NBER WORKING PAPER SERIES

FROM PAPER TO PLASTIC: UNDERSTANDING THE IMPACT OF EWIC ON WIC RECIPIENT BEHAVIOR

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Working Paper 25131
http://www.nber.org/papers/w25131

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
October 2018

This manuscript was partially funded by the Duke-UNC USDA Center for Behavioral Economics and Healthy Food Choice Research (BECR), which is funded by grant 59-5000-4-0062 from the U.S. Department of Agriculture. The views expressed in this manuscript research are those of the investigators and cannot be attributed to the Duke-UNC USDA BECR Center or the U.S. Department of Agriculture, its Economic Research Service, or its Food and Nutrition Service, nor to the National Bureau of Economic Research. We would also like to thank participants at the 2016 NBER Health Economics Summer Institute, participants at the 2017 American Economic Association annual meeting, participants at the 2017 Agricultural and Applied Economics Association annual meeting, and participants at the Department of Human Sciences Seminar Series for their valuable comments.

From Paper to Plastic: Understanding the Impact of eWIC on WIC Recipient Behavior
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NBER Working Paper No. 25131
October 2018
JEL No. H42,I1,I12

ABSTRACT

Evidence shows that the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is underutilized. WIC enrolls only sixty percent of eligible persons. Participants claim only a fraction of available benefits. Researchers suggest that people underutilize WIC because of the time needed to enroll in and use WIC and because participants may believe that, if others notice them participating in WIC, community members will stigmatize them. Recently enacted policies may reduce both time costs and potential for stigma associated with WIC. Congress mandated that, by 2020, all states disburse WIC benefits through an Electronic Benefits Transfer (eWIC) system. The eWIC potentially reduces the time required for each transaction and makes it more difficult to identify beneficiaries. We analyze data on grocery expenditures of 11,887 WIC-participating households in one state over the period it implemented eWIC. We find that, after beneficiaries began redeeming WIC benefits through eWIC, spending on non-WIC eligible foods did not change but redemptions of WIC benefits increased.

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A data appendix is available at http://www.nber.org/data-appendix/w25131

INTRODUCTION

To deliver food assistance, the United States Department of Agriculture (USDA) has increasingly used Electronic Benefits Transfer systems (EBT, also referred to as eWIC). Since June 2004 the USDA has used eWIC to deliver Supplemental Nutrition Assistance Program (SNAP) benefits. Partly based on that experience, Congress mandated that, by 2020 all states use eWIC to disburse WIC benefits. Currently, 26 states have implemented eWIC (USDA 2018a). Our objective is to understand the economic effects of eWIC on WIC recipient behavior, specifically benefit redemptions.

In fiscal year 2017 Special Supplemental Nutrition Program for Women, Infants, and Children received over $5.5 billion (USDA 2018b) in funding making it the third largest nutrition assistance program. For reference, 12.5% of the US population participates in the SNAP program (USDA 2018c). By contrast, approximately 45.4% of all infants, 23.5% of children (USDA 2018b; US Census Bureau 2018), and 35.8% of pregnant and postpartum women (Ver Ploeg and Betson 2003) participate in WIC.

The WIC program aims to provide a nutritionally adequate and balanced diet to low-income pregnant and postpartum women, infants, and children ages 1-4 who are "at nutritional risk." By design, and in contrast to the SNAP program, WIC provides specific foods (milk, eggs, bread, and cereal) in specific quantities. WIC also gives beneficiaries a small cash amount that they may *only* spend on fruits and vegetables (cash value vouchers).

Applicants who meet WIC program requirements (state resident, income, and at nutritional-risk) are eligible for six months of benefits with the possibility of extending benefits for one or more additional six-month periods. Evidence suggests that WIC staff deem virtually all applicants to be at nutritional-risk (Bitler, Currie, and Scholz, 2003). A pregnant woman is

eligible for benefits during nine months of pregnancy and for at least six months post-partum. If a woman decides to partially or fully breastfeed her child, she can receive benefits for up to twelve months after she delivers. WIC eligible children remain eligible until their fifth birthday.

During each six-month period of eligibility, recipients receive benefits in two separate three-month installments. However, WIC delivers vouchers for specific amounts of food that recipients may only redeem on a month-by-month basis. They may not redeem three months' worth of benefits all at once.

The literature presents mixed evidence on whether WIC achieves its nutritional targets. Studies convincingly suggest that WIC mothers bear children who weigh more at birth (Rossin-Slater, 2013; Hoynes, Page, and Stevens, 2011; Bitler and Currie, 2005) though some researchers debate that evidence (Joyce, Gibson, and Colman, 2005; Joyce, Racine, and Yunzal-Butler, 2008). Less robust evidence partially supports hypotheses that WIC participants experience less food insecurity (Kreider, Pepper, and Roy, 2016; Metallinos et al., 2011; Black et al., 2004), improves their diet, health (Yen, 2010; Lee and Mackey-Bilaver, 2007) and cognition (Jackson, 2015), and increases children's iron, potassium and fiber intake (Yen, 2010). Some evidence hints that older siblings may benefit when younger siblings participate in WIC (Robinson, 2013).

A smaller literature documents that people do not fully exploit the benefits available under WIC. Researchers estimate that, in 2013, only 60.2 percent of eligible persons enrolled in WIC (Johnson et al., 2015). Further, in Kentucky, Michigan, and Nevada only 12.6 percent of WIC recipients redeemed all WIC benefits while 5.3 percent redeem none (Phillips et al., 2014).

Given its recent introduction, there are relatively few studies of whether and how eWIC affects WIC beneficiary behavior. Meckel (2016) finds that the eWIC system may reduce WIC participation because it reduces the number of stores that participate in WIC. Qualitative

evidence suggests that individual WIC participants shop more frequently under eWIC and that they view eWIC systems favorably because the transaction is faster and they feel less embarrassed. (Phillips et al., 2014). An unpublished simulation also suggests that eWIC reduces perceived stigma (Manchester and Mumford, 2010).

Our study is one of the first to examine whether and how the introduction of eWIC affects benefit redemption and non-WIC food spending. We use household-level scanner data from a major grocery store chain in Ohio that track weekly household expenditures on non-WIC foods and redemptions of WIC foods for households in 56 of 88 Ohio counties. Ohio implemented eWIC in seven sets of counties between 2014 and 2015. Our sample period, from the last week of December 2013 through the first week of June 2015, includes six of the seven implementations. We show that, after eWIC, recipients redeem more WIC benefits. We find no evidence that eWIC influences how much households spend on non-WIC-eligible foods.

In the remainder of the paper, we provide some background on how WIC recipients redeemed benefits before and after a county implemented eWIC. We sketch out a set of hypotheses about how eWIC might alter recipients' behavior. We then describe our data, sample, method, and results. Lastly we discuss our results and draw conclusions.

WIC BENEFIT REDEMPTION BEFORE and AFTER eWIC IMPLEMENTATION

Before the state of Ohio introduced eWIC, WIC recipients redeemed benefits with five separate paper vouchers by following a strict process. At checkout, recipients had to first separate WIC-eligible food items from other goods. The beneficiary then handed the cashier her paper WIC vouchers. The cashier manually verified each WIC-eligible item, marked the vouchers, and informed the WIC beneficiary of any items she could not redeem with WIC benefits. If the

cashier identified non-WIC eligible items, the cashier allowed the WIC recipient to return the items. If she chose to keep them, the clerk included their cost in the total cost of all non-WIC-eligible purchases. Under paper vouchers, a beneficiary surrenders the voucher to the clerk after she redeems an item listed on it. If she redeems some but not all of the items on a given paper voucher, she forfeits the food items she does not redeem.

Within this context, we conceptually model the WIC recipient's decisions in a manner consistent with the household production literature spawned by Becker (1965). Specifically, WIC recipients combine time with other inputs, in this case food, to produce outputs of value to the household. In this framework, WIC recipients face a multi-dimensional cost constraint they use to find their utility maximizing food bundle, part of which is covered with WIC benefits. For this research, we focus on the costs associated with redeeming those benefits.

WIC recipients acquire authorized foods by paying non-market (or shadow) costs of time and stigma. Time costs include the initial fixed cost required to enroll in the program, time needed to travel to authorized WIC retailers, and time costs associated with the actual purchasing process. These latter costs include time needed to learn which foods WIC covers, finding those exact foods (in the approved quantities), enduring the process of redeeming benefits, and replacing or returning non-WIC items mistakenly selected to redeem with WIC benefits.

WIC recipients also potentially pay a stigma cost to get WIC authorized items. Recipients may feel this stigma while referring to WIC authorized food lists when making food selections. When redeeming benefits with vouchers, they may incur this stigma cost when other shoppers notice them separating out their WIC foods and handing food vouchers to the cashier. This stigma cost may increase as fellow shoppers wait additional time in line when the recipient mistakenly selects a non-WIC food item for redemption with WIC benefits, and the recipient

must decide to replace the item with the WIC authorized food or pay for the non-WIC item out of pocket.

In the case when a WIC recipient does not redeem all benefits on a voucher, she experiences a kink in her cost constraint. This kink occurs because relative prices of goods for which she attaches a non-zero value change at the point where she forfeits benefits. For example, if a recipient chooses to redeem milk but not eggs, though she would have redeemed eggs in a later trip, the effective "shadow price" of the eggs now includes the value she puts on the eggs foregone by not redeeming the WIC benefit for eggs. Furthermore, her resources available to buy other (non-WIC) goods also discontinuously falls.

The use of computer scanners under eWIC changes the benefit redemption process in ways that can reduce some of the transaction and potential stigma costs WIC recipients face. Under eWIC, a beneficiary no longer needs to separate her WIC and non-WIC purchases (though this is still encouraged in Ohio) and the cashier does not need to manually verify each WIC item. The cashier simply scans the barcodes for all the items, both WIC and non-WIC, and the computer automatically tallies them separately. Then the recipient swipes her eWIC card (as if it were a debit card), enters her personal identification number, and the system prints a receipt of her remaining benefits up to that point. Afterwards, the computer prints out a receipt listing the eligible WIC items for redemption that were scanned and prompts the beneficiary to authorize redemption of those benefits. Once the WIC recipient responds affirmatively, the system deducts the benefits and prints the recipient with the remaining balance, which she pays for out of pocket. The recipient then receives a receipt with the remaining benefits, along with a standard receipt.

If the recipient mistakenly selects a non-WIC food with the intent to purchase it with WIC benefits, the recipient may not even notice this before authorizing the transaction. If she

does notice the mistake, she may choose to pay for the item out of pocket to avoid either feeling stigmatized or the time costs of correcting the mistake. But if she chooses to pay for the cost out of pocket, she can still redeem the intended benefit, and any other unused benefits, at a later time.

As described here, eWIC reduces or eliminates many of the time and potential stigma costs associated with redeeming WIC benefits. In addition, the technology removes the potential kinks in cost constraints by allowing beneficiaries to redeem benefits at any time. We recognize that eWIC may actually increase shopping frequency, and increase travel costs, as recipients take advantage of the opportunity to redeem benefits at any time. With the data we have, we are unable to investigate these implied effects.

EXPECTED EFFECTS of eWIC

Relative to the paper voucher system, we expect eWIC beneficiaries will redeem more of their WIC benefits – primarily because they have more flexibility about when and how often they redeem benefits. This hypothesized effect will be even greater if eWIC reduces their perceived stigma. Note that this predicted effect will be attenuated immediately after a county introduces eWIC but will grow over the subsequent three months elapse because, during the three months immediately after a county introduces eWIC, some fraction of beneficiaries will still be using paper vouchers. They can choose to convert their vouchers to eWIC or wait until they receive the next three-month installment of benefits. The fraction still using paper vouchers steadily declines until, at the beginning of the fourth month after the eWIC implementation date, all beneficiaries use eWIC.

The transition to eWIC may also temporarily affect non-WIC expenditures. Under the paper voucher system, when a WIC recipient mistakenly chooses an item she believes is WIC eligible, the checkout clerk informs the WIC recipient of the error. This situation has the potential to make the WIC recipient suffer perceived stigma in addition to what she felt before when separating out her WIC from non-WIC foods, because the shoppers standing in line behind her must wait for her to decide what to do. Under the eWIC system, a WIC recipient decides herself whether or not to call attention to any errors she makes. If she would rather pay the amount out of pocket instead of facing time or stigma costs, then she will not choose to return the item. As she becomes more familiar with the new system, we expect her to learn and make fewer of these types of mistakes.

In summary, we hypothesize that, after a county implements an eWIC system:

1) WIC redemptions will increase;
2) WIC redemptions will increase by successively larger amounts through the paper-to-eWIC transition period;
3) Expenditures on non-WIC foods will initially increase, but the magnitude of the increase may fall over time as recipients learn.

DATA

To measure the effect of eWIC on recipient shopping behavior we make use of two unique data sets. First, we rely on variation in the staggered implementation of eWIC across counties in Ohio to identify the effect the transition has on WIC participant purchases. Second, we use household purchase data that we aggregate to the monthly level to study the dynamic patterns in purchasing before and after eWIC.

Expenditure Data

We use data on weekly household expenditures at one supermarket chain operating in 56 of Ohio's 88 counties. Through a cooperative agreement, the grocer provided data for 73,331 households that redeemed WIC benefits at least once in a calendar year. These data for WIC households are part of a larger sample of approximately 6 million households the grocer maintains as part of their loyalty card shopper program. Households enter and remain in the sample if at least one member of the household holds a loyalty card, spends a minimum amount each year, and uses the card on those purchases.

These grocer data track calendar-week (Sunday-Saturday) expenditures on WIC-eligible and non-WIC-eligible food items in 18 different product categories. The categories are bakery, deli, deli packaged, floral, fresh prepared, fresh produce, general merchandise, grocery, health and beauty care, liquor, meat, natural foods, packaged produce, pharmacy, packaged meat, packaged seafood, seafood, and supplies. Four of the categories – fresh produce, grocery, health and beauty care (infant formula), and packaged seafood – include WIC eligible food items. We ignore expenditures on packaged seafood because no household in the sample selected items in this category. The data also identify whether a household redeems WIC benefits with a paper voucher or eWIC. In less than 1% of the full sample, the grocer flagged expenditures as WIC redemptions but did not specify whether recipients used a voucher or EBT. We imputed missing values of this indicator by assuming beneficiaries in a given county redeemed WIC benefits using eWIC if their transaction occurred after the county had implemented eWIC.

Since the grocer did not provide WIC redemptions on milk, eggs, and cheese, which we refer to as dairy, we imputed them. We do so by subtracting WIC redemptions on all other categories from total WIC redemptions. Since all other WIC authorized foods appear in the other product categories, we are confident the dairy category only includes milk, eggs, and cheese.

Note that in weeks when a household has no record of purchasing food or redeeming benefits we cannot determine whether the household: 1) bought nothing that week; 2) bought all their groceries at a different store; or 3) did not use their loyalty card for non-WIC eligible items and redeemed no WIC benefits. In these cases we assume households spend nothing and assign missing redemption and expenditure values with zeros.

To smooth the data, we aggregate each household's weekly expenditures up to monthly spending. Consequently, a month may include either four or five full weeks. To measure expenditures over the same number of days, we scale expenditures in months with five weeks by 0.8. Our sample period includes expenditures over seventeen full months, beginning in January 2014 and ending in May 2015.

The weekly data identify the county of the store at which the household shops. When we aggregate the data, we retain the modal county identifier for households that shop in a given county three out of four (or five) weeks in a calendar month. If, in a given month, a household shops two weeks in one county and two weeks in a different county, we randomly assign one of those county identifiers to the household (N=195 households).

In Table 1, we summarize monthly food expenditures of the average household in each county or group of counties that implemented eWIC on a different date. The first column reports the average of total expenditures. The second and third columns report average expenditures on non-WIC-eligible and WIC-eligible food items. The last column shows WIC redemptions share of total expenditures. We observe that WIC-eligible food items share of weekly food expenditures is 0.15. Standard deviations are wide enough to suggest that mean expenditures did significantly vary by date of eWIC implementation.

eWIC Implementation Data in Ohio

The Ohio Department of Health implemented eWIC over the course of a year. Officials first piloted eWIC programs in five counties across three dates in 2014: July 14 (one county), August 4 (one county), and October 19 (three counties). After this pilot phase, Ohio rolled out eWIC to remaining counties on January 25, 2015 (eight counties), March 23, 2015 (sixteen counties), May 1, 2015 (twenty-seven counties), and July 1, 2015 (thirty-two counties). Figure 1 shows a map of all 88 Ohio counties, color-coded to indicate the date on which the Ohio WIC agency implemented eWIC in each county.

In Table 2, we summarize the demographic characteristics of residents of counties we include and exclude from our sample. The average excluded county has a bigger population with higher median household income than the average included county. Median income of households receiving SNAP benefits differ little across the two groups. In Appendix Tables A1.a and A1.b, (available on request), we compare demographics across counties that implemented EBT on a particular date. Population demographics (e.g. the percentage of families receiving welfare income) differ across the sample and non-sample counties.

Estimation Sample

Households are in the sample if they hold a loyalty shopper card, spend a minimum amount at the grocer, and redeem WIC benefits a least once a year. We restrict the sample to households that redeem WIC benefits at our grocer an average of once a month over the study period. This rule excludes WIC households that infrequently redeem their WIC benefits at the participating grocer. Our final sample includes 11,887 households and 91,049 shopping months.

EMPIRICAL SPECIFICATION

We specify our empirical models to exploit variation in the eWIC rollout schedule. Under the assumption that WIC-eligible people do not move to a particular county because they want to get (or avoid) an EBT card, this rollout schedule exogenously assigns the date on which WIC households begin to use eWIC. We model the introduction of the eWIC system as an event (see Hoynes, Schanzenbach, and Almond, 2016). With this method we model how eWIC changes beneficiaries' shopping behavior in any given month relative to their expenditures in a baseline (reference) month. Following similar studies, we define the baseline month as the month before a county implements the EBT system (see Hoynes and Schazenbach, 2009; Hoynes, Page, and Stevens, 2011). Robustness checks show that results do not change when we define the baseline month to be the month when a county implements eWIC. Those results are available on request.

We aim to test whether a household changes its shopping behavior before and after a county introduces EBT. We specify a model with separate month indicators for each of the five months before and five months after the baseline month. The coefficients on these indicators represent differences in expenditures in each month relative to expenditures in the baseline month. This flexible specification allows us to test whether WIC recipients anticipate and adjust to the introduction of EBT (perhaps because the local agency advertises it) and, as noted above, for the possibility that a given household still uses paper vouchers up to three months after a county implements the EBT system. We test the hypotheses that WIC households respond to EBT by redeeming more benefits and/or spending more on non-WIC food items in the post-baseline months. We also test whether the effects change over time.

Formally, we specify our empirical model as:

$$y_{ict} = \alpha_0 + \sum_{k=1}^{5} \alpha_k M_{t-k} + \sum_{j=1}^{5} \alpha_{5+j} M_{t+j} + \boldsymbol{\tau_t} + \boldsymbol{h_i} + \nu_{ict}. \quad (1)$$

where y_{ict} measures how much household *i* in county *c* spends in month *t*. We model spending on WIC and non-WIC eligible items, food categorized as general grocery foods, all produce, dairy, and infant formula, and the share of WIC redemptions relative to food expenditures.

The variables M_{t-k} (k=1-5) and M_{t+j} (j=1-5) represent five pre- and five post-eWIC month indicators. We include a vector of calendar year-month fixed effects, $\boldsymbol{\tau_t}$. The vector includes, for example, a fixed effect for January 2014 that differs from the fixed effect for January 2015. To capture unobserved time-invariant household variation we include a vector of household fixed effects, $\boldsymbol{h_i}$. We cluster standard errors at the county level because the state of Ohio introduced eWIC on different dates in different counties and households are nested within the counties. The final term v_{ict} is an error term.

In the Appendix (available on request) we also report results when we estimate equation (1) on subsamples of our data. These subsamples include: a) a balanced panel of households; b) households from the non-Pilot phase counties only; c) households that redeemed WIC infant formula benefits; d) household that never redeemed WIC infant formula benefits; e) households from all counties, including counties that did not implement eWIC in our sample period. We use Stata 13 for all of our analyses.

RESULTS

We report estimation results for WIC redemptions in Table 3 and in Figure 2 plot the event month coefficients from column 1 of Table 3 along with 95% confidence interval bars. Results suggest that, in the months before a county implements eWIC, a household's WIC redemptions do not differ from redemptions in the baseline month. After a county implements eWIC, households increase WIC redemptions, and the increase trends upwards across the event months.

Relative to baseline, total WIC redemptions steadily increase by $6.24, $9.35, and $11.50 in post-baseline months 3, 4, and 5 respectively. All estimates statistically differ from expenditures in the baseline month. Further, the $11.50 in expenditures in post-baseline month 5 statistically differs from the $6.24 increase observed in post-baseline month 3.

When we decompose WIC redemptions by food category, Table 3 reveals that the higher redemptions post eWIC occur in WIC-eligible grocery and dairy items. Redemptions for grocery foods, such as cereal, beans, and peanut butter are higher than baseline month expenditures by $1.45, $2.51, and $2.44 in post-baseline months 3, 4, and 5 respectively. Redemptions in dairy increase by $1.31, $3.50, and $6.72 in post-baseline months 3, 4, and 5 respectively. The extra WIC redemptions are reflected in results for the WIC share of expenditures. Relative to baseline the share of expenditures that WIC comprises increases steadily by 0.0085, 0.0195, and 0.026 in post-baseline months 3, 4, and 5 respectively.

Results in Table 3 suggest that WIC households do not systematically change WIC redemptions for produce or infant formula after eWIC. We estimate higher WIC redemptions for infant formula (relative to the baseline month) in the fourth pre-baseline (by $2.67) and fifth post-baseline (by $2.78) months. Both estimated differences statistically differ from zero. Joint tests of significance for all event month coefficients suggest these two larger coefficients for infant formula are not mere chance.

Table 3 also shows that, relative to the baseline month, WIC beneficiaries redeem fewer benefits on general grocery items in pre-baseline months four and five and on produce in pre-baseline months two, four, and five. Furthermore, relative to the baseline month, WIC redemptions for dairy product are lower in all five pre-baseline months (by $0.53, $0.27, $0.45, $0.19, and $.26 in pre-baseline months 5, 4, 3, 2, and 1 respectively) and $0.28 in post-baseline

month 1. These differences are statistically different from the baseline month redemptions with $p<.05$ except for pre-baseline months 4 and 1 where $p<.10$. We also observe increase in WIC share of total food expenditures after the transition to eWIC, suggesting no changes in non-WIC expenditures in the same period.

We report estimation results for non-WIC redemptions in Table 4 and in Figure 3 plot the event month coefficients from column 1 of Table 3 along with 95% confidence interval bars. WIC beneficiaries spend $13.22, $16.20, $14.36, and $10.41 less, than they do in the baseline month, on all non-WIC food items in pre-eWIC months 5, 4, 3, and 2 respectively. The reduction in pre-eWIC spending is mostly in produce and health/beauty care product categories.

We find that, after a county implements eWIC, households do not change their total non-WIC food expenditures but we observe evidence of greater spending within certain product categories. Specifically, WIC households spend more on produce, up to $2.22 more in month 5, in the months after their county implements the eWIC system. Households also spend more on non-WIC-eligible items in the health and beauty care category (which includes infant formula) in post-eWIC months 4 and 5, but point estimates are not statistically significant.

Robustness and Specification tests

Results from the series of robustness and specification tests (results available on request) we list at the end of the section titled Empirical Specification largely follow the pattern of results in Tables 3 and 4. Results are most similar for households that redeem benefits for infant formula at least once during the sample period. We also find that the month we choose to be the baseline month does not affect our results.

DISCUSSION

Our results suggest that eWIC dynamically changes how WIC households redeem WIC benefits and spend money on non-WIC food items before and after implementation. Overall results suggest that eWIC induces households to redeem more WIC benefits and this effect increases over the five post-eWIC months we observe. This pattern is consistent with the transition phase of eWIC systems. Notably, in the three month period after a county implements the eWIC system some WIC recipients still redeem benefits with paper vouchers.

At the same time, we also observe dynamic patterns that clearly have nothing to do with the process of phasing out paper vouchers and phasing in eWIC cards. In the months leading up to eWIC, WIC households in non-pilot counties redeem more benefits on general grocery items and infant formula. We are not certain of the mechanisms that drive these results but it is possible that as eWIC rolled out across counties WIC staff in pilot counties interacted with WIC recipients differently than WIC staff in counties that implemented eWIC as part of the "regular" rollout. Understanding the true mechanisms requires additional research and detailed data we currently lack, such as variation in outreach campaigns and/or eWIC informational materials.

The most consistent result we observe is post-eWIC increases in the dairy category. After a county implements the eWIC system, WIC beneficiaries redeem a greater amount of WIC benefits for dairy items. One possible explanation of this pattern is that the eWIC system lowers both transaction costs and perceived stigma costs. Under eWIC WIC households have more flexibility to redeem benefits more frequently and in smaller quantities without losing other items previously lumped together on a single paper voucher. Although we cannot test the hypothesis with our data, we also observe that families with young children probably (want to) buy dairy products more frequently. The increase in WIC redemptions on WIC-eligible dairy products post-eWIC is at least consistent with this logic.

We also note that eWIC systems are supposed to allow recipients to redeem their cash-value benefits for produce at any time during the month. In the early stages of eWIC, beneficiaries had to redeem less than the cash-value for produce to redeem any benefits at all. For example, if a woman selected $12 in groceries the eWIC system would not redeem any of her benefits because the amount exceeded the $10 in cash value for produce. Given this technical problem, it makes sense that after a county implements the eWIC system, households decrease the amount of WIC-eligible produce benefits that they redeem. This explanation is also consistent with the result that non-WIC produce expenditures are statistically positive four and five months after implementation (Table 5).

We recognize limitations in our research along several fronts. First, our data come from one grocer in Ohio and thus only include shoppers who participate in the grocer's loyalty card program, track household expenditures/redemptions not for specific items (except for infant formula) but only broader food categories, and cover a specific time period that does not include all eWIC implementation dates in Ohio. The first two of these limitations serve as a caution that ours is a selected sample. It also highlights that our data do not track WIC redemptions and non-WIC expenditures of our sample households at other stores. Consequently, we cannot (and do not) claim that our results reflect the behavior we would observe among a randomly drawn WIC recipient in Ohio. The latter data limitation restricts our results to fairly short-run effects. With our data we cannot estimate effects over longer periods of time.

We also recognize there are potentially alternative explanations for our results we cannot and do not test here. For example, using an identification strategy similar to ours, Meckel (2016) finds that the introduction of eWIC in Texas reduced the number of stores that participated in WIC, increased prices of non-WIC foods in smaller stores, and results in a net social welfare

loss. With our data we cannot test or control for such effects. Given the market implications of funneling more resources to fewer stores, this is an important area for future research.

Some of our results may also be an artifact of the period over which we observe expenditures and the particular counties in each implementation group. The households living in Ohio counties that implemented eWIC system in January and March 2015 are primarily Appalachian counties. It is possible that our results are driven by this specific set of WIC recipients. Our limited time frame in the data does not allow us to explore this further.

Lastly, our study also suffers standard data limitations. We observe limited information about the demographic characteristics of our WIC households. This severely limits our ability to identify which WIC bundle the household may receive. Furthermore, we are unable to study the effect eWIC has on shopping frequency, which is an interesting are for future work.

Despite the limitations in our data, we find consistent evidence that eWIC increases redemptions in WIC benefits. This increase suggests that the implementation of eWIC will have consequential effects on WIC redemptions and household budgets. Although we do not observe it in our sample, the literature estimates that the average WIC recipient redeems only 85 percent of the benefits she is awarded. Results in Table 3 suggest that by the fifth month post-eWIC, WIC recipients increase WIC redemptions, relative to baseline, by $11.50. This increase represents almost 20 percent of mean WIC redemptions (see Table 2) and suggests that WIC recipients will redeem almost all of benefits under eWIC. Further, because the eWIC system induces households to redeem more of their WIC benefits, eWIC systems may expand poorer households' disposable income and should relieve more of their financial constraints.

As eWIC expands to all states and WIC recipients enjoy a less complicated procedure for redeeming benefits, states can also work with grocers to provide greater convenience to

beneficiaries. For example, Wal-Mart recently piloted a program that lets SNAP recipients redeem their benefits when they use Wal-Mart's curbside grocery pickup program.[1] While shoppers still must enter the store to use their SNAP benefits for curb-side pick-up orders, they still enjoy the ease of shopping from home and an even greater chance to reduce stigma they may perceive from other shoppers. A high return on investment for food assistance programs such as WIC (Lentz and Barrett 2013) provides compelling evidence that states consider following suit.

State WIC programs might also consider working with vendors to allow WIC recipients redeem benefits through the retailer's food delivery programs. Since many WIC recipients have unreliable private transportation or rely on public systems, such an innovation could also increase uptake and use of WIC benefits. Of course, before state WIC agencies adopt such policies, they must understand whether and how store access and transportation costs affect uptake and benefit redemption (see Grindal et al., 2016) and when determining the efficacy of the program policy makers and program administrators should carefully consider how they measure impacts (Gundersen, Jolliffe, and Tiehen, 2009). There are multiple opportunities to leverage the benefits of eWIC to provide more favorable shopping conditions for those receiving benefits. Our research provides a unique view into WIC recipient behavior policy makers use to consider additional means to improve the WIC experience, and highlights many opportunities for additional research in this area.

[1] https://www.cnbc.com/2017/09/18/wal-mart-to-allow-shoppers-on-food-stamps-to-order-groceries-online.html

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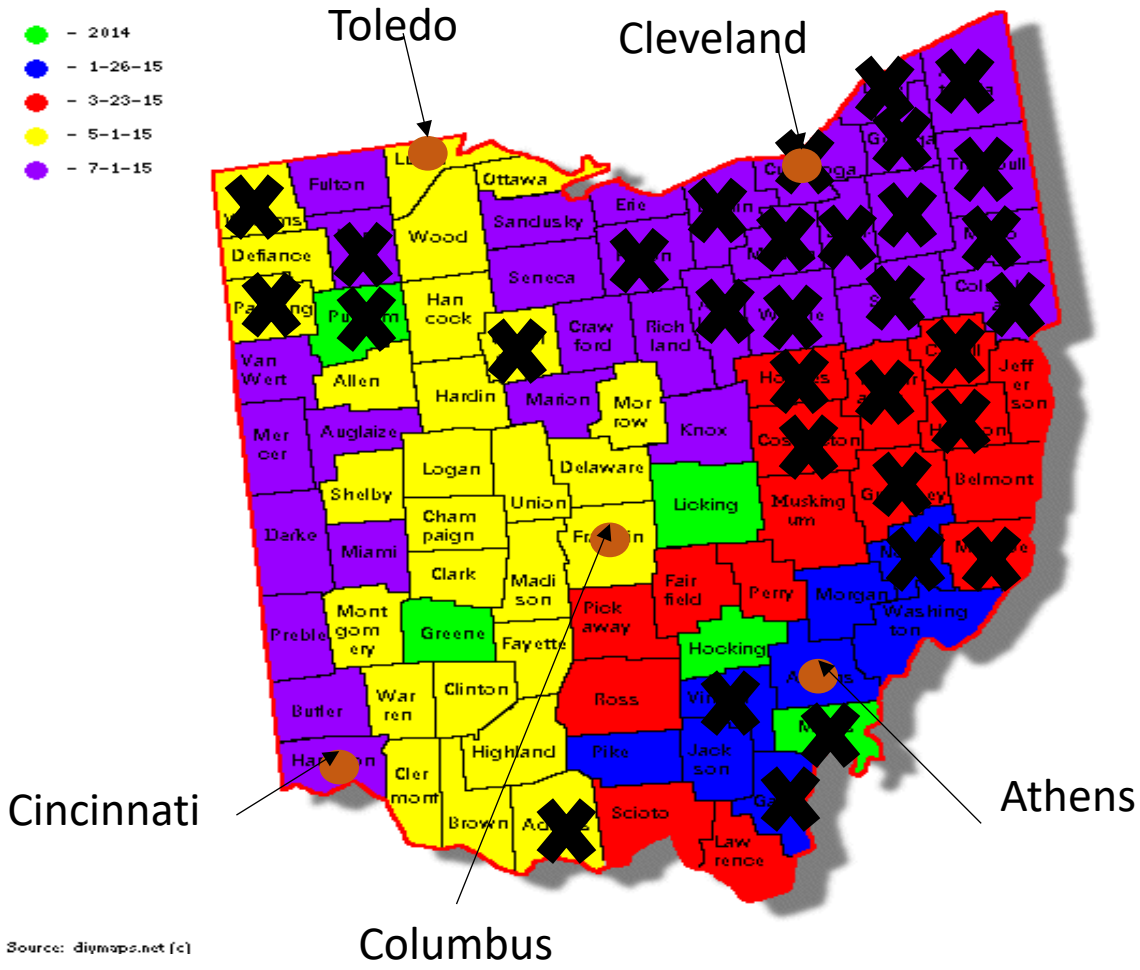

Figure 1. WIC Electronic Benefits Transfer Rollout in Ohio

Note: Black X marks indicate counties not represented in our expenditure data

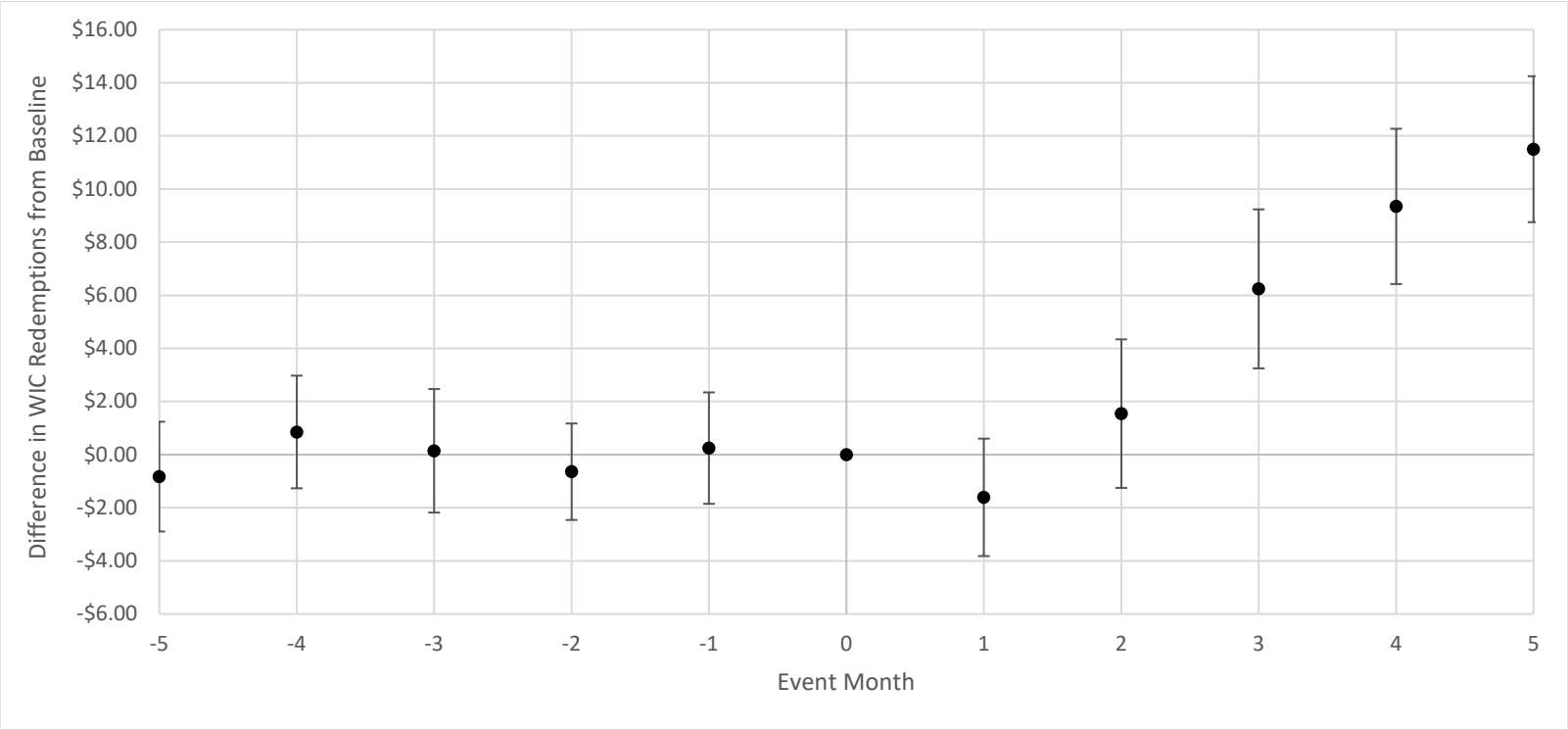

Figure 2: Impact of eWIC on WIC Redemptions across the Event Period (relative to baseline month)

Note: Bars represent upper and lower limits for a 95% confidence interval.

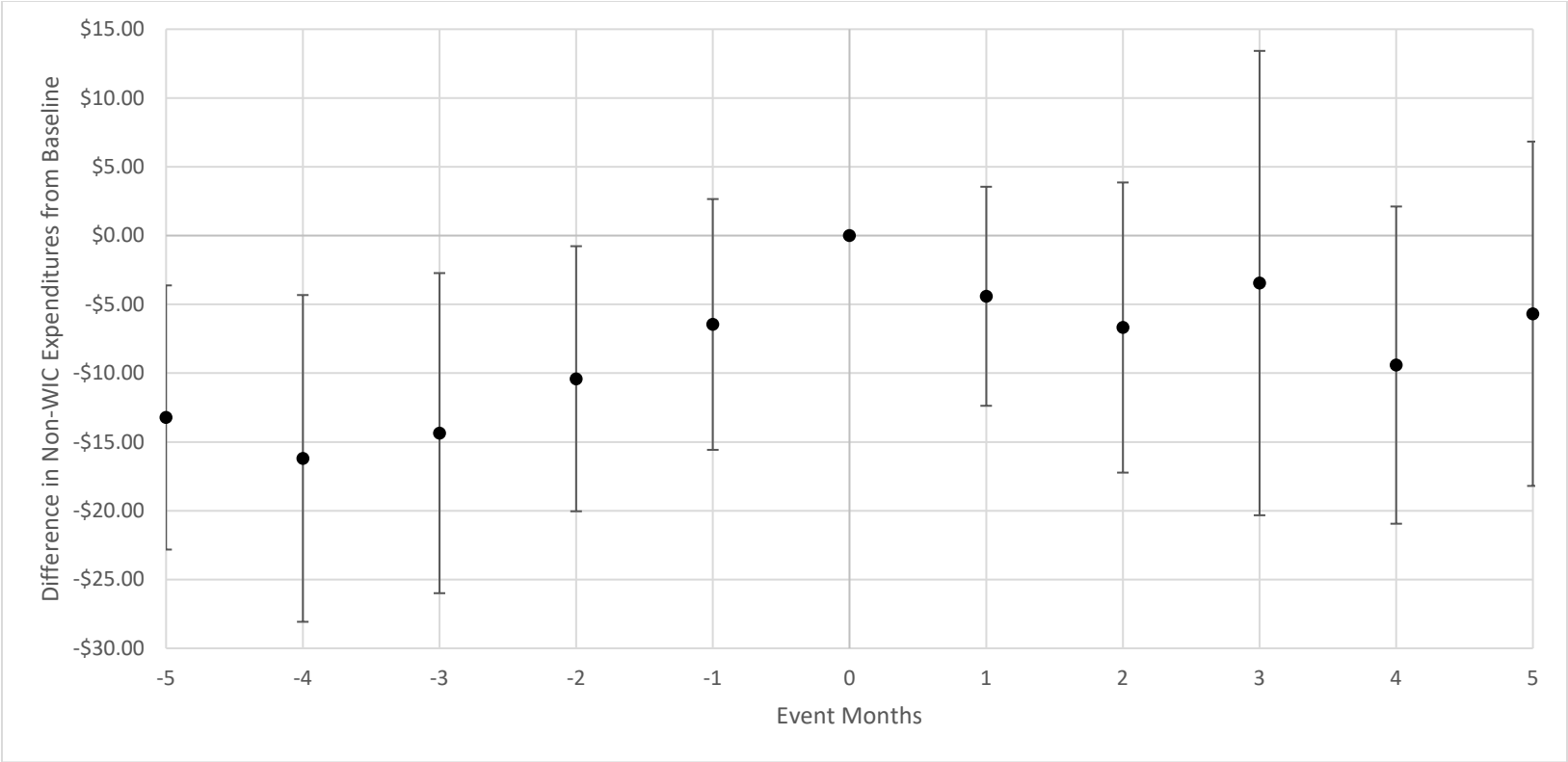

Figure 3: Impact of eWIC on non-WIC Redemptions across the Event Period (relative to baseline month)

Note: Bars represent upper and lower limits for a 95% confidence interval.

Table 1: Average monthly expenditures, total, non-WIC, and WIC eligible food

	Total	Non-WIC	WIC	WIC share
All Counties	$465.30	$406.74	$58.56	15.0%
	(356.318)	(342.605)	(64.237)	(0.157)
Counties implementing eWIC in:				
July 2014	$462.93	$404.30	$58.64	14.6%
	(318.621)	(305.346)	(65.241)	(0.156)
August 2014	$419.29	$357.77	$61.52	16.9%
	(260.162)	(245.389)	(66.780)	(0.178)
October 2014	$419.23	$363.53	$55.70	15.3%
	(251.917)	(236.139)	(62.711)	(0.173)
January 2015	$437.78	$382.14	$55.65	15.0%
	(325.189)	(311.044)	(62.514)	(0.160)
March 2015	$450.03	$393.84	$56.19	14.8%
	(447.510)	(436.232)	(66.735)	(0.161)
May 2015	$473.67	$414.60	$59.07	14.9%
	(350.474)	(336.215)	(63.770)	(0.155)

Source: Weekly household expenditure data provided by the grocer.

Table 2: Ohio county demographics of counties represented/not represented in expenditure data

	All	Included[a]	Excluded[a]
Population	131,545	125,649	141,864
- Percent white	92.2%	91.7%	93.0%
- Percent black	4.1%	4.3%	3.9%
Households	30,109	29,312	31,503
- Percent with welfare income	28.7%	29.2%	27.8%
Families	29,847	29,058	31,227
- Percent with welfare income	29.5%	30.0%	28.5%
- Percent married couples	68.6%	67.8%	70.1%
- With welfare income	12.0%	12.3%	11.6%
- Percent single male head	8.4%	8.7%	7.9%
- With welfare income	3.2%	3.4%	2.9%
- Percent single female head	23.0%	23.6%	22.0%
- With welfare income	13.7%	13.8%	13.5%
Median household income ($2015)	$48,446	$49,061	$47,371
- Households with SNAP	$17,896	$17,821	$18,026
- Households without SNAP	$54,615	$55,510	$53,050
N	88	56	32

[a]56 of Ohio's 88 counties included in the expenditure data. All demographic characteristics statistically differ across the average included/excluded counties (with p-values<.001)

Source: ACS DEMOGRAPHIC AND HOUSING ESTIMATES, 2011-2015. American Community Survey 5-Year Estimates.

https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?fpt=table

Table 3: Impact of eWIC on WIC redemptions across the event period

	All WIC Redemptions	General Grocery	Produce	Infant Formula	Dairy	WIC Share
T-5	-$0.83	-$0.98**	-$0.26***	$0.94	-$0.53***	0.003*
	(1.021)	(0.391)	(0.093)	(1.040)	(0.121)	(0.001)
T-4	$0.85	-$1.14**	-$0.41***	$2.67***	-$0.27*	0.008***
	(1.048)	(0.487)	(0.113)	(0.976)	(0.138)	(0.003)
T-3	$0.14	-$0.19	-$0.10	$0.89	-$0.45***	0.003%
	(1.149)	(0.472)	(0.113)	(0.921)	(0.095)	(0.003)
T-2	-$0.64	-$0.34	-$0.28**	$0.17	-$0.19**	-0.002%
	(0.897)	(0.296)	(0.124)	(0.678)	(0.076)	(0.002)
T-1	$0.25	$0.16	$0.05	$0.29	-$0.26*	-0.0004%
	(1.036)	(0.474)	(0.117)	(0.737)	(0.134)	(0.003)
T+1	-$1.61	-$0.29	$0.13	-$1.17	-$0.28**	-0.005**
	(1.092)	(0.503)	(0.100)	(0.791)	(0.130)	(0.003)
T+2	$1.54	$0.14	-$0.15	$0.24	$1.31***	0.004
	(1.381)	(0.615)	(0.118)	(1.071)	(0.116)	(0.003)
T+3	$6.24***	$1.45**	-$0.18	$1.47	$3.50***	0.009**
	(1.479)	(0.603)	(0.153)	(1.132)	(0.277)	(0.003)
T+4	$9.35***	$2.51***	-$0.22	$1.10	$5.96***	0.02***
	(1.444)	(0.760)	(0.196)	(1.669)	(0.433)	(0.003)
T+5	$11.50***	$2.44***	-$0.44***	$2.78**	$6.72***	0.03***
	(1.357)	(0.730)	(0.126)	(1.211)	(0.606)	(0.003)
Constant	$49.47***	$20.60***	$4.32***	$22.86***	$1.69***	0.2***
	(1.099)	(0.477)	(0.111)	(0.833)	(0.144)	(0.002)
N	91049	91049	91049	91049	91049	90559

Note: All models control for month and household fixed effects. Standard errors (in parentheses) clustered at the county level. The month before eWIC implementation is the baseline month (T).

*p<0.1; **p<0.05; ***p<0.01.

Table 4: Impact of eWIC on Non-WIC expenditures across the event period

	All non-WIC expenditures	General grocery	Produce	Health/beauty care[a]
T-5	-$13.22***	-$2.35	-$2.05***	-$3.63***
	(4.742)	(2.893)	(0.450)	(0.977)
T-4	-$16.20***	-$6.76	-$1.44**	-$1.54*
	(5.866)	(4.144)	(0.570)	(0.910)
T-3	-$14.36**	-$6.99	-$1.38**	-$2.04***
	(5.746)	(4.253)	(0.652)	(0.706)
T-2	-$10.41**	-$5.23	-$1.49***	-$0.83
	(4.759)	(3.326)	(0.427)	(0.694)
T-1	-$6.46	-$3.80	-$0.67*	-$0.19
	(4.503)	(2.797)	(0.355)	(0.798)
T+1	-$4.41	-$4.40*	$0.21	-$0.18
	(3.932)	(2.281)	(0.385)	(0.760)
T+2	-$6.68	-$5.26	$0.26	$0.52
	(5.209)	(3.564)	(0.443)	(0.839)
T+3	-$3.45	-$3.51	$1.29*	$1.11
	(8.337)	(5.574)	(0.704)	(1.042)
T+4	-$9.42	-$6.12*	$1.46***	$1.61*
	(5.695)	(3.525)	(0.491)	(0.838)
T+5	-$5.68	-$3.59	$2.22***	$1.87*
	(6.181)	(3.894)	(0.799)	(0.936)
Constant	$394.30***	$222.40***	$28.06***	$48.92***
	(4.054)	(2.422)	(0.382)	(0.869)
N	91049	91049	91049	91049

Note: All models control for month and household fixed effects. Standard errors (in parentheses) clustered at the county level. The month before eWIC implementation is the baseline month (T).

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

[a]Infant is formula included in this group. Expenditures counted in these models represent all other products in category, excluding infant formula.