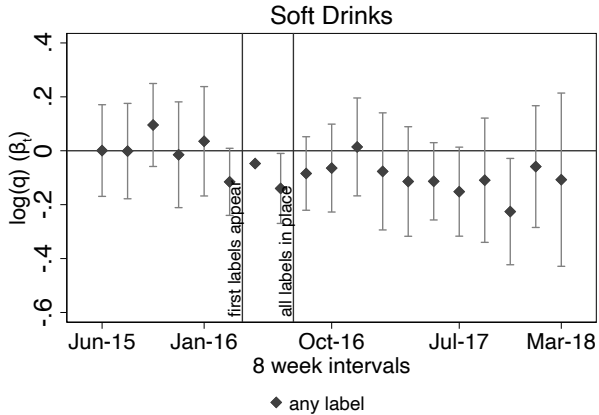
Descriptive evidence: The role of salience

- Products perceived as healthy that received a label were more affected



Descriptive evidence: The role of salience

- Small or zero effect for soft-drinks



Appendix: Alternative salience model

- Alternative specification:

$$\mathbb{E}_b[u_{ijt}] = -\alpha_b p_{jt} - \mathbb{E}_b[w_{jt}|L_{jt}](\phi_b + \Delta\phi_{bt}) + \delta_{jb} + \delta_{T(t)b} + \delta_{S(t)b} + \xi_{jtb} + \epsilon_{ijt}$$

α_l	0.0542***	ϕ_l^s	0.2630**	ϕ_l^c	0.1421***	$\Delta\phi_{lt}^c$	-0.0140*
	(0.0141)		(0.1122)		(0.0452)		(0.2136)
α_h	0.0497***	ϕ_h^s	0.2299**	ϕ_h^c	0.1338***	$\Delta\phi_{ht}^c$	-0.0233*
	(0.0155)		(0.1031)		(0.0396)		(0.2035)
ρ	0.9920***						
	(0.0046)						

Nutritional content is measured in 1000kcal and 1000gr of sugar per 100gr of cereal, and prices in dollars per 100gr of cereal. Standard errors are clustered at the market level.

descriptive model

Appendix: Alternative salience model

- Alternative specification:

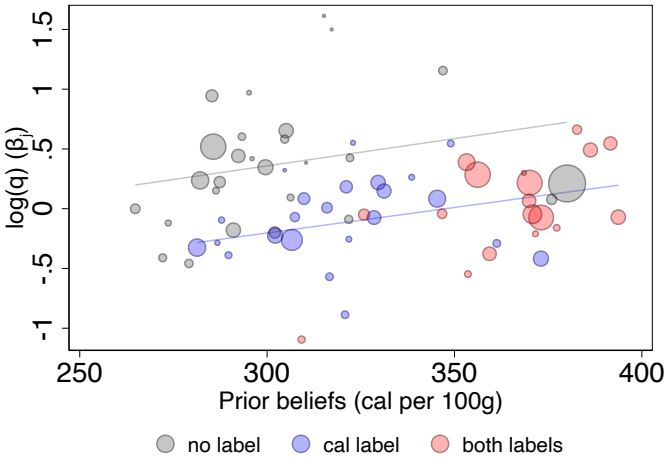
$$\mathbb{E}_b[u_{ijt}] = -\alpha_b p_{jt} - \mathbb{E}_b[w_{jt}|L_{jt}](\phi_b + \Delta\phi_{bt}) + \delta_{jb} + \delta_{T(t)b} + \delta_{S(t)b} + \xi_{jtb} + \epsilon_{ijt}$$

α_l	0.0575***	ϕ_l^s	-0.0677	ϕ_l^c	0.2576**	$\Delta\phi_{lt}^s$	0.3682*	$\Delta\phi_{lt}^c$	-0.1319*
	(0.0160)		(0.1182)		(0.0417)		(0.2136)		(0.0711)
α_h	0.0529***	ϕ_h^s	-0.0184	ϕ_h^c	0.2251**	$\Delta\phi_{ht}^s$	0.2791	$\Delta\phi_{ht}^c$	-0.1106*
	(0.0173)		(0.1152)		(0.0375)		(0.2035)		(0.0640)
ρ	0.9908***								
	(0.0053)								

Nutritional content is measured in 1000kcal and 1000gr of sugar per 100gr of cereal, and prices in dollars per 100gr of cereal. Standard errors are clustered at the market level.

descriptive model

Appendix: Non parametric results



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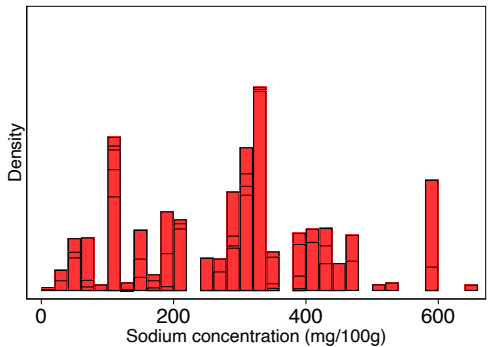
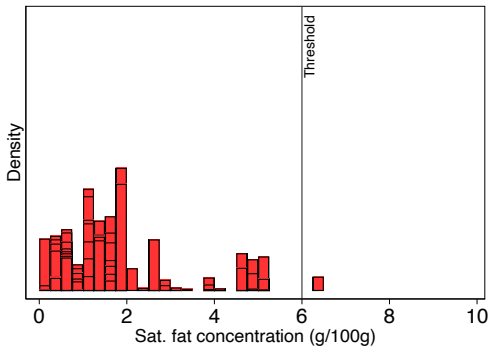
Appendix: Other nutrients



(a) Sodium content - 2016



(b) Sat fat content - 2016

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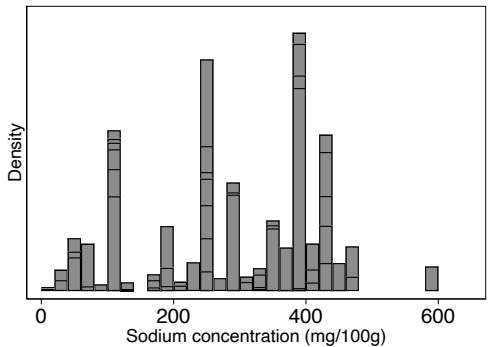
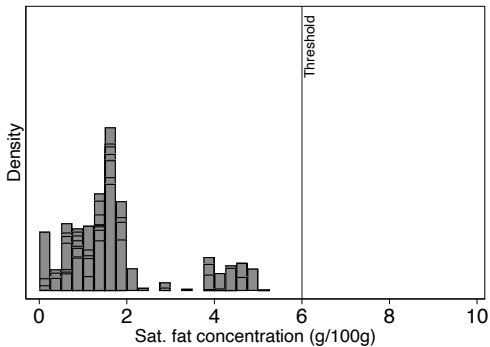
Appendix: Other nutrients



(a) Sodium content - 2018



(b) Sat fat content - 2016

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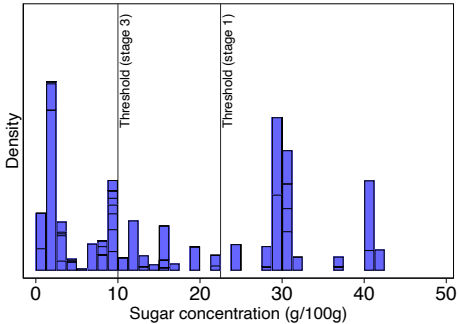
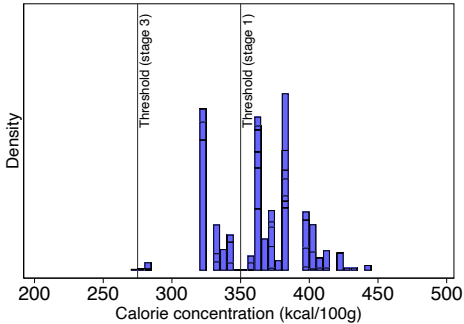
Appendix: Distribution in 2020

- Firms reformulated products to avoid receiving labels
- In 2020 no firms are bunching on calories anymore



(a) Sugar content - 2020



(b) Sugar content - 2020

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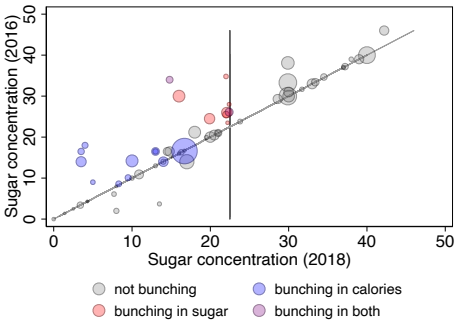
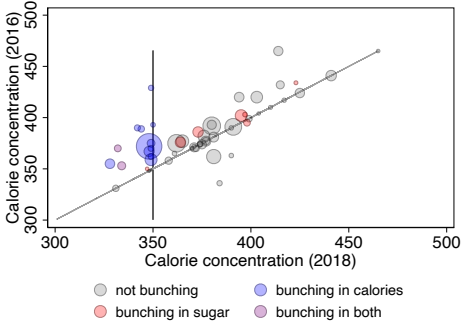
Appendix: Changes in nutritional content

- Changes in nutritional content by product



(a) Sugar



(b) Calories

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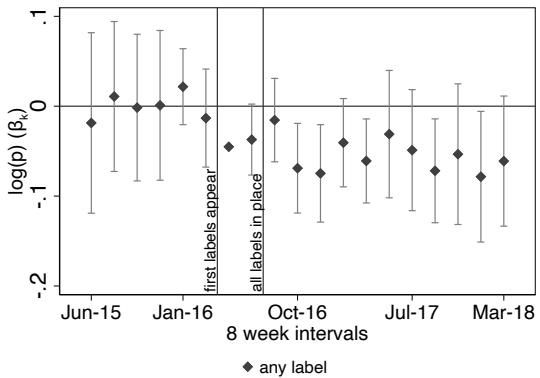
Appendix: Supply side - changes in prices

- Unlabeled products increased price relative to labeled ones
- Mix between: responses to changes in demand + increase in production costs



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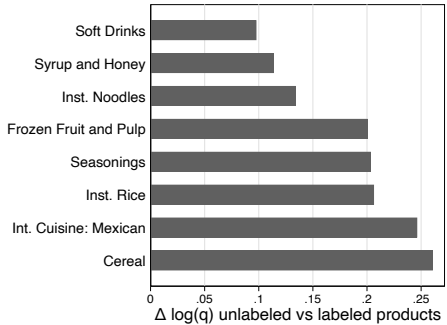
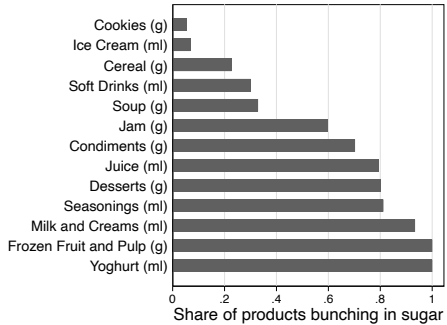
Appendix: Other categories



(a) Changes in equilibrium quantities



(b) Product reformulation

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Model: Supply

- Products are characterized by their invariant average taste level $\bar{\delta}_j$
- There is a production technology that determines a product's average taste that depends on the nutritional content w and other inputs m, and is given by $\delta_j(w, m)$
- In each period, firms choose prices and nutritional content to maximize profits
- There are constant marginal costs, that are increasing in nutritional content w and other inputs m

$$c(w, m) = p_w w + p_m m$$

Model: Supply

- Firm's problem:

$$\max_{\{p_{jt}, w_{jt}, m_{jt}\}_{j \in \Im_j}} \quad \sum_{j \in \Im_j} (p_{jt} - c(w_{jt}, m_{jt})) \cdot s_{jt}(\mathbf{p_t}, \mathbb{E}[\mathbf{w_t}])$$

$$\text{s.t.} \quad \delta_j(w_{jt}, m_{jt}) = \bar{\delta}_j \quad \forall j \in \Im_j$$

Model: Supply

- We can rewrite the problem as:

$$\max_{\{p_{jt}, w_{jt}\}_{j \in \Im_j}} \sum_{j \in \Im_j} (p_{jt} - c_{jt}(w_{jt})) \cdot s_{jt}(\mathbf{p_t}, \mathbb{E}[\mathbf{w_t}])$$

where $c_{jt}(w) = p_w w + p_m m_j(w; \bar{\delta}_j)$

Model: Supply

- We can rewrite the problem as:

$$\max_{\{p_{jt}, w_{jt}\}_{j \in \Im_j}} \sum_{j \in \Im_j} (p_{jt} - c_{jt}(w_{jt})) \cdot s_{jt}(\mathbf{p_t}, \mathbb{E}[\mathbf{w_t}])$$

  where $c_{jt}(w) = p_w w + p_m m_j(w; \bar{\delta}_j)$

- Note that costs are minimized by setting $w_{jt}^{min} \equiv \nu_j$ such that $\nabla m_j \left(\nu_j; \bar{\delta}_j\right) = -\frac{p_w}{p_m}$
  - We define ν_j as product j's "bliss point"

- We assume that the Hessian $\mathbf{H}\left(c_{jt}(w)\right) = \mathbf{H}\left(m_j\left(w; \bar{\delta}_j\right)\right)$ is positive semi-definite
  - True for a broad set of functions $\delta_j(w, m)$, including Cobb-Douglas

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Appendix: Perfect information

- Demand would be given by

$$\mathbb{E}[u_{ijt}] = \delta_{ijt} - \alpha p_{jt} - w_{jt}\phi$$

- Firm's problem:

$$\max_{\{p_{jt}, w_{jt}\}_{j \in \Im_j}} \sum_{j \in \Im_j} (p_{jt} - c_{jt}(w_{jt})) \cdot s_{jt}(\mathbf{p_t}, \mathbf{w_t})$$

- From the first order conditions, we have:

$$\begin{aligned} w_{jt}^* &= c_{w,jt}^{-1}\left(-\frac{\phi}{\alpha}\right) \\ p_{jt}^* &= c_{jt}(w_{jt}^*) + \Delta^{-1}\mathbf{s_t} \end{aligned}$$

where the (j,k) element of Δ is given by

$$\Delta_{jk} = \begin{cases} \frac{-\partial s_k}{\partial p_j} & \text{if } k \in \Im_j \\ 0 & \text{otherwise} \end{cases}$$

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Appendix: Equilibrium

- In the presence of labels, the equilibrium might no be unique

- We refine the equilibria by letting firms make decisions about nutritional content in a sequential way:
  - **Step 1**: firm 1 decides whether to bunch or not, given that no other firm is bunching
  - **Step 2**: firm 2 decides whether to bunch or not, given firm's 1 decision
  - **Step j**: ...
  - **Step J**: firm J decides whether to bunch or not, given all other firms' current decision
  - **Step J+1**: firm 1 decides whether she want to bunch or not given all other firms' current decision
  - **Step J+j**: ...
  - **Step 2J**: firm J decides whether to bunch or not, given all other firms' current decision
  - Go back to **Step J+1** and iterate until convergence to a fixed point

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Appendix: Toy model

- Let's walk through a simplified version of the model
  - Only one product and an outside option
  - We analyze the problem from the consumer's perspective

- Two counterfactuals:
  1. **Demand only**: We isolate demand responses only (i.e. prices and nutritional content are fixed)
  2. **Equilibrium**: firms respond changing prices and nutritional content

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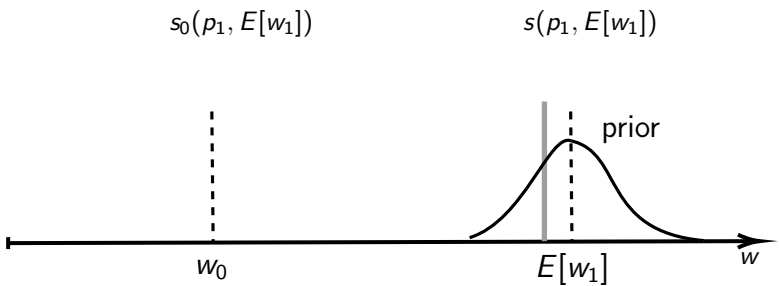
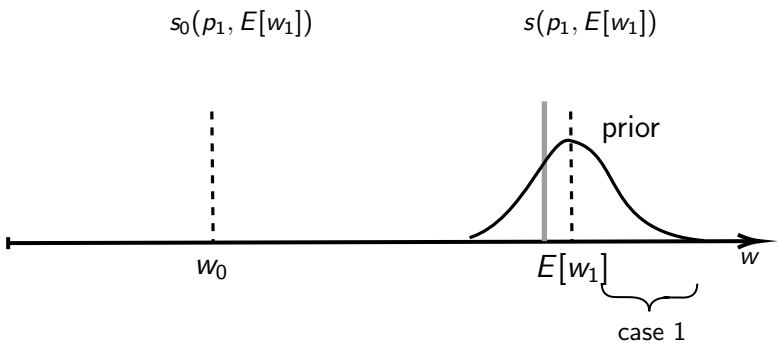
Appendix: Toy model

- Demand only:



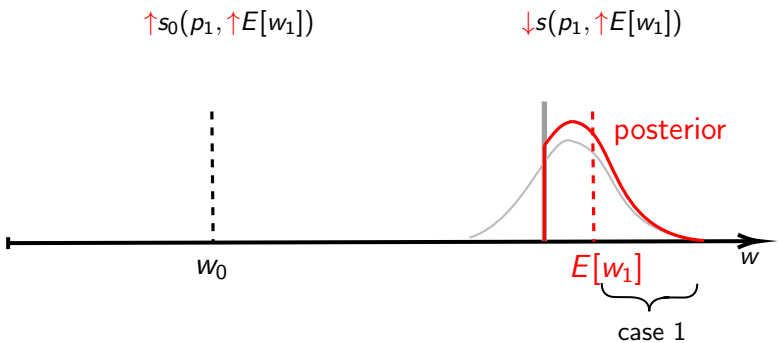
Appendix: Toy model

- Demand only:



Appendix: Toy model

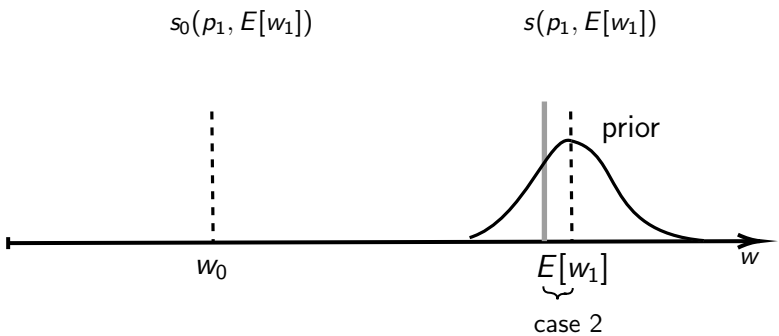
- Demand only:



↓E[sugar intake | case 1], ↑E[consumer surplus | case 1]

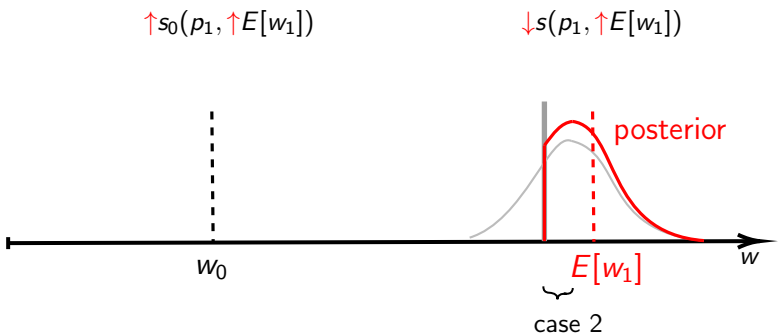
Appendix: Toy model

- Demand only:



Appendix: Toy model

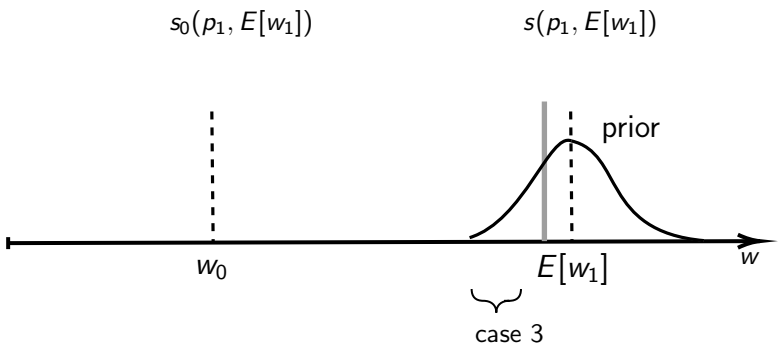
- Demand only:



↓E[sugar intake | case 2], ↓E[consumer surplus | case 2]

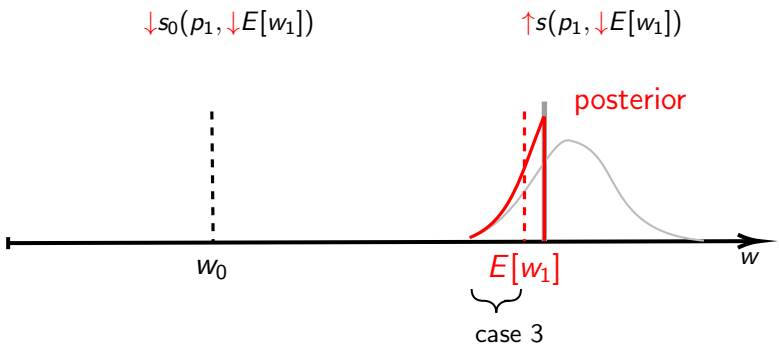
Appendix: Toy model

- Demand only:



Appendix: Toy model

- Demand only:



↑E[sugar intake | case 3], ↑E[consumer surplus | case 3]

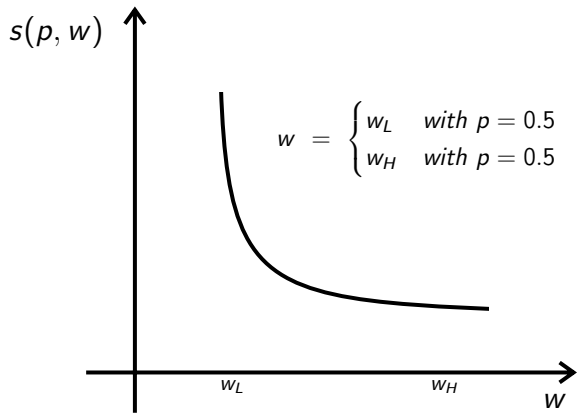
Appendix: Toy model

- Proposition 1: Consumer surplus under a labeling policy is greater or equal than under no labeling policy for any policy threshold.

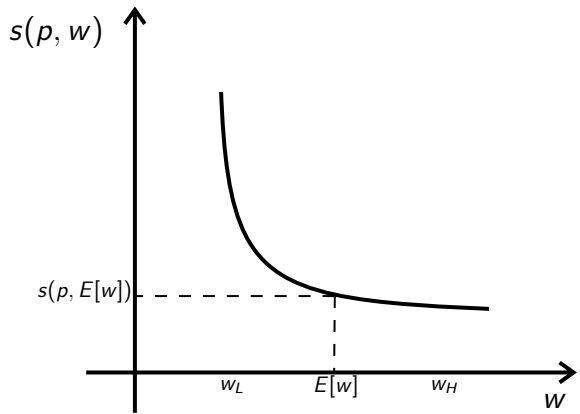
- Proposition 2: Expected sugar intake will decrease with a labeling policy regulatory if $\frac{s_{ww}(p,w)w}{2|s_w(p,w)|} < 1$, and will increase if $\frac{s_{ww}(p,w)w}{2|s_w(p,w)|} > 1$.
  - Between-product substitution:
    - If $s_{ww}(p,w) > 0$: $E[s(p,w)]$ increases with more information ($\uparrow$ sugar intake)
    - If $s_{ww}(p,w) < 0$: $E[s(p,w)]$ decreases with more information ($\downarrow$ sugar intake)
  - Within-product between-states-of-the-world substitution:
    - $s(p,w)$ is ex-post relatively smaller when w is larger ($\downarrow$ sugar intake)

back

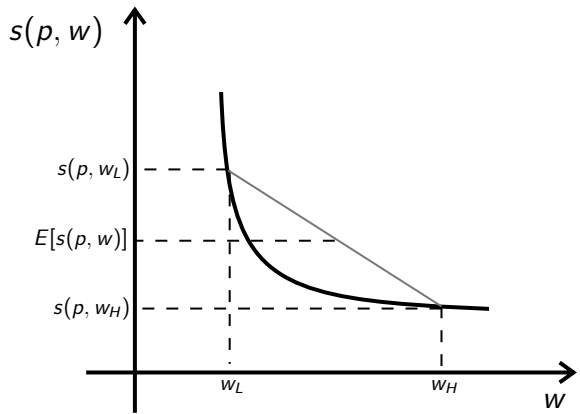
Appendix: Toy model



Appendix: Toy model



Appendix: Toy model



Counterfactuals: Toy model

- We now allow for firms to **bunch** at the threshold (keeping prices constant)

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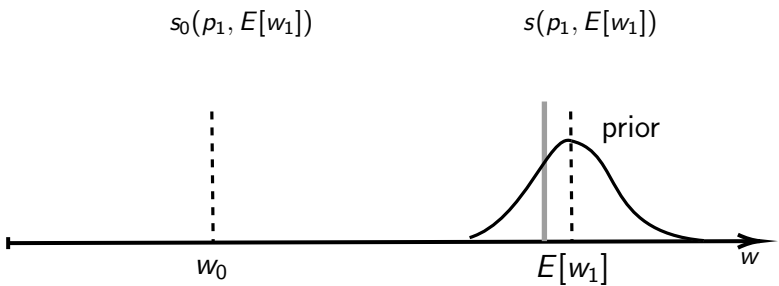
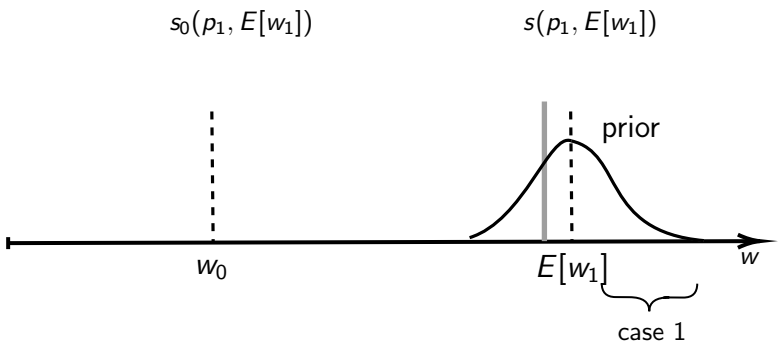
Model: Toy model

- Equilibrium:



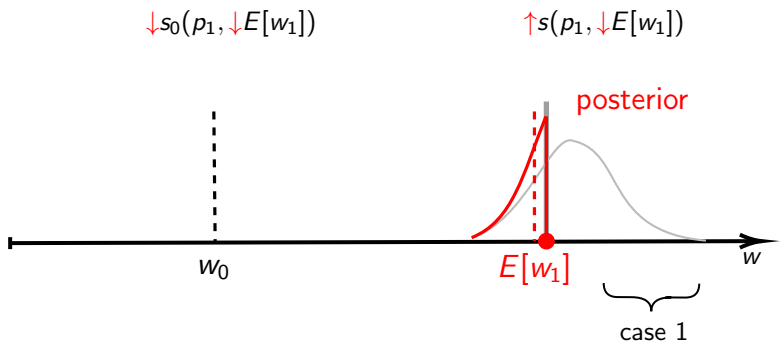
Model: Toy model

- Equilibrium:



Model: Toy model

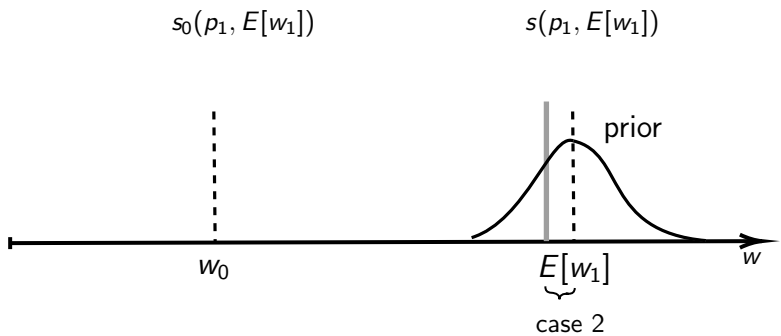
- Equilibrium:



?E[sugar intake | case 1], ?E[consumer surplus | case 1]

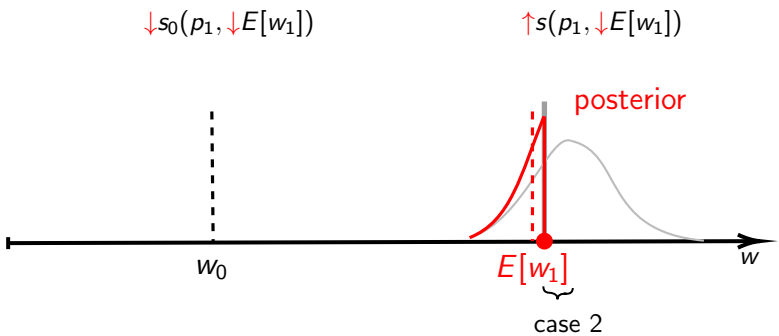
Model: Toy model

- Equilibrium:



Model: Toy model

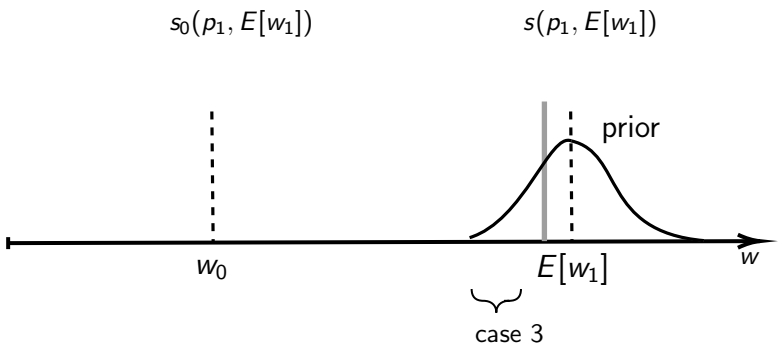
- Equilibrium:



?E[sugar intake | case 2], ?E[consumer surplus | case 2]

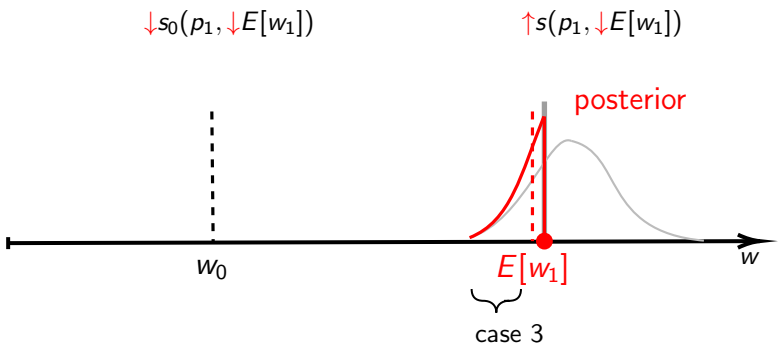
Model: Toy model

- Equilibrium:



Model: Toy model

- Equilibrium:



$\uparrow$E[sugar intake | case 3], $\uparrow$E[consumer surplus | case 3]

Model: Toy model

- Proposition 3: Consumer surplus under a labeling policy is greater or equal than under no labeling policy when firms are allowed to bunch but not to change prices.

- Proposition 4: Expected sugar intake will decrease with a labeling policy regulatory if $\frac{|s_w(p,w)|w}{s(p,w)} < 1$, and will increase if $\frac{|s_w(p,w)|w}{s(p,w)} > 1$, when firms are allowed to bunch but not to change prices.
  - Mechanical effect:
    - Product 1 becomes healthier on average ($\downarrow$ sugar intake)
  - Behavioral effect:
    - Consumers substitute from the outside option to product 1 ($\uparrow$ sugar intake)

- Proposition 5: When firms are allowed to change prices, labels increase product differentiation and expected consumer surplus can decrease under a labeling policy.

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Appendix: Alternative demand specifications

- Alternative specification:

$$\mathbb{E}_b[u_{ijt}] = -\alpha_b p_{jt} - \mathbb{E}_b[w_{jt}|L_{jt}]\phi_b + w_{jt}\gamma_b + \delta_{jb} + \delta_{T(t)b} + \delta_{S(t)b} + \xi_{jtb} + \epsilon_{ijt}$$

α_l	0.0548***	ϕ_l^s	0.2583**	ϕ_l^c	0.1316***	γ_l^s	0.0160	γ_l^c	0.0257
	(0.0142)		(0.1182)		(0.0417)		(0.0865)		(0.0285)
α_h	0.0503***	ϕ_h^s	0.2467**	ϕ_h^c	0.1122***	γ_h^s	-0.0405	γ_h^c	0.0489
	(0.0156)		(0.1152)		(0.0375)		(0.1332)		(0.0374)
ρ	0.9919***								
	(0.0046)								

Nutritional content is measured in 1000kcal and 1000gr of sugar per 100gr of cereal, and prices in dollars per 100gr of cereal. Standard errors are clustered at the market level.

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Appendix: Identification details

- We split consumers into two consumer-type bins $b \in \{\text{low SES}, \text{high SES}\}$
- The expected utility is given by:

$$\mathbb{E}_b[u_{ijt}] = -\alpha_b p_{jt} - \mathbb{E}_b[w_{jt}|L_{jt}]\phi_b + \delta_{jb} + \delta_{T(t)b} + \delta_{S(t)b} + \xi_{jtb} + \epsilon_{ijt}$$

  where $\epsilon_{ijt} \sim$ GEV (nested logit) with intra-nest correlation ρ (inside vs outside goods)

- $\mathbb{E}_b[\cdot]$ is defined over prior beliefs π_{jb}, that are given by a normal distribution $N(\mu_{jb}, \Sigma_{jb})$
- Bayesian consumers update posteriors taking the labels as a binary signal

$$\begin{aligned} \mathbb{E}_b[w_{jt}|L_{jt} = \text{yes}] &= \mathbb{E}_b[w_{jt}|w_{jt} > \bar{w}] \\ \mathbb{E}_b[w_{jt}|L_{jt} = \text{no}] &= \mathbb{E}_b[w_{jt}|w_{jt} \leq \bar{w}] \end{aligned}$$

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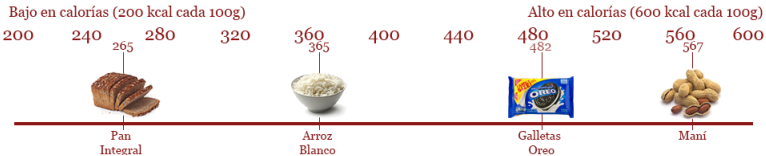
Appendix: Identification of μ_{jb}

- Survey answers inform about relative distance between μ_{jb} and μ_{kb}
- We set $\mu_{jb} = \tilde{\mu}_{jb} + \mu$, where $\tilde{\mu}_{jb}$ comes from survey and μ is a free parameter
- Relative distance between products is robust to survey designs.



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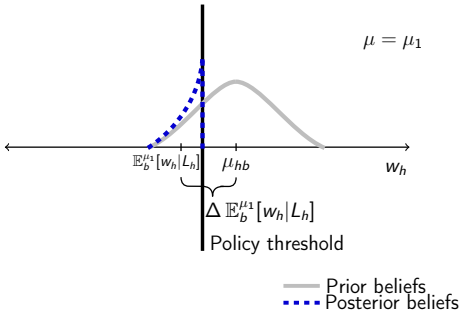
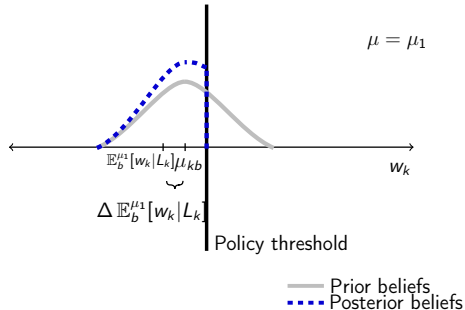
Appendix: Identification of μ_{jb}

- Change in beliefs when $\mu = \mu_1$



(a) Change in beliefs for product h

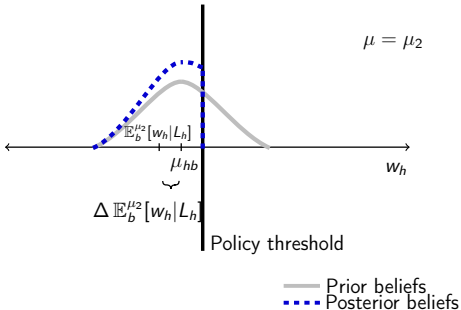


(b) Change in beliefs for product k

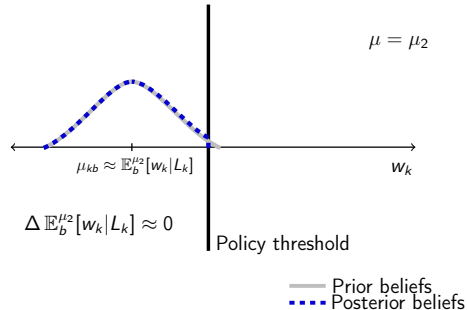
back

Appendix: Identification of μ_{jb}

- Change in beliefs when $\mu = \mu_2 < \mu_1$



(a) Change in beliefs for product h



(b) Change in beliefs for product k

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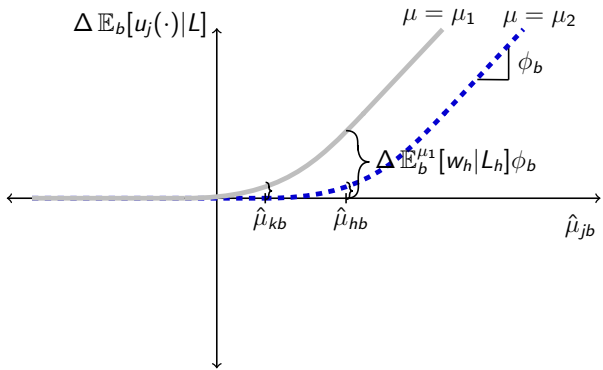
Appendix: Identification of μ_{jb}

- Model gives different predictions for different values of μ:



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Appendix: Estimation results

α_l	0.0548^{***}	ϕ_l^s	0.2801^{***}	ϕ_l^c	0.1350^{***}
	(0.0142)		(0.1087)		(0.0431)
α_h	0.0503^{***}	ϕ_h^s	0.2570^{**}	ϕ_h^c	0.1213^{***}
	(0.0156)		(0.1029)		(0.0383)
ρ	0.9919^{***}				
	(0.0046)				

Notes: Nutritional content is measured in 1000kcal and 1000gr of sugar per 100gr of cereal, and prices in dollars per 100gr of cereal. Standard errors are clustered at the market level.

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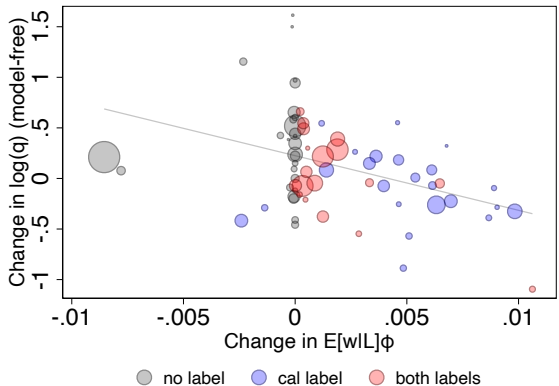
Model fit: Demand side

- x-axis: estimated change in beliefs about product healthiness
- y-axis: change in demand coming from diff-in-diff were we interact post with product fixed effects



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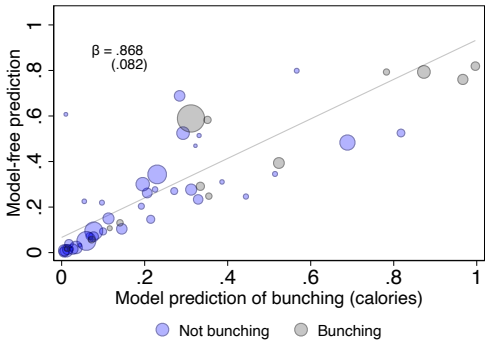
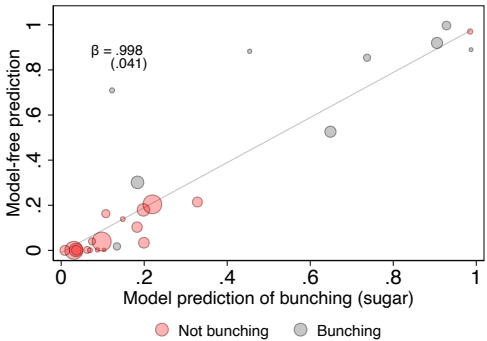
Model fit: Supply side

- x-axis: probability of bunching according to the model
- y-axis: probability of bunching estimated with a logit against a second order polinomial of nutritional content and prior beliefs' first moments $P(w_j, \mu_{jb})$





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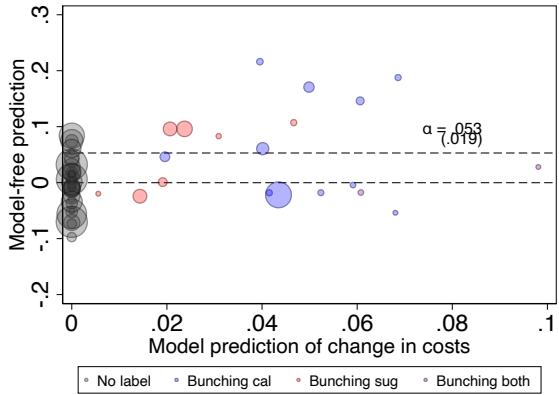
Model fit: Supply side

- x-axis: change in marginal cost due to bunching coming from the model
- y-axis: change in marginal costs derived from FOC and estimated with a diff-in-diff



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Appendix: Effects decomposition

- Total consumer surplus is given by

$$
\begin{aligned}
CS &= \sum_j \left\{ \int_{i:j \succeq_i k} u_{ijt} di \right\} \\
&= \sum_j \left\{ \int_{i:j \succeq_i k} \delta_{ijt} di - (\alpha p_{jt} + w_{jt}\phi) s_{jt} \right\}
\end{aligned}
$$

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Appendix: Effects decomposition

- The change in consumer surplus is given by

$$CS - CS(NP) = \sum_j \left\{ \underbrace{\int_{\substack{i:j\succeq_i k \\ i:j\not\succeq_i^{NP} k}} \delta_{ijt}\, di - (\alpha p_{jt} + w_{jt}\phi)\Delta s_{jt}}_{\text{demand effects}} \quad \underbrace{-(\alpha \Delta p_{jt} + \Delta w_{jt}\phi) s_{jt}^{NP}}_{\text{supply effects}} \right\}$$

where $\Delta x = x - x^{NP}$

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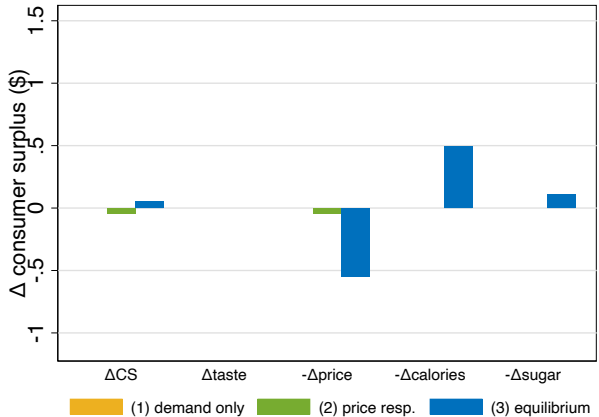
Appendix: Supply effects



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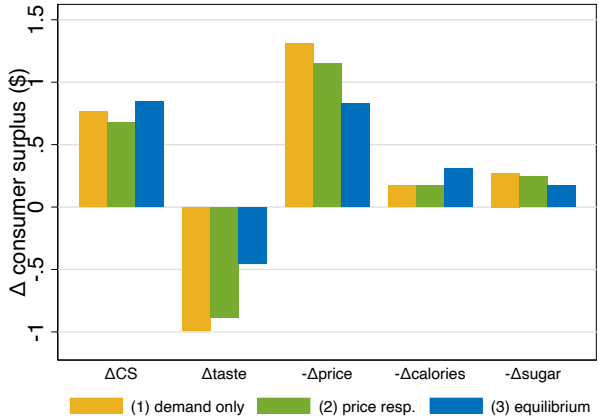
Appendix: Demand effects



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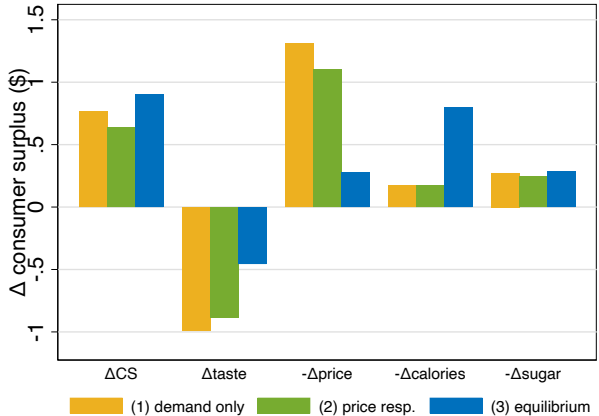
Appendix: Net effect



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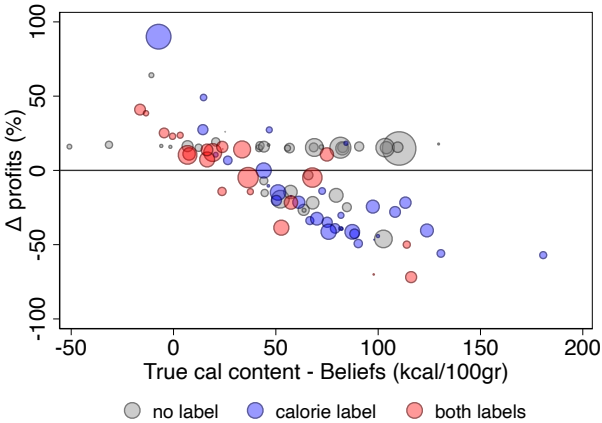
Appendix: Profits from firms



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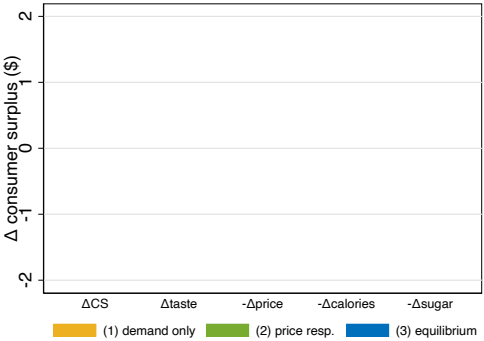
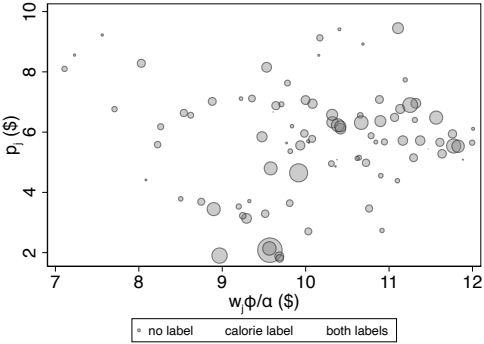
Appendix: No intervention

- Demand is driven by taste, prices, and beliefs about nutritional content



(a) Change in consumer surplus



(b) Demand for products

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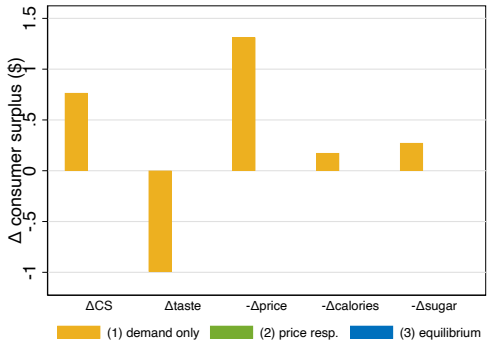
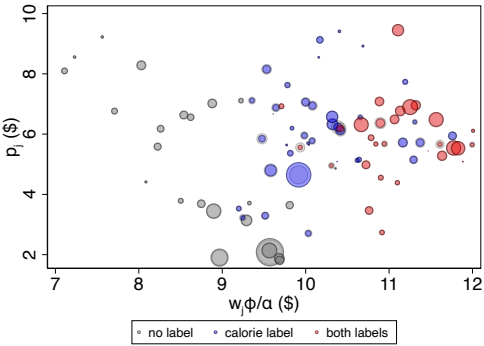
Appendix: Demand only

- Labels shift demand towards healthier and cheaper products



(a) Change in consumer surplus



(b) Demand for products

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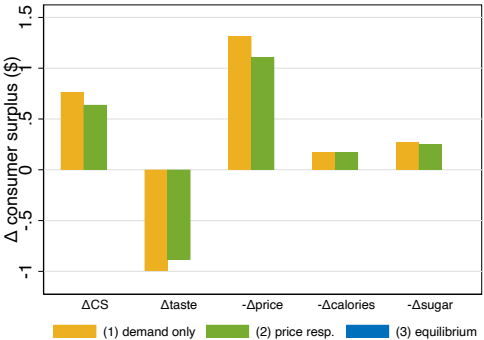
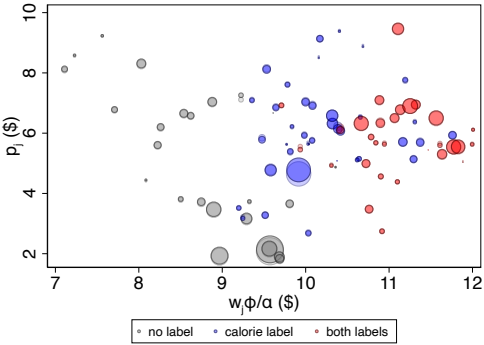
Appendix: No bunching

- Firms respond by increasing (decreasing) prices of unlabeled (labeled) products



(a) Change in consumer surplus



(b) Demand for products

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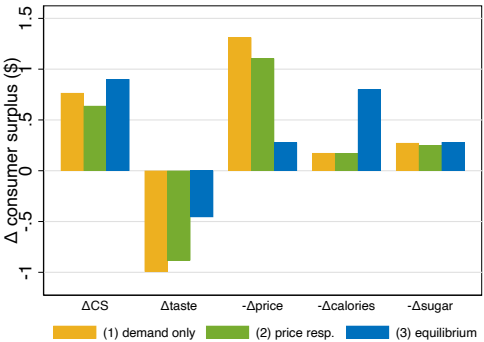
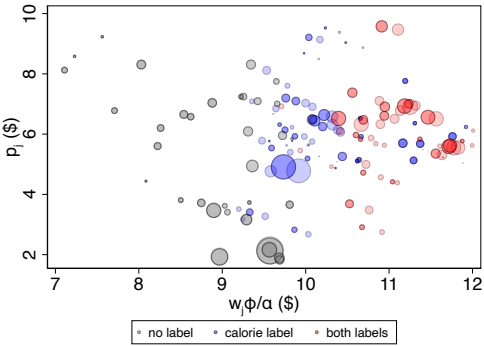
Appendix: Equilibrium

- Firms respond by reducing nutritional content but increasing prices



(a) Change in consumer surplus



(b) Demand for products

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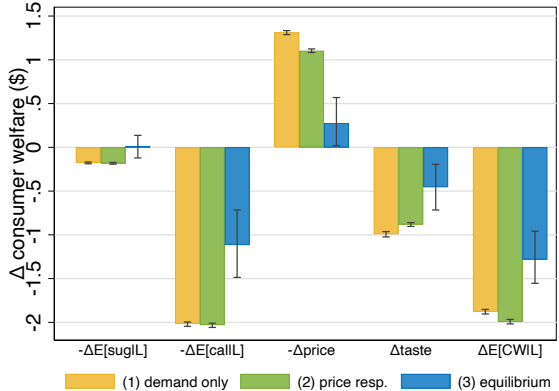
Appendix: Consumer surplus under subjective beliefs



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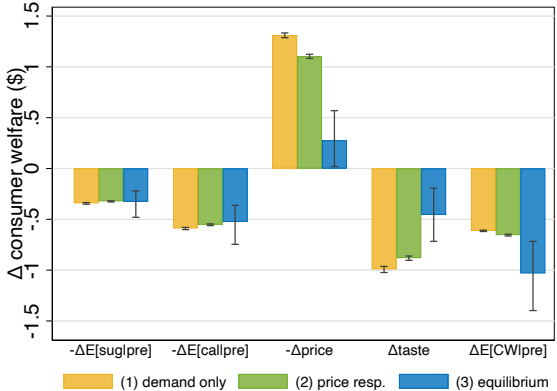
Appendix: Consumer surplus under pre-policy beliefs



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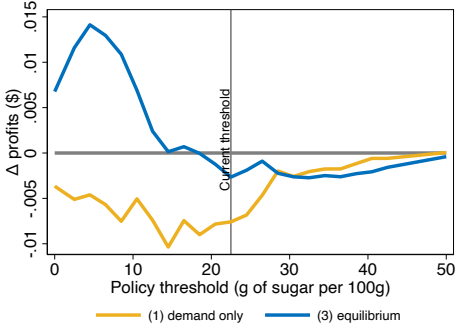
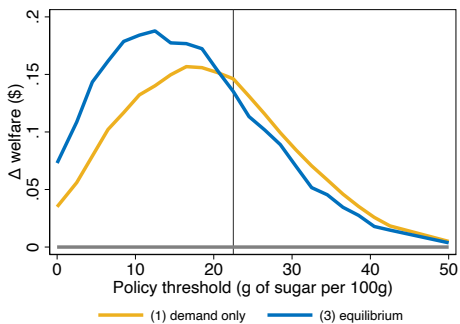
Appendix: Optimal threshold

- Firms can benefit from bunching



(a) Changes in profits



(b) Changes in welfare

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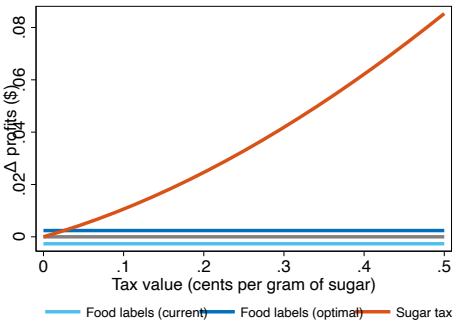
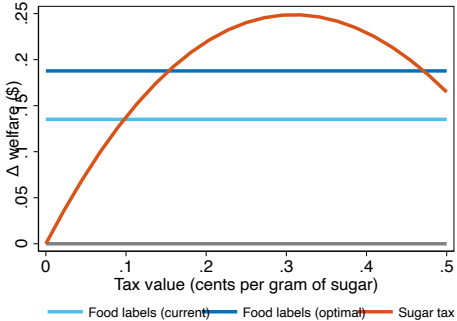
Appendix: Sugar tax

- Firms increase profits under sugar taxes



(a) Changes in profits



(b) Changes in welfare

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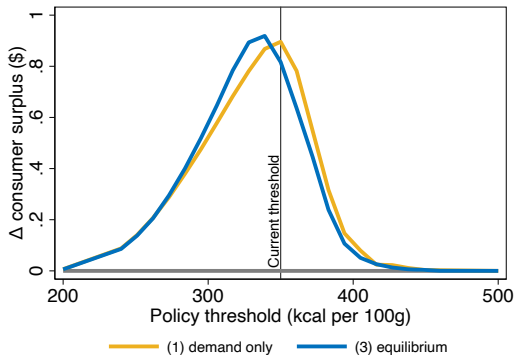
Appendix: Optimal threshold

- We compare the effects of the policy under different thresholds
  - Optimal threshold without supplier responses: maximize labels informativeness
  - Taking supply responses into account: optimal threshold pushed to the left



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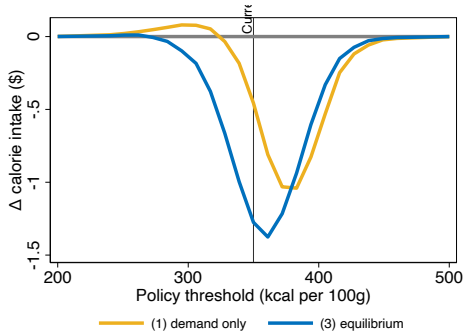
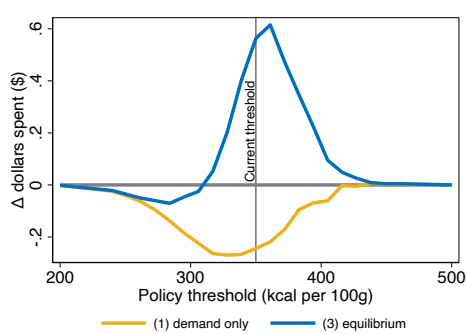
Appendix: Optimal threshold

- Supplier responses work in favor of the reduction of sugar intake
  - It comes at the cost of higher prices to consumers



(a) Changes in calorie intake



(b) Changes in average price

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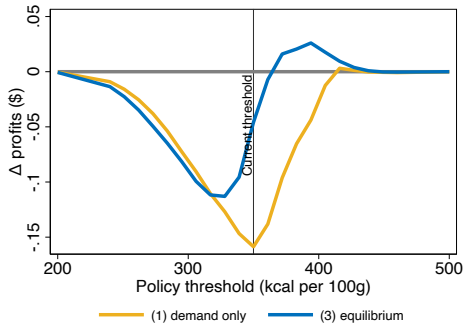
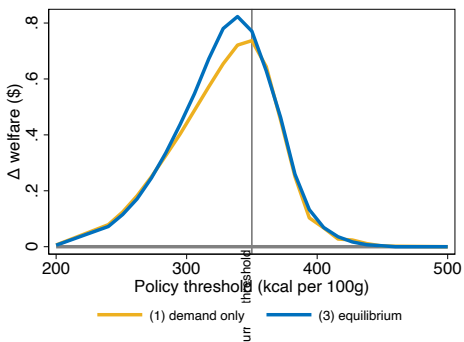
Appendix: Optimal threshold

- Firms can benefit from bunching



(a) Changes in profits

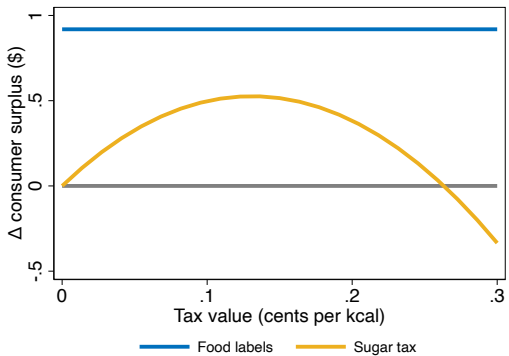


(b) Changes in welfare

back

Appendix: Calorie tax

- We compare the food labeling policy to alternative sugar taxes
  - Soda sugar taxes in the US are equivalent to ¢0.3 per gram of sugar



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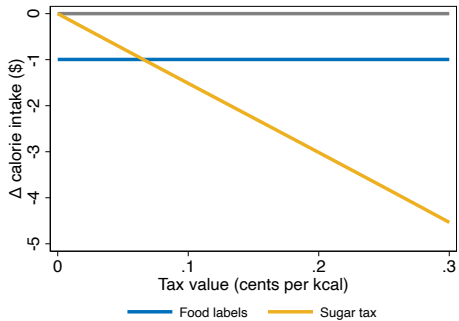
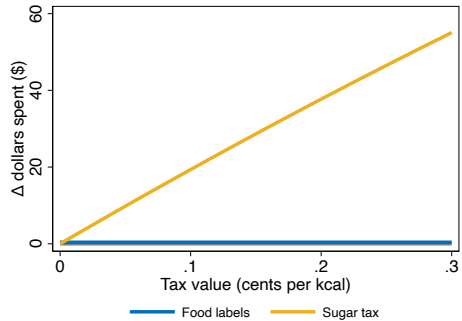
Appendix: Calorie tax

- We compare the food labeling policy to alternative sugar taxes
  - Soda sugar taxes in the US are equivalent to ¢0.3 per gram of sugar



(a) Changes in calorie intake



(b) Changes in average price

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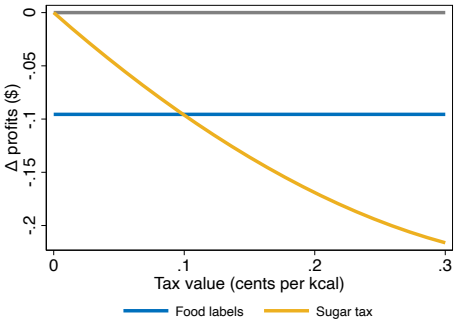
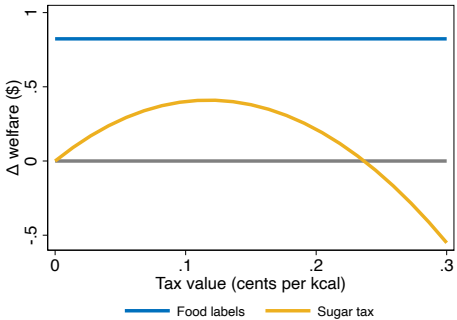
Appendix: Sugar tax

- Firms increase profits under calorie taxes



(a) Changes in profits



(b) Changes in welfare

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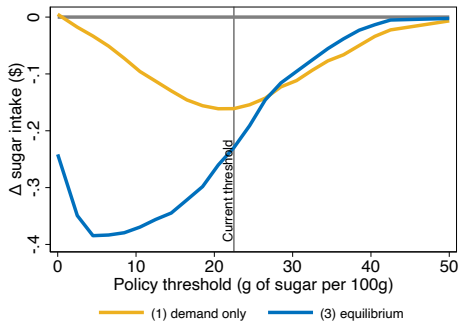
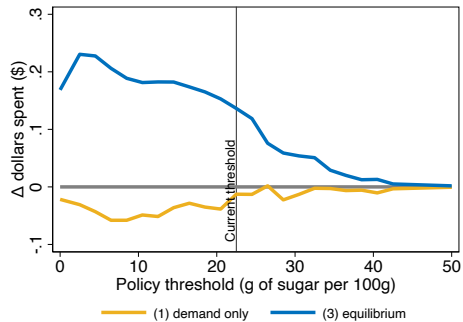
Appendix: Optimal threshold

- Supplier responses work in favor of the reduction of sugar intake
  - It comes at the cost of higher prices to consumers



(a) Changes in sugar intake



(b) Changes in dollars spent

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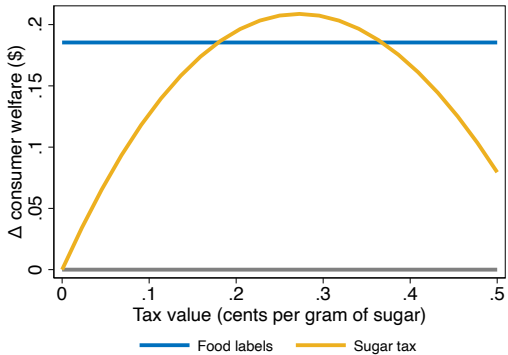
Appendix: Sugar tax

- Soda sugar taxes in the US are equivalent to 0.3¢ per gram of sugar



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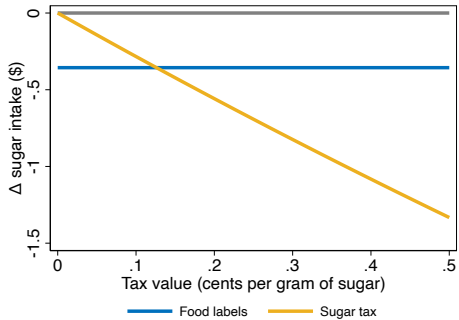
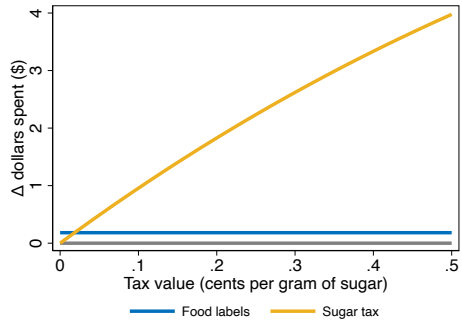
Appendix: Sugar tax

- Reductions in sugar intake are larger, but also are changes in prices



(a) Changes in sugar intake



(b) Changes in dollars spent

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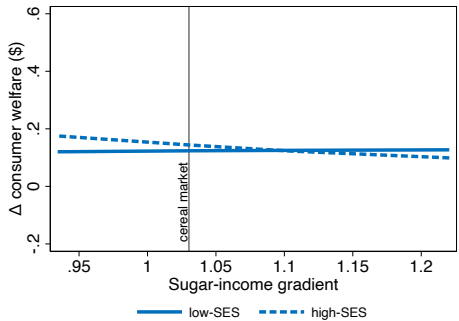
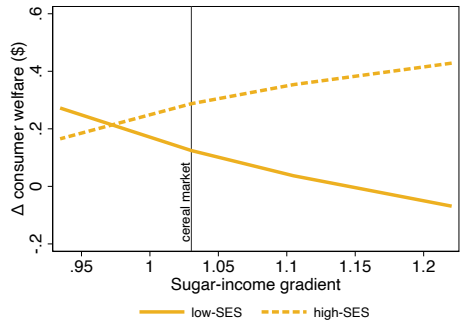
Appendix: Sugar-income gradient

- If low-SES consumers prefer high-in-sugar products more, taxes will disproportionally charge them more



(a) Food labels



(b) Sugar taxes

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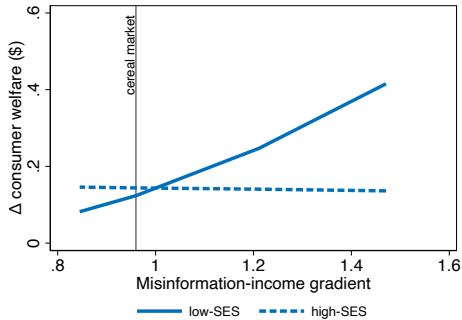
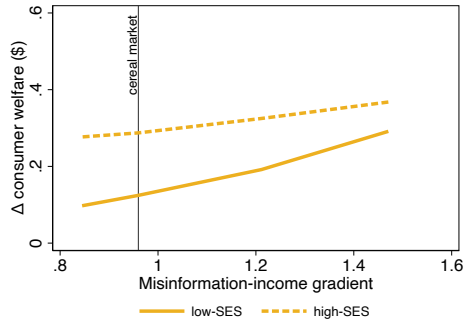
Appendix: Misinformation-income gradient

- If low-SES consumers are less informed, food labels will be better targeted



(a) Food labels



(b) Sugar taxes

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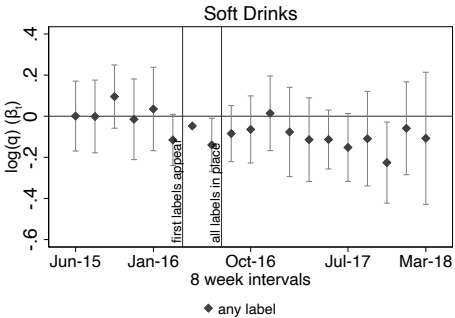
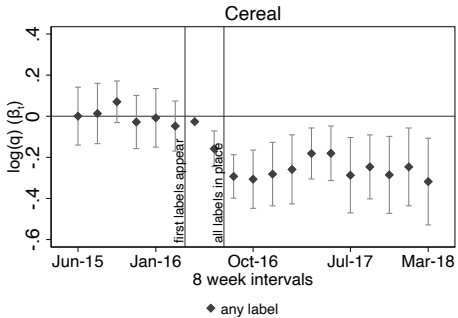
Appendix: Soft drinks vs. cereal



(a) Soft drinks



(b) Cereal

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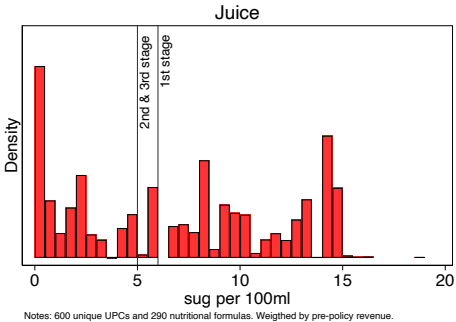
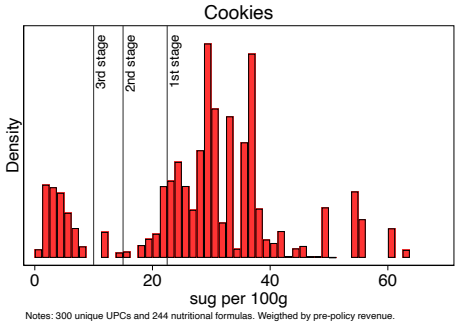
Appendix: Liquids vs. solids



Notes: 600 unique UPCs and 290 nutritional formulas. Weigthed by pre-policy revenue.

(a) Juice (2016)



Notes: 300 unique UPCs and 244 nutritional formulas. Weigthed by pre-policy revenue.

(b) Cookies (2016)

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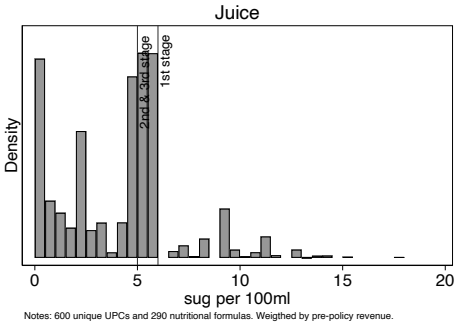
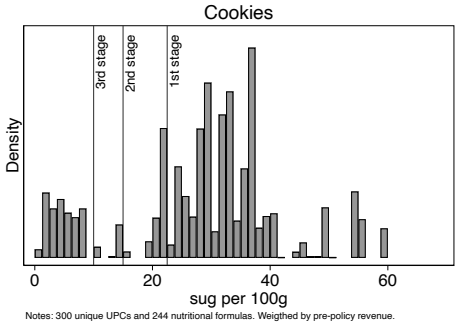
Appendix: Liquids vs. solids



(a) Juice (2018)



(b) Cookies (2018)

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Demand estimation

- We split consumers into two consumer-type bins $b \in \{\text{low SES}, \text{high SES}\}$
- The expected utility is given by:

$$\mathbb{E}_b[u_{ijt}] = -\alpha_b p_{jt} - \mathbb{E}_b[w_{jt}|L_{jt}]'\phi_b + \delta_{jb} + \delta_{T(t)b} + \delta_{S(t)b} + \xi_{jtb} + \epsilon_{ijt}$$

  where $\epsilon_{ijt} \sim$ GEV (nested logit) with intra-nest correlation ρ (inside vs outside goods)

- We exploit the following variation to identify (α_b, ϕ_b, ρ)
  - α_b: variation in prices after controlling for product, period, and store fixed effects
  - ϕ_b: variation in labeling status and prior beliefs across and within products
  - ρ: variation in products' availability across markets
- We combine the beliefs' survey with purchasing decisions to estimate $\mathbb{E}_b[w_{jt}|L_{jt}]$

alternative specifications identification details

Demand estimation: Results

- The average consumer buys 5.2kg of cereal, spending $25 a year
- The average own-price elasticity is -3.66
- Keeping taste constant, an average consumer is willing to:
  - pay 11% extra ($3.2 a year) to reduce sugar or calorie content in 1sd
- Original Cheerios have 2sd less sugar than Honey Nut Cheerios

parameter estimates model fit back

Supply estimation

- Marginal cost is given by $c_{jt}(w)$, where $\nabla c_{jt}(\nu_j) = 0$
- We use a second order Taylor approximation around ν_j

$$c_{jt}(w) = \bar{c}_{jt} + (w - \nu_j)'\Lambda_j(w - \nu_j)$$

- From the first order conditions we can recover $c_{jt}(w_{jt})$ and $\nu_j = w_{j,pre}$
- From equilibrium, we find cost at which firms are indifferent between bunching and not
- With additional parametric assumptions we estimate Λ_j by maximum likelihood

Supply estimation: Results

- Products bunching in sugar decreased sugar content in 0.6sd (8gr/100gr)
  - Marginal cost increased 12.4% on average (6.8% of final price)

- Products bunching in calories decreased calorie content 1sd (25kcal/100gr)
  - Marginal cost increased 15.3% on average (8.3% of final price)

model fit back

Related literature

1. Consumer choice in settings of imperfect information
   - Hastings and Weinstein (2008), Abaluck and Gruber (2011), Woodward and Hall (2012), Allcott (2013), Handel and Kolstad (2015), Allcott and Knittel (2019)

   → Consumers beliefs are crucial for policy effectiveness

Related literature

1. Consumer choice in settings of imperfect information

2. Quality disclosure and certification
   - Dranove et al. (2003), Jin and Leslie (2003), Greenstone et al. (2006), Dranove and Jin (2010), Roe et al. (2014), Ito and Sallee (2018), Houde (2018)

   → Framework to study equilibrium effects of mandatory disclosure policies

Related literature

1. Consumer choice in settings of imperfect information

2. Quality disclosure and certification

3. Policies to improve consumers' nutritional intake
   - Food labels: Sacks et al. (2009), Kiesel and Villas-Boas (2013), Zhu et al. (2015), Taillie et al., (2020), Araya et al. (2020), Pachali et al. (2020), Alé-Chilet and Moshary (2020)
   - Information on Menus: Elbel et al. (2009), Wisdom et al. (2010), Bollinger et al. (2011), Finkelstein et al. (2011)
   - Advertising: Ippolito and Mathios (1990,1995), Dubois et al. (2017a)
   - Taxes: Dubois et al. (2017b), Allcott et al. (2019), Aguilar et al. (2020)

   → (i) Equilibrium framework, (ii) Role of beliefs (iii) Policy counterfactuals