The Spillover Effect of Switching WIC Competitive Bidding Contracts in the Infant Formula Market

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Introduction: *Research Question*

- **WIC**
    - is the Special Supplemental Nutrition Assistance Program.
    - provides nutritious foods through retail grocery stores.
    - distribute monthly vouchers that can be redeemed for food.
    - serves nearly 8 million low-income women, infants, and children at nutritional risk.
        * 1.7 million infant participants; 45% of all infants. (2018)
- **Market**
    - The infant formula market is highly concentrated and dominated by three firms: Abbott, Gerber, and Mead Johnson.
    - WIC is the the major buyer of the infant formula.
        * WIC state agencies are required by law to have competitively bid infant formula rebate contracts with infant formula manufacturers.
        * WIC state agency gives the winner exclusive right to supply WIC's infant formula products.

WIC WIC Process

Introduction: *Detailed Research Questions and Methods*
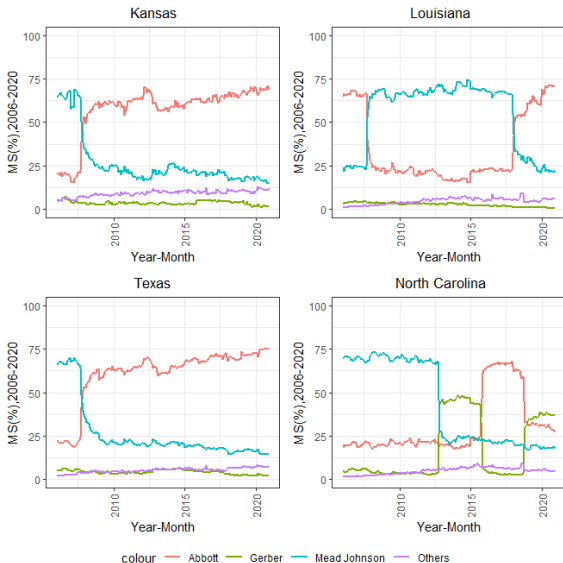
Today: Reduced-form evidence on consumers' responses to switching WIC contracts' winners.

- Are there any spillover effects on nonparticipants?
    - *Definition:* Why do non-WIC households also buy WIC contract winner's formulas?
    - Oliveira, Frazao, and Smallwood (2011), USDA

- Better understand the mechanisms behind these spillovers.
    - Choice Set Effect (proposed by Huang and Perloff, 2014)
    - Price Effect

Future Goal: A structural model in the infant formula market, to compare social welfare with and without competitive bidding contracts.

Background

Background: *Eligible conditions*

- **Categorical**
  - Women (pregnant, postpartum, breastfeeding), Infants (up to infant's birthday), children (up to the child's fifth birthday).
    * WIC formula is provided to: Partially breastfed infants, and Fully formula fed infants.
- **Residential**
  - Maybe required to live in a local service area.
    * Maximum monthly allowance amount varies by states and years.
- **Income requirement**
  - 100% ~ 185% of the federal poverty income lines.
- **Nutrition risk**
  - Applicant must be seen by a health professional who must determine whether the individual is nutrition risk.
    * The free health exam is done in the WIC clinic.
    * Each state has a annual nutritional risk criteria handbook.

Background: *WIC's Infant formula Products*

NON-WIC products   WIC products

- WIC's Infant formula is labeled on the shelves at supermarkets.
- WIC state agencies show the approved infant formula product list on their website.

- **Food list**: Infant formula; infant and adult cereal; baby food fruits, vegetables and meats; whole wheat bread, brown rice, soft corn; juice; eggs.
- **Timeline**:
    - *Mid-1980s*: Infant formula is expensive for WIC.
        * Tennessee and Oregon proposed to use competitive bidding.
        * Mead Johnson and Ross Lab resisted. Wyeth submitted the bid and won.
    - *1989*: All states are required by law to use competitive bidding for the infant formula to reduce the total WIC food costs.

Data

WIC Rebate Data (1986-2016)

- The database includes a nearly complete compilation of winning and losing rebate bids for infant formula products from 1986 to 2016.
- Sample size: 1523
- State: 50 states
    - the Washington DC and Puerto rico
    - 18 state alliances
- *Variables*:
    - Date contract began
    - Contract length
    - Previous winner
    - New winner
    - The rebate amounts that each manufacturer bid

Summary Statistics

Summary Statistics for the WIC Rebate Data

	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

Nielsen Data (2006-2019)

- *Homescan data*
  - A panel data of around $60,000$ U.S. households who continually provide information to Nielsen.
  - *Variables*: which products they buy; total expenditures per trip; when and where they buy; how much they paid for each product.
- *Retail Scanner data*
  - A weekly panel data of products in approximately $50,000$ stores.
  - *Variables*: Product's weekly price; a store-level sales units each week; brands; product's package and size; retailer's information from 2006 -2020.

How many families bought baby formula in my data?

Year	N (Total HHs)	N (Infant Formula)	N(Eligible)
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

Note: Nielsen Homescan Data: 2004-2020

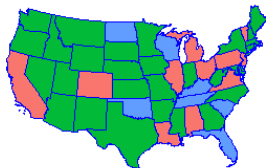# Facts and Descriptive Results

National: Market Shares and Unit Prices
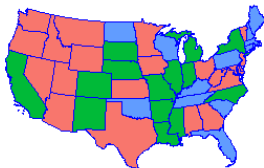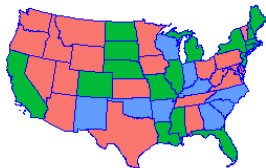
National: Price dispersion over time
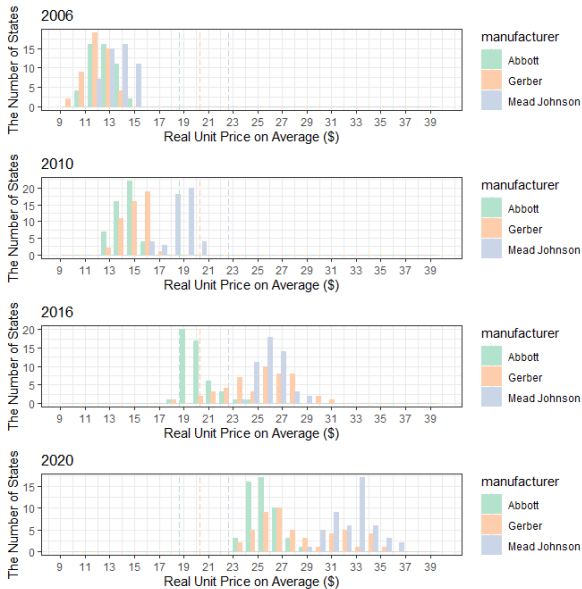
State: WIC contract winners

2006 Q3
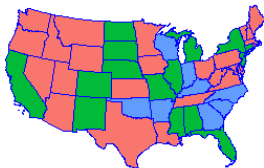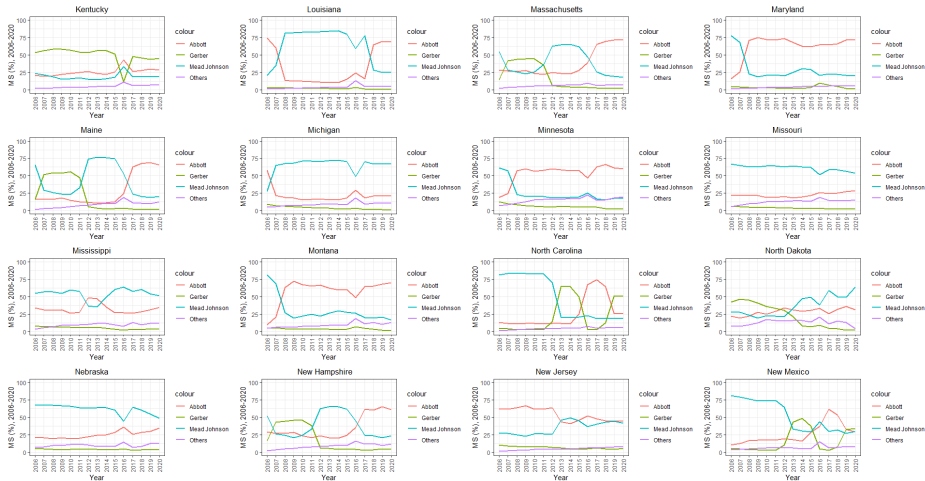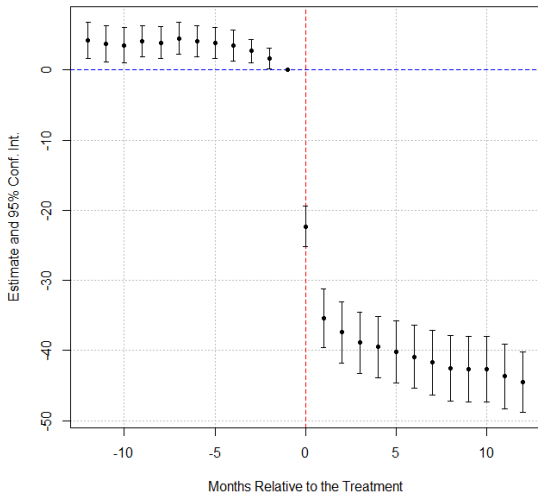
2010 Q3

2014 Q3

2020 Q3

manufacturer   Abbott   Mead Johnson   Nestle

Main Results

What is the impact of switching WIC contracts on firms' market shares?

**Main Results:** *The market shares for the previous winner*

Quantify the Impact of Switching WIC Contracts

	Dependent variable:	
	$MS_{s,ym}^{\text{Previous winner}}$	
	OLS	OLS weighted[1]
1{*post*}	−50.892***	−50.602***
	(0.265)	(0.257)
Constant	69.979***	68.823***
	(0.497)	(0.795)
Observations	4,860	4,860
R^2	0.907	0.911
Adjusted R^2	0.906	0.911
Note:	*p<0.1; **p<0.05; ***p<0.01	

[1] I weighted it on the store's total sold amount.

Main Results: *The market shares for the new winner*
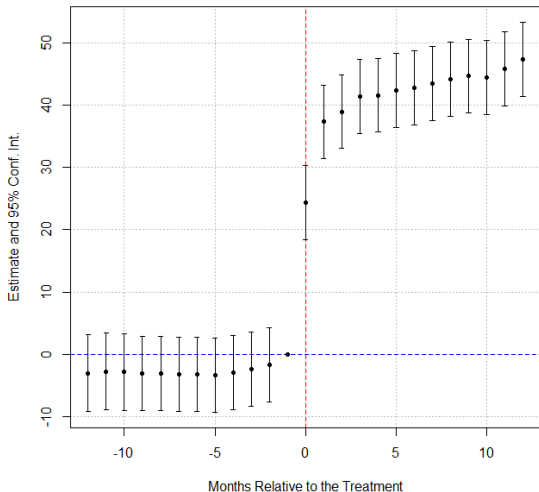
Effects of Signing Contract with j on j's Market Shares

	Retail Scanner Data:			*Home Scan Data:*		
	MS(%)	MS (%)	MS (%)	MS (%)	MS (%)	MS (%)
	Abbott	Gerber	Mead Johnson	Abbott	Gerber	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: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Is There Spillover Effect on Nonparticipants?

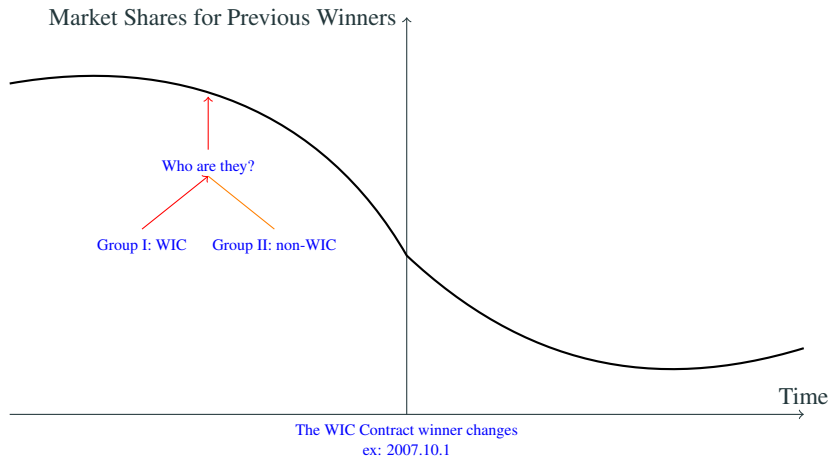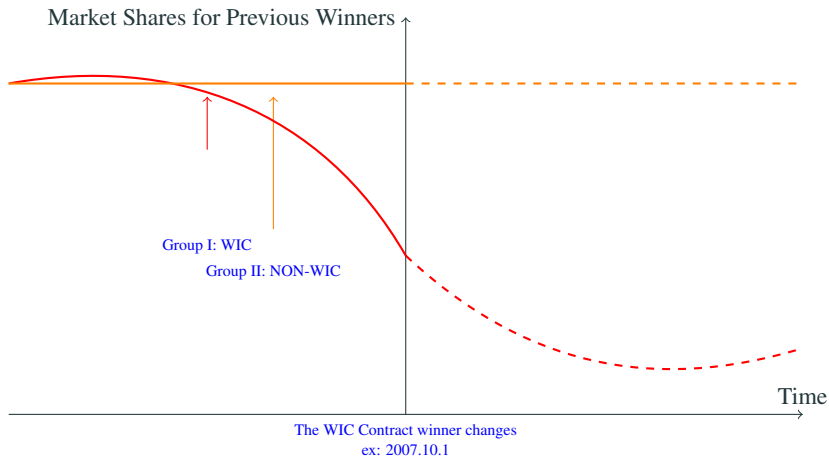## *Are there any spillover effects?*

- To disentangle the newborn's consumption from previous-babies' consumption, we will look at 4 groups' consumption pattern:
  1. WIC babies born before contract changed
     * WIC babies should always choose bidding winner's products.
  2. Non-WIC babies born before contract changed
     * Unknown.
  3. WIC babies born after contract changed
     * WIC babies should choose new winner's products.
  4. Non-WIC babies born after contract changed
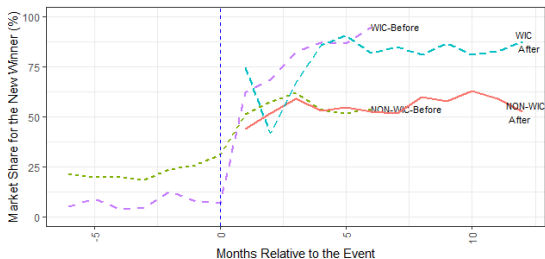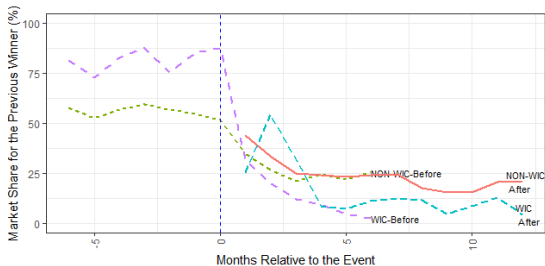   * Unknown. If there is spillover, then they should choose new winner's products.

Market Shares for Previous Winners

Who are they?

Group I: WIC   Group II: non-WIC

Time

The WIC Contract winner changes
ex: 2007.10.1

Market Shares for Previous Winners

Group I: WIC

Group II: NON-WIC

Time

The WIC Contract winner changes
ex: 2007.10.1

Are there any spillover effects?

The Heterogeneous Effects of Switching Contracts on WIC and NON-WIC HHs

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

	Dependent variable:		
	MS (%)	MS (%)	MS (%)
	for Abbott	for Gerber	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

Mechanisms: Choice Set Effect

Mechanism: *Choice Set Effect*

- **Choice Set Effect**: Given a grocery store's shelf space for infant formula products, grocery stores are required by WIC state agency to keep WIC products, so Non-WIC households have to buy WIC infant formula.
- **Question**: Is that true that the grocery stores immediately switched all infant formulas with the new WIC winning brand to limit non-WIC HHs' choice sets?
  - Among N_1, the share of grocery stores which had any positive amount sold <u>after</u> switching ($\frac{N_2}{N_1}$): 98.37
  - 98.94

  $$\frac{\sum(q^{pre}(Loser) \times 1\{q^{post} > 0\})}{\sum(q^{pre}(Loser))}$$

  - The share of grocery stores which have <u>consecutive positive</u> amount sold for the loser 3 months <u>after</u> contract switched ($\frac{N_4}{N_3}$): 92.75
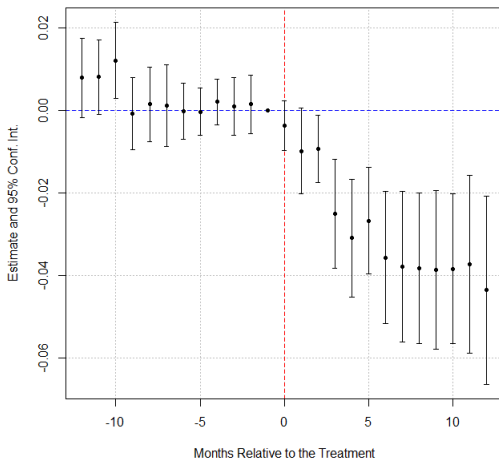
Choice Set Effect: *Intuition*

	share of stores having consecutive positive sold	shares of stores having any positive sold	weighted shares of stores having any positive sold
AL	66.05	97.03	98.73
AZ	99.05	99.54	99.66
CA	99.22	99.82	99.96
CO	99.14	99.79	99.79
CT	86.79 (79.81)	98.65 (93.55)	99.20 (99.88)
DE	94.77	98.74	99.96
FL	91.14	98.87	98.82
GA	91.25 (97.73)	98.84 (99.89)	99.42(82.52)
IA	94.80	98.92	99.83
IL	99.60	99.80	99.83
IN	98.76	99.27	99.25
KS	98.91	100	100
LA	98.41 (96.73)	100 (95.09)	100 (81.29)
MA	90.64 (77.61, 95.64)	99.17 (96.02, 99.23)	99.97 (91.26, 98.51)
Average	92.75	98.37	98.94

Note:

Choice Set Effect: *How many stores have any positive amount of previous winners products?*

- Dependent variable: $1(Q^{\text{Previous winner}} > 0)_{\text{store, year-month}}$

Choice Set Effect: *Quantify the results*

	Dependent variable:	
	$1\{Q^{\text{Previous winner}} > 0\}$	
	OLS	weight OLS
$1\{post\}$	−0.046***	−0.000
	(0.0004)	(0.000)
Constant	0.956***	1.000***
	(0.0004)	(0.000)
Observations	2,759,148	2,759,148
R^2	0.005	0.500
Adjusted R^2	0.005	0.500
Note:	*p<0.1; **p<0.05; ***p<0.01	

Choice Set Effect: *Heterogeneous Effects on Different Store Types*

	Dependent variable:	
	$1\{Q_{s,ym}^{\text{Previous winner}} > 0\}$	
	(1)	(2)
$1\{post\}$	-0.019^{***}	-0.012^{**}
	(0.003)	(0.005)
$1\{post\}\times$Drug	-0.016^{***}	-0.014^{***}
	(0.003)	(0.003)
$1\{post\}\times$Food	0.021^{***}	0.022^{***}
	(0.003)	(0.003)
$1\{post\}\times$ Gas Station	0.119^{***}	0.109^{***}
	(0.033)	(0.033)
Store FE	✓	✓
Time FE		✓
Observations	161,495	161,495
R^2	0.005	0.003
Adjusted R^2	-0.141	-0.145
F Statistic	182.879^{***} (df = 4; 140794)	89.313^{***} (df = 4; 140697)
Note:		*p<0.1; **p<0.05; ***p<0.01

Choice Set Effect: *How many stores having more than 25% of previous winners products?*

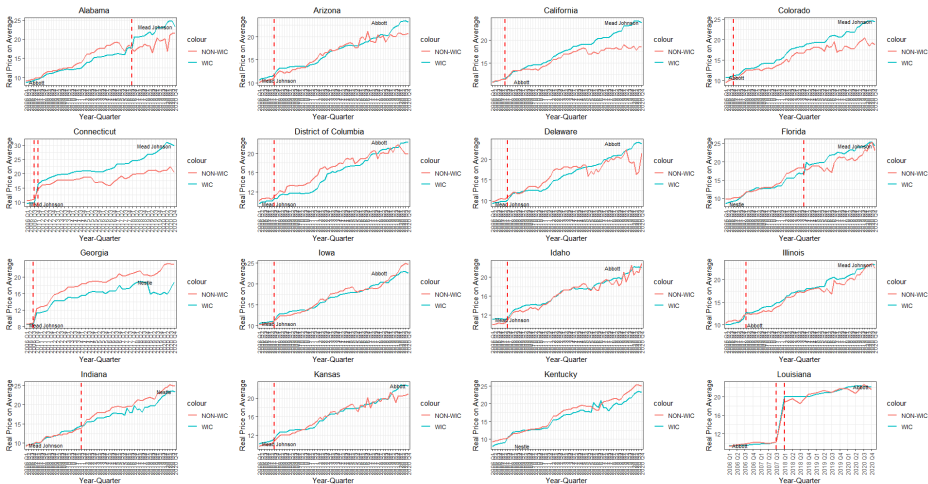- Dependent variable: $1(MS^{\text{Previous winner}} > 25)_{\text{store, year-month}}$

MS > 0   MS > 50   MS > 75   MS = 100
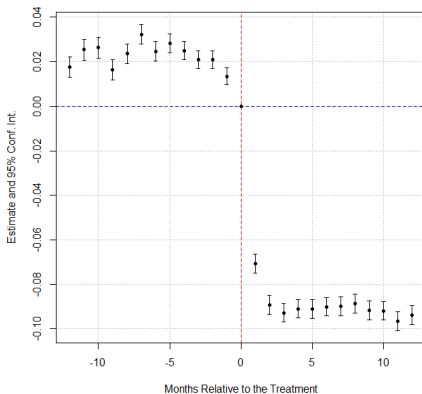
Mechanisms: Price Effect

- **Hypothesis**: If WIC products are much cheaper than non-WIC products on average, by the law of demand, consumers will all buy WIC products (winners' products). That could potentially explain the spillover effects.
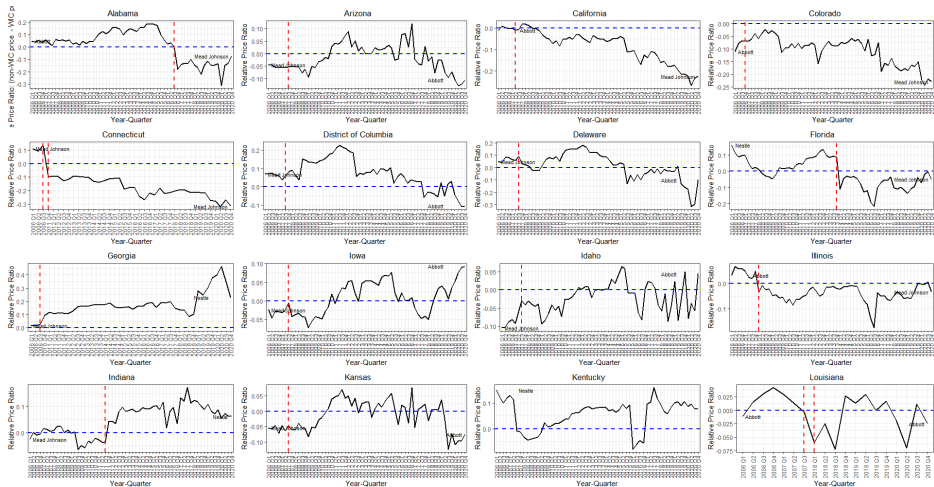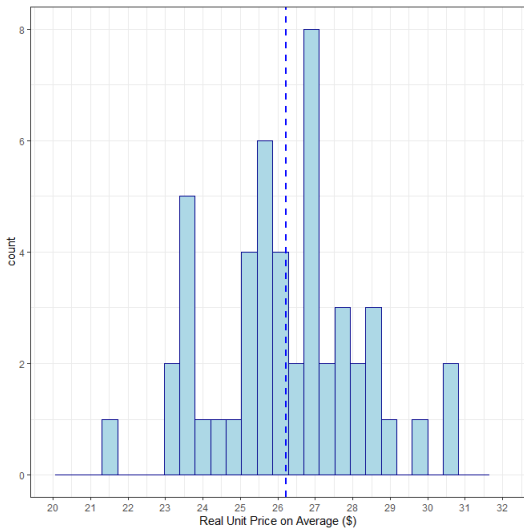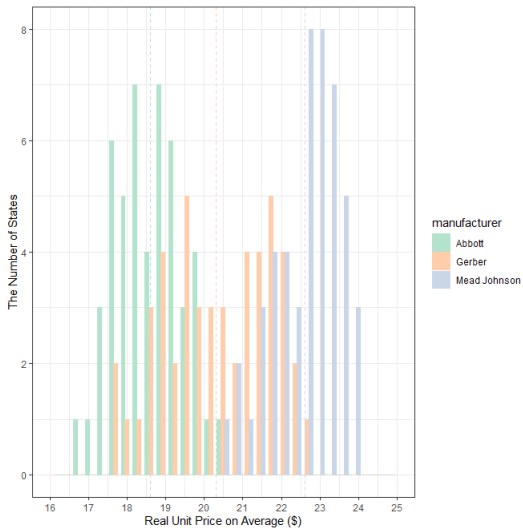
WIC and NON-WIC Prices
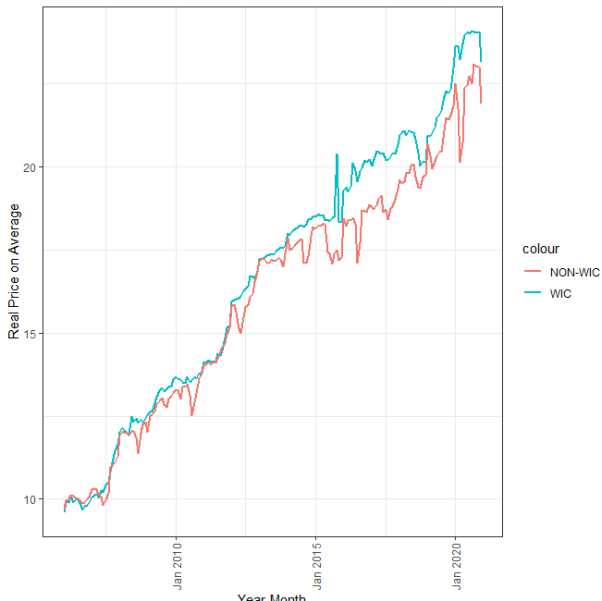
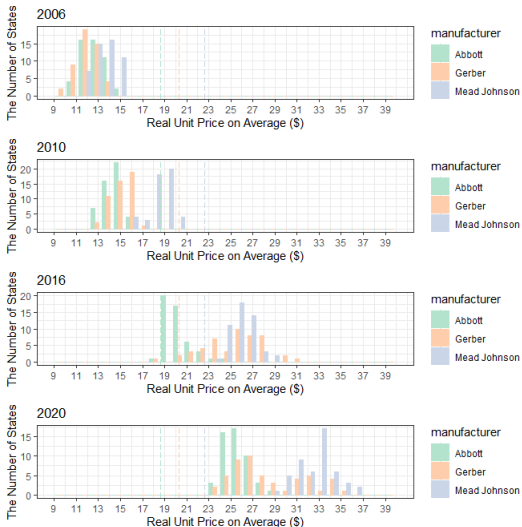# Differences between WIC and NON-WIC Prices by States

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

Price Dispersion in the U.S. for Top 3 brands

# The impact of Winning WIC Contracts on Winner's Price

Winner's Price

	Retail Scanner Data:			Home Scan Data:		
	Price($)	Price($)	Price($)	Price($)	Price($)	Price($)
	Abbott	Gerber	Mead Johnson	Abbott	Gerber	Mead Johnson
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)
Year FE	✓	✓	✓	✓	✓	✓
State FE	✓	✓	✓	✓	✓	✓
Observations	735	735	735	735	735	735
R^2	0.030	0.022	0.082	0.023	0.00002	0.046

Note: $^*p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$
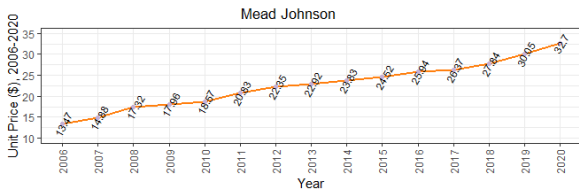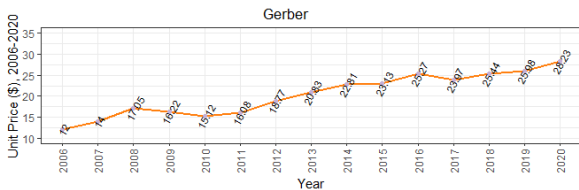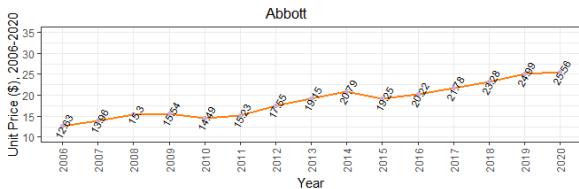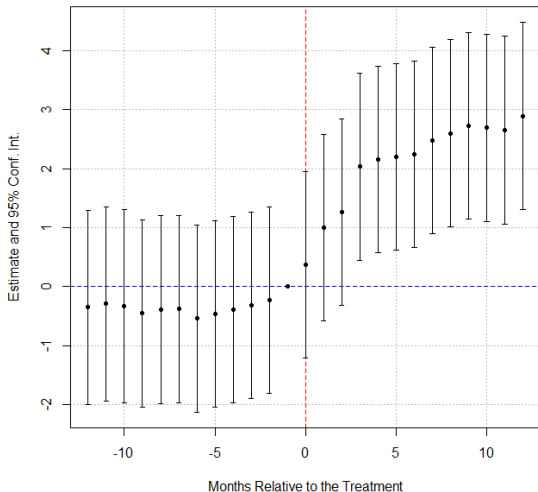
Price Correlation

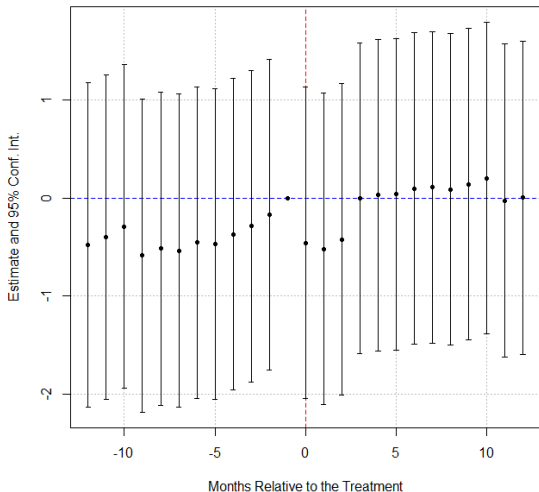$$Price_{st}^{MJ} = \beta_1 \times 1\{Abbott = 1\}_{st} + \beta_2 \times Price_{st}^{Abbott} + \epsilon_{st}$$

	Dependent variable:	
	Unit Price ($)	Unit Price ($)
	Gerber	Mead Johnson
$1\{winner = Abbott\}$	1.396**	2.071***
	(0.584)	(0.577)
Unit Price of Abbott	0.484***	0.540***
	(0.036)	(0.036)
Observations	735	735
R^2	0.225	0.277

Note: *p<0.1; **p<0.05; ***p<0.01

Conclusion

Conclusion

1. Is there a spillover effect on nonparticipants?
   - Yes, NON-WIC parents who have babies born before the contract switched, also purchased WIC infant formula. (25%)

2. Why is there a spillover effect?
   - Choice Set Effect (Small)
   - Price Effect (Main mechanism)

Future Goal: A structural model in the infant formula market, to compare social welfare with and without competitive bidding contracts.

Appendix

Maximum Monthly Allowances of Supplemental Foods For Infants In Food Packages I, II and III

Foods	--Fully Formula fed--		--Partially Breastfed--		--Fully Breastfed--	
	Food Packages I and III A: 0-3 months B: 4-5 months	Food Packages II and III 6-11 months	Food Packages I and III A: 0 to 1 month B: 1-3 months C: 4-5 months	Food Packages II and III 6-11 months	Food Package I 0-5 months	Food Package II 6-11 months
WIC Formula	A: 806 fl oz reconstituted liquid concentrate B: 884 fl oz reconstituted liquid concentrate	624 fl. oz. reconstituted liquid concentrate	A: 1 can powder B: 364 fl oz reconstituted liquid concentrate C: 442 fl. oz. reconstituted liquid concentrate	312fl. oz. reconstituted liquid concentrate		
Infant cereal		24 oz		24 oz		24 oz
Baby food fruits and vegetables		128 oz		128 oz		256 oz
Baby food meat						77.5 oz

[1] Refer to the regulatory requirements for the complete provisions and requirements for infant formula and infant foods in the WIC food packages.

Back

Two stages:

- Stage 1: Competitive bidding contracts. ($\approx$ 3 years)
    - WIC state agency and infant formula manufacturers.
    - Determine the rebate amount for each can of infant formula in the state.
- Stage 2: WIC program in the infant formula market.
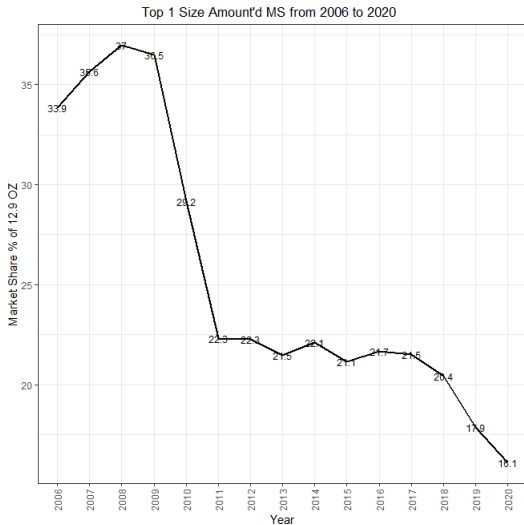

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Summary Statistics for the WIC Rebate Data

|	Frequency
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

Back

Market share for 13 OZ Infant Formula
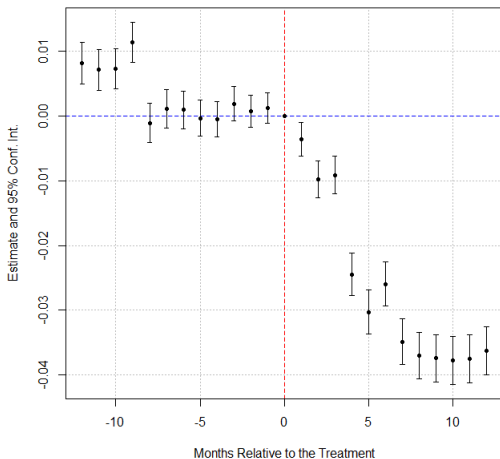

Top 1 Size Amount'd MS from 2006 to 2020

Back

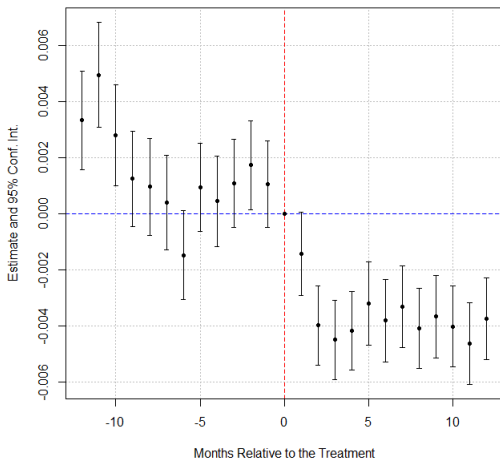# Retail price and Wholesale price for Mead Johnson 13 OZ infant formula (2010 CPI)
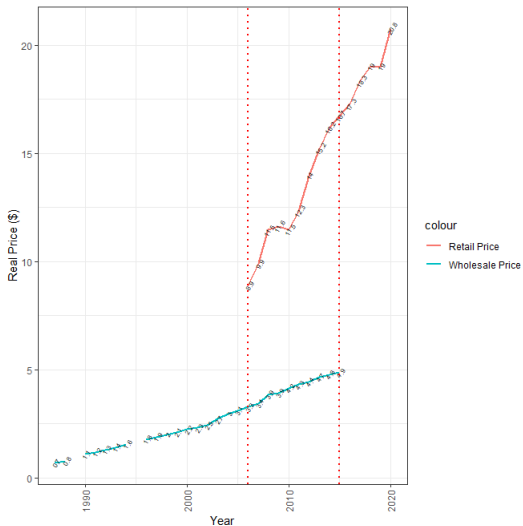
Mechanism: *Shelf Space Story*

- Dependent variable: $1(MS^{\text{Previous winner}} > 0)_{\text{store, year-month}}$
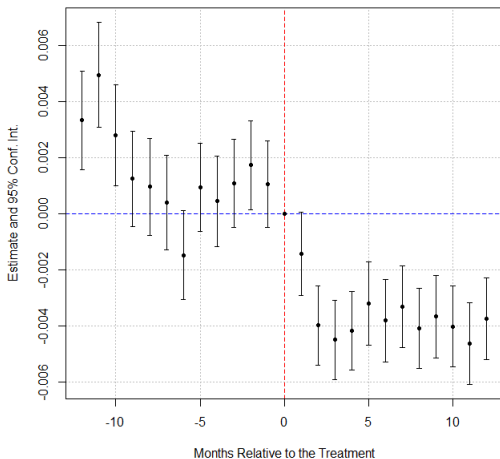
- Dependent variable: $1(MS^{\text{Previous winner}} > 50)_{\text{store, year-month}}$

Mechanism: *Shelf Space Story*

- Dependent variable: $1(MS^{\text{Previous winner}} > 75)_{\text{store, year-month}}$

Mechanism: *Shelf Space Story*

- Dependent variable: $1(MS^{\text{Previous winner}} = 100)_{\text{store, year-month}}$