How Are SNAP Benefits Spent?

Evidence from a Retail Panel

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Online Appendix

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Online Appendix Table 1: SNAP participation and choice of food retailer

	Household's primary retailer is...				
	Most popular chain	Second most popular chain	Third most popular chain	Other chain	Number of households
Overall	0.347	0.192	0.108	0.353	4820
	(0.007)	(0.006)	(0.004)	(0.007)	
SNAP participant	0.335	0.181	0.116	0.368	1581
	(0.012)	(0.010)	(0.008)	(0.012)	
SNAP non-participant					
Income $\leq$ 100% FPL	0.332	0.162	0.065	0.442	354
	(0.025)	(0.020)	(0.013)	(0.026)	
Income 101 - 185% FPL	0.344	0.175	0.133	0.348	845
	(0.016)	(0.013)	(0.012)	(0.016)	
Income $>$ 185% FPL	0.352	0.199	0.104	0.345	2038
	(0.011)	(0.009)	(0.007)	(0.011)	

Notes: The table is modeled on table 5 of Ver Ploeg et al. (2015). Data are from the National Food Acquisition and Purchase Survey (FoodAPS), collected from April 2012 through January 2013. Columns (1) through (3) show, respectively, the share of households whose primary food store is part of the most popular, second most popular, or third most popular retail chain in the state. Column (4) shows the share of households whose primary food store is part of a chain outside the top three retail chains in the state. Standard errors are in parentheses, and shares and standard errors are adjusted using recommended sample weights. We measure the popularity of each retail chain in each state by the share of resident households who list a store in the given retail chain as their primary food store, treating independent stores as single-store chains. The 2012 Federal Poverty Level (FPL) is a threshold level of income that depends on household size.

Online Appendix Table 2: Estimates of MPCF out of SNAP, baseline and single-store panels

	(1)	(2)	(3)
	SNAP-eligible spending		p-value for
Sample	Baseline	Single-store	equality of MPCs
MPCF out of SNAP benefits	0.5884	0.5332	0.2111
	(0.0073)	(0.0484)	
Number of household-months	2005392	24600	
Number of households	24456	300	

Notes: In column (1), the data come from our baseline panel. In column (2), the data come from a panel consisting of all transactions at one of the retailer's stores over the period from February 2006 through December 2012. In both cases the sample is the set of SNAP adopters in the respective panel. The unit of observation is the household-month. Columns (1) and (2) report coefficient estimates from a 2SLS regression, with standard errors in parentheses clustered by household and calendar month using the method in Thompson (2011). All models are estimated in first differences and include calendar month fixed effects. The dependent variable is SNAP-eligible spending. The endogenous regressors are SNAP benefits and the additive inverse of fuel spending. The coefficient on SNAP benefits is reported as the MPCF. Excluded instruments are (i) the product of the household's average gallons of gasoline per month and the change in the price of regular gasoline, (ii) an indicator for SNAP adoption, and (iii) an indicator for the first month of the SNAP clock. See the table in the main text for definitions of these instruments. Column (3) reports the $p-$value for a test of the hypothesis that the MPCF is equal between the two samples, treating the samples as independent.

Online Appendix Table 3: Average SNAP benefits in the retail panel and administrative data

	Average SNAP benefits
Retail panel	202.4726
	(5.5951)
Administrative data	249.2645
	(5.2846)
Number of household-months	2725
Number of households	807

Notes: The administrative data are the SNAP Quality Control Data, which are publicly available at `https://host76.mathematica-mpr.com/fns/` as of May 2017. The sample is the set of household-months that are within six months following an adoption, inclusive of the adoption month, and that can be matched to cases in the administrative data based on state of residence, calendar month, number of adults in the household, number of children in the household, age range of the head of household, median years of education for household members age 25 or older, and income category. We require an exact match based on non-missing characteristics. The table shows the average SNAP benefit from the retail panel and the average SNAP benefit received as recorded in the administrative data for the corresponding matched household-months. Standard errors in parentheses are clustered by household.

Online Appendix Table 4: Estimates of MPCs out of SNAP based on benefit changes

	(1) SNAP benefits	(2) SNAP-eligible spending	(3) SNAP-ineligible spending
Post Farm Bill ×(Share of months during 2006-2007 on SNAP)	20.586	9.929	-2.535
	(5.421)	(5.209)	(3.891)
Post ARRA ×(Share of months during 2006-2007 on SNAP)	47.654	26.172	-3.938
	(3.318)	(4.095)	(4.463)
MPC out of SNAP benefits	—	0.532	-0.093
		(0.047)	(0.045)
Number of households	208245	208245	208245
Number of household-months	4997880	4997880	4997880

Notes: The sample includes all households in the retailer panel that have at least two consecutive SNAP months during the panel. Each column reports coefficient estimates from a regression model, with standard errors in parentheses clustered by household and calendar month using the method in Thompson (2011). The unit of observation is the household-month and only months from January 2008 to December 2009 are included in the regressions. The "share of months during 2006-2007 on SNAP" is the share of calendar months between February 2006 and December 2007 during which each household used SNAP. "Post Farm Bill" is an indicator equal to one in calendar months following the implementation of the Farm Bill in October 2008. "Post ARRA" is an indicator equal to one in calendar months following the implementation of the American Recovery and Reinvestment Act (ARRA) in April 2009. Marginal propensities to consume are estimated via a 2SLS regression of SNAP-eligible (SNAP-ineligible) spending on SNAP benefits, with the interactions of the post Farm Bill and post ARRA indicators and the share of months during 2006-2007 on SNAP as excluded instruments. All models include fixed effects for household and calendar month.

Online Appendix Table 5: MPCF estimated from first and later SNAP adoptions

Sample	(1) All SNAP adopters	(2) SNAP adopters with at least two SNAP adoptions	(3)	(4)
MPCF out of				
SNAP benefits	0.5891	0.5566	0.5152	0.5314
	(0.0074)	(0.0251)	(0.0228)	(0.0177)
cash	-0.0019	-0.0059	-0.0047	-0.0017
	(0.0494)	(0.0783)	(0.0781)	(0.0783)
p-value for equality of MPCFs	0.0000	0.0000	0.0000	0.0000
p-value for overidentification test	-	-	-	0.2068
Instruments:				
Change in price of regular gasoline ×(Household average gallons per month)	Yes	Yes	Yes	Yes
Any SNAP adoption	Yes	No	No	No
First SNAP adoption	No	Yes	No	Yes
Second or later SNAP adoption	No	No	Yes	Yes
Number of household-months	2005392	117096	117096	117096
Number of households	24456	1428	1428	1428

Notes: In column (1) the sample is the set of SNAP adopters. In the remaining columns the sample is the set of SNAP adopters with at least two SNAP adoptions. The unit of observation is the household-month. Each column reports coefficient estimates from a 2SLS regression, with standard errors in parentheses clustered by household and calendar month using the method in Thompson (2011). All models are estimated in first differences and include calendar month fixed effects. The dependent variable is SNAP-eligible spending. Endogenous regressors are SNAP benefits and the additive inverse of fuel spending; coefficients on these regressors are reported as marginal propensities to consume food. The "price of regular gasoline" is the quantity-weighted average spending per gallon on regular grade gasoline among all households before any discounts or coupons. "Household average gallons per month" is the average monthly number of gallons of gasoline purchased by a given household during the panel. "Any SNAP adoption" is an indicator for whether the month is a SNAP adoption month as defined in the paper. "First SNAP adoption" is an indicator equal to one in the month of the household's first SNAP adoption and zero otherwise. "Second or later SNAP adoption" is an indicator equal to one in the month of the household's second (or later) SNAP adoption, and zero otherwise. The final column reports a p-value for a test of overidentification following Hansen (1982).

Online Appendix Table 6: Heterogeneity in MPCF by household and area characteristics

Sample	MPCF out of: SNAP benefits	MPCF out of: cash	p-value for equality of MPCFs	Number of household-months (households)
All SNAP adopters	0.5884	-0.0020	0.0000	2005392
	(0.0073)	(0.0494)		(24456)
Child present?				
No	0.6084	0.0430	0.0000	613114
	(0.0102)	(0.0622)		(7477)
Yes	0.5769	-0.0169	0.0000	1024016
	(0.0081)	(0.0428)		(12488)
Elderly head of household?				
No	0.5772	-0.0019	0.0000	1287974
	(0.0076)	(0.0486)		(15707)
Yes	0.6433	0.0484	0.0000	298070
	(0.0157)	(0.0547)		(3635)
Above median income category?				
No	0.5939	0.0241	0.0000	1042302
	(0.0089)	(0.0451)		(12711)
Yes	0.5754	-0.0167	0.0000	573590
	(0.0131)	(0.0507)		(6995)
Above high school education?				
No	0.5954	0.0226	0.0000	1024016
	(0.0077)	(0.0496)		(12488)
Yes	0.5749	-0.0334	0.0000	589416
	(0.0118)	(0.0505)		(7188)
Above median SNAP penetration?				
No	0.5907	-0.0133	0.0000	963090
	(0.0106)	(0.0506)		(11745)
Yes	0.5917	0.0174	0.0000	961778
	(0.0087)	(0.0519)		(11729)
Top quartile corr(regular gasoline share, price)?				
No	0.6159	-0.0054	0.0000	879860
	(0.0091)	(0.0619)		(10730)
Yes	0.6293	-0.0194	0.0000	293314
	(0.0177)	(0.0516)		(3577)

Notes: The sample is the set of SNAP adopters. The unit of observation is the household-month. Each column reports coefficient estimates from a 2SLS regression, with standard errors in parentheses clustered by household and calendar month using the method in Thompson (2011). All models are estimated in first differences and include calendar month fixed effects. Endogenous regressors are SNAP benefits and the additive inverse of fuel spending; coefficients on these regressors are reported as marginal propensities to consume. In all models instruments for these endogenous regressors are (i) the product of the household's average gallons of gasoline per month and the change in the price of regular gasoline, (ii) an indicator for SNAP adoption, and (iii) an indicator for the first month of the SNAP clock. See the table in the main text for definitions of these instruments. "Child present" indicates whether the household has at least one member with age 18 or below. "Elderly head of household" indicates whether the head of household is age 65 or above. "Above median income category" indicates whether the household's income category is above the median category for SNAP adopters. "Above high school education" indicates whether the median years of completed schooling for household members aged 25 or older is at least 12 years. In all cases we exclude households for which the corresponding demographic indicator is missing or undefined in our data. "Above median SNAP penetration" indicates whether SNAP penetration in the household's mailing ZIP code is above the median SNAP penetration across SNAP adopters' mailing ZIP codes. SNAP penetration is the fraction of all panelists in the given ZIP code with at least two consecutive SNAP months. "Top quartile corr(regular gasoline share, price)" indicates whether the correlation coefficient between the household's monthly share of gasoline consumption that are regular grade and the price of regular gasoline is in the top quartile among SNAP adopters who ever purchase fuel. The price of regular gasoline is computed as the quantity-weighted average spending per gallon on regular grade gasoline among all households before any discounts or coupons.

Online Appendix Table 7: Tests of fungibility, asymptotic and bootstrap standard errors

	Consumption function:			
	Linear, homogeneous	Linear, heterogeneous	Nonlinear, heterogeneous (Linear spline with knots at the quintiles)	Nonlinear, heterogeneous (Local regression)
Excess sensitivity to SNAP benefits ($\hat{\gamma}$)	0.5809	0.6166	0.7296	0.8819
(asymptotic standard errors)	(0.1631)	(0.1809)	(0.1826)	(0.0824)
[bootstrap standard errors]	[0.1552]	[0.1664]	[0.1665]	[0.0693]
Number of household-months	1944056	1944056	1944056	1936594
Number of households	23708	23708	23708	23617

Notes: The sample is the set of SNAP adopters that purchase fuel at least once. The unit of observation is the household-month. The table presents estimates of the excess sensitivity γ to SNAP benefits using the three-step estimator described in the main paper. Standard errors are clustered by household and calendar month using the method in Thompson (2011), which estimates the asymptotic variance of the parameters by $\sqrt{\hat{V}_i + \hat{V}_t - \hat{V}_{it}}$, where $\hat{V}_i$ is an estimate of the variance clustered by household, $\hat{V}_t$ is an estimate of the variance clustered by calendar month, and $\hat{V}_{it}$ is an estimate of the variance without any clustering. The standard errors in parentheses use plug-in estimates for $\hat{V}_i$, $\hat{V}_t$, and $\hat{V}_{it}$, whereas the standard errors in brackets use nonparametric bootstrap estimates based on 30 replicates. These bootstrap estimates are obtained as follows. We obtain $\hat{V}_i$ by resampling households with replacements. We obtain $\hat{V}_t$ by resampling months with replacement, retaining values of all lags so that first-differencing is well-defined when needed. We obtain $\hat{V}_{it}$ by resampling household-months with replacement, retaining values of all lags so that first-differencing is well-defined when needed. For computing the second stage in the linear spline case, we compute the quintiles of $\hat{Y}_{it}$ (as defined in the main paper) for each household without using the sampled lags. Missing values in the fourth column are due to a small number of cases in which the rule-of-thumb bandwidth is ill-defined.

Online Appendix Table 8: Effect of SNAP adoption on shopping effort

	(1)	(2)	(3)	(4)	(5)	(6)
	Change in adjusted store-brand share			Change in adjusted coupon redemption share		
	SNAP-eligible	SNAP-ineligible	Difference	SNAP-eligible	SNAP-ineligible	Difference
SNAP adoption	-0.0088	-0.0002	-0.0086	-0.0021	-0.0006	-0.0015
	(0.0005)	(0.0009)	(0.0011)	(0.0002)	(0.0007)	(0.0007)
Number of household-months	2003712	1970355	1969935	2003707	1968827	1968409
Number of households	24456	24456	24456	24456	24456	24456

Notes: The sample is the set of SNAP adopters. The unit of observation is the household-month. Each column reports coefficient estimates from a regression model, with standard errors in parentheses clustered by household and calendar month using the method in Thompson (2011). All models include calendar month fixed effects. In columns (1) and (2) the dependent variable is the change in the adjusted store-brand share for SNAP-eligible or SNAP-ineligible purchases, respectively. In column (3) the dependent variable is the difference between the change in the adjusted store-brand share for SNAP-eligible purchases and the change in the adjusted store-brand share for SNAP-ineligible purchases. In columns (4) and (5) the dependent variable is the change in the adjusted coupon redemption share for SNAP-eligible or SNAP-ineligible purchases, respectively. In column (6) the dependent variable is the difference between the change in the adjusted coupon redemption share for SNAP-eligible purchases and the change in the adjusted coupon redemption share for SNAP-ineligible purchases. Missing values arise when a given household does not buy any SNAP-eligible or SNAP-ineligible items in a given month.

Online Appendix Table 9: Effect of SNAP adoption on store-brand share, by part of month

	(1)	(2)	(3)	(4)	(5)	(6)
	Change in adjusted store-brand share: first two weeks			Change in adjusted store-brand share: second two weeks		
	SNAP-eligible	SNAP-ineligible	Difference	SNAP-eligible	SNAP-ineligible	Difference
SNAP adoption	-0.0058	-0.0016	-0.0034	-0.0045	0.0015	-0.0059
	(0.0006)	(0.0015)	(0.0017)	(0.0007)	(0.0012)	(0.0014)
Number of household-months	1973916	1812391	1806696	1997485	1833849	1827971
Number of households	24456	24456	24456	24456	24456	24456

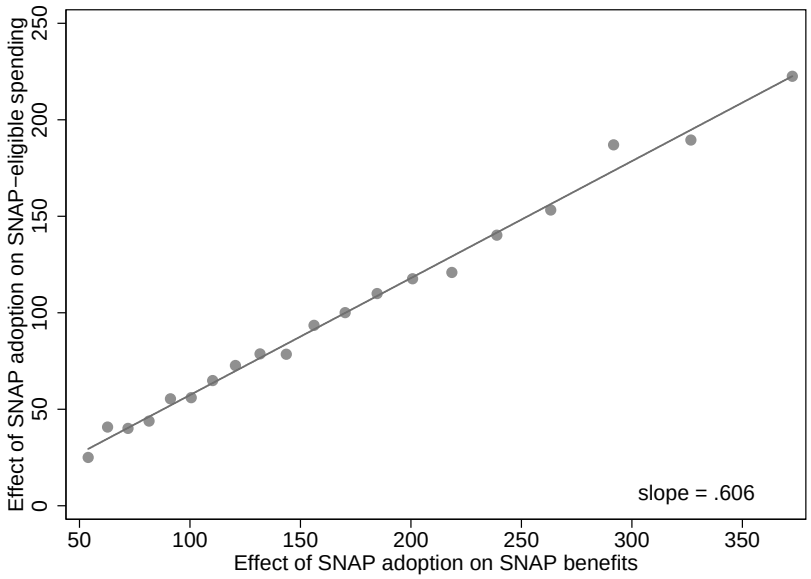
Notes: The sample is the set of SNAP adopters. The unit of observation is the household-fortnight, where we distinguish between first and second two weeks of the month. Each column reports coefficient estimates from a regression model, with standard errors in parentheses clustered by household and calendar month using the method in Thompson (2011). All models include calendar month fixed effects. In columns (1), (2), (4) and (5) the dependent variable is the change in the adjusted store-brand share for SNAP-eligible or SNAP-ineligible purchases. In columns (3) and (6) the dependent variable is the difference between the change in the adjusted store-brand share for SNAP-eligible purchases and the change in the adjusted store-brand share for SNAP-ineligible purchases. Missing values arise when a given household does not buy any SNAP-eligible or SNAP-ineligible items in a given fortnight.

Online Appendix Table 10: Effect of SNAP adoption on coupon redemption rate

	(1)	(2)	(3)
	Change in coupon redemption rate		
	SNAP-eligible	SNAP-ineligible	Difference
SNAP adoption	-0.0161	-0.0084	-0.0117
	(0.0065)	(0.0116)	(0.0148)
Number of household-months	1215050	326551	301050
Number of households	24334	22249	21794

Notes: The sample is the set of SNAP adopters. The unit of observation is the household-month. Each column reports coefficient estimates from a regression model, with standard errors in parentheses clustered by household and calendar month using the method in Thompson (2011). All models include calendar month fixed effects. In columns (1) and (2) the dependent variable is the change in the monthly coupon redemption rate for SNAP-eligible or SNAP-ineligible purchases, respectively. In column (3) the dependent variable is the difference between the change in the monthly coupon redemption rate for SNAP-eligible purchases and the change in the monthly coupon redemption rate for SNAP-ineligible purchases. The coupon redemption rate is computed as follows. The retailer provides us with information on each coupon mailed to each household, along with the amount of the discount and the dates and products for which the coupon is valid. We initialize the set of available coupons as the set of coupons ever mailed to a given household. Then for each product purchase in which a coupon was redeemed we execute, in chronological order, the following logic: If there is at least one coupon in the set of available ones that is valid on the transaction date and matches the amount of the coupon redeemed, we assume that the redeemed coupon is the one among these with the earliest expiration date and we remove that coupon from the available set. For any given purchase, we define the potential redemption to be the value of the most valuable valid coupon in the available set. We compute the monthly redemption rate as the ratio of the total value of all coupons redeemed in a given month that are matched to a counterpart in the available set, and the sum of all potential redemptions in the month. Missing values arise when potential redemptions are zero for purchases in the given category.

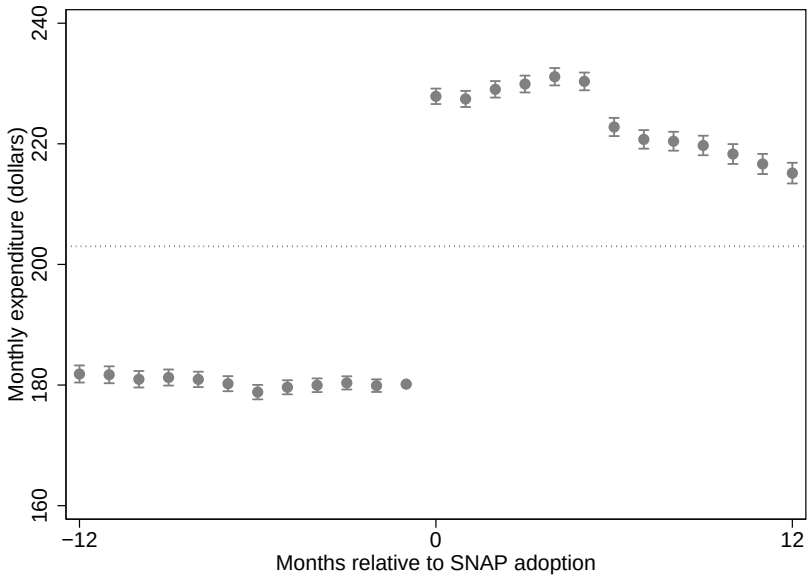
Online Appendix Figure 1: Changes in spending vs. changes in benefits across households



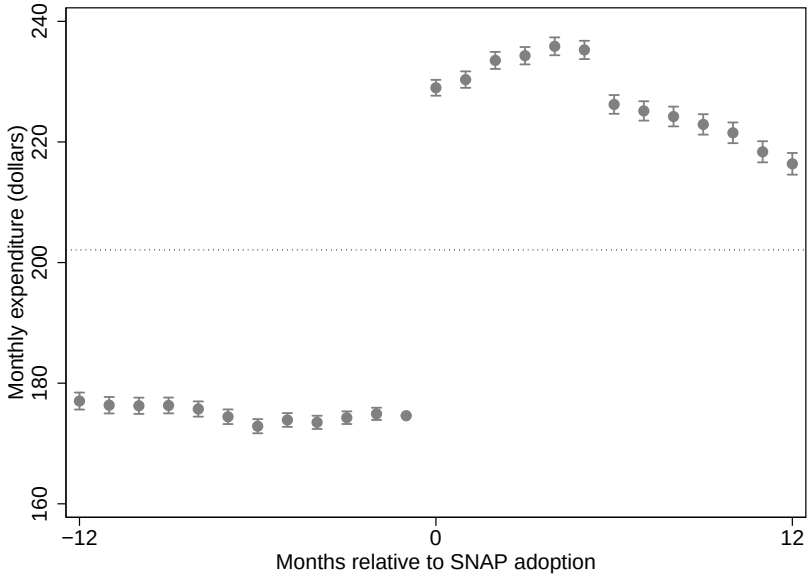
Notes: The sample is the set of SNAP adopters. The binned scatterplot is constructed as follows. We first pool all households and residualize the change in SNAP-eligible spending, the change in SNAP benefits, and the SNAP adoption indicator with respect to calendar month indicators. For each household, we regress the residual change in SNAP-eligible spending on the residual of the SNAP adoption indicator. The coefficient from this regression is the effect of SNAP adoption on SNAP-eligible spending. Next, for each household, we regress the residual change in SNAP benefits on the residual of the SNAP adoption indicator. The coefficient from this regression is the effect of SNAP adoption on SNAP benefits. We restrict attention to households for which the effect of SNAP adoption on SNAP benefits is between 50 and 400, inclusive. We then divide households into twenty equal-sized bins and plot, for each bin, the average effect of SNAP adoption on SNAP-eligible spending (y-axis) and the average effect of SNAP adoption on SNAP benefits (x-axis). The solid line shows the fit from an OLS regression of the effect of SNAP adoption on SNAP-eligible spending on the effect of SNAP adoption on SNAP benefits.

Online Appendix Figure 2: Monthly expenditure on SNAP-eligible items before and after SNAP adoption, by perishability of product

Panel A: Spending on perishable SNAP-eligible items

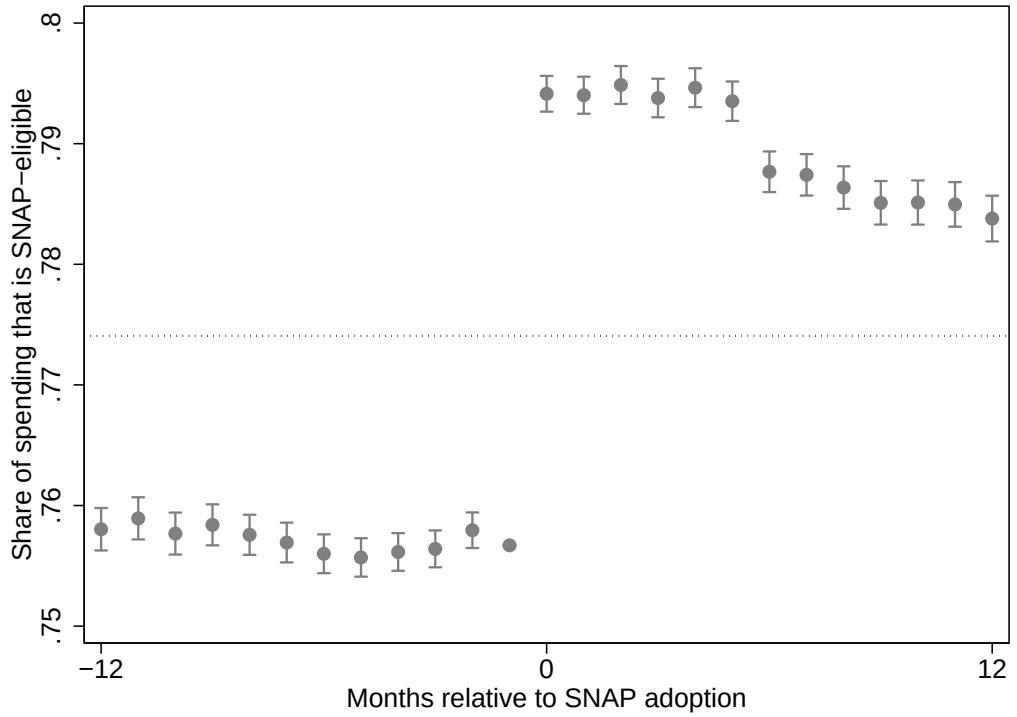


Panel B: Spending on non-perishable SNAP-eligible items



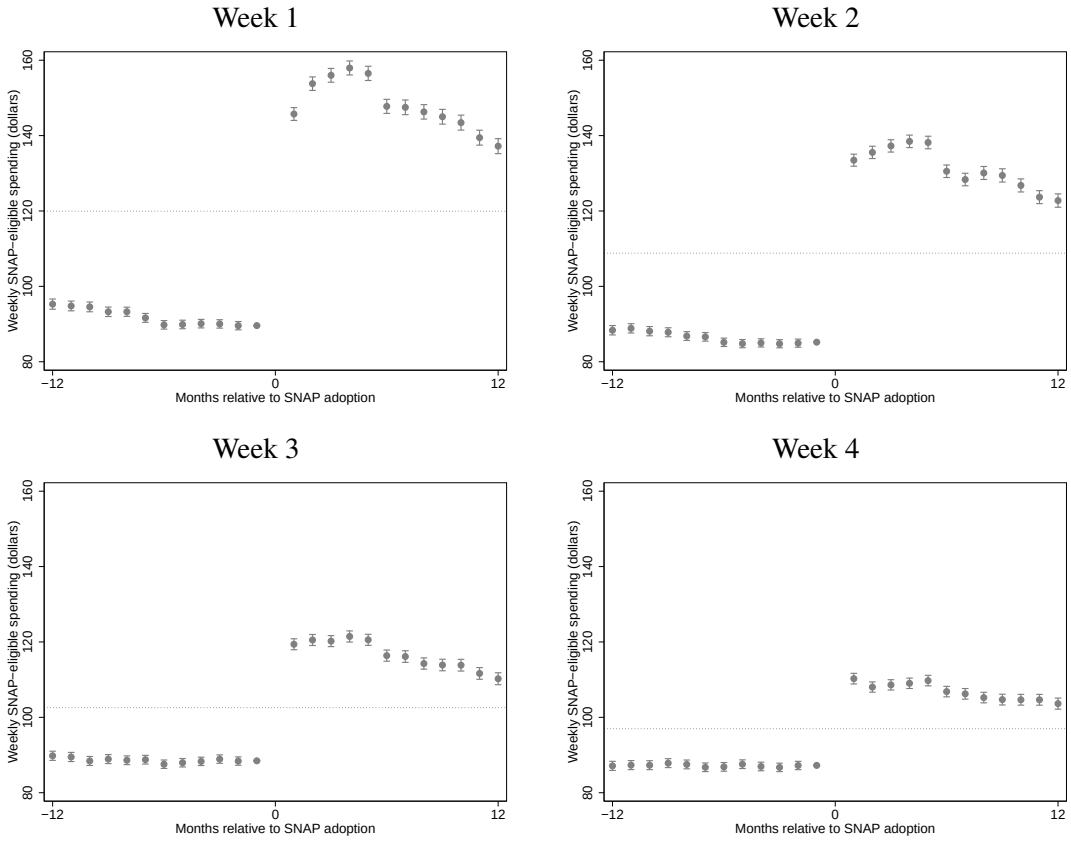
Notes: Each figure plots coefficients from a regression of spending on perishable or non-perishable SNAP-eligible items on a vector of lead and lagged indicators for month relative to the household's first SNAP adoption, with the month prior to SNAP adoption ("-1") as the omitted category. The unit of observation for each regression is the household-month and the sample is the set of SNAP adopters. Error bars are ± 2 coefficient standard errors. Standard errors are clustered by household. Each regression includes calendar month fixed effects, household fixed effects, and two indicators for observations before and after 12 months of SNAP adoption. The dotted lines show the sample mean of the dependent variable across observations within 12 months of SNAP adoption. Each coefficient series is shifted by a constant so that the observation-count-weighted mean of the regression coefficients is equal to the sample mean of the corresponding dependent variable. Perishability status has been hand-coded at the product category level. We define a product category to be perishable if it contains staple foods that will spoil within one month if left on the counter or in the refrigerator. We use the definition of staple foods from FNS (2017) and the recommended storage periods from Albrecht (2007).

Online Appendix Figure 3: SNAP-eligible share of expenditure before and after SNAP adoption



Notes: The figure plots coefficients from a regression of the share of nonfuel spending that is SNAP-eligible (out of spending that we classify as either SNAP-eligible or SNAP-ineligible) on a vector of lead and lagged indicators for month relative to the household's first SNAP adoption, with the month prior to SNAP adoption ("-1") as the omitted category. The unit of observation for each regression is the household-month and the sample is the set of SNAP adopters. Error bars are ± 2 coefficient standard errors. Standard errors are clustered by household. Each regression includes calendar month fixed effects, household fixed effects, and two indicators for observations before and after 12 months of SNAP adoption. The dotted lines show the sample mean of the dependent variable across observations within 12 months of SNAP adoption. Each coefficient series is shifted by a constant so that the observation-count-weighted mean of the regression coefficients is equal to the sample mean of the corresponding dependent variable.

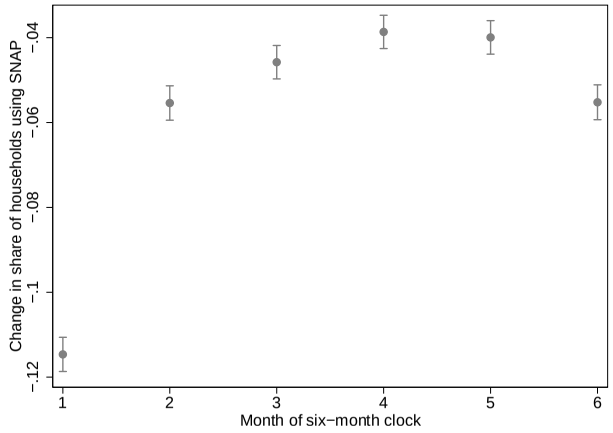
Online Appendix Figure 4: Change in SNAP-eligible spending by week of month



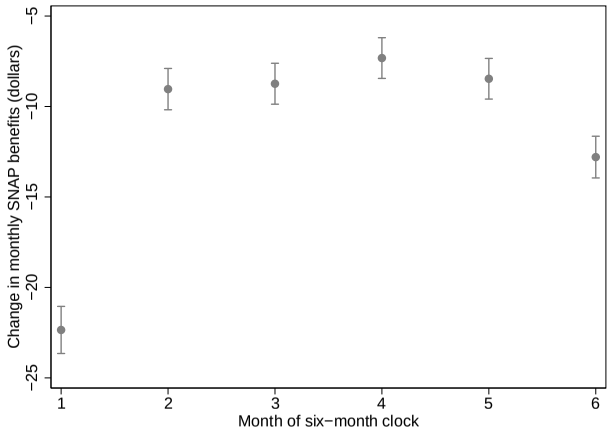
Notes: Each figure plots coefficients from a regression of SNAP-eligible spending in a given week of the month on a vector of lead and lagged indicators for month relative to the household's first SNAP adoption, with the month prior to SNAP adoption ("-1") as the omitted category. The unit of observation for each regression is the household-month. The sample is the set of SNAP adopters. Error bars are ± 2 coefficient standard errors. Standard errors are clustered by household. Each regression includes calendar month fixed effects, household fixed effects, and two indicators for observations before and after 12 months of SNAP adoption. The dotted lines show the sample mean of household weekly expenditure across observations within 12 months of SNAP adoption. Each coefficient series is shifted by a constant so that the observation-count-weighted mean of the displayed regression coefficients is equal to the sample mean of the corresponding dependent variable. The coefficient for month 0 is not shown because our definition of SNAP adoption does not identify the timing of the adoption within the month.

Online Appendix Figure 5: Participation, benefits, and spending over the six-month SNAP clock for SNAP adopters who have at least six consecutive non-SNAP months after first adoption

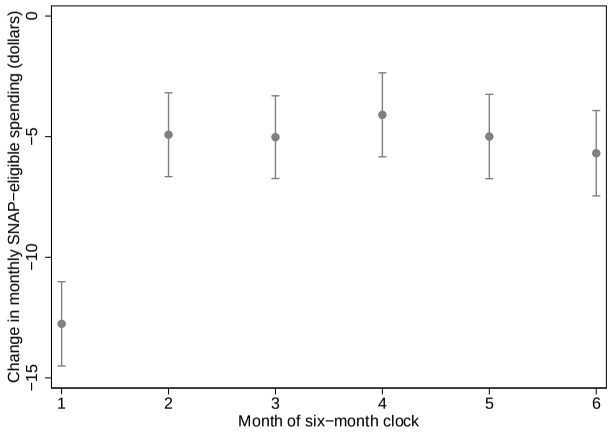
Panel A: SNAP use



Panel B: SNAP benefits

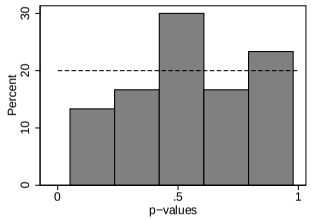
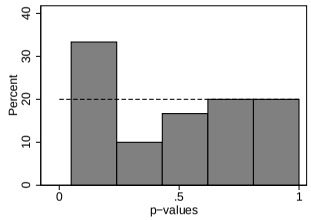
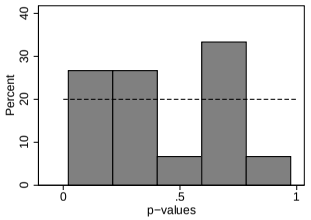
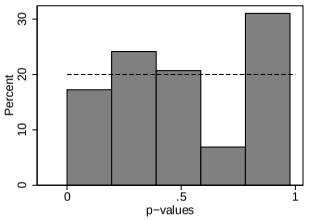
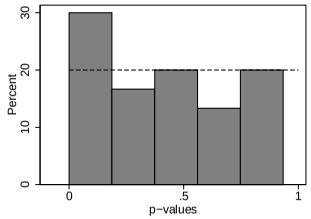
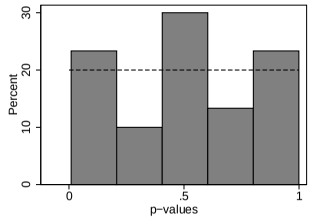
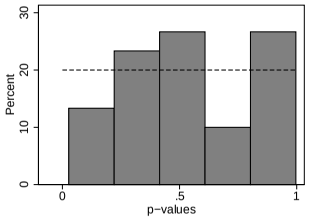
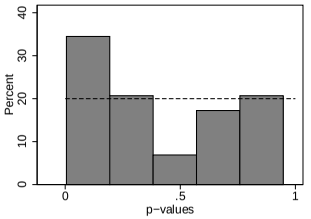
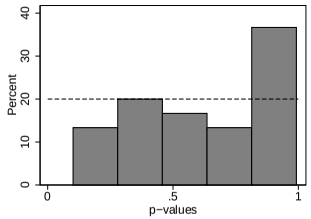
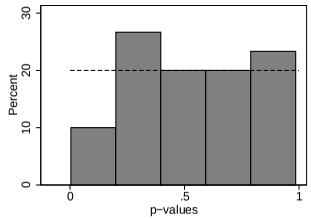
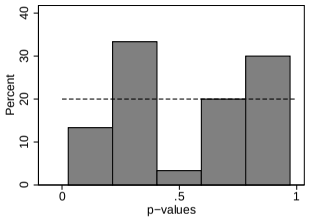
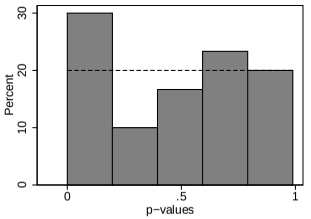


Panel C: SNAP-eligible spending



Notes: Each figure plots coefficients from a regression of the dependent variable on a vector of indicators for the position of the current month in a monthly clock that begins in the most recent adoption month and resets every six months or at the next SNAP adoption, whichever comes first. The unit of observation for each regression is the household-month. The sample is the set of SNAP adopters who have at least one period of six consecutive non-SNAP months following the household's first SNAP adoption. Error bars are ±2 coefficient standard errors. Standard errors are clustered by household. Each regression includes calendar month fixed effects. The omitted category consists of the first six months (inclusive of the adoption month) after the household's most recent SNAP adoption, all months after the first 24 months (inclusive of the adoption month) following the household's most recent adoption, and all months for which there is no preceding adoption. In Panel A, the dependent variable is the change in an indicator for whether the household-month is a SNAP month. In Panel B, the dependent variable is the change in monthly SNAP benefits. In Panel C, the dependent variable is the change in monthly SNAP-eligible spending.

Online Appendix Figure 6: Sampling experiments for fungibility tests

Simulated consumption function	Distribution of $p-$values from test that $\gamma = 0$: Linear, homogeneous	Linear, heterogeneous	Spline	Kernel
Linear, homogeneous				
Linear, heterogeneous				
Nonlinear, heterogeneous				

Notes: The sample consists of a random subset of 1000 SNAP adopters whose behavior is simulated as follows. Let f_{it} be SNAP-eligible spending, b_{it} be SNAP benefits, and y_{it} be the additive inverse of fuel spending. Let q_i be the average monthly gallons of gasoline purchased, p_t be the average price of regular gasoline, and z_{it} be the cumulative number of adoptions experienced. Let $U_{it}^{(n)}$ denote the n^{th} independent realization from a uniform distribution on $[0,1]$ for household i in calendar month t, and let $U_i^{(n)}$ denote a realization for household i, constant across all months. Food spending is given by $f_{it} = \alpha_i + \Psi_i(y_{it} + b_{it}) + \xi_{it}$, where $\alpha_i = 200U_i^{(1)} + 500$, $b_{it} = 10U_{it}^{(2)} + \left(200U_{it}^{(3)} + 100\right) z_{it} + \varepsilon_{it}^b$, and $y_{it} = 1000 - \left(U_{it}^{(4)} + 0.5\right) 0.9 q_i p_t + \varepsilon_{it}^y$. The error terms are modeled as $\xi_{it} = \left(U_{it}^{(5)} - 0.5\right) 50 + 0.1\varepsilon_{it}^b + 0.05\varepsilon_{it}^y$, $\varepsilon_{it}^b = 50\left(U_{it}^{(6)} - 0.5\right)$, and $\varepsilon_{it}^y = 50\left(U_{it}^{(7)} - 0.5\right)$. In the row labeled "linear, homogeneous" we assume that $\Psi_i(y_{it} + b_{it}) = 0.1(y_{it} + b_{it})$ for all i. In the row labeled "linear, heterogeneous" we assume that $\Psi_i(y_{it} + b_{it}) = \left(0.1U_i^{(8)} + 0.05\right)(y_{it} + b_{it})$ for all i. In the row labeled "nonlinear, heterogeneous" we assume $\Psi_i(y_{it} + b_{it}) = \left(U_i^{(9)} + 0.5\right) \ln(y_{it} + b_{it}) + \left(0.1U_i^{(10)} + 0.05\right)(y_{it} + b_{it})$ for all i. Each column corresponds to one of the four fungibility tests described in the main paper. Each plot shows the distribution across 30 simulation replicates of the $p-$values for the null hypothesis that $\gamma = 0$. The dashed horizontal line corresponds to a uniform distribution.

References not appearing in the paper

Albrecht, Julie A. 2007. Food Storage. University of Nebraska-Lincoln Extension. Accessed at <http://extensionpublications.unl.edu/assets/pdf/ec446.pdf> on April 19, 2017.

FNS. 2017. Retail Store Eligibility USDA Supplemental Nutrition Assistance Program. Accessed at <https://www.fns.usda.gov/snap/retail-store-eligibility-usda-supplemental-nutrition-assistance-program> on April 19, 2017.

Hansen, Lars Peter. 1982. Large sample properties of generalized method of moments estimators. *Econometrica* 50(4): 1029-1054.