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ARTICLE

The earned income tax credit and food insecurity

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Abstract

Although previous work on the earned income tax credit (EITC) has established that the program improves health outcomes of people from lower socioeconomic backgrounds, not much is known about the possible pathways through which higher EITC benefits affect health. This study contributes to the literature by evaluating the role of food insecurity as a mechanism underlying the relationship between the EITC and health. Using the 2009 federal EITC expansion, which increased benefit generosity for eligible families with three or more children, I estimate difference-in-differences (DD) and difference-in-difference-in-differences (DDD) models to evaluate whether the policy change is associated with improvements in food security. My analysis finds that the program expansion, which increased predicted annual EITC benefits by $496, is associated with a reduction in the likelihood of experiencing food insecurity by 8.1% for low-educated households with three children. The observed improvements in food security are larger for non-married households, a group that has previously been shown to be strongly affected by EITC changes. An evaluation of variations in state-level EITC laws provides further indication that more generous benefits reduce food insecurity. The results, which are robust to estimating several alternative specifications, provide evidence that higher EITC benefits improve the well-being of low-income households by reducing food insecurity.

KEYWORDS

earned income tax credit, expansion, food insecurity

JEL CLASSIFICATION

I18

1 | INTRODUCTION

Income-related health inequalities have increased in recent decades in the United States. Although the health of the wealthiest Americans has been relatively stagnant, individuals in the lowest income group have experienced significant health declines (Zimmermann & Anderson, 2019). Previous work has established that income assistance programs are a successful policy tool to improve the well-being for individuals from lower socioeconomic backgrounds. One program that has received particular attention in in the literature is the earned income tax credit (EITC). Although earlier research on the EITC has shown that the program is successful in lifting households above the poverty line (e.g., Meyer, 2010; Neumark & Wascher, 2001; Scholz, 1994) and increasing labor force participation (e.g., Eissa & Liebman, 1996; Hotz & Scholz, 2003; Meyer & Rosenbaum, 2001), more recent work has established that expansions of the program improve health outcomes among children and adults (e.g., Boyd-Swan et al., 2016; Evans & Garthwaite, 2014; Hoynes et al., 2015; Lenhart, 2019a). Although these positive health effects have been shown for a range of outcomes (birthweight, physical health, mental health), much less is currently know about the mechanisms through which more generous EITC benefits improve the health of affected households. By evaluating the 2009 federal expansion of the EITC, this study examines whether increasing the generosity of the program is associated reduction in the likelihood of households experiencing food insecurity.

The 2009 policy changes expanded EITC benefits for eligible households with three or more children, whereas benefits for families with fewer children remained unaffected. By using data from the Current Population Survey Food Security Supplement for the years 2001 to 2017 and comparing households that are likely eligible to receive EITC benefits with two and three children, this study examines whether the policy change altered food insecurity. The analysis estimates difference-in-differences (DD) and difference-in-difference-in-differences (DDD) specification as well as several alternative tests (e.g., event study, state-level EITCs, falsification test).

This study contributes to existing research on the determinants of food insecurity. According to data by the U.S. Department of Agriculture (USDA), 13.9% of U.S. households with children were food insecure in 2018. A better understanding of policy tools that are successful in reducing food insecurity rates is important to improve the well-being of society. Earlier work has established that food security is positively associated with several indicators of well-being, such as physical health (Gundersen & Kreider, 2009; Gundersen & Ziliak, 2015; Reis, 2012), mental health (Carter et al., 2011; Jones, 2017), and the utilization of mental health care services (Tarasuk et al., 2018).

Previous research studying the EITC has established that the program is successful in lifting families above the poverty threshold (Hoynes & Patel, 2018; Meyer, 2010; Neumark & Wascher, 2001; Scholz, 1994; Short, 2014). Short (2014) finds that the EITC along with the child tax credit lifted 4.7 million children out of poverty in 2013, which is more than any other program. Furthermore, with the exception of a recent study by Kleven (2019), prior work has shown that the program increases labor force participation for unmarried women (Bastian & Lochner, 2022; Eissa et al., 2008; Eissa & Liebman, 1996; Hotz & Scholz, 2003; McKeehan, 2018; Meyer & Rosenbaum, 2001).

Although the majority of work on federal EITC reform focuses on expansions in the 1990s, three studies show that the more recent 2009 federal expansion, which was signed by President Obama as part of the American Recovery and Reinvestment Act (ARRA), reduced poverty and improved employment outcomes. Meyer (2010) shows that the policy reduced the number of families below the poverty line by 11%, increased employment of single mothers with three or more children by 3.7%, and increased the tax credit received by working single mothers by around $515. Similarly, Mattingly (2009) finds that the 2009 expansion increased benefits by $514 for eligible married couples and by $405 for single filers with three or more children. Finally, recent work by Bastian and Lochner (2022) shows that the latest federal EITC expansion increased labor force participation, time spent working, earnings, and predicted EITC benefits among women. This paper contributes to the small number of studies exploring the effects of the 2009 EITC expansion.

In addition to evaluating the effects of EITC changes on poverty and employment, there has been a growing interest among researcher in examining potential effects of EITC benefits on health outcomes. Studies have shown that the program improves health outcomes (Averett & Wang, 2018; Baughman & Duchovny, 2016; Evans & Garthwaite, 2014; Hoynes et al., 2015; Lenhart, 2019a; Markowitz et al., 2017; Strully et al., 2010). Furthermore, the EITC has been shown to improve mental health (Boyd-Swan et al., 2016; Evans & Garthwaite, 2014) and child development (Hamad & Rehkopf, 2016).[1] Although these studies indicate that the EITC is a policy tool that reduces health inequalities (Fletcher & Wolfe, 2014), much less is known about the underlying mechanisms through which this occurs. Three previous studies have shown that EITC expansions increase health insurance coverage among households from lower socioeconomic backgrounds (Baughman, 2005; Hoynes et al., 2015; Lenhart, 2019a). Furthermore, EITC benefits have been shown to be associated with higher household food expenditures (Lenhart, 2019a) and increased spending on healthy food products (McGranahan & Schanzenbach, 2013). My study adds to the existing literature on the relationship between the EITC and health by evaluating the role of food insecurity as potential mechanism.

My analysis provides evidence that suggests that EITC expansions reduce food insecurity among households affected by the policy change. In addition to showing that the 2009 expansion increases simulated annual EITC benefits by $496 per household, I subsequently find that it is associated with a reduction in food insecurity by 8.1%. Subgroup analysis reveals that the observed reductions in food insecurity are larger for non-married households, a group that has previously been shown to be strongly affected by changes to the EITC (e.g., Eissa & Liebman, 1996; Hotz & Scholz, 2003; Meyer, 2010; Meyer & Rosenbaum, 2001). The main DD results of the study are robust to DDD models, an event study approach as well as placebo and falsification tests. Finally, an evaluation of variations in state-level EITC laws provides further indication that more generous benefits reduce food insecurity. Overall, the results show that higher EITC benefits are associated with improvements in food security among households likely eligible for the program. Given the existing findings on the link between food security and health outcomes, the results of this study indicate that food insecurity might be one of several factors explaining the previously established positive relationship between EITC benefits and health.

2 | BACKGROUND

This section provides an overview of the EITC, presents recent trends in U.S. food insecurity, and discusses potential mechanisms through which higher EITC could improve food security rates.

2.1 | Earned income tax credit

The EITC is a refundable tax credit that provides an annual earnings subsidy to lower income workers.[2] It was first enacted in 1975 as a relatively small credit capped at $400 per family. The EITC has a unique payment structure, which makes it different from other welfare programs. The size of benefits received by eligible families depends on several factors, such as the presence and number of qualifying children in the household.[3] Depending on the amount of a family's earnings and adjusted gross income, EITC payments are grouped into three ranges: (1) a phase-in range in which higher

[1]Temple (2018) shows that changes in mental well-being are associated with food insecurity. By testing the association between 18 discrete stressors (e.g., divorce, serious illness, mental illness, inability to get a job) and the likelihood of food insecurity in Australia, the author provides evidence for an association between stressors and food insecurity. However, the findings by Temple (2018) does not rule out that the events themselves and not stress influence food insecurity.

[2]The fact that the EITC is refundable means that if it exceeds a low-wage worker's income tax liability, the IRS will refund the balance (Center on Budget and Policy Priorities, 2019).

[3]See Hotz and Scholz (2003) for a detailed overview of the eligibility restrictions to the EITC.

earnings yield higher credits; (2) a plateau range in which payments remain the same even as earnings rises; and (3) a phase-out range in which higher earnings yield lower credits. Given that EITC benefits grow with each additional dollar of earnings until reaching the plateau phase, the design of the program provides an incentive for people to join the labor force and for low-wage workers (those in the phase-in phase) to increase their work hours. Previous work on the EITC has established that the program increases labor force participation, with the effects being largest among single mothers (Eissa et al., 2008; Eissa & Liebman, 1996; Hotz & Scholz, 2003; McKeehan, 2018; Meyer & Rosenbaum, 2001). In a review of the literature, Eissa and Hoynes (2006) conclude that, whereas the EITC stimulates people to join the work force, there is no evidence that it reduces the number of hours worked.

Since its original implementation, Congress has expanded the EITC several times both in terms of benefit size and eligibility requirements. Between 1984 and 2016, the phase-in rate of the EITC increased from 10% to 40% of earnings, whereas the plateau range expanded from between $5000 and $6000 to between $14,000 and $18,000. In addition to the federal EITC, many states have introduced state-level credits on top of the federal credits over the last two decades.[4] As a result, the EITC has become the largest cash transfer program as well as the most important anti-poverty policy in the United States for families with children. In 2010, over 26 million families received the credit, totaling $58.6 billion in foregone government revenue.

2.2 | ARRA EITC expansion

The 2009 EITC expansion as part of the ARRA, which was signed by President Obama, delivered the most recent federal change to the tax credit. The reform significantly increased benefits to eligible families with three or more children while keeping credits to families with one and two children unchanged. Table 1 provides an overview of EITC parameters during the period of this study (2001 to 2017). Although credit rates for eligible families with one or two children remained unchanged between 2001 and 2017, the rate increased by 5% for those with three or more children after the ARRA reform in 2009. Whereas maximum EITC credits were identical for families with either two children or at least three children prior to the ARRA, Table 1 shows a gap of up to $700 between these two groups following the expansion of the program. In addition to expanding the EITC, the ARRA also included temporary extensions of food assistance benefits, unemployment benefits, increased spending on education and health care, and significant cuts to taxes in an attempt to end the Great Recession by increasing consumer spending (Amadeo, 2019).

2.3 | Food security in the U.S. since 2000

Food insecurity rates in the U.S. had grown continuously from 2000 until the end of the Great Recession. Despite improvements in the state of the economy following the crisis, food insecurity rates have remained higher than prior to the Great Recession for 41 states (Schanzenbach et al., 2016), with 14% of all U.S. households and 19% of those with children experiencing food insecurity during 2014 (Coleman-Jensen et al., 2015). In examining the reasons for why food insecurity rates did not decline following the end of the Great Recession, researchers have proposed several explanations. Nord et al. (2014) state that rising inflation and increased food prices restricted less wealthy families from spending a greater share of their incomes on food. Anderson et al. (2017) find that increases in unemployment duration also played an important role in explaining the persistent high levels of food insecurity among U.S. households.

[4]As of January 2018, 30 states have implemented state-level EITC benefits. These vary in generosity from 3% (Montana) to 85% (California) of the federal credit.

TABLE 1 Earned income tax credit (EITC) parameters (2001 to 2017)

EITC Measures	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Credit rate (%)																	
1 Child	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
2 Children	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
3+ Children	40	40	40	40	40	40	40	40	**45**	**45**	**45**	**45**	**45**	**45**	**45**	**45**	**45**
Min. income for max. credit																	
1 Child	7140	7370	7490	7660	7830	8080	8390	8580	8950	8970	9100	9320	9560	9720	9880	9920	10,000
2 Children	10,020	10,350	10,510	10,750	11,000	11,340	11,790	12,060	12,570	12,590	12,780	13,090	13,430	13,650	13,870	13,930	14,040
3+ Children	10,020	10,350	10,510	10,750	11,000	11,340	11,790	12,060	12,570	12,590	12,780	13,090	13,430	13,650	13,870	13,930	14,040
Maximum credit																	
1 Child	2428	2506	2547	2604	2662	2747	2853	2917	3043	3050	3094	3169	3250	3305	3359	3373	3400
2 Children	4008	4140	4204	4300	4400	4536	4716	4824	5028	5036	5112	5236	5372	5460	5548	5572	5616
3+ Children	4008	4140	4204	4300	4400	4536	4716	4824	**5657**	**5666**	**5751**	**5891**	**6044**	**6143**	**6242**	**6269**	**6318**

Note: Data for the EITC parameters is obtained from the Joint Committee on Taxation and the Internal Revenue Service. The table shows changes in EITC laws for families with a different number of children. The three EITC components shown are credit rates, minimum income to qualify for maximum EITC benefits, and maximum EITC benefits.
The bold values for credit rate and maximum credit reflect the increase in EITC generosity following the expansion.

2.4 | EITC and food insecurity

Expansions of the EITC could influence food insecurity levels of affected households through their impact on employment, income, and poverty levels. Prior work on the EITC has established that expansions of the program lead to increases in labor force participation by providing incentives to work (Bastian & Jones, 2021; Eissa et al., 2008; Eissa & Liebman, 1996; Grogger, 2003; McKeehan, 2018; Meyer & Rosenbaum, 2001). Evaluating all EITC expansion since 1990, Bastian and Jones (2021) find that an increase in maximum EITC benefits by $1000 increases employment by 0.6% points, which corresponds to a participation elasticity of 0.33. By focusing on a period when welfare reform was fully implemented and finding that the 2009 ARRA expansion increased average employment by 1% to 2% points, the authors provide evidence suggesting that similar estimates for the 1990s expansion are not driven by welfare reform. This finding is consistent with results from a recent study by Bastian and Lochner (2022), which also shows that the 2009 EITC expansion increased labor force participation.

In addition to the effects on employment, prior research has established that EITC is a successful policy tool in moving households above the poverty threshold (Hoynes & Patel, 2018; Meyer, 2010; Neumark & Wascher, 2001; Scholz, 1994; Short, 2014). Evaluating the average effect of all EITC expansions between 1990 and 2009, Bastian and Jones (2021) show that an increase in maximum EITC benefits by $1000 increases average annual earnings by $558. The expansion of EITC benefits provides an income boost to eligible families, which could reduce parents' concerns about having enough money to afford food for their children, help families increase their food expenditures (Lenhart, 2019a), and allow them to purchase higher quality food (McGranahan & Schanzenbach, 2013). Consistent with this, previous work has shown that low economic status and unemployment are key determinants of food insecurity (Anderson et al., 2017; Nord, 2009; Nord et al., 2014).

3 | DATA

The data used in the main analysis of this study come from the Food Security Supplement (CPS-FSS), an annual supplement to the current population survey (CPS) that is conducted by the U.S. Census Bureau.[5] The CPS-FSS data are collected every December and consists of detailed information on household-level food security. I use data for the period 2001 to 2017, which provide eight periods before the EITC expansion (2001–2008) and nine after (2009–2017).

The CPS-FSS includes a set of 18 questions on food security, which apply to the respondent's household as a whole. The questions cover whether individuals are concerned about insufficient food budget or food supply, inadequate food quality consumed by household members, and reductions in food intake and its consequences for adults and children. The first 10 questions are related to adult food security status, whereas the last eight questions are related to food security of the children.[6] The full set of questions is shown in the Appendix. Using the number of affirmative responses, the USDA developed a procedure to measure different levels of food insecurity experienced by household in the previous 12 months.[7]

As shown by Bickel et al. (2000), households that provide affirmative answers to at least eight questions are classified as having very low food security, and those with between three to seven affirmative answers are considered to have low food security. In most research and policy discussions, these two categories are combined into one definition of food insecure (Coleman-Jensen et al., 2015; Gundersen & Ziliak, 2015). In the main part of the analysis, I follow this approach and use a

[5]I obtained the data from the Integrated Public Use Microdata Series (IPUMS) website (Flood et al., 2020).
[6]Because all households in the sample have children, I am able to use all 18 questions asked in the CPS-FSS.
[7]Responses of "yes," "often," "sometimes," "almost every month," and "some months but not every month" are coded as affirmative (Bickel et al., 2000).

dichotomous indicator for food insecurity, which includes both low and very low food security (at least three affirmative responses). In alternative specifications, I estimate the effect of the policy on the likelihood of very low household food security as well as on low and very low child food security.[8]

In order to obtain estimates for the "first-stage" effects of the policy change on EITC benefits, I calculate simulated EITC benefits for each household in the sample using the tax simulator program NBER TAXSIM (version 27; for more information, see Feenberg & Coutts, 1993). The program incorporates up to 27 household characteristics, such as wages, marital status, the number of dependent children, and state of residence to provide predicted EITC benefits for each family.[9] Several previous studies have used the TAXSIM program to capture the increases in EITC benefits following policy changes (e.g., Bastian & Lochner 2022; Eissa & Hoynes, 2011; Hoynes et al., 2015; Jones & Michelmore, 2018; Lenhart, 2019a). Work by Jones and Ziliak (2019) shows that predicted benefits obtained using the TAXSIM simulator align more closely with actual EITC payouts reported in IRS recipient files than payments calculated from survey data alone. In addition to predicted EITC benefits, I also use total income after tax and transfers as an alternative outcome variable to evaluate the effect of the policy change on household income. This variable is generated as the sum of reported total household income and predicted household EITC benefits (through TAXSIM).[10]

Finally, to isolate the effect of the EITC from other factors that could have influenced food insecurity during the period of my analysis, I use administrative data from the Quality Control (QC) database for Supplemental Nutrition Assistance Program (SNAP) units to evaluate the effects of the ARRA on SNAP and unemployment benefits. Although the CPS provides data on SNAP participation and SNAP benefits, it has been established that underreporting of SNAP participation in surveys such as the CPS is a significant limitation (e.g., Meyer & Mittag, 2019a; Meyer & Mittag, 2019b; Shantz & Fox, 2018). If underreporting of SNAP benefits in the CPS changed over time or is different across families in the sample, estimates obtained from using CPS data on SNAP might be confounded in my analysis. To account for the role of misreporting on the estimates, I use QC data when examining whether the EITC expansion impacted SNAP participation/benefits as well as unemployment benefits.

3.1 | Sample selection

To examine the relationship between the 2009 EITC expansion and food insecurity, I follow previous work on the EITC and narrow the sample to low-educated individuals with at most a completed high school degree (Averett & Wang, 2013; Evans & Garthwaite, 2014; Hoynes et al., 2015). This approach allows the estimation of intent-to-treat effects for a group that is likely affected by changes to the program. The main analysis of the paper uses individuals with at most a high school degree who have either two or three children in the household. This provides a sample size of 114,465 household-month level observations.[11] In alternative specifications, I use smaller samples, which are likely to be affected by the EITC expansion as well as more likely to suffer from food insecurity—households with reported family incomes of less than $50,000 and individuals with less than a high

[8]As recommended by the USDA, child food insecurity is measured by using the number of affirmative responses to the eight questions that related to the food security of children living in the household (Nord & Bickel, 2002).

[9]The availability of state identifiers in the CPS-FSS allows simulating both federal and state-level EITC benefits. I add the two measures to create a variable showing the total simulated EITC benefits for each household in the sample. Although the CPS data do not provide information on all 27 factors, I have data on household ID, tax year, state, marital status, age of head of household, age of spouse (if available), number of dependents, number of children under 13, number of children under 17, the number of qualifying children, and income. For income, I use the middle point of the family income bands provided in the CPS. TAXSIM factors for which I do not have information for are dividend income, interest received, capital gains/losses, taxable pensions, rent paid, real estate taxes paid, and mortgage deductions. Although this is a limitation of the analysis, I believe that these factors are less important overall than those that are available in the CPS.

[10]The CPS reports total family income in 16 categories, such as $5000 to $7499 and $30,000 to $34,999. To create a continuous measure of total family income, I use the midpoint of each of the two categories. For the highest income category ($150,000 or more), I use $150,000.

[11]The sample represents 58,011 unique households.

school degree. Given that the EITC is designed to reward work, I narrow the sample to working-age individuals between the ages 18 to 65.[12] In additional robustness tests, I include households with one child as well as individuals with at least some college education, two groups that should not have been affected by the 2009 expansion.

3.2 | Descriptive statistics

Table 2 presents descriptive statistics for the low educated individuals with two and three children who form the main sample of the analysis. The statistics show that respondents with two children are on average older, less likely to be married, more likely to be employed, and report higher total family incomes. Variables that show no statistically significant differences between the two groups are the number of adults living in the household, hours worked per week, and part-time employment.[13]

The statistics for EITC benefits confirm that the expansion significantly increased expected payments for families with three children. Following the policy change, the average gap in simulated EITC benefits between the two groups increases from $108.70 to $642.46.[14] Finally, Table 2 shows statistics for the share of household that are food insecure before and after the EITC expansion. It is noticeable that households with three children are more food insecure overall than those with two children. The descriptive statistics for the pre- and post-ARRA periods indicate that the share of three-child households experiencing food insecurity was higher in the years prior to 2009. Compared to the pre-ARRA period, the share of households experiencing food insecurity declined by 1.26% points for this group in post-ARRA years while increasing by 0.48% points among two-child households.[15]

Figures 1 and 2 show changes in EITC income and food insecurity among low-educated households with two and three children. Consistent with Table 2, Figure 1 shows that simulated EITC benefits were very similar for the two groups prior to 2009, while a substantial gap emerged immediately after the expansion of the program. Thus, Figure 1 provides graphical motivation for using the policy change to evaluate the effects of the program on food security. Figure 2 shows that the gap in food insecurity rates between the two groups narrowed in the years after 2008.[16] In addition to these two graphs, the later part of the analysis estimates event study models to evaluate annual treatment effects and examine whether the DD parallel trends assumption is plausible.

4 | ECONOMETRIC METHODS

This study estimates differences-in-differences (DD) models to evaluate the effects of the 2009 EITC expansion on food insecurity. To further test for the robustness of the main results, I also estimate DDD models, a placebo and a falsification test.

[12]Although working grandparents and other relatives above the age of 65 caring for qualifying children living with them can be eligible for EITC benefits, these households are not included in the study. The Internal Revenue Service (2017) points out that these relatives are often not aware that they might be eligible for EITC benefits. Due to the potential low-take up rates among these groups, the study only includes working-age individual between the ages 18 to 65 who are caring for children.

[13]The Section 4.2 discusses the statistically significant differences for some of the observable characteristics in more detail.

[14]All income measures represent 2017 dollars, which are obtained by using the Consumer Price Index—Urban Consumers.

[15]Appendix Table A1 provides descriptive statistics for the high-educated sample, which is used in the DDD analysis. Compared to the changes for the low-educated sample, the (predicted) EITC statistics show much substantially smaller changes in (predicted) EITC benefits for this group.

[16]Appendix Figure A1 confirms this by showing changes in the food insecurity gap between households with three and two children during the sample period.

TABLE 2 Descriptive statistics (2001–2017)

	At most high school sample		
Variable	**Two kids**	**Three kids**	**T-stat difference**
Age	39.55	38.29	**
	(9.88)	(8.53)	
Male	0.4683	0.4565	*
	(0.4990)	(0.4981)	
Married	0.7355	0.7500	**
	(0.4411)	(0.4330)	
No. of adults in HH	1.8642	1.8697	
	(0.4394)	(0.4421)	
White	0.8191	0.8091	*
	(0.3849)	(0.3930)	
Black	0.1022	0.1112	**
	(0.3029)	(0.3144)	
Employed	0.7043	0.6698	***
	(0.4563)	(0.4703)	
Hours worked	39.61	39.59	
	(12.38)	(12.86)	
Part-time employment	0.1523	0.1527	
	(0.3593)	(0.3597)	
Family income	43,593.18	39,896.91	***
	32,190.16)	(30,795.35)	
Annual SNAP benefits	299.18	266.05	***
	(149.71)	(138.87)	
Received any SNAP	0.1976	0.1410	***
	(0.3982)	(0.3481)	
Total simulated EITC			
Pre-ARRA	855.59	964.29	**
	(1263.87)	(1308.71)	
Post-ARRA	1653.04	2295.50	***
	(2030.39)	(2357.58)	
Pre/post difference	797.45	1331.21	
Food insecure			
Pre-ARRA	0.1777	0.2361	***
	(0.3822)	(0.4247)	
Post-ARRA	0.1825	0.2235	***
	(0.3863)	(0.4166)	
Pre/post difference	0.0048	−0.0126	
Observations	78,376	36,089	

Note: Income, earned income tax credit (EITC) and SNAP amounts represent 2017 dollars. The final column shows a formal *t*-test of the difference between the two groups.

Abbreviation: ARRA, American Recovery and Reinvestment Act.

*$p < 0.10$.**$p < 0.05$.***$p < 0.01$.

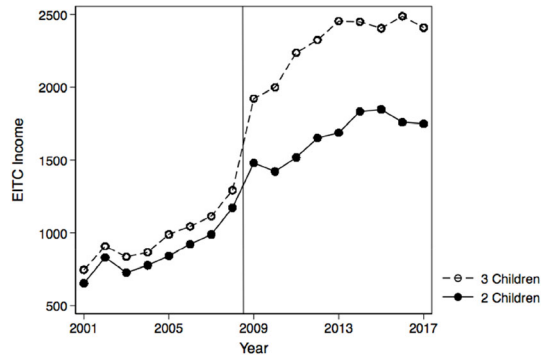

FIGURE 1 Earned income tax credit (EITC) benefits for treatment and control group (2001–2017). Figure 1 includes individuals with either two or three children and at most a high school degree. The graph shows simulated EITC benefits for the two groups, with the benefits measured in 2017 dollars.

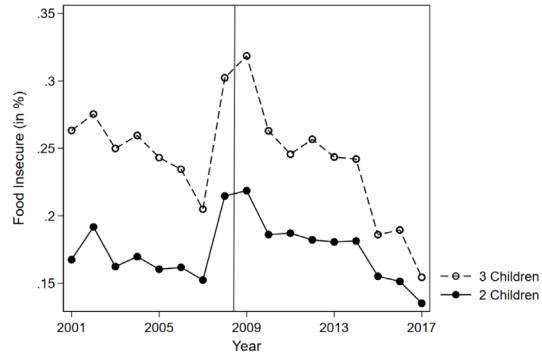

FIGURE 2 Food insecurity rates for treatment and control group (2001–2017). Figure 2 includes individuals with either two or three children and at most a high school degree and shows the share of food insecure households for the two groups.

4.1 | DD models

The nature of the policy change offers the opportunity to use a DD framework to measure the average treatment effects of the expansion. For the main analysis, households with three children form the treatment group, whereas those with two children form the control group. As shown in Table 1, all three EITC parameters (credit rate, minimum income for maximum credit, maximum credit) were identical for the two groups between 2001 and 2008. Following the expansion of the program as part of the ARRA, both credit rates and maximum credits increase significantly for households with three or more children. I exclude households with more than three children from the main part of the analysis because they might differ more from those in the control group. The main DD model estimated in the analysis is shown in the following equation:

$$Y_{ist} = \beta_0 + \beta_1 3\text{KIDS}_{ist} + \beta_2 X_{ist} + \delta_{\text{DD}} \text{POST}_t \times 3\text{KIDS}_{ist} + \beta_3 Z_{st} + \lambda_1 \text{Year}_t + \lambda_2 \text{State}_s + \varepsilon_{ist}, \quad (1)$$

where Y_{ist} is an indicator that equals one if household i living in state s at time t is food insecure, and zero otherwise. In order to evaluate the effects of the policy change on EITC benefits and total income, I also estimate models where Y_{ist} represents the amount of EITC benefits a household is eligible to receive as well as total household income after tax and transfers (both outcomes are based on the TAXSIM simulations).

The variable $3KIDS_{ist}$ equals one if three children live in the household, whereas $POST_t$ is an indicator for the period after the policy change (2009 to 2017). X_{ist} represents a set of baseline covariates, which include age, gender, race, marital status, and completed years of education.[17] The main parameter of interest is δ_{DD}, which captures the effect of the EITC expansion on food insecurity. Furthermore, Z_{st} controls for state-level variations in per capita expenditures on SNAP and Medicaid, which can capture changes in the generosity of two other programs targeting low-income households. Finally, year and state fixed effects are included in the analysis to account for differences in food insecurity rates across time and space. All models are estimated using CPS sampling weights that are provided by IPUMS.[18]

In additional specifications, I include state-specific linear time trends and annual state-level unemployment rates to further account for unobservable characteristics that could be related to changes in food security rates.[19] In line with prior research on the EITC that shows that the expansions in the program differentially affect married and single individuals (e.g., Eissa & Liebman, 1996; Hotz & Scholz, 2003; Meyer, 2010; Meyer & Rosenbaum, 2001), I additionally estimate separate specifications for married and non-married respondents.[20] All models are estimated using ordinary least squares with standard errors clustered at the state level.

4.2 | Threats to identification

The main DD analysis of this study faces several potential limitations and concerns that limit the extent to which the estimates can be interpreted as causal evidence for the effects of the 2009 EITC expansion on food insecurity. This section discusses the various threats to identification and introduces several additional specifications that aim to support the hypothesis that changes in food insecurity are caused by EITC and not by other factors.

Pre-2009 parallel trends

The key identifying assumption for the DD analysis of this study is that the trends in the control group provide an estimate of the trends that would have occurred in the treatment group in the absence of the EITC expansion. Figure 1 shows that pre-ARRA trends in simulated EITC benefits were almost identical for households with two and three children, whereas a clear boost in predicted EITC payments is observable immediate after the expansion of the program. Figure 2 shows trends in food insecurity rates for the two groups used in the DD analysis. Although the pre-2009 trends are comparable in the sense that they move in the same direction and both groups experience a decline in average food insecurity rates between 2002 and 2007, differences in the magnitudes of these changes are noticeable leading to the fact that the trends are not as parallel as in Figure 1. For example, although both groups experience a decline in food insecurity between 2007 and 2008 followed by an increase between 2008 and 2009, these changes are larger among three-child households than for those with two children.

To examine the fact that trends in food insecurity are not fully parallel, I add two specifications to the analysis. First, I estimate event study models to measure annual treatment effects of the policy

[17]Although the analysis is at the household level, individual controls included such as marital status, race, or employment status represent information for the head of the household. This is consistent with previous work examining determinants of low food security using the CPS-FSS data (Anderson et al., 2016).

[18]My analysis uses the food security-specific weights provided by IPUMS.

[19]Following previous research on the EITC and labor supply, I allow the coefficient for unemployment rates to differ between treatment and control groups.

[20]Food security rates have been shown to differ across racial groups and family structure, with food insecurity being more prevalent among racial and ethnic minority groups (Balistreri, 2016; Bartfeld & Dunifon, 2006; Nam et al., 2015; Ribar & Hamrick, 2003; Rose et al., 1998) as well as among single households (Coleman-Jensen et al., 2017). Due to the fact that the sample of Black households with two or three children who answered the CPS-FSS is relatively small, a subgroup analysis by race is not feasible for this study.

change on predicted EITC benefits and food insecurity. In addition to the unconditional trends shown in Figures 1 and 2, these results provide a more detailed overview of prepolicy trends. To estimate the event study models, I augment Equation (1) as below:

$$Y_{ist} = \beta_0 + \beta_1 3\text{KIDS}_{ist} + \beta_2 X_{ist} + \sum_{t=2001}^{2017} \delta_t \text{Year}_t \times 3\text{KIDS}_{\text{ist}} + \lambda_1 Year_t + \lambda_2 \text{State}_s + \varepsilon_{ist}, \quad (2)$$

where the year indicators (Year_t) are interacted with the treatment indicator (3KIDS_{ist}). The excluded reference category is the year prior to the EITC expansion. Second, related to the event study analysis, I estimate four different placebo tests using the pre-ARRA period (2001 to 2008) and artificial EITC expansions between 2004 and 2006. Finding no statistically significant effects for this time period can indirectly test for the presence of parallel trends in the pre-expansion period while also showing that the main results are not spuriously driven by other policies or events that occurred throughout the study period.

The role of other non-EITC factors

In the presence of other factors differentially impacting households forming the treatment and control groups, the DD estimate will be biased. For example, if households with three children recovered more quickly from the Great Recession than two-child households, this could explain any relative improvements in food security levels instead of the expansion of EITC benefits. Another policy change that was introduced as part of the ARRA that poses a threat to identification is the temporary expansion of SNAP benefits, which is discussed in more detail in the next subsection. Although I am not able to directly measure the extent of the potential bias due to events other than the EITC expansion driving changes in differential changes in food insecurity across the two main household types, I conduct two additional analyses to test for the role of non-EITC factors.

First, I estimate a DDD model, which allows taking into account any potential non-EITC related trends in the treatment and the control group by adding households with two and three children who are not likely affected by the EITC expansion as additional comparison groups to the analysis. Depending on the sample used, these groups will either be highly educated individuals or high-income households. Finding that DD and DDD estimates are similar in terms of direction and statistical significance could further support the validity of the DD setup and findings. The addition of DDD models using groups that are not likely impacted by the EITC to the main DD analysis is consistent with previous work examining expansions of the federal EITC (e.g., Averett & Wang, 2013; Evans & Garthwaite, 2014; Lenhart, 2019a). The estimated DDD model is given by:

$$\begin{aligned} Y_{ist} = {} & \beta_0 + \beta_1 3\text{KIDS}_{ist} + \beta_2 \text{LOWED}_{ist} + \beta_3 \text{POST}_t \times 3\text{KIDS}_{ist} + \beta_4 \text{POST}_t \times \text{LOWED}_{ist} + \beta_5 X_{ist} \\ & + \beta_6 \text{LOWED}_{ist} \times 3\text{KIDS}_{ist} + \delta_{\text{DDD}} \text{POST}_t \times \text{LOWED}_{ist} \times 3\text{KIDS}_{ist} + \lambda_1 \text{Year}_t + \lambda_2 \text{State}_s + \varepsilon_{it}, \end{aligned} \quad (3)$$

where LOWED_{ist} is an indicator that equals one if the respondent has at most a high school degree. The main parameter of interest in estimating Equation (3) is δ_{DDD}, whereas all other variables remain the same as in Equation (1).

Second, I exploit the facts that several states have state EITC laws in place on top of the federal credit and that these state credits vary from 3.5% (Louisiana) to 85% (California).[21] As shown in Appendix Table A2, there were 59 state-level EITC changes during the period of this study.

[21]In 2017, 26 states plus Washington DC had a state EITC in place.

Evaluating the effects of changes in state-level EITC generosity on food insecurity provides a second source of EITC variation for the study. For this state-level analysis, I restrict the sample to households with three or more children (the original treatment group) to ensure that the only variation in EITC benefits for these specifications arises from the state-wide policy changes. Finding consistent effects for the expansion of the federal benefit in 2009 and state-level changes that occurred throughout the study period (2001 to 2017) on food insecurity provides additional support that any effects on food insecurity in the main analysis are related to the ARRA expansion of the EITC. To measure the effects of changes in state EITC generosity on food insecurity, I use two EITC indicators. Consistent with previous work (e.g., Lenhart, 2019b; Lenhart, 2021; Markowitz et al., 2017), I split states into three groups—those without any state EITC, those with low state EITC (less than 10% of the federal rate), and those with high state EITCs (at least 10% of the federal rate).[22] Table A2 shows that the 59 policy changes correspond to 24 switches across these three categories.

Other ARRA provisions

In addition to permanent expansion of EITC benefits, the ARRA also included a temporary increase in SNAP benefits, which was implemented simultaneously to the EITC reform. In response to the high rates of unemployment and the rising poverty following the onset of the Great Recession, the ARRA temporary increased maximum monthly SNAP benefits by 13.6% for all eligible households between April 2009 and October 2013, independent of the number of the children.[23] Given that SNAP benefits are based on a households' expected contribution toward buying food, they increase with household size. This implies that, although the percentage increase in SNAP benefits experienced by households with two and three children was the same, families with three children experienced a larger increase. Nord and Prell (2011) show that the ARRA increased maximum monthly SNAP benefits by $80 and $95 for households with four and five people, respectively.[24]

Although I control for state-level per capita SNAP expenditures to capture changes in the program during the time of the study, the simultaneous change in SNAP benefits still poses a threat to the identification to the main DD analysis given that an association between SNAP and food insecurity has been established in previous work (e.g., Nord & Prell, 2011). To further examine the potential role of SNAP, I use administrative QC data to evaluate changes in the share of households with two and three children relative to all SNAP recipients. Finding similar trends over time for this measure across the two groups would indicate that there were no differences in SNAP take up rates over time, which could confound the analysis of this study. Furthermore, I use QC data to show changes in SNAP benefits for the two household types. This will allow me to compare the extent of the relative increase in EITC and SNAP benefits for households with three children following the ARRA. Finally, I estimate several specifications that measure the effects of state-level variations in EITC generosity on food insecurity (more details in Section 5.7).

In addition to altering SNAP and EITC benefits, ARRA also included a temporary change in unemployment benefits (UB) and unemployment insurance (UI). Individuals receiving UB were provided additional support through a temporary weekly supplemental payment (2009 and 2010) and a partial tax exemption for benefit payments received in 2009. ARRA also offered states financial incentives to broaden access to the UI system and increase the generosity of benefits. If these

[22]10% is used as the cutoff as it is the median state EITC during the sample period. Although previous work has used the same cutoff (Lenhart, 2019b; Lenhart, 2021; Markowitz et al., 2017), it should be noted that the results are robust to alternative cutoff points.

[23]It should be noted that the real value of this temporary increase declined over time because the amount was not adjusted for inflation during this time.

[24]It should be noted that, although the EITC amount depends on the number of children, Nord and Prell's (2011) findings refer to the SNAP benefits by total household size.

provisions impacted families with two and three children differently, the results of this study could be confounded by them. Given that UB and UI do not continuously increase by household size like the SNAP program, it seems unlikely that these short-term provisions differentially impacted households in the treatment and the control group of this study. Using SNAP Quality Control data, Figure A2 shows trends in the likelihood of receiving any UB benefits for households with two and three children who are receiving SNAP benefits. The graph indicates that the two groups followed similar trends throughout the study period and that no change in the trends is noticeable after ARRA. Figure A3 shows annual unemployment benefits for the two groups. Although it shows that the increase in UB benefits between 2009 and 2010 was higher for three-child households, the trends for the two groups are very similar for the other years of the study period. Overall, both graphs indicate that ARRA did not differentially impact the likelihood of receiving UB as well as the generosity of benefits across the two household types, which suggests that the ARRA changes related to unemployment income do not confound the results of this study.[25]

Changes to composition of the sample

Although selecting a sample based on education to evaluate the effects of the EITC is an approach that is established in the literature, a potential concern would be if the sample composition is different in the pre- and post-expansion years. This would occur if the policy change influenced observable and unobservable characteristics of individuals in the treatment group or if characteristics changed over time independent from the EITC expansion. I examine this concern in more detail in two ways.

First, I test whether differences in observable characteristics between the two main groups of the study remained similar between the pre- and post-ARRA period. The fact that there are statistically significant statistical differences between the two groups for some of the observed variables (Table 2) is a limitation given that the two groups in DD models should ideally be as similar as possible. Although the main assumption of a DD analysis relies on trends over time rather than differences in levels, it would be concerning if these differences point to changes in unobservable characteristics between the pre- and post-period. Appendix Table A3 shows that the gap between the treatment and the control group remained similar in the pre- and post-ARRA period for variables that show statistically significant differences in Table 2. Combined with the fact that the level differences for these variables are relatively small overall, this supports the hypothesis that changes in unobservable outcomes are not driving the main results.

Second, I re-estimate the main DD analysis several times by replacing food insecurity with various observable characteristics as the outcome variables to specifically test whether the policy change led to changes in the composition of the treatment group. These results are presented in Appendix Table A4. With the exception of one outcome (likelihood of being White), I find small and statistically insignificant effects for all other outcomes. Despite showing that there were no changes in the observable composition of the sample following the EITC expansion, I am not able to rule out that unobservable changes might influence the findings of the study.

5 | RESULTS

This section presents the results of the policy change on both predicted EITC benefits and on the likelihood of households being food insecure.

[25] An assumption underlying this is that trends in unemployment benefits among families with two or three children were similar for households receiving SNAP benefits and for all households.

TABLE 3 The effect of the policy on simulated earned income tax credit (EITC) income (difference-in-differences [DD] models)

	Total simulated EITC		
Samples	**(1)**	**(2)**	**(3)**
Panel A: at most high school degree			
Policy effect	519.73***	495.61***	497.28***
	(29.27)	(27.55)	(27.35)
Baseline mean	$964.29		
N	114,465	114,465	114,465
Panel B: less than $50,000 HH income			
Policy effect	618.47***	607.14***	609.56
	(33.85)	(36.16)	(36.56)
Baseline mean	$1416.12		
N	70,313	70,313	70,313
Panel C: less than high school			
Policy effect	515.64***	490.95***	495.68***
	(38.56)	(35.52)	(34.58)
Baseline mean	$1388.96		
N	32,692	32,692	32,692
Control variables		x	x
State-specific time trends			x

Note: Robust standard errors, clustered by states, are shown in parentheses. The EITC benefits are obtained using the TAXSIM program and are measured in 2017 dollars. The model estimated in Column (1) includes no control variables. The model estimated in Columns (2) controls for age, gender, race, marital status, years of completed education, the number of people living in the household. In addition to these baseline controls, the model estimated in Column (3) also controls for per capita expenditures on Medicaid and SNAP. Furthermore, state and year fixed effects are controlled for in all specifications. Furthermore, all models include sampling weights provided in the IPUMS data set.
*$p < 0.10$. **$p < 0.05$. ***$p < 0.01$.

5.1 | Effects on EITC benefits and after-tax income

Before evaluating whether the policy change is associated with changes in food insecurity, Table 3 provides DD results for the effects of the EITC expansion on predicted EITC benefits. Panel A shows the DD estimates for the sample of individuals with at most a high school degree. In the baseline model with control variables (column 2), I find that, compared to households with two children, the expansion increased annual simulated EITC benefits by $495.61 for households with three children ($p < 0.01$). Compared to the baseline mean, this effect corresponds to an increase in predicted EITC income by 51.4%. Column (3) shows that these results are robust to the inclusion of state-specific linear time trends. Panel B shows that this positive effect on simulated EITC benefits is even larger when using a sample of low-income households. The DD estimate for this sample indicates that the policy change led to a relative increase in predicted EITC benefits of $607.14 ($p < 0.01$). Although the magnitude of this effect is substantially larger, it should be noted that it corresponds to a smaller percentage increase (42.9%) than the estimate in Panel A due to a larger baseline mean for this sample. Finally, Panel C shows that the increase in predicted EITC benefits is similar when using individuals with less than a high school degree compared to the sample that includes those with a completed high school degree (Panel A).

The EITC income estimates are comparable with previous findings on the effects of the ARRA expansion on EITC benefits. Meyer (2010) shows that the policy change increased benefits received by single, working mothers by about $515 on average, whereas Mattingly (2009) finds an increase of $514 for eligible married couples with three or more children.

TABLE 4 The effect of the policy on after-tax income (difference-in-differences [DD] models)

	After tax/transfer income		
Samples	**(1)**	**(2)**	**(3)**
Panel A: at most high school degree			
Policy effect	901.97***	1081.41***	1016.64***
	(263.51)	(258.15)	(261.33)
Baseline mean	$34,723.87		
N	114,465	114,465	114,465
Panel B: less than $50,000 HH income			
Policy effect	957.79***	1096.92***	1042.58***
	(199.79)	(193.35)	(195.82)
Baseline mean	$21,907.56		
N	70,313	70,313	70,313
Panel C: less than high school			
Policy effect	745.14**	951.52**	887.13**
	(385.99)	(383.89)	(384.74)
Baseline mean	$26,570.40		
N	32,692	32,692	32,692
Control variables		x	x
State-specific time trends			x

Note: Robust standard errors, clustered by states, are shown in parentheses. Income represents predicted income after tax and transfers based on the TAXSIM program and is measured in 2017 dollars. The models in Columns (2) and (3) control for age, gender, race, marital status, years of completed education, the number of people living in the household, as well as per capita expenditures on Medicaid and SNAP. Furthermore, state and year fixed effects are controlled for in all specifications. Furthermore, all models include sampling weights provided in the IPUMS data set.
*$p < 0.10$. **$p < 0.05$. ***$p < 0.01$.

Table 4 presents the effects of the policy change on total household income after tax and transfers. In the main DD specification for sample of individuals with at most a high school degree, I find that the EITC expansion increased total after-tax income by $1081.41 ($p < 0.01$) for families with three children compared to those with two children. Given that the after-tax income measure is the sum of reported household income and predicted EITC benefits, the fact that this effect is $585.80 larger than the corresponding EITC income estimate in Table 3 suggests that individuals in the treatment group altered their employment status following the policy change. This is consistent with recent findings in the literature showing that, compared to households with fewer children, the 2009 EITC expansion increased labor force participation among households with three children (Bastian & Jones, 2021; Bastian & Lochner, 2022). The DD estimates for the other two samples in Panel B and C are consistent indicating that the increase in after-tax income is larger than the increase in predicted EITC benefits.

5.2 | Effects on food insecurity

Table 5 presents estimates for the effects of these EITC increases on food insecurity. Using the sample of individuals with at most a high school degree, I find that the expansion is associated with a reduction in the likelihood of three-child households being food insecure by 1.92% points ($p < 0.05$) compared to households with two children. This corresponds to an 8.1% reduction compared to the baseline mean. To put this effect in perspective with respect to the effects on

TABLE 5 The effect of the policy on food security (difference-in-differences [DD] models)

	Food insecure		
Samples	**(1)**	**(2)**	**(3)**
Panel A: at most high school degree			
Policy effect	−0.0181**	−0.0192**	−0.0174**
	(0.0085)	(0.0078)	(0.0079)
Baseline mean	0.2361		
N	114,465	114,465	114,465
Panel B: less than $50,000 HH income			
Policy effect	−0.0294***	−0.0281***	−0.0255***
	(0.0104)	(0.0102)	(0.0102)
Baseline mean	0.3092		
N	70,313	70,313	70,313
Panel C: less than high school			
Policy effect	−0.0282**	−0.0283**	−0.0262*
	(0.0139)	(0.0144)	(0.0146)
Baseline mean	0.3046		
N	32,692	32,692	32,692
Control variables		x	x
State-specific time trends			x

Note: Robust standard errors, clustered by states, are shown in parentheses. The models in Columns (2) and (3) control for age, gender, race, marital status, years of completed education, the number of people living in the household, as well as per capita expenditures on Medicaid and SNAP. Furthermore, state and year fixed effects are controlled for in all specifications. Furthermore, all models include sampling weights provided in the IPUMS data set.
*$p < 0.10$. **$p < 0.05$. ***$p < 0.01$.

after-tax income shown in the previous section, my results suggest that a $100 increase in after-tax income is associated with a reduction in food insecurity by 0.75% among low-educated households with children.

Panels B and C show that the estimated reductions in food insecurity are substantially larger for the alternative two samples. I find that, compared to households with two children, the EITC expansion is associated with a reduction in the likelihood of households with three children experiencing food insecurity by 2.81 ($p < 0.01$) and 2.83 ($p < 0.05$) percentage points for the low-income and the very low education sample, respectively. These larger estimates are consistent with the fact that these two samples are more likely to be impacted by the policy change and were, on average, also more likely to be food insecure prior to 2009. Although the magnitude of the DD estimates in Panel B and C is much larger than the main estimate in Panel A, it should be noted that the estimated effects are only slightly larger in comparison to the baseline means (9.1 and 9.3% compared to 8.1%). Overall, the intent-to-treat estimates shown in Table 5 show that higher EITC benefits improve food security levels of affected families.

Appendix Table A5 shows the effects of the expansion on three alternative measures of food insecurity.[26] The estimates in Panel A indicate that the policy did not significantly impact the likelihood of households having very low food security (at least eight affirmative responses). Similarly, Panels B and C show that the policy did not impact the food insecurity of children. Although the small baseline means for these three outcomes could be a potential

[26]Although this table only shows estimates for the sample of individuals with at most a high school degree, the results remain similar when using the alternative two samples used in Tables 3–6.

TABLE 6 The effect of the policy on simulated EITC income, after-tax income and food security (difference-in-difference-in-differences [DDD] models).

Samples	Total simulated EITC (1)	After tax/transfers income (2)	Food insecure (3)
Panel A: at most high school degree			
Policy effect	359.13***	914.50	−0.0175**
	(35.35)	(682.04)	(0.0071)
Baseline mean	$964.29	$34,723.87	0.2361
N	291,961	291,961	291,961
Panel B: less than $50,000 HH income			
Policy effect	606.19***	1014.11**	−0.0203**
	(27.48)	(509.01)	(0.0102)
Baseline mean	$1416.12	$21,907.56	0.3092
N	247,809	247,809	247,809
Panel C: less than high school			
Policy effect	293.38***	1758.04**	−0.0300
	(44.16)	(692.16)	(0.0187)
Baseline mean	$1388.96	$26,570.40	0.3046
N	210,188	210,188	210,188
Control variables	x	x	x

Note: Robust standard errors, clustered by states, are shown in parentheses. All specifications control for age, gender, race, marital status, years of completed education, the number of people living in the household, as well as per capita expenditures on Medicaid and SNAP. Furthermore, state and year fixed effects are controlled for in all specifications. Furthermore, all models include sampling weights provided in the IPUMS data set. * $p < 0.10$.
$p < 0.05$.*$p < 0.01$.

explanation for the small and statistically insignificant effects, the results suggest that the policy change is associated with improvements in food security among adults living in affected households. In an additional specification, I use the number of affirmative responses to all 18 food insecurity questions as a continuous outcome variable. Consistent with the main results, I find that the EITC expansion is associated with a relative reduction in the number of affirmative responses by 0.09 ($p < 0.10$) for household with three children, which corresponds to a 6.40% change.[27]

5.3 | DDD results

Table 6 presents DDD results obtained from estimating Equation (2) for the three samples used in the study. Overall, the DDD estimates are consistent with the main DD results shown in Tables 3–5. This suggests that the previously observed impacts of the EITC expansion on predicted EITC benefits, after-tax income, and food security remain when accounting for potentially different trends for these outcomes between households with two and three children by including additional comparison groups that should not be affected by the policy change (higher education and income). Although some of the DDD estimates are smaller in magnitude than the corresponding DD effects, all estimates confirm the results from Tables 3–5.

[27]The estimates for the continuous food security measure are not shown in the paper but are available upon request.

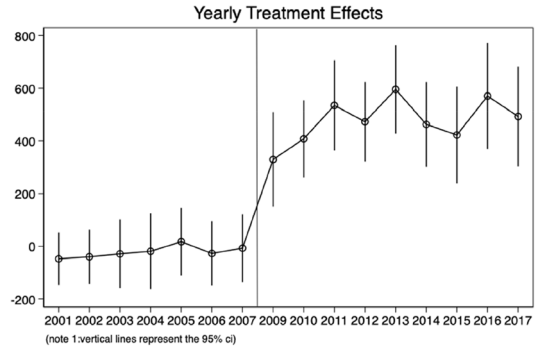

FIGURE 3 Event study results (real annual EITC benefits, at most high school sample). Figure 3 provides annual treatment effects on EITC benefits obtained from estimating Equation (3). 2008 is the excluded time period.

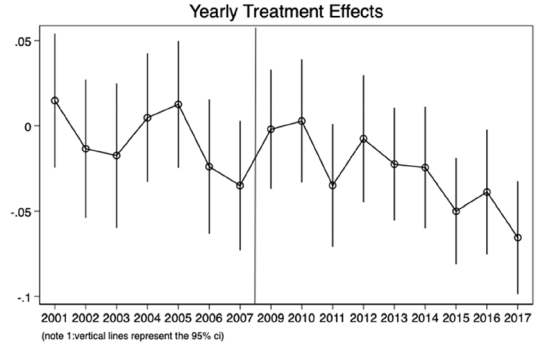

FIGURE 4 Event study results (food insecurity, at most high school sample). Figure 4 provides annual treatment effects on the likelihood of being food insecure obtained from estimating Equation (3). 2008 is the excluded time period.

5.4 | Event study results

The event study estimates for predicted EITC income and food insecurity for the sample of individuals with at most a high school degree are presented graphically in Figures 3 and 4, respectively, whereas the annual treatment effects are shown in Table 7. Figure 3 shows that there are no differential pre-2009 trends in predicted EITC income across families with two and three children. Although I find no statistically significant differences in simulated EITC benefits between the two groups in the years up to 2008, all annual treatment effects between 2009 and 2017 following the EITC expansion are large and statistically significant ($p < 0.01$). The event study estimates for food insecurity show that one of the seven pre-policy estimates indicates a statistically significant difference between the two groups (2007, $p < 0.10$), whereas four of the nine post-expansion estimates indicate statistically significant reductions in food insecurity for the treatment group ($p < 0.05$ and $p < 0.01$). Appendix Figures A6 and A7 show event study estimates from the low-income sample for simulated EITC benefits and food insecurity, respectively. Consistent with the DD results shown in Table 3, I find larger effects on simulated total EITC for this sample (Figure A6), and this increase in predicted benefits is again observable immediately after the policy change. For the event study analysis on food

TABLE 7 Event study results (at most high school degree sample)

Annual Treatment Effects	Total simulated EITC	Food insecure
Treat*2001	−47.57	0.0148
	(49.64)	(0.0196)
Treat*2002	−39.80	−0.0135
	(51.50)	(0.0202)
Treat*2003	−28.75	−0.0175
	(65.11)	(0.0211)
Treat*2004	−18.88	−0.0046
	(71.89)	(0.0188)
Treat*2005	17.50	−0.0126
	(63.67)	(0.0185)
Treat*2006	−27.28	−0.0239
	(60.60)	(0.0196)
Treat*2007	−6.89	−0.0351*
	(64.15)	(0.0189)
Treat*2009	329.39***	−0.0021
	(89.42)	(0.0174)
Treat*2010	407.96***	0.0028
	(72.77)	(0.0180)
Treat*2011	534.72***	−0.0350**
	(85.06)	(0.0176)
Treat*2012	472.64***	−0.0077
	(75.11)	(0.0185)
Treat*2013	595.50***	−0.0225
	(83.61)	(0.0165)
Treat*2014	462.66***	−0.0245
	(80.03)	(0.0177)
Treat*2015	422.42***	−0.0501***
	(91.26)	(0.0155)
Treat*2016	570.28***	−0.0389**
	(100.27)	(0.0182)
Treat*2017	492.63***	−0.0656***
	(94.14)	(0.0165)
Control variables	x	x
Observations	114,465	114,465

Note: Robust standard errors, clustered by states, are shown in parentheses. Earned income tax credit (EITC) income is measured in 2017 dollars. All models control for age, gender, race, marital status, years of completed education, the number of people living in the household, as well as per capita expenditures on Medicaid and SNAP. Furthermore, state and year fixed effects are controlled for in all specifications. Furthermore, all models include sampling weights provided in the IPUMS data set. The excluded time period is 2008.
*$p < 0.10$.**$p < 0.05$.***$p < 0.01$.

security using the low-income sample (Table A6), I find that six of the nine annual treatment effects between 2009 and 2017 show statistically significant reductions in the likelihood of experiencing food insecurity.[28]

[28]Appendix Table A7 presents DD and DDD estimates from the placebo analysis using the years 2001 to 2008 as well as an artificial policy change in 2005. For both simulated EITC income and food insecurity, I find small and statistically insignificant effects in all specifications, which is consistent with the event study estimates shown in Table 7. Appendix Table A8 presents DD and DDD effects for three alternative placebo tests with artificial policy changes in 2004 and 2006. Out of the 12 estimates, two EITC effects and one food insecurity estimate are statistically significant, whereas all other results show small and imprecisely estimated effects.

It is noticeable that the food insecurity effects become larger and statistically significant only several years after the expansion in 2009. A possible explanation for this is that changes in employment are a pathway through which the EITC expansion reduces food insecurity. It might take some time after the policy change before individuals find work, as shown in recent work by Miller et al. (2018). Although the prior EITC literature focused on evaluating contemporaneous effects of expansions to the program, four recent studies provide evidence that exposure to higher EITC benefits over a longer period has significant positive effects on employment and earnings (Bastian & Michelmore, 2018; Neumark & Shirley, 2020), as well on physical health (Braga et al., 2020; Jones et al., 2022).

Third, average after tax/transfer income among households with three children used in the analysis is $34,724 during the pre-ARRA period. According to U.S. Department of Health and Human Services (2009), the poverty line for a five-person household was $25,790, which implies that, compared to the 2009 threshold, families in the treatment group were earning 135% of the federal poverty line.[29] The National Center for Children in Poverty (2012) states that, on average, families need an income equal to about two times the federal poverty level to meet their most basic needs, and that families below this level are referred to as low income. Thus, despite receiving a substantial income boost through the expansion of the EITC, most treated families were likely not financially secure immediately following the policy change. It might be the case that receiving the increased EITC benefits for several years allows families to feel more financially secure.

5.5 | Effects on SNAP benefits

Whereas the previous analysis indicates that the EITC expansion are associated with reductions in food insecurity, it does not rule out the fact that other non-EITC factors might also play a role. To isolate the effects of the EITC, I use administrative QC data provided by the USDA and examine the effects of ARRA on SNAP participation and SNAP benefits. First, I evaluate trends in the share of SNAP households with two and three children relative to all SNAP recipients with children between 2001 and 2017 to check whether the two household types experienced different participation changes during the study period. Appendix Figure A4 shows that participation rates were almost unchanged for both household types during this period (at around 32% and 18%–19% for households with two and three children, respectively). Next, I examine changes in average real SNAP benefits over time. Although Figure A5 shows that average annual benefits increased for both household types during the study period, it is noticeable that the gap in benefits widened following ARRA between 2009 and 2013. This is consistent with the fact that the temporary SNAP expansion, which expired in 2013, had a larger effect on households with more children (Nord & Prell, 2011). Appendix Table A9 shows that the gap in average annual SNAP benefits between households with two and three children increased from $668.04 in the pre-ARRA years to $1170.96 in the post-ARRA period, which corresponds to a widening of the gap by $502.92.[30]

Given that the SNAP program is designed to provide nutritional assistance, the temporary relative increase in SNAP benefits for eligible three-child households between 2009 and 2013 compared to those with two children could confound the estimates for the association between the EITC expansion and food insecurity. Although the delayed reductions in food insecurity observed in the event study analysis (Figures 4 and A7, Tables 7 and A6) combined with recent evidence in the literature showing that exposure to higher EITC benefits has long-term effects on employment, income, and well-being (Bastian & Michelmore, 2018; Braga et al., 2020; Jones et al., 2022;

[29]For a four-person household, the poverty line was $22,050 in 2009.

[30]Although it is possible that more this relative increase was larger for certain more disadvantaged groups of the population, I find the same increase when restricting the QC data to single mothers with two or three children.

TABLE 8 Effects by marital status: Households with two versus three children

	Total simulated EITC		Food insecure	
Analysis	Married (1)	Non-married (2)	Married (3)	Non-married (4)
Panel A: DD analysis				
DD effect	520.49***	408.80***	−0.0173*	−0.0258**
	(33.79)	(59.07)	(0.0092)	(0.0118)
Baseline mean	$846.92	$1358.37	0.2025	0.3491
N	84,659	29,737	84,659	29,737
Panel B: DDD analysis				
DDD effect	410.10***	143.56*	−0.0113	−0.0421**
	(41.81)	(76.60)	(0.0090)	(0.0180)
Baseline mean	$846.92	$1358.37	0.2025	0.3491
N	235,585	56,109	235,585	56,109
Control variables	x	x	x	x

Note: Robust standard errors, clustered by states, are shown in parentheses. Earned income tax credit (EITC) income is measured in 2017 dollars. All models control for age, gender, race, years of completed education, the number of people living in the household as well as per capita expenditures on Medicaid and SNAP. Furthermore, state and year fixed effects are controlled for in all specifications. Furthermore, all models include sampling weights provided in the IPUMS data set.
*$p < 0.10$.**$p < 0.05$.***$p < 0.01$.

Neumark & Shirley, 2020) supports the role of the EITC expansion, I am not able to fully rule out that the effects are the result of a combination of both EITC and SNAP expansions.

5.6 | Effects by marital status

Table 8 provides results obtained when separately estimating DD and DDD models for married and non-married individuals. The results show that, compared to households with two children, married individuals in households with three children receive a larger increase in simulated EITC benefits than those who are unmarried. When examining the impact on food insecurity, I find that the EITC expansion is associated with a larger relative reduction in food insecurity among non-married individuals with three children. Due to a substantially higher level of food insecurity among unmarried families with three children, it should be noted that the DD estimates represent a larger percent change for married (8.5%) than unmarried (7.4%) households. These differential impacts across marital status are further emphasized by Appendix Table A10, which shows that the effects of the policy change on after-tax income is substantially larger among unmarried people.[31] This finding is consistent with recent work by Neumark and Shirley (2020), who show that more generous EITC benefits lead to substantially larger long-run increases in earnings among unmarried mothers. The results for after-tax income and food insecurity among unmarried individuals indicate that employment and poverty are potential mechanisms explaining how the EITC expansion is associated with food security. Findings in the EITC literature have established that increases in the program have

[31]Table A11 furthermore shows the effects of the policy on predicted EITC benefits and food insecurity among non-married individuals by gender. The results indicate that improvements in food security were experienced by both non-married men and women. A limitation of this analysis is the relatively small sample size, especially for men. In additional specifications, I also separate the non-married sample between households with one and two adults. I find that the EITC expansion reduced the likelihood of food insecurity by 2.62 and 2.55 percentage points for these two groups, respectively. Although the estimate for one-adult households is statistically significant at the 5% level, the two-adult result is imprecisely estimated. One limitation of the two-adult analysis is the relatively small sample size.

TABLE 9 Effects of state-level EITC generosity on simulated EITC income and food insecurity (difference-in-difference [DD] models, three-child households)

	Total simulated EITC		Food insecure	
Samples	**(1)**	**(2)**	**(3)**	**(4)**
Panel A: at most high school degree				
(control: no EITC)				
Low EITC	27.08	44.25	−0.0106	−0.0138
	(99.54)	(92.91)	(0.0133)	(0.0129)
High EITC	172.11**	156.72*	−0.0224*	−0.0208
	(73.09)	(92.35)	(0.0125)	(0.0132)
Baseline mean	$1861.31	$1861.31	0.2294	0.2294
N	36,038	36,038	36,038	36,038
Panel B: less than $50,000 HH income				
(control: no EITC)				
Low EITC	61.29	84.86	−0.0265	−0.0326*
	(96.45)	(100.52)	(0.0163)	(0.0181)
High EITC	329.52***	327.40***	−0.0402**	−0.0448**
	(95.23)	(117.12)	(0.0168)	(0.0193)
Baseline mean	$2538.81	$2538.81	0.3024	0.3024
N	23,675	23,675	23,675	23,675
Control variables	x	x	x	x
State-specific time trends		x		x

Note: Robust standard errors, clustered by states, are shown in parentheses. Low earned income tax credit (EITC) is defined as a state-level EITC rate between 0 and 10% of the federal EITC rate, whereas High EITC is defined as a state-level EITC rate of at least 10% of the federal rate. The EITC benefits are measured in 2017 dollars. All models control for age, gender, race, marital status, years of completed education, the number of people living in the household, as well as per capita expenditures on Medicaid and SNAP. Furthermore, state and year fixed effects are controlled for in all specifications. Furthermore, all models include sampling weights provided in the IPUMS data set.
*$p < 0.10$.**$p < 0.05$.***$p < 0.01$.

stronger effects on employment and poverty outcomes among single households (e.g., Eissa & Liebman, 1996; Hotz & Scholz, 2003; Meyer, 2010; Meyer & Rosenbaum, 2001).

5.7 | Robustness checks

To account for potential differences across individuals in the original treatment and control groups, I also estimate several specifications that exploit the fact that there were 59 changes in state-level EITC benefits. These specification test whether increases in the generosity of state EITC laws affect both predicted EITC benefits and food insecurity. The estimates for the state-level level analysis are presented in Table 9 for the sample of individuals with at most a high school degree (Panel A) and for the low-income sample (Panel B).

The estimates in Column (1) show that, compared to households living in states with no state-level EITC laws, living in states with high EITC laws (at least 10% of federal credit) is associated with an increase of predicted benefits of $172.11 ($p < 0.05$) and 329.52 ($p < 0.01$) for the low-education and low-income sample, respectively. Although showing that state EITC policies increase the benefits received by households, it should be noted that these effects are substantially lower than the EITC results for the federal expansion (Table 3).

TABLE 10 Falsification test: Households with one versus two children

	Total simulated EITC		Food insecure	
Analysis	**(1)**	**(2)**	**(3)**	**(4)**
Panel A: DD model				
Policy effect	−325.30***	−325.70***	0.0036	0.0033
	(19.34)	(19.50)	(0.0052)	(0.0052)
Baseline mean	$509.69		0.1673	
N	174,810	174,810	174,810	174,810
Panel B: DDD model				
Policy effect	−231.68***	−229.57***	−0.0008	−0.0009
	(18.41)	(18.32)	(0.0050)	(0.0050)
Baseline mean	$509.69		0.1673	
N	435,829	435,829	435,829	435,829
Control variables	x	x	x	x
State-specific time trends		x		x

Note: Robust standard errors, clustered by states, are shown in parentheses. Earned income tax credit (EITC) income is measured in 2017 dollars. All models include a set of control variables, which include age, gender, race, marital status, years of completed education, the number of people living in the household as well as per capita expenditures on Medicaid and SNAP. In addition to these control variable, the models estimated in Columns (2) and (4) also include state-specific time trends. Furthermore, state and year fixed effects are controlled for in all specifications. Finally, all models include sampling weights provided in the IPUMS data set.
***$p < 0.01$.

Columns 3 and 4 present the food insecurity results in Table 9. The estimates provide evidence that more generous state EITC laws are associated with reductions in the likelihood of households suffering from food insecurity. Compared to families in states with no state EITC laws, those living in states with high EITC policies are 2.24% points (low-education sample, $p < 0.10$) and 4.02% points (low-income sample, $p < 0.05$) less likely to be food insecure. These estimates correspond to reductions in food insecurity of 9.8% and 13.3% for households with three children.

The results in Table 9 again indicate that higher EITC benefits are associated with reductions food insecurity and thus support the fact that the main results of this study are not driven by other differences across states or across the treatment and control group of the analysis. The fact that the estimates for both predicted EITC benefits and food security are larger when using the low-income sample is consistent with the results in Tables 3 and 5 and consistent with the fact that this sample is likely impacted more by the EITC expansion.

Table 10 shows DD and DDD estimates obtained from a falsification test that compares outcomes between households with one child (treatment group) and two children (control group). Consistent with the fact that simulated EITC benefits for households with one child increased by less than those with two children (Table 2), I find small but statistically significant declines in predicted EITC income in this specification. These effects are significantly smaller than the EITC estimates in the main analysis (two vs. three children). Table 10 shows that there were no differential changes in food insecurity rates between the two groups, indicated by small and statistically insignificant food insecurity estimates.

6 | DISCUSSION AND CONCLUSIONS

The findings of this study advance the understanding of how the EITC affects societal well-being. The tax credit has become the most important cash transfer program in the U.S. and has been shown to lift families above the poverty threshold. I find that the 2009 expansion of the program increased

predicted EITC benefits and after-tax income for households with three children by $496 and $1081, respectively, while also being associated with a reduction in the likelihood of households suffering from food insecurity by 8.1%. The decline in food insecurity is shown to be larger for non-married individuals, who have been shown to be affected the most by expansions of the program (e.g., Eissa & Liebman, 1996; Hotz & Scholz, 2003; Meyer, 2010; Meyer & Rosenbaum, 2001). Given the established link between food insecurity and health outcomes (Carter et al., 2011; Gundersen & Kreider, 2009; Gundersen & Ziliak, 2015; Jones, 2017; Reis, 2012), my findings indicate that food insecurity might be one of several potential explanations underlying the link between EITC expansions and improved health outcomes. My findings are consistent with results from previous work showing that the EITC increases household food expenditures (Lenhart, 2019a) and increases spending on healthier food products (McGranahan & Schanzenbach, 2013).

My estimates suggest that a $100 increase in after-tax income reduces food insecurity of 0.75%. This result is consistent with prior findings on the determinants of food insecurity. Bartfeld and Dunifon (2006) estimate that a $100 increase in wages per job reduces food insecurity by 0.34% among households with children in the United States. A likely explanation for the lower estimate in their study is that the authors do not restrict the sample to low-educated individuals. Using Canadian data, Loopstra and Tarasuk (2013) find that a $2000 increase in income and a gain of employment reduces the number of affirmative responses to the same set of food security questions used in my study by 0.29 and 1.33, respectively. Previous findings by Leete and Bania (2010) suggest that negative income shocks have larger effects on food security than positive ones. Examining households at or below 200% of the poverty level, the authors find that a negative income shock of around $500 increases a household's probability of food insufficiency by 20%.

The majority of eligible households receive their EITC benefits in the form of tax refunds in the early part of the year (Goodman-Bacon & McGranahan, 2008). Consistent with this, recent work by Jones and Michelmore (2019) shows that EITC benefits reduce debt holdings by at least 60% during tax season while having only limited effects on savings behavior throughout the year. Given that the CPS food security questions are asked in December, the observed effects might be attenuated and not reflect the true impact of increasing EITC benefits on food security. Future work should examine whether the program leads to even larger immediate reductions in food insecurity than those found in my study.

The Great Recession imposes a threat to both the internal and the external validity of the findings presented in this study. SNAP benefits were temporarily increased after the start of the Great Recession as part of ARRA. Despite the facts that these increases occurred for all eligible households (with any number of children), changes in SNAP benefits could still explain the findings of the study to some extent. Future research should attempt to improve the understanding of the interactive effects of SNAP and EITC benefits on food insecurity to guide policymakers in reducing the number of households struggling to purchase enough high-quality food.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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