# The Role of WIC in the U.S. Retail Infant Formula Market

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UF IFAS UNIVERSITY of FLORIDA
FOOD & RESOURCE ECONOMICS DEPARTMENT

1 Motivation

2 Background

3 Model

4 Key Insights

# 1.1 Motivation

- Infant formula is essential for children's healthy growth, especially when breastfeeding isn't feasible.
  - ⇒ Medical reasons or practical constraints.
  - ⇒ About 75% of children in the U.S. were partially or fully fed with formula (CDC, 2022).
- WIC is an influential agent in the U.S. infant formula market.
  - ⇒ WIC partners with a subset of offline retailers for food benefit distribution.
  - ⇒ WIC consumers can obtain infant formula for free at WIC-authorized stores.
  - ⇒ Over 50% of U.S. infant formula sales are made through WIC.
- Limited knowledge of how WIC's delivery system affects retail competition.

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  - ⇒ Over 50% of U.S. infant formula sales are made through WIC.
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## 1.2 Research Objectives

1. Study the impact of WIC's delivery system on retail competition.

   ⇒ Three types: offline WIC-authorized retailers (W-retailers),
   offline non-authorized retailers (NW-retailers),
   online retailers (E-retailers).

2. Explore the potential of integrating e-commerce into WIC's delivery system.

   ⇒ In recent years, the USDA Food and Nutrition Service (FNS) has worked to expand online shopping access for WIC consumers.

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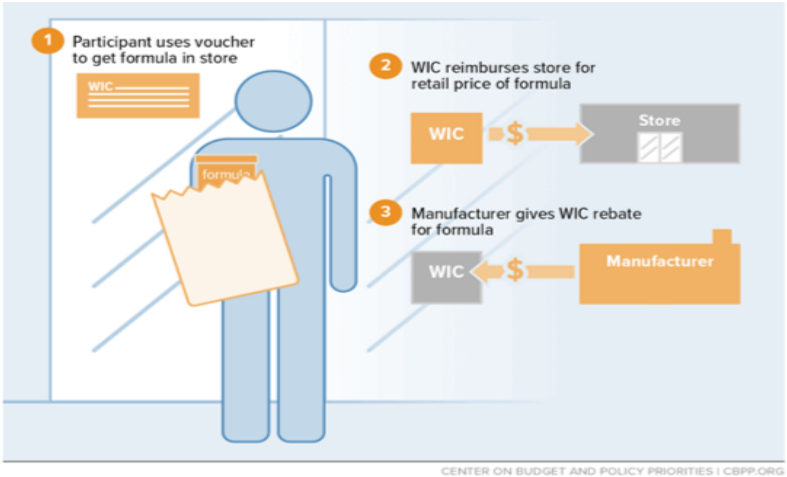
## 2.1 WIC's Food Delivery Systems

| Delivery Method | Mechanism | Notes |
|---|---|---|
| **1. Retail Food Delivery** | Purchase at WIC-authorized stores using vouchers or EBT cards. | The sole delivery system currently implemented nationwide. |
| **2. Direct Distribution** | Food packages picked up from central warehouses or clinics. | Used where vendor access is limited. |
| **3. Home Food Delivery** | Prepackaged food delivered to WIC participants' homes. | Designed for rural areas, disabled participants, or special cases. |

# 2.2 Retail Food Delivery



## 2.3 How Offline Retailers Get WIC-authorized?

- To apply for and maintain WIC authorization, retailers must follow these requirements.
  1. Adhere to non-price-discrimination policies.
  2. Comply with WIC price regulations.
     $\Rightarrow$ However, the price ceilings are set high to accommodate unusual circumstances.
  3. Offer a variety of WIC-approved products.
  4. Meet the minimum stocking requirements.

- WIC authorization is capped.
  $\Rightarrow$ Authorization also depends on local needs and administrative capacity.

## 2.4 Data Limitation

Why Not an Empirical Study?

| Required Data | Available? |
|---|---|
| **Market Data** | |
| Offline retail prices and aggregate sales | ✓ |
| Online (Amazon) prices and aggregate sales | × |
| Retail marginal costs or mark-ups | × |
| **WIC Data** | |
| Information on WIC store authorization | × |
| Store-level share of WIC redemptions | × |
| State-level WIC price caps | × |

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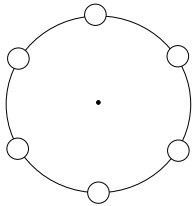
## 3.1 Basic Set-up



An Circular Market

Built upon the Salop circular model (Salop, 1979; Balasubramanian, 1998).

- A circle with circumference 1 represents the entire market.
- Consumers are uniformly distributed along the circle.
- Each consumer purchases one unit of infant formula.
- Offline retailers are located equidistantly along the circle.
- An E-retailer is located at the center of the circular market.

## 3.1 Demand Side

- $\theta$ portion of WIC & $(1-\theta)$ portion of non-WIC consumers.
- WIC consumers obtain infant formula at authorized stores for free.
- $V$ denotes the consumer's valuation of the formula.
- Offline shopping incurs a cost of $t * |l_i|$, with $t$ as the travel cost per unit distance and $|l_i|$ as the distance traveled. $(t > 0)$
- Online shopping incurs a consistent cost of $\mu$. $(\mu > 0)$

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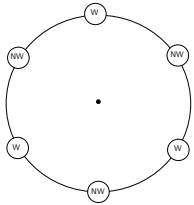
| | **Utility** | |
|---|---|---|
| | Non-WIC Consumer | WIC Consumer |
| Shop offline | $V - P - t\|li\|$ | $V - t\|li\|$ |
| Shop online | $V - P - \mu$ | $V - \mu$ |

# 3.1 Supply Side




The Circular Market, $N = 3$

- Offline retailers: W-retailers & NW-retailers.
- NW-retailers serve non-WIC consumers only.
- An E-retailer enters the market under specific conditions.
- To simplify, we assume:

  $\Rightarrow$ $N$ of W-retailers and $N$ of NW-retailers are located alternately.

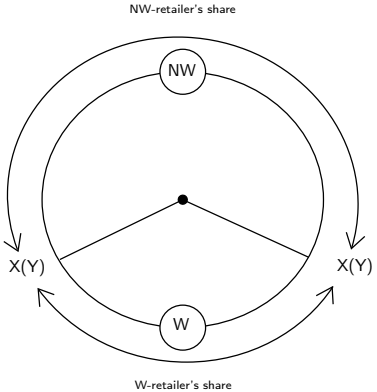
  $\Rightarrow$ All retailers have identical marginal costs, denoted by $c$.

## 3.1 Sequential Decision-Making

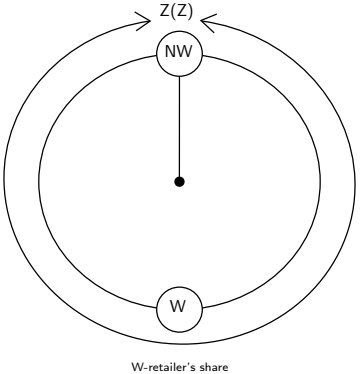
1. Given the store type and location, retailers set the price simultaneously to maximize profit.
2. Each consumer selects the store, based on a combination of price and location.

$\Rightarrow$ We solve this game using backward induction.

# 3.2 Scenario 1: No E-commerce Involvement




(a) Non-WIC Segment

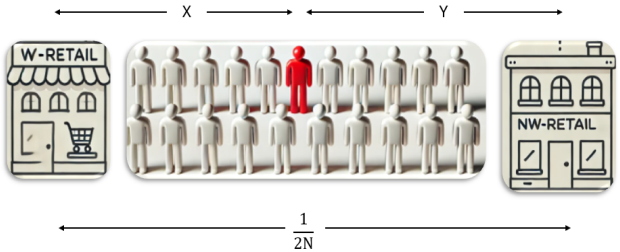



(b) WIC Segment

Spatial Setting of the Circular Market in Scenario 1, $N = 1$

## 3.2 Scenario 1: Absence of the E-retailer

In the non-WIC market segment:

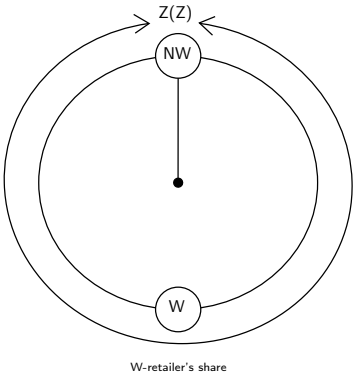



$$
\begin{aligned}
V - tx - p_w &= V - ty - p_{nw} \\
&= V - t\left(\frac{1}{2N} - x\right) - p_{nw}
\end{aligned}
\quad \Rightarrow \quad
x = \frac{1}{4N} + \frac{p_{nw} - p_w}{2t}
$$

$$
S_W^{NW*} = (1-\theta) \cdot 2x
$$

## 3.2 Scenario 1: No E-commerce Involvement

In the WIC market segment (e.g., $N = 1$):

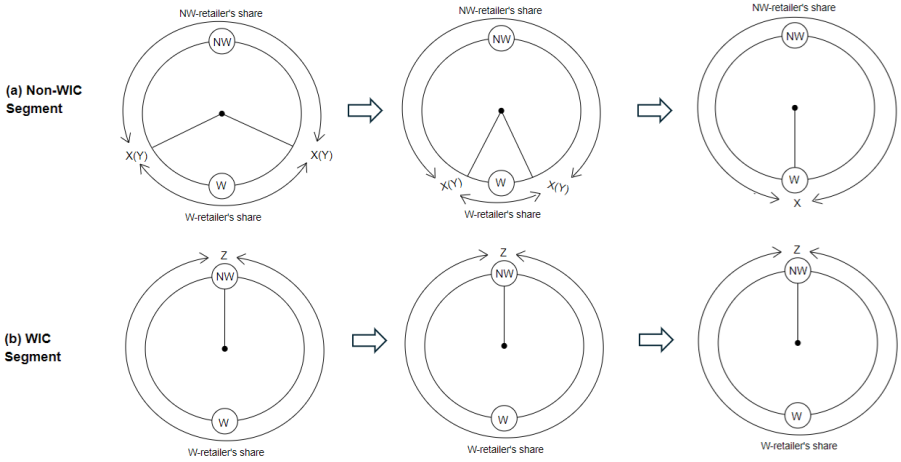



$\Rightarrow$ All W-retailers receive an equal market share of WIC consumers. Thus, we have

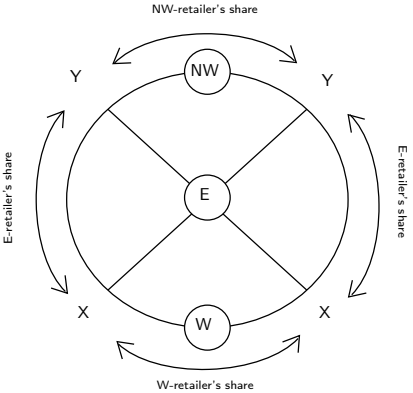
$$S_w^W = 2\theta z = \frac{\theta}{N}$$

# 3.2 Scenario 1: No E-commerce Involvement

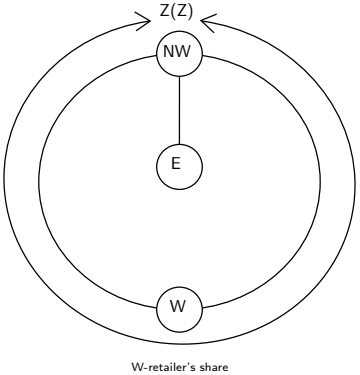
As $\theta \uparrow$,



# 3.2 Scenario 2: E-commerce in the Non-WIC Segment



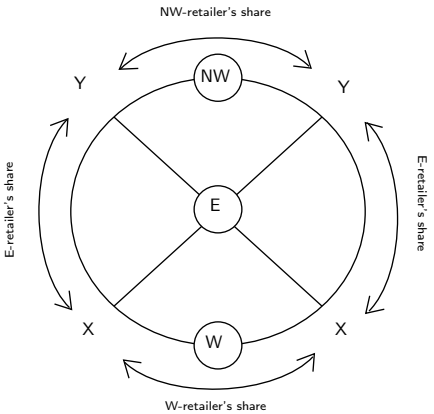

(a) Non-WIC Segment



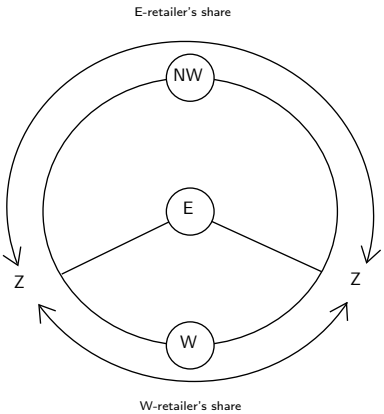

(b) WIC Segment

Spatial Setting of the Circular Market in Scenario 2, $N = 1$

# 3.2 Scenario 3: E-commerce in Both Segments




(a) Non-WIC Segment




(b) WIC Segment

Spatial Setting of the Circular Market in Scenario 3, $N = 1$

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# 4.1 Key Insights

Within our stylized market environments:

1. WIC's Impact on Retailer Pricing
   - Drives up prices across all types of retailers, especially WIC-authorized stores.
   - Effects are greater with higher offline shopping costs, lower offline retail density, and a greater fraction of WIC consumers.
2. E-commerce involvement in the non-WIC segment boosts non-WIC welfare and reduces WIC formula spending.
3. Under certain conditions, online WIC access may improve WIC consumer welfare and reduce WIC formula spending.
4. Retailers' pricing strategies and market structure also depend on WIC price caps.
5. These insights are applicable to other WIC-eligible foods.

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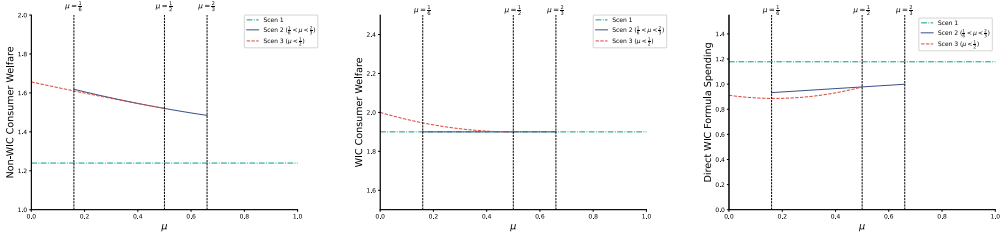
# 4.2 Graphical Illustration, $\theta = 0.4$




(a). Non-WIC Consumer Welfare (b). WIC Consumer Welfare (c). Direct WIC Formula Spending

*Note.* The figures are generated using the parameter values $\theta = 0.4$, $V = 5$, $c = 2$, $N = 1$, and $t = 1$. (1) when $\mu \in [0, \frac{1}{6})$, no FEE exists in Scenario 2; (2) when $\mu \in (\frac{1}{2}, \frac{2}{3})$, Scenario 3 reverts to Scenario 2; (3) when $\mu \geq \frac{2}{3}$, Scenario 2 reverts to Scenario 1.

## 4.3 Strengths and Limitations

### Strengths

1. Extend the Salop model
   - Three types of retailers
   - Two types of consumers
   - Policy-induced market segmentation
2. WIC's delivery system
   - Characterize the impact of WIC's delivery system on retail competition and consumers' shopping decisions within a spatial framework.
   - Provided insights into the potential implications of online WIC access.
   - Illustrate the importance of WIC regulation.

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   - Provided insights into the potential implications of online WIC access.
   - Illustrate the importance of WIC regulation.

### Limitations

1. Simplify retailers' pricing strategies and consumer shopping decisions
2. Restrict attention to a single geographic market
3. Focus on category-level pricing (no brand differentiation)
4. Do not explicitly model upstream manufacturers

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# Thank you!

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# Appendix A1. Equilibrium Analysis: Scenario 1

W-retailers and NW-retailers maximize their profits by

$$\max_{p_w < \tilde{p}_w} \pi_w = \underbrace{(p_w - c)(1-\theta)\left(\frac{1}{2N} + \frac{p_{nw} - p_w}{t}\right)}_{\text{Profit from non-WIC consumers}} + \underbrace{(p_w - c)\frac{\theta}{N}}_{\text{Profit from WIC}}$$

$$\max_{p_{nw}} \pi_{nw} = \underbrace{p_{nw}(1-\theta)\left(\frac{1}{2N} - \frac{p_{nw} - p_w}{t}\right)}_{\text{Profit from non-WIC consumers}}$$

# Appendix A1. Equilibrium Analysis: Scenario 1

Competitive Market Equilibrium:

$$p^*_{w,1} = c + \frac{t}{2N} + \frac{2t\theta}{3N(1-\theta)}; \quad p^*_{nw,1} = c + \frac{t}{2N} + \frac{t\theta}{3N(1-\theta)};$$
$$S^{NW*}_{w,1} = \frac{3-5\theta}{6N}; \quad S^{NW*}_{nw,1} = \frac{3-\theta}{6N};$$
$$S^{W*}_{w,1} = \frac{\theta}{N}; \quad S^{W*}_{nw,1} = 0;$$
$$S^{Total*}_{w,1} = \frac{3+\theta}{6N}; \quad S^{Total*}_{nw,1} = \frac{3-\theta}{6N};$$
$$\pi^*_{w,1} = \frac{t(3+\theta)^2}{36N^2(1-\theta)}; \quad \pi^*_{nw,1} = \frac{t(3-\theta)^2}{36N^2(1-\theta)};$$

---

Required conditions:

- $\theta < \frac{3}{5}$;
- $(p^*_{w,1} - c)S^{Total*}_{w,1} > (\bar{p}_w - c)\frac{\theta}{N}$.

W-retailers, NW-retailers, and the E-retailer, respectively, maximize their profits by

$$\max_{p_w < \bar{p}_w} \pi_w = (p_w - c)\left[\frac{2(1-\theta)(p_e - p_w + \mu)}{t} + \frac{\theta}{N}\right],$$

$$\max_{p_{nw}} \pi_{nw} = (p_{nw} - c)\frac{2(1-\theta)(p_e - p_{nw} + \mu)}{t},$$

$$\max_{p_e} \pi_e = (p_e - c)(1-\theta)\left(1 - \frac{2N(p_e - p_w + \mu)}{t} - \frac{2N(p_e - p_{nw} + \mu)}{t}\right).$$

# Appendix A2. Equilibrium Analysis: Scenario 2

Competitive Market Equilibrium:

$p^*_{w,2} = c + \frac{t}{12N} + \frac{\mu}{3} + \frac{7t\theta}{24N(1-\theta)}$;
$S^{NW*}_{w,2} = \frac{2-7\theta}{12N} + \frac{2\mu(1-\theta)}{3t}$;
$S^{W*}_{w,2} = \frac{\theta}{N}$;
$S^{Total*}_{w,2} = \frac{2+5\theta}{12N} + \frac{2\mu(1-\theta)}{3t}$;
$\pi^*_{w,2} = \frac{[t(2+5\theta)+8N\mu(1-\theta)]^2}{288N^2t(1-\theta)}$;

$p^*_{nw,2} = c + \frac{t}{12N} + \frac{\mu}{3} + \frac{t\theta}{24N(1-\theta)}$;
$S^{NW*}_{nw,2} = \frac{2-\theta}{12N} + \frac{2\mu(1-\theta)}{3t}$;
$S^{W*}_{nw,2} = 0$;
$S^{Total*}_{nw,2} = \frac{2-\theta}{12N} + \frac{2\mu(1-\theta)}{3t}$;
$\pi^*_{nw,2} = \frac{[t(2-\theta)+8N\mu(1-\theta)]^2}{288N^2t(1-\theta)}$;

$p^*_{e,2} = c + \frac{t}{6N} - \frac{\mu}{3} + \frac{t\theta}{12N(1-\theta)}$;
$S^{NW*}_{e,2} = \frac{2-\theta}{3} - \frac{4N\mu(1-\theta)}{3t}$;
$S^{W*}_{e,2} = 0$;
$S^{Total*}_{e,2} = \frac{2-\theta}{3} - \frac{4N\mu(1-\theta)}{3t}$;
$\pi_{e,2} = \frac{[t(2-\theta)-4N\mu(1-\theta)]^2}{36Nt(1-\theta)}$;

---

Required conditions:

- $\frac{N\mu}{t} < \frac{2-\theta}{4(1-\theta)}$;
- $\theta < \frac{2t+8N\mu}{7t+8N\mu}$;
- $p^*_{w,2}S^{Total*}_{w,2} > (\bar{p}_w - c)\frac{\theta}{N}$.

W-retailers, NW-retailers, and the E-retailer, respectively, maximize their profits by

$$\max_{p_w \le \bar{p}_w} \pi_w = (p_w - c)\left[\frac{2(1-\theta)(p_e - p_w + \mu)}{t} + \frac{2\theta\mu}{t}\right],$$

$$\max_{p_{nw}} \pi_{nw} = (p_{nw} - c)\frac{2(1-\theta)(p_e - p_{nw} + \mu)}{t},$$

$$\max_{p_e \le \bar{p}_e} \pi_e = (p_e - c)\left[(1-\theta)\left(1 - \frac{2N(p_e - p_w + \mu)}{t} - \frac{2N(p_e - p_{nw} + \mu)}{t}\right) + \theta\left(1 - \frac{2N\mu}{t}\right)\right].$$

# Appendix A3. Equilibrium Analysis: Scenario 3

Competitive Market Equilibrium (requires $\mu < \frac{t}{2N}$ and $\theta < \frac{t+4N\mu}{11N\mu}$):

$p^*_{w,3} = c + \frac{t}{12N} + \frac{\mu}{3} + \frac{(t+5N\mu)\theta}{12N(1-\theta)}$;
$S^{NW*}_{w,3} = \frac{1}{6N} + \frac{\mu(4-11\theta)}{6t}$;
$S^{W*}_{w,3} = \frac{2\mu\theta}{t}$;
$S^{Total*}_{w,3} = \frac{1}{6N} + \frac{\mu(4+\theta)}{6t}$;
$\pi^*_{w,3} = \frac{[t+N\mu(4+\theta)]^2}{72N^2t(1-\theta)}$;

$p^*_{nw,3} = c + \frac{t}{12N} + \frac{\mu}{3} + \frac{(t-N\mu)\theta}{12N(1-\theta)}$;
$S^{NW*}_{nw,3} = \frac{1}{6N} + \frac{\mu(4-5\theta)}{6t}$;
$S^{W*}_{nw,3} = 0$;
$S^{Total*}_{nw,3} = \frac{1}{6N} + \frac{\mu(4-5\theta)}{6t}$;
$\pi^*_{nw,3} = \frac{[t+N\mu(4-5\theta)]^2}{72N^2t(1-\theta)}$;

$p^*_{e,3} = c + \frac{t}{6N} - \frac{\mu}{3} + \frac{(t-N\mu)\theta}{6N(1-\theta)}$;
$S^{NW*}_{e,3} = \frac{2}{3} - \theta - \frac{4N\mu(1-2\theta)}{3t}$;
$S^{W*}_{e,3} = \frac{(t-2N\mu)\theta}{t}$;
$S^{Total*}_{e,3} = \frac{2}{3} - \frac{2N\mu(2-\theta)}{3t}$;
$\pi^*_{e,3} = \frac{[t-N\mu(2-\theta)]^2}{9Nt(1-\theta)}$;

---

Required conditions:

- $\frac{N\mu}{t} < \frac{1}{2}$;
- $4N\mu(1-2\theta) < t(2-3\theta)$;
- $\theta < \frac{t+4N\mu}{11N\mu}$;
- $(p^*_{w,3} - c)S^{Total*}_{w,3} > (\bar{p}_w - c)\frac{2\mu\theta}{t}$;
- $(p^*_{e,3} - c)S^{Total*}_{e} > (\bar{p}_e - c)\frac{(t-2N\mu)\theta}{t}$.

Non-WIC consumers:

$$CW_1^{NW*} = (V-c)(1-\theta) + \frac{t(45-54\theta+5\theta^2)}{72N(1-\theta)};$$

$$CW_2^{NW*} = (V-c)(1-\theta) - \frac{t(44-56\theta-\theta^2)}{288N(1-\theta)} - \frac{\mu(5-4\theta)}{9} + \frac{2N\mu^2(1-\theta)}{9t};$$

$$CW_3^{NW*} = (V-c)(1-\theta) - \frac{t(11-12\theta)}{72N(1-\theta)} - \frac{\mu(10-23\theta+15\theta^2)}{18(1-\theta)} + \frac{N\mu^2(16-64\theta+73\theta^2)}{72t(1-\theta)}.$$

WIC consumers:

$$CW_1^{W*} = \left(V - \frac{t}{4N}\right)\theta\,;$$

$$CW_2^{W*} = \left(V - \frac{t}{4N}\right)\theta\,;$$

$$CW_3^{W*} = \left(V - \mu + \frac{N\mu^2}{t}\right)\theta\,.$$

WIC formula spending:

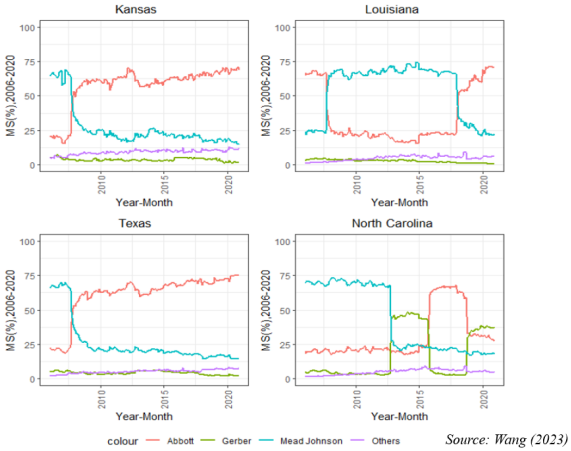
$$WS_1^* = \left[c + \frac{t}{2N} + \frac{2t\theta}{3N(1-\theta)}\right]\theta\,;$$

$$WS_2^* = \left[c + \frac{t}{12N} + \frac{\mu}{3} + \frac{7t\theta}{24N(1-\theta)}\right]\theta\,;$$

$$WS_3^* = \left[c + \frac{t^2 - N\mu t(3-\theta) + N^2\mu^2(8-\theta)}{6Nt(1-\theta)}\right]\theta\,.$$

# Appendix B1. Upstream Competition under the WIC Rebate Program

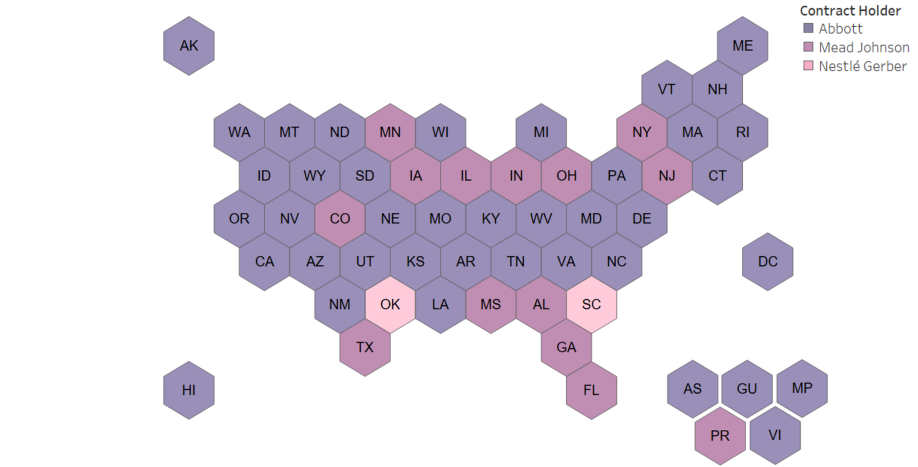
Correlation between Market Shares and Competitive Bidding Contracts




*Source: Wang (2023)*

# Appendix B2. The WIC Rebate Program

## WIC Infant Formula Contracts by State in 2024



# Appendix B3. Maximum Monthly Allowances of Infant Formula

| | **Fully Formula fed** | **Partially Breastfed** | **Fully Breastfed** |
|---|---|---|---|
| Age | *A: 0-3 months*<br>*B: 4-5 months*<br>*C: 6-11 months* | *A: 0-3 months*<br>*B: 4-5 months*<br>*C: 6-11 months* | *0-11 months* |
| Maximum Monthly Allowances | *A: Up to 806 fl. oz.*<br>*B: Up to 884 fl. oz.*<br>*C: Up to 624 fl. oz.* | *A: Up to 364 fl. oz.*<br>*B: Up to 442 fl. 0z.*<br>*C: Up to 312 fl. oz.* | *N/A* |

Source: FNS, USDA