Relationship Between Maternal Behavior During Pregnancy, Birth Outcome, and Early Childhood Development: An Exploratory Study

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RELATIONSHIP BETWEEN MATERNAL BEHAVIOR DURING PREGNANCY, BIRTH OUTCOME, AND EARLY CHILDHOOD DEVELOPMENT: AN EXPLORATORY STUDY

Abstract

This study examines the relationship between maternal behavior during pregnancy, birth outcomes, and early childhood development. Specifically, in the context of four measures of maternal behavior during pregnancy (maternal smoking, drinking, prenatal care, and maternal weight gain), three measures of birth outcome (gestational age, birth length, and birth weight), and 32 exogenous covariates observed during pregnancy, we investigate the importance of maternal choices during pregnancy and birth outcomes in forecasting child health (as indicated by height and weight), child behavioral problems, and a child math/reading test score at age five or six. Strikingly, birth outcomes have virtually no structural/causal effects on early childhood developmental outcomes, and only maternal smoking and drinking during pregnancy have some effects on child height. Not surprisingly, family child-rearing environment has sizeable negative and positive effects on behavioral problems index and math/reading test score, respectively, and a mildly surprising negative effect on child height.

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1. Introduction

One of the problems in examining the effects of maternal behavior during pregnancy and birth outcomes on early childhood development is the endogeneity of the former. For example, suppose children differ in the production technology of early childhood outcomes. If mothers who smoke during pregnancy tend to attend prenatal care more often and take other remedies than mothers who do not smoke during pregnancy, children of smoking mothers may be healthier than those of non-smoking mothers. This can spuriously cause a positive or an attenuated negative relation between maternal smoking during pregnancy and measures of early childhood development, contrary to the conventional wisdom. Similarly, if heavy infants stay heavy during early childhood, an OLS regression would detect a strong and positive association between birth weight and child weight in early childhood, whereas a simultaneous equations modeling approach that controls for the endogenous determination of birth weight, may detect a negligible effect of birth weight on child weight in early childhood.

The primary distinguishing feature of our work is that we view maternal choices during pregnancy, birth outcomes, family child-rearing environment, together with measures of early childhood development as *endogenous* to the child developmental process, i.e., they are determined within the system under analysis. In the context of four measures of maternal behavior during pregnancy (maternal smoking, drinking, prenatal care, and maternal weight gain), three measures of birth outcome (gestational age, birth length, and birth weight), and 32 exogenous covariates observed during pregnancy, we investigate the importance of maternal choices during pregnancy and birth outcomes in forecasting child health (as indicated by height and weight), child behavioral problems, and a child math/reading test score at age five or six. Our modeling framework is far more elaborate than considered previously in either the biomedical or economics literature.

Using data from the National Longitudinal Survey of Youth, we find that the effects of maternal smoking on birth outcomes are negative, and smoking reduces birth weight by .3175kg. The effects of maternal drinking on birth outcomes are mixed and small. Obtaining prenatal care in the first trimester translates into an increase of 2.089 weeks in gestation, 1.047cm in birth length, and .5407kg in birth weight. Maternal nutrition has positive effects on birth outcomes but the size of these effects is small. Gestation has the expected positive effects on birth length and birth weight, but their size is not large. Strikingly, birth outcomes have virtually no structural/causal effects on early childhood developmental outcomes, and only maternal smoking and drinking during pregnancy have some effects on child height. Not surprisingly, family child-rearing environment has sizeable negative and positive effects on behavioral problems index and math/reading test score, respectively, and a mildly surprising negative effect on child height. Despite little evidence of a structural/causal effect of birth weight on early childhood outcomes, our results demonstrate that birth weight nonetheless has strong predictive effects on early childhood developmental outcomes. Furthermore, these effects are largely invariant to whether family child-rearing environment is taken into account. Family child-rearing environment has both structural and predictive effects on early childhood developmental outcomes, but they are largely orthogonal and in addition to the effects of birth weight.

The paper proceeds as follows. In Section 2 we discuss the data. In Section 3 we present our modeling framework. We report empirical results in Section 4. Some concluding remarks are offered in Section 5.

2. Data

As in Li and Poirier (2000, 2001a, 2001b, 2002a, 2003b),[1] we utilize the National Longitudinal Survey of Youth (NLSY). The NLSY is an ongoing study of 12,686 young men and women aged 14 to 21 as of January 1, 1979, and it comprises both random cross-sectional sampling and supplemental sampling of individuals. The data for this paper are drawn from the National Longitudinal Survey of Youth Merged Child-Mother file (NLSCM) for 1998. The NLSCM contains data for each child born to a woman in the original NLSY, as well as a selection of variables from the NLSY main file. Where necessary, additional variables are constructed using the NLSY main file for 1998. The price indices on cigarette, alcohol, medical services and food are obtained from the consumer price index data base of the Bureau of

[1] Our first analysis [Li and Poirier (2003b)] concentrated on the smallest sample (Native Americans) in our data set and laid out the basic econometric methodology. Subsequent work [Li and Poirier (2001a, 2001b, 2002a)] contained detailed analyses in which the five ethnic/racial groups considered here were treated separately, and then tested for pooling. We found that a pooled model with group differences confined only to intercepts was overwhelmingly favored by the data [Li and Poirier (2000, 2002a)]. Likewise the analysis here is predicated on intercept-only group differences.

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We build on our earlier analyses [Li and Poirier (2000, 2002a)] by using the same four measures of maternal behavior during pregnancy $z_{(1)}$ (maternal smoking, maternal drinking, prenatal care, and nutritional intake as measured by weight gain) and three measures of birth outcome $z_{(2)}$ (gestational age, birth length, and birth weight) measured at birth, and by adding a new contemporaneous aggregate assessment of the family child-rearing environment (called the Home Observation for Measurement of the Environment, HOME) to predict four new early childhood developmental outcome variables measured at age 5 or 6. We condition on 32 exogenous variables, denoted by x.[2] The five new endogenous variables are now discussed.

First, we introduce a measure of the cognitive stimulation and emotional support provided by the child's family. This variable, z_8 = HOME [Center for Human Resource Research (1998)], is based on both maternal-reports and interviewer observations on the overall quality of the home environment, maternal emotional and verbal responsivity, maternal acceptance of an involvement with her child, organization of the environment, materials for learning, variety of stimulation, and measures of parental modeling of maturity. We specify a reduced form equation for z_8 thinking of it as another input which summarizes the current surroundings of the child at the time of testing.

Second, we proxy the health status of the child in terms of *child height* (z_9 = CH) and *child weight* (z_{10} = CW). This is a common practice in economic history [Fogel (1999)], economics [Blau et al. (1996)], and the health sciences. The relationship between birth length and birth weight and size later in life has been studied all the way up to adults. For example, Sorenson et al. (1999) conclude that the associations between birth length and adult height persist after adjustment for birth weight, gestational age, and other cofounders, while the associations between birth weight and adult height almost disappear when adjusting for birth length and the same cofounders. They also note a connection between morbidity and height.

Third, we use a *behavioral problems index* (z_{11} = BPI) based on responses of mothers to twenty-eight questions dealing with specific behaviors (antisocial, anxious-depressed, hyperactive, headstrong, dependent, and peer-conflicting) that children may have exhibited in the previous three months. Higher scores represent more behavioral problems.

Finally, we use the combined *Peabody Individual Achievement Test* score in mathematics and reading (z_{12} = PIAT). Teplin et al. (1991) find that few surviving *very low birth weight* (birth weight < 1,500g) children have signs of major neurologic disabilities or mental retardation, but they do have more subtle learning, behavioral, and visual motor difficulties which emerge during their kindergarten years. HOME, child height, child weight, behavioral problems index, and PIAT math/reading test score are all measured at either age 5 or 6.

As before, we only analyze singleton first-born live births, ignoring sample selection problems arising from parity considerations (i.e., infants that are not first-born) and abortions. There are some observations lost (802) due to missing data compared to the sample (1,962 observations) in Li and Poirier (2000, 2002a). Nonetheless, our results for the original seven-equation model of the birth process change modestly, but not importantly from our earlier results. Summary statistics of all twelve endogenous variables by racial/ethnic groups are in Li and Poirier [2002b, Appendix A].

We break the 32 exogenous variables into six groups: $x = [x_{(1)}', x_{(2)}', x_{(3)}', x_{(4)}', x_{(5)}', x_{(6)}']'$. $x_{(1)}$ is 2×1 and consists of a constant equal to one and a binary indicator equal to one if the new outcomes are measured at age 6, and equal to zero at age 5. $x_{(2)}$ is 4×1 and contains four racial/ethnic dummies for Supplementary Whites, Blacks, Hispanics, and Native Americans. $x_{(3)}$ is 3×1 and contains infant gender and maternal age. $x_{(4)}$ is 4×1 and characterizes our physical description of the mother in terms of height, weight, and age at menarche.[3] $x_{(2)}$, $x_{(3)}$, and $x_{(4)}$ cover basic physical characteristics (the race and gender of the infant, and the age and size of the mother) which we expect to be particularly

[2]We employ three additional exogenous variables to the 29 in Li and Poirier (2000, 2002a). The first variable is a dummy variable x_2, where $x_2 = 1$ if the five new endogenous variables are measured at age 6 and $x_2 = 0$ if measured at age 5. The second variable, x_9, is the mother's age at birth squared. The third variable, x_{13}, is the mother's age at the onset of menarche.

[3]Women with early menarche tend to have smaller pelvises. Novotny et al. (2000) argue that maternal pelvic size is an important indicator of fetal growth which can be related to later health outcomes. Maternal nutrition influences the size, shape, and angle of the pelvis, especially nutrients influencing bone development. In a multivariate model the authors find that maternal height, hip, infant gender, and gestational age predict infant birth weight, but maternal height does not contribute significantly. Interestingly, mother's ethnicity also does not have significant additional explanatory power in their model. The age of menarche can also have substantial sociological effects on personal development.

important in the birth outcome equations. Following biomedical tradition, physical characteristics of the father are omitted [see Basso, Olsen and Christensen (1999)].[4] $x_{(5)}$ is 6×1 and contains calendar time, regional dummies, maternal AFQT score, and family income. $x_{(6)}$ is 13×1 and contains socio-economic characteristics of the mother and her family. $x_{(5)}$ and $x_{(6)}$ are risk factors that causally are quite far removed from the biological event of LBW. We expect these variables to be important in the maternal behavior equations, but not in the biologically-based birth outcome equations nor for our new early childhood outcome variables.

We have centered the variables so as to impart a meaningful interpretation to the intercepts in our model. The case in which all elements of x other than x_1 are zeros describes generically a mother we will refer to as our reference mother. This reference mother is twenty-three years old, lives in the north-central region, gives birth to a female infant in January 1985, has access to health insurance, lives with another adult, has a household income of $25,000, has a *body mass index* (BMI = weight in kg / [height in meters]^2) of 24 based on a height of 162cm and a weight of 63kg, with menarche at 13 years old, who worked three of the four quarters in the year before giving birth, has four siblings, has the mean AFQT score of other twenty-three-year-old women in the NLSY, was on-time in school (within one grade) in an urban household with an employed male at age 14, whose mother (the maternal grandmother) completed twelve years of education and the prices for cigarette, alcohol, medical services, and food are at the 1984 level. Our reference mother is someone for whom we expect favorable birth outcomes.

3. The Model

While we draw upon the economics literature for our modeling strategy, our specific model is constructed based on biological considerations. We specify reduced form equations for the four maternal choices during pregnancy (smoking, drinking, prenatal care, and weight gain) and HOME, and then a triangular specification in which gestation depends on maternal choices during pregnancy, birth length and birth weight together have a bivariate relationship depending on maternal choices and gestation, child height and child weight depends on maternal choices and birth outcomes and HOME, and child behavioral problem index and PIAT test score depends on all ten endogenous variables. The model is diagonal with numerous exclusion restrictions on the regression coefficients and three (unit) restrictions on the variance-covariance matrix.

We consider a sample of T independent singleton first-born live births indexed by the subscript i. Consider the four observed measures of maternal behavior during pregnancy $z_{i(1)} = [y_i', z_{i(WG)}]'$: three binary indicators $y_i = [S_i, D_i, PC_i]'$ of maternal smoking, drinking, and obtaining prenatal care in the first trimester, and a continuous measure of maternal nutrition, $z_{i(WG)}$, defined as maternal weight gain (WG) during pregnancy. Let $y_i^* = [S_i^*, D_i^*, PC_i^*]'$ (i = 1, 2, ..., T) denote latent variables underlying the binary measures of maternal behavior during pregnancy $y_i = [S_i, D_i, PC_i]' = [\mathbf{1}(S_i^*), \mathbf{1}(D_i^*), \mathbf{1}(PC_i^*)]'$ (i = 1, 2, ..., T), where $\mathbf{1}(\bullet)$ denotes an indicator function which equals one if the argument is positive and equals zero otherwise. Define $z_{i(1)}^* = [y_i^{*\prime}, z_{i(WG)}]'$. We also consider the three measures of birth outcome $z_{i(2)} = [G_i, BL_i, BW_i]'$ (i = 1, 2, ..., T) mentioned earlier. Finally, let x_i (i = 1, 2, ..., T) denote the K×1 vector of the exogenous variables (K = 32).

For birth i, suppose the four maternal behavior measures are generated by

$$z_{i(1)}^* = \Delta_1' x_i + \varepsilon_{i(1)}, \tag{1}$$

where Δ_1 is an unrestricted K×4 matrix of unknown parameters. The three birth outcome measures are generated by

$$\Gamma_2' z_{i(2)} = \Gamma_1' z_{i(1)} + \Delta_2' x_i + \varepsilon_{i(2)}, \tag{2}$$

where Γ_1 (4×3) is an unrestricted matrix, Γ_2 is nonsingular with

$$\Gamma_2' = \begin{bmatrix} 1 & 0 & 0 \\ -\gamma_{BL,G} & 1 & 0 \\ -\gamma_{BW,G} & 0 & 1 \end{bmatrix}, \tag{3}$$

[4] Barker (1996) notes the widespread professional opinion that the mother controls fetal growth, not the fetus' genome. The bases are studies of half siblings: those with the same father have different sizes at birth, whereas those with the same mother have similar sizes. After birth paternal genes become more important.

$\Delta_2' = [\Delta_{21}', \Delta_{22}', \Delta_{23}', \Delta_{24}', \Delta_{25}', \Delta_{26}']$, with Δ_{21} (2×3), Δ_{22} (4×3), and Δ_{23} (3×3) unrestricted, $\Delta_{25} = 0_{6\times3}$, $\Delta_{26} = 0_{13\times3}$, and

$$\Delta_{24}' = \begin{bmatrix} \delta_{G,BMI} & \delta_{G,MH} & \delta_{G,MW} & \delta_{G,Men} \\ \delta_{BL,BMI} & \delta_{BL,MH} & 0 & \delta_{BL,Men} \\ \delta_{BW,BMI} & 0 & \delta_{BW,MW} & \delta_{BL,Men} \end{bmatrix}. \tag{4}$$

The first three equations in equation (1) are the latent representations underlying the trivariate Probit specification of the three binary indicators in y_i. The triangular structure of the coefficient matrix Γ_2 in equation (3) implies that gestation depends on the four maternal behavior measures, and birth length and birth weight together have a bivariate relationship depending on the four maternal behavior measures and gestation. Equations (1)-(4) comprise the specification used in our earlier work [Li and Poirier (2000, 2002a)].

We now add $z_{i(3)} = HOME_i$ measuring the family's cognitive stimulation and emotional support for the child at age 5 or 6. We are concerned only with a reduced form representation

$$z_{i(3)} = \Delta_3' x_i + \varepsilon_{i(3)}, \tag{5}$$

where the K×1 vector Δ_3 is unrestricted. Our interest in HOME is indirect. We are primarily interested in how well maternal choices during pregnancy and birth outcomes can forecast subsequent outcomes in early childhood. Of course other variables become available after birth. Indeed the list is potentially long depending on the purposes at hand. To get a feel for how such predictability can be improved by using other variables observed at the time of testing, but long after birth, we use the aggregate measure HOME. Furthermore, by taking into account HOME, we can examine whether some of the raw correlations between birth and early childhood outcomes persist after controlling for HOME.

Our primary concerns are two structural child health equations

$$z_{i(4)} = \Gamma_3' z_{i(1)} + \Gamma_4' z_{i(2)} + \Gamma_5' z_{i(3)} + \Delta_4' x_i + \varepsilon_{i(4)}, \tag{6}$$

where $z_{i(4)} = [CH_i, CW_i]'$ consists of child height and child weight at the age indicated by x_2, and two structural behavioral/test-outcome equations

$$z_{i(5)} = \Gamma_6' z_{i(1)} + \Gamma_7' z_{i(2)} + \Gamma_8' z_{i(3)} + \Gamma_9' z_{i(4)} + \Delta_5' x_i + \varepsilon_{i(5)}, \tag{7}$$

where $z_{i(5)} = [BPI_i, PIAT_i]'$ consists of a behavioral problems index and a combined PIAT math and reading test score, Γ_3 (4×2), Γ_4 (3×2), Γ_5 (1×2), Γ_6 (4×2), Γ_7 (3×2), Γ_8 (1×2), and Γ_9 (2×2), are unrestricted matrices, $\Delta_4 = [\Delta_{41}', \Delta_{42}', \Delta_{43}', \Delta_{44}', \Delta_{45}', \Delta_{46}']$, with Δ_{41} (2×2), Δ_{42} (4×2), and Δ_{43} (3×2) unrestricted, $\Delta_{45} = 0_{6\times2}$, $\Delta_{46} = 0_{13\times2}$,

$$\Delta_{44}' = \begin{bmatrix} \delta_{CH,BMI} & \delta_{CH,MH} & 0 & \delta_{CH,Men} \\ \delta_{CW,BMI} & 0 & \delta_{CW,MW} & \delta_{CW,Men} \end{bmatrix}, \tag{8}$$

and $\Delta_5' = [\Delta_{51}', \Delta_{52}', \Delta_{53}', \Delta_{54}', \Delta_{55}', \Delta_{56}']$, with Δ_{51} (2×2), Δ_{52} (4×2), and Δ_{53} (3×2) unrestricted, $\Delta_{56} = 0_{13\times2}$, and

$$\Delta_{54}' = \begin{bmatrix} 0 & 0 & 0 & \delta_{BPI,Men} \\ 0 & 0 & 0 & \delta_{PIAT,Men} \end{bmatrix}, \quad \Delta_{55}' = \begin{bmatrix} 0_4' & 0 & 0 \\ 0_4' & \delta_{PIAT,AFQT} & 0 \end{bmatrix}. \tag{9}$$

The HOME variable $z_{i(3)}$ serves as a new endogenous input into a bivariate description of health summarized in equation (6) by child height ($z_{i9} = CH_i$) and child weight ($z_{i10} = CW_i$). These three variables in turn determine $z_{i11} = BPI_i$ and $z_{i12} = PIAT_i$ in equation (7). Only the exogenous variables appearing in the birth outcome equations plus maternal AFQT score are included as exogenous variables in the structural equations for $z_{i9}, ..., z_{i12}$. The specification of numerous zero restrictions on Δ_2, Δ_4, and Δ_5 ensures that the order condition for identification is satisfied.

The combined 12×1 disturbance vector in equations (1), (2), and (5)-(7), $\varepsilon_i = [\varepsilon_{i(1)}', \varepsilon_{i(2)}', \varepsilon_{i(3)}, \varepsilon_{i(4)}', \varepsilon_{i(5)}']'$, is assumed distributed as i.i.d. $N_{12}(0_{12}, \Sigma)$ (i = 1, 2, ..., T) given x_i, with variance-covariance matrix $\Sigma = [\Sigma_{ij}]$ (i,j = 1, 2, ..., 5). The model is not recursive because Σ is permitted to be nondiagonal. The model is nonlinear because of the jointly determined dummy endogenous variables $y_i = [S_i, D_i, PC_i]'$. Computational details are given in Li and Poirier (2002b) which is an elaboration of this paper not subject to space constraints.

4. Empirical Results

4.1 Estimation Results

Table 1 contains the posterior means and standard deviations of the variance-covariance matrix Σ.[5] The correlations in Table 1 measure the degree to which the "unexplained" parts (disturbances) of our endogenous variables are related after conditioning on x. There is evidence of positive correlation between the unexplained parts of smoking and drinking, and little or no correlation amongst the unexplained parts of the remaining maternal behavior measures. The unexplained part of birth weight is positively correlated with the unexplained parts of gestation and birth length. Of particular interest is the off-diagonal block of correlations between maternal behavior during pregnancy and birth outcomes. The unexplained parts of smoking and drinking have some correlation with the unexplained parts of all three measures of birth outcome. The unexplained part of prenatal care is negatively correlated with the unexplained parts of birth outcomes, and the correlations between the unexplained part of prenatal care and those of gestation and birth weight are sizeable.

The unexplained parts of smoking and drinking exhibit some correlation with the unexplained parts of early childhood outcomes, and the disturbance for birth weight is mildly correlated with the disturbances for child weight, behavioral problems index, and PIAT math/reading test score. The unexplained part of HOME is correlated with those of smoking, drinking, child height, and PIAT math/reading text score. Not surprisingly, the unexplained parts of child height and weight are positively correlated. The unexplained part of PIAT math/reading test score is noticeably correlated with the unexplained parts of child weight, and behavioral problems index. In contrast, there is little indication of correlation between the unexplained part of weight gain and those of birth outcomes, HOME, and early childhood outcomes. Similarly, there is little correlation between the unexplained part of gestation and those of early childhood outcomes.

Table 2 contains the posterior means and standard deviations of the coefficients Δ_1 and Δ_3 on exogenous variables in reduced form equations (1) and (5), respectively. When discussing maternal height and weight, we take into account both their effects through BMI and their linear effects. The coefficients of most variables among x_7 - x_{32} have substantial posterior mass away from zero, i.e., the posterior probability that the coefficient is of the given sign is greater than .90, in some equations suggesting they satisfy at least one requirement of a legitimate instrumental variable for the birth and early childhood outcome equations.

In particular, the three new exogenous variables as compared to the set of exogenous variables in Li and Poirier (2000, 2002a) have additional explanatory power. Disturbingly, the age at which the test is taken seems related to smoking and HOME. There is clear evidence of nonlinearities in maternal age, particularly as related to HOME. Maternal age at menarche is negatively related to smoking, drinking, and particularly, negatively related to HOME. Other results regarding Δ_1 in Table 2 are broadly consistent with Li and Poirier (2000, 2002a). The racial/ethnic group differences remain and have become more noticeable in the prenatal care equation. Blacks are noticeably disadvantaged in terms of HOME (mean effect lowers HOME by 5.744 compared to Main Whites). Maternal AFQT score (x_{18}), household income (x_{19}), number of quarters worked during pregnancy (x_{23}), and grandmother's education (x_{25}) have substantial mass over positive regions for their effects on HOME, while missing health insurance variable (x_{21}), number of adults in household (x_{22}), and non-urban at age 14 (x_{27}) have substantial negative effects on HOME. Finally, HOME varies both by region and over time.

Table 3 contains the posterior means and standard deviations of the coefficients Δ_2, Δ_4, and Δ_5 on exogenous variables in structural equations (2), (6), and (7), respectively. The effects of exogenous variables on maternal behavior during pregnancy and birth outcomes (Δ_2) are broadly consistent with our earlier results [Li and Poirier (2000, 2002a)]. Relative to Main Whites, Supplementary Whites have slightly lower birth weights. Blacks and Hispanics have smaller babies (shorter and lighter), and noticeably so for Blacks. Native Americans have slightly longer gestational ages. The posterior mean effect of a male infant on birth length is .4842cm and on birth weight is .0369kg. Maternal size has reasonable positive effects on birth outcomes although the posterior mean effects are not large.

Table 3 also contains the posterior means and standard deviations of the coefficients Δ_4 and Δ_5 on exogenous

[5]To direct attention to cases where there is substantial posterior probability for a parameter to be away from zero, we outline each cell with a border indicating if the posterior interquartile range includes zero (no border), the posterior probability that the coefficient is of the given sign is greater than .75 and less than .90 (single line), the posterior probability that the coefficient is of the given sign is greater than .90 and less than .95 (double line), and the posterior probability that the coefficient is of the given sign is greater than .95 (bold line).

variables in structural equations (6) and (7), respectively. The three new exogenous variables again have additional explanatory power. As expected, the age of testing is positively related to child height and weight, but surprisingly seems not related to behavioral problems index and PIAT math/reading test score. Maternal age matters for child height, behavioral problems index, and PIAT math/reading test score, and there is clear evidence of nonlinearities in maternal age, particularly as related to PIAT math/reading test score. Maternal age at menarche is negatively related to PIAT math/reading test score. Relative to Main Whites, Blacks are taller and heavier. The absence of group differences in the sample means of behavioral problems index reappears in Table 3. The prevalence of group differences in the sample means of PIAT math/reading test score also reappears in Table 3, but with one important difference: after controlling for x, there is substantial probability of a positive effect for Blacks on PIAT math/reading test score! There are no gender differences in early childhood developmental outcomes. Maternal size is positively related to the child's size, and maternal AFQT score is positively related to the child's PIAT math/reading test score.

Table 4 contains the posterior means and standard deviations of the coefficients Γ_j (j = 1, 2, ...,9) on included endogenous variables in structural equations (2), (6), and (7), respectively. Consider the birth outcome parameters (in the columns of Table 4 headed by G, BL, and BW). The coefficients of maternal behavior during pregnancy in these birth outcome equations are similar to our earlier results [Li and Poirier (2000, 2002a)]. We find that the effects of maternal smoking on birth outcomes are negative, and smoking reduces birth weight by .3175kg. The effects of maternal drinking on birth outcomes are mixed and small. Obtaining prenatal care in the first trimester translates into an increase of 2.089 weeks in gestation, 1.047cm in birth length, and .5407kg in birth weight. Maternal nutrition has positive effects on birth outcomes but the size of these effects is small. Gestation has the expected positive effects on birth length and weight, but their size is not large.

Next consider the early childhood outcome parameters (in the columns of Table 4 headed by CH, CW, BPI, and PIAT). Among maternal behavior measures, only smoking and drinking have some effects on child height. Strikingly, birth outcomes have virtually no structural/causal effects on early childhood outcomes. It appears difficult to reject the null hypothesis that maternal behavior during pregnancy and birth outcomes have no causal effects on child height, child weight, behavioral problems index, and PIAT math/reading test score, i.e., $\Gamma_3 = \Gamma_6 = 0_{4\times 2}$, $\Gamma_4 = \Gamma_7 = 0_{3\times 2}$ (more evidence later). Not surprisingly, HOME has sizeable negative and positive effects on behavioral problems index and PIAT math/reading test score, respectively, and a mildly surprising negative effect on child height. Finally, child weight has a mildly negative effect on PIAT math/reading test score.

Table 4 also contains the posterior means and standard deviations of the population R^2 for each birth and early childhood outcome equation. The R^2 measures the fit of the restricted reduced form equations as suggested by Carter and Nagar (1977) and is implemented in Li and Poirier (2000, 2002a). Clearly, much unexplained variation remains, particularly for all three measures of birth outcome and behavioral problems index.

4.2 Prediction Results

Table 5 contains the marginal posterior predictive means and standard deviations of the reference mother by racial/ethnic groups. Black and Hispanic reference mothers are the least likely to smoke during pregnancy, and there is not much variation across reference mothers in terms of all other measures of maternal behavior during pregnancy and birth outcomes. Black reference mother is relatively disadvantaged in terms of the family child-rearing environment, but there is not much difference across reference mothers in early childhood developmental outcomes.

Table 6 contains the implied posterior probabilities for joint binary measures of maternal behavior of the reference mother. Of particular interest in Table 6 is the fact that Black and Hispanic reference mothers have the lowest predicted probability of the worst behavioral combination (Smoking = 1, Drinking = 1, Prenatal care = 0), and the highest predicted probability of the best behavioral combination (Smoking = 0, Drinking = 0, Prenatal care = 1). As will shown later, such good behavioral choices for Blacks and Hispanics do not necessarily lead to better birth or early childhood outcomes.

The predictive results in Tables 5 and 6 condition on the exogenous characteristics of the reference mother, and so they take into account only data available before birth. We now investigate the predictive effects of maternal behavior during pregnancy and birth outcomes, and HOME on early childhood outcomes. This entails a comparison of conditional predictive densities for early childhood outcomes.

Table 7 contains the posterior means and standard deviations of the effects of latent maternal behavior on the posterior predictive means of early childhood outcomes, when conditioning on (observed) maternal behavior and birth outcomes. The derivation details are provided in Li and Poirier (2003a, 2002b). The left hand side of Table 7 is unconditional of HOME, whereas the right hand side of the table conditions on HOME as well. S* and D* have positive and negative effects, respectively, on child height. D* has a noticeable negative effect on PIAT math/reading test score, and to a lesser extent a positive (worsening) effect on behavioral problems index.

Table 7 also contains the posterior means and standard deviations of the effects of observed maternal behavior and birth outcomes on the posterior predictive means of early childhood outcomes, when conditioning on maternal behavior and birth outcomes. Again the left hand side of Table 7 is unconditional of HOME, whereas the right hand side of the table conditions on HOME as well. As in Table 4, smoking and drinking have negative and positive effects, respectively, on child height in Table 7. In contrast to Table 4, weight gain has positive and negative effects on child height and PIAT math/reading test score, respectively.

Interestingly, birth outcomes do have substantial predictive effects on early childhood outcomes. Somewhat perplexing, gestation has negative effects on both child height and weight. Reassuringly, birth length has a positive effect on child height. Most importantly, birth weight has substantial effects on child weight and behavioral problems index, and a somewhat weaker effect on PIAT math/reading test score in sensible directions! The last results underlie our claim that while birth weight does not appear to have much of a structural/causal effect on early childhood outcomes we study (see Table 4), it does have important predictive effects, and these effects are largely unchanged by taking into account the contemporaneous effect of HOME on early childhood outcomes. The predictive effect of HOME is substantial for three of the four measures of early childhood developmental outcomes. Overall, the results in Table 7 are for the most part unaffected by conditioning on HOME.

Table 8 contains the posterior means and standard deviations of the effects of exogenous variables on the posterior predictive means of early childhood outcomes, when conditioning on maternal behavior and birth outcomes. The derivation details are provided in Li and Poirier (2003a, 2002b). The left hand side of the table is unconditional of HOME, whereas the right hand side of the table conditions on HOME as well. Note how variables like number of quarters worked during pregnancy (x_{23}) and grandmother's education (x_{25}), although quite removed from the structural PIAT equation, still have a noticeable positive effect on PIAT math/reading test score that is transmitted through maternal behavior during pregnancy and birth outcomes, and HOME.

It is striking that Table 8 shows little explanatory power the exogenous variables offer to child weight - only the age6 (x_2) and Black (x_4) dummies matter. Nor does conditioning on HOME change things. Similarly, after conditioning on HOME, few exogenous variables have much effect on behavioral problems index. Furthermore, some exogenous variables have little, if any, effects on early childhood developmental outcomes - the interquartile ranges of the coefficients of the Supplementary White dummy (x_3), maternal height (x_{11}), no health insurance available (x_{20}), no employed male in household at age 14 (x_{28}), and the food price index (x_{32}) always overlap with zero.

4.3 Hypotheses of Interest

Our maintained hypothesis, denoted H_*, imposes an absolutely continuous prior density $f(\theta|H_*)$, $\theta \in \Theta$. This section describes three alternative parametric hypotheses over which we assign positive prior probability.

As in our earlier work, we want to first consider whether our specification passes some overidentifying tests. We choose to enlarge our initial window by adding $\Delta_{25}'x_{i(5)}$ to equation (2) and testing H_*: $vec(\Delta_{25}) = 0_{18}$ versus H_1: $vec(\Delta_{25}) \neq 0_{18}$. This is not a mechanical diagnostic check, but rather a substantive hypothesis questioning the structural interpretation of equation (2). Do the variables in $x_{i(5)}$ (e.g., maternal AFQT score) affect birth outcomes only indirectly through maternal choices during pregnancy (H_*) or also directly (H_1)? Using the prior density $f(\theta, \Delta_{25}|H_1) = f(\theta|H_*)\varphi(vec(\Delta_{25})|0_{18}, \xi_5 I_{18})$ with $\xi_5 = 1$, yields the log-Bayes factor $\ell n(B_{*1}) = \ell n[f(y|H_*)/f(y|H_1)] = 41$ strongly favoring our maintained specification. Thus, all of our analyses in this paper are conditional on H_*.

Our next hypothesis of interest is whether there is a causal relationship between maternal behavior during pregnancy and birth outcomes. To this end we compare H_* to the fourteen restrictions H_2: $\Gamma_1 = 0_{4\times 3}$, $\Gamma_2 = I_3$. Using the prior density $f(\theta_{(-2)}|H_2) = f(\theta_{(2)}|H_*)$, where $\theta_{(-2)}$ contains the elements of θ excluding Γ_1 and Γ_2, yields the log-Bayes factor $\ell n(B_{*2}) = \ell n[f(y|H_*)/f(y|H_2)] = 77$ which again strongly favors our maintained specification and a causal connection between maternal behavior during pregnancy and birth outcomes.

We next consider whether there is a causal effect of maternal behavior during pregnancy and birth outcomes on early childhood outcomes. To this end we compare H_* to the thirty-two restrictions H_3: $\Gamma_3 = \Gamma_6 = 0_{4\times 2}$, $\Gamma_4 = \Gamma_7 = 0_{3\times 2}$, $\Gamma_9 = 0_{2\times 2}$. Using the prior density $f(\theta_{(-3)}|H_3) = f(\theta_{(-3)}|H_*)$, where $\theta_{(-3)}$ contains the elements of θ excluding Γ_3, Γ_4, Γ_6, Γ_7, and Γ_9, yields the log-Bayes factor $\ell n(B_{*3}) = \ell n[f(y|H_*)/f(y|H_3)] = -173$ which strongly favors there being no causal relationship between maternal behavior during pregnancy and birth outcomes and early childhood outcomes.

5. Conclusions

The goal of this study is to examine the relationship between maternal behavior during pregnancy, birth outcomes, and early childhood development. We take the seven-equation maternal behavior during pregnancy and birth outcome model of Li and Poirier (2000, 2001a, 2001b, 2002a, 2003b) and augment it with five new equations measuring family child-rearing environment and early childhood developmental outcomes.

Briefly, smoking has a noticeable negative causal effect on birth weight. Prenatal care has positive structural effects on birth outcomes. Gestation has positive causal effects on both birth length and birth weight. The usual ethnic differences in birth weight are apparent with Blacks having the lowest and Main Whites having the highest birth weights. Interestingly, Black and Hispanic mothers have the lowest predicted probability of the worst maternal behavioral combination (Smoking = 1, Drinking = 1, Prenatal care = 0), and the highest predicted probability of the best maternal behavioral combination (Smoking = 0, Drinking = 0, Prenatal care = 1). Although some observations are lost due to missing data compared to the sample in Li and Poirier (2000, 2002a), the results for the seven-equation model of maternal behavior during pregnancy and birth outcomes change only modestly from our earlier results.

Strikingly, birth outcomes have virtually no structural effects on early childhood outcomes, and only smoking and drinking have effects on child height. Not surprisingly, family child-rearing environment has sizeable negative and positive effects on behavioral problems index and math/reading test score, respectively, and a mildly surprising negative effect on child height. The three new exogenous variables as compared to Li and Poirier (2000, 2002a) have explanatory power. As expected, the age of testing is positively related to child height and weight, but surprisingly seems not related to behavioral problems index and math/reading test score. There is clear evidence of nonlinearities in maternal age. Maternal age at menarche is negatively related to math/reading test score. In the child height and weight equations maternal height and weight are positively related to child height and weight, respectively. Not surprisingly, ethnic differences in child math/reading test score manifest themselves, but their direction is surprising: after controlling for exogenous variables and taking into account maternal behavior during pregnancy and birth outcomes, Blacks have higher math/reading test score than all other ethnic groups.

References

Barker, D. J. P. (1996). Transcript of evidence by Professor David Barker, Commission of Inquiry into Fetal Sentience. See http://www.care.org.uk/resource/pub/fs/barkerc.htm.

Basso, O, J. Olsen and K. Christensen (1999). Low birth weight and prematurity in relation to paternal factors: A study of recurrence. *International Journal of Epidemiology* 28, 695-700.

Blau, D. M., D. K. Guilkey and B. M. Popkin (1996). Infant health and the labor supply of mothers. *Journal of Human Resources* 31, 90-139.

Carter, R. A. L. and A. L. Nagar (1977). Coefficients of correlation for simultaneous equation systems. *Journal of Econometrics* 6, 39-50.

Center for Human Resource Research (1998). *1996 Child & Young Adult Data Users Guide*. Ohio State University.

Fogel, R. W. (1999). Catching up with the economy. *American Economic Review* 89, 1-21.

Li, K. and D. J. Poirier (2003a). The roles of birth inputs and outputs in predicting health, behavior, and test scores in early childhood. *Statistics in Medicine,* forthcoming. Available at http://finance.sauder.ubc.ca/~kaili/Child_SM.pdf.

Li, K. and D. J. Poirier (2003b). An econometric model of birth inputs and outputs for Native Americans. *Journal of Econometrics* 113, 337-361.

Li, K. and D. J. Poirier (2002a). Bayesian analysis of an econometric model of birth inputs and outputs. *Journal of Population Economics*, forthcoming. Available at http://finance.sauder.ubc.ca/~kaili/BW_JPE.pdf.

Li, K. and D. J. Poirier (2002b). The roles of birth inputs and outputs in predicting health, behavior, and test scores in early childhood. Working paper, University of British Columbia, available at http://finance.sauder.ubc.ca/~kaili/Child_LiPoirier.pdf.

Li, K. and D. J. Poirier (2001a). An econometric analysis of the birth process by racial/ethnic groups. In: E. George, ed., *Bayesian Methods with Applications to Science, Policy, and Official Statistics: ISBA 2000*, 321-330.

Li, K. and D. J. Poirier (2001b). Using the National Longitudinal Survey of Youth in the US to study the birth process: A Bayesian approach. *Research in Official Statistics* 4, 127-150.

Li, K. and D. J. Poirier (2000). An econometric model of birth inputs and outputs: A detailed report. Working paper, University of British Columbia, available at http://finance.sauder.ubc.ca/research/ abstracts/UBCFIN00-3.html.

Novotny, R., J. Davis, R. Wasnich, et al. (2000). Maternal pelvic size, measures by dual energy X-ray absorptiometry, predicts infant birthweight. *American Journal of Human Biology* 12, 552-557.

Sorenson, H. T., S. Sabroe, K. J. Rothman, et al. (1999). Birth weight and length as predictors for adult height. *American Journal of Epidemiology* 149, 726-729.

Teplin, S. W., M. Burchinal, N. Johnson-Martin, et al. (1991). Neurodevelopmental, health, and growth status at 6 years of children with birth weights less than 1001 grams. *Journal of Pediatrics* 118, 768-777.

Table 1: Posterior Means (Standard Deviations) of the Variance-Covariance Matrix Σ

	S^*	D^*	PC^*	WG	G	BL	BW	HOME	CH	CW	BPI	PIAT
S^*	**1.000 (.0000)**	.3503 (.0462)	-.0407 (.0580)	-.0027 (.0409)	.1401 (.1343)	-.0109 (.1034)	.1510 (.1897)	-.1178 (.0392)	.2296 (.1821)	.0266 (.1373)	.0459 (.0597)	.0740 (.0676)
D^*		**1.000 (.0000)**	-.0276 (.0530)	.0542 (.0380)	.0987 (.1057)	.0885 (.0856)	-.1124 (.1327)	-.1162 (.0368)	-.4008 (.0819)	.0792 (.1332)	.0860 (.0603)	-.0177 (.0672)
PC^*			**1.000 (.0000)**	-.0066 (.0413)	-.4407 (.1424)	-.1333 (.1219)	-.4983 (.1116)	.0444 (.0425)	.0238 (.1001)	-.1027 (.1304)	.0363 (.0583)	-.0227 (.0632)
WG				39.12 (1.621)	.0780 (.1223)	-.0720 (.1672)	.0270 (.1310)	-.0081 (.0294)	.0202 (.1289)	.0716 (.1496)	-.0501 (.1415)	-.0085 (.1452)
G					5.341 (.4198)	.0439 (.1513)	.4271 (.0906)	-.0266 (.0314)	-.0288 (.1275)	.0586 (.1726)	-.0053 (.0802)	.0368 (.0873)
BL						13.16 (.9626)	.3315 (.0664)	.0256 (.0306)	.0185 (.2241)	.0959 (.2814)	-.0576 (.1390)	.1065 (.1507)
BW							.2802 (.0313)	.0077 (.0330)	.0773 (.1172)	.1416 (.1887)	-.0836 (.0598)	.1089 (.0636)
HOME								578.7 (24.31)	.2055 (.0792)	.0351 (.0905)	.0091 (.0786)	-.3381 (.0803)
CH									73.85 (8.362)	.4243 (.0695)	.0155 (.0901)	.0431 (.1039)
CW										21.23 (3.712)	-.0074 (.1062)	.1529 (.1206)
BPI											708.3 (48.28)	-.0771 (.0545)
PIAT												457.6 (42.17)

Note: Variances for S^*, D^* and PC^* are normalized to unity. Off-diagonal elements are given as *correlations*, not covariances.

Table 2: Posterior Means (Standard Deviations) of Δ_1 in (1) and Δ_3 in (5)

	Variables	Δ_1 S	Δ_1 D	Δ_1 PC	Δ_1 WG	Δ_3 HOME
x_1	1	-.0822 (.1007)	.1636 (.0864)	.8796 (.1324)	10.94 (.5821)	58.85 (1.865)
x_2	= 1 if tested at age 6 = 0 if tested at age 5	-.0982 (.0674)	.0013 (.0580)	-.0103 (.0785)	.3824 (.3475)	-1.536 (1.155)
x_3	Supplementary White dummy	.1104 (.1454)	.1105 (.1329)	.3957 (.1876)	.6637 (.7518)	1.562 (1.634)
x_4	Black dummy	-.6944 (.1200)	-.1806 (.1013)	-.0398 (.1261)	-.9387 (.5601)	-5.744 (1.415)
x_5	Hispanic dummy	-.7999 (.1411)	-.1379 (.1120)	-.0745 (.1390)	.0147 (.6381)	.0079 (1.492)
x_6	Native American dummy	.2303 (.1697)	.0537 (.1534)	.1650 (.1998)	-1.398 (.8766)	.9088 (1.720)
x_7	Male child	-.0040 (.0750)	.0406 (.0677)	.0785 (.0829)	.1169 (.3591)	-1.487 (1.142)
x_8	Mother's age - 23yrs.	-.0253 (.0202)	.0497 (.0189)	.0791 (.0219)	-.1835 (.1050)	1.254 (.3469)
x_9	(Mother's age - 23yrs.)^2	-.0028 (.0026)	-.0028 (.0023)	-.0015 (.0026)	.0123 (.0114)	-.0965 (.0394)
x_{10}	BMI (weight(kg) / [height(m)]^2) - 24	.1161 (.1077)	-.0661 (.1024)	.2848 (.1029)	-.3527 (.4761)	.2351 (1.229)
x_{11}	Maternal height - 162cm	.0397 (.0324)	-.0035 (.0303)	.0724 (.0306)	-.0588 (.1422)	.3076 (.3758)
	Marginal effect of maternal height	.0021 (.0026)	.0063 (.0025)	-.0032 (.0019)	.0457 (.0300)	.2379 (.1116)
x_{12}	Maternal weight - 63kg	-.0440 (.0403)	.0208 (.0384)	-.1079 (.0382)	.1877 (.1772)	-.3382 (.4595)
	Marginal effect of maternal weight	.0001 (.0015)	-.0017 (.0014)	.0002 (.0011)	.0533 (.0173)	-.2486 (.0621)
x_{13}	Maternal age at menarche - 13yrs.	-.0449 (.0276)	-.0451 (.0258)	-.0090 (.0289)	.0638 (.1267)	-.9376 (.4669)
x_{14}	Northeast	.0104 (.1219)	.0022 (.1082)	.1968 (.1443)	.8992 (.6472)	4.182 (1.674)
x_{15}	South	-.3081 (.0999)	-.3990 (.0874)	-.0473 (.1088)	.6371 (.4802)	1.464 (1.450)

Table 2 (continued): Posterior Means (Standard Deviations) of Δ_1 in (1) and Δ_3 in (5)

	Variables	Δ_1 S	Δ_1 D	Δ_1 PC	Δ_1 WG	Δ_3 HOME
x_{16}	West	-.0881 (.1143)	-.0436 (.0947)	-.0436 (.0947)	.9461 (.5593)	2.275 (1.600)
x_{17}	Calendar time - (19)85	.0520 (.0823)	.0164 (.0679)	-.0678 (.0948)	.0010 (.4181)	-1.741 (.4473)
x_{18}	(AFQT score / mean of NLSY women of same age) - 1	-.3272 (.0811)	.1977 (.0667)	-.1375 (.0807)	-.5271 (.3542)	5.739 (1.087)
x_{19}	Household income in $1000 - 25	-.0048 (.0028)	.0049 (.0024)	.0090 (.0029)	-.0038 (.0126)	.1965 (.0454)
x_{20}	No health insurance available	.1314 (.1056)	.0270 (.0870)	-.1292 (.1153)	.0636 (.5310)	.3228 (1.340)
x_{21}	Missing health insurance availability	-.0895 (.1162)	.0825 (.1007)	.1590 (.1218)	.4895 (.5950)	-2.439 (1.397)
x_{22}	Number of adults in household - 2	-.0214 (.0412)	.0098 (.0368)	-.0177 (.0405)	-.1203 (.1956)	-1.132 (.6546)
x_{23}	Number of quarters worked during pregnancy - 3	-.0340 (.0389)	.0689 (.0309)	.0112 (.0354)	.3060 (.1632)	1.786 (.5469)
x_{24}	Number of maternal siblings - 4	.0169 (.0180)	.0046 (.0150)	-.0065 (.0170)	.0323 (.0796)	.1114 (.2806)
x_{25}	Grandmother's education - 12yrs.	.0480 (.0170)	.0347 (.0150)	.0197 (.0169)	.1368 (.0830)	1.242 (.2598)
x_{26}	Not on time in school at age 14	.3260 (.1236)	.0404 (.1088)	-.2185 (.1298)	-.2671 (.6398)	-1.318 (1.541)
x_{27}	Non-urban at age 14	-.0982 (.0885)	-.1746 (.0786)	.1092 (.0949)	-.1196 (.4598)	-1.980 (1.246)
x_{28}	No employed male in household at age 14	.0604 (.0912)	-.0177 (.0775)	-.0550 (.0945)	.0166 (.4509)	-.8581 (1.276)
x_{29}	Cigarette price index	-.6342 (.7224)	.3506 (.5730)	-.7879 (.8344)	-1.247 (3.676)	.1241 (1.955)
x_{30}	Alcohol price index	-.4064 (1.386)	-.5034 (1.008)	1.5299 (1.681)	.7222 (7.654)	-.1550 (1.999)
x_{31}	Medical services price index	.7114 (1.291)	-.7346 (.9948)	.7054 (1.710)	2.991 (7.992)	-.0799 (1.973)
x_{32}	Food price index	-.5081 (1.253)	-.2302 (.9940)	-.7772 (1.590)	-.7812 (7.570)	-.1004 (1.999)

Table 3: Posterior Means (Standard Deviations) of Δ_2 in (2), Δ_4 in (6), and Δ_5 in (7)

		Δ_2			Δ_4		Δ_5	
	Variables	**G**	**BL**	**BW**	**CH**	**CW**	**BPI**	**PIAT**
x_1	**1**	37.37 (.7515)	24.32 (10.77)	1.299 (.8322)	114.7 (19.35)	24.05 (14.85)	68.14 (27.78)	60.66 (26.42)
x_2	**= 1 if tested at age 6 = 0 if tested at age 5**	.0106 (.1150)	-.0185 (.1547)	.0068 (.0271)	6.434 (.4750)	2.463 (.2616)	-1.074 (1.706)	-1.256 (1.586)
x_3	**Supplementary White dummy**	.1471 (.2621)	-.1811 (.3630)	-.0965 (.0613)	-.1078 (.9300)	-.1089 (.5536)	.7634 (1.707)	-.4535 (1.570)
x_4	**Black dummy**	-.0263 (.2027)	-.6294 (.2751)	-.1557 (.0504)	1.387 (.8118)	1.176 (.5081)	-.0155 (1.572)	2.121 (1.442)
x_5	**Hispanic dummy**	.0567 (.2160)	-.2805 (.2977)	-.0944 (.0559)	-.0194 (.8317)	.2407 (.4721)	-.1450 (1.521)	-2.361 (1.367)
x_6	**Native American dummy**	.3657 (.3025)	-.0696 (.4163)	-.0083 (.0727)	-.7166 (1.077)	-.6614 (.6452)	-.9767 (1.790)	-1.848 (1.673)
x_7	**Male child**	-.0036 (.1293)	.4842 (.1913)	.0369 (.0298)	.3050 (.5525)	.2507 (.3263)	1.337 (1.268)	-.7940 (1.091)
x_8	**Mother's age - 23yrs.**	-.0876 (.0242)	.0141 (.0380)	-.0136 (.0058)	-.1609 (.1025)	-.0443 (.0584)	-1.081 (.2548)	.4951 (.2091)
x_9	**(Mother's age - 23yrs.)^2**	-.0025 (.0038)	-.0036 (.0061)	-.0009 (.0009)	.0010 (.0147)	.0029 (.0080)	-.0496 (.0443)	.0697 (.0358)
x_{10}	**BMI (weight(kg) / [height(m)]^2) - 24**	-.2174 (.1597)	.0415 (.0300)	-.0332 (.0091)	.0277 (.0810)	-.2499 (.1149)	**.0000 (.0000)**	**.0000 (.0000)**
x_{11}	**Maternal height - 162cm**	-.0491 (.0471)	.0737 (.0191)	**.0000 (.0000)**	.2035 (.0607)	**.0000 (.0000)**	**.0000 (.0000)**	**.0000 (.0000)**
	Marginal effect of maternal height	.0153 (.0117)	.0614 (.0180)	.0098 (.0027)	.1953 (.0552)	.0740 (.0340)	**.0000 (.0000)**	**.0000 (.0000)**
x_{12}	**Maternal weight - 63kg**	.0978 (.0598)	**.0000 (.0000)**	.0190 (.0034)	**.0000 (.0000)**	.1744 (.0520)	**.0000 (.0000)**	**.0000 (.0000)**
	Marginal effect of maternal weight	.0150 (.0067)	.0158 (.0114)	.0063 (.0015)	.0106 (.0309)	.0792 (.0191)	**.0000 (.0000)**	**.0000 (.0000)**
x_{13}	**Maternal age at menarche - 13yrs.**	.0398 (.0472)	-.1336 (.0739)	-.0094 (.0109)	.0829 (.1919)	-.0440 (.1077)	-.4198 (.5334)	-.7693 (.4349)
x_{18}	**(AFQT / mean of NLSY women of same age) - 1**	**.0000 (.0000)**	**.0000 (.0000)**	**.0000 (.0000)**	**.0000 (.0000)**	**.0000 (.0000)**	**.0000 (.0000)**	3.235 (1.104)

Table 4: Posterior Means (Standard Deviations) of Γ_j (j = 1, 2, ..., 9) in (2), (6), and (7)

	G	BL	BW	CH	CW	BPI	PIAT
S	-.5220 (.4991)	-.3382 (.5669)	-.3175 (.1648)	-4.590 (2.424)	.3587 (1.055)	.4787 (1.872)	-.1975 (1.824)
D	-0.3012 (.3770)	-.3962 (.4607)	.1101 (.1077)	5.800 (1.170)	-.8624 (.9370)	.0836 (1.921)	.6810 (1.846)
PC	2.089 (.6164)	1.047 (.6790)	.5407 (.1216)	-.7533 (1.510)	1.084 (1.179)	-1.008 (1.934)	.2632 (1.880)
WG	.0042 (.0461)	.1127 (.0994)	.0075 (.0112)	.0030 (.1843)	-.0374 (.1182)	.0834 (.6352)	-.1009 (.5217)
G	**.0000 (.0000)**	.6331 (.2750)	.0395 (.0225)	-.2122 (.7159)	-.0733 (.4747)	-.4306 (1.263)	.1929 (1.173)
BL	**.0000 (.0000)**	**.0000 (.0000)**	**.0000 (.0000)**	.0757 (.5707)	-.0583 (.3833)	.3541 (1.067)	-.5279 (.9562)
BW	**.0000 (.0000)**	**.0000 (.0000)**	**.0000 (.0000)**	1.375 (1.750)	.2911 (1.676)	-.4769 (1.943)	-.0146 (1.919)
HOME	**.0000 (.0000)**	**.0000 (.0000)**	**.0000 (.0000)**	-.0564 (.0288)	.0088 (.0163)	-.2109 (.0775)	.4959 (.0711)
CH	**.0000 (.0000)**	**.0000 (.0000)**	**.0000 (.0000)**	**-1.000 (.0000)**	**.0000 (.0000)**	-.0227 (.3307)	.1062 (.2671)
CW	**.0000 (.0000)**	**.0000 (.0000)**	**.0000 (.0000)**	**.0000 (.0000)**	**-1.000 (.0000)**	.0012 (.7471)	-.9860 (.6481)
R^2	.0330 (.0082)	.0517 (.0114)	.0775 (.0131)	.2114 (.0211)	.1634 (.0205)	.0641 (.0130)	.2075 (.0203)

Table 5: *Marginal* Posterior Predictive Means (Standard Deviations) of the Reference Mother by Group

	Main White	Supp. White	Black	Hispanic	Native American
S*	.4666 (.4989)	.5117 (.4999)	.2193 (.4138)	.1905 (.3927)	.5556 (.4969)
D*	.5648 (.4958)	.6070 (.4884)	.4895 (.4999)	.5100 (.4999)	.5854 (.4926)
PC*	.8076 (.3942)	.8932 (.3089)	.7964 (.4027)	.7851 (.4108)	.8447 (.3622)
WG	10.95 (6.285)	11.58 (6.330)	10.01 (6.309)	10.96 (6.322)	9.572 (6.354)
G	38.71 (2.144)	38.97 (2.182)	38.78 (2.157)	38.85 (2.150)	39.06 (2.176)
BL	50.50 (3.870)	50.60 (3.920)	49.96 (3.875)	50.45 (3.877)	50.51 (3.929)
BW	3.259 (.5124)	3.211 (.5198)	3.164 (.5112)	3.239 (.5124)	3.245 (.5177)
HOME	58.71 (24.26)	60.58 (24.37)	53.21 (24.19)	59.11 (24.31)	59.77 (24.18)
CH	112.0 (7.448)	111.6 (7.372)	114.2 (7.527)	112.9 (7.578)	110.7 (7.541)
CW	19.90 (4.262)	19.75 (4.261)	21.02 (4.277)	20.03 (4.287)	19.28 (4.307)
BPI	58.23 (27.31)	58.74 (27.27)	59.11 (27.23)	57.77 (27.27)	56.63 (27.46)
PIAT	62.25 (20.56)	62.65 (20.61)	61.26 (20.69)	60.17 (20.58)	61.53 (20.73)

Table 6: Posterior Probabilities for Joint Binary Measures of Maternal Behavior of the Reference Mother by Group

	PC = 1	PC = 0	Column Sum	PC = 1	PC = 0	Column Sum	PC = 1	PC = 0	Column Sum
	Main White			Supplementary White			Black		
S = 1									
D = 1	.2543	.0655	.3198	.3237	.0408	.3645	.1158	.0332	.1490
D = 0	.1177	.0291	.1468	.1321	.0151	.1472	.0556	.0147	.0703
Row Sum	.3720	.0946		.4558	.0559		.1714	.0479	
S = 0									
D = 1	.1994	.0456	.2450	.2167	.0258	.2425	.2692	.0713	.3405
D = 0	.2362	.0523	.2885	.2207	.0251	.2458	.3558	.0844	.4402
Row Sum	.4356	.0979		.4374	.0509		.6250	.1557	

	Hispanic		Column Sum	Native American		Column Sum
S = 1						
D = 1	.1032	.0319	.1351	.3172	.0626	.3798
D = 0	.0433	.0122	.0555	.1479	.0279	.1758
Row Sum	.1465	.0441		.4651	.0905	
S = 0						
D = 1	.2931	.0819	.3750	.1748	.0308	.2056
D = 0	.3455	.0890	.4345	.2048	.0340	.2388
Row Sum	.6386	.1709		.3796	.0648	

Table7: Posterior Means (Standard Deviations) of Predictive Effects of Endogenous Variables on Early Childhood Development

	Not conditioned on HOME				Conditioned on HOME			
Variable	**CH**	**CW**	**BPI**	**PIAT**	**CH**	**CW**	**BPI**	**PIAT**
S*	2.408 (.9850)	-.0886 (.4596)	.7062 (1.357)	.6222 (1.262)	2.429 (.9878)	-.0652 (.4604)	.4467 (1.352)	.8617 (1.254)
D*	-2.172 (.4605)	.1838 (.2791)	1.004 (1.107)	-1.258 (.9127)	-2.163 (.4599)	.1988 (.2796)	.8413 (1.099)	-1.108 (.9062)
PC*	.0361 (.8422)	-.1486 (.5055)	.2355 (2.354)	1.679 (1.937)	.0162 (.8444)	-.1740 (.5076)	.5141 (2.364)	1.426 (1.931)
S	-5.108 (2.438)	.7577 (1.187)	-.6379 (3.179)	.2520 (3.139)	-5.120 (2.436)	.7439 (1.186)	-.4829 (3.169)	.1115 (3.103)
D	6.261 (1.178)	-.9492 (.8792)	.5585 (3.277)	2.257 (2.782)	6.261 (1.178)	-.9501 (.8795)	.5679 (3.275)	2.249 (2.775)
PC	-.5052 (1.770)	.4744 (1.071)	.1517 (4.428)	-3.842 (3.885)	-.4839 (1.772)	.5010 (1.072)	-.1434 (4.459)	-3.576 (3.837)
WG	.0692 (.0430)	-.0038 (.0215)	-.0962 (.1290)	-.2117 (.0978)	.0699 (.0430)	-.0029 (.0214)	-.1055 (.1272)	-.2033 (.0954)
G	-.3139 (.2038)	-.2275 (.0868)	.1956 (.5002)	.0195 (.3933)	-.3127 (.2037)	-.2262 (.0869)	.1813 (.4932)	.0332 (.3811)
BL	.3007 (.1335)	.0117 (.0565)	.0264 (.2928)	.0996 (.2334)	.2980 (.1340)	.0079 (.0563)	.0683 (.2901)	.0612 (.2278)
BW	.2764 (1.540)	1.541 (.6665)	-3.965 (3.130)	2.892 (2.500)	.2521 (1.543)	1.514 (.6657)	-3.661 (3.092)	2.616 (2.461)
HOME					.0130 (.0106)	.0169 (.0054)	-.1863 (.0327)	.1715 (.0240)

Table 8: Posterior Means (Standard Deviations) of Predictive Effects of Exogenous Variables on Early Childhood Development

	Variables	Not conditioned on HOME				Conditioned on HOME			
		CH	CW	BPI	PIAT	CH	CW	BPI	PIAT
x_1	1	107.6 (8.527)	22.97 (4.034)	62.68 (22.35)	50.09 (17.95)	107.0 (8.489)	22.21 (4.004)	71.10 (22.15)	42.30 (17.28)
x_2	= 1 if tested at age 6 = 0 if tested at age 5	6.934 (.4948)	2.418 (.2528)	-.4102 (1.422)	-3.665 (1.101)	6.958 (.4959)	2.448 (.2529)	-.7373 (1.402)	-3.364 (1.072)
x_3	Supplementary White dummy	-.2103 (.9772)	.0273 (.5068)	-.2982 (2.092)	.2397 (1.891)	-.2312 (.9778)	.0006 (.5063)	-.0053 (2.055)	-.0314 (1.818)
x_4	Black dummy	3.756 (1.021)	1.395 (.4431)	1.469 (1.966)	-.4903 (1.671)	3.854 (1.037)	1.519 (.4498)	.1117 (1.965)	.7609 (1.646)
x_5	Hispanic dummy	2.510 (1.093)	.2886 (.5085)	.6085 (2.092)	-1.667 (1.837)	2.536 (1.097)	.3189 (.5086)	.2710 (2.058)	-1.356 (1.779)
x_6	Native American dummy	-1.353 (1.162)	-.5337 (.5905)	-2.342 (2.297)	-1.609 (2.064)	-1.370 (1.164)	-.5551 (.5905)	-2.107 (2.259)	-1.828 (1.987)
x_7	Male child	.5372 (.4951)	.1498 (.2482)	1.935 (1.293)	-2.165 (1.061)	.5597 (.4970)	.1788 (.2481)	1.616 (1.274)	-1.871 (1.027)
x_8	Mother's age - 23yrs.	.1218 (.1315)	-.0144 (.0564)	-1.473 (.3044)	1.168 (.2721)	.1067 (.1319)	-.0345 (.0564)	-1.251 (.2952)	.9635 (.2515)
x_9	(Mother's age - 23yrs.)^2	.0012 (.0152)	.0029 (.0069)	-.0189 (.0427)	.0224 (.0322)	.0025 (.0153)	.0047 (.0069)	-.0382 (.0421)	.0402 (.0314)
x_{10}	BMI (weight(kg) / [height(m)]^2) - 24	-.8340 (.6471)	-.0952 (.2409)	-.2971 (.9711)	-.4361 (.9729)	-.8343 (.6479)	-.0942 (.2411)	-.3062 (.9254)	-.4293 (.8616)
x_{11}	Maternal height - 162cm	-.0137 (.1920)	.0224 (.0694)	-.1118 (.2849)	-.0739 (.2900)	-.0173 (.1923)	.0181 (.0695)	-.0640 (.2702)	-.1183 (.2554)
x_{12}	Maternal weight - 63kg	.3189 (.2403)	.1044 (.0889)	.2130 (.3551)	-.0739 (.3590)	.3225 (.2406)	.1087 (.0890)	.1656 (.3368)	-.0298 (.3168)
x_{13}	Maternal age at menarche - 13yrs.	.1131 (.1705)	-.0192 (.0848)	-.1350 (.5022)	-1.138 (.3836)	.1272 (.1714)	-.0009 (.0848)	-.3357 (.4950)	-.9529 (.3737)
x_{14}	Northeast	-.3545 (.7008)	-.0144 (.2105)	-.7655 (1.075)	1.843 (1.160)	-.4056 (.7036)	-.0807 (.2107)	-.0384 (1.006)	1.173 (.9837)
x_{15}	South	-.8751 (.6426)	.0877 (.2708)	1.238 (1.072)	.0316 (1.100)	-.8766 (.6439)	.0867 (.2701)	1.248 (1.022)	.0242 (.9735)
x_{16}	West	-.1147 (.6002)	-.0398 (.1786)	.0470 (.9164)	1.063 (1.023)	-.1413 (.6030)	-.0740 (.1783)	.4233 (.8528)	.7167 (.8496)

Table 8 (continued): Posterior Means (Standard Deviations) of Effects of Exogenous Variables on Early Childhood Development

	Variables	Not conditioned on HOME				Conditioned on HOME			
		CH	CW	BPI	PIAT	CH	CW	BPI	PIAT
x_{17}	Calendar time - (19)85	-.0449 (.4594)	-.0500 (.1179)	.3127 (.5370)	-.6926 (.5347)	-.0262 (.4599)	-.0254 (.1181)	.0400 (.5207)	-.4417 (.4975)
x_{18}	(AFQT/mean of NLSY women of same age) - 1	2.018 (.6164)	-.0792 (.3081)	-1.384 (1.179)	7.175 (1.192)	1.947 (.6125)	-.1742 (.3059)	-.3425 (1.167)	6.217 (1.164)
x_{19}	Household income in $1000 - 25	.0330 (.0194)	.0010 (.0083)	-.0520 (.0367)	.0918 (.0362)	.0307 (.0194)	-.0021 (.0082)	-.0186 (.0353)	.0610 (.0325)
x_{20}	No health insurance available	-.3923 (.5939)	-.0295 (.1894)	-.3321 (.8176)	.3908 (.9310)	-.4049 (.5973)	-.0454 (.1914)	-.1604 (.7579)	.2328 (.7816)
x_{21}	Missing health insurance availability	.9165 (.7032)	-.0370 (.2232)	.6085 (1.004)	-1.227 (1.056)	.9537 (.7085)	.0098 (.2266)	.0964 (.9516)	-.7566 (.9185)
x_{22}	Number of adults in household - 2	.2082 (.2221)	-.0173 (.0597)	.2239 (.3025)	-.4325 (.3810)	.2231 (.2237)	.0018 (.0603)	.0132 (.2664)	-.2380 (.2998)
x_{23}	Number of qrts. worked during pregnancy - 3	.3952 (.2210)	-.0230 (.0703)	-.4058 (.3498)	1.110 (.3629)	.3719 (.2209)	-.0540 (.0707)	-.0633 (.3357)	.7947 (.3142)
x_{24}	Number of maternal siblings - 4	-.0669 (.0981)	-.0043 (.0247)	-.0545 (.1192)	.0522 (.1603)	-.0693 (.0987)	-.0073 (.0250)	-.0226 (.1025)	.0226 (.1244)
x_{25}	Grandmother's education - 12yrs.	-.1191 (.1142)	-.0088 (.0419)	-.3876 (.1775)	.6217 (.1830)	-.1373 (.1170)	-.0323 (.0438)	-.1291 (.1741)	.3834 (.1652)
x_{26}	Not on time in school at age 14	-1.049 (.8604)	.0079 (.3255)	-.1241 (1.201)	-.4771 (1.265)	-1.049 (.8619)	.0099 (.3251)	-.1438 (1.148)	-.4579 (1.126)
x_{27}	Non-urban at age 14	-.3600 (.5130)	.0482 (.1629)	.7379 (.7603)	-1.611 (.8581)	-.3243 (.5184)	.0951 (.1670)	.2202 (.7264)	-1.136 (.7322)
x_{28}	No employed male in household at age 14	-.2772 (.5030)	.0202 (.1309)	.2504 (.6156)	-.4980 (.7865)	-.2689 (.5048)	.0315 (.1312)	.1292 (.5461)	-.3859 (.6285)
x_{29}	Cigarette price index	4.940 (4.174)	-.3101 (1.117)	.0340 (5.072)	3.644 (4.523)	4.935 (4.184)	-.3247 (1.127)	.1932 (4.973)	3.505 (4.363)
x_{30}	Alcohol price index	-1.831 (7.680)	.5737 (2.093)	1.170 (9.399)	-5.722 (8.709)	-1.769 (7.702)	.6580 (2.111)	.2478 (9.279)	-4.886 (8.446)
x_{31}	Medical services price index	-6.975 (7.584)	.3485 (2.026)	.4262 (9.012)	-2.627 (8.269)	-6.964 (7.602)	.3724 (2.040)	.1698 (8.902)	-2.395 (8.048)
x_{32}	Food price index	1.152 (7.300)	.0675 (1.805)	1.255 (8.066)	-.7129 (7.645)	1.156 (7.316)	.0716 (1.821)	1.211 (7.917)	-.6727 (7.406)

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