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Preliminary

Abstract

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is a large U.S. government program that provides infant formula to low-income households. States procure infant formula through auctions of sole-sourced exclusive supply contracts and in total, purchase infant formula for about 50% of all U.S. infants. This paper studies the impact of the WIC program on consumer behavior with a focus on the spillover effect of the WIC program on households who are not eligible for the program. Using household-level data and the timing of WIC contract changes across states, we provide empirical evidence that the in-store retailer environment drives the spillover effect more than hospital-provided formula samples. To identify the retailer effect, we leverage the fact that WIC does not permit online ordering and transactions and uses household-level data. To identify the hospital effect, we leverage variation in hospital provision of formula samples across states and the distance from consumers to hospitals that do and do not provide infant formula samples. We also show that among non-WIC households, those who are lower-income are most affected by the spillover effect.

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Researcher(s)' own analyses calculated (or derived) based in part on data from Nielsen Consumer LLC and marketing databases provided through the NielsenIQ Datasets at the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business.

The conclusions drawn from the NielsenIQ data are those of the researcher(s) and do not reflect the views of NielsenIQ. NielsenIQ is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.

1 Introduction

Government programs intended to provide goods and services to a specific population can have impacts on the rest of the market. For example, a $1 increase in Medicare's fees can increase private payments by more than $1 (Clemens and Gottlieb, 2017), and Low-Income Housing Tax Credits can either depreciate or appreciate neighboring housing values (Woo, Joh, and Van Zandt, 2016). Leung and Seo (2023) find that grocery prices increase with Supplemental Nutrition Assistance Program (SNAP) take-up, and Jaravel (2018) find that state-wide SNAP take-up correlates with lower prices and greater product variety.

In this paper, we study why a large government nutrition program's implementation dramatically changes the purchasing behavior of consumers who do not participate in the program. Our setting is the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) which distributes essential foods such as infant formula to low-income households and serves as many as 50% of US infants.[1] States procure infant formula through auctions, and the winning manufacturer supplies infant formula for all WIC participants over several years. Participating households receive vouchers for the WIC supplier's formula that are redeemed at retail stores, and the government then reimburses the retailer at the retail price. A manufacturer that receives this exclusive contract can experience an increase in market share from 10% to 90% (Oliveira, Frazao, and Smallwood, 2011). While some of this increase is due to the 50% of infants' WIC voucher redemption, the remaining increase must be due to non-participants purchasing the WIC supplier's product even though they obtain no benefit from the government for doing so.

Why does the WIC program impact the purchasing behavior of non-participating households? One possible explanation is that the WIC program changes the physical retail environment. Retailers label WIC products with a logo that non-WIC households may perceive as a government endorsement of quality, and formula manufacturers report that contracting with WIC allows them to acquire greater shelf space and better market their products to non-WIC consumers (GAO, 2006). A second explanation is that hospitals are more likely to recommend or provide samples of the WIC supplier's formula to new mothers to avoid

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

distinguishing between WIC and non-WIC households. Peer effects offer a third explanation; new mothers may observe their friends using the WIC supplier without knowing that the product was obtained for free.

We explore the potential mechanisms driving demand spillover, focusing on the influence of physical retail stores and hospitals. Although previous work has hypothesized that retailers and hospitals may play a role in generating spillover effects of the WIC program, no empirical evidence of these mechanisms exists. The mechanism of the spillover effect has implications for existing policies governing the use of the WIC logo, minimum retail stocks of the WIC product, and bans on formula samples provided in hospitals.

We compile several rich datasets to provide empirical evidence that the in-store retailer environment drives the spillover effect more than hospital-provided formula samples. We use household-level in-store purchases from NielsenIQ Homescan panelists and both online and in-store purchases from Numerator. We take advantage of the Numerator data's coverage of both online and in-store transactions. We identify households that do not qualify for WIC based on income. We leverage the timing of changes in the WIC supplier across different states using WIC auction data (Davis, 2012). We obtain hospitals' formula provision practices from the Centers for Disease Control and Prevention (CDC)'s national survey of Maternity Practices in Infant Nutrition and Care (mPINC).

We first provide empirical evidence that the manufacturer that wins the WIC contract increases its share among ineligible households by 30 percentage points after accounting for price changes.

Next, to identify the impact of the retail environment, we leverage the fact that WIC does not permit online ordering and transactions. Consequently, when shopping online, consumers are not exposed to WIC logos or the increased shelf presence of WIC brand products. To identify the impact of hospital-provided infant formula samples, we leverage variation in hospital provision of formula samples across states and the distance from consumers to hospitals that do and do not provide infant formula samples.

We find that the physical retail environment plays a crucial role in influencing the purchasing behavior of households ineligible for WIC. Utilizing detailed data on both online and offline transactions from Numerator, we find that offline transactions are much more likely

to involve the WIC supplier's product. We use the timing of the WIC contracts to show that in-store purchasing behavior responds to changes in the WIC supplier within the same state more than online purchasing behavior.

In contrast to the evidence on the retailer environment, we find limited evidence that hospitals drive the spillover effect. Non-WIC households in states with hospital-provided formula samples are no more likely to purchase the WIC contract brand than households in states where up to 43% of hospitals had eliminated hospital-provided formula samples. We additionally find that non-WIC households whose closest hospital provides formula samples are no more likely to buy from the WIC supplier than non-WIC households whose closest hospital does not provide formula samples. Finally, the probability of purchasing the WIC brand differs more between in-store and online purchasers than between purchasers whose closest hospitals differ in their provision of formula samples.

The mechanism of the spillover effect has distributional and policy implications. We document that in-store purchasers are lower-income, less college-educated, and more likely to be black or Hispanic than those who purchase formula online. We also show that these vulnerable populations are more likely to purchase the WIC brand even after controlling for the purchase method. Because the spillover effect operates through the retail rather than the hospital channel, one may be concerned because households make quick decisions with minimal evaluation when shopping for consumer goods (Dickson and Sawyer, 1990). Rapid decisions may especially be prevalent during the first year of an infant's life and for vulnerable populations who may have limited information about products and additional pressures to work difficult hours, take on more than one job, or care for family members. In contrast, the limited spillover effect from hospitals could suggest that hospitals are doing a good job of counseling families to the appropriate formula, regardless of whether they provide formula samples. This suggests that expanding the existing movement to prevent formula samples from being provided in hospitals would not reduce the spillover effect. Finally, the WIC program is considering allowing WIC participants to redeem vouchers online. We expect that this policy will incentivize online retailers to place the WIC product first in search results or otherwise feature the WIC product, and reduce the incentive of in-store retailers to allocate better or more shelf space to the WIC product. This would generate spillover

effects among online purchasers but decrease spillover effects among in-store purchasers. We therefore expect online redemption of WIC vouchers to reduce inequality.

This paper contributes to the existing body of literature that documents the substantial effect of the WIC infant formula procurement program on market shares. Using scanner data on infant formula retail sales at the state level, Oliveira, Frazao, and Smallwood (2011) document that the market share of a manufacturer increases by 74 percentage points after winning the WIC contract. Choi, Ludwig, Andreyeva, and Harris (2020) and Rojas and Wei (2019) quantify the increase in market share using variation in the shares of eligible and non-eligible products as states' WIC suppliers change over time. Huang and Perloff (2014) infer the spillover effect using scanner data by assuming that WIC participants respond to contract changes immediately while non-participants respond with a lag. The way in which the WIC program is implemented can also affect non-WIC households through changes in prices (Abito, Hui, Salant, and Uetake, 2022; An, Davis, Huang, Liu, and Xiao, 2017; McLaughlin, Saitone, and Sexton, 2019; Meckel, 2020). We contribute to this body of work by directly quantifying the impact of becoming the WIC supplier on non-participating households' purchasing behavior using individual-level panel data and determining the mechanism through which the spillover effect operates. Additionally, because we can tie purchases to specific demographic variables, we also provide novel insights on the distributional impacts of the WIC spillover effect.

Although standard economic theory assumes that consumer make purchases that maximize their utility, a long marketing literature shows that the retail environment impacts purchasing behavior. Dreze, Hoch, and Purk (1994) find that increasing the difficulty of price comparison by physically separating different size packages of bath tissue increased category sales by 5%. They also find that product location has a much larger impact on sales than the space devoted to product. Milliman (1982) finds that decreasing the tempo of background music also decreased the pace of shopping and increased expenditures. The retail environment can have a large impact on total expenditures because consumers make purchases quickly with limited price comparison (Dickson and Sawyer, 1990). We contribute to this literature by providing evidence that a government assistance program can also change the retail environment in a way that increases consumer purchases.

There is also a large literature studying how healthcare providers impact patient choices, including physician-induced demand (Gruber and Owings, 1996; Baker, 2010), defensive medicine (Mello, Chandra, Gawande, and Studdert, 2010; Studdert, Mello, Sage, DesRoches, Peugh, Zapert, and Brennan, 2005), and geographic variation in healthcare (Finkelstein, Gentzkow, and Williams, 2016). Much of this literature is concerned with the way that government programs such as Medicare and Medicaid impact healthcare decisions and costs. In the context of infant feeding, a review of nine randomized controlled trails found that commercial discharge pack provided by formula companies reduce the length of exclusive breastfeeding (Donnelly, Snowden, Renfrew, Woolridge, Pregnancy, and Group, 1996). In contrast to some of this work, we do not find evidence that hospital-provided formula samples increase purchases of the WIC supplier's product.

Finally, our work is also related to the literature that investigates the effect of consumer misperception about product attributes on market outcomes. Bronnenberg, Dubé, Gentzkow, and Shapiro (2015) for example show that misinformation and consumer mistakes explain the high willingness to pay for branded health products relative to the corresponding store brand. Abito and Salant (2019) examine the extended warranty market and provide observational and experimental evidence that overestimation of product failure rates drive the high willingness to pay for extended warranties on TVs. They show that providing information about product failure rates is more effective in improving consumer welfare as opposed to introducing more competition in this market. We contribute to this literature by studying the potential role of a large and important government program in driving potential misperception about products through the retail and hospital channels.

The remainder of the paper is structured as follows. Section 2 provides background on the infant formula market and the WIC program, Section 3 introduces the data, Section 4.1 presents the analysis on the retail channel, Section 4.2 presents the analysis on the hospital channel, and Section 5 concludes.

2 Background

2.1 Infant formula market

Infant formula is an essential product with limited substitutability.[2] Although the American Academy of Pediatricians recommends exclusively breastfeeding infants for the first year of life,[3] many women do not produce enough milk or lack the support needed to breastfeed. 6 month breastfeeding rates are 59% for Asian, 45% for white and Hispanic, and 28% for black mothers.[4] Thus, a household that is considering purchasing infant formula likely does not have breastfeeding as an outside option if infant formula prices increase. Additionally, if breast milk is not available, infant formula cannot be produced at home because a baby's nutritional needs are very specific and any contamination or imbalance in vitamins and minerals can cause serious health consequences.[5]

The infant formula market is heavily regulated. Infant formula falls under section 412 of the Federal Food, Drug, and Cosmetic Act. The act lays out minimum standards for the nutrient content, quantity, and quality of infant formula, along with requirements for recordkeeping and recall practices. The act also requires all infant formula manufacturers to register with the US Food and Drug Administration (FDA). The act also gives the FDA the authority to set and adjust requirements for nutrient quality control standards, submission requirements, labeling, and nutrient specifications.[6] All formula sold legally in the US is reviewed by the FDA, which regularly inspects formula products and the manufacturing facilities where they are made.[7] Heavy regulations that differ from those in other countries and import tariffs have together limited imports of formula into the US.

Moreover, the infant formula market in the US has been highly concentrated. Only

[2]Commonly available infant formulas contain mostly cow's milk with purified whey and a mixture of vitamins and minerals.

[3]https://www.cdc.gov/nutrition/infantandtoddlernutrition/breastfeeding/recommendations-benefits.html

[4]https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4410446/

[5]https://www.cdc.gov/nutrition/infantandtoddlernutrition/formula-feeding/choosing-an-infant-formula.html

[6]https://www.ibisworld.com/united-states/market-research-reports/infant-formula-manufacturing-industry/

[7]https://www.cdc.gov/nutrition/infantandtoddlernutrition/formula-feeding/choosing-an-infant-formula.html

four manufacturers together produce 90% of infant formula sold in the US, and only 2% is imported[8]. Among the four manufacturers, the three companies, Abbott (Similac), Mead Johnson (Enfamil), and Nestle (Good Start), produce national brands, while the fourth one, Perrigo, is the private label manufacturer that produces generic infant formula and its products are sold through retailers such as Walmart, Costco, and Target. Infant formula products are typically available in two different sizes, regular size (12-13 oz) and bulk size (48-50 oz). The three national brands offer both regular and bulk-size products, and Perrigo offers only bulk-size products.

2.2 The WIC program and auctions

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is a federal assistance program of the Food and Nutrition Service (FNS) of the United States Department of Agriculture (USDA) that aims to supplement the health of at-risk low-income pregnant, postpartum, and breastfeeding women, infants, and children up to age five.[9] It is the third largest food and nutrition assistance program and served about 6.2 million participants per month in fiscal year 2020, including almost half of all infants born in the United States.[10] The WIC program provides certain foods to eligible participants, including powdered infant formula, infant cereal, and other dietary supplements for children and mothers. Based on the estimates by USDA, in 2017, 2.2 million infants (56 percent of all infants in the United States) were eligible for WIC and 79% of eligible infants participated in the program.[11] This paper focuses on milk-based powder formula, which accounts for 72% of all infant formula in dollar sales to WIC and non-WIC consumers.[12]

WIC is an expensive program, with annual costs totalling about $6 billion.[13] Since the late 1980s, WIC State agencies have attempted to control costs by holding auctions in which infant formula manufacturers offer discounts in return for the exclusive right to

[8]https://www.theguardian.com/us-news/2022/may/18/baby-formula-shortage-why-is-there-none-what-to-do-causes-explained

[9]https://www.fns.usda.gov/wic/about-wic

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

[11]https://www.fns.usda.gov/wic-2017-eligibility-and-coverage-rates

[12]https://www.ers.usda.gov/amber-waves/2011/september/infant-formula-market/

[13]https://www.cbpp.org/research/food-assistance/wics-competitive-bidding-process-for-infant-formula-is-highly-cost

supply the state's WIC program. WIC participants are then given vouchers for a specific brand and quantity of the winner's product to redeem at retail stores, who then bill the federal government at their retail price for each redeemed voucher.

To determine the brand that supplies WIC, the federal government holds auctions where manufacturers bid a rebate paid to the government for each redeemed voucher, and a wholesale price that puts the rebate into context. The lowest net price (wholesale price - rebate) wins the auction. Demand for a manufacturer's produce increases when a manufacturer becomes the WIC supplier not only because WIC participants purchase their products, but because non-participants also shift consumption to the winner's products. The manufacturer therefore trades off losses from providing rebates with gains from increased demand from retailers for their product. In particular, non-participating households' dramatic shift to the winner's product may incentivize manufacturers to bid high rebates that are close to or even *above* their wholesale price.

Current USDA policy restricts the use of the WIC acronym and logo in infant formula advertising, but most states do not restrict this practice in their WIC contracts. GAO (2006) has recommended that the Secretary of Agriculture educate states about this policy and ensure that all state formula contracts include provisions that restrict the use of these trademarks. However, the Department of Agriculture notes that such advertising may be useful to help inform healthcare providers and WIC participants of the foods available through WIC. WIC also sets requirements for minimum stocks of the WIC product to ensure availability for WIC participants, and this regulation may contribute to the spillover effect on non-WIC consumers. Finally, there has been a movement to ban hospitals from providing formula samples. The number of such "Baby-friendly facilities" has grown, representing less than 4% of live births in 2010 to over 25% of live births in 2024.

3 Data

For our empirical analysis, we combine several unique data sets. In particular, we combine household panel data on online and offline purchases with federal poverty guidelines, WIC auction outcomes, and hospital data on infant formula provision and assistance in making

WIC appointments.

We use two sources of household purchase data. First, NielsenIQ Homescan for 2006-2016 includes rich demographic information including race, income, education, household size, and voluntary reporting of program participation. Of the 12,000 households who purchased powdered infant formula during this period, we focus on the 9,000 households who did not report receipt of WIC benefits *and* did not qualify for WIC benefits because their reported income was above 185% of the federal poverty level for their household size.[14] We then limit the data to the 4,860 households that have purchased infant formula at least twice, with a separation of at least one month between the first and last transactions.

Second, we analyze households' online and offline purchases from 2019 to 2023 from Numerator. Numerator is a market research firm that has recruited over two million U.S. households. This firm compiles data on the purchasing habits of its panelists, obtaining half through snapshots of physical receipts, and half through linked loyalty accounts and email scraping. The data encompass a diverse range of categories (e.g. consumer packaged goods, durable goods, electronics, cannabis, fast food, and food delivery), include purchases made through both e-commerce and traditional retail channels for home use or consumption, and cover various types of retail stores as well as online purchases (e.g. grocery, mass retailers, club stores, convenience stores, liquor stores). The data also include demographic information including race, income, education, and household size.

To identify households that are ineligible for WIC benefits, we merge each household dataset with the federal poverty guidelines from the U.S. Department of Health and Human Services by year and household size. Households with income over 185% of the federal poverty level are ineligible for WIC.

To examine ineligible households' purchases in states in which a new winner replaces the incumbent manufacturer, we combine data on the WIC auction winners and contract start and end dates between 1988 and 2019 provided by Professor David Davis.[15] In addition, we collect the contract start and end dates with the winner manufacturer's identity between

[14]Households that have income above 185% of the poverty level can still be eligible for WIC if they are enrolled in other welfare programs such as Medicaid and Food stamps. We will take this into account in a future version of the paper.

[15]https://econpapers.repec.org/paper/sdaworkpa/12008.htm

2019 and 2023 by contacting each local state WIC agency.

Finally, we obtain hospital formula provision practices from the Centers for Disease Control and Prevention (CDC)'s national survey of Maternity Practices in Infant Nutrition and Care (mPINC). The survey includes all hospitals in U.S. states and territories that provide maternity care services for the years 2011, 2013, 2015, 2018, 2020, and 2022. Prior to 2018, the survey asked hospitals whether infant formula samples were given to breastfeeding mothers upon discharge. Starting in 2018, the survey began asking the question to include all mothers, regardless of their breastfeeding status. We therefore focus on the hospital data starting from 2018.

We first examine Homescan panelists who do not participate in WIC and make at least two separate trips between 2006-2016. Table 1 shows that these households make on average 10 trip-upc purchases over 13 months. They purchase 16 cans of formula containing 365 ounces of powder, of which 139 ounces are purchased from the WIC supplier for that state and month. On average, they pay $330 for the formula over the period of study. The average number of manufacturers purchased is 1.6.

Table 1: Non-WIC household characteristics: NielsenIQ

	N	mean	sd	min	p25	median	p75	max
trips	4,860	9.8	9.7	2.0	3.0	7.0	12.0	103
brands purchased	4,860	1.6	0.7	1.0	1.0	1.0	2.0	4
cans	4,860	16.1	18.2	2.0	5.0	10.0	21.0	244
oz	4,860	365.3	400.7	24.0	102.2	231.3	490.1	4,284
WIC oz	4,860	138.7	270.2	0.0	0.0	25.8	153.3	4,113
total price paid	4,844	331.0	381.2	8.3	90.4	203.9	431.7	7,012
duration (months)	4,860	13.5	17.8	2.0	4.0	7.0	12.0	131

Note: Table shows the number of trips taken by each household from 2006-2016, as well as cans of formula, ounces of formula, ounces of formula purchased from the WIC supplier, the price paid, and the duration from the first purchase to the last purchase. Households with a duration of at least one month are represented.

Source: NielsenIQ Homescan Data 2006-2016.

We now examine manufacturers' market shares across all households in the Homescan

data. The infant formula industry is dominated by three firms, Abbott, Mead Johnson, and Nestle, with stores also offering their own brands. Table 2 displays market shares within two different size categories. Since powdered infant formula provided by the WIC program comes in containers containing between 12-16 ounces of powder, we refer to these containers as "regular" sizes and larger containers as "bulk" sizes. Abbott and Mead Johnson together capture 75% (62%) of households' purchases of regular (bulk) sized formula.

Table 2: Manufacturer share of powdered milk containers

Manufacturer	Regular cans	Regular share	Bulk cans	Bulk share
Abbott	27,367	0.37	20,473	0.30
Mead Johnson	27,161	0.37	21,513	0.32
Nestle	18,883	0.25	7,698	0.11
Store	723	0.01	18,367	0.27

Note: Table shows the number and share of cans that Homescan households purchase from each manufacturer in regular and bulk-size containers. Regular size refers to 12-16 oz and bulk size refers to containers larger than 16 oz.

Source: NielsenIQ Homescan Data 2006-2016.

We provide evidence that a manufacturer that wins the WIC auction becomes more attractive even to households that do not participate in the WIC program. We examine states in which a new manufacturer replaces the incumbent WIC manufacturer during 2006-2016.[16] Figure 1a shows manufacturers' share of non-WIC households' purchases of regular-size cans that are eligible for redemption in the program. Prior to the contract change, the incumbent WIC supplier enjoys a high share of over 60% among households ineligible for the program, while the future WIC supplier holds a share of less than 20%. After the new WIC supplier takes up the contract, their share quickly increases while the former WIC supplier's share drops. The third manufacturers' share stays stable at 20% throughout this period.

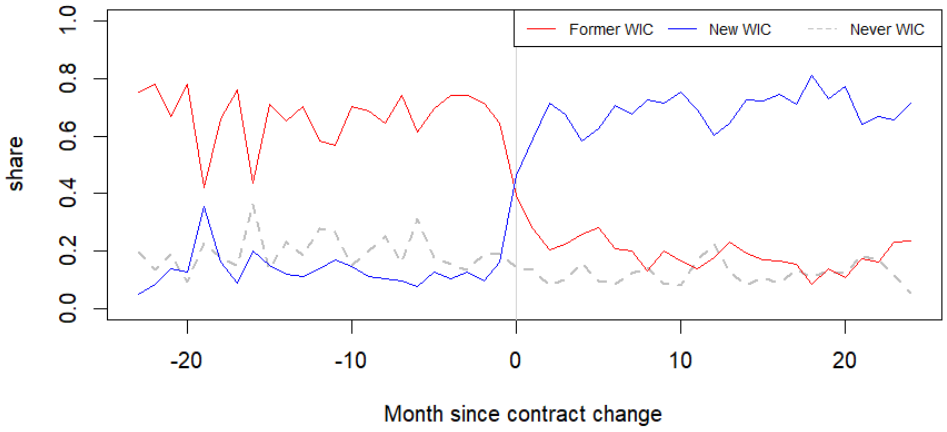
In contrast, Figure 1b shows that the contract changes have little impact on manufacturers' share of non-WIC households' purchases of bulk-size cans that are ineligible for redemption in the program.

Some of the share changes may be driven by changes in prices. Figure 2 displays price paid

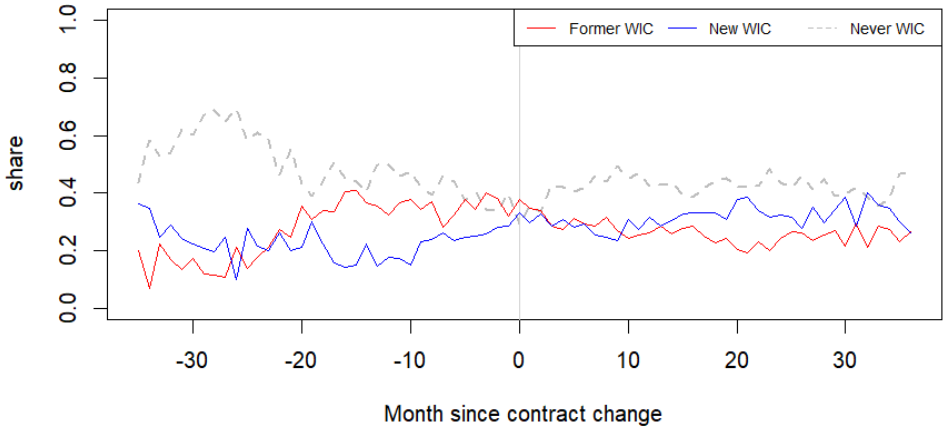
[16]States with more than one such contract change are split up into 2 "states", each with a single contract change, with the date of the split as the midway point between the two contract changes.

Figure 1: Share of ineligible household purchases by manufacturer

(a) WIC-ineligible "Regular" Size



(b) WIC-ineligible "Bulk" Size



Source: NielsenIQ Homescan Data 2006-2016, David Davis auction bid data.

by NielsenIQ Homescan panelists by manufacturer, size, and whether the manufacturer was the WIC supplier. Abbott and Mead Johnson set the highest prices, with Nestle priced lower. Store brands are half the price of the 3 premium brands. The Abbott and Mead Johnson products are priced lower and Nestle products are priced higher when the manufacturer wins the WIC contract. This is consistent with retailers increasing Nestle prices due to increased demand and inelastic demand from WIC participants when Nestle wins the contract, and with retail price caps curbing prices when the most expensive premium brands win the WIC contract. Prices for bulk products are similar regardless of whether a manufacturer wins the WIC contract.

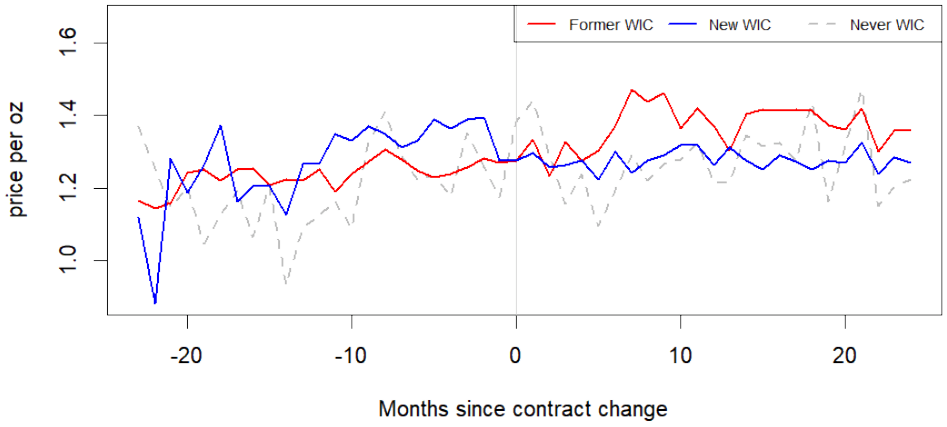
Figure 2: Price by Manufacturer and WIC Status

Note:
Panels show price per oz for each manufacturer, for periods where the manufacturer is or is not the WIC supplier. The left panel shows prices for 12-16 oz containers (regular size) and the right panel shows prices for containers above 16 oz (bulk size). 95% confidence intervals are shown.
Source: NielsenIQ Retail Scanner Data, auction data provided by David Davis. Years 2006-2016 are represented.

Figure 3 shows that when a manufacturer becomes the WIC supplier, their prices decrease, while the incumbent supplier's prices increase after their contract ends.

To quantify the magnitude of the share changes beyond what would be expected from price changes, Table 3 examines the shares of non-participating households' purchases of formula in ounces that are captured by each manufacturer in each state and month, controlling for prices. Column 1 focuses on regular sized products and shows that a manufacturer's

Figure 3: Price of ineligible household purchases by manufacturer



Note: Figure shows price per ounce for 12-16 oz containers (regular-size) for the incumbent WIC supplier, the new WIC supplier, and the third bidding manufacturer who is neither the incumbent nor the new WIC manufacturer. Source: NielsenIQ Homescan and Retail Scanner Data 2006-2016, David Davis auction bid data.

share increases by 30 percentage points after becoming the WIC supplier. For Abbott, the reference manufacturer, shares increase from 44% to 75% after becoming the WIC manufacturer, while Nestle (Mead Johnson) starts with slightly lower (higher) shares when not supplying WIC. Column 2 allows the effect of supplying WIC to differ across manufacturers and estimates that becoming the WIC manufacturer increases Abbott and Mead Johnson's shares by 29 percentage points from baselines of 46% and 51%, while Nestle's shares increase by 35 percentage points from a baseline of 40%. All specifications include state, year, and month-fixed effects.

One may be concerned that the gain in market share is driven not by consumers' preferences for the WIC supplier's products but by changes in choice sets induced by stores carrying a manufacturer's products only when are the WIC supplier. Columns 3 and 4 address this concern by limiting the set of stores to "big stores" that sell all 3 premium brands. We find roughly the same spillover effect, suggesting that the spillover effect is not purely driven by unavailability of non-WIC products.

The spillover effect is smaller but still present for bulk-sized products. Columns 5 and

Table 3: Market share regression

	Manufacturer share							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
WIC	0.308***	0.291***	0.283***	0.266***	0.057***	0.038***	0.052***	0.033***
	(0.008)	(0.015)	(0.008)	(0.015)	(0.005)	(0.010)	(0.005)	(0.010)
WIC*MEADJ		0.005		−0.002		0.014		0.014
		(0.021)		(0.022)		(0.014)		(0.014)
WIC*NESTLE		0.058**		0.065***		0.060***		0.062***
		(0.024)		(0.025)		(0.016)		(0.017)
STORE BRAND	−0.065	−0.083*	−0.048	−0.067	−0.016	−0.023	−0.006	−0.014
	(0.048)	(0.048)	(0.057)	(0.058)	(0.016)	(0.017)	(0.017)	(0.017)
MEADJ	0.051***	0.048***	0.048***	0.049***	−0.010	−0.015*	−0.013**	−0.019**
	(0.009)	(0.013)	(0.009)	(0.014)	(0.006)	(0.008)	(0.006)	(0.009)
NESTLE	−0.038***	−0.066***	−0.041***	−0.073***	−0.144***	−0.165***	−0.135***	−0.157***
	(0.011)	(0.016)	(0.012)	(0.017)	(0.007)	(0.009)	(0.008)	(0.010)
PRICE	0.018	0.008	0.014	0.002	−0.130***	−0.130***	−0.114***	−0.114***
	(0.026)	(0.026)	(0.027)	(0.027)	(0.035)	(0.035)	(0.036)	(0.036)
Constant	0.440***	0.464***	0.470***	0.495***	0.582***	0.593***	0.602***	0.613***
	(0.040)	(0.042)	(0.042)	(0.044)	(0.036)	(0.036)	(0.037)	(0.037)
Included sizes	Regular	Regular	Regular	Regular	Bulk	Bulk	Bulk	Bulk
Included stores	All	All	Big	Big	All	All	Big	Big
Observations	5,581	5,581	5,199	5,199	11,812	11,812	11,374	11,374
Adjusted R^2	0.393	0.393	0.374	0.375	0.309	0.310	0.307	0.308

6 show that supplying WIC increases a manufacturer's share of bulk-sized products by 4-10 percentage points. The effect is particularly strong for Nestle, which experiences an increase of 10 percentage points from a baseline of 44%. Although changes in choice set are less of a concern here because bulk products are not eligible for WIC vouchers, for completeness, in columns 7 and 8, we limit analyses to stores carrying all three brands to again confirm that the gain in market share is not driven by the unavailability of a manufacturer's products when they are not the WIC supplier.

Table 4: Non-WIC household characteristics: Numerator

	N	mean	std	min	25%	50%	75%	max
Trips	38,117	9.1	9.2	2	3	6	12	192
Brands purchased	38,117	1.7	0.8	1	1	1	2	8
cans	38,117	16.7	22.1	2	5	10	21	1,747
Total price paid WIC	20,431	352.4	503.4	0	70.2	175.4	435.2	28,911.3
oz	38,117	318.7	392.5	0	84.0	182.3	409.2	21,535.9
WIC oz	20,431	204.1	309.8	0.0	38.0	99.2	248.1	19,075.2
Total price paid	38,117	460.0	557.4	0.0	126.4	267.6	589.3	32,755.7
Duration (days)	38,117	345.9	340.6	30	114	232	396	1,694

Note: Table shows the number of trips taken by each household from 2019-2023, as well as cans of formula, ounces of formula, ounces of formula purchased from the WIC supplier, the price paid, and the duration from the first purchase to the last purchase.
Source: Numerator Data 2019-2023.

Table 4 reports the summary statistics of the variables from Numerator. We report the same set of variables in Table 1. We find that the statistics look similar between the two data sets. For example, the average number of trips is 9.1 and the number of brands purchased is 1.7. In Table 1, those are 9.8 and 1.6, respectively.

4 Mechanism

4.1 Mechanism 1: In-store Shelf Space and WIC Logo

We examine the impact of in-store shelf space and the presence of the WIC logo on the demand spillover to households ineligible for WIC. Retailers might allocate increased or better shelf space to products from WIC-affiliated manufacturers to satisfy the demand of WIC-eligible households. Alternatively, retailers may place a WIC logo on shelves to denote WIC-approved brands. Households not eligible for WIC could perceive these logos or the expanded or better shelf space as indicators of superior quality. Figure 4 presents several examples of such logos displayed on shelves in grocery stores. As in the figure, consumers

Figure 4: WIC Logos in Grocery Stores

can easily identify the logos and may perceive it as a signal for high quality.[17]

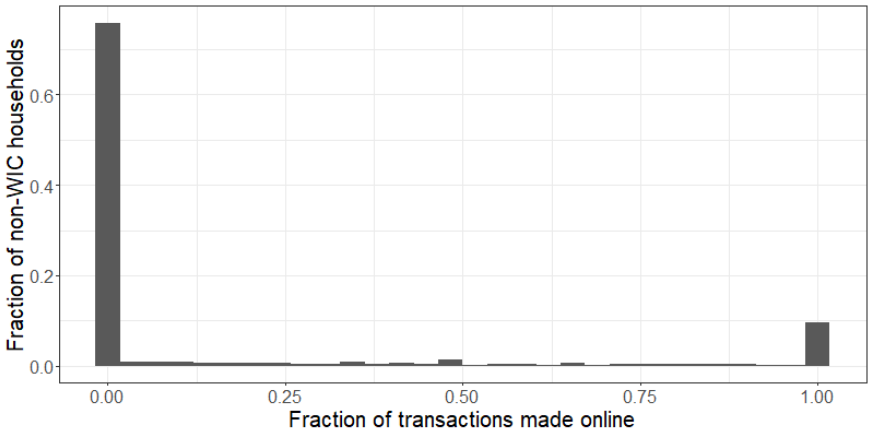
Our approach to investigating the potential mechanism behind demand spillover hinges on the fact that WIC typically does not permit online ordering and transactions. Although the USDA is considering proposals to eliminate barriers to online ordering and internet-based transactions in WIC, as of 2023, only a few states and supermarkets have begun to experiment with online ordering and widespread implementation of this policy across all states is expected to take some time. Consequently, consumers engaged in online grocery shopping do not encounter WIC logos, and online grocery stores are not subject to the same physical constraints as their offline counterparts. By comparing consumer behavior in online and offline shopping environments, we can deduce the impact of factors unique to offline grocery stores, such as the presence of WIC logos and allocated shelf space.

4.1.1 Descriptive evidence

We present several key summary statistics. Firstly, Figure 5 displays a histogram illustrating the proportion of online purchases made by each WIC-ineligible household. Notably, approximately 80% of households have never bought infant formula from online retailers. Additionally, around 10% of households exclusively obtain their infant formula through online channels. Given that the WIC logo is only visible in physical retail stores, online groceries face no shelf space limit, and online retailers have no incentive to prioritize WIC products in search listings to attract WIC households, we hypothesize that households not eligible for

[17]For instance, Luffarelli, Mukesh, and Mahmood (2019), Cian, Krishna, and Elder (2014) study the effects of logo design on consumer behavior and perception about the brands.

Figure 5: Fraction of Purchases Made Online



Note: Figure shows a histogram of the fraction of purchases made online by each non-WIC household.

WIC are more inclined to buy WIC brands online than offline.

Table 5 compares the demographic characteristics of non-WIC households who shop exclusively in-store, exclusively online, and both in-store and online. Online shoppers have more income, are more educated, are more likely to be white and Asian, and are less likely to be black or Hispanic. Table 6 compares the purchase characteristics of non-WIC households who shop exclusively in-store, exclusively online, and both in-store and online. Online shoppers make fewer purchases over a shorter period of time but spend more on each purchase, and are more likely to purchase bulk-size containers.

Table 5: Comparison of in-store and online purchasers' demographics

Purchase Type	Income	College	Black	Hispanic	Asian
In Store	97,256	0.81	0.086	0.093	0.078
Online	101,734	0.86	0.071	0.082	0.081
both	104,888	0.87	0.058	0.080	0.080

Note: The table compares the demographics of non-WIC households who shop exclusively in-store, exclusively online, and both in-store and online.
Source: Numerator data 2019-2023.

Table 7 presents the percentages of WIC brand purchases in both offline and online transactions. Our findings indicate that 47% of offline transactions involve the purchase of WIC brand products, in contrast to 27% of online transactions. This substantial difference underscores that the prevalence of WIC brand purchases is significantly higher in offline

Table 6: Comparison of in-store and online purchasers' purchases

Purchase Type	Purchases	Total Spent	Duration (days)	Bulk
In Store	7.5	184	141	0.51
Online	4.5	201	70	0.75
both	22.2	679	407	0.67

Note: The table compares the purchases of non-WIC households who shop exclusively in-store, exclusively online, and both in-store and online.
Source: Numerator data 2019-2023.

Table 7: Fraction of Purchases involving the WIC Brand

Purchase Type	Fraction involving WIC brand
In Store	0.47
Online	0.27

Note: Table shows the fraction of purchases made by non-WIC households that involve the WIC brand.
Source: Numerator data 2019-2023.

transactions compared to online ones.

Table 8: Fraction of Purchases involving the WIC Brand: Regular vs Bulk Size

	Regular size	Bulk size
In Store	0.62	0.27
Online	0.42	0.22

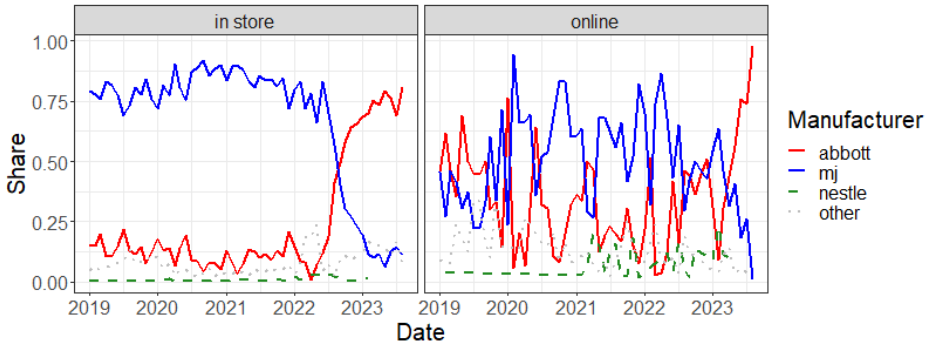
Note: Table shows the fraction of regular-size and bulk-size purchases that involve the WIC brand, among purchases made by non-WIC households.
Source: Numerator data 2019-2023.

Table 8 breaks down the proportion of WIC brand purchases into two categories: regular size and bulk size. It is important to note that WIC typically provides regular-size cans, but not bulk-size cans. Echoing the trends observed in Table 7, this table reveals that consumers are less inclined to purchase WIC brand products when shopping online. This suggests a noticeable shift in consumer preferences for WIC brands between online and offline shopping environments, likely influenced by the absence of physical WIC branding cues in the online setting.

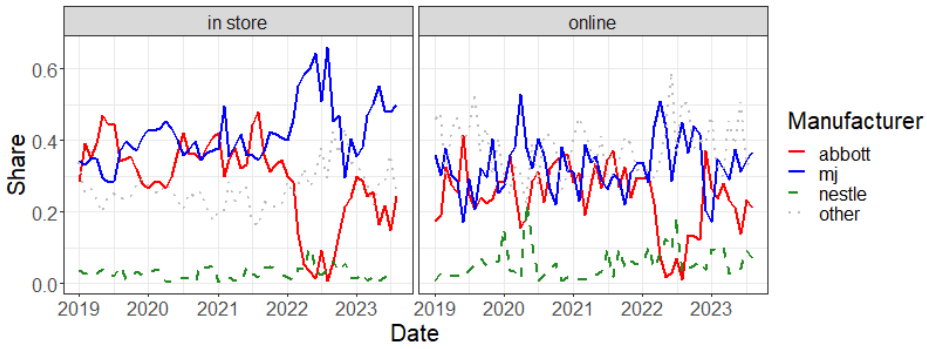
We now illustrate the distinction between online and offline shopping by examining how market shares shift when a manufacturer secures a new WIC contract in a state. Figure 6 tracks the market shares of various manufacturers in California, both for offline and online shopping, over a period of time. Notably, Mead Johnson held the WIC contract in California

Figure 6: Market Shares in California: Offline vs Online

(a) Regular size



(b) Bulk size

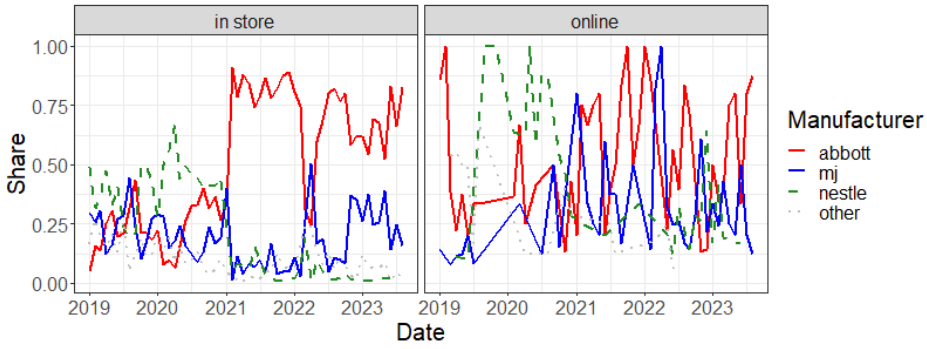


Note: Panel (a) shows manufacturers' share of non-WIC households' regular-sized purchases that are made in store and online. Panel (b) shows manufacturers' share of non-WIC households' bulk-sized purchases that are made in store and online. Abbott became the new WIC supplier in California in 2022.
Source: Numerator data 2019-2023.

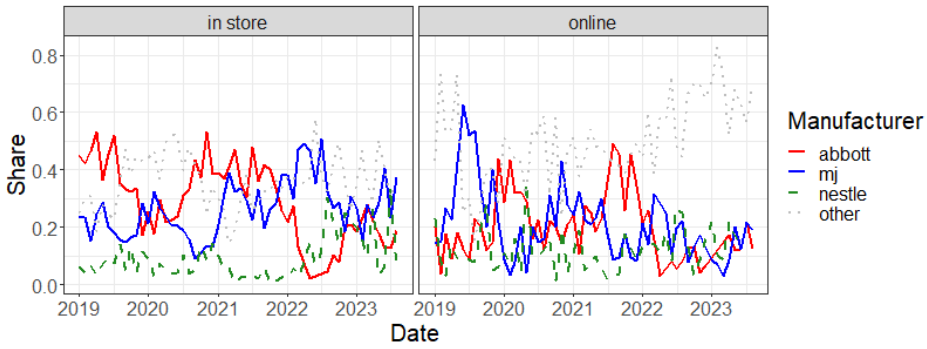
until October 2022, after which Abbott began its contract from November 2022. In the realm of offline shopping, it's evident that the WIC brand significantly dominates the market. However, this dominance is not as apparent in the online shopping sector. For instance, even before holding the WIC contract, Abbott already had a substantial online market share in 2019. In contrast, bulk-sized containers are not eligible for WIC redemption. They therefore do not receive the WIC logo in retail stores and are likely not allocated more or better shelf space that ineligible households can interpret as a signal of higher quality. Figure 6b shows that Abbott does not enjoy an increase in share for bulk purchases among ineligile households when they become the WIC supplier.

Figure 7: Market Shares in Wisconsin: Offline vs Online

(a) Regular size



(b) Bulk size



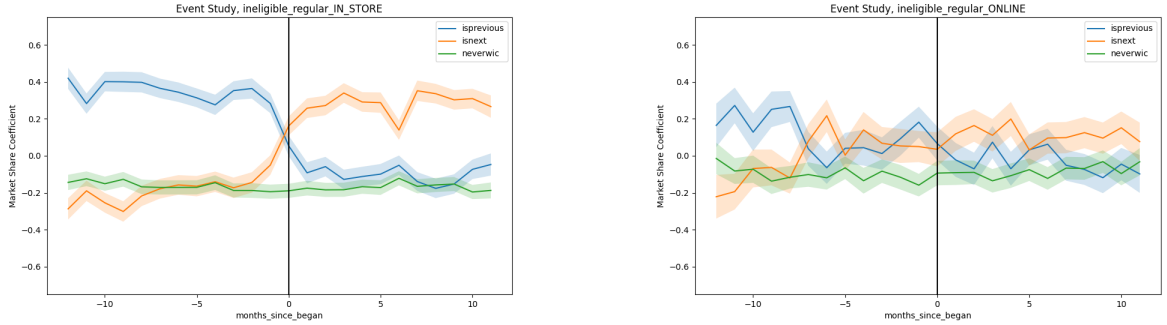
Note: Panel (a) shows manufacturers' share of non-WIC households' regular-sized purchases that are made in store and online. Panel (b) shows manufacturers' share of non-WIC households' bulk-sized purchases that are made in store and online. Abbott became the new WIC supplier in Wisconsin in 2021.
Source: Numerator data 2019-2023.

A similar pattern is observed in Wisconsin. Here, Nestle maintained the WIC contract until December 2020, with Abbott taking over in January 2021. As illustrated in Figure 7, Nestle's products were predominant in the offline market prior to the contract change, and subsequently, Abbott's products gained predominance. Yet, this trend isn't mirrored in the online shopping data, suggesting a less pronounced impact of WIC contracts on consumer choices in the online marketplace.

4.1.2 Regression Analysis

First, we consider the event study models to illustrate how WIC contract changes affect market shares in in-store markets and online markets. In other words, we aim to generalize

Figure 8: Event Study Results: In-store vs. Online, Regular Size



Note: Panel (a) shows the event study coefficients for the in-store market shares, while Panel (b) shows online market shares.

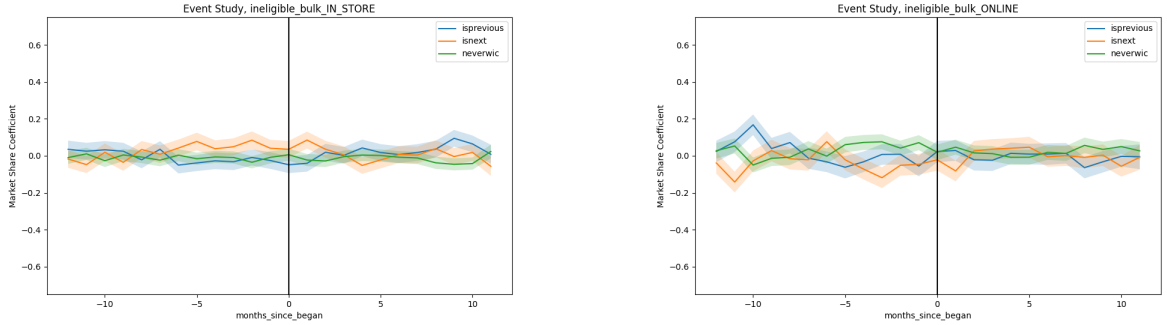
the findings based on the figures in the previous subsection (Figures 6 and 7). In particular, we estimate the following regression for in-store market shares and online market shares.

$$share_{i,s,t} = \sum_{j=-m}^{m} \gamma_{i,j} D_{i,s,t-j} + \alpha_i + \mu_s + \delta_t + \beta X_{i,s,t} + \epsilon_{i,s,t}, \tag{1}$$

where $share_{i,s,t}$ is the market share of manufacturer type i in state s at time t. There are three types of manufacturers ($i \in \{\text{previous, next, never}\}$). If $i = \text{previous}$, then the manufacturer holds the WIC contract before the contract change, if $i = \text{next}$, the manufacturer holds the new WIC contract, and if $i = \text{never}$, then the manufacturer does not hold the WIC contract. Next, $D_{i,s,t-j}$ is a dummy variable that indicates for event time j. That is, the event ("a contract change") occurs j periods before this observation's calendar time. The coefficients after the event has occurred ($\gamma_{i,j}$ for $j \geq 0$) capture the dynamic effects of the treatment.

Figures 8 report the estimated coefficients, where for panel (a), we use the in-store market shares, while for panel (b), we use the online market shares. We find that the in-store market share of the previous contract holder decreases by 50% in the in-store category, while the market share of the new contract holder increases by 50% when the contract changes. The market share of the manufacturer that does not have a WIC contract before and after the contract change remains the same. By contrast, we do not find any systematic patterns for the online market shares as in panel (b). Thus, we confirm that the patterns we show in the previous subsection generally hold.

Figure 9: Event Study Results: In-store vs. Online, Bulk Size



Note: Panel (a) shows the event study coefficients for the in-store market shares, while Panel (b) shows online market shares.

In Figure 9, we report the estimated coefficients of equation (1) where the market shares are calculated within the bulk size category. As in Figure 8, panel (a) uses the in-store market shares while panel (b) uses the online market shares. Both figures illustrate that market shares do not respond to the contract change in both categories. Since bulk-size products are not eligible for WIC anyway, consumers may not be exposed to WIC logos when ineligible consumers purchase bulk-size products.

We further examine the differences in shopping patterns between offline and online transactions. First, we run the following regression to see (i) whether consumers are less likely to purchase WIC brand products online compared to offline, and (ii) the extent to which incorporating consumer fixed effects alters the coefficient related to the online transactions. The first objective seeks to validate the summary statistics previously discussed, confirming the observed trend. The second objective aims to understand how consumer behavior, potentially influenced by knowledge of WIC brands acquired in physical stores, varies in online settings.

$$WIC_{it} = \beta_0 + \beta_1 Online_{it} + \beta_2 Bulk_{it} + X_i'\gamma + \varepsilon_{it}. \tag{2}$$

In the model, WIC_{it} is a dummy variable for whether a household purchases WIC brand's product or not, $Online_{it}$ is a dummy variable for whether the transaction is online or not, $bulk_{it}$ is a dummy variable for whether a household buys a bulk-size product, and X_i is the

vector of household characteristics.

Table 9 presents the results of our analysis, where each column incorporates a different set of fixed effects, either manufacturer fixed effects, household fixed effects, or both. The data reveals a couple of notable trends: Firstly, the coefficient on $Online_{it}$ is consistently negative and statistically significant across most specifications. This strongly supports the observation that consumers are less likely to purchase WIC brand products during online shopping.

Secondly, when household fixed effects are included in the model, the absolute value of the online coefficients becomes smaller. This implies that consumers who are possibly aware of which brands are supported by WIC, based on their offline shopping experiences, may still prefer WIC brand products in online shopping. This trend indicates that consumers' brand preferences, potentially developed in physical stores, could influence their online purchasing decisions.

To delve deeper into the potential mechanism at play, we examine whether households that predominantly make online purchases are less inclined to buy WIC brand products. This inquiry stems from the assumption that such households have fewer opportunities to encounter WIC logos during their offline shopping experiences. By analyzing the purchasing patterns of these households, we can gain insights into the influence of WIC branding and physical store marketing on consumer behavior, particularly in relation to WIC brand recognition and preference.

The regression we run is the following.

$$WICshare_i = \beta_0 + \beta_1 Onlineshare_i + \beta_2 Bulkshare_i + X_i'\gamma + \varepsilon_i. \tag{3}$$

The findings are summarized in Table 10. Across all models, the data consistently indicates that the coefficient corresponding to the online purchase share is negative and statistically significant. This supports our expectation that households engaging more in online purchases tend to buy fewer WIC brand products. This trend may reflect their limited exposure to WIC branding, which is more prevalent in offline retail settings.

Additionally, the results reveal that households with lower income, those identifying as

Table 9: Online WIC Purchase Regression

	(1)	(2)	(3)	(4)	(5)
Online	-0.120***	-0.131***	-0.0906***	-0.00450***	-0.0838***
	(0.00199)	(0.00208)	(0.00198)	(0.00163)	(0.00198)
item_unit_price		0.000719***	0.00202***	-0.000248***	0.00195***
		(0.0000391)	(0.0000377)	(0.0000304)	(0.0000376)
Bulk			-0.335***	-0.0836***	-0.327***
			(0.00173)	(0.00145)	(0.00174)
Income - mid					-0.0419***
					(0.00861)
Income - high					-0.0450***
					(0.00847)
Asian					0.0975***
					(0.00285)
Black					0.0862***
					(0.00313)
Hispanic					0.123***
					(0.00275)
Other					0.0577***
					(0.00439)
Advanced					-0.0898***
					(0.00707)
College					-0.0656***
					(0.00690)
High school					-0.0297***
					(0.00713)
_cons	0.390***	0.370***	0.554***	0.428***	0.630***
	(0.000922)	(0.00143)	(0.00165)	(0.00129)	(0.0108)
N	343062	343062	343062	313445	343062
R^2	0.01	0.01	0.11	0.79	0.12

Note: Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: WIC Share and Online Share Regression

	Share of purchases that are of WIC brand		
	(1)	(2)	(3)
Online share	-0.123***	-0.078***	-0.070***
	(0.005)	(0.005)	(0.005)
price		0.002***	0.001***
		(7.83×10^{-5})	(7.8×10^{-5})
bulk share		-0.290***	-0.281***
		(0.004)	(0.004)
middle income tercile			-0.026***
			(0.004)
top income tercile			-0.030***
			(0.004)
college			-0.039***
			(0.004)
asian			0.083***
			(0.006)
black			0.098***
			(0.006)
hispanic			0.146***
			(0.006)
other			0.035***
			(0.007)
Constant	0.402***	0.511***	0.528***
	(0.002)	(0.003)	(0.005)
Observations	76,430	76,430	76,430
R^2	0.008	0.08	0.10
Adjusted R^2	0.008	0.08	0.10

IID standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Figure 10: WIC Sample Bag in Hospitals

Note: Panel (a) shows an example of a hospital formula sample for new mothers. Panel (b) shows an image of an advertisement for Abbott's brand.

Hispanic, and those with lower levels of education are more likely to purchase WIC brand products. This demographic information provides valuable insights into the consumer groups that are most influenced by the WIC program and may rely more on the benefits it offers. These findings contribute to a broader understanding of purchasing patterns related to WIC brand products and how they vary across different segments of the population.

4.2 Mechanism 2: Hospital Formula Samples

Previous literature has proposed that hospitals could drive increased sales of the WIC supplier's products among ineligible households. The Government Accountability Office found that free formula samples given to new mothers upon discharge ("discharge packs") affected both WIC and non-WIC households' formula consumption (GAO, 2006). Because half of infants will use the WIC contract brand, hospitals may provide this brand to new mothers so that they don't need to switch brands after leaving the hospital. However, hospitals may provide the WIC contract brand to all mothers, regardless of whether they are eligible for the program (Oliveira, Frazao, and Smallwood, 2011). Figure 10 provides examples of industry-sponsored hospital samples and advertising that emphasize the brand's provision in hospitals.

To identify whether hospital infant formula samples are driving the WIC spillover effect,

we use variation in whether hospitals provides formula samples to new mothers upon discharge. We first compare the probability of purchasing the WIC brand in states that have begun and have not begun eliminating the practice of providing infant formula samples to new mothers. Sadacharan, Grossman, Sanchez, and Merewood (2011) identify the 10 states with the best and worst records in eliminating infant formula samples as of 2007. In the 10 best record states, 18% to 43% of hospitals had eliminated formula samples, while in the 10 worst record states, 0%-1% of hospitals had eliminated formula samples. Since nearly all hospitals in the worst record states provide formula samples, if hospital-provided formula samples causes non-WIC households to purchase the WIC brand, we would expect non-WIC households in these states to purchase the WIC brand at a higher rate than non-WIC households in the states that have eliminated hospital-provided formula samples.

Table 11 compares the demographic characteristics of non-WIC households who differ in whether their state provides a discharge pack with infant formula samples. Households living in states that provide formula samples have less income, are more likely to be black, and are less likely to be Asian. Table 12 compares the purchase characteristics of these non-WIC households. Households living in states that provide formula samples are less likely to purchase bulk-size containers.

Table 11: Comparison of purchaser's demographics by state's hospital characteristics

State Type	Fraction of Households	Income	College	Black	Asian	Other Race	White
Top 10 states with discharge packs	0.19	76,008	0.49	0.13	0.05	0.08	0.74
Top 10 states w/o discharge packs	0.18	79,055	0.51	0.06	0.10	0.11	0.72
Other	0.63	73,568	0.49	0.11	0.03	0.05	0.81

Note: The table compares the demographics of non-WIC households by whether they live in one of the top 10 states that have eliminated formula samples in 2007 (WA, MN, CA, VT, MA, WI, NM, NH, OR, RI) or one of the top 10 states that continue to provide formula samples in 2007 (AR, DC, MD, MS, NJ, OK, SD, WV, IA, TX).
Source: NielsenIQ data 2006-2016.

We find that households in states that provide discharge packs are not much more likely to purchase the WIC contract brand than the households in states that have begun eliminating formula samples. Figure 11 compares the fraction of non-WIC households that purchase the WIC brand in 10 states that began eliminating infant formula hospital discharge packs and 10 states that have not eliminated them. We focus on NielsenIQ Homescan panelists' first

Table 12: Comparison of purchases by purchaser's state's hospital characteristics

Purchase Type	Cans Purchased	Total Spent	Duration (days)	Bulk
Top 10 states with discharge packs	9.9	196	237	0.65
Top 10 states w/o discharge packs	10.5	208	230	0.71
Other	10.3	201	224	0.64

Note: The table compares the purchases of non-WIC households by whether they live in one of the top 10 states that have eliminated formula samples in 2007 (WA, MN, CA, VT, MA, WI, NM, NH, OR, RI) or one of the top 10 states that continue to provide formula samples in 2007 (AR, DC, MD, MS, NJ, OK, SD, WV, IA, TX).
Source: NielsenIQ data 2006-2016.

purchases as these are most likely to be influenced by receiving hospital formula samples, regular-sized purchases, and purchases made in 2007 to match the hospital discharge pack provision data.

We next leverage variation in the hospitals closest to non-participants and whether those hospitals provide formula samples or refer patients to WIC. Table 13 compares the demographic characteristics of non-WIC households who differ in whether their nearest hospital provides a discharge pack with infant formula samples or helps make appointments to obtain WIC benefits. Households whose nearest hospital provides formula samples have less income, are less educated, and are more likely to be white. Households whose nearest hospital helps make WIC appointments have more income. Table 14 compares the purchase characteristics of these non-WIC households. The purchase characteristics are similar across households whose hospitals differ in formula sample provision or WIC appointment assistance.

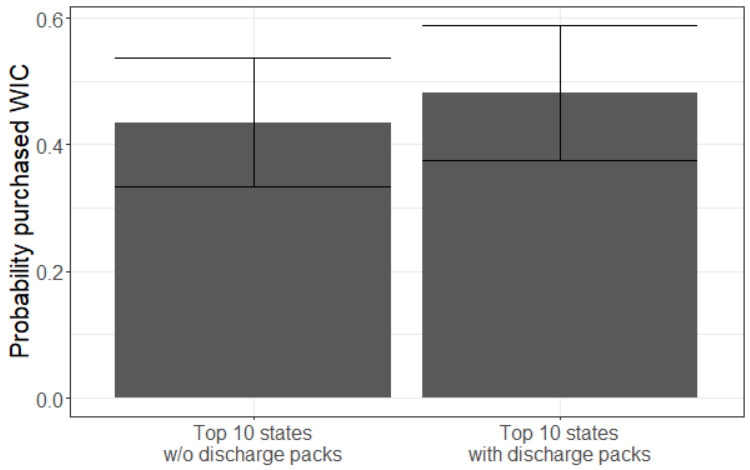
Table 13: Comparison of purchasers' demographics by hospital characteristics

Hospital Type	Fraction of Households	Income	College	Black	Hispanic	Asian	White
None	0.38	99,851	0.83	0.09	0.10	0.08	0.69
Discharge pack	0.20	95,398	0.81	0.07	0.10	0.06	0.74
WIC appointments	0.30	100,046	0.84	0.09	0.10	0.10	0.67
WIC appointments, Discharge pack	0.12	98,064	0.81	0.08	0.09	0.07	0.73

Note: The table compares the demographics of non-WIC households by whether their nearest hospital provides a discharge pack with infant formula samples or helps make appointments to obtain WIC benefits.
Source: Numerator data 2019-2023, mPINC data 2018-2022.

Figure 12 shows that the probability that a purchase involves a WIC product is similar among households regardless of whether their nearest hospital provides formula samples or helps mothers make WIC appointments. Figure A.1 in the appendix shows that this pattern

Figure 11: Probability of WIC purchase by state hospital characteristics



Note: Figure compares the fraction of non-WIC households that purchase the WIC brand in 10 states that began eliminating infant formula hospital discharge packs and 10 states that have not eliminated them. Purchases are limited to regular-sized purchases that are the households' first purchase of infant formula. 95% confidence intervals are shown.
Source: NielsenIQ Homescan Data 2007.

holds within household income terciles.

The spillover effect is more likely driven by the retailer channel rather than the hospital channel. Figure 13 shows that the probability of purchasing the WIC brand differs more between in-store and online purchasers than between purchasers who live near hospitals that do and do not provide discharge packs with formula. Figure A.2 in the appendix shows that this pattern holds within household income terciles.

5 Conclusion

The mechanisms that drive the WIC program's spillover effects on ineligible households has remained a puzzle since the early 2000's. In this paper, we leverage data on online and offline purchases, hospital provision of infant formula samples, and the timing of WIC contracts to identify the role that the retail and hospital environment plays in increasing ineligible households' purchases. We find that the physical retail environment plays a crucial role in influencing purchasing behavior of households ineligible for WIC. In contrast, we find limited

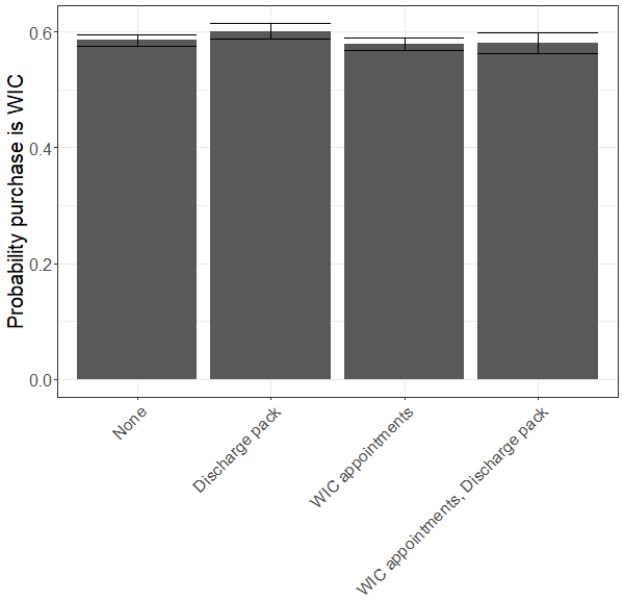
Table 14: Comparison of purchases by purchasers' hospital characteristics

Purchase Type	Purchases	Total Spent	Duration (days)	Bulk
None	9.4	260	174	0.56
Discharge pack	9.3	252	169	0.54
WIC appointments	9.2	258	167	0.56
WIC appointments, Discharge pack	9.0	247	165	0.55

Note: The table compares the purchases of non-WIC households by whether their nearest hospital provides a discharge pack with infant formula samples or helps make appointments to obtain WIC benefits.
Source: Numerator data 2019-2023, mPINC data 2018-2022.

evidence that hospital-provided formula samples drive the spillover effect. The mechanism of the spillover effect has implications for existing policies governing the use of the WIC logo, minimum retail stocks of the WIC product, and bans on formula samples provided in hospitals.

Figure 12: Probability of WIC purchase by hospital characteristics



Note: Figure compares the fraction of non-WIC households that purchase the WIC brand among those whose nearest hospital neither provides discharge packs containing formula nor helps make WIC appointments, only provides discharge packs containing formula, only makes WIC appointments, or both. Purchases are limited to regular-sized purchases that are the households' first purchase of infant formula. 95% confidence intervals are shown. Source: Numerator data 2019-2023.

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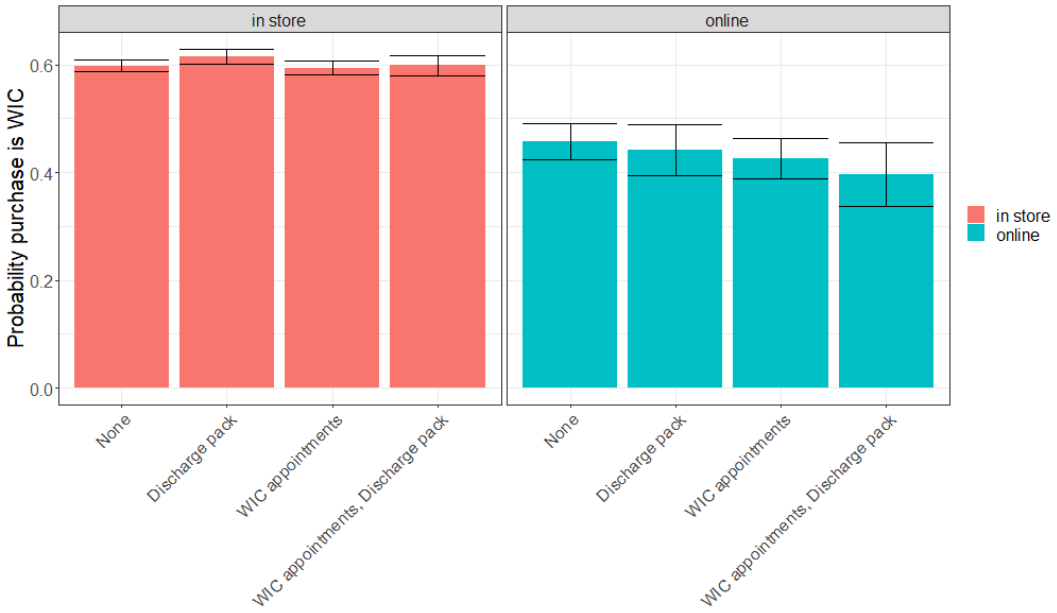
Figure 13: Probability of WIC purchase by hospital characteristics and purchase method



Note: Figure compares the fraction of non-WIC households that purchase the WIC brand among those whose nearest hospital neither provides discharge packs containing formula nor helps make WIC appointments, only provides discharge packs containing formula, only makes WIC appointments, or both. The left panel shows the purchases made in store. The right panel shows the purchases made online. Purchases are limited to regular-sized purchases that are the households' first purchase of infant formula. 95% confidence intervals are shown.
Source: Numerator data 2019-2023.

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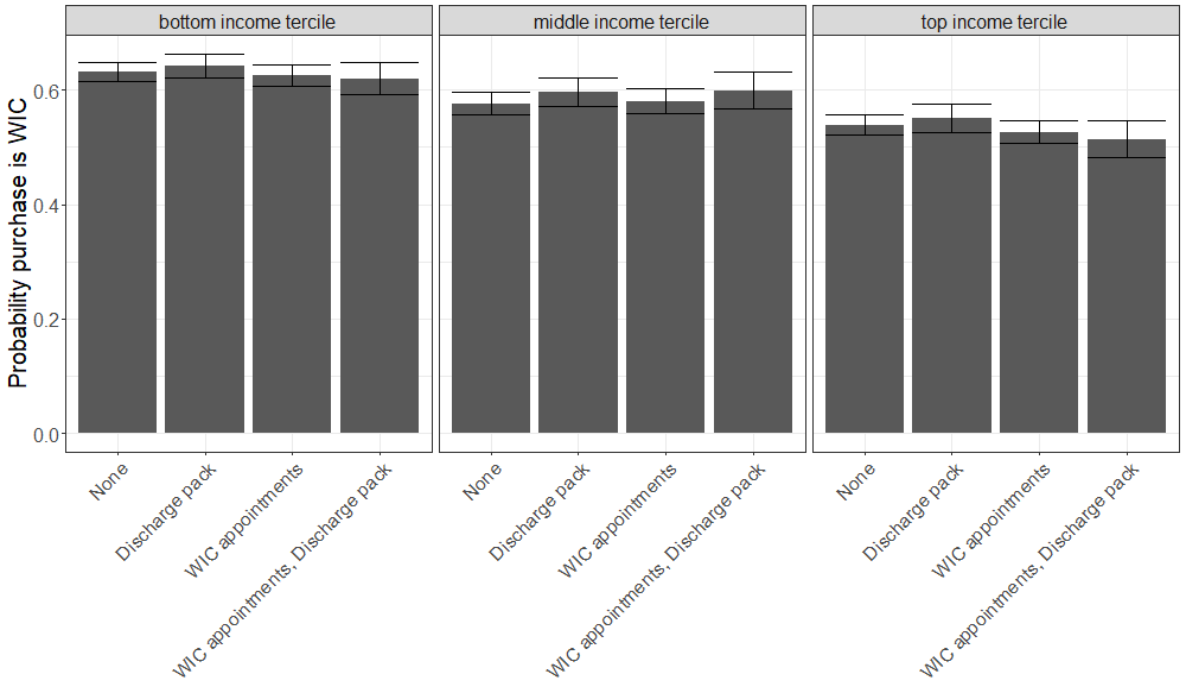
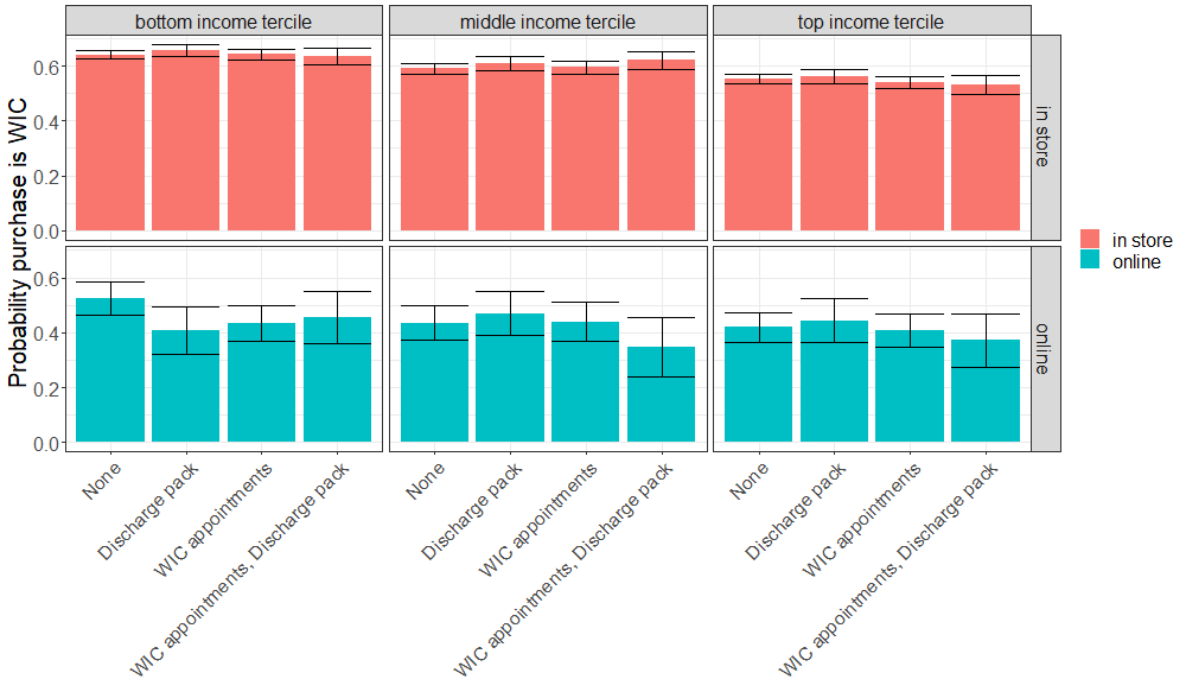
A Appendix

Figure A.1: Probability of WIC purchase by hospital characteristics and income



Note: Figure compares the fraction of non-WIC households that purchase the WIC brand among those whose nearest hospital neither provides discharge packs containing formula nor helps make WIC appointments, only provides discharge packs containing formula, only makes WIC appointments, or both. The left, middle, and right panels show purchases made by households in the bottom, middle, and top income tercile. Purchases are limited to regular-sized purchases that are the households' first purchase of infant formula. 95% confidence intervals are shown.
Source: Numerator data 2019-2023.

Figure A.2: Probability of WIC purchase by hospital characteristics, purchase method, and income



Note: Figure compares the fraction of non-WIC households that purchase the WIC brand among those whose nearest hospital neither provides discharge packs containing formula nor helps make WIC appointments, only provides discharge packs containing formula, only makes WIC appointments, or both. The top three panels show purchases made online and the bottom three panels show purchases made in store. The left, middle, and right panels show purchases made by households in the bottom, middle, and top income tercile. Purchases are limited to regular-sized purchases that are the households' first purchase of infant formula. 95% confidence intervals are shown.
Source: Numerator data 2019-2023.