Product Reformulation: A Suitable Substitute?

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Motivation

- Different motivators for product innovation
  - Supply-side: Cost shocks, regulations, competitive differentiation
  - Demand-side: Shifts in consumer preferences (e.g., healthy choices)

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- Two strategies firms use for product innovation
  - Introducing *new* products
  - Modifying *existing* products

    $\Rightarrow$ **Reformulation**: modifying the ingredients or composition of an existing product

What is product reformulation?

Example: Cocoa Pebbles oil substitution

Pre-Reformulation

Ingredients: Rice, Sugar, Hydrogenated Vegetable Oil (Coconut and Palm Kernel Oils), Cocoa (Processed with Alkali), Salt, Caramel Color, Natural and Artificial Flavor

Post-Reformulation

Ingredients: Rice, Sugar, **Canola Oil**, Cocoa (Processed with Alkali), Salt, Caramel Color, Natural and Artificial Flavor

Impact on product quality and differentiation

- Small ingredient changes $\rightarrow$ non-obvious changes in nutritional quality

	Nutrient	Pre	Post
↑	Calories	120	140
↑	Total Sugars	10g	12g
↑	Sodium	170mg	220mg
↑	Protein	1g	2g
↑	Vitamin A	15% DV	50% DV
↓	Saturated Fat	1g	0g
↓	Iron	25% DV	15% DV

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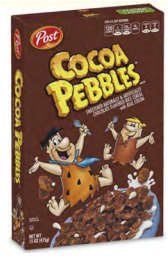

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A broader trend or a strategy firms use to differentiate?

Research questions

1. How prevalent is product reformulation, and what tactics do firms employ?

2. What impact does reformulation have on product quality and differentiation?
   - Quality: Improve or reduce nutritional quality?
   - Differentiation: Converge or diverge in nutritional quality?

3. How do consumers respond to reformulated products?
   - Superior product: $\uparrow$ unit sales $\rightarrow$ profit gain and new customer acquisition
   - Suitable substitute: $\simeq$ unit sales $\rightarrow$ adapt to supply shocks or policy w/o profit loss
   - Inferior alternative: $\downarrow$ unit sales $\rightarrow$ profit loss and reputation damage

Data

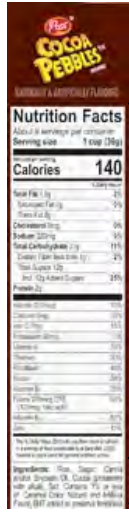
- **Product attributes**: USDA Global Branded Food Products (2018 – 2023)
  - Panel of products in food & beverage industries
  - Ingredient list, nutrient content, and modified date
- **Store sales and prices**: NielsenIQ Store Scanner Data (2018 – 2023)
  - Weekly-store-UPC scanner data
- **Sample construction**:
  - Final sample: 225 product categories
  - Branded food & beverage products
  - Excludes alcoholic beverages, fresh produce & meat

Identifying and documenting reformulation

Reformulation : Any change in a product's ingredient list or nutrient value.

- Ingredient list: Ordered by descending weight
- Nutrient value: Nutrient amount per 100g

		Nutrient Value	
		No change (0)	Change (1)
Ingredient List	No change (0)	0,0	0,1
	Change (1)	1,0	1,1



Reformulation is prevalent and involves multiple tactics

Reformulation is widespread across categories and time

- Observed in 99% (223) of food and beverage categories
- Market share: 1.7% (UPCs), 25.8% (units sold)
- Persistent across entire sample period (2018–2023)

We categorize tactics based on modifications to ingredients and compositions

Type of Change	Tactic	Example
Ingredient	Add new ingredient	Adds a preservative
	Remove ingredient	Removes a sweetener
	Substitute ingredient	Replaces syrup with honey
Composition	Adjust amount	Dilution
	Increase flexibility	Allows multiple types of sugar
	Decrease flexibility	Restricts to single type of sugar

Measuring the impact of reformulation on product quality

- **Ingredient Quality**
  - Organic content: No consistent trend toward more organic
  - Planned analysis: High-fructose corn syrup (HFCS) and processing-level

- **Nutrient Quality (NRF Index)**

$$NRF(100g) = \sum \left(\frac{\text{Beneficial nutrients}}{DV} \right) - \sum \left(\frac{\text{Limiting nutrients}}{UL} \right)$$

  - Beneficial: Protein, Fiber, Calcium, Iron
  - Limiting: Sugar, Saturated Fat, Sodium
  - Higher NRF $\Rightarrow$ More nutrient-dense product

How does reformulation reshape nutritional quality distribution within a category?

Possible scenarios

Scenario	Nutritional Change	Distributional Change
Shift right	$\uparrow$ Nutritional quality	**Mean** $\uparrow$
Shift left	$\downarrow$ Nutritional quality	**Mean** $\downarrow$
No Shift	$\simeq$ Nutritional quality	**Mean** $\simeq$

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- **Finding**: *Average nutrient* changes close to zero for most categories Average
  - No statistically significant change in 74% of categories
  - Likely due to offsetting $\uparrow$ and $\downarrow$ among products

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- **Finding**: *Average nutrient* changes close to zero for most categories Average
  - No statistically significant change in 74% of categories
  - Likely due to offsetting $\uparrow$ and $\downarrow$ among products
- **But, *absolute nutrient* changes moderate** ($5 - 15\%$)

How does reformulation affect product differentiation?

Finding: Average nutritional changes $\simeq 0$, but absolute changes are moderate in most categories.

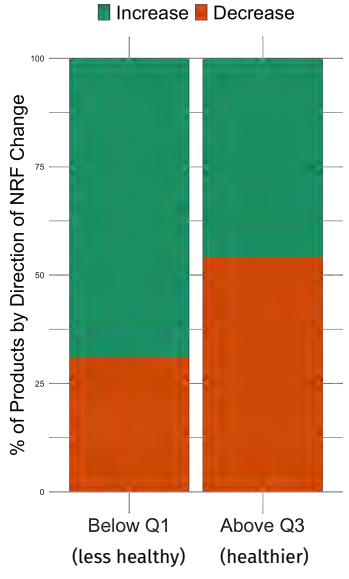
Question: Does reformulation reflect a category-wide trend, or do firms use it to differentiate?

Possible Scenarios

Scenario	Nutritional Change	Distributional Change	
Convergence	healthier ↓, unhealthier ↑	**Variation** ↓	Trend
Divergence	healthier ↑, unhealthier ↓	**Variation** ↑	Differentiate

Do healthier products improve while unhealthier products worsen?

- Case study: Cereal
  - NRF variance $\downarrow$ (Std: 44 $\rightarrow$ 38)
  - Lower-NRF $\uparrow$ Higher-NRF $\downarrow$
  - **Finding**: Convergence in NRF



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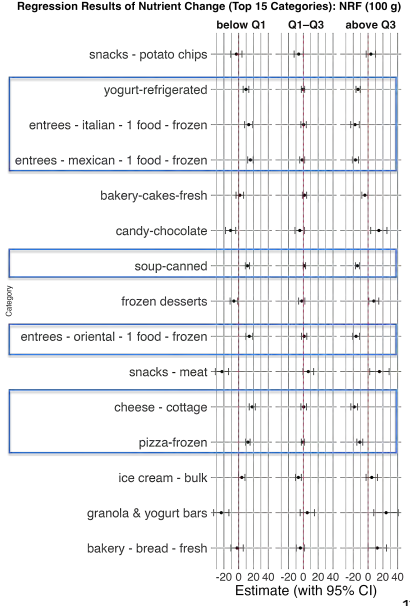
- Across all categories:
  - **Finding**: 58% of categories show convergence in NRF

		Above Q3 (healthier)	
		Decrease	Increase
Below Q1 (less healthy)	Decrease	7.5%	27%
	Increase	58%	7.5%

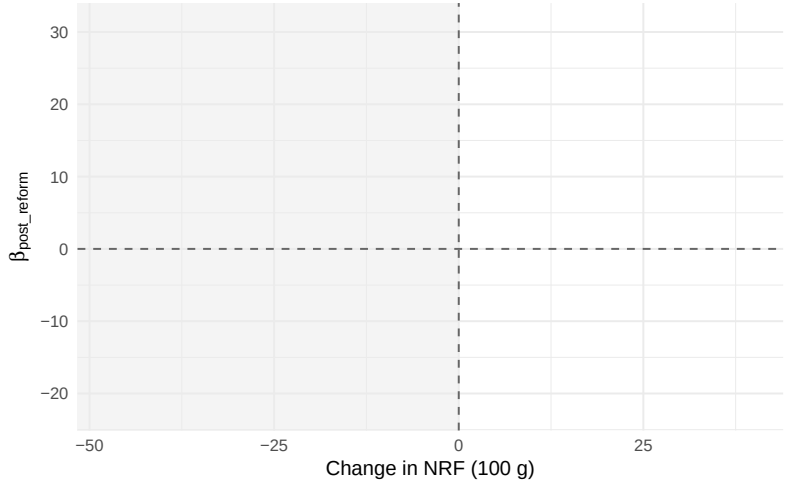


How do consumers respond to reformulation?

$$\log(q_{jst} + 1) = \beta_j \cdot \text{PostReform}_{jt} + \alpha_j \cdot \log(p_{jst}) + \text{Store FE} + \text{Time FE} + \epsilon_{jst}$$

- **Data:** 1 year pre- and post-reform at product level
- **Finding:** Small demand response for most products
  - No statistically significant change in 73% of products
  - Close to zero (Median: 0.5% ↑)

Do consumers respond when nutritional quality declines?



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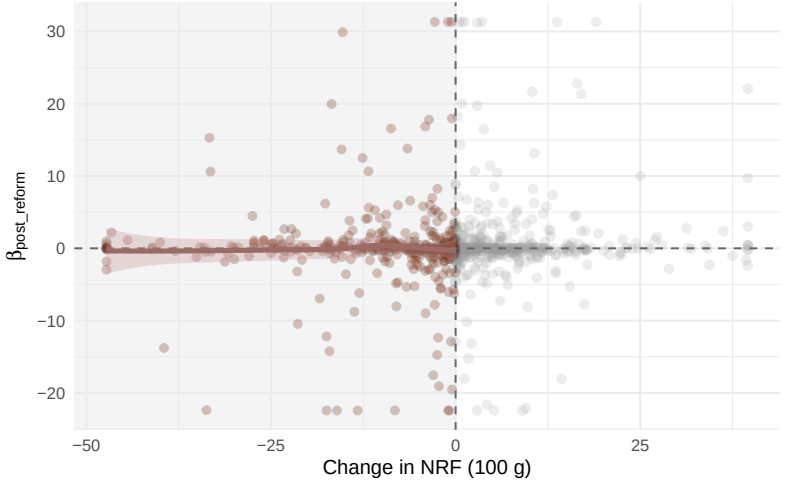

- **Finding**: Minimal demand response – even when nutritional quality declines

Summary and Next Steps

- **So far**:
  - Reformulation widely observed across categories and time
  - Nutritional quality converges after reformulation in most categories
  - Demand response minimal — even when nutritional quality declines

- **Next steps**:
  - Examine consumer level repeat purchase behavior to evaluate behavior post-purchase experience

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