Does Food Program Limit Your Choices in Grocery Stores? Evidence: The Spillover Effect of Switching WIC Contracts in the Infant Formula Market *

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Abstract

The Women, Infants, and Children nutritional Program (WIC) grants exclusive contracts (or competitive bidding contracts) to infant formula manufacturers, who provide rebates that lower the cost to recipients. However, these exclusive contracts may create considerable market power for formula manufacturers and spillovers to non-WIC formula buyers. This paper tries to answer three questions: First, what happens if a manufacturer wins a WIC competitive bidding contract in the infant formula market in terms of market shares and prices? Second, is there any spillover effect? Lastly, why is there spillover? Our results show that when the WIC contract changes hands, the previous contract winners' market share declines by 50% within one month, but the new winner's market shares increase by around 50% on average. Much of this change comes from households who are not eligible for WIC, suggesting a large spillover effect. To explain it, we test whether households who are not eligible for WIC buy contract winners' formula because there is no other option in their choice sets or because the winners' formula is cheaper than others. The finding suggests that both price and shelf space hypotheses play small roles in explaining the spillover. Hence, on the extensive margin, food programs do not limit non-beneficiaries choice sets in grocery stores.

Keywords: Exclusive contracts; Spillover effects; Shelf Allocation; Consumer behavior; WIC program

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1 Introduction

When this government-funded assistance program selects its partner, they usually have some strict criteria: First, whether the manufacturer can guarantee the food's quality or not; Second, who can provide the lowest price. Since manufacturers also know the potential profits of cooperating with the government-funded program, it is reasonable that all manufacturers would like to sacrifice some profits by providing lower prices to the program, and then compensate its loss by extracting profits from non-beneficiaries. Under this situation, if there should be only one partner, then it should be the most efficient way for the government-funded assistance program to use an auction to determine its partner. The potential assumption behind it is that: Manufacturers know that if they sign the contract with the government-funded assistance program, then they will get some extra profits from non-beneficiaries. However, we do not have quantity evidence to show that it is true. In this paper, we focus on this aspect and try to provide quantitative evidence to show the existence of spillover demands from the government-funded assistance program by using the WIC program as an example and exploring the mechanisms behind these spillovers.

The Special Supplemental Nutrition Assistance Program for Women, Infants, and Children (WIC) is a large safety net program in the U.S., which aims to provide specific amounts of free food to low-income households at nutritional risk. According to the USDA 2022 Report, 1.7 million infants (less than one-year-old) enrolled in the WIC program, which is 45% of all infants in the U.S.[1] These enrolled babies can get certain brands and amounts of infant formula products free of charge by using vouchers, and then WIC state agencies reimburse these infant formulas according to the net retail price set by WIC competitive bidding contracts.[2] Since infant formula unit prices kept increasing over the past decade, (see Figure 1), the WIC program has been suffering from increasing costs. To reduce its costs, each WIC state agency is required to have an auction (or what they called: competitively bidding contracts [3]) to determine which manufacturer can supply infant formula in each state. The contract winner is the manufacturer bidding the lowest unit price or the highest rebates in that state. Once the contract winner is determined, the WIC state agency gives them exclusive selling rights to supply WIC infant formula products in that state. However, given that the infant formula manufacturer is almost a

[1] Sources: https://www.fns.usda.gov/wic/eligibility-and-coverage-rates-2018. Data: 2008-2019 Current Population Survey, Annual Social and Economic Supplement (CPS-ASEC) for the US estimate, 2007-2018 Puerto Rico Community Survey and census for territories, WIC administrative data, and WIC participant and program characteristics report.

[2] Net retail price is defined as the difference between unit retail price and determined rebates.

[3] 7 CFR Part 246: Special Supplemental Nutrition Program for Women, Infants and Children (WIC): Exclusion of Combat Pay From WIC Income Eligibility Determinations, A Rule by the Agriculture Department, and the Food and Nutrition Service; Publication date: June 16, 2011

monopoly in each state (Figure 2), our research questions are: *If WIC households obtain infant formulas for free, how about non-WIC households? Are there any spillover effects on non-WIC households? If so, how to explain these spillover effects?*

[Data and Methodology] We answer these questions using the event study and two-stage least square method by employing Nielsen Retail data, Nielsen Home scan data, IPUMS data, and a WIC rebate data.

Our finding consists of three parts: Basic facts about the American infant formula market; and how the policy impacts the WIC-beneficiaries' demands and non-beneficiaries demands and prices when the WIC contract winner changed; and how to explain nonbeneficiaries are also influenced by changing contract winners.

First of all, to better understand the market, we present some market facts in Chapter 4. We focus on 12 to 13-oz milk-based liquid concentrated infant formula products and describe the changes in prices and market shares of three main manufacturers in the infant formula market. First, we find that real unit prices increase from 2006 to 2020. On average, the unit price increased by $30 in 2020, which is twice more than the price in 2010. Besides, Mead Johnson is always the most expensive one, and Nestle is always the cheapest one. Second, our finding suggests that the market shares of the three main infant formula manufacturers keep being stable in the past fifteen years, and Abbott has the largest market share–around 50 percent of total market shares–all the time. (Figure 1) However, at the state level, Abbott does not occupy the largest market shares in all states, but there is a strong positive relationship between who wins the WIC contract, and who gets the largest market shares.(Figure 2)

Then, we study what happened when the WIC competitive bidding contract changed its winner in a state. Our result shows that changing the contract winner has a significant impact on both previous and new winners' market shares, as well as their real unit prices. Particularly, after changing the contract winner, the previous contract winners' market share declines 50% within one month, but the new winners' market share increases 50% on average. Much of this change comes from households who are not eligible for WIC. In addition, changing the WIC contract winner also causes relative price ratios between new winners and previous winners to decline around 5%.

These finding also lead to our last findings: Is there any spillover effects? How to explain these spillovers? The brief answer is: Yes, there are demand spillover effects on non-beneficiaries. To explain the mechanisms behind these spillovers, we examine two hypothesizes: First one is initially proposed by Huang & Perloff (2014), which states that households who are not eligible for WIC buy contract winners' formula because there is no other option in their choice sets. We test whether it is true by using product-store-year-month level data, and we find that on average 92% of grocery stores in our data have consecutive sold amounts of both previous and new

winner's infant formula products in each state, regardless of contract change or not. Hence, it seems that the hypothesis proposed by Huang cannot fully explain the spillover effect. Then, we propose our own innovative hypothesis–pricing effect, and we think households who are not eligible for WIC buy contract winners' formula because the new winner's infant formula is relatively cheaper than others. We find that the new winner's infant formula is on average 5% cheaper than the previous winner's infant formula. Hence, this hypothesis can also explain the spillover.

This paper is closely related to two papers: Huang & Perloff (2014) and Abito, Hui, Salant, and Uetake (2023, working) [4]. Huang and Perloff explained manufacturers are willing to sell formulas to WIC agencies at lower prices because it can increase demands from non-beneficiaries. However, their results are limited by available data sets, so they cannot distinguish WIC households and non-WIC households. In our paper, we use Nielsen Home Scan data to solve this problem and complement their results. Our results show that around 25% changes in market shares are coming from non-WIC households. In addition, they propose three mechanisms that can explain why non-WIC households are willing to choose WIC contract brands. Specifically, First, the WIC contract brand gains extra profits by gaining more and better shelf spaces; Second, the WIC label itself is a governmental endorsement, which can increase demand; Lastly, pediatricians are more likely to recommend the WIC brand to non-WIC consumers. However, they did not examine these three mechanisms. In our paper, we examined the shelf space hypothesis and found that it had very little effect on explaining the non-WIC household's preferences for WIC brands. Because of that, we propose a new hypothesis: the pricing effect. Abito, Hui, Salant, and Uetake (2023, working) estimated the demands from the non-WIC households by using logic demand model, but our paper focus more on explaining why non-WIC households buy WIC infant formula products, and show that WIC competitive bidding contracts will not impact consumers' choice sets.

The paper is related to two fields of the literature. The paper is also connected to work on the public economics literature, Huang & Perloff (2014), Oliveira et al. (2010), Davis (2012), Bitler & Currie (2005), Hanks et al. (2019), Gleason & Pooler (2011), Gray et al. (2019), Just & Gabrielyan (2016), Hoynes et al. (2011) state the potential spillover effect from the WIC contracts in the infant formula market, but have not quantified the spillover. We use rich data sets to quantify the spillover effect of WIC contracts, and explain mechanisms behind that.

[4] https://sites.google.com/view/mabito/research

2 Background

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is available in all 50 states and serves almost 8 million low-income women, infants, and children at nutritional risk every month, which is 2% of the total population. According to a USDA report, there 6.3 million WIC participants each month in 2022 in the United States, and around 39% are infants. Operating the WIC program is expensive. Each WIC state agency has to offer a large amount of nutritional food and infant formula products for WIC households. Infant formula is the most expensive of these foods, as emphasized by Carlson, Greenstein, and Neuberger (2017): "In the mid-1980s, infant formula accounted for nearly 40 percent of total WIC food costs".[5]

To combat this high food cost, since 1989 the Code of Federal Regulations suggests for states to implement a competitive bidding contract scheme.[6] The system operates at three levels: Manufacturers, WIC vendors, and WIC households.

First, each WIC state agency holds an auction for the exclusive selling right to supply WIC infant formula products. In return, the winner gives the WIC state agency a rebate (or discount) for each can of infant formula purchased by WIC participants. The higher rebates (or lower discount) a bidder submits, the higher chance the bidder wins the auction. The most common length of the contract is three years, according to the WIC rebate data shown in the Table 1.

Second, after determine the contract winner, the WIC state agency requires its local authorized grocery stores to offer the contract winner's infant formula products, and to keep specified minimum amounts in stock. These minimum stock requirements vary by state and year. For example, Alsaka's WIC program required it vendors to keep at least **32 cans** Similac Advance Early Shield Powder (Abbott) starting from 2019 Jan 1st [7]; By contrast, Michigan's WIC program required its vendors to have at a minimum **12 units** of 12.4 oz can powder Similac Advance formula in 2021 [8]. Huang & Perloff (2014) state that "Grocery stores provide relatively large amounts of shelf space to the WIC contract winner. Non-WIC customers infer that the WIC brand is superior and are more likely to buy it".

Third, eligible WIC households redeem winner's infant formula products by using the WIC checks at authorized grocery stores. WIC state agencies reimburse these expenditures each

[5] https://www.ers.usda.gov/topics/food-nutrition-assistance/wic-program/

[6] 7 CFR Part 246: Special Supplemental Nutrition Program for Women, Infants and Children (WIC): Exclusion of Combat Pay From WIC Income Eligibility Determinations, A Rule by the Agriculture Department, and the Food and Nutrition Service; Publication date: June 16, 2011

[7] The information is from Alaska WIC Vendor Minimum Stocking Requirements. We thank WIC Vendor Manager Erin Fahsholtz in State of Alaska Division of Public Assistance for their help.

[8] The information is from Michigan WIC Vendor Minimum Stocking Requirements. We thank WIC Vendor Manager Dawn Pline at the Michigan Department of Health and Human Services for their help

year. Since WIC households get infant formula products for free, we are curious about: How about non-WIC households? Are there any spillover effects on non-WIC households? If so, how to explain these spillover effects?

3 Data and Analysis Sample

Our analysis combines data on infant formula purchases by consumers, infant formula sales by retailers, as well as WIC implementation details over time. The following are our primary sources of data.

We gathered monthly-level infant formula purchase records from the Nielsen Consumer Panel Data. The original consumer panel data contains around 60,000 U.S. households who continually provided consumption and demographic information to the Kilts Nielsen Data Center from 2006 to 2020. This database provides us with precise information on the products a household buys, the time, location, and price of each purchased product, total expenditures per shopping trip. It also gives household demographic information, as well as whether a household participates in the WIC program at the time of survey. The sample size by year is shown in Table 3, as well as the number of households who purchase infant formula, and (among them) those who participate in WIC. There are about 60000 households in the Nielsen Home scanner data from 2007 to 2020. In each year, roughly 2000 households are buyers of infant formula in each, around 10% of whom indicate they are currently enrolled in the WIC program. The limitation of this variable is that it under-estimates the ratio of WIC households in the U.S., because most observations in Nielsen Home scan data are from above average-income families. To deal with this limitation, we create an additional sample from the Current Population Survey (CPS) to use for robustness checks. This data provides a more accurate description about which families receive The WIC benefits at the household-year level. The summary statistics of WIC densities are shown in Table 5. Table 5 provides means and standard deviations (in parentheses) for household-level and county-level total number of WIC eligible women or infants who received any food in the typical year and quarter.

Our second dataset is the WIC Rebate database is publicly available, collected by David E. Davis from South Dakota State University. The database includes a nearly complete compilation of winning and losing rebate bids for WIC eligible infant formula products, from 1986 to 2016. This paper focuses on 12-13 ounce cans of milk-based liquid concentrate. The data provides the following variables: contract start date, contract end date, contract type, contract length, and rebate amount by manufacturers, previous winners, and new winners. The data helps us identify each state's contract winners from 2006 to 2015. For post-2015 contract winners, we identified them from each state's WIC official website. The summary statistics for each

variable are shown in Table 1 and Table 2.

On the retail side, we use the Kilts Nielsen Retail Scanner Data from 2006 to 2020. The scanner data is a weekly panel of products in approximately 50,000 stores, containing detailed information at the product level: product's weekly price; store-level sales units each week; brands; product's package and size; retailer's information from 2006 -2020. The summary statistics are shown in Table 4.

4 What Happens When A Company Wins or Loses the WIC Contract?

Because WIC products are such a huge section of the infant formula market, a change in the company holding the WIC contract is likely to substantially affect the market. In this section, we present some stylized graphs to illustrate these dynamics.

4.1 Market Shares

Figure 2 shows how the market shares of main infant formula manufacturers fluctuate over time in a dozen different states between Jan 2006 and Dec 2020. Several observations are noteworthy. First, in each state, at any given time, there is almost always a dominating manufacturer capturing over 50% of the market. Second, that dominant brand undergoes sharp switches: for instance in Lousiana, Abbott dominates at first, then dramatically loses to Mead Johnson in 2008, before recapturing the dominant position 2018. These sharp switches correspond to the years in which a there was a change in the winner of the state's WIC contract, and provide a striking illustration of the consequence of such a win on sales within that state.

$$ms_{j,state} = \frac{\sum_{store} Q_{j,store \in state}}{\sum_j \sum_{store} TQ_{j,store \in state}} \times 100\%$$

We use the Nielsen Retail scan data from 2006 to 2020 for two event studies. The event is that the WIC competitive bidding contract switches its winner in a state in a given year. In some states, the contract switched its winner more than once in the past sixteen years. In other states, the contract switched once or never changed its winner. We look at average changes in previous and new winners' market shares twelve months before and after the event by running the event study regression 1.

$$MS_{s,ym}^{\text{Previous winner}} = \sum_{t=-12,\notin 0}^{t=12} \delta_t + \alpha_s + \epsilon_{s,ym} \tag{1}$$

Figure 3 shows that previous winners' market shares dropped around 40% after the contract switched its winner on average. Figure 4 shows that new winners' market shares increased about 40% after the contract switched its winner.

To see the heterogeneity effect of winning the WIC contract, we run the following regression:

$$Price_{jst} = \alpha \times 1\{j = Winner\}_{st} + \delta_s + \eta_t + \epsilon_{jst} \tag{2}$$

The results are shown in Table 12.

4.2 Price

After observing market share changes over time, a related question is: Does switching WIC contracts also impact the unit price of infant formula products? To answer this question, first, we show the real unit price changes over time by the state in Figure 11 in the appendix, in which all real prices are adjusted by using the 2010 CPI. We find that: Different from the market share graph, the real price increases over time in each state. From the first glance at Figure 11, we could not find any strong correlation between switching WIC contracts and changes in real price.

We draw the distribution of real unit prices in Figure 12 to delve into the price. It shows that the real average price for all infant formula products is around $26, regardless of manufacturers. Then, we draw the price distribution graphs by manufacturers in four years: 2006, 2010, 2016, and 2020, in Figure 13. There are three takeaways from figure 4: First, Mead Johnson is always the most expensive, and Abbott is always the cheapest. Second, unit prices of all infant formulas have been growing in the past 16 years. Last but not least, the price variations are growing over time.

$$Price_{jst} = \alpha \times 1\{j = Winner\}_{st} + \delta_s + \eta_t + \epsilon_{jst} \tag{3}$$

To understand the correlation between contract winners and unit price, we run the regression 3 by using both Retail scan data and Home scan data. After controlling for the year and state fixed effects, the results are shown in Table 6. we find that: Each manufacturer has a different pricing strategy after winning the contract. Abbott increases its unit price $1.965 after

it wins the WIC competitive bidding contract in a state in a year. Gerber (Nestle) and Mead Johnson tend to decrease their prices after they win the contract. Particularly, Gerber tends to decline its unit price around $2.809, and Mead Johnson declines its unit price around $4.334. In the aggregate effect, winning the WIC contract lead to the firm's unit price decline of $0.592 on average.

5 Are There Demand Spillovers?

From section 4, we know that changing the WIC brand causes new WIC winners' market shares to increase 40 percent on average. In this section, we answer two related questions: Are these 40 percent all coming from WIC households? If not, how much of it is from non-WIC households?

To answer these questions, the ideal experiment is to use consumer-level panel data to see how each infant's parent changes choices on infant formula brands as the WIC contract winner changes in the state they live in. Let us assume that each firm's unit price does not change a lot within a short time, then we expect to see line A in Figure 7, which is a flat line. It means that consumption patterns for non-WIC households should not change as the WIC contract winner changes. By contrast, we expect WIC households will change their choices immediately since they can always get the WIC contract winner's goods for free, keep buying the previous winner's product will make them start paying formula by themselves. We expect their consumption pattern looks like line B in Figure 7.

Under this setup, if we find that most parents who are not enrolled in the WIC program change their babies' infant formula from the previous winner's brand to the new winner's brand, then we can say there is a demand spillover.

$$MS^{j}_{st} = \beta_1 \times 1\{\text{Winner} = j\}_{st} \times 1\{WIC\}_i + \beta_2 \times 1\{\text{Winner} = j\}_{st} + \beta_3 \times 1\{WIC\}_i + \delta_t + \sigma_s + \epsilon_{ist} \tag{4}$$

Our empirical results can be visualized in Figure 8. The upper figure shows changes in previous winners' market shares. It could be decomposed into four types of demands. The green dashed line shows that: After the contract switched, the previous contract winners' market shares from NON-WIC households with babies born before the contract changed declined from 55% to around 25%. It implies a strong spillover effect from switching WIC contracts on non-WIC households' consumption. Besides, the market shares from WIC households dropped around 70%, which indicates that WIC parents might have love brand loyalty for infant formula products. The bottom figure shows that new winners' market shares increase for WIC and NON-

WIC households, which mirrors the upper graph and has almost the same implication as the upper graph: There is a spillover effect on non-WIC households.

To support the above graph, we estimate the regression 4 using the Nielsen Homescan data, in which β_2 captures the impact of switching WIC contracts on non-WIC households. Table 13 shows there are around 23.678% ~ 30.578% impacts of switching WIC contracts coming from non-WIC households.

6 Does WIC Limit Your Choices?

Huang and Perloff (2011) first proposed the choice set effect. [9] They suggested that winning the WIC contract is extremely valuable to a manufacturer because the increased retail shelf space increases non-WIC sales. Since WIC infants account for half of infant formula consumers, retailers will devote more shelf space and better product placement to the WIC contract brand, resulting in increased product visibility that may spur sales to non-WIC consumers. Furthermore, WIC-authorized stores are required to maintain a minimum stock of the WIC contract brand. Smaller grocery stores have limited shelf space and, as a result, may stock only one brand of formula–the WIC contract brand. Non-WIC patrons of these stores have limited options and may purchase the WIC contract brand rather than shop for a non-WIC brand at a different store. A related question: Is that true that the grocery stores immediately switched all infant formulas with the new WIC-winning brand? However, Huang and Perloff did not test this hypothesis in their paper. We test it by using the store-year-month level retail data. To answer this question, I calculated the share of grocery stores in each state with consecutive positive sold amounts of previous winners' products three months after the contracts switched. Tables 9 and 10 show that even after the contract switched, around 98% stores in a state have positively sold for previous winners' infant formula products, which rejects the hypothesis above. To support this result, the event study 5 is employed by using the store-year-month level data to show that, and the result is shown in Figure 3.

$$1(Q^{\text{Previous winner}} > 0)_{\text{store, year-month}} = \sum_{t=-12, \not\in 0}^{t=12} \delta_t + \alpha_{\text{store}} + \epsilon_{\text{store, year-month}} \tag{5}$$

Figure 9 shows the number of stores that sold non-WIC infant formula products dropped around 4% after contracts changed. This 4% decline could partially explain the 40% drop in previous winners' market shares. However, we also wonder whether other mechanisms could explain the changes in market shares.

[9] They called it "shelf-space story" in their paper. But the idea is the same.

7 How prices impact non-beneficiaries choices?

Reduced-form Analysis

We propose an innovation hypothesis and try to explain the changes in market shares. Our statement is that: **Non-WIC households are buying WIC infant formula products because WIC infant formula is cheaper than non-WIC infant formula.** We test whether this statement is correct using the event study 6 , which shows the result in Figure 10.To motivate the result, Figure 14 in the Appendix compares unit prices of WIC infant formula and non-WIC infant formula over time by states.

$$\frac{(Price_{pre} - Price_{new})}{Price_{new}}_{s,ym} = \sum_{t=-12,\notin 0}^{t=12} \delta_t + \alpha_s + \epsilon_{s,ym} \tag{6}$$

Figure 10 implies that: After the WIC contract switched its winner, the difference in unit price between previous winners' infant formula and new winners' infant formula increased by around 10% within 12 months. It implies that the substitution effect dominates the income effect for non-WIC households.

We decomposed this trend into two parts: changes in unit prices of previous winners' products and changes in the unit price of new winners' products, and these are shown in Figure 5 and 6. Although these are just descriptive results that imply no causal effect, we think a 10% price change is large enough to change non-WIC households' consumption behaviors.

Structural Analysis

To show that the price effect could explain why non-WIC households are buying WIC products, we run a logit regression with Hausman IV in the equation 7.

I define the market as the store-year-quarter level. The instruments are the national level Hausman IV, which is the average price of the product j in other stores in the same time–year quarter. We focus on the 12 ~ 13 OZ liquid concentrated infant formula products because these are the most popular types of formula in the sample data. We assume there are N households who buy any infant formula products, and each household, indexed as i, faces a mutually exclusive and exhaustive choice set:

$$\mathbb{C}_i = \{\text{Abbott (Y =1)}, \text{Nestle (Y = 2)}, \text{Mead Johnson (Y = 3)}, \text{Others (Y = 0)}\}$$

$$ln(MS_j) - ln(MS_{outside})_{syq} = \beta_0 + \beta_1(P_j - P_{outside})_{syq} + \beta_2 1\{Winner\}_{jyq} + \beta_3 \text{WIC density}_{cyq} + \epsilon_{scjyq} \tag{7}$$

There are two choice-specific variables: P_j: Real price measured in dollars (2010 base year); $Winner_j$: Whether infant formula manufacturer j wins the competitive bidding contracts in state s at time t. One market-specific variable: wic density in the county c in the quarter t. [10]

The indirect utility of each consumer i (i = 1,2,3,..., N) purchasing product j (j = 0, 1,2,3) in the state s at time t:

$$u_{ij,st} = \alpha Price_{j,st} + \gamma_2 Winner_{j,st} + \beta_3 \text{WIC density}_{cst} + \eta_j + \epsilon_{ij,st}$$

where X_i are all households observable, and $Price_{j,st}$, $Winner_{j,st}$ are all choice specific attributes. Suppose $j = 0$ (others) is outside option. Assume $\epsilon_j \sim^{i.i.d} T1EV$ with a pdf $f(\epsilon_j) = e^{-\epsilon_j} e^{-e^{-\epsilon_j}}$, for each j = 0,1,2,3.

Each household i chooses one manufacturer of infant formula j (j = 0,1,2,3). The probability of i making choice j is given by:

$$\begin{aligned} P_{ij} &= Pr(u_{ij} + \epsilon_{ij} > u_{ij'} + \epsilon_{ij'}, \forall j \neq j') \\ &= Pr(\epsilon_{ij'} - \epsilon_{ij} < u_{ij} - u_{ij'}, \forall j \neq j') \\ &= \int_{\epsilon} 1(\epsilon_{ij'} - \epsilon_{ij} < u_{ij} - u_{ij'}, \forall j \neq j') f(\epsilon) d\epsilon \end{aligned} \tag{8}$$

Suppose $j = 0$ (others) is outside option. Assume $\epsilon_j \sim^{i.i.d} T1EV$ with a pdf $f(\epsilon_j) = e^{-\epsilon_j} e^{-e^{-\epsilon_j}}$, for each j = 0,1,2,3. Then we have the market shares:

$$MS_{i0} = \frac{1}{1 + \sum_{j=1}^{3} exp(u_{ij} - u_{i0})}$$

$$MS_{i1} = \frac{exp(u_{i1} - u_{i0})}{1 + \sum_{j=1}^{3} exp(u_{ij} - u_{i0})}$$

$$MS_{i2} = \frac{exp(u_{i2} - u_{i0})}{1 + \sum_{j=1}^{3} exp(u_{ij} - u_{i0})}$$

[10] In the sample data, each column of these matrices reflects the choice-specific attribute for the corresponding choice. In other words, the first column is attributes for the other brands, the second column for Abbott, and so on.

$$MS_{i3} = \frac{exp(u_{i3} - u_{i0})}{1 + \sum_{j=1}^{3} exp(u_{ij} - u_{i0})}$$

Then,

$$ln(\frac{MS_{ij}}{MS_{i0}}) = ln(exp(u_{ij} - u_{i0}))) = \beta_0 + \beta_1 (P_j - P_{outside})_{syq} + \beta_2 1\{Winner\}_{jyq} + \beta_3 \text{WIC density}_{cyq}$$

The results 8 show that price could explain 10% of changes in market shares coming from non-WIC households.

8 Conclusion

In this paper, we study three questions: First, What happens if a manufacturer wins a WIC competitive bidding contract? We find that winning the WIC contract grants a manufacturer around a 40% increase in its market shares on average. Second, given that changes in market shares reflect changes in quantity demanded, we wonder whether non-WIC households are also influenced by switching WIC contracts. Hence, a second-order question is: Is there any spillover effect? Our results show a significant spillover in non-WIC households' consumption behaviors. Lastly, we study: Why is there spillover? We test two hypotheses: One is proposed by the existing literature-choice set effect, and we admit that it has some explanatory power but is very limited. Second, we proposed our innovative hypothesis– price effect and found that it has some potential explanation power. However, the shortage of this paper is that we only tested the choice set effects on the extensive margins, instead of on intensive margins. For example, is it possible that WIC contract infant formula is usually placed in the obvious locations on the shelf? These might need further studies to delve into.

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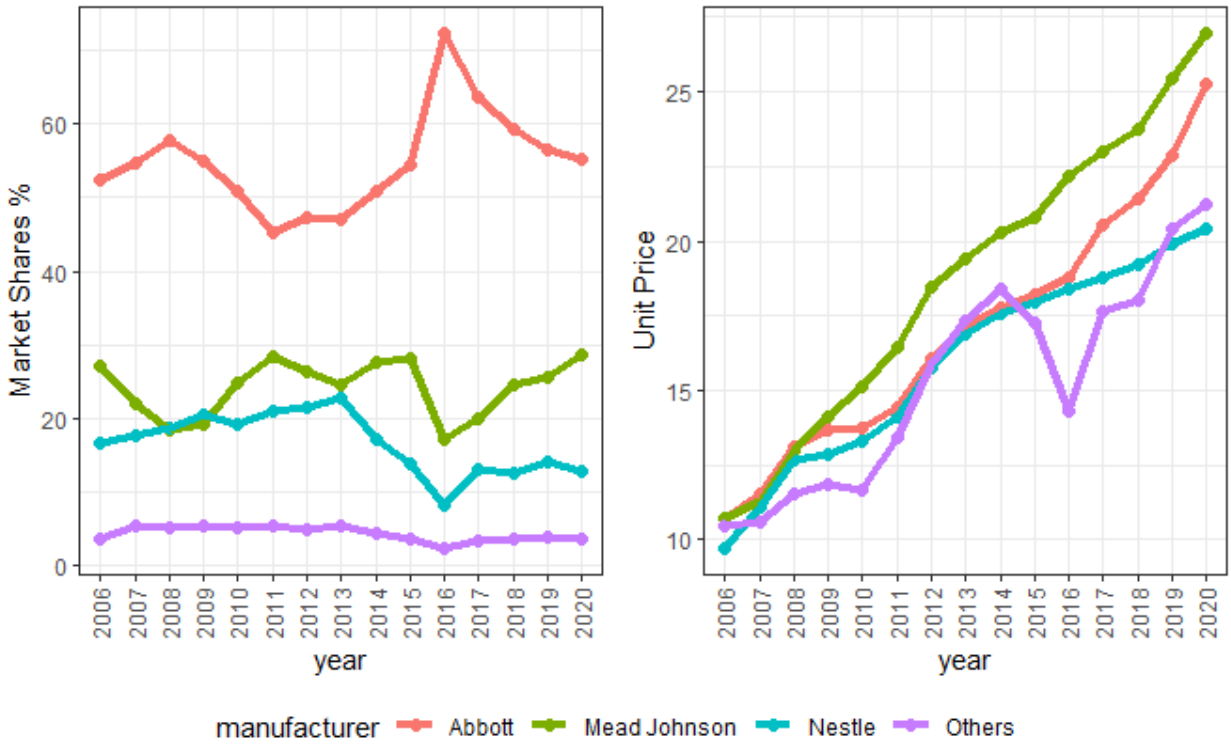
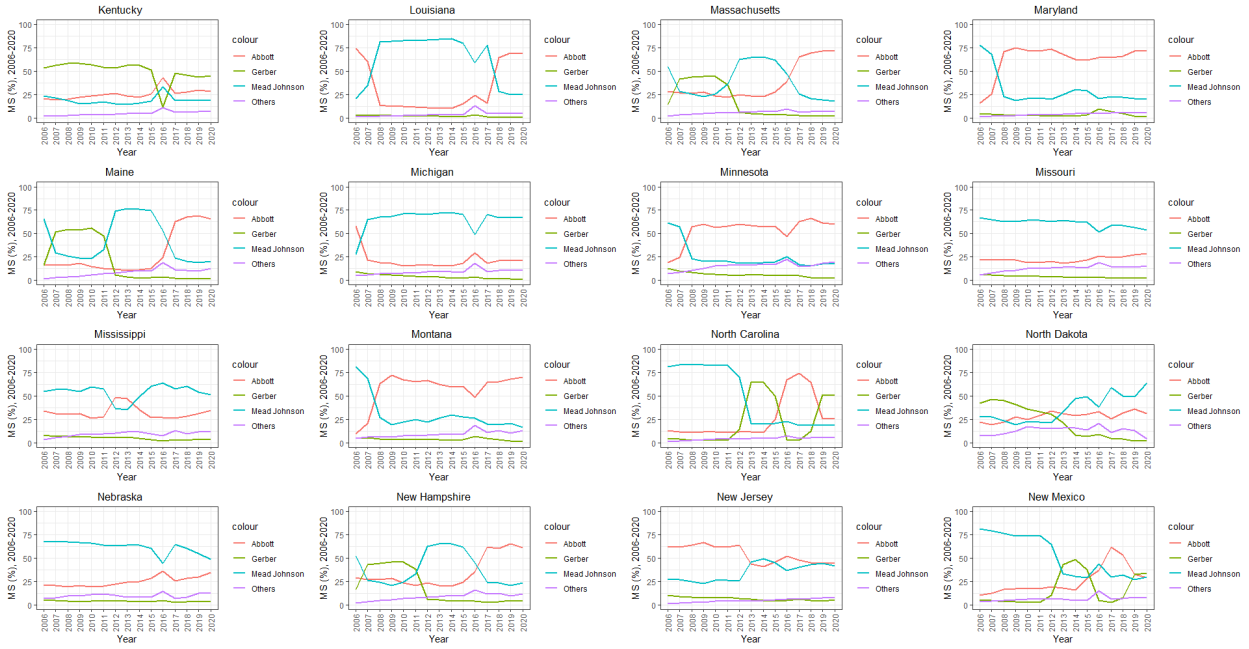
Figures

Figure 1: Market Shares and Prices Changes over Time



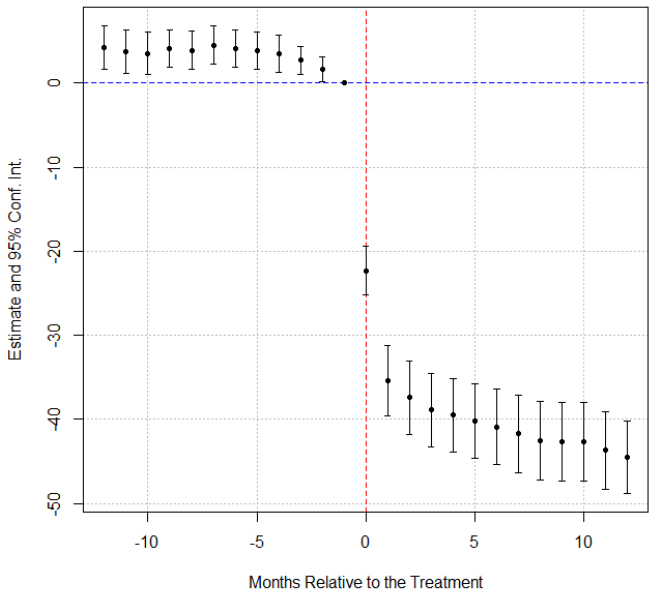
Notes: These graphs show the annual market shares and prices of main three infant formula manufacturers from 2006 to 2020. *Sources:* Nielsen Retail Scan data from 2006 to 2020.

Figure 2: Market Shares Changes over Time in 15 States



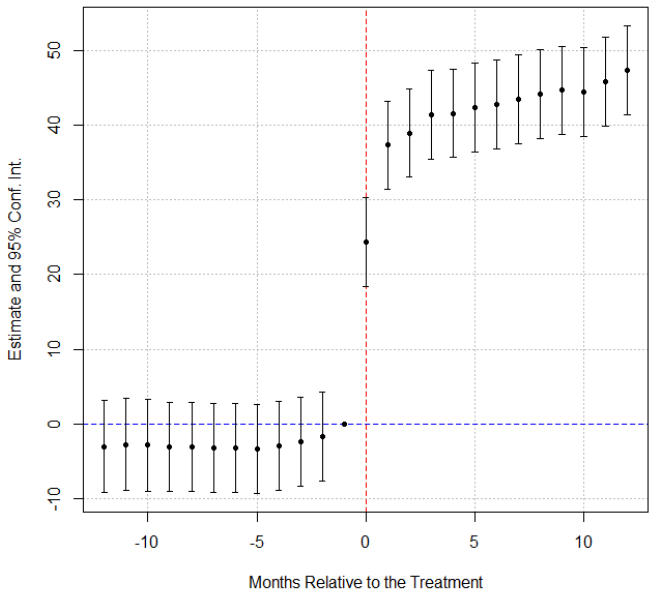
Notes: These graphs show the annual market shares of main three infant formula manufacturers in 15 states from 2006 to 2020: Kentucky, Louisiana, Massachusetts, Maryland, Maine, Michigan, Minnesota, Missouri, Mississippi, Montana, North Carolina, North Dakota, Nebraska, New Hampshire, New Jersey, and New Mexico. The graphs for the others states are shown in the Appendix. From the above graphs, we could find two interesting facts: First, there is a close relationship between firms' market shares and the WIC competitive bidding contract in each state. Second, the WIC contract's winner's market shares increased more than 50 percent after the bidding. WIC competitive bidding contracts seem to cause the imperfect competition market in each state. *Sources:* Nielsen Retail Scan data from 2006 to 2020.

Figure 3: Event Study Results: Market Shares for Previous winners



Notes: The event is that the competitive bidding contract switched the winner in the month m year y, in the state s. The reference time is -1, which means one month before the bidding contract switches winner. The above graph shows the estimates and confidence intervals for the previous winner's market shares at time t in state s. We find that the previous winner's market share dropped more than 30% immediately after the contract switches. 12 Months after the contract changes, the previous winner's market shares become stable. *Sources:* Nielsen Retail scan data from 2006 Jan to 2020 Dec, the WIC rebate data from 2006 to 2015, and https://www.fns.usda.gov/wic.

Figure 4: Event Study Results: Market Shares for New winners



Notes: The event is that the competitive bidding contract switched the winner in the month m year y, in the state s. The reference time is -1, which means one month before the bidding contract switches winner. The above graph shows the estimates and confidence intervals for the previous winner's market shares at time t in state s. We find that the previous winner's market share dropped more than 30% immediately after the contract switches. 12 Months after the contract changes, the previous winner's market shares become stable. *Sources:* Nielsen Retail scan data from 2006 Jan to 2020 Dec, the WIC rebate data from 2006 to 2015, and https://www.fns.usda.gov/wic.

Figure 5: Event Study Results: Average Prices for Previous winners

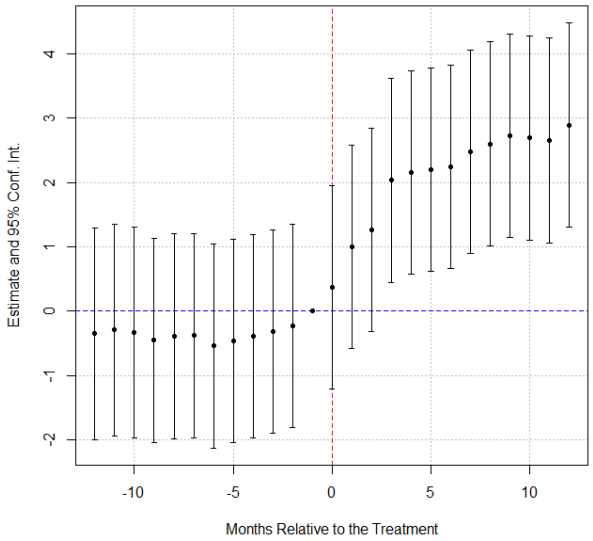


Figure 6: Event Study Results: Average Prices for New winners

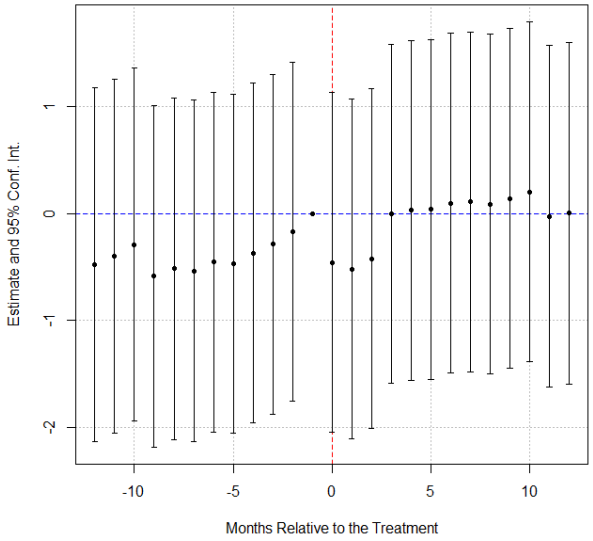


Figure 7: Expected Consumption Behaviors

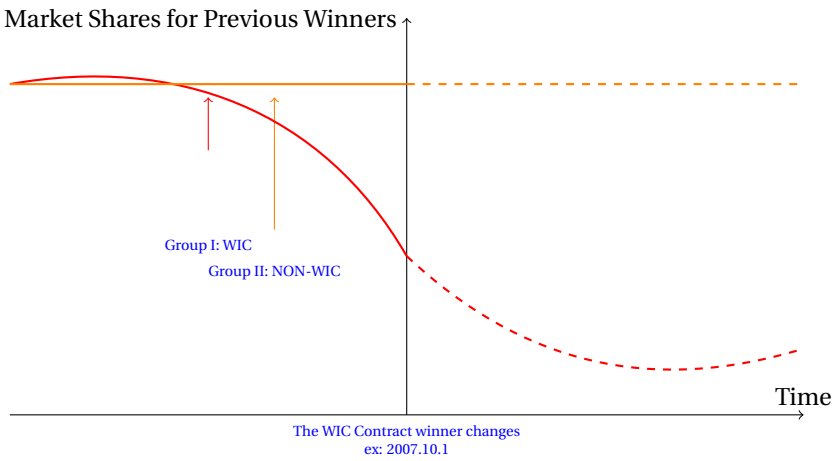
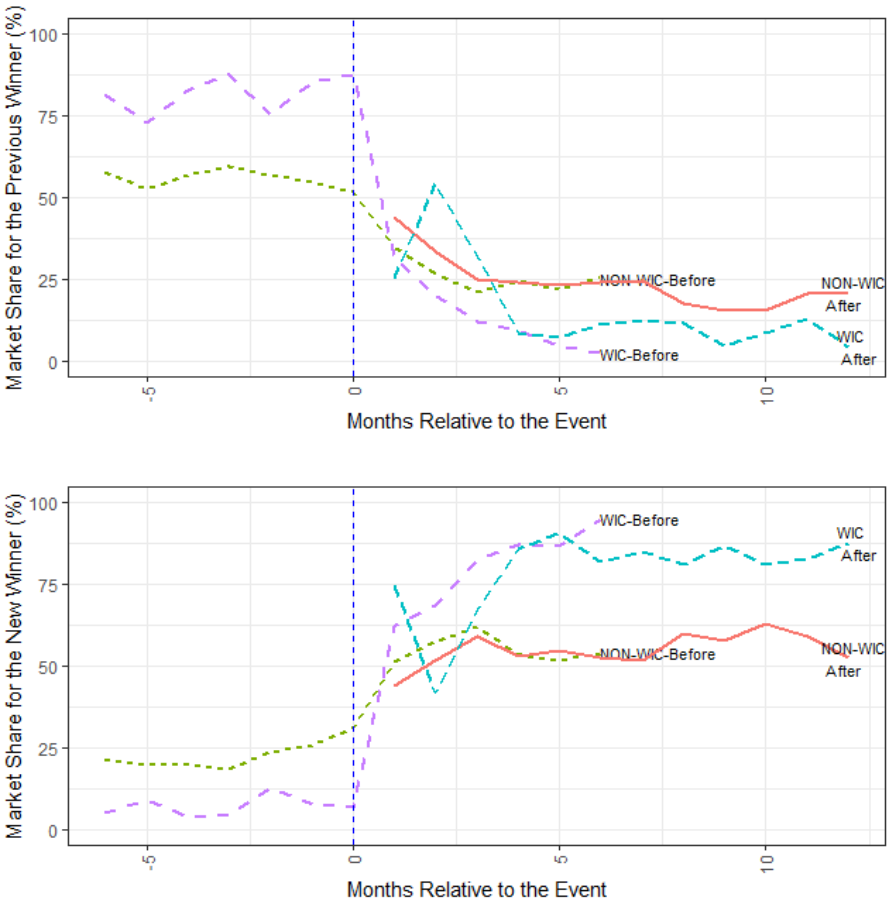
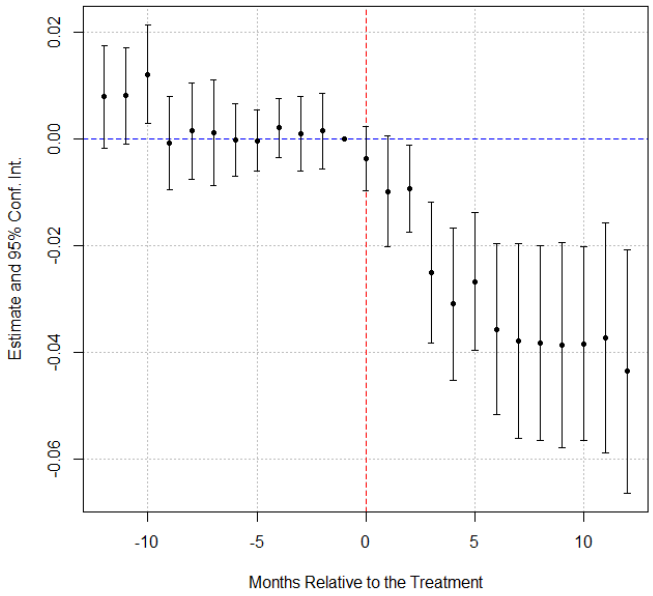


Figure 8: Event Study: Spillover Effects on Non-WIC households



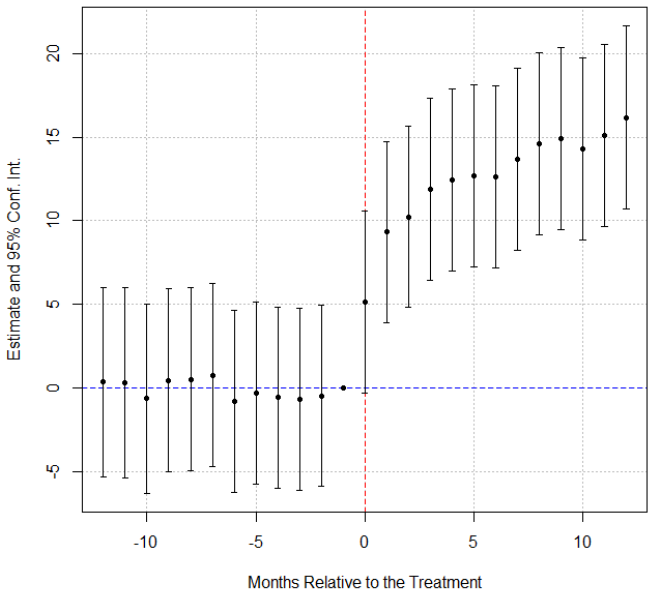
Notes: The upper figure shows changes in previous winners' market shares. It could be decomposed into four types of demands. The green dashed line shows that: After the contract switched, the previous contract winners' market shares from NON-WIC households with babies born before the contract changed declined from 55% to around 25%. It implies a strong spillover effect from switching WIC contracts on non-WIC households' consumption. Besides, the market shares from WIC households dropped around 70%, which indicates that WIC parents might have love brand loyalty for infant formula products. The bottom figure shows that new winners' market shares increase for WIC and NON-WIC households, which mirrors the upper graph and has almost the same implication as the upper graph: There is a spillover effect on non-WIC households. *Sources:* Nielsen Homescan data 2006-2020.

Figure 9: Event Study Results: Market Shares for New winners



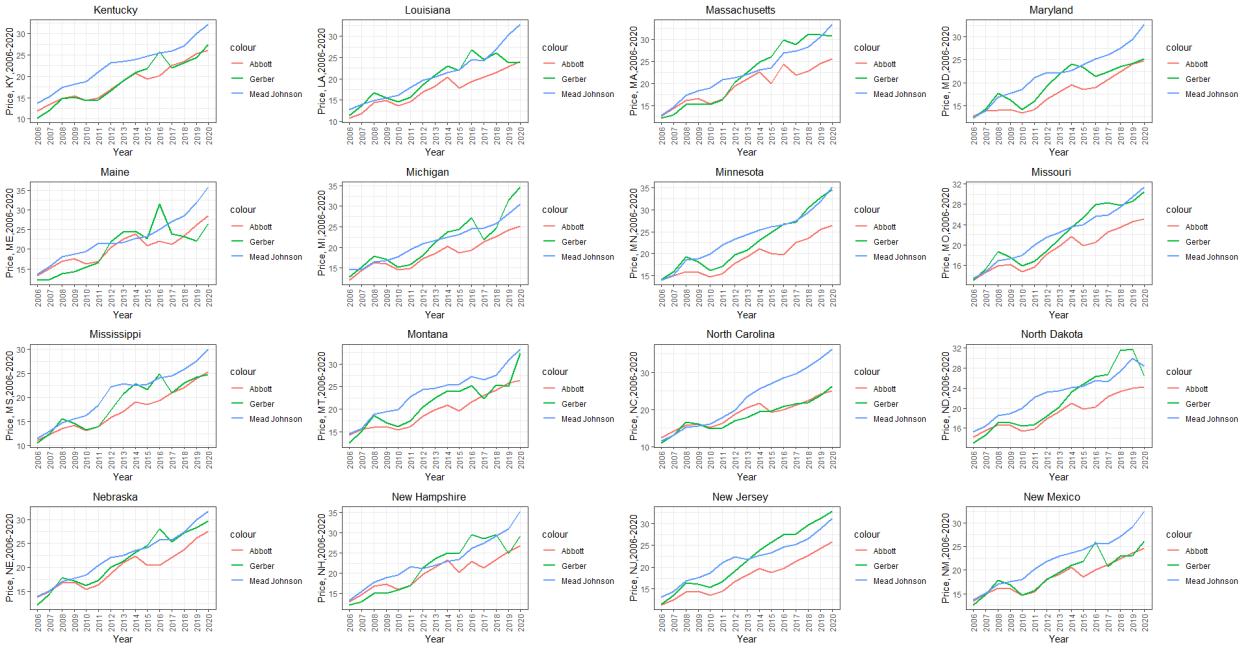
Notes: The event is that the competitive bidding contract switched the winner in the month m year y, in the state s. The reference time is -1, which means one month before the bidding contract switches winner. The above graph shows the number of stores that sold non-WIC infant formula products dropped around 4% after contracts changed. *Sources:* Nielsen Retail scan data from 2006 Jan to 2020 Dec.

Figure 10: Event Study Results: $\frac{(Price_{pre} - Price_{new})}{Price_{new}}$



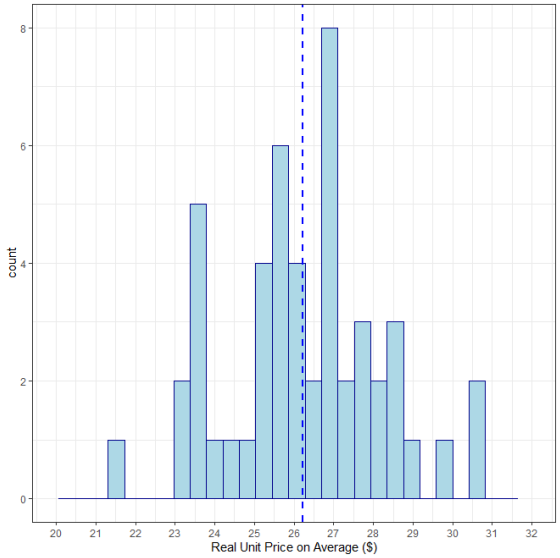
Notes: The event is that the competitive bidding contract switched the winner in the month m year y, in the state s. The reference time is -1, which means one month before the bidding contract switches winner. The above graph shows that: After the WIC contract switched its winner, the difference in unit price between previous winners' infant formula and new winners' infant formula increased by around 10% within 12 months. *Sources:* Nielsen Retail scan data from 2006 Jan to 2020 Dec.

Figure 11: Real Unit Price Changes over Time in 15 States



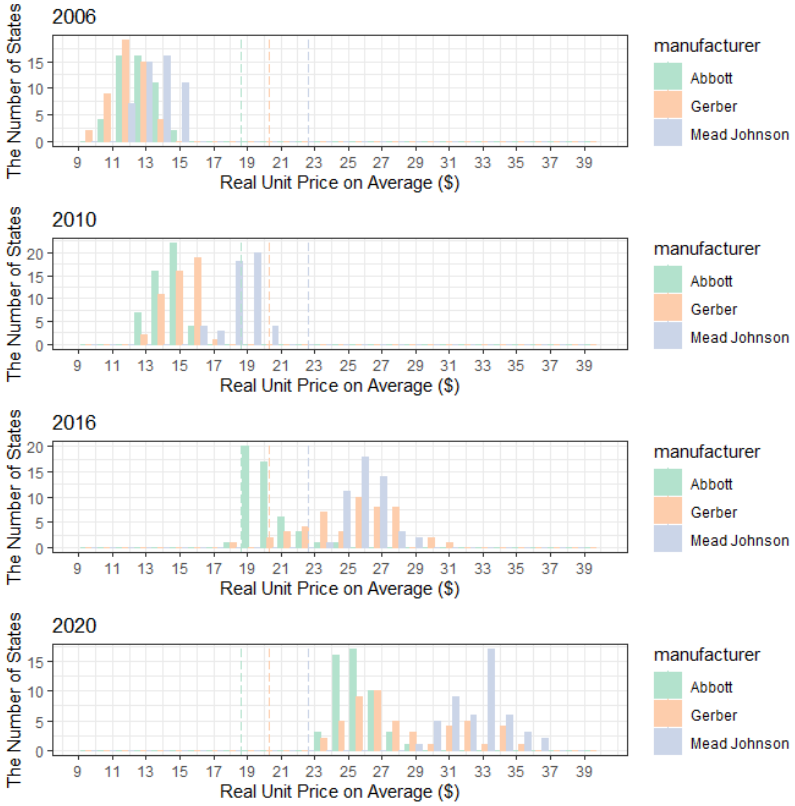
Notes: These graphs show the real unit price of three infant formula manufacturers in 15 states from 2006 to 2020: Kentucky, Louisiana, Massachusetts, Maryland, Maine, Michigan, Minnesota, Missouri, Mississippi, Montana, North Carolina, North Dakota, Nebraska, New Hampshire, New Jersey, and New Mexico. The graphs for the others states are shown in the Appendix. From the above graphs, we find that: Different from the market share graph, the real price keeps increasing over time in each state. From the first glance for the figure, we could not find any strong correlation between switching WIC contracts and changes in real price. Real prices are all adjusted by using the 2010 CPI. *Sources:* Nielsen Retail Scan data from 2006 to 2020, and U.S. Bureau of Labor Statistics. https://fred.stlouisfed.org/series/CPIAUCSL

Figure 12: Price Dispersion in the U.S. for all brands, 2006-2020



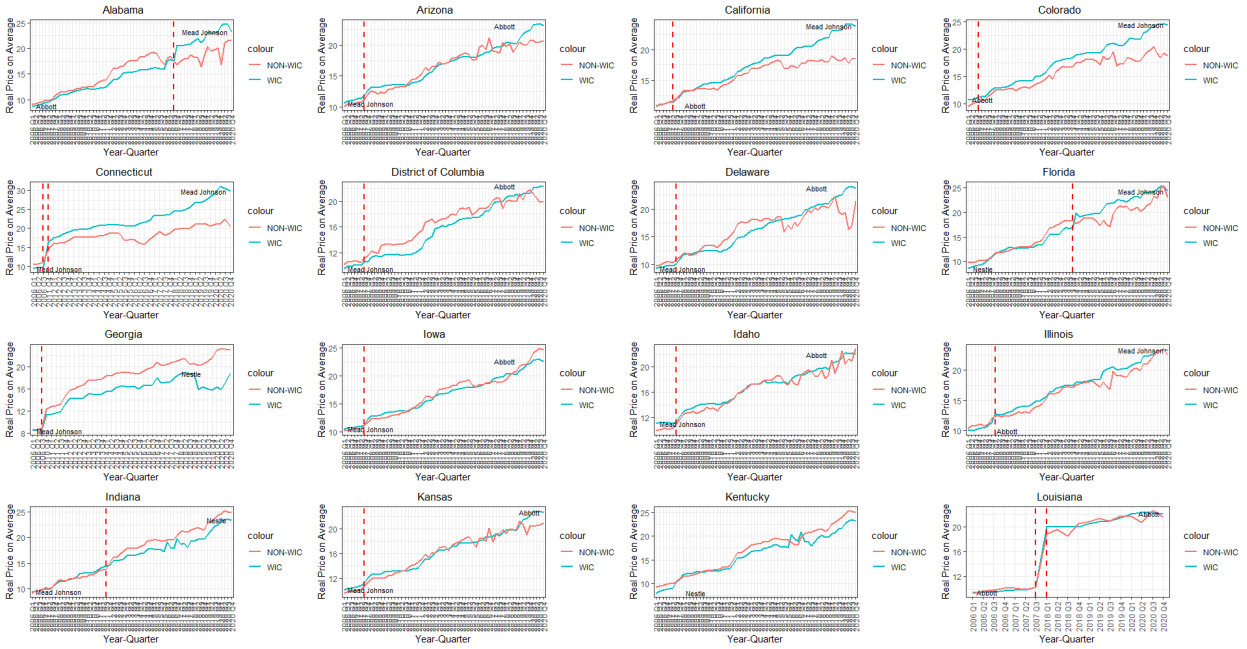
Notes: The above graph shows the variation in real prices of infant formula from 2006 to 2020. It shows that the real average price for all infant formula products is around $26, regardless of package size or brand. Real prices are all adjusted by using the 2010 CPI. *Sources:* Nielsen Retail Scan data from 2006 to 2020.

Figure 13: Price Dispersion in the U.S. for Top 3 Manufacturers, 2006, 2010, 2016, 2020



Notes: The above graph shows the variation in real prices of infant formula by manufacturers in 2006, 2010, 2016, and 2020. There are three takeaways from figure 4: First, Mead Johnson is always the most expensive, and Abbott is always the cheapest. Second, unit prices of all infant formulas have been growing in the past 16 years. Last but not least, the price variations are growing over time. The potential reason could be that an increasing number of package sizes are available in the market. Real prices are all adjusted by using the 2010 CPI. *Sources:* Nielsen Retail Scan data from 2006 to 2020.

Figure 14: Real Price Changes over Time in 16 States



Notes: These graphs show the real prices of WIC-contract and non-WIC-contract infant formula in 16 states from 2006 to 2020. The graphs for the others states are shown in the Appendix. From the above graphs, we find that when Mead Johnson became the winner in a state, the real unit price for the WIC infant formula product increased. It leads to 2 related questions: First, does MJ always supply bigger package sizes of products? Why is MJ always more expensive than the other two brands? Second, what's the causal relationship between MJ becoming a winner and MJ increasing WIC prices? *Sources:* Nielsen Retail Scan data from 2006 to 2020.

Tables

Table 1: Summary Statistics for WIC Competitive Bidding Contracts

	Frequency
Contract Length	
3 Years	38.9%
2 Years	7.3%
1 Year	4.7%
Missing or Exit the contract	37.6%
Formula type	
Milk-based liquid concentrate	37.3%
Soy-based liquid concentrate	22.6%
Milk-based powder	16.3%
Soy-based powder	16.9%
Winner	
Mead Johnson	46.5%
Abbott	25.1%
Gerber	19.1%
Note:	WIC Rebate Data: 1986-2016

Notes: The table presents the frequency of *Source:* WIC Rebate Data from 2006 to 2015

Table 2: Summary Statistics for WIC Rebates

	Mean ($)	SD	Min($)	Median($)	Max($)
Rebate					
Mead Johnson	5	4	0	3.2	15.7
Abbott	4.7	3.8	0	3.2	14.9
Gerber	3.1	4.2	0	1.1	14.9
Wholesale price					
Mead Johnson	6.5	4.6	1.3	4.1	15.8
Abbott	6.4	4.5	1.3	4.1	14.9
Gerber	6.1	4.3	1.6	4.2	15.1

Note: WIC Rebate Data: 1986-2016

Table 3: Summary Statistics of Eligible WIC Households in the Homescan Data

Year	N (Total HHs)	N (Infant Formula)	N(WIC Participants)
2004	39577	1677	150
2005	38863	1567	119
2006	37786	869	60
2007	63350	3033	239
2008	61440	2544	240
2009	60506	2448	194
2010	60658	2276	179
2011	62092	2552	189
2012	60538	2292	149
2013	61097	1910	125
2014	61557	1923	178
2015	61380	2019	240
2016	63150	2401	289
2017	62831	2327	221
2018	61384	2174	190
2019	61483	2056	153
2020	60101	2017	152

Notes: The above table presents the summary statistics for the eligible WIC households each year. The second column presents the total number of households in the Nielsen retail scan data. The third column counts the number of households buying infant formula products in the reported year. The last column shows the total number of WIC households. *Source:* Nielsen Homescan Data 2004-2020

Table 4: Summary Statistics

Statistic	$s_{js,yq}$	$price_{js,yq}$	$1\{j \in winner\}$
Abbott	0.468	16.000	0.396
	(0.353)	(4.312)	(0.489)
Mead Johnson	0.386	17.499	0.420
	(0.347)	(5.545)	(0.494)
Nestle	0.198	14.602	0.255
	(0.246)	(4.226)	(0.436)
Others	0.061	14.170	0
	(0.098)	(4.206)	(0.000)

Notes: Table 4 provides means and standard deviations (in parentheses) for store-level market shares and prices by manufacturers in the typical year and quarter. Real prices are all adjusted by using the 2010 CPI. Note that Abbott has the highest market shares. Mead Johnson has the highest prices, but also has the highest frequency of being WIC contract winners. Total number of store-manufacturer-year-quarter observations is 4,001,043. The total number of store-year-quarter observations is 1,145,962 for Abbott, 1,154,949 for Mead Johnson, 902,680 for Nestle, and 797,452 for others. *Source:* Nielsen Retail Scan data from 2006 to 2020.

Table 5: Summary Statistics

Statistic	$1\{WIC\}_{iyq}$	$1\{WIC\}_{cyq}$
Enrolled in WIC last Month	0.151	0.245
	(0.358)	(0.167)

Notes: Table 5 provides means and standard deviations (in parentheses) for household-level and county-level total number of WIC eligible women or infants who received any food in the typical year and quarter. Total number of observations on WIC is 24,652,105. I excluded all observation in the following cases: refused to answer; or don't know; or no response; or NIU; or missing. After this selection, the household-level sample is 417,569. Among these, 354,648 observations show that they did not receive; and 62,921 show that they received. The county-level sample is 4,089. *Source:* IPUMS data from 2006 to 2020.

Table 6: Effects on Unit Price (Hetergeneous Effects)

	Retail Scanner Data:				*Home Scan Data:*			
	Price($)	Price($)	Price($)	Price($)	Price($)	Price($)	Price($)	Price($)
	Abbott	Gerber	Mead Johnson	ALL	Abbott	Gerber	Mead Johnson	ALL
Abbott	1.965***				2.434***			
	(0.430)				(0.604)			
Gerber		−2.809***				−0.101		
		(0.722)				(0.824)		
Mead Johnson			−4.334***				−3.667***	
			(0.553)				(0.635)	
winner				−1.165***				0.023
				(0.237)				(0.309)
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
State FE	✓	✓	✓	✓	✓	✓	✓	✓
Observations	735	735	735	2,205	735	735	735	3,508
R^2	0.030	0.022	0.082	0.011	0.023	0.00002	0.046	0.000
Note:				*p<0.1; **p<0.05; ***p<0.01				

Notes: The above table shows that: Each manufacturer has a different pricing strategy after winning the contract. Abbott increases its unit price $1.965 after it wins the WIC competitive bidding contract in a state s in a time year t. Gerber (Nestle) and Mead Johnson tend to decrease their prices after they win the contract. Particularly, Gerber tends to decline its unit price around $2.809, and Mead Johnson declines its unit price around $4.334. Real prices are all adjusted by using the 2010 CPI. *Sources:* Nielsen Retail Scan data from 2006 to 2020.

Table 7: Spillover Effects for non-WIC (WIC-Density)

	Dependent variable:
	Market Shares$_j$
$1\{j = \text{winner}\}$	0.517^{***}
	(0.001)
WIC density	-0.018^{***}
	(0.001)
$1\{j = \text{winner}\} \times$ WIC density	0.037^{***}
	(0.002)
Constant	0.231^{***}
	(0.002)
Observations	470,377
R^2	0.694
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 8: Store-Year-Quarter Market with Hausman IV and Raw Milk IV, with YQ FE and Firm FE

	Dependent variable:	
	$ln(MS_j) - ln(MS_{outside})$	
	OLS	*instrumental variable*
	(1)	(2)
$P_j - P_{outside}$	-0.149^{***}	-0.178^{***}
	(0.003)	(0.003)
$1\{winner\}$	1.717^{***}	1.664^{***}
	(0.017)	(0.017)
WIC Density	-0.223^{***}	-0.253^{***}
	(0.040)	(0.041)
$(P_j - P_{outside}) \times 1\{winner\}$	0.056^{***}	0.100^{***}
	(0.005)	(0.005)
$1\{winner\}\times$ WIC Density	0.912^{***}	0.928^{***}
	(0.068)	(0.068)
$(P_j - P_{outside})\times$ WIC Density	0.044^{***}	0.073^{***}
	(0.012)	(0.012)
$(P_j - P_{outside}) \times 1\{winner\}\times$ WIC Density	-0.141^{***}	-0.170^{***}
	(0.021)	(0.021)
Constant	1.852^{***}	1.877^{***}
	(0.015)	(0.015)
Firm FE	✓	✓
Year-Quarter FE	✓	✓
Observations	160,008	160,008
R^2	0.363	0.367
Adjusted R^2	0.363	0.367
Residual Std. Error (df = 159984)	1.487	1.482
F Statistic (df = 23; 159984)	$3{,}965.828^{***}$	$4{,}038.593^{***}$
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 9: Choice Set Effect

State	% A	% B	% C
AL	96.81	97.03	98.73
AZ	98.03	99.54	99.66
CA	98.40	99.82	99.96
CO	99.76	99.79	99.79
CT	97.80 (97.63)	98.65 (93.55)	99.20 (99.88)
DC	100	100	100
DE	98.15	98.74	99.96
FL	95.43	98.87	98.82
GA	92.17 (98.02)	98.84 (99.89)	99.42(82.52)
IA	98.23	98.92	99.83
ID	100	100	100
IL	95.91	99.80	99.83
IN	96.94	99.27	99.25
KS	98.42	100	100
LA	97.57 (87.81)	100 (95.09)	100 (81.29)
MA	98.77 (98.14, 99.04)	99.17 (96.02, 99.23)	99.97 (91.26, 98.51)
MD	98.55	99.08	99.83
ME	98.82 (100, 100)	100 (96.18, 99.47)	100 (99.95, 99.85)
MI	98.46	99.35	99.62
MN	97.53	99.72	99.99
MT	98.78	100	100
NC	97.74 (94.17, 87.79)	98.51 (93.47, 95.22)	99.98 (99.82, 99.61)
ND	69.23	92.59	99.96
NH	97.98 (96.74, 100)	100 (95.69, 99.53)	100 (99.85,99.87)
NJ	98.03	99.33	99.93
NM	99.19 (99.33, 97.40)	100 (98.65, 99.33)	100 (99.99, 99.95)
NV	98.77	98.76	99.99
OR	99.44	99.72	99.99
PA	98.16 (94.38)	99.06 (94.31)	99.88 (99.94)
RI	98.80 (95.60, 100)	100 (94.25, 100)	100 (99.91, 99.53)
TN	94.28	94.59	99.66
TX	98.32	99.67	99.48
UT	100	99.33	99.99
VA	96.70	97.23	99.59
WA	98.21	100	100
WV	98.49	98.46	99.99
WY	100	100	100
Average	97.06	98.37	98.94

Notes: The first column A shows the share of grocery stores that have the positive sold amount of non-contract infant formula products in a state three months before contract switching ($\frac{N_1}{N}$). The second column B shows that conditional on a store having consecutive positive sold for losers infant formula products (N_1), the share of grocery stores which had any positive sold amount after switching contracts ($\frac{N_2}{N_1}$). The last column C shows the share of grocery stores which have consecutive positive amount sold for the non-contract infant formula products 3 months after contract switched($\frac{\overline{\sum(q^{pre}(Loser)\times 1\{q^{post}>0\}})}{\sum(q^{pre}(Loser))}$). *Sources:* Nielsen Retail Scan data from 2006 to 2020.

Table 10: Choice Set Effect: Robustness Check

State	% D	% E	% F
AL	86.58	66.05	0.74
AZ	96.21	99.05	0
CA	97.31	99.22	0.11
CO	96.06	99.14	0
CT	93.39 (83.86)	86.79 (79.81)	0 (4.70)
DC	100	100	0
DE	94.44	94.77	0.65
FL	86.94	91.14	0.60
GA	89.44 (96.82)	91.25 (97.73)	0.80(0)
IA	95.05	94.80	0.74
ID	98.29	97.39	0
IL	94	99.60	0
IN	95.06	98.76	0.25
KS	96.32	98.91	0
LA	95.75 (62.08)	98.41 (96.73)	0 (0)
MA	96.12 (87.34, 97.49)	90.64 (77.61, 95.64)	0.43 (2.56, 0.40)
MD	95.46	96.76	0.38
ME	98.23 (86.34, 98.41)	96.39 (78.48, 96.24)	0 (1.27, 0)
MI	95.38	95.56	0.14
MN	94.25	95.93	0
MT	96.34	97.47	0
NC	89.65 (78.72, 78.55)	94.47 (85.99, 90.52)	0.57 (1.90, 2.55)
ND	64.10	100	0
NH	95.46 (87.91, 96.70)	97.36 (78.31, 91.04)	0 (3.70,0)
NJ	95.93	98.22	0.41
NM	97.56 (93.29, 94.16)	98.33 (91.37, 97.24)	0 (0, 0.69)
NV	95.08	98.71	0
OR	97.48	97.41	0
PA	93.73 (72.07)	96.26 (77.64)	0.18 (1.38)
RI	93.98 (75.82, 95.18)	88.46 (66.67, 93.67)	0 (2.90, 0)
TN	85.01	85.46	2.18
TX	97.36	98.93	0.17
UT	95.33	100	0
VA	87.10	92.06	0.83
WA	97.02	97.85	0
WV	88.89	94.32	0
WY	100	94.92	0
Average	91.49	92.75	0.59

Notes: The first column D shows the share of grocery stores with consecutive positive sold amounts for the loser three months before the contract switched. The second column, E, shows the share of grocery stores with consecutive positive sold amounts for the loser three months after the contract switched. The last column F shows the share of grocery stores with consecutive 0 sold amount for the loser three months before the contract switched..
Sources: Nielsen Retail Scan data from 2006 to 2020.

Table 11: From 2006 to 2020: Infant formula Products in the Nielsen Retail Scan Data

	size amount	MS (q)	Sold Amount	Average Real price
1	12.90	18.25	685112267	17.27
2	12.40	13.35	490430019	17.08
3	12.00	10.50	403148089	16.63
4	12.50	8.82	246416308	18.14
5	13.00	8.38	356491761	5.52
6	32.00	7.75	295774986	9.40
7	12.60	3.73	131711220	20.26
8	23.20	3.49	126968490	25.85
9	24.00	2.90	113802514	21.55
10	8.00	2.89	92945977	12.20
11	12.70	2.37	89647308	16.47
12	22.20	1.85	48763684	27.63
13	25.70	1.80	76285511	27.50
14	2.00	1.58	53797221	9.46
15	13.10	1.09	38348212	18.42
16	16.00	0.98	40656662	28.00
17	16.60	0.91	24137156	40.63
18	20.00	0.83	30758162	22.21
19	23.40	0.72	22213169	26.67
20	22.00	0.72	27025585	25.07
21	12.10	0.70	14999138	17.40
22	21.00	0.66	23432500	23.99
23	22.50	0.66	19434346	27.55
24	21.50	0.59	14705659	26.57
25	22.56	0.53	16398041	28.52
26	33.20	0.51	4659840	25.18
27	30.80	0.49	16927383	30.67
28	19.80	0.45	10636936	41.69
29	20.70	0.44	2363419	35.21
30	12.80	0.41	15611242	17.88
31	25.75	0.39	16051310	23.32
32	34.00	0.39	12923506	34.05
33	29.80	0.38	5806499	37.74
34	19.50	0.35	7818230	29.59
35	17.50	0.32	8468394	38.42
36	16.10	0.28	7200368	40.65
37	21.10	0.26	1912102	31.92
38	20.90	0.25	1851697	31.81
39	6.50	0.24	3612520	2.52
40	35.00	0.24	5496333	31.21
41	29.10	0.23	1223193	39.93
42	30.88	0.23	7182552	30.80
43	19.90	0.22	1616927	31.24
44	40.00	0.21	6713409	26.03

Table 12: Effects of Signing Contract with j on j's Market Shares

	Retail Scanner Data:			*Home Scan Data:*		
	MS(%) Abbott	MS (%) Gerber	MS (%) Mead Johnson	MS (%) Abbott	MS (%) Gerber	MS (%) Mead Johnson
Abbott	41.111***			34.363***		
	(0.838)			(2.133)		
Gerber		41.365***			32.606***	
		(0.740)			(1.980)	
Mead Johnson			42.142***			29.900***
			(0.796)			(1.932)
Year FE	✓	✓	✓	✓	✓	✓
State FE	✓	✓	✓	✓	✓	✓
Observations	735	735	735	735	735	735
R^2	0.779	0.820	0.804	0.275	0.284	0.259
Adjusted R^2	0.763	0.807	0.790	0.223	0.232	0.206
Note:						*p<0.1; **p<0.05; ***p<0.01

Table 13: Is there any significant difference between WIC and Non-WIC HHs?

	Dependent variable:		
	MS (%) for Abbott	MS (%) for Gerber	MS (%) for Mead Johnson
Winner j × $1\{WIC\}$ (β_1)	−2.434	9.098***	7.525***
	(3.075)	(2.646)	(2.598)
Winner j (β_2)	30.578***	26.059***	23.678***
	(2.789)	(2.309)	(2.253)
$1\{WIC\}$ (β_3)	−9.889***	−1.727	−14.450***
	(2.113)	(1.100)	(1.548)
Constant	32.605***	8.916**	24.097***
	(6.267)	(4.010)	(5.128)
Observations	1,470	1,470	1,470
R^2	0.317	0.442	0.359
Note:			*p<0.1; **p<0.05; ***p<0.01