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Improving population health by reducing poverty: New York's Earned Income Tax Credit

Jeannette Wicks-Lim[a,*], Peter S. Arno[b]

[a] Political Economy Research Institute, University of Massachusetts, Amherst, United States
[b] Political Economy Research Institute, University of Massachusetts, Amherst, National Academy of Social Insurance, Washington D.C., United States

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ABSTRACT

Despite the established relationship between adverse health outcomes and low socioeconomic status, researchers rarely test the link between health improvements and poverty-alleviating economic policies. New research, however, links individual-level health improvements to the Earned Income Tax Credit (EITC), a broad-based income support policy. We build on these findings by examining whether the EITC has ecological, neighborhood-level health effects. We use a difference-in-difference analysis to measure child health outcomes in 90 low- and middle- income neighborhoods before and after the expansion of New York State and New York City's EITC policy between 1997-2010. Our study takes advantage of the relatively exogenous source of income variation supplied by the EITC—legislative changes to EITC policy parameters. This feature minimizes the endogeneity problem in studying the relationship between income and health. Our estimates link a 15-percentage-point increase in EITC benefit rates to a 0.45 percentage-point reduction in the low birthweight rate. We do not observe any measurable link between EITC benefits and prenatal health or asthma-related pediatric hospitalization. The magnitude of the EITC's impact on low birthweight rates suggests ecological effects, and an additional channel through which anti-poverty measures can serve as public health interventions.

1. Introduction

A well-established literature exists describing the relationship between low socioeconomic status and higher levels of morbidity and mortality in the United States (Chetty et al., 2016; Adler & Rehkopf, 2008; Muennig, Franks, Jia, Lubetkin & Gold, 2005; Braveman et al., 2005; Lantz, House, Lepkowski, Williams, Mero & Chen, 1998; Pappas, Queen, Hadden & Fisher, 1993).[1] Despite such health disparities, researchers rarely test the link between health improvements and anti-poverty policies (Bhatia, 2014; Rigby, 2013; Auspos et al., 2000; Bos, Huston, Granger, Duncan, Brock & McLoyd, 1999; Connor et al. 1999).

The EITC, one of the federal government's largest anti-poverty programs, has been a recent exception. Research has begun to link improved income resulting from EITC benefits to improved health outcomes (Baughman & Duchovny, 2016; Muennig, Mohit, Wu, Jia & Rosen, 2016; Hoynes, Miller and Simon, 2015; Evans & Garthwaite, 2014; Larrimore, 2011; Strully et al., 2010; Arno, Sohler, Viola & Schechter, 2009). This study adds a new dimension by examining the EITC's ecological health impact. Specifically, we examine whether EITC benefits impact health outcomes across a geographic unit—the neighborhood—distinctive from the individual or household level.

The paper is organized as follows: Section 2 situates our study within the existing research. Section 3 describes our data and methodology. Section 4 presents our results and Section 5 discusses their implications. Section 6 concludes.

2. Related literature

2.1. EITC's Impact on Health

Studies that examine the link between EITC benefits and individual-level health outcomes generally find a positive relationship (Baughman & Duchovny, 2016; Hamad & Rehkopf, 2015; Hoynes, Miller and Simon 2015; Evans & Garthwaite 2014; Rehkopf et al. 2014; Strully et al. 2010).[2] These studies typically use policy parameter changes to identify the EITC's individual-level impact on health outcomes such as biomarkers of physical and

* Corresponding author. 418 N. Pleasant St., Amherst, MA 01002, USA.
E-mail address: wickslim@peri.umass.edu (J. Wicks-Lim).

[1] Findings on the relationship between health and income have been inconsistent in countries besides the U.S. Studies with U.K. children found positive and significant to no income affects on health (Apouey and Geoffard, 2013; Case et al. 2008; Propper et al., 2007; Currie et al. 2007).

[2] Bruckner et al. (2013), in contrast, finds increased EITC benefits linked to lower birthweights.

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mental stress, low birthweight rates and parents' self-reported health status of children.

A key advantage to studying the relationship between the EITC and health outcomes is that legislated EITC policy parameter changes cause income to vary independently of individuals' health status. Therefore, changes in health outcomes linked to changes in policy parameters can reasonably be assumed to occur *in response to* changes in income rather than the reverse.

2.2. Neighborhood effects: an ecological approach

None of the studies that examine the link between EITC and health investigate the potential role of ecological effects. That is, do EITC benefits impact the context, or ecology, of a neighborhood and thereby the health outcomes of neighborhood residents generally? In this section we consider how the concentrated infusion of EITC benefits into a low-income neighborhood could improve the economic, physical and/or social environment and, consequently, health outcomes neighborhood-wide.

2.2.1. The role of concentrated poverty

During 2006-2010, half of the country's poor lived in what the U.S. Census Bureau defines as "Areas of Poverty"—neighborhoods with a poverty rate of at least 20%. Poor households in high poverty areas are poor *and* live in neighborhoods that "lack the infrastructure to lead a healthy life," (Macintyre & Ellaway 2003, p. 34). Conditions in high poverty areas—such as limited access to jobs, few neighborhood amenities like well-maintained parks, frequent exposure to crime—induce stress and increase health risks for all households there regardless of individual circumstances (Jacob et al., 2013; Kneebone & Berube, 2008; Leventhal & Brooks-Gunn, 2003). Thus, to the extent that improved average household income lowers the level of concentrated poverty, it should improve health neighborhood-wide.

Health also improves significantly with movement up the income ladder from low to average levels, with diminishing returns to health from income gains at higher incomes, i.e., the income-gradient in health outcomes is non-linear (Robert & House, 2000). Given the "double-jeopardy" of being poor in high poverty areas, the impact of income on health may be greatest among households in areas of concentrated poverty. Past studies of how the EITC affects health have not accounted for this spatial dimension of poverty.

2.2.2. Multiplier effects

Due to the geographic clustering of poor households, poor *neighborhoods* receive relatively large cash injections from the EITC program. These cash injections have greater potential impact in the context of the less prosperous local economies of low-income neighborhoods compared to middle-income neighborhoods. For example, during 2005-2007, annual EITC benefits equaled about 4% of the average annual household income level in impoverished NYC neighborhoods. This compares to 1% among middle-class neighborhoods.[3]

The geographic concentration of EITC benefits in poor neighborhoods can cause EITC benefits to produce what economists refer to as a "multiplier effect." The multiplier effect refers to how an injection of income can spur new local economic activity that, in the end, generates greater income than the initial injection. This occurs, for example, when EITC recipients spend their EITC dollars at neighborhood businesses. These EITC dollars then go into the paychecks of those businesses' workers who, in turn, spend their earnings at other businesses (and thus, their dollars go into the paychecks of those businesses' workers and so on), generating new rounds of increased spending. Thus, through the multiplier effect, EITC benefits can measurably improve the overall economic environment in low-income neighborhoods, not just the lives of EITC recipients.[4]

Multiplier effects have been estimated for Nashville, Tennessee; Baltimore, Maryland; and San Antonio, Texas: every $1.00 increase in EITC benefits generates $1.07, $1.44, and $1.58, worth of economic activity, respectively (Haskell, 2006; Jacob France Institute, 2004; Texas Perspectives, Inc., 2003).

2.2.3. Social networks and social capital

Research on low-income families' household budgets finds that they frequently rely on modest, reciprocal financial gifts and loans to cover their budget shortfalls.[5] As a result, raising the income among a subset of households in a low-income neighborhood effectively increases the everyday resources for a broader network of households. EITC benefits thus may literally spillover to recipients' wider communities.

EITC benefits may be especially likely to make such gifts and loans possible. Households generally receive EITC benefits in a lump sum—as a one-time injection of wealth. This enables families to set aside a small amount of savings for unexpected expenses (Halpern-Meekin et al. 2015; Smeeding et al., 2000). These benefits also allow families to purchase large ticket items (e.g. a used car, household appliance or vacation) or wipe out large or overdue bills.

Though not the focus of this report, these EITC-facilitated routine acts of mutual financial support in low-income communities may also protect health over the longer term. Increased mutual financial support builds social capital, defined by Kawachi, Kennedy, Lochner, & Prothrow-Stith (1997) as "…civic participation, norms of reciprocity, and trust in others, that facilitate cooperation for mutual benefit (p.1491)." This type of mutual support has a powerful protective effect on health and operates as a public good (Texas Perspectives, Inc., 2003; Kawachi et al., 1997).

3. Background, data and methods

3.1. EITC benefit schedule

The number of dependent children in one's family and one's total family earnings basically determine one's EITC benefit level. Households with no children get a maximum credit of 7.65% of earnings, whereas the maximum benefit for households with three or more children equals 45%.[6] Benefits initially increase with earnings at a fixed rate (the "phase-in" range) before hitting a maximum benefit level. Then, over a "plateau" range of earnings, benefit levels do not change. At earnings beyond the plateau range (the "phase-out" range), benefits decrease at a fixed rate.

For example, in tax year 2016, a single parent with three or more qualifying children could receive a maximum $6269 federal EITC credit. The EITC credit remains at $6269 for households with earnings between $13,930 and $18,190. EITC credits then fall at a rate of 21.06% of every dollar earned above $18,190, falling to zero at $47,955 in earnings. As a result, the largest EITC credit goes to those earning 25% below the federal poverty line.[7] Due to the refundable nature of the credit, even if workers have no federal income tax liability, as is true

[3] This is based on data from Tables 1 and 2, and assuming the average household has 3 members.

[4] Spencer (2007) estimates that every additional $1000 in EITC benefits for low-income Los Angeles neighborhoods supports three additional retail jobs.

[5] Halpern-Meekin, Edin, Tach, & Sykes (2015) document how EITC-eligible low-income households frequently relied on small loans or gifts from families and friends to clear small, but serious, financial impasses—e.g., $10 for milk and bread or to cover bus fare. Similarly, Morduch et al. (2014) collected financial diaries across low- to middle-income families and found that 41% of existing loans were from families and friends.

[6] The 2009 American Recovery and Reinvestment Act (ARRA) temporarily added a fourth schedule for families with at least three children. This has been extended to 2017.

[7] A four-person family (with three children) had a poverty income threshold of $24,300 in 2016. The phase-out range for this family type begins at $18,190–25% below the poverty line.

of most families below the poverty threshold, they can still receive the full value of the credit. Thus, it effectively serves as a wage subsidy.[8]

3.2. State and local EITC supplements

In 2016, 25 states and Washington DC had state-level EITC programs that supplement the federal credit (IRS, 2016). State EITC programs generally provide credits equal to a simple percentage of the federal benefit level. The 2016 state supplemental rates ranged between 3.5% (Louisiana) and 40% (Washington DC), with a median state EITC rate of 15 percent. New York's supplemental EITC rate is among the highest, reaching 30% as of 2003. Two municipalities have also adopted supplementary EITC programs: NYC adopted a local EITC program in 2004 with benefits equal to 5% of the federal credit. Montgomery County, Maryland, enacted a county credit set equal to the state's credit in 1999.[9]

3.3. Empirical strategy

We use a difference-in-difference empirical strategy to identify the impact of the EITC on neighborhood health outcomes. Local and state EITC benefit rates constitute the intervention, which varies over time due to credit rate changes. The local and state EITC rates affecting NYC residents, combined, increased from 20 to 35% of the federal benefit over the study period.[10] This includes a multiple step increase in New York State's credit from 20 to 25% of the federal benefit in 2001; then to 27.5% in 2002, and to 30.0% in 2003 where it remained through 2010. New York City added its local credit equal to 5% of the federal benefit in 2004.

Our panel data has annual observations for about 90 low- and middle-income zipcodes that proxy as NYC neighborhoods.[11] Each set of neighborhoods is fixed over time. Our low-income neighborhoods have a high concentration of EITC filers (39.3%) and serve as our treated group over the study period, 1997-2010. Our control group, middle-income neighborhoods, have a relatively low concentration of EITC filers (23.8%). Consequently, any increase in EITC rates applies a larger "dose" of EITC benefits to low-income neighborhoods relative to middle-income neighborhoods (more on this below).[12]

The first "difference" is the change in health outcome observed among poor neighborhoods over time as EITC rates increase.[13] The second "difference" is the change in these health outcomes observed among poor neighborhoods net of any change observed among moderate-income neighborhoods at the same time. Thus, we identify the health effect of EITC benefits as the difference in health outcome trends between the control group (middle-income neighborhoods) and treated group (low-income neighborhoods) that correlates with changes in the state and local EITC rate.[14] We add controls to account for variations in health outcomes over time and across neighborhoods unrelated to EITC benefits, particularly local economic trends and neighborhood demographic differences. Our model is:

$$\begin{aligned} Health\ outcome_{zt} &= a + B_1(state\ and\ local\ EITC\ rate)_{t-1} \\ &+ B_2(low\text{–}income\ neighborhood)_z \\ &+ B_3(state\ and\ local\ EITC\ rate)_{t-1} \times (low\text{–}income\ neighborhood)_z \\ &+ D_1(\%\ HS\ Deg\ or\ Less)_z + D_2(\%\ African\ American)_z + D_3(\%\ Latino)_z \\ &+ T_1(NYC\ unemployment\ rate)_t + T_2(NYC\ minimum\ wage\ rate)_t \\ &+ \sum_{(C=1)}^{4} C_c(county\ indicators)_C \\ &+ Y_1(Year\ 2001)_t + other\ controls\ for\ local\ economic\ trends + e_{zt} \end{aligned}$$

where the subscripts refer to zipcode (z), year (t), and county (c). The interaction term between the EITC rate and the low-income (i.e., high-dose, EITC-treated) neighborhood indicator with coefficient B_3 is our variable of interest. We lag our EITC rate variable by one year.[15] We include demographic measures to control for important fixed differences between neighborhoods and include county-level indicators that may capture any spatial heterogeneity specific to NYC's boroughs.

Many economic trends rise (or fall) over time in a monotonic way (e.g. overall economic output), making it difficult to isolate changes in health occurring as a result of similarly monotonically increasing EITC rates from other trends. Therefore, to control for spurious trends we add: (1) two specific local economic trends: the City's unemployment rate and effective minimum wage rate, (2) a linear time trend or County indicators interacted with a linear time trend. We also include a single indicator variable for 2001 to absorb some of the exogenous shock caused by the September 11 terrorist attacks.

We chose two poverty-sensitive health outcome measures for children from the Agency for Healthcare Research and Quality (AHRQ) Prevention Quality Indicators: low birthweight rate and pediatric asthma hospitalizations.[16]

Low birthweight rate serves as a global measure of health because past research has linked it to a wide range of effects (Black et al., 2007; Currie & Moretti, 2007; Hyson & Currie, 1999). Also, birthweights respond in the short-term to maternal diets, which EITC benefits can improve quickly (McGranahan & Schanzenbach, 2013; Rehkopf et al. 2014).

Pediatric asthma hospitalizations have been strongly linked to both household and zipcode-level average incomes. EITC benefits could help families afford reliable transportation for medical appointments, house repairs, or asthma-related medications—factors shown to decrease asthma hospitalization rates (AHRQ, 2001).

We also examine *prenatal care* which can improve birthweight (Hoynes et al., 2015). EITC benefits may increase healthcare spending or induce greater employment that can increase access to care through employer-provided health insurance (Schmeiser, 2012; Wicks-Lim & Pollin, 2012; Hotz & Scholz, 2010; Hoynes, 2009; Eissa & Hoynes, 2006; Meyer & Rosenbaum, 2001; Eissa & Liebman, 1996).

[8] These parameters differ based on filing status. Jointly-filing married couples follow a more generous benefit schedule. See the Tax Policy Center's "Tax Facts, Historical EITC parameters,"

[9] Due to the fiscal stress caused by the Great Recession, Montgomery County's EITC refund was reduced from 100% of Maryland's state EITC to the following rates: 72.5% in 2011, 68.9 in 2012, and 75.5 in 2013. The rate was restored to 100% in fiscal year 2016 (http://bit.ly/2aQpdqW).

[10] Rate changes, rather than changes in EITC benefits, better isolate income changes unrelated to economic trends that affect health. Directly measuring how changes in EITC benefits impact health could produce a spurious correlation as economic trends can influence benefit levels and health outcomes simultaneously. For example, if one earner in a two-earner household becomes unemployed, this could lower their income sufficiently to make them eligible for EITC benefits. In this case, a household's worsening economic situation leads to an increase in EITC benefits *and* an increase in stress that may negatively impact health. We examine instead EITC rate changes to identify the relationship between benefits and health, since variations in EITC rates cause changes in benefits unrelated to economic trends.

[11] We use zipcodes interchangeably with neighborhoods. NYC's high population density insures that each zipcode represents a limited geographic area with a median area of 1.8 mi.^{2} and a mean area of 4.3 mi.^{2} (see: http://proximityone.com/cen2010_zcta_dp.htm). This allows us to measure how EITC benefits and health outcomes interact at a geographic unit reasonably described as a neighborhood.

[12] This difference-in-difference approach is similar to that used by Hoynes et al. (2012, 2015) where the group that serves as the control experiences a meaningfully smaller dose of treatment relative to the treated group.

[13] Strully et al. (2010), in contrast, examines the impact of the *presence* of a state EITC, rather than the impact of varying benefit rates.

[14] During the study period the federal EITC program expanded twice. The Economic Growth and Tax Relief Reconciliation Act of 2001 increased federal EITC benefits and expanded coverage for married households filing jointly between 2002 and 2008. The 2009 ARRA increased federal EITC benefits again for married-jointly filers, and added the fourth benefit schedule for households with at least three children. We adjust the local credit rate to reflect these increases in federal benefits. Details and a full table of the adjusted rates are in an on-line appendix.

[15] Nearly all EITC recipients receive benefits as a lump sum in the year *after* they earn the income used to determine their benefit amount (Smeeding et al., 2000).

[16] See AHRQ's, "Pediatric Quality Indicators: Overview," http://bit.ly/2b9TrFa

3.4. Data and variable definitions

3.4.1. Health outcomes

Our data on low birthweight and prenatal care rates come from the NYS Department of Health Vital Statistics Program's County/zipcode Perinatal Data Profile.[17] Each year of perinatal data at the zipcode level is a three-year average. Low birthweight is defined as: % of live births, newborns weighing between 100-2499 grams (2499 grams = 5.5 lbs.). Our prenatal care measure equals the % of live births with no or late (initiated in the 3rd trimester) prenatal care.

Our prenatal care data suffer from measurement errors. For example, 50 out of 88 zipcodes had a value of zero in 2009. This compares to only one or two zipcodes having a value of zero for all other years. Additionally, we observed dramatic spikes in the prenatal measure for 1999 and 2008 and for two zipcodes (11224 and 11235).

To remedy these data quality issues, we drop these zipcodes and data for 2009 and replace the values for 1999 and 2008 with an average from the year immediately preceding and following.[18] These adjustments may prevent our regression model from detecting any measurable relationship between prenatal care and EITC benefits.

Our pediatric asthma health outcome measure is the number of hospital discharges with a principal diagnosis code of asthma among children 5-14 years old per 1000 provided by Infoshare.[19]

To reduce noise in these measures due to small sample sizes, we drop observations from zipcodes with very few live births (< 30) from our analysis of low birthweight and prenatal care. This accounts for less than 0.5% of our annual zipcode observations. For our analysis of asthma hospitalization rates, we drop zipcodes with very few youth (again, < 30). This results in excluding 2.1% of annual zipcode observations.

3.4.2. Treated and control neighborhoods

The *treated group* includes low-income neighborhoods particularly impacted by EITC benefit changes, defined as those in the highest quartile of the measure, "Real EITC benefit per capita," averaged over the entire 1997-2010 time period. This group includes neighborhoods that annually received, on average, at least $300 in benefits per capita.

Our EITC benefit data are based on zipcode-level administrative data from the IRS made available through the Brookings Institute's Metropolitan Policy Program (http://brook.gs/2amfD31). We convert the EITC benefit amount into a per capita measure using the average population size from the U.S. Census Bureau's 2000 Census and the 2006-2010 Five-Year data set from American Community Survey (ACS).

Our *control group* consists of moderate-income zipcodes that are less impacted by EITC benefit changes.[20] These are defined as those zipcodes not in our treated group and with an average real household median income below $60,400. This income cutoff is the "average average income": $60,400 is the 50th percentile value across zipcodes of real median incomes averaged from 1997-2010.

3.4.3. Demographics

We use demographic data published by the U.S. Census Bureau from the 2000 Census and the 2006-2010 American Community Survey. Specifically, we average Census tract-level data for these two time points and then aggregate the measure to the zipcodes that existed during January-March 2010 using the Housing and Urban Development (HUD) USPS Zipcode Crosswalk Files.

Zipcodes, constructed to make mail delivery more efficient, can vary somewhat over time with population shifts, whereas Census tracts do not. At the same time, the demographic characteristics of the zipcodes appear to remain consistent. Measures of three major demographic attributes—% Black, % Latino, and % with a high school degree or less—by zipcode at these two time points are nearly perfectly correlated, with coefficients ranging between 0.94 and 0.98.

This high level of correlation also suggests that, despite the documented demographic shifts occurring over this time period, such as a decrease in NYC's share of Black residents (Logan & Stults, 2011), the shifts overwhelmingly move in the same direction across zipcodes. In other words, these measures behave as "fixed" over time with regard to demographic *differences between* zipcodes.

3.4.4. Economic trend variables

The U.S. Department of Labor's Bureau of Labor Statistics publishes the data for the economic trend variables including the NYC unemployment rate and the New York minimum wage rates.

4. Results

4.1. Summary statistics

Table 1 presents summary statistics of the main variables in our analysis. Compared to our middle-income neighborhoods, our low-income neighborhoods have noticeably higher proportions of African American (46 vs. 26%) and Latino residents (40 vs. 22%), and residents with a high school degree or less (65 vs. 53%).

As noted above, the EITC participation rate in our control group (middle-income neighborhoods) is 24%, substantially lower than the 39% participation rate in the treated group (low-income neighborhoods). The difference in the actual dollar receipt of EITC benefits per capita between the treated and control neighborhoods exceeds $200. The income/health gradient is apparent across these neighborhoods.

Fig. 1 illustrates which neighborhoods belong to our low-income and middle-income neighborhoods, as well as the neighborhoods we exclude from our analysis. Our low-income neighborhoods cluster together and appear in four of the five NYC counties. The four counties that have low-income neighborhoods also contain middle-income neighborhoods that serve as controls.

Table 2 presents average benefits at two points in time (1997-99 and 2005-07) for low-income and middle-income neighborhoods to illustrate the change in flow of EITC dollars over the study's time period as the EITC rate increased from 20 to 35%.[21] During this period, low-income neighborhoods experienced a per capita benefit gain of $126—six times more per capita that the net $21 gain in middle-income neighborhoods.

This larger net gain in EITC benefits per capita in low-income neighborhoods primarily reflects a larger dollar increase in EITC benefits among EITC *recipients* in low-income neighborhoods relative to those in middle-income neighborhoods. We know this because the EITC participation rates are relatively stable over the study period. The share of EITC filers among low-income neighborhoods is 38.5 and 37.3% in 1997-99 and 2005-07, respectively. The middle-income neighborhood figures are 22.9 and 23.0%. Therefore, the net gain in EITC benefits in low-income neighborhoods reflects an increase in benefits per recipient rather than an increase in the share of EITC recipients over time.

[17] See http://on.ny.gov/2b9TWip.

[18] GLM does not allow gaps between time periods. Thus, we drop 2010 data along with the 2009 data.

[19] Infoshare derives these data from the Statewide Planning and Research Cooperative System (SPARCS) of the NYS Department of Health.

[20] We exclude high-income zipcodes (real median-income > $60,400 in 2012$) for two reasons: (1) This restriction makes the control group more appropriate because the effects of other economic trends will more likely overlap across low- and moderate-income neighborhoods (as opposed to high-income neighborhoods); (2) this exclusion eliminates a spike of zero values in the prenatal care and asthma health outcome measures clearly due to the inclusion of high-income neighborhoods. Excluding high-income neighborhoods allows our health outcome measures to have a more normal distribution better suited for GLM and OLS.

[21] These two time points span the full range local EITC rate changes, coincide with business cycle peaks and precede the onset of the Great Recession.

Table 1
Means of main variables.

Variable	Middle-income Neighborhoods (Control)	Low-income Neighborhoods (Treated)
% African American	26.1%	45.5%
% Latino	22.3%	40.0%
% HS Degree or Less	52.8%	64.9%
Real Household Median Income (2012$)	$49,839	$35,676
% EITC filers	23.8%	39.3%
EITC $ per capita (2012$)	$220	$436
% Low Birthweight	8.3%	9.3%
% No/Late Prenatal Care	7.7%	8.2%
Pediatric Asthma Hospitalizations Per 1000	4.77	8.48
Number of Observations	616	630
Total Sample Size	1246	

Notes: Unit of observation is neighborhood. There are 44 middle-income neighborhoods in our sample, each with 14 annual observations (1997-2010), i.e., 616 observations. There are 14 annual observations for each of the 45 low-income neighborhoods in our sample, 630 observations.

Note that the per capita net benefit gain for low-income neighborhoods–$105–represents a substantially higher gain for households that directly receive EITC benefit dollars. Consider first that the average household in these neighborhoods includes 3 members. Therefore, the average net increase in EITC benefit per household is about $315. Second, not every household directly receives EITC dollars–about 40 percent of the households report having filed for EITC benefits. This suggests that among households who directly receive EITC benefit dollars, the average EITC benefit is about $800 ($315/0.40). This is a meaningful, if modest, relative income gain equal to two percent of the average real income in these neighborhoods ($36,000).

4.2. Regression results

To estimate the model for the health outcomes with values bound between 0 and 1—proportion low birthweight and proportion no/late prenatal care—we use both an ordinary least-squares regression model (OLS) and a generalized linear model (GLM). Our GLM uses the logit function to link the probability of the health outcome variable to a linear predictor function. The latter approach limits predicted values to between 0 and 1.

Estimating an OLS model with a limited dependent variable can produce biased coefficients (Kennedy, 1998, p. 249). OLS, however, frequently produces estimates similar to methods more suited to this type of data and are easier to interpret. Therefore, we present OLS results and compare them to the more oblique GLM results.

We estimate standard errors assuming heteroskedastic errors (by panel) that are contemporaneously correlated across panels and exhibit within-panel first-order autocorrelation. These error structure assumptions are important for accurately assessing the impact of EITC "treatment" on outcomes, measured as moving averages. Our third health outcome measure—pediatric asthma-related hospitalizations per 1,000—is not bound between 0 and 1. Therefore, we only estimate an OLS model for this dependent variable.

Table 3 presents our OLS results for the parameterized EITC "treatment" affect interacted with our low-income neighborhood indicator. Each entry in the table represents a different regression.

For each outcome, we present three estimates, each with a different set of controls: (1) the unemployment rate and the real value of the minimum wage, (2) controls in (1) plus a linear time trend to control for other cross-county local economic trends, (3) controls in (1) and (2) plus controls that allow time trends to vary by county.

The first row estimates indicate that increases in EITC benefits reduce low birthweight rates and are statistically significant at the 0.05 level. For example, a 10 percentage-point increase in the state and local EITC rate typically results in a -0.2 percentage-point change in the low birthweight rate among low-income neighborhoods. The second row estimates for percent no/late prenatal care also indicate an inverse relationship with EITC benefits, but none are statistically significant at conventional levels. The third row shows results for pediatric asthma-related hospitalizations per 1,000. The estimates are consistently negative, but are also imprecise.

Table 4 presents analogous GLM results for the percentage low birthweight and late/no prenatal care dependent variables. To facilitate the interpretation, we present alongside the GLM coefficient and standard errors, the difference between the average marginal effect of the EITC rate for our low-income and middle-income neighborhoods.[22] This measure provides a comparable metric to the OLS coefficient on the state and local EITC rate interacted with the low-income neighborhood indicator.

The GLM results are largely consistent with the OLS results. For low birthweight rates, the estimates are negative and statistically significant at conventional levels. The magnitudes of the estimated average marginal effect of the EITC for low-income neighborhoods on low birthweight rates are somewhat larger compared to the OLS results, at about -0.03. The estimates for the no/late prenatal care measure are too imprecise to rule out an estimate of zero effect at conventional levels.

We conclude that our estimates for prenatal and asthma outcomes are too imprecise to reliably establish any relationship with the EITC. Our estimates for low birthweight, on the other hand, are consistently negative and precise enough to conclude that low birthweight rates have an inverse relationship with EITC benefits.

We conducted three sets of robustness tests, to account for geographical heterogeneity, the secular decline in low birthweight rates, and other definitions of low-income neighborhoods. These robustness tests did not meaningfully change our results. Details and the accompanying regression estimates are available in an on-line appendix.

Our preferred specification (1) uses GLM as a more appropriate estimation method for the low birthweight rate outcome and (2) includes county-specific time trends because these most thoroughly control for potential spurious trends. Based on these criteria, our results suggest that increasing the state and local EITC rate by 10 percentage points reduces low birthweight rates by 0.30 percentage points.

5. Discussion

These results provide empirical evidence that increased state and local EITC benefits improves at least one measure of health for low-income NYC neighborhoods—low birthweight rates. At least two other studies link improvements in health outcomes to increases in state EITC benefits similar in size to what we are examining. Strully et al. (2010) link improved birthweight levels to the presence of a state EITC benefit. The average state EITC rate examined by Strully et al. is roughly equal to the increase in the combined New York state and local credits, i.e., 15 percentage points. Baughman and Duchovny (2016) find limited health effects among older children who live in households likely to receive EITC benefits. The average state EITC benefits among these children is about $230 (2012$).[23] This state EITC benefit level is similar, but lower, than the average net increase in EITC benefits we

[22] The average marginal effect is an average of the marginal effect of a change in the local EITC rate on the health outcome while holding only the neighborhood indicator fixed (i.e., low income or middle income) and using observed values for all other independent variables. Williams (2012) provides a thorough discussion of this measure.

[23] See Table 2, p.113, in Baughman and Duchovny (2016).

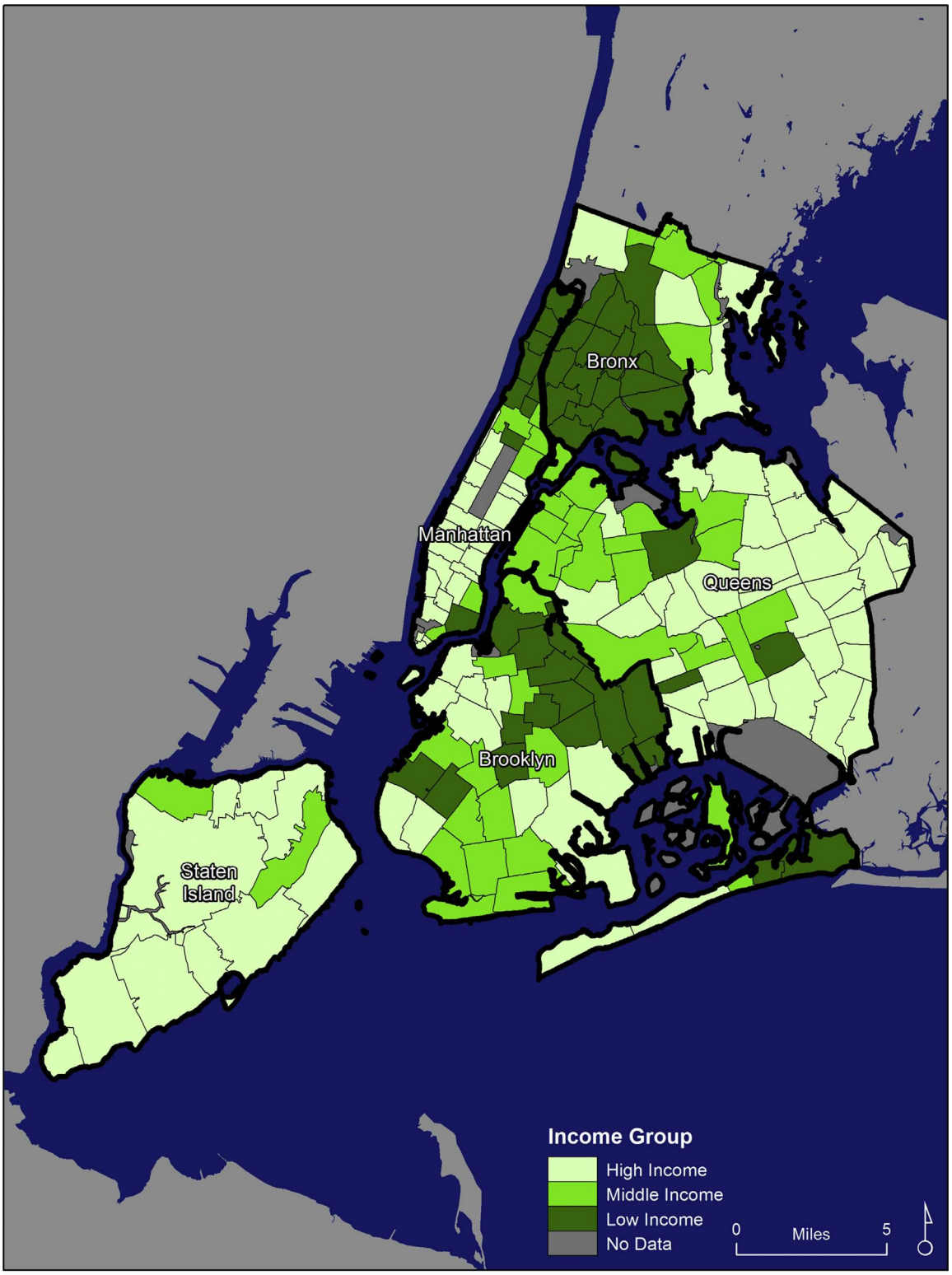

Fig. 1. NYC Neighborhoods by Level of EITC Receipt Per Capita. Notes: Neighborhoods are defined by Per Capita EITC at the zipcode level. High income zipcodes receive below-average EITC benefits per capita, middle income zipcodes receive average EITC benefits per capita; and low income zipcodes receive above-average EITC benefits per capita. See text for details.

observed among households in our low-income neighborhoods ($315, as noted above).

We have argued that we expect to observe a relatively larger impact from EITC benefits when the benefits are injected, in a concentrated way, into high poverty areas. Based on our preferred specification, we find that a 15 percentage-point increase in EITC rates (the rise in the NYS and NYC EITC rates combined over the study period) would result in a 0.45 percentage-point reduction in low birthweight rates. We assess the magnitude of our estimate in two ways.

First, we compare our estimate of how much recent EITC policy expansions reduced low birthweight rates to the overall ups and downs in low birthweight rates during this study's entire 14-year period (1997 to 2010). The average low birthweight rate across NYC's poor neighborhoods only varied between 9.0% and 9.8% – a range of 0.8

Table 2
Average change in EITC benefits from 1997-99 to 2005-07.

	EITC benefit per capita (2012$)		
	20% EITC (1997-99)	35% EITC (2005-07)	Difference
Middle-income (Control)	$201	$222	$21
Low-income (Treated)	$336	$462	$126
		Difference-in-Difference	*$105*

percentage points. As a result, the impact of recent EITC policy expansions on reducing low birthweight rates are sizable relative to the range of improvements achieved at any point in the last 14 years.

Second, we compare our neighborhood-level EITC effect to its effect at the individual level. Hoynes et al. (2012) present estimates of how the EITC affects low birthweight rates at the individual/family level appropriate for comparison with our neighborhood-level estimates. Specifically, they estimate how much a $1,000 EITC (2009$) "treatment on treated" (ToT) reduces low birthweight rates among single mothers with young children and a high school degree or less.[24]

These single mothers make up their treated (or "high-impact") group since a large share of that demographic group qualifies for EITC benefits: 42% of single women 18-45 years old with a child under age 3 and a high school education or less receive EITC benefits. Our treated group – low-income neighborhoods – has a comparable level of EITC eligibility (39%) as indicated by the share of EITC tax filers (see Table 3).[25] In other words, our poor neighborhoods, with respect to EITC "exposure," resemble the demographic group of single mothers with young children and a high school degree or less. We can therefore directly compare our estimates of a $1,000 (2009$) ToT to that of Hoynes et al. (2012) to gauge whether differences exist between the individual/household level and neighborhood-level EITC health effects. We present the comparison figures in (Table 5).

Our regression estimate from our preferred estimation suggests that a 15-percentage-point EITC rate increase reduces the low birthweight rates in NYC's impoverished neighborhoods by 0.45%. We know from the figures presented in Table 2 that households experienced an average net gain of $315 (in 2012$) in benefits from 1997-99 to 2005-07 when the state and local EITC rate increased by 15-percentage points.[26] If we scale this figure to show the impact of a $1,000 (2009$) EITC treatment, the ToT per $1,000 would be 1.4 percentage points, representing a 15% reduction in the average low birthweight rate in those neighborhoods.

In the last row of Table 5, we present Hoynes et al.'s estimates of the impact of the ToT per $1,000 at the individual level. Their estimates for this figure range between 6.7 and 10.8%. Our point estimate of the EITC health impact measured at the neighborhood level appears substantially larger than when measured at the individual level—in the range of 50% larger.[27]

Our results indicate no consistent relationship between EITC benefits and pediatric asthma hospitalization rates or receipt of prenatal care. Low birthweight rate may be most responsive in the short term to the meaningful, yet modest, relative income gains that our low-income neighborhoods experience.

The role of health insurance in accessing healthcare may weaken the ability of increased income to lower pediatric asthma hospitalizations rates or raise the receipt of prenatal care. Increased income, or employment, related to greater EITC benefits may increase health insurance coverage. At the same time, barriers to accessing services exists within health insurance plans, including high co-pays and deductibles, and limited choices and availability of physicians. We cannot examine the channels by which EITC benefits may influence these health-related outcomes with our data. Data quality issues for our prenatal care measure also likely contribute to our inconsistent and imprecise estimates.

The fact that health outcomes did not improve across the board allows us to rule out with some confidence one type of spurious relationship impossible to control for within our model: neighborhood gentrification.[28] Over the time period of our study, if higher income households replace lower income households within the same neighborhood, we would expect that this would cause all three health outcomes to measurably improve, not just one.

6. Conclusion

Past research has linked EITC and improved health at the individual level. Our analysis suggests that the EITC's positive impact on health outcomes spillover beyond such individual-level effects. In our study, we link the NYS and NYC EITC expansions between 1997 and 2010 to improved low birthweight rates in the city's low-income neighborhoods. We use prior empirical estimates to distinguish compositional effects from contextual effects and find that the magnitude of our estimates suggests ecological, neighborhood-level health effects. This points to an additional channel through which anti-poverty measures can serve as public health interventions: by reducing *neighborhood* poverty rates. Ours is the only study that we are aware of that conducts a neighborhood-level analysis of EITC's impact on health.

This study also provides important evidence of a causal link from income to health more generally since EITC policy changes in New York provide a source of income variation that is relatively exogenous to individual or household characteristics.

This study primarily analyzes data from NYC and may not be generalizable to other areas. Future research should analyze other geographic units to determine if similar effect results are found. Finally, this work underscores the importance of additional research and more serious consideration of broad-based public policy initiatives to improve population health.

[24] These figures come from Hoynes et al. (2012), an earlier version of Hoynes et al. (2015). Hoynes et al. (2012) use the EITC credit received by single mothers with high school education or less to gauge the impact of EITC expansion on health (see Table 4, p. 43). These figures differ from the 2015 published version where they assess the health impact of changes in less-educated single mothers' *after-tax income* resulting from an EITC expansion. Their measure of after-tax income incorporates earnings and other income subsidies like TANF or SSI. This approach assesses the impact of income changes induced by EITC changes on health, rather than the impact of changes in EITC benefits alone. Consequently, their 2015 published estimates of the impact of ToT per $1,000 are much smaller than their estimates in their 2012 paper. Since we focus on how changes in the EITC policy impacts health outcomes, we use Hoynes et al.'s 2012 estimates to assess our results.

[25] We use EITC filing status to proxy for EITC eligibility in our sample.

[26] We use the average net gain for households within a low-income neighborhood, not the average net gain for households within low-income neighborhoods that directly *receive* EITC benefits (i.e., the $800 figure from above). This is analogous to Hoynes et al.'s approach. They observe the impact of EITC benefits on single mothers with a high school degree or less with young children, *not* single mothers with a high school degree or less with young children who directly *receive* EITC benefits.

[27] Our neighborhood-wide estimate overlaps with Hoynes et al.'s (2012) estimated impact for Black single mothers of young children. For this subgroup, they estimate an 8.1% to 15.8% reduction in low birthweight rate (based on their ToT per $1,000; 2009$). The similarity of these estimates may reflect the concentration of Black people living in poverty areas—at a rate at least double that of the average person between 2000 and 2010 (Bishaw, 2011): 50.4% vs. 25.7% for 2000 and 46.3% vs. 18.1% vs. in 2010. Therefore, the greater impact of EITC benefits on Black single mothers observed by Hoynes et al. could be explained, in part, by the fact that roughly half of Black people live in areas of poverty.

[28] Stringer (2014) describes recent gentrification trends. We are grateful to Michael Carr for raising the question of how to account for NYC's gentrification in our model.

Table 3
The impact of EITC benefits on health outcomes: selected coefficients from OLS model.

	EITC rate, lagged x Treatment indicator					
	1		2		3	
Dependent variable:	Coeff.	SE	Coeff.	SE	Coeff.	SE
Percent Low Birthweight (PCTLBW)	-0.021**	(0.008)	-0.021**	(0.008)	-0.022***	(0.008)
Percent Late/No Prenatal Care (PRENATAL)#	-0.009	(0.019)	-0.009	(0.020)	-0.012	(0.015)
No. of Asthma-related hospitalizations per 1,000 (ASTHMA)	-3.13	(2.84)	-3.28	(2.97)	-0.81	(2.67)
Controls:	County Indicators		County Indicators +Time Trend		County Indicators x Time Trend	

Notes: Panel-corrected standard errors are in parentheses. Sample size approx. 1,100. #Prenatal regressions exclude 2009 data; sample sizes are approx. 1,050.
* p-value < 0.10;
** p-value < 0.05;
*** p-value < 0.01.

Table 4
The effect of EITC benefits on health outcomes: selected coefficients from generalized linear model.

	EITC rate, lagged x Treatment indicator					
	1		2		3	
Dependent variable:	Coeff.	SE	Coeff.	SE	Coeff.	SE
Percent Low Birthweight (PCTLBW)	-0.331**	(0.162)	-0.330**	(0.161)	-0.330*	(0.173)
Avg. Marginal Effect (Treatment – Control)	-0.028		-0.030		-0.030	
Percent Late/No Prenatal Care (PRENATAL)#	-0.316	(0.470)	-0.314	(0.475)	0.086	(0.447)
Avg. Marginal Effect (Treatment – Control)	-0.013		-0.003		0.074	
Controls:	County Indicators		County Indicators +Time Trend		County Indicators x Time Trend	

Notes: Corrected for within panel first order autocorrelation and heteroskedasticity by panel.
#Prenatal regressions exclude 2009 and 2010 data. Sample size approx.: 1000.
* p-value < 0.10;
** p-value < 0.05;
*** p-value < 0.01.

Table 5
Evaluating the estimated impact of New York Local EITC Rate Increases on low birthweight rates in low-income neighborhoods.

	GLM with County Indicators x Time Trend Controls
1. Treatment Effect*	0.45%
2. EITC Increase per household** (2012$)	$315
3. Treatment on Treated (ToT) per $1,000 (2009$)***	1.43%
4. Mean of dependent variable****	9.50%
5. ToT per $1000 (2009$), % impact (row 3/ row 4)	15.04%
6. Hoynes et al. (2012, p. 43) estimate of ToT per $1,000 (2009$), % impact	-6.7% to -10.8%

* Treatment effect is evaluated to reflect the 15-percentage-point EITC state and local credit rise that occurred over the study period. We use the average marginal effects from our preferred specifications presented in Table 4 (multiplied by 0.15).
** See Table 2 for net change in average EITC benefit.
*** To ease comparisons, we adopted the same real value benefit increase used in Hoynes et al. (2012). $1,000 in 2009$ is equivalent to $1,070 in 2012$.
**** Average % Low Birthweight Rate in Poor Neighborhoods (1997-99).

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Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://doi:10.1016/j.ssmph.2017.03.006.

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