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THE IMPACT OF MATERNAL ALCOHOL AND ILLICIT DRUG USE ON CHILDREN'S BEHAVIOR PROBLEMS: EVIDENCE FROM THE CHILDREN OF THE NATIONAL LONGITUDINAL SURVEY OF YOUTH

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ABSTRACT

This study uses data from the Children of the National Longitudinal Survey of Youth to test for evidence of a causal relationship between maternal alcohol use, marijuana use and cocaine use, and children's behavior problems. Ordinary least squares results provide strong evidence that maternal substance use is associated with children's behavior problems. Models that account for the potential endogeneity of maternal substance use yield mixed results. Models estimated using instrumental variables (IV) methods are inconsistent with OLS findings. Child-specific and family-specific fixed effects models, however, suggest that maternal alcohol, marijuana and cocaine use are associated with increases in behavior problems.

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INTRODUCTION

In 1996, approximately one out of ten American children was living in a household where at least one parent met clinical standards for alcohol and/or illicit drug dependence. Larger numbers of children in 1996 lived in households where one or more parents reported any illicit drug use [Huang et al. (1996)]. Previous researchers, mostly from the fields of psychology and psychiatry, have noted that parental substance abuse is associated with mental health problems in children, but it is not clear whether or not the relationship is causal. The observed positive correlation may be causal if illegal drug or alcohol consumption directly affects parenting ability. However, the observed relationship also may be due to unobserved factors that determine both parental substance use and children's mental health outcomes, such as environment or personality.

The objective of this study is to use a large, national sample of mothers and children to test for evidence of a causal relationship between maternal alcohol use, marijuana use and cocaine use, and children's early mental health problems, as measured by an index of behavior problems. Behavior problems during childhood are associated with psychiatric disorders, mental health services use, and delinquency later on in childhood and in adolescence [Gortmaker et al. (1990), Wacschlag et al. (1997)]. This study is based on the hypothesis that some forms of maternal substance use will interfere with the production of children's mental health by decreasing the quality of parenting inputs, or by reducing the productive efficiency of the mother. For example, use of substances by the mother may decrease the quality of the home environment or harm the parent/child relationship, leading to children's behavior problems.

Empirically, establishing a causal relationship between maternal substance use and children's behavior problems is not straight-forward. If unobserved factors exist that are

correlated with both maternal substance use and children's outcomes, an observed positive association may not be causal. For example, if mother and child both live in a stressful home environment or in a dangerous neighborhood, these issues may lead both to maternal substance use and to children's behavior problems. If the relationship between maternal substance use and children's outcomes can be explained by unobservable factors, programs and policies that reduce maternal substance use will not be effective in improving children's behavior problems. Alternatively, if maternal substance use is causally linked to children's outcomes, children will benefit from programs and policies that reduce maternal substance use. This study uses three methods to address this issue: (1) an instrumental variables (IV) method, which uses alcohol and illicit drug prices and policies as identifying instruments; (2) child-specific fixed effects models, which control for child-specific unobserved heterogeneity; and (3) family-specific fixed effects models, which control for unobserved heterogeneity at the level of the mother's family of birth.

The OLS results of this study suggest that after controlling for a range of socioeconomic and demographic factors, maternal alcohol use, marijuana use and cocaine use are all strong predictors of children's behavior problems. Child-specific and family-specific fixed effects models are consistent with the OLS findings. The results from instrumental variables (IV) estimation, which control for the correlation between substance use and unobserved characteristics, however, show no consistent relationship between maternal substance use and children's behavior problems. The identifying instruments performed very poorly in the first stage, casting doubt on the validity of the IV results. Overall, then, this analysis provides some evidence that the observed association between maternal substance use and children's behavior problems may be causal.

PREVIOUS LITERATURE

Researchers have identified a number of physiological, environmental, and genetic pathways that link maternal substance use to children's behavioral outcomes. First, maternal substance use during pregnancy may adversely affect a developing child's future behavioral outcomes through teratogenic processes. Second, maternal substance use may disrupt the home environment or affect parenting in a way that leads to children's behavior problems. Finally, mothers and children may share an unobserved genetic or environmental vulnerability to substance use and other types of problem behavior. Such a relationship may underlie what appears to be an observable physiological or environmental relationship.

These three pathways are not mutually exclusive. In fact, they are likely to overlap. Mothers who use substances during pregnancy are likely to continue substance use after pregnancy and are likely to face other genetic and environmental adversities. These factors in combination may affect children's behavioral outcomes. Determining the contribution of each of these factors is a difficult task.

Physiological Pathways: Prenatal Substance Exposure and Children's Behavioral Outcomes

Virtually all substances pregnant women ingest can cross the placenta and affect the developing fetus [Behnke and Eyler (1993)]. In many cases, prenatal substance use can lead to serious health consequences for infants. Tobacco use during pregnancy is associated with spontaneous abortion, stillbirth, perinatal death, and reduced birth weight [Fried (1993)]. Heavy alcohol use during pregnancy is linked to Fetal Alcohol Syndrome and Fetal Alcohol Effects. [Sokol & Clarren (1989)]. Very little is known about the consequences of marijuana use during

pregnancy, but there is suggestive evidence that cocaine use during pregnancy is associated with pregnancy complications, prematurity, and adverse neurological, behavioral, and fetal growth outcomes [Hans (1998), Richardson et al. (1993)].

Prenatal drug exposure also may lead to adverse behavioral outcomes that become apparent during childhood. Although it is not clear that the relationship is causal, smoking during pregnancy is associated with children's behavior problems, particularly attention deficit hyperactivity disorder (ADHD) and conduct disorder (CD) [Wacschlag et al. (1997), Fried et. al. (1992), Milberger et al. (1996), Weitzman et al. (1992), Kirstjansson et al. (1989)]. Although Fetal Alcohol Syndrome can include behavioral dysfunction, there is no evidence that lower levels of alcohol use during pregnancy have adverse effects on children's behavior [Sokol & Clarren (1989), Fried et al. (1992)].

Very little information is available on the association between prenatal illicit drug exposure and children's behavioral outcomes. Findings from the Ottawa Prenatal Prospective Study (OPPS) indicate that mothers who were regular marijuana users during pregnancy report higher rates of children's behavior problems compared to women who were not regular marijuana users during pregnancy. Prenatal marijuana exposure was associated with omission errors, one measure of attentional deficit [Fried (1995)]. A recent NIDA monograph focused on the long-term effects of prenatal drug exposure on behavioral outcomes [Wetherington et al. (1996)]. Although this monograph included some suggestive results, there is no conclusive evidence at this time that prenatal exposure to illicit substances results in adverse behavioral outcomes.

Environmental Pathways: Postnatal Maternal Substance Use and Children's Behavioral Outcomes

Prenatal exposure to substances has the potential to place children at risk for poor behavioral outcomes. The postnatal environment, however, becomes increasingly important as the child grows and develops [Fried (1993)]. In particular, maternal postnatal substance use may be an important factor in determining children's behavioral outcomes through its impact on parenting. There is evidence that substance use can affect the parent's ability to provide supervision and support for children, or to maintain a good relationship with children, and these problems in turn could lead to adverse outcomes. Parental substance use has been found to be positively associated with lower levels of supervision and discipline [Chassin et. al. (1993), Kandel (1990)]. Parental substance use problems also may lead to stress for children, or to conflict between children and parents [Barrera & Stice (1998), Chassin et. al. (1993)].

If substance use interferes with parenting, children of substance users might be more likely than other children to have mental health problems. Many researchers have found that children of substance abusing parents are at elevated risk for behavior problems and psychopathology. Kandel (1990), using a sample of 28-29 year old parents from a longitudinal study of New York State public high school students, finds that maternal drug involvement is positively related to both problematic parenting styles and children's behavior problems, as measured by maternal reports [Kandel (1990)]. Tarter et. al. (1993), Jacob et. al. (1986), Jansen et. al. (1995), and Puttler et. al. (1998) find that parental alcoholism is positively associated with children's behavior problems, as measured by the Child Behavior Checklist (CBCL) [Tarter et. al. (1993), Jansen et. al. (1995), Puttler et. al. (1998), Jacob et. al. (1986)]. Many other researchers report that parental substance use disorders are associated with numerous adverse

behavioral outcomes among pre-school to young adult children. These adverse outcomes include behavior problems, psychiatric symptoms, hyperactivity, and clinically significant depression, anxiety disorders and disruptive behavior disorders [Wacschlag et al. (1997), Clark et al. (1997), Stein et al. (1993), Stanger et al. (1999), Kuperman et al. (1999), Aytaclar et al. (1999), Sher et al. (1991)].

In addition to parental substance use disorders, researchers have identified a number of other factors that place children at elevated risk for adverse behavioral outcomes. These risk factors include premature birth, parental psychiatric disorder, family disruption and conflict, stressful life events, difficult temperament, low socioeconomic status, low parental education, and extensive maternal employment early in the child's life [Wacschlag et al. (1997), Clark et al. (1997), Chassin et al. (1991), Jansen et al. (1999), Kuperman et al. (1999), Najman et al. (1997), Baydar et al. (1991), Belsky et al. (1991)].

Economic Studies of Parental Substance Use and Children's Behavioral Outcomes

To the best of the authors' knowledge, only one group of researchers has used an economic approach to study the impact of parental substance use on children's behavioral outcomes. Jones et al. (1999) use data on parents and children from the 1988 National Health Interview Survey to estimate the impact of maternal and paternal alcohol use on children's behavior problems, as measured by the Behavior Problems Index (BPI) [Jones et al. (1999)]. After using an instrumental variables approach to account for the endogeneity of parental alcohol use, these researchers find consistent evidence that the number of alcoholic drinks consumed in the past year by the parent is positively associated with higher BPI scores (indicating more behavior problems) among children. As the authors acknowledge, however, the

identifying instruments used in the analysis had fairly low joint F statistics, which potentially resulted in biased IV estimates.

Like the Jones et al. (1999) paper, this analysis enhances the existing literature on the effects of parental substance use on children's mental health by: (1) using a national sample of mothers and children, while most existing research is based on much smaller, clinical samples; (2) using econometric methods that account for the potential endogeneity of parental substance use; and (3) considering the effects of substance use itself rather than clinically defined abuse and dependence. This study also builds on the Jones et al. (1999) paper in several ways. First, this analysis considers the impact of mothers' illicit drug use as well as alcohol use on children's behavior problems. Because large numbers of children live with parents who use and abuse illicit drugs, it is essential that researchers also address the effects of illicit drug use on children's behavioral outcomes. Furthermore, because the identifying instruments used in this analysis had fairly low predictive power, this analysis is also based on child-specific fixed effects models and family-specific fixed effects models which account for two types of unobserved heterogeneity. The use of these methods allows a comparison of results between three methods that account for endogeneity.

ANALYTIC FRAMEWORK

The equation to be estimated can be viewed as a child's mental health capital production function:

1) $BPI_{ijt} = \alpha_0 + \alpha_1 S_{jt} + \alpha_2 X_{it} + \alpha_3 X_{jt} + \alpha_4 u_i + \alpha_5 u_j + \varepsilon_{ijt}$.

This production function is specific to the ith child of mother j at time t. The output of the production function is measured by the standardized percentile score on the Behavior Problems

Index (BPI). The variable S_{jt} is a vector of alcohol and illicit substance use measures. The vector X_i includes observed child-specific factors that may determine behavioral problems, such as the child's age, gender, and mental health endowment at birth, as proxied by low birth-weight. The vector X_j includes observed mother-specific factors that may determine the child's behavioral problems. Such factors include maternal education, marital status, and household size. The vectors u_i and u_j represent the time-invariant unobserved child and maternal factors, respectively, that affect a child's mental health. Such factors can include the home environment, genetic traits or personality. The vectors u_i and u_j may have many of the same elements in common if, for example, the mother and child both reside in a violent or stressful home environment.

A maternal demand equation for a substance (alcohol or illegal drugs) is presented in equation 2:

2) $S_{jt} = \beta_0 + \beta_1 P_t + \beta_2 Y_{jt} + \beta_3 u_j + \omega_{jt}$,

where P_t is the full price of alcohol and illicit drugs which varies by state and time, and Y_{jt} represents the mother's observed characteristics which may affect illicit drug and alcohol use. The vector P_t contains the prices of both alcohol and illegal drugs because drugs and alcohol may be substitute or complement goods. The vectors X_{jt} in equation 1 and Y_{jt} in equation 2 may have many or all of the same elements in common. As in equation 1, unobserved individual traits (u_j) which do not vary over time also are determinates of maternal substance use.

Many of the studies discussed in the literature review have used ordinary least squares (OLS) to estimate equation 1. However, estimating equation 1 by OLS can lead to biased and inconsistent coefficients if maternal substance use is determined by the same unmeasured, individual-level factor that determines a child's behavioral problems ($\alpha_5 \neq 0$

and $\beta_3 \neq 0$). In this case, u_j is present in both the child behavior and alcohol equations. Thus, estimating the coefficients by OLS will violate the requirement that the right-hand side variables be orthogonal to the error term.

In order to avoid the problems presented by OLS estimation, the two stage least squares (TSLS) method is used to estimate equation 1. This technique requires that at least one exogenous variable (instrument) exists that is a predictor of maternal substance use but is not correlated with the error term in the behavior problems equation. When estimating equation 1 by TSLS, substance use is first predicted by the instruments and then the predicted values are used as regressors in equation 1. The predicted values of consumption are purged of their correlation with the error term in the behavior equation, leading to unbiased estimates of maternal drug and alcohol use on children's behavioral problems. A positive coefficient on predicted alcohol or drug consumption will indicate that increased substance use leads to increased behavioral problems. A zero coefficient provides evidence against causality.

The success of the TSLS method depends on the predictive power of the instruments in the first stage equations. Bound et al. (1995), Bollen et al. (1995), Nelson & Startz (1990), Staiger & Stock (1994) and others all have noted that a low first stage F statistic for the identifying instrumental variables may suggest that the TSLS estimates are no better than biased OLS estimates. Because of this potential problem, this study also uses fixed-effects models to account for unobserved heterogeneity. Fixed-effects models in this study take advantage of two features of the data: (1) some mothers in the data are sisters and, consequently, some children in the sample are cousins; and (2) two or three BPI scores (for the years 1988, 1992, and 1994) are available for each child. Fixed-effects methods model unobserved heterogeneity as a variable

that is unique to each mother's family of birth and unique to each individual child. The former is a family-specific fixed-effect model that is based on the idea that mothers may have obtained parenting skills and other attributes that affect their children's behavioral outcomes from their family of birth. The latter is a child-specific fixed-effect model that presumes that the individual child has unobserved fixed attributes that influence behavior problems. Some of these attributes may be shared with the mother (i.e. home environment).[2] Both these approaches use differences in maternal substance use and differences in children's behavior problems within extended families and within individual children over time. Consequently, the methods rely on the existence of sufficient variation in maternal substance use and BPI scores within extended families and within individual children over time.[3]

THE CoNLSY DATA

The data used in this study come from the Children of the National Longitudinal Survey of Youth (CoNLSY). The National Longitudinal Survey of Youth (NLSY79) is an annual, national survey that was initiated in 1979 with a sample of 12,686 young people who at that time were aged 14-21. NLSY79 respondents provided extensive information on labor market participation, education, fertility, substance use, attitudes and family background. Beginning in

[2] Models also were tested that include a fixed effect for the mother. Results are very similar to the child specific fixed-effects models presented below. The interpretation of a mother fixed-effect is not straightforward in that it compares differences in the mother's substance use over time to differences in her children's behavioral scores both at a point in time and across time. Since the mother's substance use does not vary among her children in a given year, the child fixed-effect encompass the mother fixed-effects. The family specific fixed effects models are advantageous because they rely on variation in extended families at a point in time and over time.

[3] There are substantial differences in the maternal drinking variable over time. Fifty-three percent and eighty-five percent of mothers report different numbers of days on which they drank in the past month between their 1988 and 1992, and 1992 and 1994 observations, respectively. There is much less variation in the illegal drug use measures over time. Eleven percent of mothers report different marijuana use status between 1988 and 1992, and eight percent of mothers report different marijuana use status between 1992 and 1994. Four percent of mothers report different cocaine use status between the 1988 and 1992 surveys and two percent of mothers report different cocaine status between the 1992 and 1994 surveys. The children's BPI scores demonstrate significant variation over time;

1986, children of female NLSY79 respondents were assessed in a range of areas important in child development, including motor, cognitive, and social development and behavior problems.

This analysis utilizes information on children's behavior problems index scores, child characteristics, and maternal characteristics from the 1988, 1992, and 1994 CoNLSY surveys. Children who were between 4-14 years old and who have valid data for behavior problems scores and maternal substance use measures in at least one survey year (1988, 1992 or 1994) are included in the main analysis sample. Children who have missing data for family income, age, birth-weight, mother's marital status, family size, religion, mother's education, mother's Armed Forces Qualification Test Score, and father's residence in child's household are included in the analysis sample with the missing data imputed with sample means. The final sample size is 10,579, which includes data for 6,194 children. For the family-specific fixed effects models, which require that each mother have at least one sister in the sample, the sample size is 2,498. For the child-specific fixed effects models, which require either two or three observations per child, the sample size is 7,546.

Behavior Problems Index

The Behavior Problems Index (BPI) is based on the Achenbach Behavior Problems Checklist and other child behavior scales. The BPI measures the frequency, range and type of childhood behavior problems for children at least four years old using responses from mothers [Peterson & Zill (1986)]. The BPI consists of 28 items pertaining to antisocial behavior, anxiousness/depression, headstrongness, hyperactivity, immaturity, dependency and peer conflict/social withdrawal. Mothers respond "often", "sometimes true" or "not true" to each item

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very few children had the same BPI scores in two years. Between 1988 and 1992, the mean percentage change in BPI scores was 27% and between 1992 and 1994, the mean percentage change in BPI scores was 15%.

which describes a particular troubling behavior such as “too fearful or anxious”, “not liked by other kids” or “cheats or lies”. Items with responses of “often” or “sometimes true” receive a value of one while the response “not true” receives a value of zero. The responses on the 28 items are summed and then normed based on data from the 1981 National Health Interview Survey. This study uses percentile scores from these normed distributions. Higher scores indicate higher levels of behavior problems.

Behavior problems may reflect the beginning of mental health problems as well as normal stages in child development [Crockenberg & Litman (1990), Campbell (1990)]. Consequently, the prevalence of behavior problems in populations of normal children is quite high. In populations of normal preschool children, the estimated prevalence rates for mild to moderate levels of behavior problems range from 10-15 percent [Cornely & Bromet (1986), Earls (1980)]. Although some children in this analysis may meet clinical criteria for mental disorders, the BPI percentile scores used in this study are not comparable to a DSM IV clinical diagnosis.

Even though percentile scores do not constitute a clinical diagnoses, there is evidence that young children with high percentile scores on the CBCL and other behavior problem scales are more likely than other children to have persistent behavior problems, DSM III diagnoses of externalizing disorders in later childhood, and mental health services use later in childhood [Achenbach et al. (1995), Campbell & Ewing (1990), McGee et. al. (1991), Gortmaker et. al. (1990)]. The BPI therefore offers a useful measure of children’s emerging mental health problems. In this study, children’s behavior problems will be measured by the child’s normed percentile total score on the BPI. Table 1 displays means and standard deviations for behavior problems scores for the main analysis sample.

Maternal Substance Use Measures and Other Covariates

This analysis is based on mothers' self-reports about alcohol and illicit drug use from the 1988, 1992 and 1994 surveys. Information about alcohol consumption in the past month, past year marijuana use and past year cocaine use are available in the 1988, 1992 and 1994 surveys. Past month binge drinking information is available in the 1988 and 1994 surveys only. The four substance use measures used in this analysis are: (1) number of days alcohol was consumed in the past month; (2) a dichotomous indicator for any binge drinking in the past month; (3) a dichotomous indicator for any marijuana use in the past year; and (4) a dichotomous indicator for any cocaine use in the past year. Mensch & Kandel (1988), Fendrich & Vaughn (1994), and Fendrich & Mackesy-Amiti (1995) all find that NLSY79 respondents may have under-reported or inconsistently reported their substance use. Like any type of measurement error, as long as under-reporting is random, it will lead to estimates that are less precise but still consistent.

Table 1 displays the percentage of mothers who reported substance use in the main analysis sample. Although the mothers consumed alcohol on an average of 5.07 days in the past month, past month binge drinking was less frequent (18.5 percent), and fairly small percentages of mothers reported marijuana use (10.7 percent) and cocaine use (2.9 percent) in the past year. In addition to maternal substance use, the models also include variables that control for the child's endowment of mental health at birth (proxied by low birth-weight) and a number of other exogenous, child-specific and mother-specific characteristics that have been linked to behavior problems. Table 1 summarizes these variables.

Table 2 displays cross-tabulations of changes in maternal illicit drug use over time and changes in children's BPI scores over time. Children whose mothers stopped using marijuana

between two survey years experienced decreases in BPI scores while children whose mothers started using marijuana between two survey years experienced increases in BPI scores. This pattern was true for cocaine use and children's BPI scores in 1992 and 1994, but not true for cocaine use and children's BPI scores in 1988 and 1992.

Instruments

Moffitt (1991) suggests that suitable instruments are more likely to be found from "…variation in the availability, rather than the actual receipt, of treatment across the population." This study takes advantage of geographical variability in the availability of substances by using alcohol and illicit drug prices and policies as identifying instruments. These measures are theoretically valid instruments because there is little reason to believe that the prices of drugs and alcohol are predictors of children's behavior problems, holding consumption constant. Prices, however, should predict consumption. Previous research has show that consumption of these goods is negatively related to their prices [Leung & Phelps (1993), Grossman & Chaloupka (1998), Saffer & Chaloupka (1999)].

A number of variables are used as instruments, including the real (1982-1984=1) state-level excise tax on beer, the real price of cocaine, and an indicator for whether a state has decriminalized the possession of small amounts of marijuana for personal use. Prices of marijuana generally are not available so the decriminalization indicator is used instead. For this variable, a value of 1 means the state has decriminalized; thus, users in these states face a lower expected penalty and a lower price of possessing marijuana. Beer taxes come from the Beer Association's *Brewer's Almanac*, cocaine prices come from the Drug Enforcement Administration's System to Retrieve Information from Drug Evidence (STRIDE), and information on decriminalization of marijuana comes from the Bureau of

Justice Statistics (1995). The methodology for creating the cocaine price series is described in detail in Grossman and Chaloupka (1998). Finally, total spending in 1991 by each state on police in drug enforcement per capita is included. These data come from the Office of National Drug Control Policy's, *State and Local Spending on Drug Control Activities: Report from the National Survey of State and Local Governments*.

To capture the full price of alcohol consumption, two variables representing the availability of alcohol are included. First, the percentage of each state's population living in counties dry for beer in each of the survey years is included. These data come from the Beer Institute's *Brewers' Almanac* (1996). Secondly, the number of retail outlets per 1,000 population that are licensed to sell alcoholic beverages for on-premise or off-premise consumption is included. These data come from *Jobson's Liquor Handbook*, (various years). With larger percentages of populations living in dry counties or with fewer outlets available, travel time to obtain alcohol increases, adding to the full price of alcohol.

In addition to these instruments, variables that enter the first stage include the characteristics of the mother, child and the household, although these variables also appear in the second stage equations as well.

REGRESSION RESULTS

Initially, the models are estimated using ordinary least squares (OLS) to establish baseline estimates of the effects of maternal substance use on children's behavior problems. Although the OLS method ignores the potential endogeneity of maternal substance use, it offers the advantage of being robust to many specification errors. OLS results are displayed in the first columns of Tables 3-7. The second column of each table shows the TSLS coefficients, while

columns 3 and 4 show the child-specific and family-specific fixed effects results, respectively. According to equation 1, the use of any or all three of the substances may potentially affect a child's BPI score. Nevertheless, the models in Tables 3-6 each include a different measure of substance use separately, while Table 7 presents estimates with alcohol, marijuana and cocaine use measures included simultaneously. The substances are initially included individually because of potential collinearity problems. First, marijuana and cocaine consumption tend to be highly correlated and entering the substances one at a time demonstrates the impact of the one substance on behavioral problems.[4] Secondly, in the TSLS estimates, all three substances are predicted by the same set of variable making the predicted values highly collinear, with the result that the effect of one substance becomes practically indistinguishable from the others. For this reason, Table 7 excludes TSLS models.

The OLS results in each table strongly suggest that maternal substance use is positively associated with children's behavior problems after controlling for a range of other factors. The number of days alcohol was consumed in the past month, any maternal binge drinking in the past month, any marijuana use in the past year, and any cocaine use in the past year all increase children's BPI scores. The magnitude of this impact is fairly modest for alcohol. An incremental increase in the number of days the mother drank in the past month is associated with a less than 1 percent increase in BPI scores at the mean BPI score in the sample (Table 3). Maternal binge drinking is associated with an increase of about 2.3 percentage points in BPI scores, which represents about a 4 percent increase at the mean BPI score in the sample (Table 4). Maternal marijuana and cocaine use (Tables 5 and 6), however, are associated with increases of 7.6 and 6.4 percentage points in BPI scores. These increases represent percentage increases of about 12

[4] In the main analysis sample, the Pearson correlation coefficient between marijuana and cocaine use was .34 which is statistically significant at the .01 level.

percent and 10 percent respectively at the mean BPI score in the sample. Although the alcohol and cocaine measures are statistically insignificant when the substance use measures are included in the same model, the magnitude and statistical significance of the marijuana effect remains constant (Table 7). These OLS findings strongly support previous literature, mostly based on smaller, clinical samples, that indicates that parental substance use disorders are associated with adverse mental health outcomes among children.

The OLS models also offer interesting information about the impact of child and family characteristics on behavior problems. Girls have lower BPI scores than boys, and child's age is positively related to behavior problems. Low birth-weight (5.5 pounds or less at birth) also is a positive, statistically significant predictor of behavior problems; this finding is consistent with clinical literature.[5] Children from higher socioeconomic backgrounds, as measured by family income and maternal education, have lower levels of behavior problems compared to children from lower socioeconomic backgrounds. Maternal employment also has a negative impact on behavior problems, suggesting that maternal employment captures some aspects of socioeconomic status in the models. Finally, children who live with their fathers and children with married mothers have lower levels of behavior problems compared to children who live without their fathers or in single-parent households.

To account for the potential endogeneity of the maternal substance use measures, the models are estimated using the TSLS method with alcohol and illicit drug prices and policies as identifying instruments.[6] Because the binge drinking, marijuana and cocaine use measures are dichotomous, the first stage for these models is estimated using linear probability models. The

[5] Low birth weight may be endogenous. The models were run with and without this variable, and there were no appreciable differences in the results.

[6] It is questionable whether or not the child-level variables (child's age, low birth weight and gender) should be included in the first stage. For ease of computation, these variables are included in both stages. Models were tested

predicted probabilities of substance use are then substituted into the BPI equations which are estimated using robust standard errors [Heckman and MaCurdy (1985)] . TSLS results are displayed in the second columns of Tables 3-6. In contrast to the OLS results, the TSLS results yield no consistent evidence of a statistically significant relationship between maternal substance use and BPI scores. All of the substance use measures are negative in sign and are statistically insignificant. Nevertheless, these TSLS estimates are not trustworthy because the instruments are not strong predictors of maternal substance use. The identifying instruments as a group are statistically significant predictors of maternal substance use. However, with the exception of the number of days alcohol was consumed in the past month, the R-squared statistics on the first stage equations all are below 0.10. Hausman tests indicate that the consistency of OLS cannot be rejected in all but the cocaine models.

Table 8 displays first stage results, which highlight some interesting relationships between prices and policies and maternal substance use. State excise taxes on beer are inversely related to drinking (although the effect is statistically significant only at the 10 percent level in a two-tailed test for number of days drink), marijuana use, and cocaine use. The percentage of the population in the state living in dry counties is inversely related to the number of days alcohol was consumed in the past month, marijuana use, and cocaine use. These findings suggest that mothers in this sample use alcohol and illicit drugs as complements. This evidence is consistent with other work based on samples of youth [Yamada et. al. (1998), Kenkel (1993), Moore & Cook (1995), Cook & Moore (1993), and Pacula (1998)]. Marijuana decriminalization is associated with increases in maternal marijuana and cocaine use. This finding is consistent with some studies that also report that marijuana decriminalization leads to increases in illicit drug use

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without these variable in the first stage, but their inclusion does not affect the predicted value of maternal substance use.

[Chaloupka et. al. (1998), Saffer & Chaloupka (1999), Model (1993)]. The price of cocaine is negatively related to cocaine use, but the effect is statistically insignificant. The price of cocaine, however, is negatively related to the number of days alcohol was consumed in the past month, again providing evidence that alcohol and cocaine are complements. Finally, increased spending on police for drug enforcement in 1991 has a negative impact on binge drinking, but it is also associated with increases in marijuana use.

Even though the measures of price in the first stage equation are generally consistent with economic theory, the instruments are not strong enough to render the TSLS estimates trustworthy. The poor performance of the instruments in the TSLS method suggests that other methods of accounting for endogeneity may be superior in this analysis. For this reason, the BPI models also are estimated using child-specific fixed effects models (where the fixed effect corresponds to the child) and family-specific fixed effects models (where the fixed effect corresponds to the mother's family of birth). Columns 3 and 4 of Tables 3-7 present results from these two models. (Mothers were asked about binge drinking only in 1988 and 1994, so the binge drinking fixed effects models are estimated using a subset of the full analysis sample.)

Like the OLS models, the fixed effects models indicate that maternal drinking, marijuana use, and cocaine use have a positive effect on children's behavior problems. In the child-specific fixed effects models, the number of days alcohol was consumed in the past month and marijuana use in the past year both have positive, statistically significant effects on children's behavior problems. The magnitude of these impacts is less than 1% for maternal drinking and 7% for maternal marijuana use at the mean BPI score in the sample. Cocaine use in the past year has a positive but statistically insignificant impact on behavior problems, and the impact of binge drinking is negative and statistically insignificant.

The family-specific fixed effects models support the child-specific fixed effects model results and the OLS model results. The number of drinks consumed in the past month has a small but positive, statistically significant impact on behavior problems. The marijuana use measure is positive and statistically significant at the 1 percent level. The family-specific fixed effect model indicates that marijuana use is associated with an 8 percent increase in BPI scores. The family-specific fixed effect models also indicate that cocaine use is associated with a statistically significant, 19 percent increase in BPI scores at the mean score in the sample.

SUMMARY AND CONCLUSIONS

This study provides some evidence that maternal substance use may be linked causally to children's behavior problems. Although TSLS results are problematic due to the poor performance of the identifying instruments, OLS models, child-specific fixed effects models, and family-specific fixed effects models all suggest that maternal alcohol, marijuana and cocaine use are associated with increases in 4-14 year old children's BPI scores. The magnitude of this effect is very small for the number of days alcohol was consumed in the past month. The impact of past year marijuana and cocaine use, however, ranges from 10-12 percent in the OLS models, and from 7-19 percent in the fixed-effects models. These increases in children's behavior problems are quite dramatic because the maternal illicit drug use measures are broad, capturing any use of marijuana or cocaine in the past year. The results of this study, therefore, suggest that programs and policies that reduce maternal use of illicit substances may have the added benefit of reducing adverse behavioral outcomes in children.

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Table 1
1988, 1992, 1994 Sample Means and Standard Deviations

Behavior Problems Index	Mean (N=10,579)	Standard Deviation
Standardized total percentile score	61.38	26.90
Maternal Substance Use		
Number of days consumed alcohol in past month	5.07	9.07
Had one or more binge drinking episodes in the past month (1994 data only)	0.185	0.389
Used marijuana in the past year	0.107	0.309
Used cocaine in the past year	0.029	0.406
Child Characteristics		
Female	0.496	0.500
African-American	0.319	0.466
Hispanic	0.208	0.406
Age	8.36	2.74
Weighed 5.5 pound or less at birth	0.082	0.269
Family Characteristics		
Mother's Armed Forces Qualification Test (AFQT) revised percentile score	32.54	25.11
Age of mother	30.65	3.01
Number of grades completed by mother	12.14	2.17
Mother is married	0.596	0.491
Mother is employed	0.594	0.491
Family income	$35,609	$25,111
Family size	4.44	1.51
Child's father lives in household	0.602	0.459
Mother is Baptist/Methodist	0.360	0.479
Mother is Catholic	0.332	0.385
Identifying Instruments		
State excise tax on beer	$0.479	$0.478
Marijuana is decriminalized	0.327	0.469
Cocaine price	$98.44	$22.74
Number of outlets licensed to sell liquor on or off premises in state per capita	2.87	6.53
% Population in state living in dry county	4.58	8.18
Total spending on police drug enforcement per capita	$28.83	$81.12

Table 2
Mother's Illicit Drug Use and Behavior Problems Index (BPI) Scores

	Average % Point Change in BPI Score, 1988-1992 (standard deviation) [N]		**Average % Point Change in BPI Score, 1992-1994 (standard deviation) [N]**	
all children	1.04 (24.87) [3842]		-3.98 (22.74) [6908]	
mother's illicit drug use	**marijuana**	**cocaine**	**marijuana**	**cocaine**
used both years	6.53 (22.19) [184]	-4.22 (7.57) [27]	-3.76 (21.64) [296]	-4.11 (12.37) [33]
ceased use in later year	-3.91 (21.01) [306]	3.33 (23.64) [131]	-5.10 (19.51) [220]	-3.84 21.39 [83]
started use in later year	3.06 (18.05) [122]	3.62 (18.58) [33]	1.44 (21.58) [335]	6.51 (19.25) [86]
never used	1.12 (25.49) [3230]	.973 (25.05) [3651]	-4.25 (22.93) [6057]	-4.12 (22.81) [6706]

Table 3
Effects of Number of Days Drink on BPI
1988, 1992, 1994 Sample

	OLS (1)	TSLS (2)	Child Specific Fixed Effect (3)	Family Specific Fixed Effect (4)
Drink	0.064	-0.987	0.101	0.160
	(1.97)	(-1.54)	(3.67)	(2.76)
Female	-4.980	-5.026		-5.542
	(-9.86)	(-9.48)		(-5.30)
Black	-1.364	-2.057		
	(-1.86)	(-2.35)		
Hispanic	-0.501	-2.366		
	(-0.64)	(-1.69)		
AFQT	-0.013	0.009		-0.144
	(-0.94)	(0.43)		(-2.83)
Low birth weight	2.563	2.561		4.542
	(2.71)	(2.59)		(2.35)
Child's age	0.797	0.744		0.966
	(7.81)	(6.67)		(4.69)
Mother's age	-0.098	-0.050		-1.376
	(-0.79)	(-0.38)		(-6.35)
Mother's education	-1.006	-1.004	-1.622	-0.058
	(-6.74)	(-6.41)	(-2.49)	(-0.12)
Married	-3.012	-4.439	-0.820	-0.739
	(-3.92)	(-3.74)	(-0.75)	(-0.41)
Employed	-1.521	-0.832	-1.330	-0.598
	(-2.82)	(-1.18)	(-1.79)	(-0.49)
Family income	-0.00002	-0.00001	1.91E-07	-6.66E-06
	(-4.61)	(-1.34)	(0.05)	(-0.66)
Family size	0.248	0.060	0.1389	-0.331
	(1.37)	(0.27)	(0.44)	(-0.81)
Father in household	-3.121	-3.743	2.673	-2.617
	(-3.77)	(-3.95)	(2.79)	(-1.57)
Baptist/Methodist	-0.469	-0.573		
	(-0.75)	(-0.87)		
Catholic	-2.544	-1.574		
	(-3.23)	(-1.55)		
1992	-2.783	7.509		
	(-3.29)	(1.18)		
1994	-8.574	-8.837		
	(-10.39)	(-10.04)		
N observations	10,579	10,579	7,546	2,498
N groups			3,138	347
R-squared	0.07			
F-test on instruments		4.92		
Hausman test		2.55		

Note: T-statistic in parentheses and intercept not shown. The critical value for the test of the instruments with 6 degrees of freedom is 2.10 at the 5 percent level and is 2.80 at the 1 percent level. The critical value for the Hausman test with 1 degree of freedom is 3.84 at the 5 percent level.

Table 4
Effects of Binge Drinking on BPI
1988, 1994 Sample

	OLS (1)	TSLS (2)	Child Specific Fixed Effect (3)	Family Specific Fixed Effect (4)
Binge	2.290	-3.823	-0.265	-0.044
	(2.97)	(-0.22)	(-0.17)	(-0.02)
Female	-5.166	-5.179		
	(-8.80)	(-8.77)		
Black	-1.980	-2.506		
	(-2.34)	(-1.45)		
Hispanic	-0.764	-1.369		-5.247
	(-0.85)	(-0.70)		(-4.19)
AFQT	-0.013	-0.018		-0.096
	(-0.79)	(-0.84)		(-1.55)
Low birth weight	2.452	2.509		5.137
	(2.25)	(2.35)		(2.23)
Child's age	0.646	0.673		0.721
	(5.57)	(4.76)		(2.94)
Mother's age	0.142	0.093		-1.205
	(0.98)	(0.46)		(-4.81)
Mother's education	-0.770	-0.836	-1.323	0.040
	(-4.40)	(-3.19)	(-1.40)	(0.07)
Married	-1.579	-2.216	0.667	1.464
	(-1.68)	(-1.08)	(0.36)	(0.62)
Employed	-0.719	-0.558	-0.293	0.483
	(-1.14)	(-0.71)	(-0.23)	(0.32)
Family income	-0.0001	-0.0001	-1.10E-04	-1.01E-04
	(-5.90)	(-6.16)	(-4.00)	(-2.55)
Family size	0.345	0.329	0.4090	-0.306
	(1.63)	(1.50)	(0.79)	(-0.62)
Father in household	-3.572	-3.676	5.389	-3.726
	(-3.97)	(-3.86)	(2.62)	(-1.74)
Baptist/Methodist	-0.047	-0.205		
	(-0.07)	(-0.24)		
Catholic	-2.412	-2.294		
	(-2.47)	(-2.17)		
1994	-8.832	-8.777		
	(-9.82)	(-9.60)		
N observations	7,733	7,733	4,711	1,794
N groups			3,138	347
R-squared	0.08			
F-test on instruments		2.44		
Hausman test		0.02		

Note: T-statistic in parentheses and intercept not shown. The critical value for the test of the instruments with 6 degrees of freedom is 2.10 at the 5 percent level and is 2.80 at the 1 percent level. The critical value for the Hausman test with 1 degree of freedom is 3.84 at the 5 percent level.

Table 5
Effects of Marijuana Use on BPI
1988, 1992, 1994 Sample

	OLS (1)	TSLS (2)	Child Specific Fixed Effect (3)	Family Specific Fixed Effect (4)
Marijuana	7.618	-11.091	4.271	5.044
	(9.17)	(-0.69)	(3.62)	(2.54)
Female	-4.927	-5.064		-5.517
	(-9.79)	(-9.58)		(-5.27)
Black	-1.173	-1.745		
	(-1.61)	(-1.95)		
Hispanic	-0.140	-1.303		
	(-0.18)	(-1.03)		
AFQT	-0.016	-0.005		-0.141
	(-1.17)	(-0.32)		(-2.78)
Low birth weight	2.446	2.732		4.537
	(2.60)	(2.82)		(2.35)
Child's age	0.794	0.793		0.975
	(7.81)	(7.48)		(4.74)
Mother's age	-0.066	-0.137		-1.388
	(-0.54)	(-0.99)		(-6.41)
Mother's education	-0.956	-1.079	-1.563	0.054
	(-6.42)	(-5.83)	(-2.39)	(0.11)
Married	-2.528	-3.928	-1.306	-1.303
	(-3.29)	(-2.74)	(-1.20)	(-0.74)
Employed	-1.358	-1.656	-1.288	-0.790
	(-2.53)	(-2.71)	(-1.74)	(-0.64)
Family income	-0.00002	-0.00002	2.00E-06	-3.71E-06
	(-4.45)	(-4.19)	(0.47)	(-0.37)
Family size	0.300	0.145	0.1379	-0.292
	(1.66)	(0.64)	(0.44)	(-0.72)
Father in household	-2.972	-3.430	3.843	-1.518
	(-3.60)	(-3.67)	(4.20)	(-0.93)
Baptist/Methodist	-0.479	-0.471		
	(-0.77)	(-0.74)		
Catholic	-2.461	-2.520		
	(-3.14)	(-3.16)		
1992	-1.845	-2.618		
	(-2.36)	(-2.53)		
1994	-8.425	-8.831		
	(-10.25)	(-9.73)		
N observations	10,579	10,579	7,546	2,498
N groups			3,138	347
R-squared	0.08			
F-test on instruments		4.94		
Hausman test		0.07		

Note: T-statistic in parentheses and intercept not shown. The critical value for the test of the instruments with 6 degrees of freedom is 2.10 at the 5 percent level and is 2.80 at the 1 percent level. The critical value for the Hausman test with 1 degree of freedom is 3.84 at the 5 percent level.

Table 6
Effects of Cocaine Use on BPI
1988, 1992, 1994 Sample

	OLS (1)	TSLS (2)	Child Specific Fixed Effect (3)	Family Specific Fixed Effect (4)
Cocaine	6.418	-36.251	2.855	11.765
	(4.26)	(-1.59)	(1.41)	(3.61)
Female	-4.996	-4.910		
	(-9.90)	(-9.34)		
Black	-1.366	-1.628		
	(-1.87)	(-2.10)		
Hispanic	-0.516	-1.168		-5.584
	(-0.66)	(-1.34)		(-5.34)
AFQT	-0.014	-0.001		-0.150
	(-0.98)	(-0.05)		(-2.95)
Low birth weight	2.475	3.059		4.576
	(2.62)	(3.01)		(2.37)
Child's age	0.790	0.811		0.972
	(7.76)	(7.50)		(4.73)
Mother's age	-0.076	-0.204		-1.395
	(-0.61)	(-1.42)		(-6.46)
Mother's education	-0.994	-1.076	-1.590	0.038
	(-6.66)	(-6.66)	(-2.43)	(0.08)
Married	-2.881	-4.322	-1.362	-1.174
	(-3.75)	(-3.90)	(-1.25)	(-0.67)
Employed	-1.444	-1.678	-1.315	-0.513
	(-2.68)	(-2.90)	(-1.77)	(-0.42)
Family income	-0.00002	-0.00002	1.91E-06	-4.64E-06
	(-4.54)	(-3.70)	(0.45)	(-0.47)
Family size	0.239	0.229	0.1209	-0.331
	(1.32)	(1.17)	(0.38)	(-0.81)
Father in household	-3.160	-3.152	3.740	-1.588
	(-3.82)	(-3.61)	(4.09)	(-0.97)
Baptist/Methodist	-0.480	-0.451		
	(-0.77)	(-0.69)		
Catholic	-2.488	-2.471		
	(-3.16)	(-3.07)		
1992	-1.999	-3.071		
	(-2.54)	(-3.12)		
1994	-8.485	-9.181		
	(-10.29)	(-9.97)		
N observations	10,579	10,579		
N groups			7,546	2,498
R-squared	0.07		3,138	347
F-test on instruments		7.79		
Hausman test		0.08		

Note: T-statistic in parentheses and intercept not shown. The critical value for the test of the instruments with 6 degrees of freedom is 2.10 at the 5 percent level and is 2.80 at the 1 percent level. The critical value for the Hausman test with 1 degree of freedom is 3.84 at the 5 percent level.

Table 7
Effects of Drink, Marijuana and Cocaine Use on BPI
1998, 1992, 1994 Sample

	OLS (1)	Child Specific Fixed Effect (3)	Family Specific Fixed Effect (4)
Drink	0.022	0.104	0.156
	(0.66)	(3.79)	(2.69)
Marijuana	7.154	4.223	3.179
	(8.11)	(3.49)	(1.55)
Cocaine	2.196	1.366	10.312
	(1.39)	(0.66)	(3.06)
Female	-4.934		-5.607
	(-9.80)		(-5.37)
Black	-1.159		
	(-1.59)		
Hispanic	-0.097		
	(-0.13)		
AFQT	-0.017		-0.160
	(-1.22)		(-3.14)
Low birth weight	2.423		4.727
	(2.58)		(2.45)
Child's age	0.794		0.961
	(7.81)		(4.69)
Mother's age	-0.062		-1.337
	(-0.51)		(-6.18)
Mother's education	-0.955	-1.524	0.089
	(-6.42)	(-2.34)	(0.18)
Married	-2.459	-0.720	-0.311
	(-3.20)	(-0.66)	(-0.17)
Employed	-1.368	-1.301	-0.750
	(-2.54)	(-1.76)	(-0.61)
Family income	-1.95E-05	3.01E-07	-6.88E-06
	(-4.51)	(0.07)	(-0.69)
Family size	0.301	0.129	-0.278
	(1.66)	(0.41)	(-0.68)
Father in household	-2.971	2.746	-2.416
	(-3.60)	(2.87)	(-1.45)
Baptist/Methodist	-0.478		
	(-0.77)		
Catholic	-2.483		
	(-3.17)		
1992	-2.020		
	(-2.38)		
1994	-8.394		
	(-10.21)		
N observations	10,579	7,546	2,498
N groups		3,138	347
R-squared	0.08		

Note: T-statistic in parentheses and intercept not shown.

Table 8
First Stage Results

	Number of Days Drink	Binge	Marijuana	Cocaine
Beer tax	-0.293	-0.004	-0.028	-0.011
	(-1.57)	(-0.41)	(-3.84)	(-2.76)
Marijuana decriminalization	-0.050	-0.011	0.018	0.008
	(-0.29)	(-1.14)	(2.75)	(2.20)
Cocaine price	-0.011	-0.0002	0.0003	-0.0001
	(-2.30)	(-0.74)	(1.80)	(-0.85)
Number of outlets	-0.004	0.0004	-0.0002	-0.0004
	(-0.37)	(0.62)	(-0.41)	(-1.69)
Percent dry	-0.037	-0.001	-0.0005	-0.001
	(-3.71)	(-1.92)	(-1.25)	(-4.22)
Spending on police	0.0001	-0.0002	0.0001	0.00002
	(0.06)	(-2.87)	(2.08)	(1.14)
Female	-0.041	-0.002	-0.008	0.002
	(-0.27)	(-0.23)	(-1.29)	(0.60)
Black	-0.596	-0.085	-0.024	-0.003
	(-2.67)	(-6.75)	(-2.74)	(-0.65)
Hispanic	-1.986	-0.101	-0.064	-0.020
	(-8.26)	(-7.37)	(-6.87)	(-3.89)
AFQT	0.020	-0.001	0.001	0.0003
	(4.62)	(-3.34)	(3.42)	(3.07)
Low birth weight	-0.025	0.010	0.016	0.014
	(-0.09)	(0.63)	(1.41)	(2.22)
Child's age	-0.046	0.004	0.0001	0.001
	(-1.52)	(2.61)	(0.06)	(0.88)
Mother's age	0.043	-0.008	-0.004	-0.003
	(1.17)	(-3.72)	(-2.64)	(-3.85)
Mother's education	-0.001	-0.011	-0.007	-0.002
	(-0.03)	(-4.18)	(-3.90)	(-2.11)
Married	-1.341	-0.103	-0.073	-0.033
	(-5.81)	(-7.45)	(-8.18)	(-6.66)
Employed	0.696	0.027	-0.014	-0.004
	(4.29)	(2.90)	(-2.27)	(-1.25)
Family income	0.00001	-1.57E-07	-2.34E-08	3.92E-08
	(7.12)	(-0.78)	(-0.46)	(1.40)
Family size	-0.179	-0.003	-0.008	-0.0003
	(-3.29)	(-0.88)	(-3.96)	(-0.23)
Father in household	-0.564	-0.017	-0.024	0.001
	(-2.26)	(-1.32)	(-2.50)	(0.13)
Baptist/Methodist	0.100	-0.021	0.007	0.006
	(0.52)	(-1.97)	(0.87)	(1.48)
Catholic	0.850	0.018	-0.003	-0.001
	(3.59)	(1.25)	(-0.36)	(-0.17)
1992	9.504		-0.035	-0.028
	(36.14)	--	(-3.42)	(-5.04)
1994	-0.617	0.003	-0.014	-0.021
	(-2.16)	(0.20)	(-1.24)	(-3.35)
R-squared				
	0.26	0.05	0.05	0.03

Note: T-statistic in parentheses and intercept not shown.