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Short Report

Effects of changes in earned income tax credit: Time-series analyses of Washington DC☆

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ABSTRACT

Poverty has numerous deleterious effects on health, and the Earned Income Tax Credit (EITC) is the major policy tool used to alleviate poverty in the U.S. We evaluate effects of four distinct changes in earned income tax credit law in Washington, DC on maternal behaviors and infant outcomes. An interrupted time-series design was used with 312 monthly measures from 1990 through 2015 analyzed in 2018 (total n = 225,933 births). States with no EITC were included as the comparison group; analyses involved ARIMA modeling. Outcomes were derived from birth certificates, and included percent of live births below 2500 g, mean birth weight, mean gestation weeks, first trimester prenatal care, and maternal smoking during pregnancy. We found a pattern of significant improvements across all three infant outcome measures, with the size of the effect estimate monotonically matching the magnitude of the tax credit—ranging from a 1.9 (-2.9, -0.9) reduction in rate per 100 births of low birth weight for the smaller 10% credit, to a 4.7 (-5.4, -4.0) reduction with the 40% credit. Results for maternal smoking and prenatal care were mixed. Results suggest that earned income tax credit policies improve birth outcomes; mechanisms for this effect deserve further study.

1. Introduction

The earned income tax credit (EITC) supplements incomes of low-wage workers, incentivizes employment, and reduces poverty. In the U.S., a federal EITC was first implemented in 1975, and from 1988 onward, many states and the District of Columbia added their own EITCs—a total of 29 states and DC as of December 2017. Economists have long studied the labor market effects of EITCs (Nichols, 2016), and more recently a growing literature on the health effects of EITCs has emerged, particularly infant health (see Markowitz, Komro, Livingston, Lenhart, and Wagenaar (2017) for a recent review). The focus on infant outcomes is due to the large literature documenting life-long deleterious effects on development of even modest reductions in birth weights and gestation weeks (Mathewson et al., 2017; Stephens, Lain, Roberts, Bowen, & Nassar, 2016; Swamy & SkjŠrven, 2008). Most studies to date find U.S. EITCs to be associated with improved infant health measures, although a broader review of cash transfer effects finds unconditional cash-transfer programs associated with larger and more consistent improvements in birth weight and infant mortality, while those (like EITC) that require labor force participation have more modest effects (Siddiqi, Rajaram, & Miller, 2018). Finally, results for measures of maternal behaviors thought to influence birth outcomes, for example diet, smoking, drinking or prenatal care, are less consistent than those for infant outcomes (Hoynes, Miller, & Simon, 2015; Markowitz et al., 2017; Rehkopf, Strully, & Dow, 2014).

In terms of methods, most studies of state-level EITCs to date pool states and pool a diverse set of EITC policy implementations together to derive an overall estimate of health benefit per unit of EITC value. Such studies have strengths in maximizing statistical power to detect effects, but also can mask theoretically and practically important differences in effects across jurisdictions. As one simple example, a given unit increase in EITC may well vary depending on previous EITC (an increase in tax credit from 0% to 10% may be qualitatively different than an increase from 30% to 40%). Additionally, pooling across states combines populations with varying levels of exposure to the policy, and attempts to statistically control for this varying exposure are limited by quality of measurements available.

We recently completed a comprehensive pooled difference-in-differences study of all state-level EITCs implemented through 2013, finding small but significant improvements in birth outcomes associated with state EITCs, with larger effects observed among states with more generous EITCs (Markowitz et al., 2017).

☆ Wagenaar and Livingston designed this study with advice from Markowitz. Livingston conducted all statistical analyses and wrote the methods section. Wagenaar drafted the paper. Komro is PI and led conceptualization and design. All authors substantively contributed to the final version.

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We add to the literature in this brief report by examining in detail the experience in Washington, DC, which implemented four distinct policy changes increasing their refundable EITC. These changes were spread out over eight years, providing an excellent case for interrupted time-series (ITS) analyses. Moreover, DC has one of the highest fully refundable EITCs nationwide. DC is also a good candidate for study because the low-income proportion of the population eligible for the EITC is higher than all but three states. In addition to the scientific contribution of using alternative research design and statistical methods, the present study is also important for public health practice. The history of public health policy advances over the past half century across diverse areas such as injury control; alcohol, tobacco and drug policy; infectious disease prevention and other areas reveals the important role of single-jurisdiction controlled time-series evaluations (Delcher, Wagenaar, Goldberger, Cook, & Maldonado-Molina, 2015; Holder & Wagenaar, 1994; Margolis, Wagenaar, & Liu, 1988; Staras, Livingston, & Wagenaar, 2016; Wagenaar, 1986; Wagenaar, Maldonado-Molina, & Wagenaar, 2009). Such studies reveal in practical terms public health improvements achievable by a reasonably good implementation of a particular policy, and play a significant role in facilitating diffusion of effective policies to other jurisdictions.

2. Methods

2.1. Design

We evaluate effects of four changes in EITC on prevalence of low birth weight, mean birth weight, mean gestation weeks, rate of first-trimester prenatal care, and maternal smoking during pregnancy. Monthly time series for each outcome were generated from birth certificates. These series include a long baseline of 120 months before DC's initiation of an EITC in January 2000, and 192 months covering the period of increasing EITC benefits.

ITS designs benefit from the fact that most potential confounding factors change slowly over time and are accounted for by examining a long baseline period (Wagenaar & Komro, 2013). Sudden changes in other factors coincident with changes in EITC remain a validity threat. Therefore, we also include in each model the outcome series from states with no EITC as a covariate. These other-state outcome covariates control for all confounds that operate in common across states—serving as a comparison group. The comparison group consists of the 15 states that never had an EITC during the study period and had complete data on maternal education (starting in 2009 several states had high rates of missing data). We further refine the design, in addition to full-sample analyses, by restricting both the DC and comparison series to mothers reporting less than high school education, to better approximate an intent-to-treat analysis by focusing on those most exposed to EITC benefits, and to improve comparability of DC with the comparison sites.

Data include a census of all singleton live births from January 1990 through December 2015 in DC and all comparison states, analyzed in 2018. Low birth weight is the percent of live births weighing less than 2500 g. Mean birth weight is expressed in grams, mean gestation in weeks. First trimester prenatal care is defined as percent of live births reporting prenatal care beginning in the first through third month of pregnancy. Maternal smoking is defined as percent of mothers that reported smoking during the pregnancy.

Policy indicators for changes in DC's EITC benefit were created based on effective dates of the changes in law. At initiation of DC's EITC policy in January 2000, it was defined in law as 10% of the federal EITC benefit. The credit was subsequently increased to 25% in January 2001, 35% in January 2005, and 40% in January 2008. Other than these changes in "dose," implementation mechanisms remained the same.

2.2. Statistical analysis

We estimate models of the following form:

$$Y_t = \beta_0 + \beta_1 EITC1_{t-12} + \beta_2 EITC2_{t-12} + \beta_3 EITC3_{t-12} + \beta_4 EITC4_{t-12} + \beta_5 Z_t + ARIMA(p, d, q)$$

where β_1-β_4 estimate changes in the outcomes from baseline for each of the four policy changes, β_5 controls for the association over time between the outcome in the comparison group and DC, and ARIMA(p,d,q) represents ARIMA noise parameters specific to each model to account for autocorrelation patterns (all analyses used SAS v9.4 PROC ARIMA). For each outcome, we tested for non-stationarity in the baseline period using the augmented Dickey Fuller test, and employed first-order differencing to remove trends or other non-stationarities. The advantage of differencing rather than including time trend parameters is that no assumption regarding the functional form of underlying trends is required. Policy effects were hypothesized step functions, estimating intercept (not slope) changes. Policy indicators were lagged 12 months to account for the lag in receiving EITC funds, ensuring the fiscal benefits are in effect during each pregnancy and at the time of birth. Following the standard Box-Jenkins approach, ARIMA models were constructed to achieve white noise residuals in the baseline period.

3. Results

Estimates from the full sample show a consistent pattern of significant ($p < 0.001$) improvements across all three infant outcome measures in each phase of the EITC implementation. The rate of low-birth-weight births declined significantly, and for the full sample the magnitude of the policy effect estimates monotonically matched the magnitude of the credit—a reduction of 1.9 per 100 live births for the smaller 10% EITC to a reduction of 4.7 for the highest 40% credit (Table 1 and Fig. 1). Mean birth weight increased monotonically from an estimated 48-gram improvement with the implementation of the 10% credit, up to an estimated 104-gram improvement with the 40% credit. Mean gestation weeks increased an estimated 0.12 after the 10% credit, increasing to 0.43 after the 40% credit was implemented. While the estimated effects generally follow this dose-response pattern with larger estimated effects associated with larger EITC values, it is important to note that most of the EITC effect is seen upon first implementation, and the increments in effect size with larger EITCs are relatively small and the majority are not statistically significantly different from each other.

Results for maternal behaviors were less consistent. Significant reductions were observed in reported first-trimester prenatal care for the EITC benefit increase to 25% (-6.9 per 100 births, $p = 0.03$) and 40% (-21.8, $p < 0.0001$), but not for initial implementation of the EITC or the increase from 25% to 35%. Similarly, maternal smoking increased significantly at the time of the increase in the EITC benefit from 10% to 25% (2.1, $p = 0.04$), but not for any other change in DC's EITC policy. The pattern of results are similar when restricted to mothers with less than high school education, with the exception of a consistent pattern of increased maternal smoking associated with increasing magnitude of the EITC.

4. Discussion and conclusions

Results reinforce previous findings that EITC policies are associated with improved infant outcomes. The rate of low-birth-weight births averaged 11.6 per 100 births the three years immediately prior to EITC initiation; thus, the 4.7 reduction in the rate under a 40% tax credit represents a 40.3% decrease from the baseline rate. Furthermore, the natural experiments presented by DC's four distinct EITC changes, increasing the amount of the tax credit in major steps over time, strengthen the plausibility of a causal interpretation. If one considers the amount of the tax credit analogous to dose of the intervention, our results suggest a possible dose-response relationship. Nevertheless, the bulk of the effect of the EITC tax policy is seen at the time of the first

Table 1
Effects of Changes in the Earned Income Tax Credit in Washington DC[a].

Outcome	EITC	Full Population[b] Estimate (95% C.I.)	Low-Education Population[c] Estimate (95% C.I.)
Low Birth Weight (rate per 100 live births)	10%	-1.90 (-2.93, -0.87)	-3.04 (-4.78, -1.29)
	25%	-3.07 (-3.79, -2.35)	-2.72 (-3.67, -1.76)
	35%	-3.42 (-4.28, -2.57)	-3.85 (-4.9, -2.81)
	40%	-4.69 (-5.35, -4.03)	-3.98 (-4.77, -3.19)
Mean Birth Weight (grams)	10%	47.86 (22.57, 73.16)	60.09 (25.06, 95.11)
	25%	68.7 (47.62, 89.79)	57.34 (36.65, 78.03)
	35%	70.95 (42.66, 99.23)	83.19 (53.77, 112.61)
	40%	104.31 (79.18, 129.43)	82.06 (54.38, 109.73)
Mean Gestation Time (weeks)	10%	0.12 (0.02, 0.22)	0.19 (-0.03, 0.42)
	25%	0.31 (0.25, 0.38)	0.39 (0.25, 0.52)
	35%	0.22 (0.12, 0.31)	0.36 (0.15, 0.57)
	40%	0.43 (0.35, 0.5)	0.45 (0.26, 0.64)
1st Trimester Prenatal Care (rate per 100 live births)	10%	-3.98 (-8.20, 0.25)	-5.12 (-11.48, 1.24)
	25%	-6.89 (-12.93, -0.85)	-6.07 (-15.07, 2.93)
	35%	-6.87 (-14.35, 0.61)	-5.82 (-17.13, 5.5)
	40%	-21.84 (-30.5, -13.17)	0.0[d]
Maternal smoking (rate per 100 live births)	10%	1.35 (-0.11, 2.8)	0.73 (-0.92, 2.37)
	25%	2.12 (0.07, 4.16)	4.28 (2.83, 5.72)
	35%	2.07 (-0.48, 4.61)	4.28 (2.83, 5.72)
	40%	1.09 (-1.89, 4.07)	4.61 (3.06, 6.17)

[a] All models are based on 312 monthly time-series observations from January 1990 through December 2015 including 120 baseline observations before EITC was first implemented. Effect estimates are relative to baseline.

[b] These time series were based on a census of all singleton live births in DC, a total of 225,933 over the 26-year period, with an average of 724 per month.

[c] These time series were based on a census of all singleton live births in DC where the mother reported a less than high school education, a total of 51,686 over the 26-year period, with an average of 166 per month.

[d] The estimated rate of prenatal care during the 40% EITC period was strongly correlated with the baseline period, leading to singular estimates. Estimates from this model should be interpreted with caution.

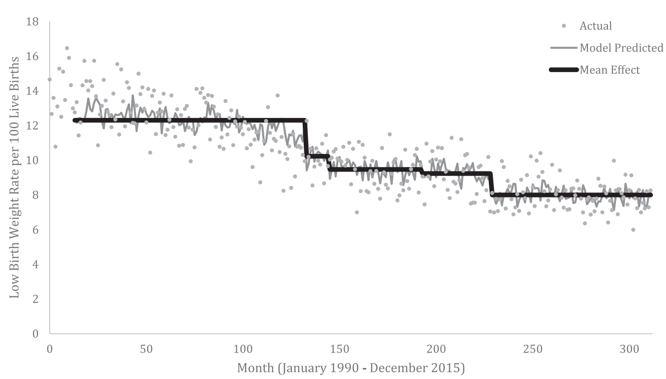

Fig. 1. Effects of Changes in the Earned Income Tax Credit on Low Birth Weight in Washington DC[a], [a]This figure shows the raw monthly rate of low birth weight, the model predicted rate of low birthweight, and the average rate of low birthweight in each EITC period, after adjustment for low birth weight rates in the comparison group and the underlying ARIMA noise structure in the baseline period.

implementation, with more modest further improvements in birth outcomes at higher EITC values. Perhaps a state EITC program initiation creates awareness, induces social influence processes, or provides a strong enough monetary incentive to entice women into the workforce, while increments in the tax credit value receive less such attention. This possible inference from the current results indicates the benefit of interrupted time-series evaluations of specific jurisdictions complementing conventional pooled cross state and time econometric studies. Such studies typically estimate average effects per unit value of the credit, implicitly assuming the effect per unit of value is identical across the range of EITCs in practice. Perhaps the DC results indicate that the effect of program initiation is conceptually distinct from the effect of the EITC dollar value.

While possible unmeasured confounding is a limitation of quasi-experimental designs such as used here, it is important to note that possible residual confounds in our design are only those other factors that changed near the same time as the DC EITC policy changes, and only in DC. Broader nationwide changes in other policies (e.g., SNAP, WIC, ACA) and broader trends such as improved prenatal care are controlled in our analyses via the comparison group. All causal factors, measured or unmeasured, that operate in common across states are efficiently controlled in the analyses by the comparison group, obviating the need to statistically control for each potential confounder separately.

Without available information on exactly which mothers were eligible or received the credits, we used mothers with less than a high school education as a secondary analysis group to attempt to focus more closely on the population exposed to this intervention. However, observing how the dose-response pattern is not as consistent with this group as it is for the full sample, and how the overall effects in the limited subsample appear similar to the total sample, perhaps this low education sample is not achieving the “intent to treat” approximation. Many mothers in this very low education group may have or may be in conditions that essentially make it impossible to work, thus legally eligible but in practice not eligible for the EITC. Future studies might assess EITC effects across education groups, rather than simply examining the lowest education group.

Results for maternal behaviors are mixed, similar to previous studies. Markowitz et al. (2017) found inconsistent and largely not statistically significant estimates of state EITC effects on maternal smoking and prenatal care, while Hoynes et al. (2015) found that the U.S. federal EITC is associated with decreased maternal smoking and increased prenatal care. Perhaps the larger federal EITC improves smoking and prenatal care behaviors, but the smaller state EITCs do not. It is also possible that pregnant women have less time for prenatal care as they increase hours worked to maximize their EITC, or the increased stress among poor mothers due to working (often multiple) low-paying jobs has deleterious effects. There is also evidence that increasing the income of low-income persons increases smoking (Kenkel, Schmeiser, & Urban, 2014), and that larger less-frequent lump sum payments may increase purchase of temptation goods such as tobacco, alcohol and sweets among the poor (White & Basu, 2016). Clearly, infant health is a result of a complex constellation of influences—medical, behavioral, social and environmental. Further research on the mechanisms of EITC’s beneficial effects on infant health is warranted.

In summary, EITCs are associated with improved birth outcomes. Results suggest DC’s tax credit policy prevents an estimated 349 infants per year from being born with low weight.

CRediT authorship contribution statement

Alexander C. Wagenaar: Conceptualization, Funding acquisition, Methodology, Writing- original draft. **Melvin D. Livingston:** Data curation, Formal analysis, Writing - review & editing. **Sara Markowitz:** Investigation, Methodology, Writing - review & editing. **Kelli A. Komro:** Conceptualization, Funding acquisition, Supervision, Writing - review & editing.

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Human participant protection

This research made use of publicly available data sets and was determined to be exempt by the Emory University institutional review board.

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Declaration of conflicting interests

None of the authors report any conflicts of interest with respect to the research, authorship or publication of this article.

References

Delcher, C., Wagenaar, A. C., Goldberger, B. A., Cook, R. L., & Maldonado-Molina, M. M. (2015). Abrupt decline in oxycodone-caused mortality after implementation of Florida's Prescription Drug Monitoring Program. *Drug and Alcohol Dependence, 150*, 63–68. https://doi.org/10.1016/j.drugalcdep.2015.02.010.

Holder, H. D., & Wagenaar, A. C. (1994). Mandated server training and reduced alcohol-involved traffic crashes - a time-series analysis of the Oregon experience. *Accident Analysis and Prevention, 26*(1), 89–97.

Hoynes, H., Miller, D., & Simon, D. (2015). Income, the earned income tax credit, and infant health. *American Economic Journal-Economic Policy, 7*(1), 172–211. https://doi.org/10.1257/pol.20120179.

Kenkel, D. S., Schmeiser, M. D., & Urban, C. (2014). Is smoking inferior? Evidence from variation in the Earned Income Tax Credit. *Journal of Human Resources, 49*(4), 1094–1120.

Margolis, L. H., Wagenaar, A. C., & Liu, W. (1988). The effects of a mandatory child restraint law on injuries requiring hospitalization. *American Journal of Diseases of Children, 142*, 1099–1103.

Markowitz, S., Komro, K. A., Livingston, M. D., Lenhart, O., & Wagenaar, A. C. (2017). Effects of state-level Earned Income Tax Credit laws in the U.S. on maternal health behaviors and infant health outcomes. *Social Science and Medicine, 194*, 67–75. https://doi.org/10.1016/j.socscimed.2017.10.016.

Mathewson, K. J., Chow, C. H., Dobson, K. G., Pope, E. I., Schmidt, L. A., & Van Lieshout, R. J. (2017). Mental health of extremely low birth weight survivors: A systematic review and meta-analysis. *Psychological Bulletin, 143*(4), 347.

Nichols, A. R., J. (2016). *The Earned Income Tax Credit Economics of Means-Tested Transfer Programs in the United States*, *2*, Chicago: University of Chicago Press2.

Rehkopf, D. H., Strully, K. W., & Dow, W. H. (2014). The short-term impacts of Earned Income Tax Credit disbursement on health. *International Journal of Epidemiology, 43*(6), 1884–1894. https://doi.org/10.1093/ije/dyu172.

Siddiqi, A., Rajaram, A., & Miller, S. P. (2018). Do cash transfer programmes yield better health in the first year of life? A systematic review linking low-income/middle-income and high-income contexts. *Archives of Disease in Childhood* (archdischild-2017-314301).

Staras, S. A. S., Livingston, M. D., & Wagenaar, A. C. (2016). Maryland alcohol sales tax and sexually transmitted infections: A natural experiment. *American Journal of Preventive Medicine, 50*(3), e73–e80. https://doi.org/10.1016/j.amepre.2015.09.025.

Stephens, A. S., Lain, S. J., Roberts, C. L., Bowen, J. R., & Nassar, N. (2016). Survival, hospitalization, and acute-care costs of very and moderate preterm infants in the first 6 years of life: A population-based study (61-68 e63) *Journal of Pediatrics, 169*. https://doi.org/10.1016/j.jpeds.2015.10.028.

Swamy, G. K., & SkjŠrven, R. (2008). Association of preterm birth with long-term survival, reproduction, and next-generation preterm birth. *JAMA, 299*(12), 1429–1436.

Wagenaar, A. C. (1986). Preventing highway crashes by raising the legal minimum age for drinking - the Michigan experience 6 years later. *Journal of Safety Research, 17*(3), 101–109.

Wagenaar, A. C., & Komro, K. (2013). Natural experiments: Research design elements for optimal causal inference without randomization. In A. C. Wagenaar, & S. Burris (Eds.). *Public Health Law Research: Theory and Methods*. San Francisco: Jossey-Bass.

Wagenaar, A. C., Maldonado-Molina, M. M., & Wagenaar, B. A. (2009). Effects of alcohol tax increases on alcohol-related disease mortality in Alaska: Time-series analyses from 1976 to 2004. *American Journal of Public Health, 99*(8), 1464–1470.

White, J. S., & Basu, S. (2016). Does the benefits schedule of cash assistance programs affect the purchase of temptation goods? Evidence from Peru. *Journal of Health Economics, 46*, 70–89.