

Impacts of Electronic Benefit Transfer on the Women, Infants and Children (WIC)

Program: Evidence from Oklahoma

Job Market Paper

Xuemei Li¹

Department of Agricultural and Resource Economics, University of California, Davis, One

Shields Avenue, Davis, California, USA, email: xmeli@ucdavis.edu

Abstract: The Special Supplemental Nutrition Program for Women, Infants and Children (WIC) has mandated changes to its food issuance and redemption method from paper vouchers to electronic benefit transfer (EBT) by 2020. This paper focuses on the changes in WIC program participation and program food costs after EBT transition. Both topics are of considerable importance because program participation has been declining since 2010. As a non-entitlement program, WIC program cost containment is essential to expand its programs and serve more eligible participants. County level WIC enrollment data and WIC food issuance and redemption data in Oklahoma are used to perform the empirical analysis. The transition to EBT is anticipated to increase participation and decrease food costs because it provides WIC participants more flexibility in redeeming food benefits, reduces the time cost and stigma cost of WIC participants, and prevents redemption of expensive, non-WIC-eligible food items. However, I find no statistically significant increase in program participation after EBT transition. But EBT reduces average participant food costs about \$8.24 per month. Applying this number to WIC participants in all the states, generates about \$56 million in cost savings annually.

¹ I thank seminar participants at the Agricultural and Applied Economics Association's 2018, 2019 Annual Meetings, the Tufts University 12th Future of Food and Nutrition Conference, and Oklahoma WIC, and participants in the Brown Bag Seminar Series in the Department of Agricultural and Resource Economics at University of California, Davis, for insightful comments and suggestions.

1. Introduction

The Special Supplemental Nutrition Program for Women, Infants and Children (WIC) provides food assistance to low-income pregnant and postpartum women, infants, and children up to age five. WIC is the third largest federal nutrition assistance program in the United States with roughly \$6 billion appropriated in 2018, of which 66 percent was spent on food benefits including the cost of food and the distribution system (USDA FNS 2018).² Established as a pilot program in 1972 and made permanent in 1974, the program covers over one-half of all newborn infants and one-quarter of all children under the age of five (FNS 2017).

Almost all the literature surrounding the nutritional effects of the WIC program finds that the program has a positive effect on the health status of participating women, infants, and children (e.g. Miller, Swaney, and Deinard 1985; Lee and Mackey-Bilaver 2007; Kropf et al. 2007; Bitler and Seifoddini 2019). Despite the documented benefits associated with program participation, several barriers prevent potential recipients from joining and fully utilizing available benefits. One of them is funding availability. As a non-entitlement program, WIC's ability to serve eligible individuals depends on cost effectiveness, given the annual Congressional appropriation. Low and decreasing coverage rates is another factor that jeopardizes the realization of the program's goals. The average coverage rate of WIC is around 55 percent, which is much lower than other U.S. food-assistance programs. Also, most participants do not fully redeem the benefits to which they are entitled. According to Phillips et al. (2014), only 12.6 percent of all WIC-eligible families in Kentucky, Michigan, and Nevada fully redeemed their WIC food benefits in 2012.

One of the primary factors causing low rates of participation and participants underutilizing their food benefits is the way in which benefits are delivered (Hanks et al. 2016). In some states,

² The largest food and nutrition program in the U.S. is the Supplemental Nutrition Assistance Program (SNAP), followed by the National School Lunch Program.

WIC benefits are delivered through paper vouchers, also known as food instruments (FIs), which specify the types and quantities of eligible foods that can be redeemed at WIC-authorized vendors. Vendors then return vouchers to state WIC agencies for reimbursement. According to federal regulation, all state WIC agencies are required to implement an EBT system by October 1, 2020. As such, an increasing number of states have undergone or are in the process of transitioning to the process of transferring to the EBT system, which replaces paper vouchers with debit cards for food benefit issuance and redemption at WIC-authorized stores. The transition to EBT is a revolutionary change for the WIC program. It fundamentally alters the channel of benefit issuance, distribution, and redemption and could generate huge impacts on WIC participants, WIC vendors, and WIC state agencies. However, to date few studies have examined its impact on program stakeholders.

In this paper, I investigate how the transition to EBT affects WIC participation rates, WIC food costs, and WIC participants' shopping patterns. While other studies have considered this question on a more macro scale (i.e., multi-state), this paper is the first to consider this question using county-level monthly enrollment data and transaction-level redemption data in the state of Oklahoma. Given that EBT was rolled out in waves across counties in Oklahoma in different stages, these data provide me with a unique opportunity to identify the immediate, and more persistent, impacts associated with a WIC agency's transition to EBT.

A person's decision to enroll in the benefit transfer program is usually modeled as a function of expected benefits and transaction costs, which include the application cost, cost of redeeming the benefits, and potential stigma cost (e.g., Riphahn 2001; Currie 2005; Manchester and Mumford 2010). First, I analyze how these factors affect participation behavior and discuss the changes in these factors after EBT transition. Then, I collect the number of WIC participants

each month in each county and calculate the share of participants in the total population. Finally, a generalized difference in difference model is employed to study the average effect of the transition on WIC participation, and how people changed their participation behavior over time after EBT implementation. Overall, I do not find evidence that more participants joined the WIC program due to EBT transition.

A similar method is used to examine the changes in WIC food costs after transferring to eWIC. The results show that food costs were reduced by about \$8.24 per participant per month or 13 percent. Three potential hypotheses are considered to explain the decreases in food costs after EBT: i) more partial redemptions, ii) more efficient vendor management system and less fraud, and iii) more benefit redemption in less expensive, large supermarket stores. While it is hard to test the first two hypotheses given the data limitations, the third hypothesis is tested by examining WIC participants' shopping preference over three vendor types—small, medium, and large. I find only weak evidence that participants shopped more frequently at large vendors post EBT transition. This finding is important in the sense that it provides evidence that EBT transition reduces WIC food costs, and WIC participants did not change their shopping patterns significantly while psychological cost of redemption decreases.

The organization of my paper is as follows. The next section provides detailed background on the WIC program including eligibility for program participation, federal and state regulations on WIC, the history of food package revisions, transition status of the distribution system, and basic information on the Oklahoma WIC program. Section 3 discusses the existing literature on WIC and details the contribution of this paper. Section 4 introduces a conceptual framework, including a description of the factors that could affect people' WIC participation decision, how these factors change after EBT transition, and a descriptive model on WIC participation. Section

5 describes the three datasets I use on WIC enrollment, WIC benefits issuance and redemption from Oklahoma WIC. Section 6 describes the EBT roll out procedure in Oklahoma, details the empirical strategy used, and discusses the results of the estimation. Finally, section 7 concludes.

2. Background

The mission of the WIC Program is to safeguard the health of low-income pregnant, breastfeeding, and postpartum women; infants; and children less than 5 years of age by providing free supplemental foods, nutrition education, and healthcare referrals. In fiscal year (FY) 2018 approximately 6.9 million people participated in WIC each month. WIC accounted for 5.7 percent of total U.S. Department of Agriculture (USDA) expenditures (\$98.6 billion) on this program category (Oliveira 2018). To be eligible for WIC, participants must have a household income at or below 185 percent of the federal poverty level or receive benefits through Temporary Assistance for Needy Families (TANF), the Supplemental Nutrition Assistance Program (SNAP), Medicaid, or certain state programs.

WIC is a federally funded program administered by the U.S. Department of Agriculture's Food and Nutrition Service (USDA-FNS). USDA-FNS provides regulatory oversight and technical assistance to 90 states, territorial, and tribal government agencies, which operate the program through local WIC agencies and clinics.^{3,4} FNS also specifies WIC-eligible foods and tailors them into seven food packages. Each eligible participant receives one of the seven packages based on his/her own characteristics such as pregnancy status, breastfeeding practices, the age of children or infants, and dietary needs. States have discretion in deciding the specific brands, types,

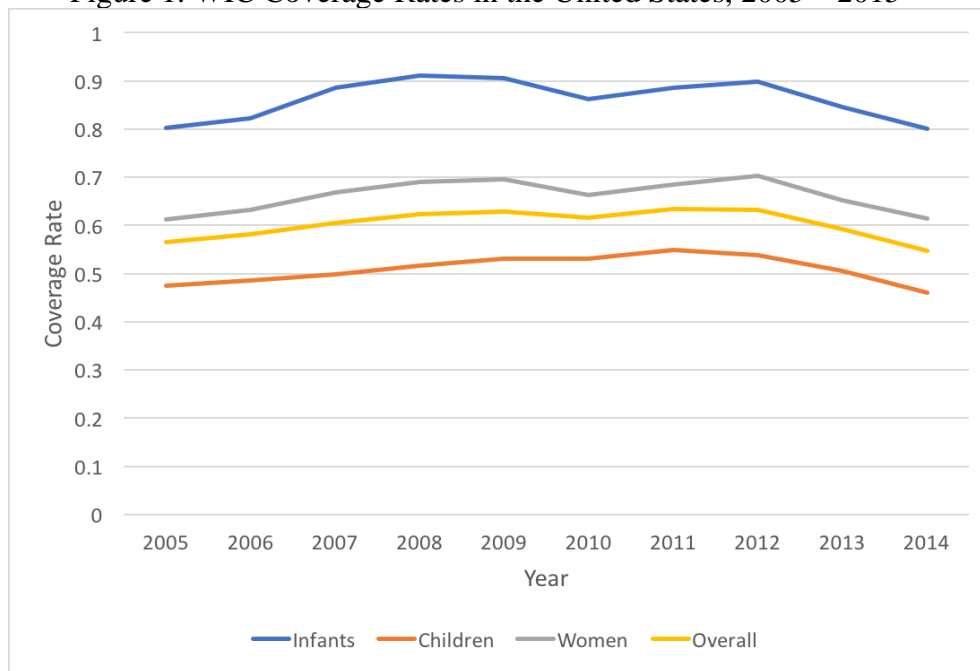
³ Local agency means a public health or welfare agency or a private nonprofit health or welfare agency, which, directly or through an agency or physician with which it has contracted, provides health services.

⁴ The 90 WIC agencies include the 50 states, the District of Columbia, Guam, the American Virgin Islands, American Samoa, the Commonwealth of Puerto Rico, the Northern Mariana Islands and 34 Indian tribal organizations.

and package sizes to include in approved WIC food packages, within the bounds of federal regulations (7 CFR 246).

As the third largest food assistance program in the U.S., WIC helps millions of people to get free supplemental food and nutrition education each year. However, WIC has a lower coverage rate (i.e., participation divided by the total number of eligible individuals) compared to other food assistance program. From 2005 to 2014, WIC’s overall coverage rate has fluctuated within the range of 55 to 64 percent (Figure 1). In 2014, 15 million people were eligible to receive WIC benefits in a given month. Of those 15 million, 55 percent, or just over 8 million people, were covered by the program (USDA 2017). At the same time, more than 80 percent of people eligible for the Supplemental Nutrition Assistance Program (SNAP) participated in the program. Also, the WIC coverage rate has declined from a high of over 63 percent in 2011 and 2012 to 55 percent in 2015. This decline in coverage rate is problematic and a cause for policy concern given the demonstrated health benefits of WIC.

Figure 1. WIC Coverage Rates in the United States, 2005 – 2015



Source: USDA, Food and Nutrition Service

Based on the guidelines and regulations established by FNS, states can choose their own food delivery systems as benefit redemption mechanisms. State agencies may choose among four types of food delivery systems – retail (paper voucher or EBT), home delivery, or direct distribution (7 CFR 246.12). Some state agencies have issued food benefits to participants from local WIC agencies every one to three months in the form of a paper voucher. Each paper voucher specifies the types and quantities of a group of approved foods (e.g., 1 gallon of milk, 64 oz. of bottled juice, and 16 ounces of whole grains), also called food instrument (FI) that can be redeemed at commercial WIC-authorized vendors. Vendors then return vouchers to state agencies for reimbursement. The authorized vendors include a variety of store types, including supermarkets, grocery stores, mass merchandisers, convenience stores, gas station food marts, commissaries, and pharmacies. The states that choose retail distribution systems are required to authorize an appropriate number and geographic distribution of stores to ensure the lowest practicable food prices while maintaining adequate participant access.

A few states have used alternate distribution methods to deliver WIC food benefits. For example, in Mississippi food benefits are provided to WIC participants through 95 distribution sites statewide, while Vermont distributed food via home delivery before its EBT transition in 2016.

Electronic benefit transfer (EBT) is today the most common way of delivering WIC benefits. It replaces paper vouchers with a credit-type card for food benefit issuance and redemption at authorized WIC vendors. According to federal regulations, all states are required to implement WIC EBT by October 1, 2020. Figure 1 shows the transition stage of each state agency in implementing the EBT system in March 2019. As of March 2019, 28 states and 14 Indian Tribal Organizations had fully transitioned to WIC EBT.

A final rule revising the food packages was published on March 4, 2014. This rule completes implementation of the first comprehensive revision to the WIC food packages. The final rule modifications included adding yogurt as a partial substitute for milk and more whole grain and fish options for women and children, as well as additional fruits and vegetables for children (7 CFR 246).

2.1. Cost Containment within the WIC Program

Since WIC is a discretionary spending program funded by the federal government, each state must operate within annual funding levels appropriated by Congress. To make the best use of the federal funds available and serve as many eligible participants as possible, state WIC agencies employ several different approaches to reduce food costs. Some of these approaches are required by federal law and should be adopted by all state agencies, while for other options that are suggested by FNS, state agencies have flexibility in choosing whether or not they are applicable based on states' own situation.

One approach to reducing program costs is to utilize a variety of vendor management strategies. States are required to implement a vendor peer group system, establish competitive pricing criteria, and set maximum allowable department reimbursement (MADR) levels in a manner that ensures that authorized vendors are charging competitive prices for WIC consumers. Further, state agencies can choose low-cost vendors for vendor authorization.

Another approach required by federal law is to enter into sole-source contracts with specific manufacturers to negotiate a lower per-unit price for certain food items, mainly infant formula (Kirlin, Cole, and Logan 2003). As part of these agreements, the WIC agency receives rebates from these manufacturers based on volume sold. The manufacture that offers the highest rebate per unit sold to the program wins the contract.

It is also very common to reduce the costs of food packages by restricting the brands available to WIC consumers or regulating the product package sizes allowed for purchase with WIC food instruments. WIC participants are provided with a WIC shopping guide, which specifies the size, type (e.g., organic vs. nonorganic), flavor, brand, etc. of products that can be purchased using WIC food instruments.⁵ Since each state can employ different cost-containment practices as long as the nutritional standards set by FNS are met, the scope and restrictiveness of these practices varies widely. In the most restrictive case, WIC consumers are only allowed to buy the least expensive brand (LEB) of some products in authorized stores. Currently, 19 of 50 U.S. states employ some LEB policy, and Texas, Arkansas, and Georgia are states applying LEB policy most broadly.

Although state agencies impose various restrictions on WIC food items to control program cost, WIC participants often still have extensive choice in certain product categories, and large price variation may still exist among authorized brands/products/package sizes. This provides the opportunity for participants to systematically choose expensive brands because they face no cost consequences in doing so. Such participant shopping behavior, if confirmed empirically, would have significant implications for program costs.

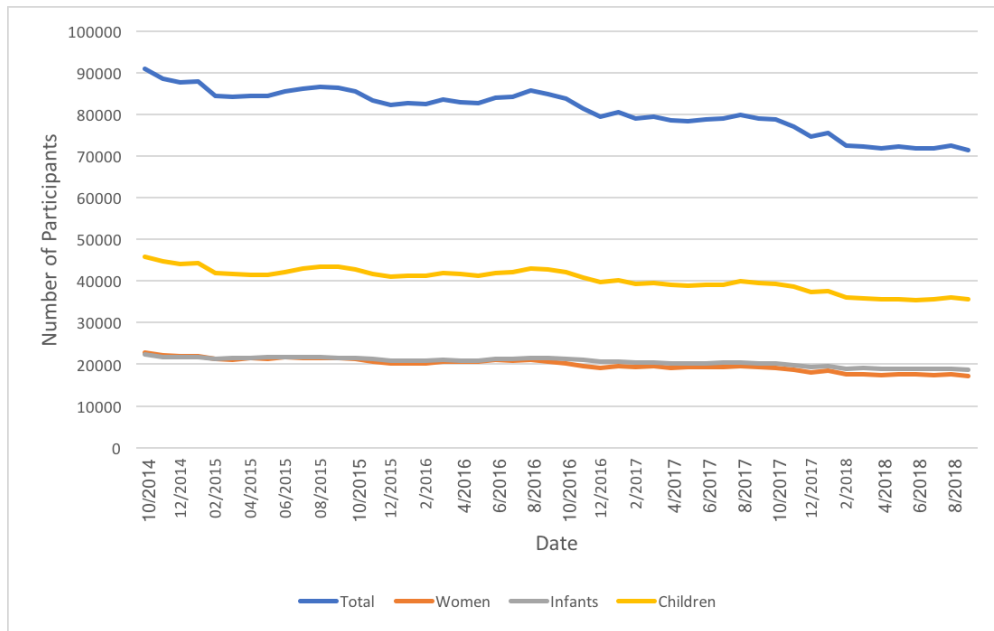
2.2. Oklahoma WIC program

The Oklahoma WIC program serves approximately 70,000 participants each month through 110 clinics statewide, accounting for about 1.10 percent of national WIC participation. WIC participation in Oklahoma has been decreasing in recent years. Average monthly participation has dropped more than 20 percent from FY2014 to FY2018 (Figure 3). The declining participation

⁵ Oklahoma's WIC shopping guide:
<https://www.ok.gov/health2/documents/2015%20Oklahoma%20Unified%20WIC%20Approved%20Food%20Card.pdf>

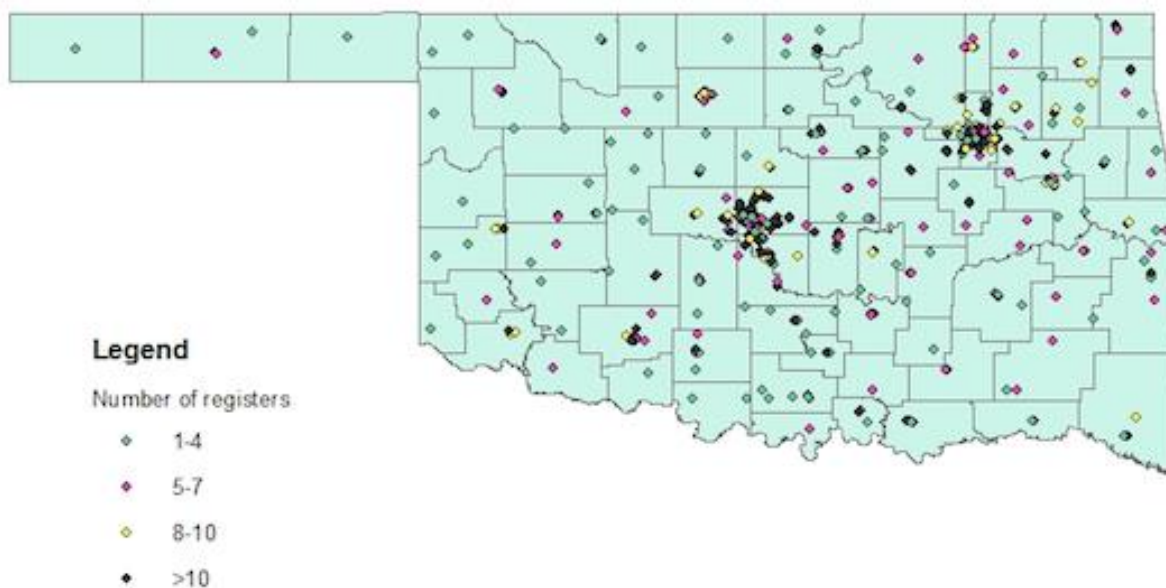
prevails in all participant categories and is consistent with the national participation trend. In FY2018, average WIC food cost per person per month was \$33 in Oklahoma, which was \$9 less than the national average.

Figure 3: Oklahoma WIC Monthly Participation, October 2014-October 2018



Oklahoma WIC consumers redeemed their WIC benefits at 458 authorized vendors in 2015. Figure 4 shows the geographic location of those WIC vendors delineated in color by number of cash registers. About 40 percent of vendors are food retail outlets and large supermarket chains that have more than 10 registers. The number of WIC vendors in a county is mainly determined by the participant/vendor ratio in that county. No more vendors will be authorized once the maximum participant/vendor ratio is reached, except when a new applicant's shelf price for WIC-approved foods are at least five percent below the department's statewide average cost (Okla. Admin. Code § 310:410-3-10). For this reason, about 35 percent of vendors are clustered in three counties-Tulsa, Oklahoma, and Cleveland, which have high population densities. The remaining 65 percent of vendors are distributed rather evenly in the other 74 counties of Oklahoma.

Figure 4: Geographic Location of WIC Vendors by Number of Registers



State agencies are required to establish a vendor peer group system to monitor vendor prices and make sure that they are cost competitive. Oklahoma elected to divide all WIC-authorized vendors into six peer groups based on geographic location, store size, store type, prices, and number of redemptions. Table 1 describes each peer group and reports the number of vendors classified in each group in 2016. WIC vendors deriving more than 50 percent of their annual food sales revenue from WIC redemption are categorized into the above 50 percent (A-50) vendor peer group. There are only 12 A-50 vendors in Oklahoma. But they accounted for 16 percent of total FI redemptions.

Oklahoma WIC participants received their food benefits through paper vouchers before the EBT transition in February 2016. Each participant was issued approximately two to four WIC FIs, plus a cash value voucher (CVV) for fruit and vegetable purchases each month.⁶ Table 2

⁶ CVV is a cash value voucher issued to WIC participants to purchase fresh and frozen fruits and vegetables.

summarizes food content, number of redemptions, expenditures, and share of Program expenditures for all active Oklahoma FI and CVV with at least 15,000 redemptions over the period January 2015 – January 2016. The 14 FI/CVV summarized in Table 3 collectively account for about 60 percent of Program food expenditures.

Table 1. Oklahoma Authorized Vendors by Peer Group

Peer Group	Peer Group Description	# of Vendors
1	Rural<\$100,000, Urban<\$15,000 & <3Reg & No Chains	65
2	Rural>\$100,000, Urban>\$15,000 &/or 3+Stores	219
3	Extreme Low-Price Vendors	152
6	Pharmacies	8
7	Above 50% Vendors	12
8	Farmers & Farmer's Markets	2
Total		458

Note: the \$ amount in this table refers to the monthly sales of the vendor. Reg indicates registers.

Table 2. FI and CVV Redeemed by Number and Value (Jan. 2015 – Jan. 2016)

FI Code ^a	Food Products ^b	Number of FI Redeemed	Value (\$) of FI Redeemed	% of Program Redemption Cost
F62001	F	15,310	1,818,208	9.76
F02001	F	9,305	1,423,015	7.64
C21031	WG, J, E, PB/DB, CH, LM	63,363	1,355,580	7.27
C21052	WG, IC, BM/LM/Y, CM/LM, J	69,886	1,207,934	6.48
F42001	F	5,101	865,503	4.64
F63021	F	6,832	845,363	4.54
C21053	CVV, O	94,000	700,798	3.76
F02211	F	3,766	599,709	3.22
C11031	CH, WM, WG, E, J, DB/PB	25,173	537,284	2.88
F42221	F	2,526	447,445	2.40
C11032	CE, WM/Y, WM, WG, J	23,690	404,089	2.17
C21041	WG, CB, J, E, CH, LM	11,321	251,770	1.35
F62002	IC, IF&V	17,043	248,338	1.33
F62003	IF&V	15,715	146,215	0.78

Notes: ^aThe first 5 digits of the FI code is the package number, the last digit indicates the FI number.

^bFood product legend: BM=buttermilk, CE=cereal, CH=cheese, CM=chocolate milk, DB=dried beans or peas, E=egg, F=infant formula, IC=infant cereal, IF&V=infant fruits & vegetables, J=juice, LM=low fat milk, O=other, PB=peanut butter, WG=whole grains, WM=whole milk, Y=yogurt

Six of the 14 leading FI/CVV contain infant formula and formula cost constitutes 30 percent of total redemption costs in 2015. Food packages with a combination of staple goods, like low fat milk, cheese, egg, whole grains, etc., were also frequently redeemed in 2015. Except for the A50 vendors, the redemption values of each group are positively related with the number of vendors. More than 90 percent of the redemptions are made in extreme low-price vendors, large chain stores, and A50 vendors. Only two farmers markets redeemed WIC CVV in 2015 with negligible redemption values.

3. Literature Review

Most of the economics literature on WIC can be divided into two categories: the first category examines nutritional effects of the program on women, infants, and children from the perspective of program evaluation; the second category studies cost-containment policies, with a focus on the market impact of sole-source infant formula contracts. A small portion of literature focuses on cost effectiveness and the impact of WIC policies on different stakeholders of WIC. To date little research has studied EBT transition and WIC families' redemption behavior. This paper contributes to these research areas by using a new and richer EBT dataset to analyze WIC participants' redemption behavior, and the impact of EBT transition on program participation and WIC food costs. Also, this work expands the economic analyses of WIC to program participation in the dimension of welfare stigma.

The literature surrounding the nutritional effects of the WIC program finds that program participation improves the health status of women, infants, and children. For example, the WIC program has been shown to mitigate iron deficiency anemia in children (Miller, Swaney, and Deinard 1985), positively influence birth weights (Kowaleski-Jones and Duncan 2002; Bitler and Currie 2005; Hoynes, Page, and Stevens 2011; Currie and Rajani 2015), reduce food insecurity (Black 2004; Metallinos et al. 2011; Kreider, Pepper, and Roy 2016), and improve participants' overall nutritional status (Lee and Mackey-Bilaver 2007, Kropf et al. 2007). WIC participation is

a good indicator of prenatal and early childhood nutrition and health environments, which, in turn, is strongly linked to cognitive development, academic learning, and eventually socioeconomic attainment (Jackson 2015).

To reduce program cost, each state awards a sole-source contract to a formula manufacturer. As part of the contract, the WIC state agency receives rebates from this manufacturer. The manufacturer that offers the highest rebate per unit sold to the program wins the contract. Receiving this sole-source contract has a considerable positive effect on the manufacturer's market share (Oliveira, Frazão, and Smallwood 2013). The rebate system is also an effective way to augment program revenues (Betson 2007), although the provision of free formula through the WIC program results in a higher wholesale price of infant formula overall (Betson 2007; Davis 2012).

As a non-entitlement program, cost effectiveness is important in controlling program cost and expanding WIC services. Kirlin, Cole, and Logan (2003) selected six states to study the relationships between state WIC cost-containment practices, program costs, and WIC participant outcomes. They find that cost-containment practices were successful in reducing average food package costs by substantial amounts, and cost-containment practices were associated with few adverse outcomes for WIC participants. This result, to some degree, addresses the concerns of lower participation rates resulting from cost-containment strategies and provides support for implementing those practices.

Saitone and Sexton (2012) study the cost-containment procedures employed in California, and their results show that there is substantial variation in price across brands/sizes, which indicates the potential cost savings from eliminating those expensive brands. Also, in another paper with Volpe in 2015, they find that larger vendors do not mark up WIC foods relative to a control

group of closely related, but ineligible, products, while smaller vendors charge considerably higher prices for staple goods that comprise WIC food packages. Thus, a potential program improvement is using large-vendor prices as a benchmark to limit prices set by smaller vendors.

Only a very small portion of the literature has focused on EBT transition and WIC participants' redemption behaviors. But it plays an important role in expanding the existing literature to other dimensions and laying a good foundation for future analysis. A survey conducted by the Altarum Institute on WIC participants suggests that most people are satisfied with the shopping experience with EBT (Phillips et al. 2014). Participants find EBT to have significant benefits, such as improved convenience, portability, and less participant stigma. The survey results suggest that the transition to EBT could encourage more eligible low-income women, infants and children to join the program. Rigorous econometric analysis is needed, however, to test whether these perceptions translate into improved participation.

Hanks et al. (2016) examine the impact of EBT on WIC recipient behavior. They find that the introduction of EBT does not increase the probability that eligible women and children enroll in the WIC program, and WIC recipients' WIC expenditure in a major grocer in Ohio increases two to four months after the EBT transition compared to pre-EBT redemptions. However, they only have enrollment data for five states and the data is aggregated to the state level. This level of aggregation limits the authors' ability to detect any potential effects from EBT, especially considering that their models lack state-specific control variables. In my work, a more detailed county-level enrollment data will be used to capture the effect of this policy on participation.

Phillips et al. (2014) use EBT redemption data in Kentucky, Michigan, and Nevada from January to March 2012 to examine WIC consumers' shopping patterns. They find that a number of family characteristics, i.e., race and ethnicity, urban/non-urban geography, the number of WIC

family members, and number of persons in the household, are associated with the full redemption of monthly WIC benefits. However, since they only use data in two months, they are not able to study participants' dynamic behavior and could not control for unobserved time-invariant heterogeneity, which may result in biased estimates.

Welfare stigma, the disutility incurred from participating in welfare, is first introduced into an economic model by Moffitt (1983), who finds that participating in benefit transfer programs generates negative utility for participants. Following Moffitt, many other researchers have employed various approaches to estimate the effect of welfare stigma on program participation, either by direct modeling (Blundell, Fry, and Walker 1988; Riphahn 2001; Fang and Silverman 2004), or experimental design (Daponte, Sanders, and Taylor 1999; Friedrichsen, König, and Schmacker 2018). They all find evidence that welfare stigma exists as a component of utility cost that may prevent participants from joining benefit transfer programs.

Manchester and Mumford (2010) construct a structural model to decompose the psychological cost of welfare participation into “external” and “internal” components. Then they use the estimates from the structural model to conduct policy simulations. They find that the implementation of EBT, which effectively eliminated the external psychological costs (or at least those costs incurred upon benefit redemption) associated with Food Stamp Program, increased take-up rates by 30 percent. They estimate that a similar EBT policy for WIC would increase take-up rates by 23 percent. One drawback of his method is that they assume constant time cost of WIC participation pre- and post-EBT implementation. This assumption is not a very realistic given WIC participants using eWIC card spend less time redeeming their food benefits.

4. Theoretical Underpinnings

When potential WIC participants consider joining the program, they take both the expected WIC food benefits and transaction costs, which include the time and effort required to apply for the program, the time and effort required to receive and redeem the benefits, and potential stigma cost, into consideration. The EBT transition changes the value of WIC participants' food benefits and transaction costs in multiple dimensions, and could potentially generate impact on their participation behavior.

Since WIC participants are getting the same food packages before and after EBT transition, the nominal value of the benefits does not change. However, the actual value of the benefits could increase after EBT transition as WIC participants gain more flexibility in terms of when and where to redeem their benefits. Unlike with paper vouchers, benefits issued for a given food instrument can be redeemed with eWIC through multiple transactions at different WIC-authorized vendors across different shopping trips. This provides WIC participants opportunities to choose from a broader selection of food items at different stores and to redeem more fresh WIC foods through multiple shopping trips, which is likely to increase the actual value of WIC food packages. In addition, while participants have no way to redeem their benefits without a complete paper voucher, they will not lose their WIC food benefits if their eWIC card is lost, stolen or damaged.

The implementation of EBT could also reduce the psychological stigma experienced by WIC participants when redeeming benefits (Moffitt 1983; Ranney and Kushman 1987; Besley and Coate 1992; Blumkin, Margalioth, and Sadka 2015). Under the paper voucher system, when WIC consumers bring checks to stores to redeem food benefits, cashiers need to check each food item individually to ensure the item is both WIC authorized and listed on the FI that the participant is attempting to redeem. Paper vouchers not only increase the transaction time, a concern with long

checkout lines, but also make WIC consumers more easily identified by other consumers in the store. Alternatively, under the EBT system, cashiers only need to scan the Uniform Product Code (UPC) label of each food item and a computer program within the store's cash register system automatically determines if items are WIC-eligible and if they are available to the participant (i.e., have not yet been redeemed). Fellow shoppers do not need to wait behind recipients as long, and it is more difficult to identify WIC recipients, potentially reducing negative stigma (Manchester and Mumford 2010).

In addition, the time cost of receiving and redeeming WIC food benefits also decreases considerably after EBT transition. Under the eWIC system, WIC participants no longer need to pick up their WIC checks every three months from local WIC offices as the food benefits can be loaded to their eWIC cards automatically. In some EBT states, including Oklahoma, WIC participants can also receive their mandatory nutrition counselling online instead of visiting local WIC clinics.

Given the advantages of the EBT system, it is reasonable to hypothesize that the transition to EBT will increase WIC participation. However, there are some offsetting factors to consider. First, eWIC reduces participants' ability to substitute ineligible items into the WIC basket as the redemption system becomes more transparent, possibly reducing the desirability of participation. Also, under the paper voucher system, because WIC participants were more easily identified by other shoppers, it potentially helped promote the program and made other people aware of the WIC program.

EBT transition could also change peoples' redemption behavior and affect WIC food cost. The average monthly WIC food cost per participant for EBT states in 2018 was \$37.52, compared to \$44.87 across all other (non-EBT) states, suggesting that EBT states have considerably lower

WIC food costs.⁷ The transition to EBT could decrease WIC food costs in three ways. First, the EBT system may change peoples' redemption patterns and allowing more partial redemptions. When WIC participants have more flexibility in redeeming their WIC benefits, some of them might choose not to redeem all the benefits in one setting because they no longer need to redeem all the foods within one voucher at one time. If, by the end of month they still have benefits left and they do not need them, they might just choose to not redeem the remaining benefits. However, they are less likely to do that when they use paper vouchers because, if they fail to redeem some food items, they will not be able to redeem them in the future.

Second, it is more convenient to monitor WIC vendors' behavior under EBT system because all the transactions are recoded electronically. This could reduce the incidence of redemptions of more expensive, non-WIC eligible, food redemptions. Recall that most states impose restrictions on the package size, type, flavor, brand, etc. of WIC-eligible products to reduce program cost. In some states like Oklahoma, WIC consumers are only allowed to buy the least expensive brand (LEB) of milk, cheese, and eggs in authorized stores. When participants use paper vouchers to redeem these foods it is the store cashier's responsibility to check each item manually to make sure that they are both WIC-eligible and are listed on the WIC check. It is inevitable that some cashiers might mistakenly authorize redemptions of some more expensive, and non-WIC-eligible food products and thus increase the WIC food cost. Also, even if sometimes the cashier recognized that non-qualified products were being purchased he/she might lack incentive to reject the redemption, as long as the total redemption value of a food package does not exceed the maximum allowable redemption value.

⁷ The average per participant WIC food cost is calculated based on the WIC data in U.S. states, not including Indian Tribal Organizations.

However, under the eWIC system an authorized product list of all WIC-eligible products is available for download to vendors' electronic cash register/point of sale (ECR/POS) systems. The store staff only need to scan each food item, and the program will automatically determine whether it is WIC eligible and can be paid by the eWIC card. This system reduces the chance of non-qualified WIC transactions being authorized.

Lastly, under the EBT system, WIC participants might shop more in large supermarkets, instead of small WIC-only stores, if EBT transition decreases psychological stigma. Participants shopping at large supermarkets will help reduce the WIC food costs. According to Saitone, Sexton, and Volpe (2015), larger WIC-authorized vendors do not mark up WIC foods relative to a control group of closely related, but ineligible, products, while smaller vendors charge considerably higher prices for staple goods that comprise WIC food packages. I conduct a test of this hypothesis in this paper.

5. Data

In order to estimate the impact that the EBT transition has on WIC participation rates and program food costs, I combine four different datasets from Oklahoma WIC: i) county level WIC enrollment data, ii) benefit redemption data prior to EBT transition, iii) benefit issuance and redemption information after EBT transition, and iv) demographic information on WIC participants and information about WIC-authorized vendors. This is then combined with county-level population and demographic data in Oklahoma.

The WIC enrollment data contains the number of WIC participants in each month in each county from February 2015 to August 2017. The benefit redemption data contain approximately 3.5 million observations from January 2015 to August 2016 under the paper-voucher system and

15 million observations under the eWIC system from February 2016 to November 2018. The redemption data have information on redeemed WIC foods (in the form of FI under the paper voucher system and specific food categories under eWIC), participants, and vendors. Data from the FI system provide information on food package number, issue date, begin date and end date of the FI (which defines the time period during which it must be redeemed), unique check number, FI status (redeemed, expired, voided, rejected), redeemed amount, and maximum allowable redemption rate. Since WIC consumers can purchase each food individually from the eligible food list under the eWIC system, the data from the EBT system provides the UPC code, price, approved quantity, maximum price, and paid amount for each redeemed individual food.

Each observation in the redemption data also provides participant ID and participant category (infant and child and pregnant, postpartum breastfeeding, postpartum non-breastfeeding woman). Since the pre-eWIC data are at an individual level and eWIC data are at a household level, each observation in the pre-eWIC data is tied to an individual ID, whereas the eWIC data is tied to a household ID. Vendor information in the redemption data includes vendor identification number, which can be used to merge with the vendor dataset to get detailed information of each vendor.

To convert household level eWIC food cost to the individual participant level, we need to know the number of WIC participants in each WIC household. This information is obtained from the eWIC benefit issuance data, which contains the identification number of individuals participating in the program and the corresponding household ID.

The dataset on WIC participant information contains the individual ID and his/her corresponding household ID, the zip code of the participant's residence, and individual's date of birth. The information on vendors includes vendor ID, vendor name, corporate ID of vendor,

vendor's geographic location, number of registers, and the peer group of the vendor at the time that the FI was submitted for redemption. The dataset also contains information for each clinic where WIC participants receive nutrition education and counseling.

To study the impact of EBT transition on WIC food cost, I calculated the average WIC food cost per participant in each month for each county. To classify the participants into different counties, I use the address of stores where participants redeem their food benefits, rather than their county of residence because the EBT transition was rolled out to vendors and clinics in each county consecutively and participants' shopping behavior could only be affected by the EBT policy if they shop at WIC-authorized vendors that were in counties that had transitioned to EBT. In situations where participants redeem their benefits at stores located in different counties, the county where the participant most frequently redeemed her/his benefits is used. However, the vendor dataset does not cover all the vendors in the redemption data. For the participants who shop at vendors that cannot be located from the vendor list, I use the participants' county of residence as a proxy.⁸

To supplement the data provided by Oklahoma WIC, I obtained population statistics by sex and age and the poverty rate from 2015-2017 from the United States Census Bureau. These data are county-level annual figures.

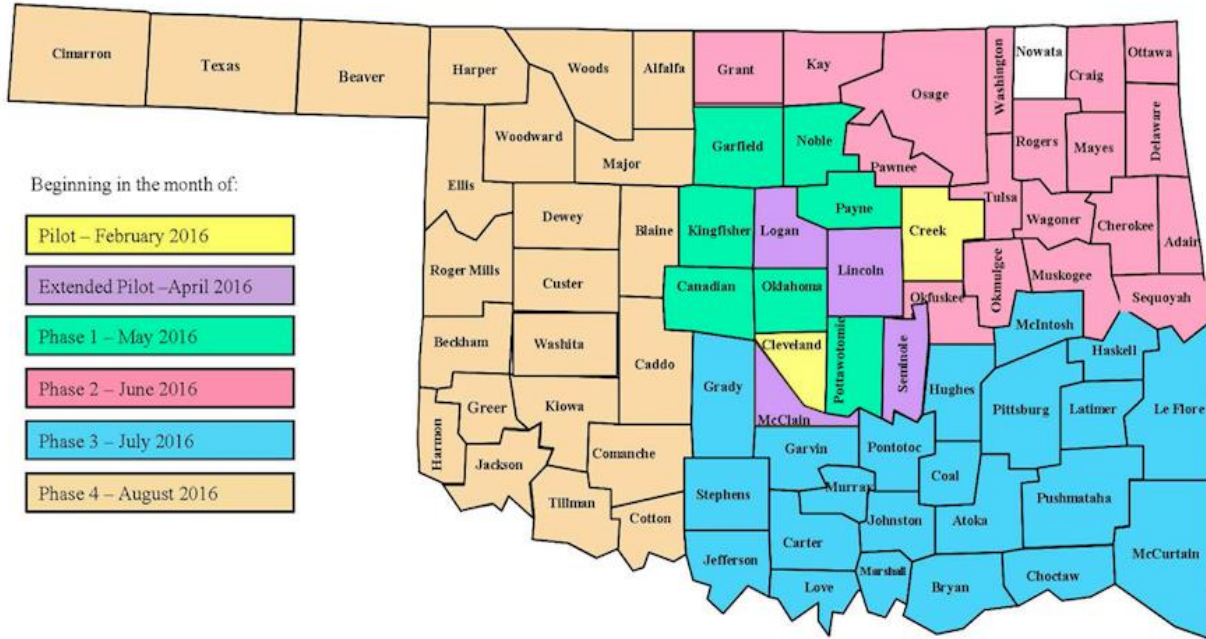
6. Empirical Models

There are 77 counties in Oklahoma. In order to roll out eWIC (EBT system), Oklahoma classified all the counties into six regions based on their locations, and applied eWIC to vendors and WIC clinics in each region consecutively from February to August 2016. Figure 5 shows the geographic location of these six regions and the EBT roll out timeline. The EBT conversion started with a few

⁸ This method is used for 0.1% of vendors in the paper voucher system and 0.03% of vendors in the eWIC system.

populous counties in central Oklahoma, then spread out to northern and southern parts of the state. The last phase involved EBT transition of the 23 counties in Western Oklahoma.

Figure 5. eWIC Roll Out Map: Oklahoma



Source: Oklahoma WIC program

6.1. Impact of EBT Transition on WIC Program Food Costs

The data used for the empirical specification encompass June 2015 to January 2017, which covers the EBT transition period, as well as six months prior and six months post-EBT implementation.⁹ Given we have multiple groups (regions) implementing EBT in different time periods, a general difference-in-difference (DID) specification (Bertrand, Duflo, and Mullainathan 2004) provides the best empirical framework to estimate the impact of EBT transition on WIC participation rates. The baseline model is as follows:

$$Participation\ Rate_{i,s,t} = \alpha_s + \lambda_t + \beta I_{s,t} + \gamma Z_{i,s,\bar{t}} + \varepsilon_{i,s,t}$$

⁹ One more month's data are used as reference month to run the WIC participation regression.

where $i = 1, \dots, 76$, indicating the counties in Oklahoma, $s = 1, \dots, 6$, are the six regions that transferred to eWIC consecutively, $t = 1, \dots, T$, indicating different transition periods. The outcome variable, *participation rate*, is the county's WIC participation share of the county's population in each month. α_s is region fixed effect, λ_t is month-year fixed effect, I_{st} is the policy variable (whether EBT is implemented in region s at time t), and Z_{ist} is a vector of exogenous control variables, which vary across years. β is the coefficient of interest. The error term $\varepsilon_{i,s,t}$ represents the effects of the variables that were omitted from the equation. I assume that the population mean of the error term is zero and observations of the error term are uncorrelated with each other.

For the control variables, I consider the number of WIC-eligible people in each region as the most important one. Since the county-level eligibility data are not readily available, I include factors that could potentially affect people's WIC eligibility. To be eligible for WIC, the individual has to be woman, infant, or child under five years old. Therefore, I added the percent of women of child-bearing ages (i.e., 15 – 44), infants, and children under age five in each county to control for the heterogeneous effect generated by eligible population. Also, as a food assistance program, WIC eligibility is tied closely to a potential participant's income. Eligible participants must have a household income at or below 185 percent of the federal poverty level. For this reason, the poverty rate in each county are also added as a control variable. The poverty rate is calculated as the number of people in poverty in each county divided by the county population.

To get the estimated treatment effect, the DID model compares the average change over time in the outcome variable for the treatment group with the average change over time for the control group. Since it compares the differences of the change, not the change itself, it mitigates the effects of extraneous factors and selection bias. In the case of EBT transition, if some

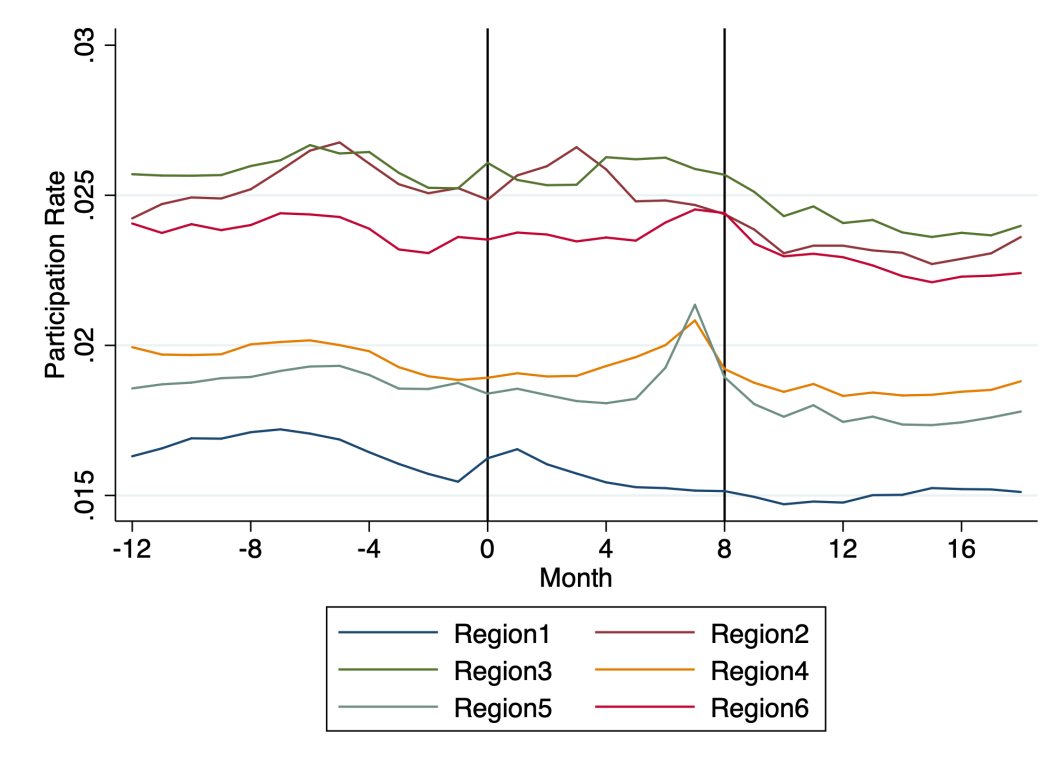
unobservable factors affected WIC participation rates in the period of EBT transition, failing to control for them would not affect the DID results as long as they have the same effect on participants residing in different regions.

However, factors that generate differential impacts on WIC participation across regions need to be controlled. In 2016, there were no other factors (e.g., policy implementation, large population migrations) that would have generated unparalleled trends for WIC participation in EBT regions and non EBT regions. Figure 6 shows the WIC participation rate in each region in the data period. The horizontal axis is constructed by setting the first month of EBT transition as month 0. The EBT transition period is from month 0 to month 8, which is the period between the two vertical lines. From the graph, we can see that the parallel trend assumption is valid most of the time before and after EBT transition regions except region 2. Region 2 is located in the middle of the state, and consists of counties, like Logan and McClain, which have relatively high household incomes. Thus, it is possible that people residing in this region have better access to media, public services, and other networks to receive information and thus respond more quickly to the policy change. To get an unbiased DID estimator, counties in region 2 are removed from the regression. Since the growth of participation rate is parallel in all the other regions, the non-EBT regions' change in WIC participation rate can be interpreted as the change EBT regions would have experienced, had they not enrolled in EBT.

The baseline model provides the average effect of EBT transition on WIC participation over the post-implementation period in the data. However, I also seek to investigate how participants, and those eligible to participate in WIC, may change their participation behavior over time. For example, some potential participants may not be aware immediately of the conversion to eWIC and may join the program a few months after the EBT transition. Some people might

change their behavior a few months before EBT transition because the upcoming EBT implementation is known and changes their future expectations of WIC.

Figure 6. WIC Participation Rate in Each Region: February 2015 – August 2017



To study peoples’ participation behavior over time, I create 12 indicator variables corresponding to six months prior to and six months after the EBT transition. Another specification with three-month horizon around EBT transition is also estimated for robustness check. These alternative specifications allow me to track the effect of the policy in each month leading up to and then following adoption.

$$Participation\ Rate_{i,s,t} = \alpha_s + \lambda_t + \beta_1 I_{pre} + \beta_2 I_{post} + \gamma Z_{i,s,T} + \varepsilon_{i,s,t}$$

where I_{pre} and I_{post} are matrices of the indicator variables to account for anticipation effects and lagged implementation effects, respectively. Elements in vectors β_1 and β_2 measure the effect of

EBT on WIC participation in specific month before and after EBT transition. α_s and λ_t are the region fixed effects and month-year fixed effects as described in the base model.

6.2. Impact of EBT Transition on WIC Program Food Costs

Similar methods are used to study the effect of EBT transition on WIC food cost. The DID model is constructed by comparing the average individual WIC food cost in each month at each county before and after EBT transition.

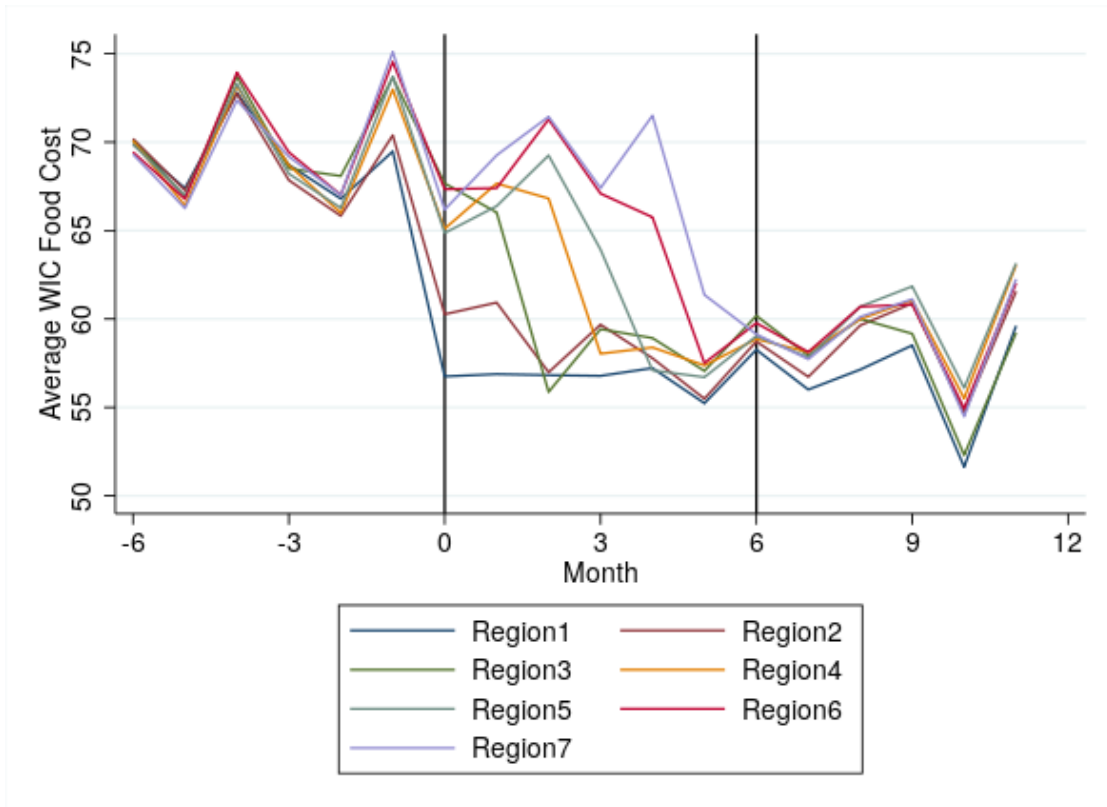
$$\text{Average WIC Food Cost}_{i,s,t} = \alpha_s + \lambda_t + \beta I_{s,t} + \gamma Z_{i,s,T} + \varepsilon_{i,s,t}.$$

Since potential WIC participants could join the program immediately and start to use their eWIC card to redeem benefits once the counties in which they redeem their WIC benefits converted to EBT. In the previous WIC-participation model, a county is defined as an EBT county once that county enrolled in EBT. However, when it comes to food redemptions, one to three months are needed for existing participants to adapt their redemption patterns after transferring to EBT because the paper vouchers are picked up every three months. If participants got their WIC checks right before the transition, they would still have to use paper vouchers to redeem their WIC benefits for up to three months after the EBT transition. For this reason, in the WIC food-cost model, I define a county as an EBT county in a particular month if 50 percent or more of the WIC foods in terms of dollar value were redeemed by eWIC card. Using this method, I get seven different regions based on the month of conversion, which ranged from April 2016 to October 2016.

The outcome variable, the average per-participant WIC food cost, is calculated by using only eWIC participants' redemption data in eWIC counties, and non-eWIC participants' redemption data in non-eWIC counties. Figure 7 shows the per-participant WIC food costs in each

of these seven regions in the data period. It is obvious that the food costs trends are parallel most of the time before EBT transition and after all the counties have completed the transition.

Figure 7. Per-Participant WIC Food Costs in Each Region: *February 2015 – August 2017*



Note: the EBT transition period is from month 0 to month 6, which is the period between the two vertical lines.

Besides EBT transition, several other factors could affect the average WIC food expenditure in a county, such as the infant share of the total participants. In 2018, the average monthly WIC food cost for infants was \$149.¹⁰ It is much higher compared to the WIC food costs of women and children, which are \$42 and \$45, respectively (USDA 2018). Also, WIC food costs are likely to be affected by the food prices in each county. While county-level price information is not available, I use median income as an attempt to control for what might be different food prices across counties.

¹⁰ This number is calculated before applying the rebate received from formula manufactures.

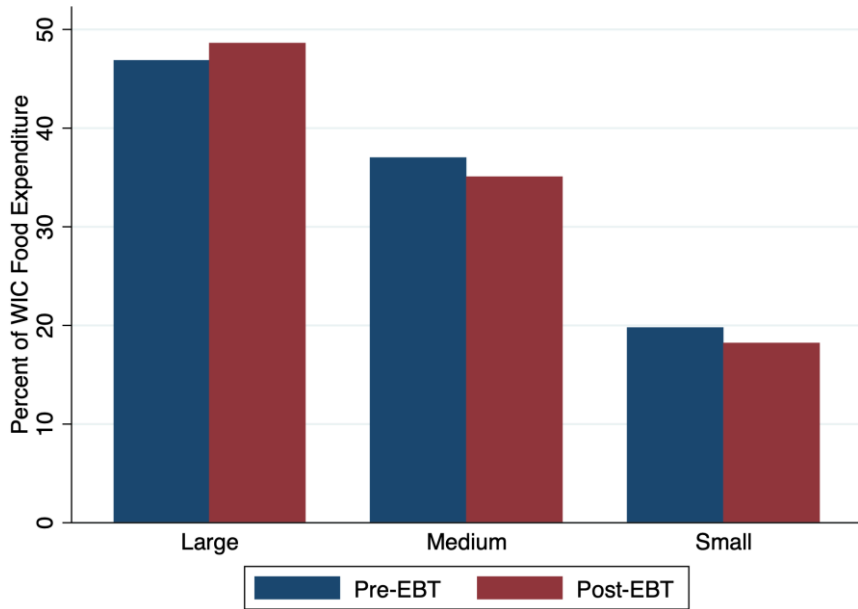
The baseline model on WIC food cost provides the average cost changes caused by the EBT policy. I specify another model which includes three indicator variables corresponding to three months after the EBT transition to track WIC participants' redemption behavior over time. It is unlikely that WIC participants would adjust their shopping patterns ahead of time because of the upcoming EBT transition. For this reason, possible anticipation effects are not studied in this model. However, WIC participants might need some time to adjust their redemption behavior after the EBT implementation. For example, at the very beginning of eWIC, participants might not be familiar with the eWIC card or its use, which could impact their redemptions of WIC benefits. Similarly, participants may only adapt their shopping behavior gradually after conversion to eWIC. Shopping behavior and WIC food costs should become more stable after participants have used the eWIC card for a few months.

6.3. Impact of EBT Transition on WIC Participants' shopping pattern

If EBT transition indeed decreases WIC participants' psychological stigma, participants will be more likely to shop in large supermarket stores instead of small vendors, including WIC-only stores. To study the impact of EBT transition on WIC participants' preference over different types of vendors, I categorize the WIC vendors into three categories - small, medium, and large based on the number of registers in the store. A small vendor has 1-3 registers, a medium vendor has 4-9 registers, and a large vendor has more than 9 registers. Figure 8 shows the average percentage of expenditure spent in these three types of vendors pre- and post-EBT transition. About 50 percent of WIC foods in terms of \$ value are redeemed at large vendors. WIC participants redeem more of their food benefits in large vendors instead of small and medium vendors after EBT transition. Table 3 shows the average price per unit of each category of WIC food in these three types of vendors, as well as the average redeemed quantity per participant per month. If WIC participants

redeem all of their food benefits from one type of vendor, it will cost them on average more than \$103 in small and medium vendors, and less than \$97 in large vendors. This provides evidence that shopping in large vendors would help reduce food costs, compared to small and medium vendors, which is consistent with the findings of Saitone, Sexton, and Volpe (2015).

Figure 8. Percentage of WIC Expenditure Across Three Types Vendors Pre-EBT and Post-EBT



To further quantify the change in WIC participants' shopping patterns due to EBT transition, I construct three DID models, and each of them studies the changes in WIC expenditure share of one type of vendor.

$$\text{Share of WIC Expenditure}_{i,s,t} = \alpha_s + \lambda_t + \beta I_{s,t} + \gamma Z_{i,s,T} + \varepsilon_{i,s,t}$$

The outcome variable in each model is the share of WIC expenditure spent in each type of vendor in each month at each county. α_s and λ_t are the region fixed effect and month-year fixed effect as before, $I_{s,t}$ is the policy variable indicating whether EBT is in implementation in region s at time t . The control variables, $Z_{i,s,T}$, are used to control for the factors other than EBT transition that

could also potentially affect WIC participants' vendor choices. For example, the share of this type of vendor in each county.

Table 3: Food Price for Each Category of WIC Food: by Vendor Types

WIC Food	Unit	Price /Unit Small Vendor	Price /Unit Medium Vendor	Price /Unit Large Vendor	Redeemed Quantity
Cheese or Tofu	LB	\$4.20	\$4.24	\$4.17	1.03
Eggs	DOZ	\$1.62	\$1.41	\$1.19	1.15
Breakfast Cereal	OZ	\$0.23	\$0.24	\$0.21	27.53
Legumes	CON	\$1.96	\$2.31	\$2.43	0.94
Fish	OZ	\$0.20	\$0.21	\$0.19	1.62
Infant Cereal	OZ	\$0.26	\$0.29	\$0.27	2.54
Infant Fruits & Veggies	OZ	\$0.16	\$0.16	\$0.15	17.91
Infant Meats	OZ	\$0.39	\$0.43	\$0.39	0.84
Bread/Whole Grains	OZ	\$0.15	\$0.17	\$0.18	19.02
Infant Formula (IF)	PDR	\$18.07	\$18.17	\$17.35	3.06
Special Formula	PDR	\$29.79	\$24.27	\$22.57	0.23
Pediasure Shake	RTF	\$8.50	\$2.23	\$2.44	0.14
Yogurt	OZ	\$0.08	\$0.08	\$0.08	21.30
Milk - whole	GAL	\$3.80	\$3.86	\$3.45	0.62
Milk - Fat Reduced	GAL	\$3.68	\$3.75	\$3.29	2.62
Juice - 12 oz	CON	\$1.74	\$1.80	\$1.79	0.63
Juice - 64 oz	CON	\$2.90	\$3.01	\$2.63	1.34
Average Monthly Cost		103.25	103.04	96.64	

Note: the monthly cost for each food category is the product of average price per unit and the redeemed quantity. Adding up the monthly costs of all food categories yields the average monthly cost.

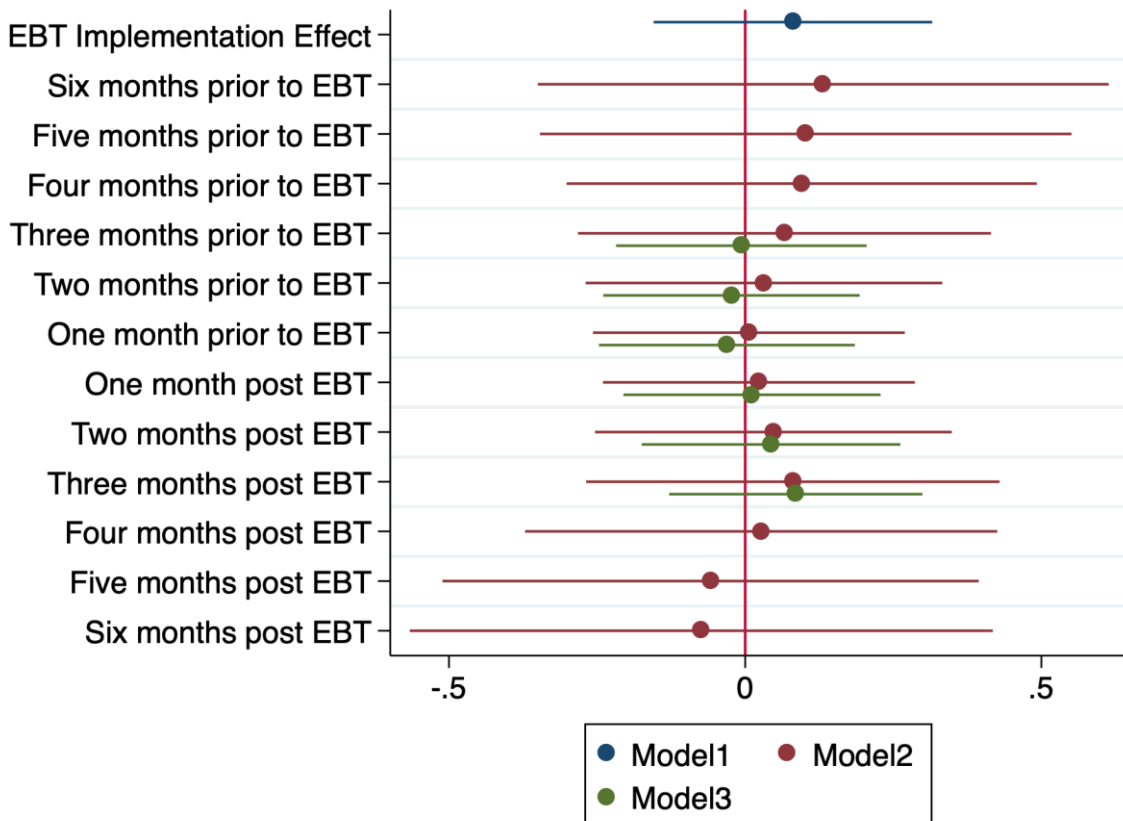
It is intuitive that WIC participants are more likely to shop at one type of vendor if the number of this type of vendor is higher in their counties. Also WIC households' shopping behavior could be affected by the density of WIC vendors in one county. Urban participants might have easier access to a wide range of vendors compared to those shopping in rural counties. I divide counties in Oklahoma into two categories, urban and rural, based on the classification method developed by the Office of Rural Health Policy,¹¹ and add the urban/rural dummy as additional control variable.

¹¹ The Office of Rural Health Policy (ORHP) is a part of Human Resources and Services Administration, of the United States Department of Health and Human Services.

7. Results

To make the results more interpretable, participation rate and poverty rate are scaled up by a factor of 100. Median income is reported in thousands of dollars. Figure 9 displays the point estimates of the WIC participation models and their confidence intervals. Results in these three models are consistent and none of them shows statistically significant effect of EBT transition on WIC program participation. The detailed regression results are listed in table 1. Regression coefficients of the baseline model is listed in column one. The second and third columns report the impact of EBT transition on WIC participation rate in each month before and after EBT implementation in three-month and six-month horizons, respectively, with the month before EBT transition as the reference month.

Figure 9. Regression Coefficients: EBT and WIC Program Participation



Given the increased flexibility and reduced time cost and stigma cost of using eWIC card, it is surprising that potential participants did not change their enrollment behavior significantly either before EBT implementation or after the transition. It is possible that when eligible participants make their WIC enrollment decision, they take more of the factors that have immediate effect on them, like the time and effort required to apply for the program and their current financial conditions, which are not affected by EBT transition, into consideration. And they consider less of the factors that create impacts in the future, e.g., the flexibility and time cost of redeeming benefits. As expected, poverty rate and the share of women and infants have positive effect on WIC participation rate.

Table 2 shows the regression results of the WIC food cost model. According to the baseline model, EBT transition reduces average WIC food cost by \$8.24 per participant per month, which is around 13 percent of the average WIC food cost before EBT transition. The second column shows that the reduction is decreasing initially upon transition and then becomes stable. As expected, the presence of more infants in a county increases average WIC food costs: a one percent increase in infant share raises the average WIC food cost by about one dollar. Since the WIC food cost is calculated based on the retail price and does not count the rebate received from formula manufactures, the effect of the infant share estimated in the model is larger than the actual cost effect for the state agency. The median income has a very small but significant negative effect on WIC food costs. One thousand dollar increase in median income would cause a \$0.08 decrease in WIC food cost, likely due to higher-income counties having better shopping options than low-income counties, which are mostly in rural areas.

Table 1. Regression Results: EBT and WIC Program Participation

VARIABLES	(1) Model 1	(3) Model 3	(2) Model 2
EBT implementation effect	0.0806 (0.120)		
Poverty rate	0.0907*** (0.00344)	0.0909*** (0.00482)	0.0907*** (0.00346)
Women & children share	0.0543*** (0.0121)	0.0537*** (0.0170)	0.0543*** (0.0122)
Six months prior to EBT			0.132 (0.246)
Five months prior to EBT			0.102 (0.229)
Four months prior to EBT			0.0955 (0.202)
Three months prior to EBT		0.0736 (0.204)	0.0664 (0.178)
Two months prior to EBT		0.0354 (0.174)	0.0317 (0.153)
One month prior to EBT		0.00853 (0.143)	0.00622 (0.134)
One month post EBT		0.0213 (0.143)	0.0232 (0.134)
Two months post EBT		0.0523 (0.178)	0.0476 (0.153)
Three months post EBT		0.0990 (0.215)	0.0805 (0.178)
Four months post EBT			0.0270 (0.203)
Five months post EBT			-0.0584 (0.231)
Six months post EBT			-0.0740 (0.251)
Constant	-0.695 (0.631)	-0.829 (0.636)	-0.826 (0.516)
County FE	YES	YES	YES
Month-Year FE	YES	YES	YES
Observations	988	988	988
R-squared	0.496	0.492	0.496

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The cost decrease obtained from the regression could be overestimated due to the different characteristic of the redemption data pre- and post- EBT transition. The redemption data are at individual level under the paper voucher system and at household level under the eWIC system. I convert the household level average food cost to individual level by the number of WIC participants in each household. If a household had more than one WIC participant but only one of them redeemed his/her WIC benefits, then the average food cost calculated using the redemption data before EBT transition would yield the accurate result. While the average cost calculated under the eWIC system would be smaller than the actual value. Because all the redemptions in this case are linked to a household ID and even only one WIC member made redemptions it is assumed that all of the WIC members in this household redeemed their WIC benefits. However, the degree of overestimation is likely to be low because all the WIC checks issued to a household are usually picked up and redeemed together by one adult in the family.

As noted, several theories could potentially explain the decrease in WIC food cost after EBT transition. One is more partial redemptions, that is, participants tend to not redeem all of their WIC foods under the eWIC system. Recall that when they use paper vouchers to redeem the WIC benefits they have to redeem all the benefits in one voucher at one time to avoid losing the unredeemed benefits. After EBT transition participants gain more flexibility in redeeming their benefits and might be less likely to fully redeem them as a consequence.

Given the demonstrated health benefits of WIC, more partial redemptions could generate negative impact on participants' health status and cause policy concerns. However, before transferring to eWIC, vouchers submitted for reimbursement provide only the total reimbursement value without any information on the specific foods purchased. We actually have little knowledge on WIC participant purchasing patterns or food preferences under the paper voucher system. Thus,

whether there are more partial redemptions under EBT and how much of the cost savings is due to an increase in partial redemptions is difficult to examine. Also, even if participants redeemed more food benefits under the paper voucher system, they might not have consumed all of them. Redemption but non-use could cause food waste and prevent participants from getting the benefit of healthy food.

Table 2: Regression Results: EBT and WIC Food Cost

VARIABLES	(1) Model 1	(2) Model 2
EBT implementation effect	-8.238*** (0.671)	
One month post EBT		-7.836*** (0.727)
Two months post EBT		-7.419*** (0.863)
Three months post EBT		-7.450*** (1.051)
Infant Share	0.993*** (0.0483)	0.985*** (0.0493)
Median Income	-0.0815*** (0.0202)	-0.0800*** (0.0205)
Constant	49.17*** (4.615)	49.29*** (4.675)
Region FE	YES	YES
Month-Year FE	YES	YES
Observations	912	912
R-squared	0.692	0.684

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The second explanation is tied to a more convenient and efficient WIC vendor management. It is expected that no more unauthorized foods will be redeemed under the eWIC system. While it is not possible to test this hypothesis with the data, I obtained some evidence from interviews with WIC staff from Oklahoma. They mentioned that they got many phone calls from WIC participants after EBT transition, who complained that they cannot not get the same

brand/type of WIC foods they used to redeem with paper voucher because the brand/type WIC participants mentioned were actually not WIC eligible but the purchases were being allowed under the voucher system.

Table 3 shows the regression results on the share of WIC food expenditure. Columns one to three correspond to the regression coefficients of small, medium, and large vendors. As none of the coefficients on the policy effect is significant in the three models, I find at best weak evidence that WIC participants redeem more of their benefits in large vendors, instead of small and medium vendors. The result somewhat contradicts the findings of Hanks et al. (2016) that WIC recipients redeemed more benefits in a supermarket chain in Ohio two to four months after the EBT transition compared to pre-EBT redemptions. Also, given the cost difference across these three types of vendor is not that great in Oklahoma, changes in shopping patterns, from small to large vendors, is not a major cause of the cost decline after EBT transition.

Table 3: Regression Result: Share of WIC Expenditure Across Three Types Vendors

VARIABLES	(1) Small Vendors	(2) Medium Vendors	(3) Large Vendors
Effect of EBT Transition	-2.834 (2.553)	-1.036 (3.496)	1.350 (2.927)
Share of Vendor	0.880*** (0.0198)	0.657*** (0.0354)	0.872*** (0.0460)
Urban	30.90*** (2.590)	0.979 (4.006)	-31.32*** (3.267)
Constant	-14.50 (9.408)	-5.316 (14.90)	39.15*** (11.78)
Region FE	YES	YES	YES
Month-Year FE	YES	YES	YES
Observations	600	792	672
R-squared	0.809	0.390	0.447

Standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1

The share of each type of vendor in a county and participants' geographic location also have an effect on their vendor preferences. It is not surprising that more vendors of one type would increase the WIC expenditure share spent in this type of vendor. And urban participants tend to redeem more of their benefits in small and medium vendors compared to those living in rural counties.

8. Conclusion

The EBT transition has a substantial effect on the way the WIC benefits are issued and redeemed, and could potentially change WIC recipients' participation behavior and redemption patterns. Yet, to date there have been few studies that have examined the impact of EBT transition on WIC participants.

In this study, I take advantage of the unique EBT implementation design in Oklahoma to study these important issues. Since counties in Oklahoma were enrolled in EBT consecutively from February 2016 to August 2016, participation information and food costs data are available at the same time in both the treated group (counties that had transferred to EBT) and untreated group (counties that had not transferred to EBT), and for the same region both pre- and post- EBT transition, which provides a great opportunity to use the DID models to obtain the casual effect of EBT transition on participants' enrollment behavior and redemption patterns.

I do not find evidence that WIC increased after EBT transition. However, this does not mean the stigma cost is negligible since many factors are taken into consideration when people make WIC enrollment decisions, and EBT transition changes these factors in different ways. The data I have only allow me to investigate the changes in participation rate due to EBT transition in general, and I am not able to quantify the effect of all the factors including stigma cost.

I find food costs were reduced by about \$8.24 per participant per month under the eWIC system. Several hypotheses could explain the decrease in food costs: the increased incidences of partial redemption, less unauthorized food redemptions, and a shift in shopping preference over less expensive supermarket stores. The first hypothesis is hard to test because WIC participants' redemption behavior is largely shielded under the paper voucher system. They redeem the whole food package together, which makes it difficult to infer the redemption information for each individual food item within the package. The second factor, that WIC shoppers could get ineligible WIC foods under the paper voucher system, is confirmed by Oklahoma WIC staff. However, we have little information on the number of unauthorized redemptions and their impact on the WIC food cost because individual transactions are unavailable through the voucher system. Finally, given the cost difference between small and large vendors is not very big in Oklahoma, and WIC participants did not change their shopping patterns significantly, we cannot conclude that the reduction in food costs is caused by increased redemptions in large vendors.

Given that 60 percent of states have transferred to EBT system, and most of the other states will complete the transition by 2020, the topic on EBT transition has very important policy implications. The insignificant relationship between EBT conversion and participation should provide impetus for WIC to search for other strategies to increase participation, so that the program can deliver its demonstrated health benefits to a larger segment of the eligible population. The reduction in per-participant WIC food costs due to eWIC is also of interest to policymakers and program administrators, especially for those in states that are in the stage of planning or implementing EBT, as they can make better budget plans and anticipate expanding their WIC services and serving more eligible people due to the reduced food costs under EBT.

However, we still have little knowledge on the causes of food costs reductions. I did not find evidence that WIC participants changed their shopping preference regarding small vs. large vendors after EBT transition. The roles of partial redemptions and reduced redemption of unauthorized foods is still unclear and more studies into the factors causing lower food costs under EBT are needed.

References

- Bertrand, M., Duflo, E., & Mullainathan, S. (2004). How Much Should We Trust Differences-in-Differences Estimates? *The Quarterly Journal of Economics*, 119(1), 249-275.
- Besley, T. & Coate, S. (1992). Understanding welfare stigma: Taxpayer resentment and statistical discrimination. *Journal of Public Economics*, 48(2), 165-183.
- Betson, D. (2007). Impact of the WIC Program on the Infant Formula Market. U.S. Department of Agriculture, Economic Research Service.
- Bitler, M. P. & Currie, J. (2005). Does WIC work? The effects of WIC on pregnancy and birth outcomes. *Journal of Policy Analysis and Management*, 24, 73-91.
- Bitler, M. P., & Seifoddini, A. (2019). Health Impacts of Food Assistance: Evidence from the United States. *Annual Review of Resource Economics*, 11, 261-287.
- Black MM. (2004). Special supplemental nutrition program for Women, Infants, and Children participation and infants' growth and health: A multisite surveillance study. *Pediatrics*, 114(1), 169-176.
- Blumkin, T., Margalioth, Y., & Sadka, E. (2015), Welfare Stigma Re - Examined. *Journal of Public Economic Theory*, 17, 874-886.
- Blundell, R., Fry, V., & Walker, I. (1988). Modelling the take-up of means-tested benefits: the case of housing benefits in the United Kingdom. *The Economic Journal*, 98(390), 58-74.

- Buescher, P.A., Larson, L.C., Nelson M.D., & Lenihan A.J. (1993). Prenatal WIC participation can reduce low birth weight and newborn medical costs: A cost-benefit analysis of WIC participation in North Carolina. *Journal of the American Dietetic Association*, 93(2), 163-166.
- Currie, J., & Rajani, I. (2015). Within-Mother Estimates of The Effects of WIC On Birth Outcomes In New York City. *Economic Inquiry*, 53(4), 1691-1701.
- Daponte, B., Sanders, S., & Taylor, L. (1999). Why Do Low-Income Households not Use Food Stamps? Evidence from an Experiment. *The Journal of Human Resources*, 34(3), 612-628.
- Davis, D.E. (2012). Bidding for WIC Infant Formula Contracts: Do Non-WIC Customers Subsidize WIC Customers? *American Journal of Agricultural Economics*, 94 (1), 80-96.
- Fang, H., & Silverman, D. (2004). On the compassion of time-limited welfare programs. *Journal of Public Economics*, 88(7-8), 1445-1470.
- Friedrichsen, J., König, T., & Schmacker, R. (2018). Social image concerns and welfare take-up. *Journal of Public Economics*, 168, 174-192.
- Hanks, A.S., Gunther, C., Lillard, D., & Scharff, R.L. (2016). "From Paper to Plastic: Understanding the Impact of EBT on WIC Recipient Behavior," *2017 Allied Social Science Association (ASSA) Annual Meeting, Chicago, Illinois*, Agricultural and Applied Economics Association.
- Hoynes, H., Page, M., & Stevens, A.H. (2011). Can targeted transfers improve birth outcomes? Evidence from the introduction of the WIC program, *Journal of Public Economics*, 95(7-8), 813-827.
- Jackson, M. I. (2015). Early Childhood WIC Participation, Cognitive Development and Academic Achievement. *Social Science & Medicine*, 126, 145–153.

- Kirlin, J., Cole, N., & Logan, C. (2003). Assessment of WIC cost-containment practices: Final report. USDA Food Assistance and Nutrition Research Program electronic publication (E-FAN-03-005).
- Kowaleski-Jones, L. & Duncan, G.J. (2002). Effects of Participation in the WIC Program on Birth Weight: Evidence from the National Longitudinal Survey of Youth. *American Journal of Public Health*, 92(5), 799-804.
- Kreider, B., Pepper, J. V., & Roy, M. (2016), Identifying the Effects of WIC on Food Insecurity Among Infants and Children. *Southern Economic Journal*, 82, 1106-1122.
- Kropf, M.L., Holben, D.H., Holcomb, J.P. & Anderson, H. (2007). Food security status and produce intake and behaviors of Special Supplemental Nutrition Program for Women, Infants, and Children and Farmers' Market Nutrition Program participants. *Journal of the American Dietetic Association*, 107(11), 1903-1908.
- Lee, B.J., & Mackey-Bilaver, L. (2007). Effects of WIC and Food Stamp Program participation on child outcomes, *Children and Youth Services Review*, 29(4), 501-517.
- Manchester, C. F., & Mumford, K. J. (2010). Welfare stigma due to public disapproval. Working Paper, available on SSRN.
- Metallinos-Katsaras, E., Gorman, K.S., Wilde, P., & Kallio, J. (2011). A longitudinal study of WIC participation on household food insecurity. *Maternal and Child Health Journal*, 15, 627.
- Miller, V, Swaney, S, & Deinard, A. (1985). Impact of the WIC Program on the Iron Status of Infants. *Pediatrics*, 75(1), 100-105.
- Moffitt, R. (1983). An economic model of welfare stigma. *American economic review*, 73(5), 1023-1035.

- Oliveira, V. (2018). The Food Assistance Landscape: FY 2018 Annual Report, EIB-207, U.S. Department of Agriculture, Economic Research Service.
- Oliveira, V., & Frazão, E. (2015). The WIC Program: Background, Trends, and Economic Issues, 2015 Edition, EIB-134, U.S. Department of Agriculture, Economic Research Service.
- Oliveira, V., Frazão, E. & Smallwood, D. (2013). Trends in Infant Formula Rebate Contracts: Implications for the WIC Program, EIB-119. U.S. Department of Agriculture, Economic Research Service.
- Oliveira, V., Prell, M., & Cheng, X.Z. (2019). The Economic Impacts of Breastfeeding: A Focus on USDA's Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), ERR-261, U.S. Department of Agriculture, Economic Research Service.
- Phillips, D., Bell, L., Morgan, R., & Pooler, J. (2014). Transition to EBT in WIC: Review of Impact and Examination of Participant Redemption Patterns. Prepared for Economic Research Service, Washington, DC.
- Ranney, C., & Kushman, J. (1987). Cash Equivalence, Welfare Stigma, and Food Stamps. *Southern Economic Journal*, 53(4), 1011-1027.
- Riphahn, R.T. (2001). Rational Poverty or Poor Rationality? The Take - up of Social Assistance Benefits. *Review of Income and Wealth*, 47(3), 379-398.
- Saitone, T.L. and Sexton, R.J. (2012). The California Women, Infants and Children (WIC) Program: Analysis of Cost-Containment Strategies and Recommendations for Improved Program Efficiency. Report for the California WIC Agency.
- Saitone, T.L., Sexton, R.J., & Volpe, R.J. (2015). A Wicked Problem? Cost Containment in the Women, Infants and Children program. *Applied Economic Perspectives and Policy*, 37(3), 378-402.

U.S. Dept. of Agriculture, Food and Nutrition Service. (2013). WIC Participation Continues to Decline. Available at <https://www.ers.usda.gov/amber-waves/2017/june/wic-participation-continues-to-decline/> (accessed January 12, 2018).

U.S. Dept. of Agriculture, Food and Nutrition Service. (2017). Women, Infants, and Children: WIC Eligibility and Coverage Rates. Available at <https://www.fns.usda.gov/wic/wic-eligibility-and-coverage-rates> (accessed May 11, 2018).