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Featured Article

Do Walmart Supercenters Improve Food Security?

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Abstract *This paper examines the effect that Walmart Supercenters, which lower food prices and expand food availability, have on food insecurity. Data come from the 2001–2012 Current Population Survey Food Security Supplements matched to Walmart Supercenter entry dates and locations. Using instrumental variables models that leverage Walmart's predictable expansion pattern outward from corporate headquarters, we find that closer proximity to a Walmart Supercenter improves household and child food security, as measured by affirmative responses to a food insecurity questionnaire and an indicator for food insecurity. The effects are largest among low-income households and children but are also sizeable for middle-income children.*

Key words: Walmart, Wal-Mart, supercenters, big box stores, food insecurity, hunger.

JEL codes: I12, I14, Q18.

The USDA's Food and Nutrition Service has long sought to end hunger. To this end, it has worked to establish programs aimed at providing ready access to affordable and nutritious foods. Meanwhile, some states and municipalities (such as Los Angeles, Chicago, and New York City) have passed laws, taxes, and mandates seeking to block or restrict entry by Walmart, America's largest corporation and largest grocer.[1] Research has shown that Walmart Supercenters lower food prices and increase food availability, so

[1]*Even when the company is not mentioned by name, some of the proposals are written in such a way as to only apply to Walmart (Hicks 2007, pp. 267–293).*

we ask: are barriers to Walmart's entry at odds with the goal of eliminating hunger?[2] We add to existing work in this area by exploring the relationship between the diffusion of new retail technologies—specifically, the Walmart Supercenter mass merchandiser format—and various measures of food insecurity. Our estimates suggest that proximity to a Walmart Supercenter reduces food insecurity, particularly for low-income families and children, which suggests that changes in retail technology are important elements in the evolution of public health over time.

The USDA defines food security as "access by all household members at all times to enough food for an active, healthy life."[3] In 2012, 14.5% of U.S. households lacked food security during at least part of the year. Moreover, 5.7% had "very low food security," meaning at least one household member had reduced food intake and disrupted eating patterns due to a lack of money or other resources for food (Coleman-Jensen, Nord, and Singh 2013).

Numerous studies find that food insecurity leads to worse health outcomes (Gundersen and Ziliak 2015). A large body of literature examines the determinants of food insecurity and the role of food assistance programs such as SNAP in solving the problem (Gundersen and Ziliak 2018). Of particular relevance to our paper, researchers have shown that high food prices and limited access to food stores are both associated with food insecurity (Gregory and Coleman-Jensen 2011; Bonanno 2015). However, the extent to which these associations reflect causal effects is unclear.

We advance the discussion about the relationship between the local food environment and food security by examining how a broad structural change in the American grocery sector—the rapid expansion of Walmart's Supercenter model—affected food security. In 1988, Walmart expanded into large-scale food retail when it opened its first Walmart Supercenter, and the company grew into the United States' largest grocer with a 19% market share (Hayes 2013). Walmart Supercenters are by far the dominant supercenter chain, with 3,561 locations in 2018 compared to just 239 Super Targets.[4] In the last decade, scholars have turned their attention to the effects of Walmart entry and changes in the structure of the grocery industry on health outcomes (Courtemanche and Carden 2011; Borrescio-Higa 2015; Michelson et al. 2018).[5] Courtemanche and Carden (2011) find that Walmart Supercenters increase obesity, while Volpe, Okrent, and Leibtag (2013) find that supercenter entry is followed by a larger proportion of food

[2] *See Basker and Noel (2009), Hausman and Leibtag (2009), Matsa (2011), and Courtemanche and Carden (2014).*

[3] *See USDA Economic Research Service, Food Security in the US: Measurement. Updated October 4, 2017. Available at: https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/measurement.aspx (last accessed September 12, 2018).*

[4] *These numbers come from two sources: Statista, Total Number of Walmart Stores in the United States from 2012 to 2018, by Type, available at: https://www.statista.com/statistics/269425/total-number-of-walmart-stores-in-the-united-states-by-type/ (last accessed September 12, 2018); and Statistic Brain Research Institute, Target Corporation Company Statistics, available at: https://www.statisticbrain.com/target-company-statistics/ (last accessed September 12, 2018).*

[5] *More generally, Walmart* per se *has become the subject of a ponderous body of research analyzing its effects on everything from (e.g.) social capital, values, and leisure activities (Goetz and Rupasingha 2006; Carden and Courtemanche 2009; Carden, Courtemanche, and Meiners 2009a, 2009b) to the size of the tax base and tax rates (Vandegrift and Loyer 2015; Vandegrift 2016) and even real estate prices (Pope and Pope 2015; Caceres and Geoghegan 2017). See Carden (2013) and Carden and Courtemanche (2016) for summaries of the literature on the mass-market merchandise sector.*

consumption that is "unhealthy." However, these studies did not examine the other side of the coin of Walmart's "Everyday Low Prices" and expanded food availability: Walmart could also improve food security, which is primarily a measure of the quantity of food available to a household, as opposed to its nutritional quality.[6]

Walmart Supercenter entry can provide a significant shock to an area's food availability and food prices. Matsa (2011) shows that Walmart entry leads to better inventory control and fewer stock-outs by competitors, which should improve the reliability of food access. Basker and Noel (2009) and Courtemanche and Carden (2014) show that Walmart Supercenters reduce local food prices both by underselling existing food retailers and by inducing these competitors to lower their own prices. Basker and Noel (2009) also find that the largest price reductions after Walmart Supercenter entry come at stores that serve primarily low-income consumers. Hausman and Leibtag (2009) and Furman (2005) argue that the consumer benefits from the diffusion of mass-market merchandisers are considerable and progressively distributed: the major beneficiaries of these firms' lower prices are low-income consumers who spend large percentages of their incomes on food.[7] Hwang and Park (2016) study the effect of the conversion of a Walmart to a Supercenter on shoppers' behavior and find that the conversion leads to larger per-visit expenditures, suggesting that supercenters affect the local food environment in part by inducing changes in shopping technologies.

We estimate the effects that Walmart Supercenters have on food security using data from the 2001–2012 waves of the December Current Population Study Food Security Supplement (CPS-FSS). Narrow geographic identifiers available in the restricted version of these data enable us to compute the distance from each household's census tract to the nearest Walmart Supercenter. Our outcomes are counts of the number of affirmative responses on the household and child-specific portions of the food insecurity questionnaire, along with binary variables for household food insecurity, household very low food security, child food insecurity, and child very low food security. We estimate instrumental variables (IV) models that leverage the predictable geographic expansion patterns of Walmart Supercenters outward from corporate headquarters. Specifically, we instrument for Walmart Supercenters with the interaction of distance from Bentonville, Arkansas (Walmart's headquarters), with time. For both households in general and children specifically, the results show that a closer proximity to the nearest Walmart Supercenter leads to sizeable and statistically significant improvements in all food security measures except the indicator for very low food security. Subsample analyses reveal that the effects are especially large for low-income households and children, though they are also sizeable for middle-income children.

[6] *As we show below, only two out of the 18 questions in the food security module address anything related to diet quality. The rest are aimed at establishing the quantity of food available to the household.*

[7] *Additionally, the income effect from Walmart's impact on nonfood prices could lead to more spending on food and better food security. In a back-of-the-envelope calculation, Courtemanche and Carden (2011) find that Walmart Supercenters' direct and indirect price effects saved the average household $177 in 2002 – additional income that could be spent on more or better nutrients.*

Methods

We begin by estimating linear probability models (LPMs) of the form

$$Y_{ict} = \beta_0 + \beta_1 \ln(DIS\_WS_{ct}) + \sum_{j=1}^{J} \gamma_j X_{jict} + \sum_{y=1}^{Y} \tau_y YR_y + \varepsilon_{ict} \quad (1)$$

where Y_{ict} is the outcome (each of the aforementioned food insecurity variables) for household i living in census tract c in year t, DIS_WS_{ct} is distance in miles from census tract c to the nearest Walmart Supercenter in year t, X_{jict} is a set of J control variables, YR_y is a set of Y year fixed effects ($YR_y = 1$ if $y = t$), ε_{ict} is the error term, and the other Greek letters are parameters to be estimated.[8] Distance from a census tract to the nearest Walmart Supercenter indicates to what extent residents are exposed to Walmart Supercenters, and therefore β_1 measures the association between Walmart Supercenters and households' food insecurity. We take the natural logarithm of distance since it seems reasonable to expect a diminishing marginal effect. For instance, if a new Walmart Supercenter reduces a household's distance to the nearest Walmart Supercenter from 50 miles to 40 miles, this change is unlikely to matter since both stores are prohibitively far away. Standard errors are heteroskedasticity-robust and clustered by census tract since census tract is the geographic level at which we measure Walmart Supercenter exposure.

Supercenter locations are likely endogenous, which complicates our interpretation of equation (1). First, omitted variable bias could result if changes over time in unobserved area characteristics influence both the entry of Walmart Supercenters and residents' levels of food security. We are able to control for some obvious confounders such as income, but it is difficult to account for all of them. Second, results may be driven by reverse causality, as big box grocers may specifically target areas with limited food supply. Indeed, *Dukes v. Wal-Mart* lead plaintiff Betty Dukes criticized Walmart for "promoting themselves to low-income people . . . They don't put Wal-Mart in those high-end parts of the community. They plant themselves right in the middle of Poorville," (Featherstone 2005).

We address these endogeneity concerns with instrumental variables, or variables that are strongly correlated with the endogenous store variables but otherwise uncorrelated with the outcome (food insecurity) variables conditional on the controls. We adopt a strategy similar to that used by Courtemanche and Carden (2011) to investigate the effect of Walmart Supercenters on obesity. This strategy is based on the observation that the pattern of Walmart Supercenter expansion starting in 1988 was to radiate outward from the area surrounding Walmart's headquarters in Bentonville. In other words, in the first few years, areas close to northwest Arkansas were the most likely to experience Walmart Supercenter entry. As time passed, entry became more likely in areas progressively further away. Distance from Bentonville therefore influenced the probability that an area experienced Walmart Supercenter entry in a given year, and this effect changed over time. This phenomenon implies that the interaction of distance

[8] *In unreported regressions, we verified that the estimated marginal effects are virtually identical using probit and logit models instead of linear probability models. This is not surprising, since LPMs have been shown to give reliable estimates of average effects (e.g., Angrist and Pischke 2008). We prefer to focus on the LPM estimates since they are easier to implement in the subsequent instrumental variables regressions.*

Figure 1 Walmart supercenter locations in 2002, 2006, and 2012

Note: The top map shows Walmart Supercenter locations in 2002, the middle map shows them in 2006, and the bottom map shows them in 2012.

from Bentonville with time provides plausibly exogenous variation that can identify the causal effect of Walmart Supercenters on food security.[9] Our sample period is 2001–2012, meaning that Walmart's Supercenter expansion pattern had already been underway for over a decade before our sample starts. Figure 1 shows Walmart Supercenter locations in 2002, 2006, and 2012, revealing that the most significant store-opening activity during this period was in major metropolitan areas relatively far from Bentonville, implying a diminishing relationship over time between distance from Bentonville and distance from Walmart.

[9]*This strategy is modeled after those of Neumark, Zhang, and Ciccarella (2008) and Dube, Lester, and Eidlin (2007), who observed a similar pattern for Walmart discount stores (as opposed to Supercenters) starting in the 1960s and used it to study the effect of Walmart on local labor markets.*

We operationalize the IV strategy by dividing the United States into 17 distance rings reflecting 100-mile increments of distance from Bentonville (e.g., fewer than 100 miles, 100–200 miles,. . ., 1,600 or more miles) and creating an indicator variable for each ring.[10] The distance ring dummies are included as controls, while the interactions of the distance ring dummies with (linear) year are used as instruments. Additionally, to address the possible concern that coastal and inland areas may have experienced different labor market shocks (and therefore different shocks to food security) during the Great Recession and subsequent recovery, we also control for the interaction of each distance ring with the national unemployment rate.[11] The resulting two-stage IV model therefore has the following first-stage equation:

$$\ln(DIS\_WS_{ct}) = \delta_0 + \sum_{j=1}^{J} \theta_j X_{jict} + \sum_{y=1}^{Y} \rho_y YR_y + \sum_{d=1}^{D} \sigma_d DIS\_BEN_d + \sum_{d=1}^{D} \varphi_d (DIS\_BEN_d * YR_y) + \sum_{d=1}^{D} \omega_d (DIS\_BEN_d * UNEM_y) + \mu_{ict} \quad (2)$$

where DIS_BEN_d is the distance from census tract c to Bentonville, $UNEM_y$ is the national unemployment rate, the other variables are the same as in equation (1), μ_{ict} is the error term, and the other Greek letters are coefficients. The second-stage regression is

$$Y_{ict} = \beta_0 + \beta_1 \ln(\widehat{DIS}_{WSct}) + \sum_{j=1}^{J} \gamma_j X_{jict} + \sum_{y=1}^{Y} \tau_y YR_y + \sum_{d=1}^{D} \alpha_d DIS_{BENd} + \sum_{d=1}^{D} w_d (DIS\_BEN_d * UNEM_y) + \varepsilon_{ict}. \quad (3)$$

This regression differs from the naïve regression (1) by replacing the distance to Walmart Supercenters with the predicted values of this variable estimated in equation (2) and adding the distance ring fixed effects and their interactions with national unemployment rate as controls.

Identification of β_1 in the IV model comes from the assumption that the distance * year interactions can be excluded from the second-state regression (3)—that is, that these interactions are uncorrelated with changes over time in food security conditional on the controls. By including the distance ring fixed effects in equation (3), we allow for the distances to be correlated with *levels* of food security; we only need to assume that they are uncorrelated

[10] *The 100-mile distance ring classification follows Neumark, Zhang, and Ciccarella (2008) and Dube, Lester, and Eidlin (2007).*

[11] *Basker (2005) criticizes Neumark, Zhang, and Ciccarella (2008) and Dube, Lester, and Eidlin (2007) distance-from-Bentonville-based identification strategy on the grounds that areas close to Bentonville (inland areas) experience differential labor market fluctuations than those far from Bentonville (coastal areas). Courtemanche and Carden (2011) conduct a wide array of robustness checks and placebo tests to verify that Basker's criticism did not apply to at least one health-related context (obesity). Nonetheless, we find that omitting the distance ring * unemployment rate interactions does meaningfully influence the estimated effects on food security, so we include them in all specifications.*

with *trends*. We will later assess the validity of the identifying assumption through a number of robustness checks.

Data

Our individual-level data come from the 2001–2012 waves of the Current Population Survey Food Security Supplement, an annual household survey conducted by the U.S. Census Bureau for the USDA. The CPS-FSS is the December supplement to the monthly Current Population Survey (CPS), which is a nationally representative survey on labor force statistics. The participants in the CPS-FSS are the same as those interviewed by the original monthly CPS. In the month when the CPS-FSS is conducted, the participants answer the labor force questions as well as a series of questions concerning food security, food consumption, and the usage of food assistance programs.

The CPS-FSS includes the standard set of 18 questions that are used to assess household and child food security. These questions are shown in table 1. We use responses to this questionnaire to construct four dependent variables for both households in general and children in those households specifically. The first variable is a simple count of affirmative responses, where the value ranges from zero to 18 for households with children and zero to 10 for households without children (since the last eight questions focus only on children). The remaining outcomes are dichotomized variables commonly used in the literature (e.g., Nord, Andrews, and Carlson 2005). "Household food insecurity" is defined as three or more affirmative answers on the questionnaire, while "child food insecurity" indicates two or more affirmative answers on the eight questions pertaining to children. "Household very low food security" is defined as eight or more "yes" answers in households with children or six or more in households without children. "Child very low food security" indicates five or more "yes" answers on the eight child-specific questions.

We also use the CPS-FSS to construct three sets of individual-level control variables: demographic characteristics, economic characteristics, and government food assistance program participation. The demographic variables include the adult responder's age; number of own children (dummies for 1, 2, 3, 4, and 5+, with 0 as the omitted base category); dummies for whether race/ethnicity is non-Hispanic white, non-Hispanic black, or Hispanic (with other race/ethnicity as the omitted category); dummies for married and formerly married (with never married as the omitted category); and dummies for high school degree but no further, some college, college degree, and graduate degree (with less than high school degree as the omitted category). The economic variables are household income (dummies for the 16 categories given by the CPS), occupation (dummies for 17 categories), and median income in the census tract.[12] The food assistance variables are indicators for whether any household member received SNAP benefits; Women, Infants, and Children (WIC) benefits; or free/reduced-price school breakfasts or lunches in the past year.[13]

[12] *About 15 percent of the sample has missing income data. We drop these individuals for the reported regressions, but the results are similar if we include them and indicate them with a dummy variable.*

[13] *We do not aim to make causal claims about the impacts of these programs, as their receipt is clearly endogenous (Kreider, Pepper, and Roy, 2016; Gundersen, Kreider, and Pepper, 2017). Later we will show in a robustness check that dropping these food assistance controls is inconsequential for the estimated effects of Walmart Supercenters.*

Table 1 Questions Used to Assess the Food Security of Households in the Current Population Survey's Food Security Supplement

Question Number	Question Text
1	"We worried whether our food would run out before we got money to buy more." Was that often, sometimes, or never true for you in the last 12 months?
2	"The food that we bought just didn't last and we didn't have money to get more." Was that often, sometimes, or never true for you in the last 12 months?
3	"We couldn't afford to eat balanced meals." Was that often, sometimes, or never true for you in the last 12 months?
4	In the last 12 months, did you or other adults in the household ever cut the size of your meals or skip meals because there wasn't enough money for food? (Yes/No)
5	(If yes to question 4) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?
6	In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food? (Yes/No)
7	In the last 12 months, were you ever hungry, but didn't eat, because there wasn't enough money for food? (Yes/No)
8	In the last 12 months, did you lose weight because there wasn't enough money for food? (Yes/No)
9	In the last 12 months did you or other adults in your household ever not eat for a whole day because there wasn't enough money for food? (Yes/No)
10	(If yes to question 9) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?
11	"We relied on only a few kinds of low-cost food to feed our children because we were running out of money to buy food." Was that often, sometimes, or never true for you in the last 12 months?
12	"We couldn't feed our children a balanced meal, because we couldn't afford that." Was that often, sometimes, or never true for you in the last 12 months?
13	"The children were not eating enough because we just couldn't afford enough food." Was that often, sometimes, or never true for you in the last 12 months?
14	In the last 12 months, did you ever cut the size of any of the children's meals because there wasn't enough money for food? (Yes/No)
15	In the last 12 months, were the children ever hungry but you just couldn't afford more food? (Yes/No)
16	In the last 12 months, did any of the children ever skip a meal because there wasn't enough money for food? (Yes/No)
17	(If yes to question 16) How often did this happen—almost every month, some months but not every month, or in only 1 or 2 months?
18	In the last 12 months, did any of the children ever not eat for a whole day because there wasn't enough money for food? (Yes/No)

Note: Questions 11–18 were asked only if the household included children ages 0–17.

Our independent variable of interest is distance from each respondent's census tract of residence to the nearest Walmart Supercenter at the end of each year. Walmart Supercenter entry dates and locations were pieced together from several sources. We began with a list of Walmart Supercenter

addresses as of July 2014 from the Brigades Open Data Network.[14] However, this list does not include the dates on which the stores opened. Entry dates through 2003 come from Thomas Holmes's website and were used in Holmes (2011).[15] We previously updated these data through 2007 using press releases on store openings (either new stores or conversions from discount stores to Supercenters) from *Walmart News*; these data were used in Courtemanche and Carden (2011, 2014). After 2007, the company only issued online press releases for some store openings and supercenter conversions, leaving 307 Supercenters (out of 3,294) unmatched to a more specific entry date. We deduced the year of entry for these remaining stores using a combination of (*a*) annual Zip Code-level and county level counts of supercenters and warehouse clubs from the U.S. Census Bureau's County Business Patterns, (*b*) the date of the store's first Yelp review that indicates it is a Supercenter, (*c*) phone calls to the stores, and (*d*) searches of internet news articles.[16]

The census tract geographic data come from the U.S. Census Bureau TIGER/Line Shapefiles for the year 2000. For each census tract, an internal point, usually a geographic center of the area, is identified, and its latitude and longitude coordinates are used to label the census tract. The distance from a census tract to the nearest Walmart Supercenter is then computed using the geodetic distance between the two sets of corresponding coordinates. The geodetic distance measures the length of the shortest arc between two points on the ellipsoid surface of the Earth. The distance from a census tract to the headquarters of Walmart in Bentonville is calculated following the same algorithm, then categorized into 17 distance rings.

We also include a set of controls for proximity to other discount grocers, constructed using a similar method. These controls are distance to the nearest Walmart Neighborhood Market, Sam's Club, and Costco. The Neighborhood Market is Walmart's newest store format, and it is similar in size and scope to a traditional grocery store. Sam's Club (owned by Walmart) and Costco are the two leading warehouse club chains. We collected data on Neighborhood Market and Sam's Club entry dates and locations using the same process described for Supercenters. Costco lists each store location and opening date on its website.

Merging the CPS-FSS to the census tract level geographic data and county-level store variables requires precise geographic identifiers that are not available in the public-use data. We therefore use the restricted version of the CPS-FSS, provided by the Census Bureau after an application process and accessed in the Census Bureau's Research Data Center in Atlanta.

[14]*The list, which includes all Walmart discount stores, Supercenters, and Neighborhood Markets as well as Sam's Clubs in both the United States and Canada, is available at https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=44&ved=0CC8QFjADOCg&url=https%3A%2F%2Fbrigades.opendatanetwork.com%2Fapi%2Fviews%2F5gyf-irpw%2Frows.pdf%3Fapp_token%3DU29jcmF0YS0td2VraWNrYXNz0&ei=RKq5U5bdB4qayASlpoC4CQ&usg=AFQjCNH42BpW-YSF7E4o7DXLhsbOrIL1_uA (last accessed June 2018).*

[15]*Holmes's data are available at http://users.econ.umn.edu/~holmes/data/WalMart/ (last accessed August 5, 2016).*

[16]*The Zip Code-level files appear to classify all supercenters and warehouse clubs that opened from 2008 to 2012 as opening in 2012. This means that those files are only useful for identifying which stores opened after 2012, which is after our sample period. The county-level files identify exact years. However, in counties where supercenters and warehouse clubs opened in multiple years from 2008 to 2012, it is not possible to tell which year pertains to the store in question, necessitating the other data-collection strategies. Yelp reviews proved particularly useful, as a reviewer often comments soon after a Supercenter opens to talk about the new (or expanded) store.*

Table 2 Summary Statistics for Key Variables

	All households; household food security	Households with children; children's food security
Count of affirmative household responses	0.925 (2.203)	0.366 (0.931)
Food insecurity	0.138 (0.345)	0.098 (0.298)
Very low food security	0.052 (0.222)	0.009 (0.093)
Distance from nearest Walmart Supercenter	17.69 (29.84)	18.46 (31.31)
Distance from Bentonville, Arkansas	843.8 (391.6)	844.0 (395.1)
Sample size	396,000	120,000

Note: Means are shown, with standard deviations in parentheses. CPS household sampling weights are used. Sample sizes are rounded to the nearest 1,000 according to U.S. Census Bureau guidelines for restricted data.

Dropping observations with missing data yields a final analysis sample of approximately 396,000 households, 120,000 of which have children. Following Research Data Center disclosure policies, we are only able to report sample sizes rounded to the nearest 1,000 observations. Table 2 presents the summary statistics for both the full sample of all households and the subsample of households with children, for the food security variables as well as distances from the nearest Walmart Supercenter and Bentonville. Fourteen percent of households are food insecure, with 5% having very low food security. Children are food insecure in 10% of households, though the rate of children's very low food security is only 1%. The average household lives 18 miles from the nearest Walmart Supercenter and 844 miles from Bentonville. Supplementary appendix table A1 shows the summary statistics for the control variables, while supplementary appendix table A2 does the same for the dummy variables for distance from Bentonville in 100-mile increments.

Results

Table 3 reports the key results for the baseline ordinary least squares (OLS) and IV regressions for each of the eight food insecurity outcomes. The left half of the table contains the results for the household measures, while the right half displays those for the child measures. Coefficient estimates for the independent variable of interest—*ln(Distance to the Nearest Walmart Supercenter)*—are shown. For the IV regressions, we also report the *F* statistic from a test of the joint significance of the instruments in the first stage, along with the *p*-value from the overidentification test of the instruments' validity. The table also contains sample sizes as well as means and standard deviations of the outcome variables, which provide a reference point when interpreting the magnitudes of the coefficient estimates.

The OLS results suggest that Walmart Supercenters, if anything, worsen food insecurity. The coefficient estimates are negative for all eight outcomes, meaning that a greater distance from Walmart is associated with less food insecurity (i.e., better food security). However, only two of the six estimates are statistically significant at the 10% level or better, and their magnitudes are small. For instance, since log-units have a percentage interpretation, a

Table 3 Results from Baseline Regressions

	Household			Children		
	Count of affirmative responses	**Indicator for food insecurity**	**Indicator for very low food security**	**Count of affirmative responses**	**Indicator for food insecurity**	**Indicator for very low food security**
Ordinary Least Squares						
ln(Distance to Walmart Supercenter)	–0.008*	–0.0009	–0.0005	–0.005*	–0.001	–0.0003
	(0.004)	(0.0007)	(0.0004)	(0.003)	(0.001)	(0.0003)
Instrumental Variables						
ln(Distance to Walmart Supercenter)	0.047**	0.012***	0.003	0.032**	0.014**	0.0003
	(0.020)	(0.004)	(0.002)	(0.014)	(0.005)	(0.0015)
First-Stage *F*-Statistic	139.5	139.5	139.5	102.2	102.2	102.2
Overidentification Test *P*-Value	0.219	0.096	0.350	0.057	0.034	0.818
Sample size	396,000	396,000	396,000	120,000	120,000	120,000
Mean (standard deviation) of dependent variable	0.925	0.138	0.052	0.366	0.098	0.009
	(2.203)	(0.345)	(0.222)	(0.931)	(0.298)	(0.093)

*Note: Standard errors, heteroskedasticity-robust and clustered by census tract, are in parentheses. Asterisks *** indicate statistical significance at the 1% level, ** = 5% level, and * = 10% level. All regressions include demographic, economic, food assistance, and food availability controls as well as year fixed effects. Instrumental variables regressions also include distance ring fixed effects and their interactions with national unemployment rate. CPS household sampling weights are used. Sample sizes are rounded to the nearest 1,000 according to U.S. Census Bureau guidelines for restricted data.*

100% increase in distance from Walmart decreases the count of affirmative household responses by just 0.008, which is just 0.9% of the sample mean for that outcome and 0.4% of a standard deviation. It is unclear, of course, whether these small associations actually reflect detrimental effects of Walmart as opposed to "negative selection" in Walmart locations.

In contrast to the OLS results, the IV estimates imply that the causal effect of Walmart Supercenters is to improve food security. The coefficient estimates are positive for all six outcomes, meaning that greater distance from Walmart worsens food insecurity. These estimates are statistically significant at the 5% level or better for four of the six outcomes. The only exceptions are the very low food security outcomes, for which the lack of significance could potentially be attributable to the relative lack of variation, as the sample rates are just 5% and 1% for households and children, respectively. Moreover, the magnitudes of the significant effects are, in our view, economically meaningful. For households in general, a 100% increase in distance from Walmart (e.g., from 10 to 20 miles) reduces the number of affirmative responses by 0.047 and the probability of being food insecure by 1.2 percentage points. These magnitudes represent 5.1% and 8.7% of the respective outcomes' sample means, and 2.1% and 3.5% of their standard deviations. For the children's food security measures, a 100% increase in distance from Walmart reduces affirmative responses by 0.032 and the likelihood of being food insecure by 1.4 percentage points. These magnitudes are 8.7% and 14.3% of the corresponding sample means and 3.4% and 4.7% of the corresponding standard deviations.

The instruments perform reasonably well in the diagnostic tests. The *F*-statistics are over 100, well beyond the rule-of-thumb critical value of 10, indicating that the instruments are sufficiently strong. The overidentification test results are more difficult to interpret. Conceptually, the overidentification test evaluates whether different subsets of instruments lead to statistically different estimated effects of the endogenous variable, with such differences suggesting that at least one of the instruments is invalid. In our case, the model is only overidentified because of our use of a flexible functional form for distance from Bentonville (separate variables for each 100-mile increment), meaning that it is unclear what a "failed" overidentification test would indicate. Nonetheless, the overidentification test only rejects the null hypothesis at the 5% level in one of the six IV regressions.

Robustness Checks

We next conduct a number of robustness checks to address possible critiques of our baseline IV model. First, the large set of control variables could conceivably "control away" part of the causal effect of Walmart. For instance, part of Walmart's effect on food security could potentially operate through its effects on employment and wages, which are theoretically ambiguous and are the subject of debate in the literature (Dube and Jacobs 2004; Basker 2005; Dube, Lester, and Eidlin 2007; Neumark, Zhang, and Ciccarella 2008; Cardiff-Hicks, Lafontaine, and Shaw 2015). In this case, including income and employment status could lead to an overcontrolling problem. Similarly, Coleman-Jensen (2011) argues that "nonstandard" work (i.e., irregular hours) is associated with greater food insecurity. If big box chains influence the share of "nonstandard" versus "standard" work, controlling for occupation could be problematic. Walmart could also

conceivably influence food security via participation in nutrition assistance programs such as SNAP or by affecting location decisions of other big box stores, either of which would create overcontrolling issues. Therefore, our first series of robustness checks explores the sensitivity of the results to dropping different subsets of controls. Specifically, we re-estimate the IV model including only demographic controls (dropping the economic, food assistance, and food availability controls), only demographic and economic controls, only demographic and food assistance controls, and only demographic and food availability controls.

The second set of checks goes the other direction, adding further controls to help address remaining concerns about the IV model's identifying assumption that distance from Bentonville is uncorrelated with changes over time in food insecurity. In particular, the densely-populated coastal areas that are relatively far from Bentonville could be trending in a different direction than less-populated inland areas that are relatively close to Bentonville. Our baseline model's detailed array of covariates, which include controls for differential effects of economic cycles across distance from Bentonville rings, should substantially mitigate this concern. Nonetheless, we conduct two robustness checks that explicitly address differential trends by population and region. The first adds the interaction of year with county population, while the second adds the interaction of year with a dummy variable indicating whether the state is on a coast.

The next concern is that, besides Supercenters, Walmart owns two other types of stores with full grocery departments—Sam's Clubs and Walmart Neighborhood Markets—that could conceivably follow the same geographic rollout pattern, creating a problem for the IV model's exclusion restriction. Recall that our baseline model controls for distance from both of these stores, but does not address the endogeneity of their locations, which could conceivably lead to spillover bias in the Walmart Supercenter coefficient estimator. This concern can be easily dismissed for Sam's Clubs, as Courtemanche and Carden (2011) previously documented that the distance-from-Bentonville expansion pattern for Sam's Clubs was finished before the start of our sample period. In unreported regressions, we confirm this by reestimating the first stage of the IV model with distance from Sam's Club as the outcome variable, finding that the *F*-statistics are quite small. Neighborhood Markets are potentially more problematic, though, as a similar analysis reveals that they did indeed follow a distance-from-Bentonville-based expansion pattern during our sample period.

We therefore conduct two robustness checks that give Neighborhood Markets "equal treatment" to Supercenters in the empirical model. First, we redefine the Walmart variable to be distance from the nearest Supercenter or Neighborhood Market (whichever is closer). Second, we allow the distance-ring-by-year interactions to instrument for both distance from the nearest Supercenter and distance from the nearest Neighborhood Market (separate variables). Note that we prefer to use these models as robustness checks rather than as the main specification since we are unaware of any evidence documenting whether Neighborhood Markets feature the same price advantages as Supercenters, meaning that their predicted effect on food insecurity is less clear.

The next series of checks experiments with different functional forms for the key variables. The first check uses a linear, rather than logarithmic functional form for the distance from the nearest Supercenter variable. The

second check uses quadratic distance from Bentonville instead of the series of dummies, meaning that the instruments are distance from Bentonville * year and squared distance from Bentonville * year. The third check allows time to be modeled more flexibly when constructing the instruments; specifically, rather than the instruments being the interaction of each distance ring with linear year, in this model, the instruments are a full set of distance-ring-by-year fixed effects.

Finally, we consider an entirely different IV strategy based on distance from the nearest Walmart food distribution center, as measured in 2000, the year before the start of the sample period. The intuition is similar to that behind distance from Bentonville. Early in the sample period, Walmart Supercenters were presumably most likely to open near existing distribution centers, but this relationship should weaken over time as the chain expands and new distribution centers open. In other words, the interaction between proximity to year 2000 distribution center locations and time provides plausibly exogenous variation in Walmart Supercenter entry. Since distribution centers were already scattered across the country by 2000, this approach is less susceptible than the distance-from-Bentonville-based strategy to the criticism of differential shocks across coastal and inland areas. Specifically, we estimate the exact same IV model as before, but replace the 100-mile distance from Bentonville dummy variables with 100-mile distance from food distribution center variables. We also estimate another model in which both the distance from Bentonville * year and distance from food distribution center * year variables are used as instruments.

Table 4 reports the estimated effects of proximity to Walmart on food security across the different robustness checks. For the four outcomes in which Walmart was statistically significant in the baseline model, there are a total of 52 robustness checks (13 for each outcome). Walmart remains significant at the 5% level in all but five of these and at the 10% level in all but two. While there is some sensitivity in the magnitudes, we do not view the sensitivity as sufficient to meaningfully affect our conclusions. For households in general, a 100% increase in distance from Bentonville increases the count of affirmative responses by 0.036 to 0.075 percentage points and the probability of being food insecure by 0.7 to 1.2 percentage points. For children, there is even less sensitivity. The effects range from 0.027 to 0.034 for the count of affirmative responses and 1.2 to 1.4 percentage points for the probability of being food insecure.[17] Moreover, even though the baseline estimate for very low household food security was statistically insignificant, in four of the 13 robustness checks, this effect becomes significant. The effect on very low child food security remains insignificant across all specifications, but this is perhaps not surprising given the very low prevalence of this condition (less than 1%). Interestingly, in the robustness check that separately estimates the effects of Walmart Supercenters and Neighborhood Markets, greater proximity to Neighborhood Markets does not significantly improve any of the food security outcomes, suggesting that these stores either do not offer the same discounts as Supercenters or cater to a different clientele (e.g., individuals who are not as close to the margin of food insecurity).

[17]*We exclude the results using linear distance from the nearest Supercenter from this discussion of magnitudes since the scale of the Supercenter variable becomes different in this specification, meaning the magnitudes are not comparable.*

Table 4 Results from Robustness Checks

	Household			Children		
	Count of affirmative responses	**Indicator for food insecurity**	**Indicator for very low food security**	**Count of affirmative responses**	**Indicator for food insecurity**	**Indicator for very low food security**
Fewer controls						
Demographic controls only	0.048**	0.0085**	0.0034	0.028*	0.0125**	0.0001
	(0.024)	(0.0037)	(0.0023)	(0.016)	(0.0050)	(0.0015)
Demographic and economic controls only	0.061***	0.0105***	0.0041*	0.032**	0.0138***	0.0003
	(0.022)	(0.0034)	(0.0022)	(0.015)	(0.0048)	(0.0015)
Demographic and food assistance controls only	0.052**	0.0090***	0.0035	0.0292**	0.0129***	0.0001
	(0.022)	(0.0034)	(0.0022)	(0.015)	(0.0048)	(0.0015)
Demographic and food availability controls	0.0458	0.0079**	0.0030	0.0314**	0.0137***	0.0002
	(0.0231)	(0.0036)	(0.0022)	(0.0152)	(0.0049)	(0.0015)
Additional controls						
Add county population * year	0.047**	0.008**	0.003	0.034**	0.014***	0.0004
	(0.020)	(0.003)	(0.002)	(0.014)	(0.005)	(0.002)
Add coastal state * year	0.047**	0.008**	0.003	0.033**	0.014***	0.0004
	(0.020)	(0.003)	(0.002)	(0.014)	(0.005)	(0.001)
Instrument for Neighborhood Market						
ln(Distance to Supercenter or Neighborhood Market)	0.0380*	0.0077**	0.0017	0.0266*	0.013***	–0.0004
	(0.0223)	(0.0035	(0.0023)	(0.0155)	(0.005)	(0.016)
Separate variables						
ln(Distance to nearest Supercenter)	0.0520**	0.009***	0.003	0.031**	0.013***	0.0005
	(0.0210)	(0.003)	(0.002)	(0.015)	(0.005)	(0.002)

Continued

Table 4 *Continued*

	Household			Children		
	Count of affirmative responses	**Indicator for food insecurity**	**Indicator for very low food security**	**Count of affirmative responses**	**Indicator for food insecurity**	**Indicator for very low food security**
ln(Distance to nearest Neighborhood Market)	–0.0372	–0.004	–0.004	–0.036*	–0.010	–0.004*
	(0.0274)	(0.004)	(0.003)	(0.020)	(0.007)	(0.002)
Alternate functional forms						
Linear distance to nearest Supercenter	0.0009***	0.0002***	0.00006*	0.0006***	0.0002***	0.00001
	(0.0003)	(0.00005)	(0.00003)	(0.0002)	(0.0001)	(0.00002)
Quadratic distance from Bentonville	0.075***	0.012***	0.007**	0.028	0.012**	0.002
	(0.026)	(0.004)	(0.003)	(0.018)	(0.006)	(0.002)
Distance ring * year fixed effects as instruments	0.036**	0.0070***	0.0021	0.032***	0.013***	0.0004
	(0.016)	(0.0026)	(0.0015)	(0.011)	(0.004)	(0.0012)
Distance from nearest food distribution center as instrument						
Distance from food distribution Center rings * year as instrument	0.057***	0.010***	0.0038*	0.034**	0.014***	0.0002
	(0.019)	(0.003)	(0.0020)	(0.014)	(0.004)	(0.015)
Use both distances from Bentonville and food distribution center	0.047***	0.0084***	0.0025	0.033***	0.014***	–5.99e–6
	(0.018)	(0.0029)	(0.0018)	(0.013)	(0.004)	(0.0014)

*Note: Standard errors, heteroskedasticity-robust and clustered by census tract, are in parentheses. Asterisks *** indicate statistical significance at the 1% level, **= 5% level, and *= 10% level. Instrumental variables regressions are shown in all cases. All regressions include demographic, economic, food assistance, and food availability controls; year fixed effects; and distance ring fixed effects and their interactions with the national unemployment rate unless otherwise indicated. CPS household sampling weights are used. Sample sizes are 396,000 for all households and 120,000 for households with children, rounded to the nearest 1,000 according to U.S. Census Bureau guidelines for restricted data.*

Table 5 Results from Income Stratifications

	Household			Children		
	Count of affirmative responses	**Indicator for food insecurity**	**Indicator for very low food security**	**Count of affirmative responses**	**Indicator for food insecurity**	**Indicator for very low food security**
Low-income subsample						
ln(Distance to Walmart Supercenter)	0.108**	0.020***	0.005	0.0504	0.027**	–0.001
	(0.047)	(0.007)	(0.005)	(0.0362)	(0.012)	(0.004)
Sample size	142,000	142,000	142,000	35,000	35,000	35,000
Mean (standard deviation) of dependent variable	1.789	0.267	0.110	0.805	0.221	0.022
	(2.887)	(0.442)	(0.313)	(1.295)	(0.415)	(0.147)
Middle-income subsample						
ln(Distance to Walmart Supercenter)	–0.001	0.002	–0.0007	0.044*	0.015*	0.002
	(0.031)	(0.005)	(0.003)	(0.023)	(0.008)	(0.002)
Sample size	124,000	124,000	124,000	37,000	37,000	37,000
Mean (standard deviation) of dependent variable	0.697	0.105	0.032	0.321	0.085	0.006
	(1.857)	(0.306)	(0.176)	(0.828)	(0.279)	(0.074)
High-income subsample						
ln(Distance to Walmart Supercenter)	0.021	0.003	0.001	0.009	0.004	–0.00006
	(0.015)	(0.003)	(0.001)	(0.009)	(0.003)	(0.0006)
Sample size	130,000	130,000	130,000	49,000	49,000	49,000
Mean (standard deviation) of dependent variable	0.1874	0.027	0.007	0.068	0.016	0.001
	(0.9850)	(0.163)	(0.083)	(0.390)	(0.126)	(0.033)

*Note: Standard errors, heteroskedasticity-robust and clustered by census tract, are in parentheses. Asterisks *** indicate statistical significance at the 1% level, ** = 5% level, and * = 10% level. Instrumental variables regressions are shown in all cases. All regressions include demographic, economic, food assistance, and food availability controls; year fixed effects; and distance ring fixed effects and their interactions with national unemployment rate unless otherwise indicated. CPS household sampling weights are used. Sample sizes are rounded to the nearest 1,000 according to U.S. Census Bureau guidelines for restricted data.*

Subsample Analyses

We close our empirical analysis by re-estimating the baseline IV model separately for low-, middle-, and high-income subsamples. Since food insecurity is most prevalent among low-income households, we expect Walmart Supercenters to lead to the largest improvements for that group. The income cutoffs used for the stratifications are chosen to divide the sample into three groups that are as similar in size as possible. Since the CPS only reports income in ranges, exactly equal sample sizes are not possible. Our low-income subsample includes households with annual incomes below $30,000, while the middle-income subsample includes those with incomes of $30,000 to $59,999, and the high-income group contains those with incomes of $60,000 and higher.

Table 5 reports the results. For the low-income group, a 100% increase in distance from the nearest Walmart Supercenter significantly increases a household's count of affirmative responses by 0.108 and its probability of being food insecure by 2.0 percentage points. These magnitudes represent 6.0% and 7.5% of the corresponding sample means. For children, the increases in the number of affirmative responses and probability of being food insecure are 0.05 and 2.7 percentage points, or 6.3% and 12.0% of the sample means. While the coefficient estimates are larger than those for the full sample presented in table 3, the effect sizes expressed as a percentage of the sample means are roughly similar. In other words, the effects are relatively large for the low-income subsample simply because food insecurity is more prevalent among that group.

The bottom two panels of table 5 display the results for the middle- and high-income subsamples. All estimates are statistically insignificant and relatively small for middle- and high-income households, as well as for high-income children. Interestingly, though, proximity to Walmart does appear to influence the food security of middle-income children: a 100% increase in distance raises the number of affirmative responses by 0.044 and the probability of being food insecure by 1.5 percentage points. Expressed as percentages of the sample means, these magnitudes are 14% and 18%. Therefore, while the absolute effects are not as large for middle-income children as they are for low-income children, they are actually larger in percentage terms.

Conclusion

This paper asks whether Walmart Supercenters, which lower food prices and expand food availability, improve food security. We estimate instrumental variables models that exploit the predictable geographic expansion patterns of Walmart Supercenters outward from corporate headquarters. Our results rely on data from the restricted-access 2001–2012 waves of the December CPS Food Security Supplement, which allow for relatively precise measurement of each household's distance from Walmart. We find that the entry of Walmart Supercenters helps to alleviate food insecurity across most measures for both households and children. The effects are strongest for low-income households and children but are still sizeable for middle-income children.

Our finding contributes to the literature in multiple ways. First, we provide new evidence on the causes of food insecurity. Considerable resources

are allocated through food assistance programs toward protecting households—especially children—from food insecurity. However, no research to date has examined the influence of big box grocers on food insecurity. Second, we contribute to the debate about Walmart's health effects. Big box grocers, Walmart Supercenters in particular, are blamed for causing obesity (Courtemanche and Carden 2011; Courtemanche et al. 2015). However, we are the first to study the other side of the coin: how the same cheap and readily available food that drives big box grocers' effect on obesity may also help in fighting food insecurity. As food insecurity is associated with higher healthcare costs (Tarasuk et al. 2015, Berkowitz et al. 2018), the increase in obesity-related health care costs associated with Walmart Supercenter diffusion are at least partially offset by reductions in food insecurity-related health spending. This improvement in food security adds another factor that local governments should consider when deciding whether to use policy levers (e.g., taxes, zoning laws) to either encourage or discourage Supercenter entry.

Caveats to our study provide directions for future research. For instance, we focus only on Walmart. Other types of food retailers, such as traditional supermarkets, smaller grocery stores, conveniences stores, and warehouse clubs, could all influence food security in different ways. To our knowledge, researchers have not yet identified quasi-experimental sources of variation to identify the causal effects of these store formats. Additionally, our research does not identify the specific mechanisms through which Walmart Supercenters influence food insecurity. While food prices are perhaps the most likely mechanism, food availability and income effects could play a role as well. Furthermore, the net effect that Walmart has on health—encompassing the improvement in food security, the increases in obesity and consumption of unhealthy food found by prior studies, and any effects on other health outcomes that have not yet been documented—remains ambiguous.

Along those lines, in recent years, Walmart has launched multiple initiatives to explicitly focus on health. During President Barack Obama's first term, Walmart joined a number of other firms and organizations in the Partnership for a Healthier America (Simon, Kocot, and Dietz 2017). As part of the partnership, Walmart adopted "Great for You" labeling for items that met the 2010 Dietary Guidelines for Americans, renovated stores in areas where food access was a concern, and worked with suppliers to reformulate some of what they sold in order to reduce sodium, sugar, and other unhealthy additives (Simon, Kocot, and Dietz 2017). Further, in 2011 Walmart collaborated with Tuskegee University to provide market access for small farmers in Alabama, which ultimately led to higher productivity for the farms that were able to participate in the study (Karki et al. 2017). Neither our identification strategy nor our data, which end in 2012, are well-suited to identify the impacts of these initiatives, but they could represent an important component of Walmart's health effects moving forward.

Supplementary Material

Supplementary material is available online at *Applied Economic Perspectives and Policy* online.

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