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Participation in the National School Lunch Program and food security: An analysis of transitions into kindergarten☆

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ABSTRACT

We use variation in state kindergarten eligibility dates to explore the protective effects of NSLP participation on household food security by focusing on the research question: What is the impact of the NSLP on household food insecurity among households with a kindergarten-aged child in the Early Childhood Longitudinal Study — Birth cohort (ECLS-B)? Our modeling approach provides consistent support for the contention that the NLSP reduces food insecurity. Additionally, we find that paying full price for school lunch is associated with increases in food insecurity among our low-income sample. Sensitivity analysis demonstrates that controlling for the reduction in child care hours among low-income households does not diminish the size of the NSLP effect. Additionally, school entry is not associated with reductions in food insecurity among families whose incomes are above 185% of the federal poverty line. Finally, our findings are robust to excluding twins. This finding is consistent with a growing literature documenting the benefits of school lunch programs but is unique for the focus on the period of school entry, at time when behavioral and cognitive patterns of school outcomes are being established for the future.

1. Introduction

The impact of food insecurity on children's development is well documented. From a developmental perspective, it is believed that food insecurity has cumulative effects at different stages of development beginning in the prenatal period (Bhattacharya, Currie, & Haider, 2004; Cook & Frank, 2008; Duncan, Brooks-Gunn, & Klebanov, 1994; Morgane, Austin-LaFrance, Bronzino, et al., 1993; Pollit, 1994; Scholl & Johnson, 2000). During infancy, hunger has negative effects during the period of neurodevelopment. Controlled experiments with animals suggest that hunger results in irreversible damage to brain development such as that associated with the insulation of neural fibers (Yaqub, 2002). The damage associated with a lack of nutritional intake accumulated during the first 2 years of life include susceptibility to infections, slowed cognitive development, slow growth, susceptibility to chronic diseases, girls are at higher risk of having low-birth weight babies, and other non-health related problems such as reduced school performance, increased school dropouts and reduced productivity during adulthood (Hoddinott, Beherman, Maluccio, Flores, & Martorell, 2008).

During schooling years, food insecurity is associated with poor school performance and academic achievement (Roustit, Hamelin, Grillo, Martin, & Chauvin, 2010; Maluccio et al., 2006; Cook & Frank, 2008). Neurologists and psychologists suggest that the impact of food insecurity on learning can be attributed to two mechanisms. First, there is a direct effect on cerebral functioning, which defines child's cognitive abilities. Second, there is an indirect effect on physical and psychological health that contributes to distraction, absenteeism and low motivational abilities for learning. Thus, the evidence indicates that the effects of nutritional inadequacy persist across childhood but that the causal mechanisms may vary at different periods of biological, cognitive and social development.

We examine the change in household food security as children enter kindergarten and are able to access the National School Lunch Program (NSLP). While others have examined the effect of NLSP on children's nutritional outcomes, (Bartfeld & Dunifon, 2006; Frisvold, 2013; Gundersen, Kreider, & Pepper, 2012), our paper is unique for its focus on the transition to kindergarten, a time period that is especially important for future school success. Specifically, we exploit variation in NLSP participation directly related to the age of children and state of residence. In order to access the NSLP program, children must be enrolled in formal kindergarten programs (i.e. not Headstart or other forms of child care), usually as part of an elementary school system. Kindergarten enrollment in largely based on turning age 5 by a cut-off point, which varies by state from August 1 in Missouri to January 1 in Connecticut (National Center for Education Statistics, US Department of Education, 2013).

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In this paper, we use this variation in state eligibility rules to explore the protective effects of NSLP participation on household food security by focusing on the research question: What is the impact of the NSLP on household food insecurity among households with a kindergarten-aged child? We use data from the Early Childhood Longitudinal Study — Birth cohort (ECLS-B) with state kindergarten enrollment policies as an instrument for participation in the NLSP. We begin by summarizing prior research on food and nutrition programs available to children around the time of kindergarten entry. Then we explain our modeling strategy and our use of the variation in kindergarten enrollment policies to address known selection problems with participation in school lunch programs. Results with sensitivity analyses follow. Our findings suggest that participation in the NLSP among kindergartners is associated with a significant reduction in the probability of being food insecure. This finding is consistent with a growing literature documenting the benefits of school lunch programs but is unique for the focus on the period of school entry, at a time when behavioral and cognitive patterns of school outcomes are being established for the future.

1.1. Literature review

The federal food and nutritional safety net designed to address the serious issue of childhood food insecurity is currently a patchwork. Program services may be delivered in the form of vouchers, (near) cash supplements, or directly as food. Services may be available to specific members of the household only or to the entire household. In addition to household income eligibility, children's eligibility for a specific program may depend upon their age and the income level of others in their day-care or school. The result of this hodge-podge of food and nutritional programs is that different households with similar income levels and number of children, may be receiving substantially different bundles of food assistance. The Supplemental Nutrition Assistance Program (SNAP) is the sole program that provides consistent nutritional assistance across the life course.

While variation may occur across the entire childhood period, there is a significant transition in the types of food and nutrition programs for which children qualify as children reach age five and become age eligible to enter kindergarten. Before age five, children are age eligible for WIC and may receive nutritional assistance through child care programs such as the Child and Adult Care Food Program (CACFP). After age five, children are no longer eligible for WIC and are much less likely to have contact with a child care center that participates in CACFP. Preliminary analyses by the Heflin, Arteaga, and Gable (2012) using the Early Childhood Longitudinal Study—Birth Cohort and similar methods to those used here suggest that household food insecurity increases by 7–13% when children reach month 61 and age out of eligibility for the WIC program. We seek to explore whether transitions into kindergarten and access to the National School Lunch, the main sources of nutritional supplementation for school-aged children, reduce food insecurity.

The NSLP is administered at the school level, with upwards of 97% of public schools participating in the NSLP. Participation in the NSLP has traditionally been limited to those who qualify based on categorical eligibility or income eligibility. Children can be categorical eligible for the NSLP based on their household participation in other federal means-tested programs, such as SNAP or TANF. Income eligibility is established by demonstrating that gross household income is below 130% of the federal poverty line for free meals, or between 130 and 185% of the poverty line for reduced meals. Beginning in 2012, schools with at least 40% of their students qualifying for free meals based on categorical eligibility can qualify for community eligibility in which meals are provided free to all children. Community eligibility is currently being phased in and was not an option during the time period of this study (Food and Nutrition Service, 2011). The NSLP also provides snacks to children during after-school programs. However, additional variation in the value of the nutritional benefit occurs through the school schedule (number of instruction days; traditional calendar with summers off versus year-round with a month off every 3 months) and the availability of the Summer Food Service Program, which serves meals during "vacation" months. In fiscal year 2011, over 31 million students received a free or reduced-price lunch daily. According to Dahl and Scholz (2011), participation rates among eligible children are 75% for the NSLP.

While the NSLP provides a stable source of food for children enrolled in school, the extent to which the NSLP is directly supportive of household food security is unclear. NSLP participation is high among the population at risk of food security: Two-thirds of households with food insecurity among children report participation in the free or reduced-price school lunch program in the last 30 days (Nord, 2009). It is unclear, however, what the nature of the relationship is between the NLSP and food insecurity. As has been found with other food assistance programs, it is likely that those who are food insecure are more likely to participate in the NSLP and that analysis of the relationship is hampered by the non-random process of NSLP program participation. The most common approach has been to use a two-stage estimator that relies upon instruments (Gao, Ishdorj, & Higgins, 2012; Gundersen & Oliveira, 2001; Jensen, 2002; Kabbani & Kmeid, 2005; Mykerezi & Mills, 2010) although new evidence is emerging using regression discontinuity (Frisvold, 2013; Heflin et al., 2012).

While most studies of program participation focus on the food stamp program (now known as SNAP), there are three studies that have tried to estimate causal effects of NSLP participation on food insecurity. Kabbani and Kmeid (2005) use CPS data from April 1995, 1997, 1999 and 2001 and find that participation in the NSLP was associated with lower odds of food insecurity for households with school-age children. In contrast, Gao et al. (2012) examine the relationship between NSLP participation and food insecurity using the third School Nutrition Dietary Assessment study (SNDA-III) sponsored by the Food and Nutrition Service (FNS) of USDA. Mathematica Policy Research, Inc. collected data from 287 schools in 94 districts from 2314 students over the 2004–2005 school year to access the dietary quality of school mean programs. Gao et al. (2012) employ an instrumental variable approach, using if the child has enough time to eat their school lunch as an identifying instrument, to predict participation in the NSLP. Their models suggest that there is no relationship between NSLP participation and children's food insecurity. On the other hand, Gundersen et al. (2012) use data from NHANES for the period 2001 to 2004 to study the impact of NSLP on child outcomes. Under a set of assumptions, they found that NSLP reduces food insecurity by at least 6% using a non-parametric approach, bounding methods, and a large age range of children—those who are between 6 and 17 years of age.

The lack of clear evidence regarding the efficacy of the NSLP on food insecurity is somewhat surprising given the recent evidence that school food programs are effective at improving child outcomes. Although Dunifon and Kowaleski-Jones reported in 2003 that participation in the NSLP do not indicate positive results for child outcomes, Bartfeld and Dunifon (2006), Gundersen et al. (2012), and Frisvold (2013) all find positive effects of school food programs on child outcomes, such as obesity, child's health, math scores, and reading scores.

1.2. Data

In order to estimate the effect of participation in the National School Lunch Program (NSLP) on food insecurity, we use the Early Childhood Longitudinal Survey, Birth Cohort (ECLS-B). We focus our analysis on households with children who are eligible to receive free or reduced lunch, those who live in households with income levels at or below 185% of the federal poverty line.

1.3. Early childhood longitudinal study, birth-cohort

The Early Childhood Longitudinal Study, Birth Cohort (ECLS-B) is conducted by the National Center for Education Statistics (NCES) to examine the development, health and learning environment of a single cohort of US children who were born in 2001. It utilizes a multi-reporter,

multi-method design to gather extensive information about children's home, parenting practices and behavior, as well as educational experiences. The ECLS-B collects data for 10,700 children and was designed to contain a nationally representative sample of ethnically and socioeconomically diverse families followed in four waves: 9 months, 24 months, 48 months and at kindergarten entrance. This last wave of data was collected at two different points in time: 7000 children attended kindergarten in 2006 and 3700 children attended kindergarten (or went directly to grade 1 without going to kindergarten) in 2007. One of the main advantages of the Early Childhood Longitudinal Study Birth—Cohort is that it contains information on the exact date when the child was born and when the child was interviewed. Restricting the sample to children living in households with incomes at or below 185% of the federal poverty level yields a sample size of 3850 children.[1]

1.4. State kindergarten entrance age cut-offs

In order to access the NSLP, children must be enrolled in kindergarten. Kindergarten enrollment in largely based on age eligibility, which varies by state. For example, in order to begin their kindergarten year, Alaska requires children to reach age 5 on or before August 15 while Connecticut requires children to reach age 5 on or before January 1. California is currently phasing in an earlier age cut-off, moving the deadline from age 5 by December 2 in 2011 to age 5 by September 1 in 2014. Eight states have cut-off dates in August, 28 in September, 3 in October, 1 in November, 2 in December and just 1 in January. Additionally, eight states allow Local Education Agencies to decide the kindergarten entrance age (National Center for Education Statistics, US Department of Education, 2013).

2. Methods

We are interested in studying the average effect of the NSLP among eligible households. As children become age eligible for kindergarten enrollment, how does access to the NSLP program influence household food insecurity? To examine this question, we need to identify the counterfactual—what would have happened to NSLP participants if they had not participated in the program upon school entry. Because children either participated in the program or did not participate in the program, it is impossible to compare the identical case in both states. This is known in the literature as a selection problem. In addition, we cannot simply use children who did not participate in the NSLP as a counterfactual for those who did participate, because there may be many reasons why they did not participate in the program. Even after controlling for observed characteristics, we are unlikely to observe all the factors that affect the participation decision. In the case of estimating treatment effects of food and nutrition programs it has been noted that eligible households tend to select into participation when they have a higher need (Currie, 2003).[2] The presence of this positive selection problem means that unless we control for the selection process, participation in food and nutrition programs is likely to be associated with increased levels of food insecurity. To address the selection problem, we use an identification strategy which relies upon instrumental variable models.

We begin by estimating probit models for the probability of experiencing food insecurity as a function of participation in the NSLP and other known correlates of food insecurity (household income, number of household members, child age, child gender, child race, parental education, urban/rural residency, and parental marital status). This naïve model does not control for the selection process into NLSP and is expected to show a positive correlation between NSLP and food insecurity.

Then we address the selection problem by using the relative distance from children's birthdates to the kindergarten eligibility rules which vary by state and year. For example, Missouri requires children to reach age 5 on or before August 1 to begin their kindergarten year. If child X's birthday is on August 1, then, our instrument will take a value of zero. If child Y's birthday is July 1, then the child was one month older than the required age to start kindergarten, so our instrument takes a value of $+1$. If on the other hand, child Z turns 5 by September 1, then this child cannot start kindergarten until next year; but he or she was just one month behind, so our instrument takes a value of -1. Our strategy exploits the fact that children who are very close in age to their state's kindergarten eligibility cut-off date should be, on average, very similar to children on the other side of the cut-off. Because not all children begin kindergarten when age eligible, we do not have perfect compliance and a fuzzy regression discontinuity design is employed. This means that NSLP participation is instrumented by using the relative distance from children's birthdates to the state kindergarten eligibility rule in an instrumental variable set up. As such, we interpret all model results as a local average treatment effect.

2.1. Measures

Our outcome of interest is food insecurity in households with children. The ECLS-B administered the USDA's food security module, which consists of 18 questions, 10 items for households in general and 8 items specifically for children. Examples of these questions include: "In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money to buy food?" and "In the last 12 months, did any of your children ever skip a meal because there wasn't enough money for food?" For the full battery of questions, see Nord (2009). Based on the existing standard in the field and USDA's guidelines, when zero to two items of the total 18 were affirmatively endorsed, a household is categorized as food secure; when three or more items were affirmatively counted, a household is considered food insecure.

We use two different measures of food insecurity, a 12-month measure and a measure of persistent food insecurity. Because the ECLS-B questionnaire only asked about the last 12 months, we created a persistent food insecurity measure, using the option "almost every month" for questions referring to frequency. Sample items include, "Did you or other adults in your household ever cut the size of your meals or skip meals because there wasn't enough money for food? (If yes) How often did this happen? (1) Almost every month; (2) Some months, but not every month; and (3) In only 1 or 2 months." When two or more items of the total six questions documenting frequency were affirmatively endorsed, a household was categorized as persistently food insecure.

Our preferred measure is the persistent food insecurity measure. Our rationale is that by relying upon identification strategies that focus on the impact of the NSLP on food insecurity during the transition to kindergarten, we needed to be certain that our food security measure is not including periods of food insecurity that only occurred before kindergarten entry. However, it is important to notice that the correlation between the 30 day measure and the 12-month measure is high and statistically significant. Others have found similar results (Nord, 2013).

Following the lead of Dunifon and Kowaleski-Jones (2003), our main measure is based on parental reports of if the child usually eats a free- or

[1] While the Current Population Survey (CPS) is considered the preferred dataset for analyses of household food insecurity, exact age in months is not provided nor is school enrollment information for children. As a consequence, only approximate age is available, a significant problem given our identification strategy using the kindergarten age cut-off month. We estimated general models of the probability of being observed food insecure for children aged five to six using the state of residence as an instrument for NSLP participation using the December 2001–2011 CPS. These models support our findings presented here. However, given that the counterfactual cannot be cleanly identified without school enrollment or precise age, we only show our findings for the ECLS-B.

[2] It is also possible that selection occurs in the opposite direction in that more informed households are the ones that participate. However, empirically positive selection is generally considered to be the larger problem of the two.

reduced-price lunch provided by the school. However, we also take advantage of an additional measure, "Does CHILD usually receive a complete lunch offered at school?" We combine these two variables to create a measure of if the child eats a full-price meal at school. Our results show model estimates for two different counterfactuals: 1) among children who eat school lunch, what is the effect of the free and reduced price program on household food insecurity (n = 1600); and 2) what is the effect of the free and reduced price program (and full-priced meals) on household food insecurity relative to not eating a school lunch at all (n = 3850). The later models have the advantage of allowing us to observe the relationship between paying full price for school lunch on food insecurity among households with children.[3]

3. Results of probit using age relative to state kindergarten entry cut-off as IV

3.1. Persistent food insecurity

Table 1 presents probit and IV probit models for the ECLS-K sample below 185% of the federal poverty line. We begin by presenting probit model results for the probability of reporting food insecurity without correcting for positive selection into the NSLP program; in the second model, we present results using the age relative to the kindergarten cut-off date for the state as an instrumental variable. The Wald test for endogeneity is statistically significant in all models presented.[4] All models include controls for the child's age, gender, race, maternal education, marital status, urban/rural residency, household income, and month of interview.

Beginning with the top panel and left column of Table 1, we present results using the 12-month measure of food insecurity. The probit results show a positive and statistically significant relationship between participation in the NLSP program and food insecurity, relative to children who pay full priced meals. This positive selection into the NLSP program with respect to household food insecurity is both expected and consistent with the prior literature and the reason that we use an instrumental variable approach as our second step in the analysis.

Using the fuzzy regression discontinuity approach which relies upon the distance from the state kindergarten age cut-off to identify participation in the NLSP program, we observe that NSLP participation in the second stage model is negatively associated with food insecurity and statistically significant regardless of the counterfactual group.[5] The marginal effect is −.7046 when the counterfactual is children that pay for their school lunch and −.7429 when the comparison is children that do not eat school lunch. Interestingly, we see that paying full-price for school lunch is associated with an increase in food insecurity relative to children who do not eat school lunch among all children below 185% of the federal poverty line. This suggests that the NLSP program is providing a critical source of support among households who benefit from it. It is important to remember that these substantively large marginal effects represent the local average treatment effect and not the average treatment effect for all participants in the NSLP program.

Moving to the bottom panel of Table 1, results are presented for the persistently food insecure measure, which are largely consistent with those in the top panel. Probit results once again indicate that NSLP participation is associated with a positive and statistically significant effect on the probability of being food insecure, relative to children who pay for their school lunch, suggesting that positive selection bias is present. In our IV probit model, we find that participating in the NSLP, relative to children who pay for their school lunch, has a negative but statistically insignificant relationship with household food insecurity. However, when we estimate our models against the counterfactual of children who do not eat school lunch results again confirm those for the 12 month measure. In IV probit models that address the endogeneous selection process into NLSP, we find that participation in the free and reduced lunch program has a strong and negative effect on the probability of being persistently food insecure, relative to not eating school lunch. Once again, students that pay full-price for school meals have a substantially large and statistically significant *increase* in their probability of being food insecure, relative to those children who do not eat school lunch. Thus, both measures of food insecurity confirm that participation in the NLSP is associated with reductions in food insecurity among households with children and that paying full price for school lunch increases the probability of food insecurity.

Table 1
Marginal effects of the National School Lunch Program on food insecurity.

	Probit		IV probit	
Food insecurity, 12-month measure				
Counterfactual: full-priced school lunch participants (n = 1600)				
NSLP program	0.0846	**	−0.7046	***
	(0.0386)		(0.2080)	
Counterfactual: does not eat school lunch (n = 3850)				
NSLP program	0.0650	*	−0.7429	***
	(0.0390)		(0.2087)	
Full-priced school lunch	−0.0341		0.7697	***
	(0.0359)		(0.1916)	
Food Insecurity, persistent measure				
Counterfactual: full-priced school lunch participants (n = 1600)				
NSLP program	0.0177	***	−0.4368	
	(0.0058)		(1.7844)	
Counterfactual: does not eat school lunch (n = 3850)				
NSLP program	0.0246		−0.7286	***
	(0.0162)		(0.2338)	
Full-priced school lunch	−0.0216	*	0.7823	***
	(0.0125)		(0.1908)	

NOTE: Authors' calculations based on ECLS-B data. Reported sample size rounded to nearest 50.
Models include controls for age of child, gender, race and ethnicity, urban/rural, education of parents, marital status, income and month of the interview.
Robust standard errors shown in parentheses.
* p < 0.10.
** p < 0.05.
*** p < 0.01.

3.2. Sensitivity analysis

While our main models on different measures of food insecurity yield consistent findings regarding the protective effect of transitioning into the NSLP program upon kindergartner entry for household food insecurity, we also present two additional sensitivity analyses aimed to reduce concerns that the effect that we are identifying is due to school entry and not specifically participation in the NSLP. The first analysis incorporates information regarding child care explicitly; the second focuses on presenting results for those who do not qualify for the NSLP.

It is likely that for many families school entry is associated with reduced costs, such as those from lower child care expenses, which improve household food security irrespective of NSLP participation.

[3] Neither comparison group is perfect. For example, the group eating full-priced lunch is more advantaged in terms of household incomes, parental education, and marital status than the group eating free and reduced lunch. Additionally, the full-priced lunch group is less likely to report receiving food stamps, Medicaid or welfare.

[4] We conducted a test of relevance of instruments, test of endogeneity and test of overidentifying restrictions and all of these tests indicated that the IV probit model was the preferred one.

[5] First stage results are shown in Appendix Table 2.

Table 2
Sensitivity analysis: marginal effects of the National School Lunch Program on food insecurity with child care hours.

	Probit		IV probit	
Food insecurity, 12-month measure				
Counterfactual: full-priced school lunch participants (n = 1600)				
NSLP program	0.0849	**	−0.7036	***
	(0.0386)		(0.2103)	
Child care hours	−0.0005		−0.0001	
	(0.0012)		(0.0013)	
Counterfactual: does not eat school lunch (n = 3850)				
NSLP program	0.0647	*	−0.6872	***
	(0.0390)		(0.2397)	
Full-priced school lunch	−0.0362		0.7137	***
	(0.0359)		(0.2376)	
Child care hours	−0.0003		−0.0006	
	(0.0006)		(0.0006)	
Food insecurity, permanent measure				
Counterfactual: full-priced school lunch participants (n = 1600)				
NSLP program	0.0167	***	−0.4756	
	(0.0056)		(1.6829)	
Child care hours	0.0005	**	0.001	
	(0.0002)		(0.0019)	
Counterfactual: does not eat school lunch (n = 3850)				
NSLP program	0.0245		−0.6631	**
	(0.0162)		(0.2833)	
Full-priced school lunch	−0.022	*	0.7228	***
	(0.0127)		(0.256)	
Child care hours	−0.0001		−0.0006	
	(0.0002)		(0.0006)	

NOTE: The authors' calculations based on ECLS-B data. Reported sample size rounded to nearest 50.
Models include controls for age of child, gender, race and ethnicity, urban/rural, education of parents, marital status, income and month of the interview.
Robust standard errors shown in parentheses.
* p < 0.10.
** p < 0.05.
*** p < 0.01.

Table 3
Falsification test using sample above 185% of the federal poverty line.

	Probit	IV probit
Food insecurity, 12-month measure		
Counterfactual: full-priced school lunch participants (n = 1500)		
NSLP program	0.000021	−0.0697
	(.00007)	(0.2999)
Counterfactual: does not eat school lunch (n = 4500)		
NSLP program	0.00067	−0.1145
	(0.0012)	(0.2961)
Full-priced school lunch	−0.00026	0.0651
	(0.0004)	(0.1747)
Food insecurity, persistent measure		
Counterfactual: full-priced school lunch participants (n = 1500)		
NSLP program	3.78e−11	NA
	(4.77e−10)	NA
Counterfactual: does not eat school lunch (n = 4500)		
NSLP program	1.51e−17	−2.27e−08
	(2.96e−16)	(2.28e−06)
Full-priced school lunch	2.30e−17	6.76e−08
	(3.40e−16)	(6.74e−06)

NOTE: Authors calculations based on ECLS-B data. Reported sample size rounded to nearest 50.
Models include controls for age of child, gender, race and ethnicity, urban/rural, education of parents, marital status, income and month of the interview.
Robust standard errors shown in parentheses.
NA indicates that the model did not converge due to a lack of variability in the outcome.
* p < 0.10.
** p < 0.05.
*** p < 0.01.

Therefore, in Table 2, we explicitly control for the hours spent in paid child care at the time of the interview.[6] We find that not only is there no direct effect of the change in the number of hours that the child spends in child care on the transition to food security, but that the main effect of NSLP attenuates only slightly and remains robust to the initial estimation shown in Table 1.

In Table 3, we replicate the analysis shown in Table 1 but instead of limiting our sample to those who qualify for NLSP with incomes below 185% of the federal poverty line, we limit our sample to those with incomes *above* 185% of the federal poverty line. If the effect that we are able to identify in our prior models is coming from NLSP participation and not school entry generally, then we would expect to see no effect for the sample that is not income eligible for the NSLP. For example, if sending children to school changes family routines, home eating behaviors or household production in some way that alters the probability of being food insufficient, then these effects might be visible in a sample of children that are not eligible for the NSLP but also transitioned to kindergarten. Findings shown in Table 3 are consistent with the interpretation that the NSLP supports household food security for eligible households. We observe no evidence that entering school is associated with the probability of persistent food insecurity or being food insecure using the 12 month measure regardless of which counterfactual group is used. While it is possible that family processes for low-income families differ from those of households that are ineligible for the NSLP, this analysis provides supports to the earlier findings that our modeling approach is estimating the effects of NSLP and not the general effect of school entry.

An additional concern is that a family with several children may receive more food from the school lunch program than a family without siblings. Because ECLS-B oversamples twins and includes children with siblings, we reran our analysis on a sample restricted to singletons to address this potential concern. Appendix Table 1 shows these results. We observe very similar results to those shown in Table 1.

4. Conclusion

This paper examines the effect of the National School Lunch Program (NLSP) on household food insecurity relying upon state variation in the age eligibility cut-off for participation in kindergarten as the source of identification of the local average treatment effect. Our modeling approach provides consistent support for the contention that the NLSP reduces food insecurity. Additionally, we find that paying full price for school lunch is associated with increases in food insecurity among our low-income sample. Our findings are consistent across a 12 month measure of food insecurity as well as a measure of persistent food insecurity. Sensitivity analysis demonstrates that controlling for the reduction in child care hours among low-income households does not diminish the size of the NSLP effect. Additionally, school entry is not associated with reductions in food insecurity among families whose incomes are above 185% of the federal poverty line. Finally, our findings are robust to excluding twins.

The confidence in our findings rests upon the ability of our identification strategy to estimate treatment effects of participation in the NSLP relative to different counterfactual groups. We utilize state policy variation in kindergarten age cut-offs and the

[6] While we would prefer to include a measure of child care costs instead of hours, child care costs were not included in the survey questionnaire at wave 5.

randomness of individual month of birth as exogenous factors to control for observed and unobserved differences between NSLP participants and non-participants. Additional falsification tests and controls for child care add to the robustness of our findings. However, it is possible that other factors associated with school entry, besides access to the NSLP and reductions in the hours spent in child care, lead to reductions in food insecurity for low-income households. These other mechanisms remain unspecified at this point and until they can be identified and tested, our results support the argument that the NLSP is a source of protection for low-income households from food insecurity as they enter kindergarten.

The finding that NSLP is associated with reductions in food insecurity contributes to the growing literature suggesting that the federal food program is effective (Bartfeld and Dunifon, 2006, Gundersen et al., 2012 and Frisvold, 2013). Our paper is unique for the focus on the transition to kindergarten, a time period that is especially important for future school success. Numerous studies on child development have examined this transition and found that kindergarten performance is positively associated with achievement scores for elementary school and high school. In the same line, kindergarten sets the stage for what is going to happen for the future performance (Pianta, Cox & Snow, 2007). As reading, studying and behavioral habits are learned in school when entering into kindergarten, it is necessary that a child is well nourished to be able to concentrate during class and learn (Alderman, Hoogeveen, & Rossi, 2009). Our study focuses on the effects of the NSLP during this key time in a child's life, in which study habits, as well as nutritional-related habits, learned in school are likely to last throughout the life course (San Juan, 2006; Verduci et al., 2007).

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Appendix Table 1. Effects of NSLP on food security for singletons

Identification strategy	Probit		IV Probit	
Food insecurity, *12-month measure*				
Counterfactual: full-priced school lunch participants (n = 1300)				
NSLP program	0.0974	**	−0.6994	***
	(0.039)		(.2206)	
Counterfactual: does not eat school lunch (n = 3200)				
NSLP program	0.0725	*	−0.7794	***
	(0.0417)		(0.1809)	
Full-priced school lunch	−0.0406		0.8102	***
	(0.0381)		(0.1481)	
Food insecurity, *persistent measure*				
Counterfactual: full-priced school lunch participants (n = 1300)				
NSLP program	0.0176	***	−0.4703	
	(0.006)		(1.7272)	
Counterfactual: does not eat school lunch (n = 3200)				
NSLP program	0.02488		−0.7658	***
	(0.0172)		(0.2017)	
Full-priced school lunch	−0.0217	*	0.8219	***
	(0.013)		(0.1471)	

NOTE: Authors calculations based on ECLS-B data. Reported sample size rounded to nearest 50.
Models include controls for age of child, gender, race and ethnicity, urban/rural, education of parents, marital status, income and month of the interview.
Robust standard errors shown in parentheses.
* p < 0.10.
** p < 0.05.
*** p < 0.01.

Appendix Table 2. First stage results (effects of participating in the free and reduced lunch program)

	Model 1[a]			Model 2[b]			Model 3[c]			Model 4[d]		
	Coef.		S.E.	Coef.		S.E.	Coef.		S.E.	Coef.		S.E.
Rural area	0.0647		0.0417	0.0465	**	0.0190	0.0654		0.0417	0.0471	**	0.0190
Number of members in HH	0.0305	***	0.0098	0.0155	***	0.0044	0.0303	***	0.0097	0.0153	***	0.0044
Child is female	0.0327		0.0236	0.0134		0.0122	0.0330		0.0235	0.0131		0.0121
Child is White, non-Hispanic	−0.0090		0.0500	−0.0034		0.0212	−0.0086		0.0500	−0.0032		0.0212
Child is Black, non-Hispanic	0.0820	*	0.0466	0.0577	***	0.0213	0.0822	*	0.0466	0.0569	***	0.0213
Child is Hispanic	0.1159	***	0.0415	0.0379	**	0.0193	0.1157	***	0.0415	0.0380	**	0.0193
Parent attended some college	−0.0049		0.0268	−0.0024		0.0144	−0.0054		0.0268	−0.0031		0.0144
Parent attended 4+ years of college	0.0129		0.0520	−0.0521	**	0.0265	0.0125		0.0520	−0.0521	**	0.0265
Parent is divorced, separated, widowed	0.0080		0.0349	0.0095		0.0209	0.0076		0.0344	0.0098		0.0207
Parent is married	−0.0224		0.0372	0.0069		0.0176	−0.0229		0.0371	0.0064		0.0175
Log of income (thousands)	−0.0801	***	0.0143	−0.0451	***	0.0077	−0.0797	***	0.0142	−0.0455	***	0.0077
Instrument (distance- birthdate and kindergarten eligibility rule)	−0.0039	*	0.0021	−0.0026	*	0.0015	−0.0038		0.0031	−0.0026	*	0.0015

Notes: The authors' calculations were based on ECLS-B data.
[a]Model 1: food insecurity, 12-month measure, counterfactual: full-priced school lunch participants (n = 1600).
[b]Model 2: food Insecurity, 12-month measure, counterfactual: does not eat school lunch (n = 3850).
[c]Model 3: food insecurity, persistent measure; counterfactual: full-priced school lunch participants (n = 1600).
[d]Model 4: food insecurity, persistent measure; counterfactual: does not eat school lunch (n = 3850).
* p < 0.10.
** p < 0.05.
*** p < 0.01.

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