Positive Income Shocks and Very Preterm Births among Black Mothers in California

INTRODUCTION

Non-Hispanic blacks exhibit the highest incidence of preterm birth of any race/ethnicity in the U.S.[1] The literature reports this association across myriad places and times.[2,3] Explanations for this finding, especially among blacks at the lower end of the socio-economic distribution, include that gravid women lack sufficient income to shelter themselves from financial anxiety and other stressful life events,[4] ensure timely and thorough prenatal care,[5] or meet nutritional and weight gain guidelines.[6] In light of a recent report[7] and these explanations, researchers have recommended that the federal government expand cash transfer programs to include pregnant women that have a biologically elevated risk of delivering a preterm or low weight infant.[8] This recommendation assumes that cash supplementation may improve the health trajectory of these gestations.

Researchers, however, disagree on whether lack of financial resources among pregnant women *per se* plays a causal role in birth outcomes. Although the literature posits intervening physiological and behavioral mechanisms,[9] several inferential problems remain. The most serious of these include the health selection hypothesis[10] that the reported maternal socioeconomic position / infant health association arises from aspects of the mother that precede both a downward drift into financial hardship and subsequent infant morbidity. Such

factors could include innate or acquired characteristics, as well as the socio-economic environment of the mother.

An ideal estimation of the causal role of financial resources on birth outcomes would randomly assign gravid women to varying income levels and examine the attendant births. We know of no such study. The disbursement of income tax refunds to working poor families, however, provides an opportunity for quasi-experimental approaches to the problem of health selection. In our study, we utilize the fact that the majority of recipients of the Earned Income Tax Credit (EITC) obtain a relatively large, positive income shock in the months of February or March. By comparing the birth outcomes of demographically similar mothers who either did or did not receive their tax credits during the 2nd or 3rd trimesters, a period the literature identifies as critical to obstetric outcomes,[11,12] we may obtain a causal estimate of the effect of a positive income shock on pregnancy. We employ an analytic framework, similar to an 'intent to treat' analysis in randomized clinical trials, to measure the exposure.[13] We examine the odds of a very preterm birth (i.e., less than 32 completed weeks) as a measure of the quality of gestation. To control for potential confounding due to calendar effects, we also use a control population of nulliparous women who, based on EITC rules, cannot receive a large cash benefit.

The Earned Income Tax Credit

The EITC has become the largest federal cash transfer program for lower-income families in the U.S.[14] Two tax acts, in 1990 and 1993 (and placed into

effect in 1991 and 1994), doubled the real dollars of EITC disbursement between 1990 and 1996.[15]

To receive the EITC, a taxpayer must have a positive wage and salary income below a specified amount. The tiered payout structure favors low-income families with children. Figure 1 displays the EITC payouts based on family income and number of qualifying children for 1993, the midpoint of our analysis. Single or married couples with a qualifying child under age 19 receive over 95% of EITC dollars; in addition, low-income, single women with children stand to gain the largest share of the EITC by entering the labor force.[16]

Unlike other income transfer programs in which recipients obtain monthly checks, about 99% of taxpayers that qualify for the EITC receive their credit as an annual lump sum, with over two-thirds of these payments received in February or March.[17] This payment represents a large fraction of their annual income (see Figure 1). The literature also indicates that most EITC recipients immediately spend, rather than save, this payment. Edwards finds that recipients spend about 70 percent of their checks within two months.[17]

Very Preterm Births

Very preterm infants account for approximately 2% of births[1] but about 43% of infant deaths in the U.S.[18] Although the causes of very preterm delivery remain largely unknown, the literature finds that its incidence appears sensitive to ambient[19-21] as well as individual[22-24] stressors during the second and third trimester. Other exposures that reportedly influence the risk of very preterm

include weight gain during pregnancy[25], prenatal care,[6] and alcohol[26] and tobacco use.[27] The receipt of income, therefore, may either increase or decrease the incidence of very preterm depending on how recipients use the funds. They could reduce incidence by sheltering themselves better from stressors, improving nutrition, or accessing higher-quality health care. They, on the other hand, could increase the incidence by using funds for health-damaging goods.

Hypothesis

We test the hypothesis, suggested by the extension of the program to pregnant women, that the EITC disbursement varies inversely with the risk of very preterm births among low-income women likely to receive the EITC. We examine non-Hispanic black women who gave birth in California from 1989 to 1997. Black women exhibit the greatest risk of very preterm of any race/ethnicity[1] and appear more likely than mothers of other racial/ethnic backgrounds in California to receive a large EITC.[28]

Several reports find that increases in discretionary income may promote consumption of health-damaging goods (e.g., cigarettes, alcohol, illicit drugs) at the individual and family level.[29-31] Such responses by pregnant women or their families to the EITC may elevate the risk of a very preterm delivery. These circumstances imply that EITC benefits may vary positively with the incidence of very preterm births. We, therefore, examine our hypothesis with two-tailed tests of significance.

METHODS

Variables and Data

We know of no dataset of gravid women with information on both the EITC payout and the attendant birth outcome. As a surrogate, we used the California Birth File, which contains birth certificate information on all births to California residents. Reporting of births in California is believed to be nearly 100% complete.[32]

We examined California birth data for 108 months beginning in January 1989 and ending December 1997. We chose this period for three reasons. First, this series uses consistent definitions of the variables in the analysis (e.g., maternal race/ethnicity). Second the literature reports that the EITC reached a large proportion (i.e., 80 to 87%) of its intended beneficiaries over this period.[33] Third, during this time frame, the structure of other federal and state income-transfer programs remained relatively stable.

We specify as the dependent variable the odds of a very preterm birth, as measured by the clinical estimate of gestational age, among singleton, live births to non-Hispanic black women. We use very preterm rather than very low birth weight because infants born very low weight include both small-for-gestational age and preterm infants. Much literature reports distinct etiologies of these two outcomes and therefore recommends their separation in epidemiologic analyses. In addition, as compared with mild or moderately preterm births, very preterm births are less likely to be misclassified as term births when using gestational age estimates from vital statistics data.

The Birth File contains data on socio-demographic and perinatal variables, including maternal race/ethnicity, educational attainment, parity, Medicaid health insurance status and infant date of birth. We, as described below, use these variables to specify a population of gravid women that research suggests appear eligible for a relatively large EITC benefit.[15]

Tax rules permit classification of pregnant women based on their likelihood of receiving the EITC. Two key eligibility rules that we exploit include having a qualifying child and an income below a pre-specified amount. Before 1994, no EITC benefit accrued to taxpayers without children. Beginning in 1994, the Internal Revenue Service allowed a maximum credit of approximately $323 to childless families, which differs substantially from the allowable credit for single- or two- child families.[15] This difference implies that mothers who deliver their first live birth over our test period will receive little to no EITC. In contrast, mothers with previous children that deliver another live birth may receive a larger EITC.

The Birth File includes information on educational attainment of the mother as well as Medicaid health insurance status. Maternal education at or below a high school diploma in the U.S. serves as a strong predictor of low income status.[16] Moreover, California's Medicaid program (i.e., MediCAL) targets low-income individuals. Taken together, a large fraction of gravid mothers that report one or two previous children, MediCAL eligibility, and a completed education at or below a high school diploma would have incomes that qualify for the EITC. We use these criteria to identify black gravid women at "risk" of receiving the EITC. For the sake of brevity, we refer to this group as the

EITC Test Population. We use as the dependent variable the monthly odds of very preterm birth among the EITC Test Population.

Literature concerned with the antecedents of very preterm indicates that exposures during the second or third trimester of gestation may affect its incidence. Consistent with this logic, we classify the EITC Test Population from 1991 to 1997 as "exposed" if their infants were in the second or third trimester of gestation in February or March. We classify all other births as "unexposed." We consider infants born in the years 1989 and 1990 as unexposed since complicated tax rules prevented many low-income families from qualifying for the EITC.[16]

For reasons described below, we also include in our analysis the monthly odds of very preterm among black women that report *no previous children* but have MediCAL eligibility and a completed education at or below a high school diploma.

Design

The odds of very preterm may exhibit trend, the tendency to remain elevated or depressed, or oscillate after high or low values.[34] These patterns, referred to as autocorrelation, complicate observational tests because the expected value of the patterned series is not its mean. Researchers have addressed this problem by identifying autocorrelation and expressing it as an effect of earlier values of the dependent variable itself. This purely empirical approach, as outlined by Box and Jenkins,[35] removes autocorrelation from the

dependent variable such that the expected value of the residuals is zero. In our test, removing autocorrelation from the odds of very preterm before testing the effect of the EITC also minimizes the risk of a spurious association that could arise from a shared pattern between the EITC and high or low values of very preterm.

We build on the above logic but implement a more rigorous approach. We use as a control variable in the time-series equation the monthly odds of very preterm among gravid mothers that report *no previous children* but have MediCAL eligibility and an education at or below high school. These mothers do not qualify for the large EITC. Inclusion of this control variable removes any patterning in very preterm that was induced by forces at work for all low-income women. Our control strategy, therefore, precludes a type I error that could arise from an unmeasured confounder affecting both groups of gravid women that coincides with the EITC disbursement.

Analyses

We tested our hypothesis through the following four steps. First, we modeled the monthly odds of very preterm for infants from the EITC Test Population as a function of the monthly odds of very preterm among infants whose low-income mothers do *not* receive the EITC (i.e., no previous live births). Second, we inspected the residuals from Step 1 for autocorrelation. We used the strategy, referred to as autoregressive, integrated, moving average (i.e., ARIMA) models, to identify and model this autocorrelation for the 108 months beginning

January 1989. Third, we added the binary independent variable for the EITC, coded as "1" for Februaries from 1991 to 1997 and "0" otherwise, to the equation resulting from step 2. We specify an induction period between 2 to 5 months because we hypothesize that gestations in the second or third trimester during February/March may respond to the EITC. The EITC variables have lags of 2 (i.e., very preterm in April, two months after the February EITC) as well of 3, 4, and 5 months to insure capturing any second trimester effects. Fourth, we estimated the equation resulting from Step 3 and examined the error terms for autocorrelation. If any were found, we included the relevant ARIMA parameters and re-estimated the resulting equation.

If the time-series test indicated any statistically significant coefficients, we examined whether results generalized to low-income non-Hispanic white women in California. Although they exhibit a lower incidence of very preterm as compared with non-Hispanic blacks, white women may also respond to positive income shocks in ways that affect the quality of their gestation.

Our identification strategy can be viewed as analogous to an 'intent-to-treat' framework used for randomized clinical trials.[13] Briefly stated, we consider **X** the exposure ("treatment") of interest— a population of gravid women's receipt of the EITC in the second or third trimester; **Y**, the odds of very preterm; and **Z** **(**"treatment assignment**"**) the months of EITC disbursement among only the population identified as likely to receive the EITC. **Z** serves as a valid estimator of the effect of **X** on **Y** if it meets three conditions: (1) **Z** precedes, and affects, **X**; (2) **Z** affects **Y** only through **X**; and (3) **Z** and **Y** share no common cause. Given

these conditions, the **Z-Y** effect may approximate the **X-Y** effect, although the magnitude of the **Z-Y** effect relative to **X-Y** may be attenuated if **X** does not always equal **Z**. We apply this framework and use the month of EITC disbursement-very preterm effect (**Z-Y**) to estimate the EITC receipt-very preterm effect (**X-Y**).

The institutional review board of the California Department of Health Services and the University of California at Berkeley School of Public Health approved the study. We used de-identified, publicly available vital statistics data; therefore, informed consent was not required.

RESULTS

From 1989 to 1997 black mothers in the EITC Test Population had 70,895 live infants. We classified 2,636 of these infants as very preterm. Figure 2 plots the monthly odds of very preterm (mean = .0380; standard error [SE] = .0109).

Table 1 displays results from the time-series equation in which we include four lags of the EITC variable, the odds of very preterm among low-income black women with no previous children, and autocorrelation. The autoregressive parameter at Lag 3 indicates that high or low outlying values in very preterm were followed 3 months later with smaller outlying values in the same direction.

Contrary to our hypothesis, the odds of very preterm moves above its expected value following the EITC. The EITC coefficient at lag 2 months is positive and its 95 percent confidence interval does not contain the null value.

Outliers in very preterm other than those we hypothesize may have distorted our estimates. We applied outlier detection and correction routines to the equation in Table 1. These routines detected one outlier. Control for this outlier changed our estimates in that both the positive EITC coefficients at lags 2 and 3 months became larger (coef. at lag 2 = .0112, SE= .0042; coef. at lag 3 = .0079, SE = .0041).

The coefficient at lag 2 indicates a .011 increase in the odds of very preterm birth two months after the EITC disbursement. This result implies a 29% increase in the odds of very preterm above mean levels (i.e., .011 / .0380) statistically attributable to the EITC.

We then tested whether the discovered relation among black women generalized to low-income non-Hispanic white women who similarly may qualify for the EITC. Research finds that, unlike Hispanics in California over the test period, whites appeared likely to apply for, and receive, the EITC.[28] We proceeded through the same analytic steps as described in the Methods except that we now examined white mothers in California.

Over the test period, white mothers of the EITC Test Population yielded 188,585 live infants, of which 3,109 were very preterm (monthly mean odds of preterm = .0168; SE = .0036). Table 2 shows the final time-series model that includes the EITC at appropriate lags, the comparison population of low-income, nulliparous women who do not qualify for the EITC, and autocorrelation. The coefficients for EITC lags 3 and 4 months are positive and their 95 percent

confidence intervals do not contain 0. We tested whether findings appeared sensitive to outliers in very preterm births; no outliers were found.

Validation of the EITC Test Population

As described above, the validity of using the 'intent to treat' (**Z-Y**) effect to estimate the desired (**X-Y**) 'treatment' effect requires that **Z** affects **X**. We know of no data in California that allows us to gauge the magnitude of the **Z-X** relation (i.e., whether our designated EITC Test Population actually receives the EITC in February/March). As a surrogate, we used data from the Center for Disease Control and Prevention's Pregnancy Risk Assessment and Monitoring Survey (PRAMS) in the years 1996-1997.[36] PRAMS, a population-based survey of new mothers in 26 states, includes questions on dependent children and taxable income which allows identification of EITC-eligible households. We identified the PRAMS mothers that meet our "EITC Test Population" criteria (i.e., Medicaid eligible, high school education or less, one previous live birth) and calculated the proportion that has positive wage income to qualify them for the EITC.

Results indicate that ~47% of black and ~66% of white mothers in the PRAMS EITC Test Population qualify for the EITC. This finding provides indirect evidence of such a relation in California and that the coefficients in Table 2 and 3 approximate the treatment effect of EITC receipt on very preterm. However, due to imperfect treatment compliance—that is, not all women in the EITC Test

Population (**Z**) actually receive the EITC (**X**)—our results may underestimate the true effect.

DISCUSSION

Time-series analysis of low-income non-Hispanic black women in California indicates that the odds of a very preterm birth increases above expected values two months after the positive EITC income shock. Subsequent analysis of low-income white women in California also supports a positive relation. Taken together, these findings imply that the EITC disbursement may adversely affect gestations among low-income black and white women.

Strengths of the tests include adjustment for seasonality and other forms of autocorrelation in very preterm that occur generally across all low-income black (or white) mothers in California. Results, therefore, cannot arise from high values of very preterm that are "scheduled" in months following EITC disbursement. Furthermore, the acute timing of the EITC in February and March minimizes the possibility that health selection accounts for the results.

Several reports presage our findings. Prior research indicates that positive income shocks adversely affect health in low income populations.[29-31] These reports typically assume that these shocks increase use of health-damaging goods among individuals and/or families receiving the income. Recent

results from a randomized, large scale, conditional cash transfer program among low-income adults in Mexico further support this argument.[37]

We also note that the use of alcohol and illicit substances raises the risk of very preterm as do the stressors on the mother that follow from drug and alcohol use by others in a household (e.g., increased domestic violence by the spouse).[27,38,39] The literature, moreover, reports that lower-income blacks appear more likely than others to live in areas with a higher concentration of liquor stores, which raises the possibility that the discovered effects may arise in part from the interplay of community context and EITC receipt.[40] We remind the reader that data limitations precluded a direct test of these intervening mechanisms. These explanations, therefore, should not be taken as anything other than informed speculation.

Other limitations include that we did not have information on the cash value of EITC received. We caution against using the coefficients as measures of any association between personal EITC receipt and very preterm birth. We use the timing of EITC payout to gauge an ambient positive income shock to a population of low-income gravid women which should be considered similar to studies of the effect of air pollution or heat waves on health. Studies such as ours do not permit inference regarding individual-level responses to the exposure at any dose.

An intuitive reaction to findings such as ours might be that income transfers adversely affect gestations among female recipients. We caution against this inference for several reasons. These include that we studied the

effect of income shocks—not of transfers received at regular, relatively short intervals that approximate the receipt of income through labor market participation. Receipt of income at these regular intervals may raise overall income levels, promote investments in health, and improve the trajectory of the gestation.

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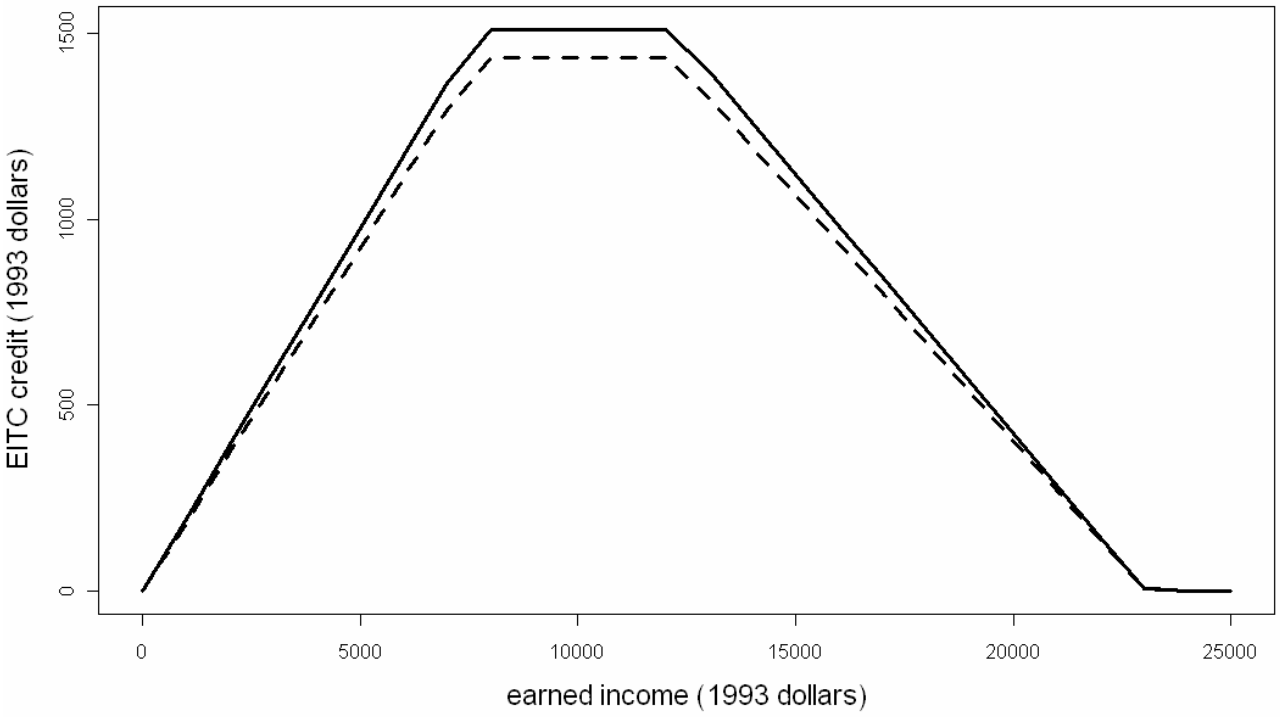

Figure 1. Earned Income Tax Credit benefits by earned income and number of qualifying children for 1993, the midpoint year of the test period.

Dashed line shows values for households with one qualifying child, solid line shows values for households with 2 or more qualifying children. In 1993, households with 0 qualifying children did not qualify for the credit. Values based on National Bureau of Economic Research Taxsim Program for married California residents filing jointly with no other sources of earned income.

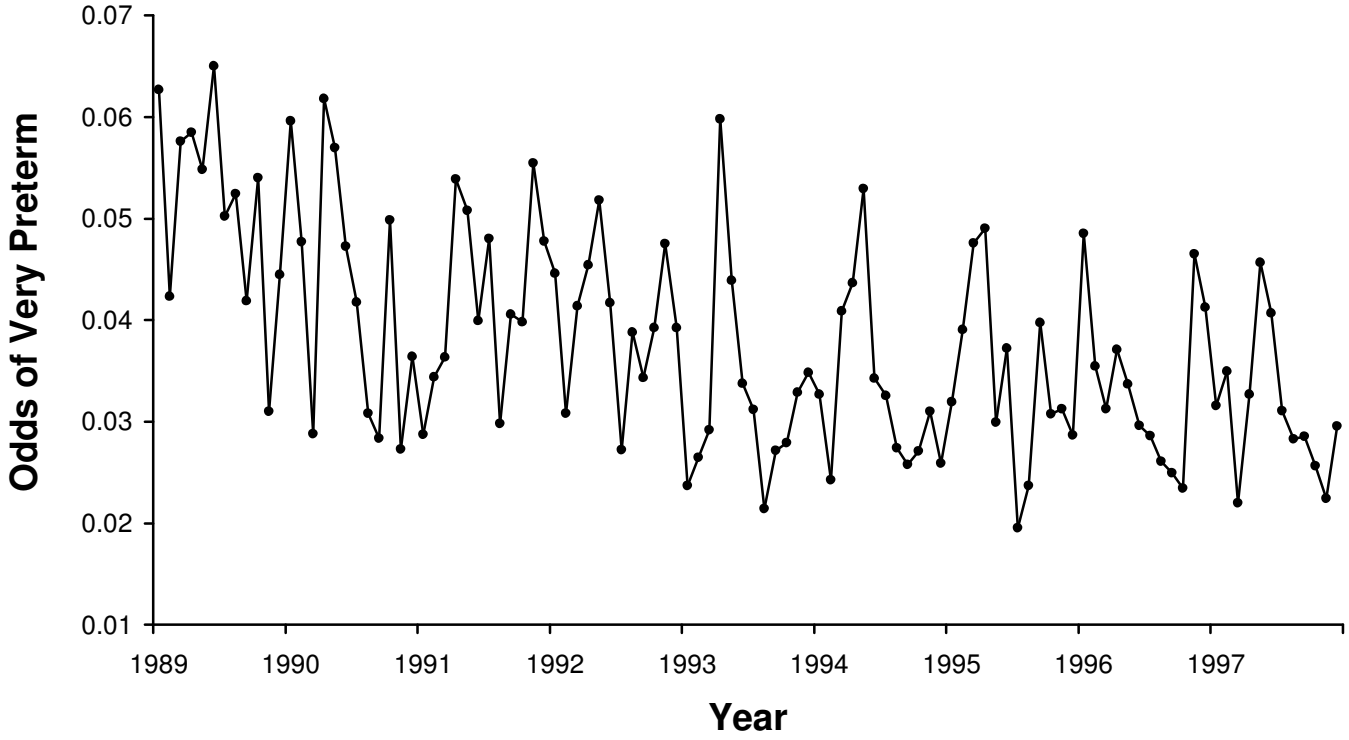

Figure 2. Monthly odds of a very preterm (i.e., < 32 completed weeks) birth among the EITC Test Population[1] in California.

[1] Non-Hispanic black mothers who report a previous live birth, Medi-CAL eligibility, and at or below a high school education

	Final Equation
Constant	none
Very Preterm for low-income	0.7544 (0.0399)***
mothers with *no previous children*	
Earned Income Tax Credit	
Lagged at:	
2 months	.0109 (.0044)*
3 months	.0076 (.0042)
4 months	-.0007 (.0042)
5 months	-.0007 (.0044)
Autocorrelation	
Moving Average Parameters	None
Autoregressive Parameters	
Lag 3	0.2786 (0.0967)**

*p<0.05; 2-sided test
**p<0.01; 2-sided test
***p<0.001; 2-sided test

Table 1. Non-Hispanic Blacks, Time Series equation for the odds of very preterm delivery (≤32 weeks) among the EITC Test Population (n = 108 months beginning January 1989). Standard errors in parentheses.

	Final Equation
Constant	0.0132 (0.0015)***
Very Preterm for low-income mothers with *no previous children*	0.1550 (0.0694)*
Earned Income Tax Credit	
Lagged at:	
2 months	.0006 (.0013)
3 months	.0030 (.0013)*
4 months	.0027 (.0013)*
5 months	-.0007 (.0012)
Autocorrelation	
Moving Average Parameters	
Lag 9	-0.3051 (0.1171)*
Autoregressive Parameters	
Lag 3	0.2440 (0.0999)*

*p<0.05; 2-sided test
**p<0.01; 2-sided test
***p<0.001; 2-sided test

Table 2. Non-Hispanic Whites, Time Series equation for the odds of very preterm delivery (≤32 weeks) among the EITC Test Population (n = 108 months beginning January 1989). Standard errors in parentheses.