When the Honeymoon is Over: The Effects of Family Structure on Children's Cognitive and Non-cognitive Achievements

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A dissertation submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Economics.

Chapel Hill
2017

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ABSTRACT

NING FU: When the Honeymoon is Over:
The Effects of Family Structure
on Children's Cognitive and Non-cognitive Achievements.
(Under the direction of Donna B. Gilleskie)

This dissertation examines the effects of family structure on children's cognitive and non-cognitive achievements, using data on females and their children from the 1979 cohort of the National Longitudinal Survey of Youth. To deal with dynamic selection into married, cohabiting or single households, I model women's relationship status, school enrollment, employment, family size, and investment in children over the life cycle. All of these behaviors, and the production of children's achievements, are estimated using a random effects joint estimation procedure, which allows the unobserved heterogeneity of the woman and her children to influence both maternal behaviors and children's outcomes. I find that, compared to growing up in single households, being born and raised in married households significantly decreases children's behavioral problems by 0.17 to 0.28 standard deviations, depending on the child's age and gender. These gains are exhibited by children under age ten. Moreover, compared to being raised in cohabiting households, growing up in continuously married households decreases girls' behavioral problems by 0.4 standard deviations, during ages four to six. In addition to measuring causal marginal effects of family structure, this dissertation uses simulation to evaluate how various policy interventions, including marriage promotion, maternal education promotion, and parenting skills training, could potentially impact children's cognitive and non-cognitive achievements differently.

ACKNOWLEDGMENTS

Firstly, I would like to express my sincere gratitude to my advisor Donna B. Gilleskie for her invaluable guidance, encouragement and support. The passion and rigor she brings to research are highly contagious and motivating, and her expertise and understanding have always kept my hopes up through tough times in my Ph.D. pursuit. Above all, I am thankful for the wonderful example she has set about how to be loving and compassionate as a person. It has been an honor to be her student, and I could not have imagined having a better advisor and mentor.

I would also like to thank my thesis committee members, Luca Flabbi, Jane Cooley Fruehwirth, David K. Guilkey, and Helen V. Tauchen, for their continuous contributions of time, ideas, and guidance. I am fortunate to have a committee that not only raise deep questions for my research, but also go far and beyond in guiding me to answer them. Their immense knowledge, constructive comments, and warm encouragement have greatly improved not only the quality of my research, but also my overall experience as a Ph.D. student. I am also grateful for the guidance I received from Klara S. Peter when I was a predoc trainee at the Carolina Population Center. She held my hand through my first Ph.D. research project, and her diligence to research has been a great inspiration for me throughout my Ph.D. study.

I thank Raquel Bernal, Hanming Fang and Michael P. Keane for generously sharing their data on U.S. welfare policies. I am also grateful for the Robert Gallman Scholarship, the Williamson Family Fund, the Mathematica Research Policy Summer Research Fellowship, and the Dissertation Completion Fellowship for their generous support for my research.

My sincere thanks also goes to my colleagues at UNC, who have been providing friendship, insightful comments, and moral support throughout my Ph.D. study. The highly collegial environment in the department has made the Ph.D. study so much more fun.

Lastly, a special thanks to my parents and my husband. Their love and support have always been my greatest source of strength.

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CHAPTER 1

INTRODUCTION

The United States has experienced dramatic changes in family structure since the 1960s. In 2014, over 40 percent of births were to unmarried women, up from only 5.3 percent in 1960.[1] Data indicate that children growing up in single or cohabiting households have less education, worse health outcomes, and lower future marriage and socioeconomic prospects (e.g., McLanahan and Sandefur, 1994; Buchanan, Maccoby, and Dornbusch, 1996; Ermisch and Francesconi, 2001; Manning and Lamb, 2003; Brown, 2004; Amato, 2005). Intended to reduce single parenthood and improve children's welfare, the federal government has been providing \$150 million each year since 2005 to support the Healthy Marriage and Responsible Fatherhood Initiative based, in part, on these observed correlations. However, in order to design effective evidence-based policy, it is essential to realize that the frequently-cited correlations between non-marital parenthood and children's adverse outcomes do not necessarily imply a causal relationship. Using the National Longitudinal Survey of Youth 1979, this dissertation measures the causal impacts of family structure on school-aged children's cognitive and non-cognitive achievements.[2]

With the goal of uncovering causal relationships, this dissertation develops and estimates a dynamic, multiple-equation model to explain women's simultaneous behaviors over the life cycle regarding their relationship status, school enrollment, employment, family size and investment in children, and to empirically evaluate how the observed behaviors influence children's cognitive and non-cognitive achievements. When making decisions each period, women take into account their histories of relationships, schooling, employment, family size, and children's past achievements.

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[1]Statistics are from Child Trends Data Bank (2015).

[2]This research was conducted with restricted access to Bureau of Labor Statistics (BLS) data. The views expressed here do not necessarily reflect the views of the BLS.

Their behaviors are also affected by demographic characteristics of the household and the time-varying state and local environment. These decisions could change across periods as circumstances evolve, such as the accumulation of work experience, aging of the woman and her children, or fluctuations in local unemployment rates. A woman's behaviors, her child's past cognitive and non-cognitive achievements, and the unobserved characteristics of the mother and of the child jointly determine each child's achievements in each period.

Compared with the existing literature that explores causal effects of family structure on children's outcomes, this dissertation stands out in three ways. First, it establishes the unbiased causal impacts of family structure on children's achievements, while jointly considering other life-cycle decisions, such as employment and fertility, all of which could impact children's achievements. Current causal studies focus on the endogeneity of only one behavior, namely family structure, treating related behaviors as exogenous. Failing to model jointly-made decisions that may be correlated with unobservables may produce biased effects of family structure on children's achievements. In this dissertation, I jointly model the dynamics of relationship status, as well as other major life-cycle behaviors and children's achievements, allowing all these dynamic behaviors and outcomes to influence each other, as well as be influenced by exogenous characteristics, unobserved correlated heterogeneity and random shocks.

Second, this dissertation examines the impacts of family structure on children who have never experienced family structure changes. The fixed-effects approach, which is commonly used in the literature to address the endogeneity of family structure, relies on either differences in family structure experience across siblings in the same household (i.e., the household fixed effects), or changes in family structure a child experiences over time (i.e., the child fixed effects). The effects identified from such transition households cannot be used to infer the effects of family structure on children who are born and raised in always single/cohabiting/married households. The joint estimation approach used in this dissertation enables me to identify and compare the latter effects. Specifically, I find that, compared to growing up in continuously single households, being born and raised in continuously married households significantly decreases children's behavioral problems by 0.17 to 0.28 standard deviations, depending on the child's age and gender. These beneficial impacts are statistically significant for children under age 10. Moreover, compared to being raised in cohabiting households, growing up in continuously married households decreases girls' behavioral problems by 0.4 standard deviations, during ages 4 to 6.

Third, I evaluate the potential impacts of alternative policy interventions that aim to change different aspects of women's behaviors, and I establish bounds for such effects. The literature on the production of children's cognitive and non-cognitive achievements has explored the impacts of existing policies or natural experiments. However, without modeling individuals' dynamic behaviors, these papers are not equipped to examine how children's outcomes would differ under alternative intervention scenarios. For example, if a marriage intervention program does not affect participants' propensity to get married, policy evaluation studies cannot infer how children's achievements would have changed if the program was effective in changing marriage rates. In addition, evaluations of a marriage intervention program are not able to answer broader questions about the potential impacts of an intervention on the target population that improves a mother's education level instead of promoting marriage. Through estimation and simulation of channels of influence on children's outcomes, this dissertation can answer both types of questions. Specifically, I find that effective marriage promotion programs have the potential to produce small, favorable impacts on children's behavioral problems for initially single households. Interventions that successfully encourage unmarried mothers to continue their education and interventions that increase parental investment could benefit children's cognitive and non-cognitive achievements.

CHAPTER 2

RELATED LITERATURE

2.1 Family Structure is Not Random

The difficulty in measuring the effects of family structure on children's outcomes stems from the nonrandomness of family structure. Specifically, observed and unobserved characteristics of the parent(s) and of the child may be correlated with both the observed family structure and the child outcomes. Researchers have used two approaches to address this endogeneity of family structure. The first approach uses within-family (across siblings) or within-child (at different ages) fixed effects (Aughinbaugh, Pierret, and Rothstein, 2005; Gennetian, 2005; Björklund, Ginther, and Sundström, 2007; Cooper, Osborne, Beck, and McLanahan, 2011). It is worth noting that the fixed-effect approach can only eliminate invariant unobserved characteristics. It fails to capture time-varying determinants that jointly influence family structure and child achievements. For example, suppose a mother recently lost her job. On the one hand, this event could worsen the relationship with her husband and eventually lead to a divorce and, on the other hand, it could negatively impact her child's achievements since she might alter investment in the child due to the job loss. Fixed-effects analysis would fail to capture the changes in employment and parental investments (if not modeled), and lead to the potentially incorrect conclusion that the family structure change causally decreases children's achievements. In this dissertation, several mechanisms are jointly modeled as endogenous dynamic life-cycle behaviors that may affect child development. These include relationship, schooling, employment, family size, and investment in children.

The second approach that has been used in the literature to address the potentially nonrandom nature of family structure includes families that experience a parental death to serve as an exogenous source of family dissolution (Francesconi, Jenkins, and Siedler, 2005). However, the assumption that a parental death is exogenous to other child development inputs or child development itself is questionable. As McLanahan, Tach, and Schneider (2013) point out, deaths related to violence or accidents may reflect selection into risky behaviors, and illness-related deaths may reflect selection into particular lifestyles (such as smoking and drinking) or genetic endowment that may also affect child outcomes. Biblarz and Gottainer (2000), for example, find that, compared with children raised in single-mother families created by the death of the father, children raised in divorced single-mother families have significantly lower levels of education, occupational status, and happiness in adulthood. Corak (2001) finds that, relative to children from intact families, children whose parents divorced postpone marriage and they are more likely to suffer separation or divorce once married. Children from bereaved families, on the other hand, are no different in their marital behavior than those from intact families. As such, the measured effect of parental dissolution associated with a parental death cannot be expanded to that of divorced or selected single parenthood.

To better understand why and how family structure is determined, a number of studies use dynamic structural models to explicitly model the decision making process of forward-looking individuals with regard to marriage, cohabitation and divorce, along with other life-cycle decisions such as employment and schooling (Brien, Lillard, and Stern, 2006; Keane and Wolpin, 2010; Laufer and Gemici, 2011; Blau and van der Klaauw, 2013; Flabbi and Flinn, 2015). These papers provide a theoretical framework to make explicit how different life-cycle decisions are correlated and jointly determined, and to derive the demand functions used in this dissertation. Given the focus on children's outcomes, this dissertation includes parental investment as an endogenous time-varying behavior that is not commonly modeled in this literature. It also allows a woman's behavior to be influenced by her children's past cognitive and non-cognitive achievements.

2.2 Production of Children's Cognitive and Non-cognitive Achievements

This dissertation relates to the literature on the production of school-aged children's cognitive and non-cognitive achievements. Two types of parameters are the focus of empirical work in this literature: the policy effect and the productive effects of inputs.[1] The policy effect identifies the average or total effect of an intervention on achievements without controlling for other possible inputs. This effect is estimated using experiments such as the Tennessee Student/Teacher Achievement Ratio (STAR) experiment (Finn and Achilles, 1990; Mosteller, 1995; Krueger, 1998, 2003; Fryer, Levitt, and List, 2015; Mayer, Kalil, Oreopoulos, and Gallegos, 2015), or natural experiments such as welfare reform and state-level policy changes (e.g., Bernal and Keane, 2011; Juhn, Rubinstein, and Zuppann, 2015). The productive effects, on the other hand, measure the impact of each input on child's cognitive and non-cognitive achievements, holding all other inputs constant (Todd and Wolpin, 2003, 2007; Cunha and Heckman, 2007, 2008; Bernal, 2008; Gayle, Golan, and Soytas, 2011; Del Boca, Flinn, and Wiswall, 2014; Attanasio, Meghir, and Nix, 2015). Bernal (2008) focuses on a sample of married women and finds that the effects of maternal employment and child care on children's cognitive achievements are negative and sizable. Del Boca et al. (2014) also focus on investment decisions in intact families, and they find that both parents' time inputs are important for the cognitive development of their children, while the monetary inputs are not as important. Using data from India, Attanasio et al. (2015) find that goods investment is effective in improving children's cognition at all stages of childhood. Gayle et al. (2011) model the decisions of fertility, employment and time investment into children for single families and married families separately, and estimate that paternal time investment increases their children's probability of graduating from high school and getting some college education while maternal time increases the probability of achieving a college degree. These existing empirical analyses of children's achievement production functions emphasize the importance of parental behavioral inputs on children's development. However, they do not model the family structure dynamics as an endogenous input itself (e.g., presence of a male parental figure) or as a modifier of productive inputs (e.g., restrictions on TV time or enforcement of study time may have different effects as the number of adults in the household varies). By 1) modeling the production function of children's achievements that allows family structure to affect both the level of children's achievements and the productivity of

[1] Todd and Wolpin (2003) discuss the two types of parameters in detail.

other inputs, and 2) using policy and price variations as exclusion restrictions for women's behaviors, this dissertation is able to examine the productive effect of family structure and evaluate the mechanisms of various policy effects.

This dissertation is also closely related to the discussion on the static and dynamic complementarity of parental investments, and the self-productivity of skills (Cunha, Heckman, Lochner, and Masterov, 2006; Cunha and Heckman, 2007, 2008; Cunha, Heckman, and Schennach, 2010; Aizer and Cunha, 2012). Theoretical and empirical evidence have shown that parents invest more in children with higher endowments due to the complementarity between endowments and investments (static complementarity), and parental investments and existing human capital are complements in the production of later human capital (dynamic complementarity). Cunha and Heckman (2008) also provide support for the skill self-productivity. They find that non-cognitive skills promote the formation of cognitive skills, but cognitive skills in general do not promote the formation of non-cognitive skills. This dissertation is able to provide empirical support for the existence of complementarity and self-productivity in the production of children's achievements.

CHAPTER 3

EMPIRICAL FRAMEWORK

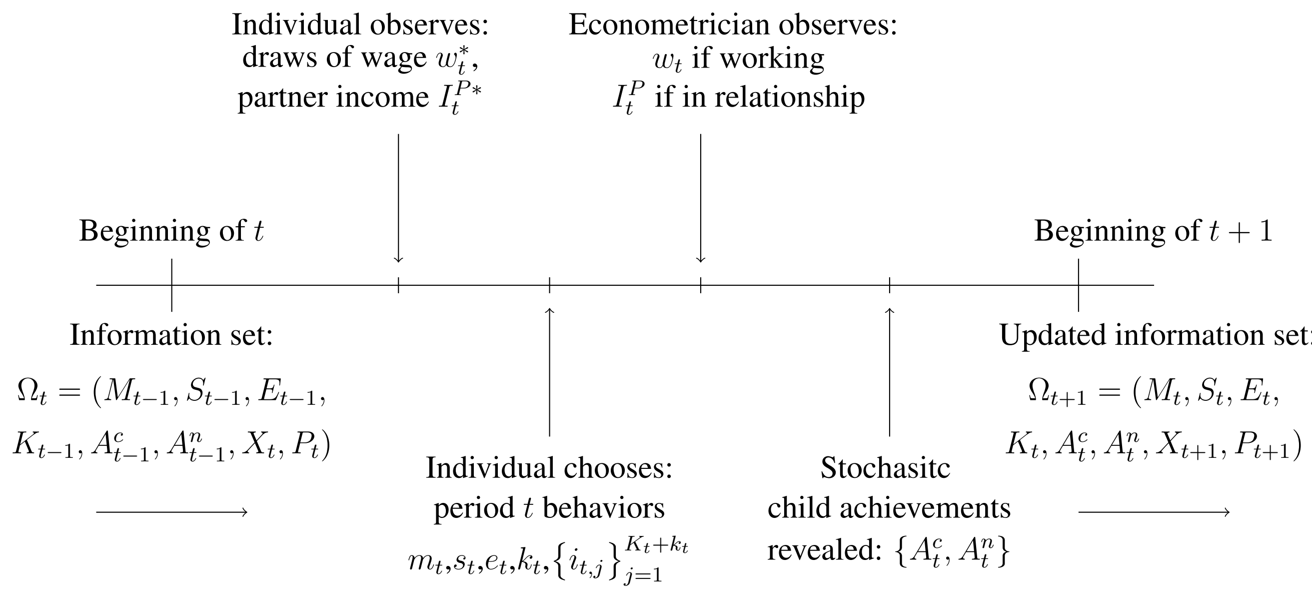
The dynamic empirical model is motivated by a theoretical structural framework in which a forward-looking woman makes per-period (annual) decisions about her relationship status, school enrollment, employment, family size, and investment in children to maximize her lifetime utility. Her decisions jointly influence her children's outcomes over time. In the empirical estimation, I approximate the choice probabilities as functions of information known to the woman at the beginning of each period. This information includes the woman's past behavior histories and her children's previous achievements, as well as their demographic characteristics and the current state and local policy environment. I jointly estimate these demand equations with child achievement production functions, allowing for correlation through both mother-level and child-level observed and unobserved heterogeneity. I estimate the correlated unobserved heterogeneity components as random effects whose distributions are approximated as discrete and are estimated by the data (i.e., no assumptions on functional form). I also address econometric considerations such as the non-randomness of survey attrition and initial conditions.

3.1 Timing and Notation

A woman enters each period t with an observed information set, Ω_t, which includes the histories of her relationships, M_{t-1}; of school enrollment, S_{t-1}; of employment, E_{t-1}; of children in the household, K_{t-1}; and of her children's cognitive achievements, A^c_{t-1}, and non-cognitive achievements, A^n_{t-1}, observed at the end of period $t-1$. This information set also includes exogenous characteristics of her and her children, X_t, and the state or county-level price and supply conditions, P_t, observed at the point of decision-making. This vector of information known at the beginning of period t is denoted $\Omega_t = (M_{t-1}, S_{t-1}, E_{t-1}, K_{t-1}, A^c_{t-1}, A^n_{t-1}, X_t, P_t)$. The relationship history vector, M_{t-1}, contains the woman's relationship status last period m_{t-1}, the duration of the relationship up to period t and the number of times she has been married up to period t. The woman's education history vector, S_{t-1}, includes her school enrollment status last period, s_{t-1}, and her highest grade completed up to period t. Her employment status last period, e_{t-1} and her work experience up to period t make up the employment history E_{t-1}. The family size vector, K_{t-1}, indicates whether the number of children in the household changed in the last period, k_{t-1}, and the number of children under and above age five in the household up to period t. Children's cognitive achievements, A^c_{t-1}, is a vector of each child's cognitive achievement in $t-1$, $\{A^c_{t-1,j}\}_{j=1}^{K_{t-1}}$. Similarly, children's non-cognitive achievements, A^n_{t-1}, is a vector of each child's non-cognitive achievement in $t-1$, $\{A^n_{t-1,j}\}_{j=1}^{K_{t-1}}$. The exogenous variables, X_t, include the mother's characteristics (such as age, race, AFQT score), children's characteristics (such as age, race, gender), and calendar year trends. Lastly, the state and local policy environment is denoted by the vector $P_t = (P^M_t, P^S_t, P^E_t, P^K_t, P^I_t, P^A_t)$. Different superscripts indicate the variables in P_t that relate to particular endogenous behaviors and outcomes; namely, cost or supply-side variables that affect relationship status, P^M_t; parental school enrollment, P^S_t; employment, P^E_t; family size, P^K_t; and investment in children, P^I_t. The vector also contains variables that capture average characteristics of local schools, P^A_t.

Figure 3.1 depicts the per-period elements of an individual's decision-making process with regard to timing and observability. At the beginning of a period t, a woman draws an hourly wage offer of her own, w^*_t, and an income of her potential spouse/partner, I^{P*}_t, both of which are unobserved by the econometrician. She then jointly decides 1) whether to be married, cohabiting or single, m_t, 2) whether to enroll in school, s_t, 3) whether to be employed or not, and whether to work full-time/part-time and full-year/part-year if working at all, e_t, 4) whether or not to change the number of children living in the household, k_t, and 5) how much to invest in each child j, $i_{t,j}$.

Figure 3.1: Timeline



Each period, a woman chooses her period t behaviors, m_t,s_t,e_t,k_t,$\{i_{t,j}\}_{j=1}^{K_t+k_t}$, where each behavior may include several alternatives. That is, for relationship status ($m_t = m$), the alternative set is:

$$m = \begin{cases} 0, & \text{to be in marriage} \\ 1, & \text{to be in cohabitation} \\ 2, & \text{to be single} \end{cases} .$$

If the woman is in a relationship, the econometrician observes her spouse/partner's income $I_t^P = I_t^{P*}$. The school enrollment ($s_t = s$) alternatives are:

$$s = \begin{cases} 0, & \text{to not enroll} \\ 1, & \text{to enroll} \end{cases} .$$

The employment ($e_t = e$) alternatives are:

$$e = \begin{cases} 0, & \text{to work full-year full-time} \\ 1, & \text{to work full-year part-time} \\ 2, & \text{to work part-year full-time} \\ 3, & \text{to work part-year part-time} \\ 4, & \text{to be unemployed} \\ 5, & \text{to be out of labor force} \end{cases} .$$

If the woman works, the econometrician observes her wage $w_t = w_t^*$. The change in the number of children in the household, k_t, can be any integer, where positive values could be due to childbirth, child adoption, or marriage to a partner who already has children, and negative values could reflect child mortality, that children are sent to foster care or to their grandparents, loss of custody after divorce, or that children are old enough to leave the household. I let $k_t = 0$ indicate no change in the number of children in year t, and $k_t = 1$ and $k_t = -1$ indicate an increase and a decrease in the number of children, respectively, in year t. That is,

$$k = \begin{cases} -1, & \text{increase the number of children} \\ 0, & \text{no change in the number of children} \\ 1, & \text{decrease the number of children} \end{cases} .$$

Lastly, the parental investment for child j, $i_{t,j}$, is a continuous variable. As the data section explains in detail, parental investment is not in terms of dollars or hours exclusively. Instead, it is an overall measure of the cognitive stimulation and emotional support provided by the household. All these behaviors impact the cognitive and non-cognitive achievements of each child j, $A^c_{t,j}$ and $A^n_{t,j}$, respectively, which are realized at the end of the period.

3.2 Estimable Structural Equations and Production Functions

The derived demand for each behavior in period t is specified as a function of the information set coming into period t, Ω_t, and the structural or primitive parameters of the individuals' utility function and the child achievement production function. We approximate these highly non-linear functions using an n^{th}-order Taylor series approximation to define choice probabilities that are functions of endogenous and exogenous variables known entering each period. These demand equations and the production functions are correlated through both observable and unobservable family characteristics. The additive error terms that capture the unobserved determinants of each equation ℓ, ϵ_t^ℓ, are decomposed into three components: a mother endowment component, μ; a child j endowment component, ν_j; and an idiosyncratic component, ε_t^ℓ, where $\epsilon_t^\ell = \rho^\ell \mu + \omega^\ell \nu_j + \varepsilon_t^\ell$. The factor loadings, ρ^ℓ and ω^ℓ, on each non-idiosyncratic components of heterogeneity, μ and ν_j, are denoted with equation-specific superscripts, and indicate the relative importance of the associated heterogeneity in each equation. They also vary by outcome for behaviors with more than two alternatives. The equation-specific idiosyncratic terms ε_t^ℓ are assumed to be Type-I Extreme Value distributed for discrete behaviors m_t, e_t, s_t and k_t, thus implying logit and multinomial logit probabilities that enter the likelihood function. They are i.i.d. normally distributed for the continuous investment behaviors, i_t; expected wages, w_t; spouse/partner incomes, I_t^P; and the continuous cognitive achievement, $A_{t,j}^c$ and non-cognitive achievement, $A_{t,j}^n$. I allow the unobserved heterogeneity components to be approximated by discrete step-wise functions (see Heckman and Singer, 1984; Mroz and Guilkey, 1992; Mroz, 1999) rather than imposing a distributional form (such as normality).[1]

An individual's contributions to the likelihood function include probabilities of her observed discrete behaviors and densities of the observed parental investment, her wage and her spouse/partner's income, and her children's achievement outcomes. The probabilities of being single ($m_t = 2$) or

[1]Using Monte Carlo analysis, Mroz (1999) finds that when the true distribution of the unobserved heterogeneity is normal, there is little bias or efficiency loss by assuming a discrete factor random effects model. Moreover, when the unobserved heterogeneity is not normally distributed, the discrete factor approximations perform better than maximum likelihood estimators that incorrectly assume joint normality.

cohabiting ($m_t = 1$) relative to being married ($m_t = 0$) in period t are (in log odds):

$$ln\Big[\frac{p(m_t = m)}{p(m_t = 0)}\Big] = f^M(M_{t-1}, S_{t-1}, E_{t-1}, K_{t-1}, A_{t-1}, X_t, P_t) + \rho_m^M \mu \qquad m = 1, 2. \quad (3.1)$$

The linear functions f^ℓ for behavior ℓ has as its arguments the pre-determined or endogenous variables, exogenous characteristics and state and local supply-side variables that may be interacted in the fully specified equations.

The probability of being enrolled in school ($s_t = 1$) relative to not enrolled ($s_t = 0$) in period t is (in log odds):

$$ln\Big[\frac{p(s_t = 1)}{p(s_t = 0)}\Big] = f^S(M_{t-1}, S_{t-1}, E_{t-1}, K_{t-1}, A_{t-1}, X_t, P_t) + \rho^S \mu \ . \quad (3.2)$$

The probabilities of working full-year part-time ($e_t = 1$), working part-year full-time ($e_t = 2$), working part-year part-time ($e_t = 3$), being unemployed ($e_t = 4$), or being out of labor force ($e_t = 5$) relative to working full-year full-time ($e_t = 0$) in period t are (in log odds):

$$ln\Big[\frac{p(e_t = e)}{p(e_t = 0)}\Big] = f^E(M_{t-1}, S_{t-1}, E_{t-1}, K_{t-1}, A_{t-1}, X_t, P_t) + \rho_e^E \mu \qquad e = 1, 2, 3, 4, 5. \quad (3.3)$$

The probabilities of a change in the number of children in the household relative to no change in the number of children ($k_t = k$) are (in log odds):

$$ln\Big[\frac{p(k_t = k)}{p(k_t = 0)}\Big] = f^K(M_{t-1}, S_{t-1}, E_{t-1}, K_{t-1}, A_{t-1}, X_t, P_t) + \rho_k^K \mu \qquad k = -1, 1. \quad (3.4)$$

where $k_t = 1$ and $k_t = -1$ indicate that at least one child is acquired or lost, respectively, in year t. The continuously-valued investment in child j in period t is specified as:

$$i_{t,j} = f^I(M_{t-1}, S_{t-1}, E_{t-1}, K_{t-1}, A_{t-1,j}, X_t, P_t) + \rho^I \mu + \omega^I \nu_j + \varepsilon_t^I \ . \quad (3.5)$$

where ε_t^I is serially-uncorrelated and follows a normal distribution.

Modeled jointly with selection into employment, I estimate an equation for log wages using a woman's observed wage in period t conditional on being employed. The log mean of the wage distribution is a linear function of her relationship history, M_{t-1}; the family size history, K_{t-1}; her education experience, S_{t-1}; work experience, E_{t-1}; demographic characteristics, X_t; the local employment situation, P_t^E; her unobserved heterogeneity, μ, and an i.i.d. disturbance term ε_t^W:

$$ln(w_t|e_t \leq 3) = f^W(M_{t-1}, S_{t-1}, E_{t-1}, K_{t-1}, X_t, P_t^E) + \rho^W \mu + \varepsilon_t^W \ . \tag{3.6}$$

Similarly, I model a woman's spouse/partner's observed income in period t, conditional on the woman being in a relationship, as a linear function of the same observed and unobserved characteristics and an i.i.d. disturbance term ε_t^P. The log mean of the partner's income distribution is:

$$ln(I_t^P|m_t \neq 2) = f^P(M_{t-1}, S_{t-1}, E_{t-1}, K_{t-1}, X_t, P_t^E) + \rho^P \mu + \varepsilon_t^P \ . \tag{3.7}$$

The production function for child j's cognitive achievement at the end of period t, $A_{t,j}^c$, follows the value-added specification, and is a linear function of her previous cognitive and non-cognitive achievements coming into period t, namely $A_{t-1,j}^c$ and $A_{t-1,j}^n$; the mother's current period investment in the child, $i_{t,j}$; relationship, m_t; schooling, s_t; employment, e_t; and family size change, k_t; the state and local school characteristics, P_t^A; and both the family-level (μ) and child-specific (ν_j) unobserved heterogeneity, respectively. The random disturbance term, ε_t^C, such as a health shock to the child, might also impact child's performance on the test, and is assumed to be i.i.d. distributed. The estimable production function is:

$$A_{t,j}^c = f^C(A_{t-1,j}^c, A_{t-1,j}^n, i_{t,j}, m_t, s_t, e_t, k_t, X_t, P_t^A) + \rho^C \mu + \omega^C \nu_j + \varepsilon_t^C \ . \tag{3.8}$$

Similarly, child j's non-cognitive achievement transition follows:

$$A_{t,j}^n = f^N(A_{t-1,j}^n, A_{t-1,j}^c, i_{t,j}, m_t, s_t, e_t, k_t, X_t, P_t^A) + \rho^N \mu + \omega^N \nu_j + \varepsilon_t^N \ . \tag{3.9}$$

Note that the demand equations (3.1)-(3.5) are functions of the same explanatory variables because behaviors are jointly made. The vector of state and local policy conditions P_t, which includes $(P_t^M, P_t^S, P_t^E, P_t^K, P_t^I, P_t^A)$, enters into each demand equation to capture own- and cross-price effects. These demand behaviors are jointly estimated with the wage equation (3.6) if the mother is employed, the spouse/partner's income equation (3.7) if the mother is not single, and each child's cognitive and non-cognitive achievement production functions (3.8) and (3.9). The unobserved determinants of each equation are correlated through common family-specific and child-specific unobserved heterogeneity terms.

3.3 Attrition and Initial Condition Equations

In order to take into account nonrandom sample attrition, I include an equation for the probability of attrition at the end of each period t that is jointly estimated with equations (3.1)-(3.9). The probability of attrition at the end of period t depends on the updated information set, which accounts for period t behaviors and outcomes, as well as the unobserved heterogeneity determinants. I also include equations that model the missingness of a woman's wages if she works, and the missingness of the income of her spouse/partner, if she is in a relationship.

Since the initially-observed cognitive and non-cognitive achievements of the children do not follow a value-added specification, I allow them to be a function of accumulated behaviors, exogenous characteristics of the household, and the mother and child unobserved heterogeneity. The cognitive and non-cognitive achievements are first measured at age five and four, respectively. I jointly estimate these initial condition equations with the set of dynamic demand and production equations. Table 3.1 summarizes the jointly estimated set of 14 equations and their determinants. The first column of Table 3.1 lists all the dependent variables of the system of equations, and columns 2-4 contain the explanatory variables for each equation, including the pre-determined endogenous variables, exogenous variables and unobserved heterogeneity. The probabilities formed by each of the equations all enter into the likelihood function below.

Table 3.1: Specification Summary for Jointly Estimated Set of Equations

Outcome	Explanatory Variables		
	Pre-determined Endogenous	Exogenous	Unobs'd Het
Behaviors			
Relationship Status m_t	$M_{t-1}, S_{t-1}, E_{t-1}, K_{t-1}, A^c_{t-1}, A^n_{t-1}$	$X_t, P^M_t, P^S_t, P^E_t, P^K_t, P^I_t, P^A_t$	μ, ε^M_t
Enrolled s_t	$M_{t-1}, S_{t-1}, E_{t-1}, K_{t-1}, A^c_{t-1}, A^n_{t-1}$	$X_t, P^M_t, P^S_t, P^E_t, P^K_t, P^I_t, P^A_t$	μ, ε^S_t
Employed e_t	$M_{t-1}, S_{t-1}, E_{t-1}, K_{t-1}, A^c_{t-1}, A^n_{t-1}$	$X_t, P^M_t, P^S_t, P^E_t, P^K_t, P^I_t, P^A_t$	μ, ε^E_t
Δ Children k_t	$M_{t-1}, S_{t-1}, E_{t-1}, K_{t-1}, A^c_{t-1}, A^n_{t-1}$	$X_t, P^M_t, P^S_t, P^E_t, P^K_t, P^I_t, P^A_t$	μ, ε^K_t
Investment in child j $i_{t,j}$	$M_{t-1}, S_{t-1}, E_{t-1}, K_{t-1}, A^c_{t-1}, A^n_{t-1}$	$X_t, P^M_t, P^S_t, P^E_t, P^K_t, P^I_t, P^A_t$	$\mu, \nu_j, \varepsilon^I_t$
Distributions			
Wage w_t if employed	$M_{t-1}, S_{t-1}, E_{t-1}, K_{t-1}, A^c_{t-1}, A^n_{t-1}$	X_t, P^E_t	μ, ε^W_t
Partner income I^P_t if in a relationship	$M_{t-1}, S_{t-1}, E_{t-1}, K_{t-1}, A^c_{t-1}, A^n_{t-1}$	X_t, P^E_t	μ, ε^P_t
Achievements			
Child math score $A^c_{t,j}$	$m_t, s_t, e_t, k_t, i_{t,j}, A^c_{t-1,j}, A^n_{t-1,j}$	X_t, P^A_t	$\mu, \nu_j, \varepsilon^C_t$
Child behavior score $A^n_{t,j}$	$m_t, s_t, e_t, k_t, i_{t,j}, A^c_{t-1,j}, A^n_{t-1,j}$	X_t, P^A_t	$\mu, \nu_j, \varepsilon^N_t$
Initial Conditions			
Initially observed math score $A^{c0}_{t,j}$	M_t, S_t, E_t, K_t, I_t	X_t, P^A_t	$\mu, \nu_j, \varepsilon^{iC}_t$
Initial observed behavior score $A^{n0}_{t,j}$	M_t, S_t, E_t, K_t, I_t	X_t, P^A_t	$\mu, \nu_j, \varepsilon^{iN}_t$
Other			
Attrition at_t	$M_t, S_t, E_t, K_t, A^c_t, A^n_t$	X_t	μ, ε^A_t
Wage missing if emp wm_t		X_t	μ, ε^{wM}_t
Partner income missing pm_t		X_t	μ, ε^{pM}_t

3.4 Likelihood Function

The unconditional likelihood function for woman z is given by:

$$\sum_{q=1}^{Q}\theta_q\Bigg\{\Bigg\{\prod_{t=1}^{T}\Bigg[\Big(\sum_{m=0}^{2}p(m_{zt}=m|\Omega_{zt},\mu_q)\mathbb{1}(m_{zt}=m)\Big)\Big(\sum_{s=0}^{1}p(s_{zt}=s|\Omega_{zt},\mu_q)\mathbb{1}(s_{zt}=s)\Big)$$
$$\times\Big(\sum_{e=0}^{5}p(e_{zt}=e|\Omega_{zt},\mu_q)\mathbb{1}(e_{zt}=e)\Big)\Big(\sum_{k=-1}^{1}p(k_{zt}=k|\Omega_{zt},\mu_q)\mathbb{1}(k_{zt}=k)\Big)$$
$$\times\Big(\sum_{a=0}^{1}p(at_{zt}=a|\Omega_{zt},\mu_q)\mathbb{1}(at_{zt}=a)\Big)\Big(\sum_{b=0}^{1}p(wm_{zt}=b|\Omega_{zt},\mu_q)\mathbb{1}(wm_{zt}=b)\Big)$$
$$\times\Big(\sum_{c=0}^{1}p(pm_{zt}=c|\Omega_{zt},\mu_q)\mathbb{1}(pm_{zt}=c)\Big)$$
$$\times\,\phi^{W}(w_{zt}|\Omega_{zt},\mu_q)^{\mathbb{1}(e_{zt}\leq 3)\mathbb{1}(wm_{zt}=0)}\phi^{P}(I^{P}_{zt}|\Omega_{zt},\mu_q)^{\mathbb{1}(m_{zt}\neq 2)\mathbb{1}(pm_{zt}=0)}\Bigg]\Bigg\}$$
$$\times\Bigg\{\prod_{j=1}^{J}\sum_{r=1}^{R}\delta_r\Bigg[\phi^{A^{c0}}(A^{c0}_{ztj}|\Omega_{zt},\mu_q,\nu_r)\phi^{A^{n0}}(A^{n0}_{ztj}|\Omega_{zt},\mu_q,\nu_r)\Bigg]^{\mathbb{1}(j\leq K_{zt}+k_{zt})}$$
$$\times\prod_{t=1}^{T}\Bigg[\phi^{I}(i_{ztj}|\Omega_{zt},\mu_q,\nu_r)\phi^{Ac}(A^{c}_{ztj}|\Omega_{zt},\mu_q,\nu_r)\phi^{An}(A^{n}_{ztj}|\Omega_{zt},\mu_q,\nu_r)\Bigg]^{\mathbb{1}(j\leq K_{zt}+k_{zt})}\Bigg\}\Bigg\} \tag{3.10}$$

where a woman z faces type q permanent heterogeneity, μ_q, with probability θ_q, and her child j faces type r permanent heterogeneity, ν_r, with probability δ_r. $p^X(\cdot)$ is the probability for behavior/outcome X, if X is a discrete variable; $\phi^X(\cdot)$ is the probability density for behavior/outcome X, if X is a continuous variable. They are derived from the equations listed in Table 3.1. The parameters of the likelihood function are estimated with full information maximum likelihood.

3.5 Identification

Identification of the causal effects of family structure on children's achievements requires that there are exogenous variables that are correlated with the joint behaviors, but do not have independent impacts on children's achievements other than through behavioral inputs. This exclusion restriction requirement is satisfied by the timing assumption of the model, and the time-varying state and local variables that represent the price and supply side conditions, such as local marriage market characteristics, unemployment rates and college tuitions. Specifically, the identification is achieved through two channels: a within-period channel and an across-period channel.

First, within each period t, women living in different states/counties may experience different combinations of state and local environments. All of these state and local variables of period t, P_t, enter into the behavior equations (3.1)-(3.5), as they may jointly influence women's behaviors. But conditional on the period t observed behaviors, only state and local factors that may affect children's achievements, namely those representing local school characteristics, enter into the child achievement production equations. For example, local unemployment rates in period t may affect a woman's schooling and labor supply, but conditional on women's schooling status, employment status, and accumulated human capital stock in period t, these unemployment rates do not affect their children's achievements independently. Therefore, they are excluded from children's achievement production functions, and serve as within-period exclusion restrictions.

Second, the identification also comes from across-period exclusion restrictions. Namely, even women living in the same community in period t, may have different location histories, therefore may have experienced varying state and local environments before period t. All these state and local environments before period t have influenced women's past endogenous behaviors, which in turn affect their behaviors in period t. Again, conditioning on women's behaviors in period t, these past state and local environment variables do not have independent effects on children's achievements in period t, therefore serving as additional exclusion restrictions. For example, the variation in state-level average college tuitions in period $t-1$ could affect women's schooling status in period $t-1$, which then may influence women's schooling status in period t - an input for children's achievement production functions in period t. Conditional on the women's enrollment status in period t, the variations of state-level average tuitions in $t-1$ do not have an independent effect on children's achievements in period t. Therefore, they implicitly serve as across-period exclusion restrictions for children's achievement production functions in period t. In fact, all the state and local environment variables before period t, serve such purpose. The exclusion restrictions used in this dissertation have passed the overidentification test.

CHAPTER 4

DATA

I use panel data from the National Longitudinal Survey of Youth 1979 (NLSY79) and the NLSY79 Children and Young Adults (NLSY79-CS). The NLSY79 is a nationally representative sample of 12,686 young men and women who were 14 to 22 years old when they were first surveyed in 1979. These individuals were interviewed annually through 1994 and are currently interviewed on a biennial basis. In addition to demographic information such as gender, race, ethnicity, and date of birth, the survey also provides detailed information on their relationship, employment, and fertility at each wave. Starting from 1986, the NLSY79 began to interview all children born to female NLSY79 respondents. For each child, the survey gathers information on measures of children's cognitive and non-cognitive achievements, as well as parental investment in each child. My research sample includes women who have not attrited by 1986 and who were observed for at least two consecutive periods (1986 and 1987). I exclude the military subsample, whose decision making process is likely to be different from the rest of the NLSY79 sample. I also excluded the economically disadvantaged, nonblack/non-Hispanic subsample, which was discontinued from 1990. I follow 4,395 women and 8,579 children from 1986 to 2012 or until the first time they attritted from the NLSY79 survey. Table 4.1 shows the research sample size and attrition of adults by year. The research sample contains 95,843 adult-year observations, and the attrition rate by wave is generally below 5 percent. Tables 4.2 - 4.5 display descriptive statistics for the dependent variables, endogenous explanatory variables, exogenous explanatory variables, and state/local environment variables, respectively.

Table 4.1: Empirical Distribution of Research Sample

Year	Sample Size	Attriters	Attrition Rate
1986	4395	–	–
1987	4395	148	3.37
1988	4247	56	1.32
1989	4191	88	2.10
1990	4103	48	1.17
1991	4055	60	1.48
1992	3995	42	1.05
1993	3953	60	1.52
1994	3893	112	2.88
1995	3781	–	–
1996	3781	116	3.07
1997	3665	–	–
1998	3665	183	4.99
1999	3482	–	–
2000	3482	178	5.11
2001	3304	–	–
2002	3304	109	3.30
2003	3195	–	–
2004	3195	100	3.13
2005	3095	–	–
2006	3095	67	2.16
2007	3028	–	–
2008	3028	99	3.27
2009	2929	–	–
2010	2929	100	3.41
2011	2829	–	–
2012	2829	–	–

Number of person-year observations: 95,843

Table 4.2: Descriptive Statistics for Dependent Variables

Variable name	Mean	Std dev	Min	Max
Categorical dependent variables over all person-years				
Relationship status at t				
Single	0.377	0.485	0	1
Cohabiting	0.067	0.249	0	1
Married	0.556	0.497	0	1
Acquisition/loss of children at t				
No change	0.884	0.320	0	1
Lose any children	0.052	0.223	0	1
Acquire any children	0.063	0.244	0	1
School enrollment at t	0.100	0.300	0	1
Employment at t				
Full-year, full-time	0.575	0.494	0	1
Full-year, part-time	0.081	0.272	0	1
Part-year, full-time	0.106	0.307	0	1
Part-year, part-time	0.038	0.191	0	1
Unemployed	0.017	0.129	0	1
Out of labor force	0.185	0.388	0	1
Wage missing at t	0.035	0.183	0	1
Spouse/partner income missing at t	0.442	0.626	0	1
Attrition at t	0.024	0.152	0	1
Continuous dependent variables over all person-years				
Investment in child: HOME percentile score	47.576	29.111	0	99
Hourly wage—employed	13.728	10.802	1	152
Spouse/partner income—partnered	44519.900	41398.200	1	1080241
Cognitive outcome: child PIAT math percentile score	52.982	27.936	1	99
Non-cognitive outcome: child behavioral problem percentile score	54.529	27.283	13	100
Initial condition: child PIAT math percentile score	49.759	27.400	1	99
Initial condition: child behavioral problem percentile score	55.692	27.619	12	100

Note: Dollar amounts are in year 2000 dollars.

Table 4.3: Descriptive Statistics for Endogenous Individual Explanatory Variables

Variable name	Mean	Std dev	Min	Max
Endogenous individual variables over all person-years				
Relationship history				
Married in t-1	0.550	0.498	0	1
Years married entering t if married in t-1	11.411	7.808	1	41
More than one marriage entering t	0.186	0.389	0	1
Cohabited in t-1	0.067	0.249	0	1
Years cohabited entering t if cohabited in t-1	4.203	4.160	1	27
Single in t-1	0.383	0.486	0	1
Years newly single entering t if single in t-1	7.084	6.104	1	40
First-year becoming single in t if previously partnered in t-1	0.030	0.171	0	1
Child history				
Acquire any children in t-1	0.070	0.250	0	1
Lose any children in t-1	0.048	0.214	0	1
Number of children aged less than five entering t	0.247	0.520	0	4
Number of children aged greater than or equal to five entering t	0.877	1.030	0	5
Child's father non-biological in t	0.046	0.210	0	1
Child PIAT math percentile score entering t	52.173	26.702	1	99
Average PIAT math percentile score of all kids in HH entering t	0.532	0.243	0.01	0.99
Lowest PIAT math percentile score of all kids in HH entering t	0.474	0.264	0.01	0.99
Child behavioral problem percentile score entering t	54.431	26.150	12	100
Average behavioral problem percentile score of all kids in HH entering t	0.557	0.240	0.12	1.00
Lowest behavioral problem percentile score of all kids in HH entering t	0.502	0.250	0.12	1.00
Education history				
Enrolled in t-1	0.107	0.309	0	1
Highest grade completed entering t	13.205	2.398	0	20
Employment history				
Full-year full-time employed in t-1	0.567	0.495	0	1
Full-year part-time employed in t-1	0.081	0.272	0	1
Part-year full-time employed in t-1	0.109	0.312	0	1
Part-year part-time employed in t-1	0.040	0.196	0	1
Unemployed in t-1	0.017	0.130	0	1
Out of labor force in t-1	0.186	0.389	0	1
Years employed entering t	13.622	8.083	0	33

Table 4.4: Descriptive Statistics for Exogenous Individual Explanatory Variables

Variable name	Mean	Std dev	Min	Max
Time-invariant individual variables in year 1986				
Black race	0.305	0.460	0	1
Hispanic	0.185	0.388	0	1
AFQT score	41.003	28.260	0	100
AFQT score missing	0.031	0.174	0	1
Country of birth: non-U.S.	0.066	0.247	0	1
Residence at age 14: non-U.S.	0.022	0.146	0	1
Residence at age 14 missing	0.002	0.045	0	1
Birthplace of mother: non-U.S.	0.103	0.304	0	1
Birthplace of mother missing	0.003	0.050	0	1
Birthplace of father: non-U.S.	0.097	0.296	0	1
Birthplace of father missing	0.024	0.153	0	1
Highest grade completed of mother	10.798	3.191	0	20
Mother's education missing	0.053	0.223	0	1
Highest grade completed of father	10.926	3.912	0	20
Father's education missing	0.147	0.354	0	1
Time-variant individual variables over all person-years				
Age in years	36.869	8.076	21	56
Child age	6.223	4.063	1	17
Female child	0.487	0.500	0	1
Rural residence	0.230	0.421	0	1
Residence type missing	0.024	0.153	0	1
Northeast region	0.158	0.365	0	1
North central region	0.235	0.424	0	1
South region	0.419	0.493	0	1
West region	0.188	0.391	0	1
Region missing	0.006	0.078	0	1
State of residence missing	0.010	0.099	0	1

Note: Dollar amounts are in year 2000 dollars.

Table 4.5: Descriptive Statistics for Exogenous Price and Supply-Side Variables

	Level of Variation	Mean	Std Dev	Min	Max
Relationship and family size variables					
Total population in 000,000s	state	4.340	5.414	0.241	38.000
Sex ratio for white: male aged 20-60 / female aged 20-60	state	1.019	0.048	0.954	1.345
Sex ratio for black: male aged 20-60 / female aged 20-60	state	1.076	0.277	0.807	2.330
AFDC/TANF per family of three in 00s	state	4.280	1.760	1.241	11.628
State expenditure for child support enforcement per capita	state	6.140	2.487	2.114	18.592
Schooling variables					
Two year public college tuition (in-state) in 000s	state	1.787	0.804	0.150	5.720
Four year public college tuition (in-state) in 000s	state	3.834	1.779	0.876	11.241
Four year private college tuition in 000s	state	13.286	4.808	2.148	28.655
Employment variables					
Unemployment rate for male	state	5.939	2.195	2.000	15.800
Unemployment rate for female	state	5.555	1.778	2.000	13.700
Annual average pay in 000s	state	31.623	6.018	20.829	59.960
EITC credit rate for family of two children	state	0.336	0.125	0.110	0.560
Parental investment variables					
Number of public libraries per thousand capita	state	0.112	0.088	0.028	0.649
Per capita spirits consumption in Gallons	state	0.880	0.326	0.371	2.666
Child school input variables					
Pupil-teacher ratio	county	15.795	3.087	8.000	30.000
State expenditure per pupil in 000s	state	7.332	2.130	3.492	17.432
Teacher salary in 000s	state	41.154	6.507	29.390	62.491

Note: Data presented are means over 50 states and the District of Columbia for the years 1986-2012. Dollar amounts are in year 2000 dollars.

4.1 Description of Key Variables

A goal of this dissertation is to understand the effects of family structure on child achievements. Figure 4.1 depicts the probabilities of each family structure (single, cohabiting, married) over the life cycle for the cohort of women in my sample. The probability of women being married increases sharply in their twenties' from 28% to 55%, while the their probability of being single plummets from 63% to 36%. Both probabilities become more stable starting from age 30. The probability of cohabitation, on the other hand, decreases slowly and steadily throughout their life cycle, with an average of 6.7%.

Family structure is closely related to other maternal behaviors that may also influence children's cognitive and non-cognitive development. Maternal human capital, including education and work experience, could affect children's development through channels such as parenting practices or the role model effect. As Panels A and B in Figure 4.2 show, the distribution of the schooling and employment status differ by family structure types, with single women most likely to enroll in school and work full-year and full-time. Another factor that could impact the resource availability for the child is the family size. Panel C in Figure 4.2 shows that women who are married are more likely to have a child in their 20's and 30's, compared with cohabiting or single women. The probability is reversed after women reach their 40's. Lastly, parental investment is associated with family structure. Panel D of Figure 4.2 shows that married mothers invest the most in their children and single mothers invest the least (in terms of average investment). To the extent that all these behaviors interact with family structure types, and could potentially impact children's achievements, it is important to account for the endogeneity of such behaviors over the life cycle in order to identify the unbiased causal impacts of family structure.

For the measure of parental investment, the NLSY79-CS assesses the home environment of children using the Home Observation Measurement of the Environment-Short Form (HOME-SF). HOME-SF includes four sets of questions that depend on the age of the child: ages 0–2, 3–5, 6–9 and 10 and above. One part of the HOME-SF is self-administered by the mother of the child, with questions such as how often do you read to child (to mothers of children age under 3), and

Figure 4.1: Family Structure Probabilities at Age t

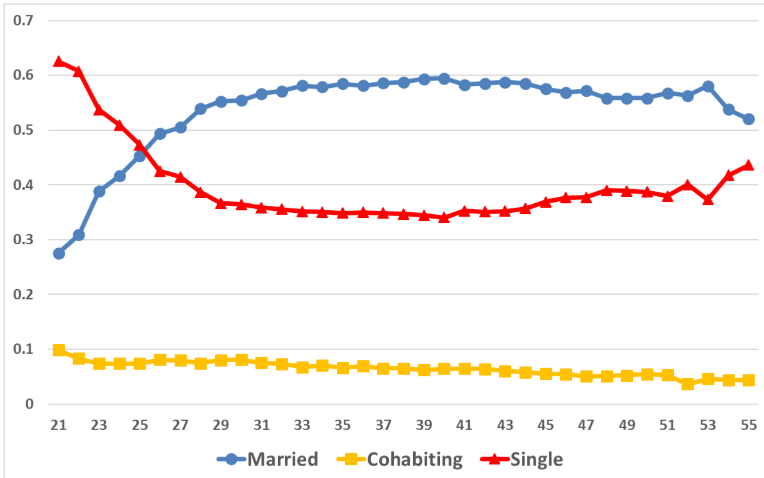
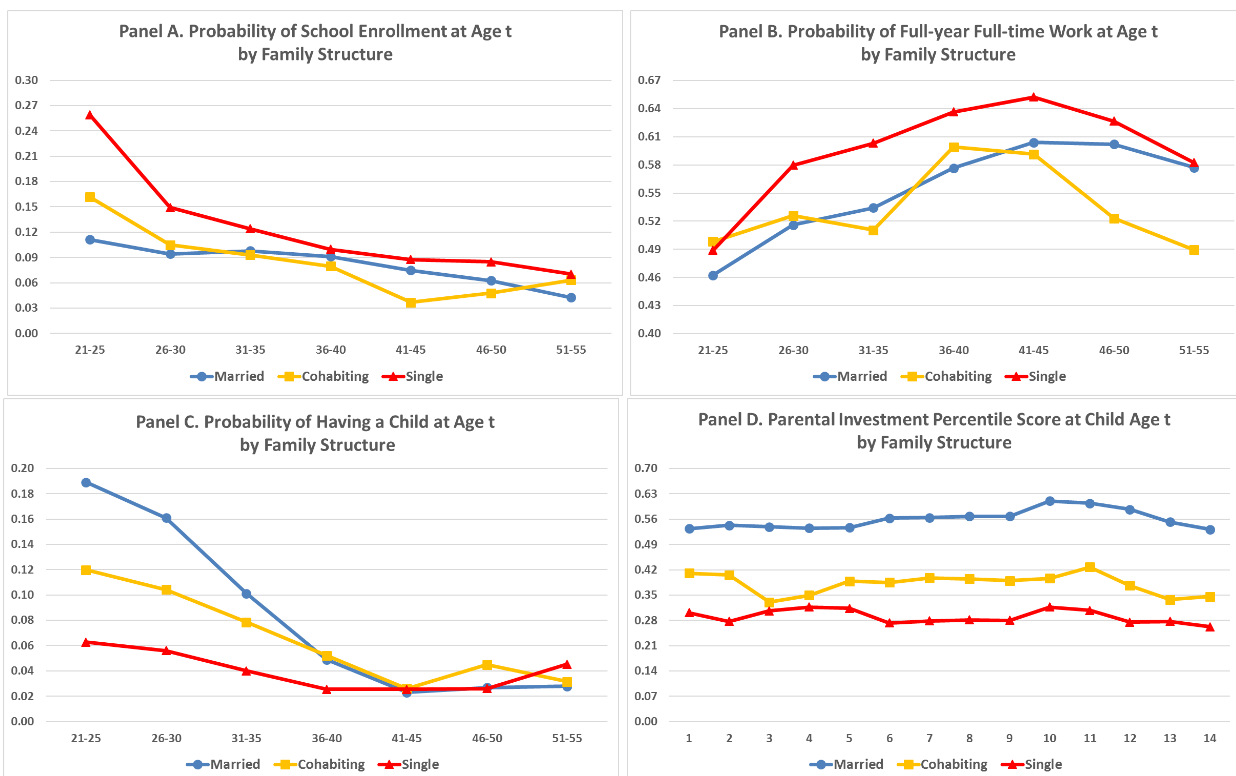


Figure 4.2: Comparisons of Behavior Probabilities by Family Structure



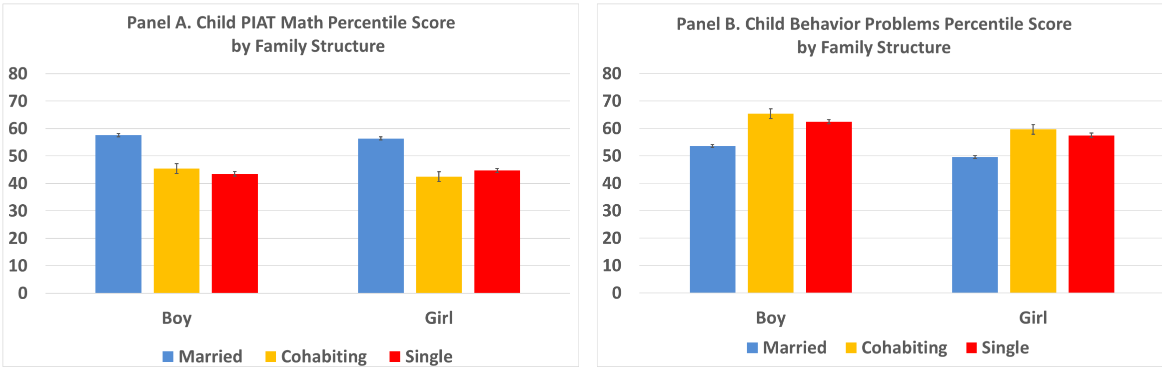
how many times, if any, have you had to spank child in the past week (to mothers of children aged 3-5). The other part is the interviewer's observation, with questions such as whether mother encouraged child to contribute to the conversation (observed by the interviewer).[1] These questions are designed to measure the cognitive stimulation and emotional support from the mother, and I use the age-specific HOME-SF percentile scores as the measure of investment in children.

To measure child cognitive achievement, I use the Peabody Individual Achievement Test (PIAT) math score provided in the NLSY79-CS. PIAT is among the most widely used brief assessment of academic achievement for children aged five or over. The majority of children in the NLSY79-CS have more than three valid PIAT scores, making it possible to estimate women's time-varying investment in children and the evolution of their children's cognitive achievements. The PIAT math test measures a child's attainment in mathematics. It consists of 84 multiple-choice items of increasing difficulty, ranging from early skills as recognizing numerals and progresses to measuring advanced concepts in geometry and trigonometry. The PIAT math percentile scores I use are derived on an age-specific basis from children's PIAT math raw scores. Panel A of Figure 4.3 shows that both boys and girls from married households have significantly higher math scores, compared to their peers in single or cohabiting households.

To measure child non-cognitive achievement, I use the Behavior Problem Index (BPI), created by Peterson and Zill (1986) and collected by the NLSY79-CS to measure the frequency, range, and type of childhood behavior problems for children age four and over. The BPI used in the NLSY79-CS includes 28 questions administered to mothers of each child, asking about specific behaviors in the following domains: (1) antisocial behavior, (2) anxiousness/depression, (3) headstrongness, (4) hyperactivity, (5) immature dependency, and (6) peer conflict/social withdrawal. The BPI percentile scores I use are derived on age-specific BPI raw scores, the higher of which indicate more severe behavior problems. Panel B of Figure 4.3 shows that behavior problems are significantly less severe for children from married households.

[1]The HOME-SF questionnaires are listed in Appendix Tables A.1-A.4.

Figure 4.3: Children's Achievements by Family Structure



4.2 Exogenous Prices and Supply-side Variables

I obtain the state/county-level aggregate variables that capture exogenous price and policy variations from the following data sources: (1) the school quality data, measured by pupil-teacher ratio, teacher salary and expenditure per child, comes from the Common Core Data (CCD); (2) the college tuition data, serving as price variation for school enrollment, comes from the National Center for Education Statistics; (3) the local employment statistics and average wages come from the Bureau of Labor Statistics; (4) the data on EITC policies comes from the Tax Policy Center; (5) the data on welfare policies from 1986 to 1995 comes from Fang and Keane (2004) and Bernal and Keane (2011), and the data from 1996 to 2012 comes from the Welfare Rules Database collected by the Urban Institute; (6) the data on the number of public libraries comes from Institute of Library and Museum Service, and (7) the data on alcohol consumption comes from National Institutes of Health.

CHAPTER 5

ESTIMATION RESULTS

5.1 Replication of Previous Literature

Before estimating the preferred model specified in the previous chapter, I estimate the reduced-form models commonly used in the literature using my research sample of women and their children. The purpose of this section is two-fold: 1) it demonstrates that I find similar results regarding the effects of family structure on children's outcomes when using the common approaches, and 2) it reinforces the differences in estimated marginal impacts when one accounts for selection and endogeneity bias manifested in unobservable permanent characteristics of the household or the child.

Table 5.1 presents the coefficients for alternative specifications of children's cognitive and non-cognitive production functions, including OLS, household fixed effects, and child fixed effects, using my research sample. For children's cognitive production function, the OLS regression shows that comparing with living in a married household, living in a cohabiting household statistically significantly decreases children's PIAT math scores by 5.02 percentage points, while living with a single mother decreases children's math scores by 3.50 percentage points. When using the household fixed effects model, which eliminates the unobserved heterogeity shared across siblings within the same household, the magnitude of the effect of cohabitation reduces to 2.36 percentage points, and the effect of living in single households becomes statistically insignificant. When using the child fixed effects model, which eliminates the child-specific permanent unobserved heterogeneity, the effects of both cohabitation and singleness become statistically insignificant.

For the production function of children's non-cognitive achievement, Table 5.1 shows similar patterns across specifications. While OLS estimates show that living in a cohabiting or single household increases children's behavioral problems by 6.76 and 6.66 percentage points, respectively, the magnitudes of these effects are smaller after accounting for household-level unobserved heterogeneity, and become statistically insignificant after eliminating child-specific permanent unobservables. The changes of coefficients in these alternative specifications emphasize the existence of the household-level and child-specific unobserved heterogeneity, which could potentially bias the estimates if not properly accounted for. In the dynamic multiple equation model below, I explicitly model both levels of unobserved heterogeneity and estimate their distributions.

These results are consistent with findings from the literature examining the effects of family structure on children's outcomes. Using household or child fixed effects to account for unobserved heterogeneity, the literature generally finds that the negative impacts of unmarried parenthood on children's outcomes become smaller or statistically insignificant, compared to results from OLS regressions. For example, using data from both the NLSY79 and the Panel Study of Income Dynamics (PSID), Björklund et al. (2007) show that the negative impacts of non-intact family types (including single mother, single father, stepmother, stepfather families) on children's educational attainment become statistically insignificant with household fixed effects. Aughinbaugh et al. (2005) also find that the negative effects of divorce on children's PIAT Math score and Behavioral Problem Index score disappear after using child fixed effects.[1]

[1] Aughinbaugh et al. (2005) use the raw scores of PIAT Math and Behavioral Problem Index for children in the NLSY79-CS data, while this dissertation uses the percentile scores. Therefore, the magnitudes of the effects are not directly comparable.

Table 5.1: Alternative Specifications of Achievement Production Functions

	Math Percentile Score			Behavior Problems Score		
	OLS	Household fixed effects	Child fixed effects	OLS	Household fixed effects	Child fixed effects
Cohabiting	-5.017***	-2.358**	-1.256	6.758***	2.663**	1.579
	(1.206)	(1.061)	(0.908)	(1.399)	(1.147)	(1.109)
Single	-3.504***	-1.230	-0.219	6.656***	1.917**	1.173
	(0.702)	(0.856)	(0.715)	(0.830)	(0.826)	(0.809)

Note: Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Explanatory variables include an indicator for non-biological father, the age, race and gender of the child, women's age, education level, and region of residence, time trend, and indicators for missing values.

5.2 Results from the Dynamic Dynamic Multiple-equation Model

This section discusses the key findings using the estimated dynamic multiple-equation model. I first test how the estimated model fits the observed data. Then, I use the estimated coefficients to discuss factors that influence women's family structure and patterns displayed in children's achievement production functions. Lastly, I calculate the contemporaneous and life-cycle marginal effects of family structure on children's cognitive and non-cognitive achievements.

5.2.1 Model Fit

It is important that the estimated model captures the patterns displayed in the observed data. I use the estimated parameters to simulate women's life-cycle behaviors and their children's outcomes from the first period forward, and use the simulated values of endogenous explanatory variables to update behaviors and outcomes in the next period. The comparison of the summary statistics for the simulated behaviors and outcomes with the observed data in Table 5.2 suggests that the estimated model fits the data well.

5.2.2 Estimated Coefficients

Results from estimation of the correlated set of equations are detailed in Appendix Tables A.5-A.19. The coefficients on endogenous explanatory variables are listed first followed by those for exogenous variables and unobserved heterogeneity. Here I focus my discussion on the key behavior of interest in this dissertation, namely women's relationship status. The estimated coefficients

Table 5.2: Summary Statistics for Model Fit

Outcomes	Observed		Simulated	
	Mean	Std. Dev.	Mean	Std. Dev.
Relationship Status				
Married	0.556	0.497	0.551	0.497
Cohabiting	0.067	0.249	0.069	0.254
Single	0.377	0.485	0.379	0.485
School Enrollment	0.100	0.300	0.110	0.313
Employment Status				
Full-year full-time employed	0.575	0.494	0.561	0.496
Full-year part-time employed	0.081	0.272	0.084	0.278
Part-year full-time employed	0.106	0.307	0.104	0.305
Part-year part-time employed	0.038	0.191	0.039	0.195
Unemployed	0.017	0.129	0.018	0.132
Out of labor force	0.185	0.388	0.193	0.395
Family Size Changes				
Have a chid	0.063	0.244	0.061	0.240
Lose a child	0.052	0.223	0.038	0.191
No change	0.884	0.320	0.901	0.299
Parental investment				
HOME percentile score	0.476	0.291	0.475	0.260
Child Achievements				
PIAT Math percentile score	0.523	0.278	0.515	0.285
BPI behaviral problem percentile score	0.547	0.273	0.540	0.285
Wage and Income				
Hourly wage	13.73	10.80	13.62	8.30
Spouse/Partner income	44518.86	41398.52	44680.61	43114.62

Note: Hourly wage and spouse/partner income are in year 2000 dollars.

and their standard errors are shown in Appendix Table A.5 and A.6, in which the reference relationship status is married, and the alternative statuses are cohabiting and single, respectively. The coefficients on relationship history display three features. First, there exist self-sustaining effects within each relationship status. That is, being in a relationship status last period increases the probability of choosing the same relationship status in the current period. In addition, as the duration of a particular relationship status increases, it is more likely that the woman stays in the same relationship. Second, singleness and cohabitation reinforce each other. That is, being single last period increases a woman's probability of choosing cohabitation over marriage in the current period. Similarly, cohabiting last period increases the chance of being single over married this period. The third finding is that the same past life-cycle behavior may have varying roles when it comes to choosing alternative relationship status (cohabiting/single) versus marriage. For example, after having a child in the last period, a woman is less likely to choose singleness over marriage, but she is no less likely to choose cohabitation over marriage. Another example is that unemployment increases the woman's probability of being single over married, but it does not impact the probability between cohabitation and marriage. One endogenous factor that has consistent impacts on relationship choice is the woman's education level. More educated women are more likely to choose marriage both over cohabitation and over singleness.

The estimated coefficients of the correlated set of equations also provide empirical support for the existence of complementarity of parental investments, and the self-productivity of skills. Appendix Table A.15 shows that parents invest more in children who have lower behavioral problems, which is consistent with the theory of static complementarity of parental investment (Cunha et al., 2006). In addition, Appendix Tables A.18 and A.19 display that non-cognitive achievement promotes the formation of cognitive achievement, but cognitive achievement in general do not promote the formation of non-cognitive achievement. The same patterns of the self-productivity of skills are found in Cunha and Heckman (2008).

5.2.3 Estimates of the Contemporaneous and Life-cycle Marginal Effects

In order to understand the dynamic impacts of family structure on children's achievements, I first calculate the effects of a one-period change in family structure from cohabiting or single household to married household on children's contemporaneous achievements. That is, holding everything else the same, if the child is living in a married rather than a cohabiting or single household this year, how might her cognitive and non-cognitive development differ in the same year? I call this the *contemporaneous* (or one-period) effect. Table 5.3 shows that the contemporaneous effects are statistically insignificant, indicating that children's cognitive and non-cognitive achievements are not immediately affected by changes in family structure.

A lack of contemporaneous effects does not necessarily imply that family structure does not influence children's development in the long run. I now calculate the *life-cycle* marginal effects

Table 5.3: Contemporaneous Marginal Effects of Family Structure on Child Achievements

	Family Structure Alternatives			**Marginal Effects**	
	Married	Cohabiting	Single	Cohabiting → Married	Single → Married
Math percentile score	50.48	49.99	50.65	0.50	-0.17
	(5.55)	(5.87)	(5.68)	(1.97)	(0.99)
Behavioral problem	48.63	48.75	48.70	-0.12	-0.07
percentile score	(4.00)	(4.10)	(4.02)	(1.06)	(0.49)

Note: Standard errors (in parentheses) are bootstrapped parametrically with 200 draws. *** p<0.01, ** p<0.05, * p<0.1.

between a cohabiting/single household and a married household. That is, I simulate schooling, employment, family size and parental investment behaviors of each woman if they were married, cohabiting or single throughout their lives and compare the simulated cognitive and non-cognitive achievements for the children. It is worth noting that the life-cycle effects include both the accumulated change in children's contemporaneous outcomes, and the changes of outcomes due to changes in all life-cycle behaviors associated with the change of family structure. Tables 5.4 and 5.5 display the life-cycle marginal effects on children's cognitive achievements (math percentile scores) through age 5 to 14 for boys and girls, respectively. The statistically insignificant estimates indicate that family structure does not have life-cycle impacts on children's cognitive achievements. In contrast, Tables 5.6 and 5.7 show that family structure does influence children's non-cognitive achievements, especially during their early ages. Specifically, the last column of Table 5.6 shows that, compared to being born and raised in single households throughout the childhood period, boys' behavior problems decrease by around 7 percentage points, or 0.27 standard deviation, when born and raised in married households. The beneficial effects are statistically significant for boys from age 4 to age 10. For girls, growing up in continuously married households have beneficial effects when compared to single households and cohabiting households. Specifically, column 5 of Table 5.7 shows suggestive evidence that, compared to growing up in cohabiting households, girls' behavior problems decrease by around 11 percentage points, or 0.4 standard deviations, during age 4 to age 6 if raised in continuously married households. Column 6 of Table 5.7 shows that when compared with being raised in single households, growing up in continuously married households also decreases girls' behavior problems by around 5 percentage points, or 0.18 standard deviations, during ages 4 to 8.

Table 5.4: Life-cycle Marginal Effects of Family Structure on Boys' PIAT Math Percentile Score by Age

	Family Structure Alternatives			**Marginal Effects**	
Boy Age	Married	Cohabiting	Single	Cohabiting → Married	Single → Married
5	50.00	51.34	47.71	-1.34	2.29
	(11.50)	(12.82)	(11.60)	(6.44)	(3.23)
6	51.86	53.47	51.26	-1.61	0.60
	(12.13)	(13.07)	(12.31)	(6.05)	(2.97)
7	53.54	54.72	53.68	-1.18	-0.15
	(15.05)	(15.86)	(15.32)	(6.12)	(3.06)
8	55.17	55.57	55.27	-0.39	-0.10
	(18.42)	(19.30)	(18.79)	(6.52)	(3.40)
9	56.50	55.72	56.29	0.78	0.21
	(21.48)	(22.48)	(21.91)	(7.16)	(3.86)
10	57.48	55.41	56.73	2.07	0.76
	(24.07)	(25.22)	(24.58)	(7.99)	(4.40)
11	57.95	54.66	56.40	3.29	1.55
	(26.31)	(27.55)	(26.87)	(9.00)	(5.00)
12	57.61	53.06	55.46	4.55	2.15
	(28.18)	(29.43)	(28.81)	(10.10)	(5.66)
13	56.66	50.99	54.39	5.66	2.27
	(29.75)	(30.96)	(30.47)	(11.28)	(6.35)
14	55.06	48.63	53.43	6.44	1.63
	(31.16)	(32.25)	(31.99)	(12.59)	(7.10)

Note: Standard errors (in parentheses) are bootstrapped parametrically with 200 draws. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 5.5: Life-cycle Marginal Effects of Family Structure on Girls' PIAT Math Percentile Score by Age

	Family Structure Alternatives			**Marginal Effects**	
Girl Age	Married	Cohabiting	Single	Cohabiting → Married	Single → Married
5	52.55	56.50	51.23	-3.95	1.33
	(11.54)	(13.16)	(11.64)	(7.45)	(3.66)
6	53.31	57.16	53.77	-3.85	-0.46
	(12.15)	(13.41)	(12.29)	(7.04)	(3.31)
7	54.09	57.24	55.42	-3.16	-1.33
	(15.04)	(16.13)	(15.23)	(7.06)	(3.29)
8	54.84	56.99	56.45	-2.15	-1.61
	(18.44)	(19.50)	(18.67)	(7.37)	(3.54)
9	55.30	56.04	56.34	-0.74	-1.05
	(21.51)	(22.63)	(21.80)	(7.89)	(3.95)
10	55.33	54.78	55.74	0.55	-0.41
	(24.18)	(25.34)	(24.50)	(8.61)	(4.45)
11	55.22	53.25	55.03	1.97	0.18
	(26.40)	(27.57)	(26.77)	(9.49)	(5.04)
12	54.34	51.06	53.85	3.28	0.49
	(28.29)	(29.42)	(28.73)	(10.53)	(5.68)
13	52.86	48.35	52.36	4.51	0.50
	(29.84)	(30.88)	(30.36)	(11.66)	(6.36)
14	50.43	45.07	50.72	5.36	-0.29
	(31.16)	(32.03)	(31.80)	(12.88)	(7.09)

Note: Standard errors (in parentheses) are bootstrapped parametrically with 200 draws. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 5.6: Life-cycle Marginal Effects of Family Structure on Boys' Behavioral Problem Percentile Score by Age

	Family Structure Alternatives			**Marginal Effects**	
Boy Age	Married	Cohabiting	Single	Cohabiting $\rightarrow$ Married	Single $\rightarrow$ Married
4	54.14	60.75	60.29	-6.61	**-6.15****
	(24.08)	(23.85)	(23.69)	(5.90)	(2.50)
5	51.89	58.66	59.20	-6.77	**-7.31*****
	(22.17)	(21.98)	(21.86)	(5.62)	(2.53)
6	51.71	58.18	59.45	-6.47	**-7.75*****
	(21.33)	(21.22)	(21.08)	(5.64)	(2.68)
7	51.86	57.68	59.47	-5.82	**-7.61*****
	(21.19)	(21.15)	(20.97)	(5.84)	(2.86)
8	52.34	57.44	59.64	-5.10	**-7.30****
	(21.57)	(21.56)	(21.35)	(6.18)	(3.08)
9	52.87	57.14	59.69	-4.28	**-6.83****
	(22.31)	(22.29)	(22.07)	(6.59)	(3.31)
10	53.36	56.84	59.65	-3.48	**-6.29***
	(23.22)	(23.18)	(22.95)	(7.03)	(3.55)
11	53.89	56.76	59.61	-2.88	-5.73
	(24.18)	(24.11)	(23.86)	(7.47)	(3.78)
12	54.09	56.33	59.38	-2.23	-5.28
	(25.10)	(25.04)	(24.77)	(7.90)	(4.03)
13	54.14	55.99	59.37	-1.85	-5.23
	(25.96)	(25.92)	(25.62)	(8.28)	(4.30)
14	53.66	55.40	59.22	-1.74	-5.56
	(26.73)	(26.73)	(26.40)	(8.65)	(4.61)

Note: Standard errors (in parentheses) are bootstrapped parametrically with 200 draws. *** p<0.01, ** p<0.05, * p<0.1.

Table 5.7: Life-cycle Marginal Effects of Family Structure on Girls' Behavioral Problem Percentile Score by Age

	Family Structure Alternatives			**Marginal Effects**	
Girl Age	Married	Cohabiting	Single	Cohabiting → Married	Single → Married
4	50.85	62.10	55.61	**-11.25***	**-4.76****
	(24.03)	(23.74)	(23.84)	(6.42)	(2.37)
5	48.82	60.00	54.45	**-11.18***	**-5.63****
	(22.10)	(21.90)	(22.05)	(6.15)	(2.35)
6	48.97	59.72	54.63	**-10.75***	**-5.65****
	(21.24)	(21.12)	(21.23)	(6.16)	(2.50)
7	49.41	59.54	54.94	-10.13	**-5.54****
	(21.12)	(21.06)	(21.13)	(6.39)	(2.70)
8	49.98	59.37	55.18	-9.39	**-5.20***
	(21.53)	(21.48)	(21.52)	(6.72)	(2.93)
9	50.53	59.03	55.02	-8.50	-4.49
	(22.30)	(22.23)	(22.25)	(7.14)	(3.17)
10	51.20	58.82	54.95	-7.61	-3.75
	(23.23)	(23.13)	(23.14)	(7.59)	(3.42)
11	51.77	58.75	55.00	-6.98	-3.23
	(24.19)	(24.07)	(24.05)	(8.03)	(3.67)
12	51.93	58.44	55.01	-6.51	-3.08
	(25.12)	(25.00)	(24.94)	(8.44)	(3.93)
13	52.06	58.17	55.05	-6.11	-2.99
	(25.96)	(25.85)	(25.74)	(8.85)	(4.19)
14	51.63	57.75	54.78	-6.11	-3.15
	(26.71)	(26.66)	(26.50)	(9.19)	(4.46)

Note: Standard errors (in parentheses) are bootstrapped parametrically with 200 draws. *** p<0.01, ** p<0.05, * p<0.1.

CHAPTER 6

POLICY EXPERIMENTS

Having established the contemporaneous and life-cycle impacts of family structure on children's achievements, I now evaluate how policy interventions with different focuses, when capable of changing target population's behaviors, could have different impacts on children's cognitive and non-cognitive achievements. Specifically, the first experiment aims to promote marriage, the second to improve maternal education level, and the third to emphasize parenting skills training.

6.1 Experiment A - Marriage Promotion

In the past few decades, policy makers in the U.S. have been implementing intervention programs that aim to promote healthy relationship and marriage. The "Building Strong Families Project" is among the most rigorously implemented and evaluated programs across the country. It is designed as a random control trial and offers relationship skills education and other support services to a specific target population - unmarried couples who are expecting or who have just had a baby. However, the evaluation of this project shows that after three years, the likelihood for couples to stay together or get married was not affected by the intervention (see Wood, Moore, Clarkwest, and Killewald, 2014). In this counterfactual experiment, I evaluate how children's cognitive and non-cognitive achievements would have changed if such program were redesigned and became more successfully in promoting marriage to the target population.

I implement this experiment by simulating individuals' behaviors in each period to identify women who are unmarried and are having a new child in the same period, for which I name the target population and the critical period, respectively. I then randomly select 50 percent of this target population, and experimentally make them be married in the critical period. I continue to simulate their life-cycle behaviors afterwards, and compare their children's outcomes with and without such intervention. Panel A of Table 6.1 shows that when looking at the target population together, such intervention does not have statistically significant effects on children's achievements. However, when separating the target population by what their relationship status in the critical period would have been without the intervention, Panel B of Table 6.1 shows suggestive evidence that for women who would otherwise be single in the critical period, their children's behavior problems decrease by 1.4 percentage points with the intervention, which amounts to a 0.05 standard deviation decrease compared with the baseline achievements. Table 6.2 provides an upper bound for the impacts of such marriage intervention programs on children's achievements. In this table, I experimentally make the entire target population to get married in the critical period, and simulation their life-cycle behaviors afterwards. Similar patterns hold in this extreme case: for women who would otherwise be single in the critical period, their children's behavior problems now decrease by 1.99 percentage points with the intervention, which amounts to a 0.07 standard deviation decrease.

Table 6.1: Experiment A1 - Effects of Marriage Promotion on Child Achievements with 50% Success Rate

	With Intervention	No intervention	Difference
Panel A. Overall target population			
Math percentile score	50.75	51.01	-0.25
	(19.34)	(19.37)	(1.12)
Behavioral problem percentile score	55.44	56.72	-1.28
	(20.71)	(20.62)	(0.94)
Panel B. Initially single-mother households			
Math percentile score	50.80	51.09	-0.29
	(19.39)	(19.44)	(0.88)
Behavioral problem percentile score	55.39	56.81	**-1.42***
	(20.77)	(20.72)	(0.76)
Panel C. Initially cohabiting households			
Math percentile score	50.53	50.64	-0.11
	(19.31)	(19.32)	(1.51)
Behavioral problem percentile score	55.62	56.34	-0.73
	(20.54)	(20.27)	(1.43)

Note: Standard errors (in parentheses) are bootstrapped parametrically with 200 draws. *** p<0.01, ** p<0.05, * p<0.1.

Table 6.2: Experiment A2 - Effects of Marriage Promotion on Child Achievements with 100% Success Rate

	With Intervention	No intervention	Difference
Panel A. Overall target population			
Math percentile score	50.72	51.00	-0.28
	(19.35)	(19.37)	(1.75)
Behavioral problem percentile score	54.78	56.72	-1.94
	(20.78)	(20.62)	(1.42)
Panel B. Initially single-mother households			
Math percentile score	50.75	51.09	-0.34
	(19.37)	(19.32)	(1.37)
Behavioral problem percentile score	54.82	56.80	**-1.99***
	(20.80)	(20.27)	(1.13)
Panel C. Initially cohabiting households			
Math percentile score	50.60	50.64	-0.04
	(19.32)	(19.32)	(2.33)
Behavioral problem percentile score	50.60	56.34	-1.76
	(20.65)	(20.27)	(2.05)

Note: Standard errors (in parentheses) are bootstrapped parametrically with 200 draws. *** p<0.01, ** p<0.05, * p<0.1.

6.2 Experiment B - Maternal Education Promotion

The changes of family structure in the U.S. since the 1960s are not shared across women's education levels. McLanahan (2012) shows that the vast majority of women with college degrees have been choosing to give birth within the context of marriage, with the probability of mothers being single remaining less than 10 percent throughout the period from 1960 to 2010. On the other hand, women with lower education have experienced dramatic increases in non-marital births. For high school graduates and college dropouts, the probability of mothers being single has increased from less than 10 percent in 1960 to around 40 percent in 2010, and the probability for women with less than high school degrees has increased from around 10 percent to almost 50 percent. This education gap leads to another policy question: how would children's cognitive and non-cognitive achievements change if the intervention for single and cohabiting mothers focus on facilitating women to pursue higher education? In fact, numerous government and non-profit programs have been providing assistance for single mothers to continue their education, through scholarships, grants or work-study arrangements. In this experiment, I explore how such programs could potentially impact the children's achievements.

To implement this experiment, I simulate individuals' behaviors in each period to identify women who are unmarried and have lower than college education. I then randomly select 50 percent of this target population, and experimentally make them enroll in school. I allow their life-cycle behaviors to evolve afterwards and compare their children's achievements with and without the intervention. Table 6.3 shows that with their mothers enrolling in school and obtaining higher levels of education, children's behavior problems decrease by 0.64 percentage points - a 0.02 standard deviation decrease, and the effects are statistically significant for both single and cohabiting households. At the same time, children's math scores improve by 0.84 percentage points - a 0.03 standard deviation increase. In the extreme case when such intervention is able to enroll all of the target population in school, as is shown in Table 6.4, the beneficial effects are augmented, with children's behavior problems decreasing by 1.02 percentage points, and math score increasing by 1.4 percentage points.

Table 6.3: Experiment B1 - Effects of Education Promotion on Child Achievements with 50% Success Rate

	With Intervention	No intervention	Difference
Panel A. Overall target population			
Math percentile score	49.26	48.42	**0.84***
	(19.33)	(19.31)	(0.50)
Behavioral problem percentile score	57.38	58.02	**-0.64***
	(20.44)	(20.39)	(0.36)
Panel B. Initially single-mother households			
Math percentile score	49.57	48.73	**0.84***
	(19.53)	(19.51)	(0.49)
Behavioral problem percentile score	57.27	57.86	**-0.59***
	(20.62)	(20.56)	(0.35)
Panel C. Initially cohabiting households			
Math percentile score	47.32	46.49	0.84
	(18.61)	(18.63)	(0.06)
Behavioral problem percentile score	58.07	59.01	**-0.95****
	(19.46)	(19.46)	(0.41)

Note: Standard errors (in parentheses) are bootstrapped parametrically with 200 draws. *** p<0.01, ** p<0.05, * p<0.1.

Table 6.4: Experiment B2 - Effects of Education Promotion on Child Achievements with 100% Success Rate

	With Intervention	No intervention	Difference
Panel A. Overall target population			
Math percentile score	49.81	48.42	**1.40****
	(19.35)	(19.31)	(0.66)
Behavioral problem percentile score	57.00	58.02	**-1.02****
	(20.47)	(20.39)	(0.48)
Panel B. Initially single-mother households			
Math percentile score	49.88	48.73	**1.43****
	(19.57)	(19.51)	(0.65)
Behavioral problem percentile score	56.91	57.86	**-0.96****
	-20.65	(20.56)	(0.47)
Panel C. Initially cohabiting households			
Math percentile score	48.68	18.63	1.18
	(18.63)	(18.63)	(0.82)
Behavioral problem percentile score	57.28	19.46	**-1.38****
	(19.48)	(19.46)	(0.55)

Note: Standard errors (in parentheses) are bootstrapped parametrically with 200 draws. *** p<0.01, ** p<0.05, * p<0.1.

6.3 Experiment C - Parental Investment Increase

As shown in Panel D of Figure 4.2, the amount of parental investment in children is closely related to family structure choices. Governments and foundations in the U.S. have supported various parenting education programs, aimed at improving parenting knowledge, attitudes and practices. In this counterfactual experiment, I evaluate how children's achievements would change if such programs are effective in encouraging parents to invest more in their children and to improve their parenting skills. Specifically, I use the model to experimentally increase parental investment (measured by HOME-SF score) by up to 10 percentage points or up to 30 percentage points throughout the children's life, and compare children's outcomes with and without the intervention in each scenario. Comparing the HOME-SF raw scores and percentage scores, a 10 percentage points increase is equivalent to changing parenting practice in one to two items in the questions listed in Appendix Table A.1-A.4, and a 30 percentage points increase amounts to changing three to four items. Note that all the other life-cycle behaviors, including relationship status, evolve freely with this experiment.

Table 6.5 shows that a 10 percentage point increase in parental investment can decrease children's behavior problems by 1.38 percentage points, which amounts to a 0.05 standard deviation decrease. It can also increase children's math scores by 0.92 percentage points - a 0.03 standard deviation increase. Such beneficial effects are statistically significant for both boys and girls. When increasing parental investment by 30 percentage points, as is shown in Table 6.6, not only do children's behavior problems further decrease, now by 3.89 percentage points, a 0.14 standard deviation decrease, their average math score also increases by 2.59 percentage points, or 0.09 standard deviation. Again, these beneficial effects are statistically significant for both boys and girls.

Table 6.5: Experiment C1 - Effects of Parental Investment Increase (by 10 percentage points) on Child Achievements

	With intervention	No intervention	Difference
Panel A. All children			
Math percentile score	52.44	51.52	**0.92****
	(18.86)	(18.85)	(0.40)
Behavioral Problem percentile score	54.55	55.93	**-1.38*****
	(20.60)	(20.56)	(0.41)
Panel B. Boys			
Math percentile score	52.64	51.73	**0.91****
	(18.85)	(18.84)	(0.40)
Behavioral Problem percentile score	56.24	57.64	**-1.40*****
	(20.56)	(20.50)	(0.41)
Panel C. Girls			
Math percentile score	52.23	51.31	**0.92****
	(18.84)	(18.87)	(0.41)
Behavioral Problem percentile score	52.86	54.23	**-1.37****
	(20.66)	(20.63)	(0.40)

Note: Standard errors (in parentheses) are bootstrapped parametrically with 200 draws. *** p<0.01, ** p<0.05, * p<0.1.

Table 6.6: Experiment C2 - Effects of Parental Investment Increase (by 30 percentage points) on Child Achievements

	With intervention	No intervention	Difference
Panel A. All children			
Math percentile score	54.11	51.52	**2.59****
	(18.86)	(18.88)	(1.13)
Behavioral Problem percentile score	52.04	55.93	**-3.89*****
	(20.60)	(20.65)	(1.16)
Panel B. Boys			
Math percentile score	54.30	51.73	**2.57****
	(18.85)	(18.85)	(1.14)
Behavioral Problem percentile score	53.71	57.64	**-3.93*****
	(20.56)	(20.63)	(1.18)
Panel C. Girls			
Math percentile score	53.91	51.31	**2.60****
	(18.84)	(18.91)	(1.13)
Behavioral Problem percentile score	50.38	54.23	**-3.85*****
	(20.66)	(20.67)	(1.15)

Note: Standard errors (in parentheses) are bootstrapped parametrically with 200 draws. *** p<0.01, ** p<0.05, * p<0.1.

CHAPTER 7

CONCLUSION

This dissertation uses a dynamic multiple-equation approach to examine the effects of family structure on children's cognitive and non-cognitive achievements. Using data on women and their children in NLSY79 from 1986 to 2012, I jointly model women's dynamic behaviors on relationship, school enrollment, employment, family size and investment in children, and how these behaviors jointly influence their children's cognitive and non-cognitive achievements. In this model, women's behaviors can be influenced by their behavior histories, their children's previous achievements, the demographic characteristics of household members, the state and local environment, the unobserved heterogeneity, and random shocks.

Simulations based on the estimated model demonstrate the following major conclusions. First, I find little evidence that family structure has immediate (short-run) effects on children's achievements. Second, in the long run, compared to single households, a continuous marriage reduces behavioral problems for boys aged 4 to 10 by about 7 percentage points, and for girls aged 4 to 8 by about 5 percentage points. In addition, young girls age 4 to 6 also benefit from growing up in continuously married households instead of cohabiting households through a reduction of behavior problems by around 11 percentage points. Third, effective policy interventions that target unmarried couples who are expecting or who have recently had a baby, could potentially have small but significant impacts on the behavioral problems of children from original single households. Fourth, programs that are able to encourage less than college educated unmarried mothers to continue their education have small beneficial effects on both children's cognitive and non-cognitive achievements. Fifth, programs that enhance parenting skills can potentially reduce both boys' and girls' behavior problems, and improve their cognitive achievements.

APPENDIX A

NLSY79-CHILD HOME-SF SCALES AND JOINT ESTIMATION RESULTS

Table A.1: NLSY79-Child HOME-SF Scales for Children under age 3

Scale*	Question Text
C	How often does child have a chance to get out of the house?
C	About how many children's books does child have?
C	How often do you get a chance to read to child?
C	How often do you take child to the grocery store?
C	About how many, if any, cuddly, soft, or role-playing toys does child have?
C	About how many, if any, push or pull toys does child have?
C	Some parents spend time teaching their children new skill while other parents believe children learn best on their own. Which most closely describes your attitude?
E	How often does child eat a meal with both you and his/her father/step/father-figure?
E	How often do you talk to child while you are working?
E	About how many times, if any, have you had to spank child in the past week?
E	Interviewer: Mother spontaneously spoke to child twice or more (excluding scolding)?
E	Interviewer: Mother responded verbally to child's speech?
E	Interviewer: Mother caressed, kissed, or hugged child at least once?
E	Interviewer: Mother slapped or spanked child at least once?
E	Interviewer: Mother interfered w/ child's actions or restricted child from exploring $\geq$ 3 times?
C	Interviewer: Mother provided toys or interesting activities for child?
E	Interviewer: Mother kept child in view/ could see child/ looked at him/her often?
C	Interviewer: Child's play environment is safe?

* C=Cognitive stimulation; E=Emotional support.

Table A.2: NLSY79-Child HOME-SF Scales for Children age 3-5 years

Scale*	Question Text
C	How often do you read stories to child?
C	About how many children's books does child have?
C	About how many magazines does your family get regularly?
C	Does child have the use of a CD player, tape deck, or tape recorder, or record player at home and at least 5 children's records or tapes?
C	Do you or have you helped [child] with numbers?
C	Do you (or someone else) help [child] with the alphabet?
C	Do you (or someone else) help [child] with colors?
C	Do you (or someone else) help [child] with shapes and sizes?
E	How much choice is child allowed in deciding foods s/he eats at breakfast & lunch?
E	About how many hours is the TV on in your home each day?
E	If child got so angry that s/he hit you, what would you do?
C	How often does a family member get a chance to take child on any kind of outing?
C	How often has a family member taken or arranged to take child to any type of museum?
E	How often does child eat a meal with you and his/her father/stepfather/father-figure?
E	About how many times, if any, have you had to spank child in the past week?
E	Interviewer: Mother conversed w/ child ≥ 2 times (no scolding or suspicious comments)?
E	Interviewer: Mother answered child's questions or requests verbally?
E	Interviewer: Mother caressed, kissed, or hugged child at least once?
E	Interviewer: Mother introduced interviewer to child by name?
E	Interviewer: Mother physically restricted or (shook/grabbed) child?
E	Interviewer: Mother slapped or spanked child at least once?
E	Interviewer: Mother's voice conveyed positive feeling about child?
C	Interviewer: Child's play environment is safe?
C	Interviewer: Interior of the home is dark or perceptually monotonous?
C	Interviewer: All visible rooms of house/apartment are reasonably clean?
C	Interviewer: All visible rooms of house/apartment are minimally cluttered?

* C=Cognitive stimulation; E=Emotional support.

Table A.3: NLSY79-Child HOME-SF Scales for Children age 6-9 years

Scale*	Question Text
C	About how many books does child have?
C	How often do you read aloud to child?
E	How often is child expected to make his/her own bed?
E	How often is child expected to clean his/her own room?
E	How often is child expected to clean up after spills?
E	How often is child expected to bathe himself/herself?
E	How often is child expected to pick up after himself/herself?
C	Is there a musical instrument that child can use here at home?
C	Does your family get a daily newspaper?
C	How often does child read for enjoyment?
C	Does your family encourage child to start and keep doing hobbies?
C	Does child get special lessons or belong to any organization that encourages activities such as sports, music, art, dance, drama, etc.?
C	How often has a family member taken or arranged to take child to any type of museum?
C	How often has a family member taken or arranged to take child to any type of musical or theatrical performance within the past year?
E	How often does your whole family get together with relatives or friends?
E	How often does child spend time with his/her father, stepfather, or father-figure?
E	How often does child eat a meal with both mother and father?
C	When your family watches TV, do you or (father) discuss programs with him/her?
E	Mother response to tantrum
E	How many times in the past week have you had to spank child?
E	Interviewer: Mother encouraged child to contribute to the conversation?
E	Interviewer: Mother answered child's questions or requests verbally?
E	Interviewer: Mother conversed with child excluding scolding or suspicious comments?
E	Interviewer: Mother introduced interviewer to child by name?
E	Interviewer: Mother's voice conveyed positive feeling about child?
C	Interviewer: Interior of the home is dark or perceptually monotonous?
C	Interviewer: All visible rooms of the house/apartment are reasonably clean?
C	Interviewer: All visible rooms of the house/apartment are minimally cluttered?
C	Interviewer: Building has no dangerous structural or health hazards within a school-aged child's range.

* C=Cognitive stimulation; E=Emotional support.

Table A.4: NLSY79-Child HOME-SF Scales for Children age 10-14 years

Scale*	Question Text
C	How many books does child have?
E	How often is child expected to make his/her own bed?
E	How often is child expected to clean his/her own room?
E	How often is child expected to pick up after himself/herself?
E	How often is child expected to keep shared living areas clean and straight?
E	How often is child expected to do routine chores?
E	How often is child expected to help manage his/her own time?
C	Is there a musical instrument that child can use here at home?
C	Does your family get a daily newspaper?
C	How often does child read for enjoyment?
C	Does your family encourage child to start and keep doing hobbies?
C	Does child get special lessons or belong to any organization that encourages activities such as sports, music, art, dance, drama, etc.?
C	How often has any family member taken or arranged to take child to any type of museum?
C	How often has a family member taken or arranged to take child to any type of musical or theatrical performance within the past year?
E	How often does your whole family get together with relatives or friends?
E	How often does child spend time with his/her father, stepfather, or father-figure?
E	How often does child spend time with his/her father, stepfather, or father-figure in outdoor activities?
E	How often does child eat a meal with both mother and father?
C	When your family watches TV together, do you or child's father (or stepfather or father-figure) discuss TV programs with him/her?
E	Mother response to tantrum
E	Interviewer: Mother encouraged child to contribute to the conversation?
E	Interviewer: Mother answered child's questions or requests verbally?
E	Interviewer: Mother conversed with child excluding scolding or suspicious comments?
E	Interviewer: Mother introduced interviewer to child by name?
E	Interviewer: Mother's voice conveyed positive feeling about child?
C	Interviewer: Interior of the home is dark or perceptually monotonous?
C	Interviewer: All visible rooms of the house/apartment are reasonably clean?
C	Interviewer: All visible rooms of the house/apartment are minimally cluttered?
C	Interviewer: Building has no potentially dangerous structural or health hazards within a school-aged child's range.

* C=Cognitive stimulation; E=Emotional support.

Table A.5: Estimation Results: Relationship Status (cohabiting relative to married)

Variable name	Coeff	Std Err	
Years married entering t if married in t-1	-0.095	0.016	***
Cohabited in t-1	6.387	0.165	***
Years cohabited entering t if cohabited in t-1	0.122	0.013	***
Single in t-1	5.095	0.161	***
Years single entering t if single in t-1	0.005	0.008	
More than one marriage entering t	-0.026	0.070	
Number of children under age 5 entering t	0.094	0.050	*
Number of children above age 5 entering t	0.060	0.031	*
Acquire any children in t-1	0.074	0.091	
Lose any children in t-1	0.102	0.106	
Enrolled in t-1	0.042	0.074	
Highest grade completed in t-1	-0.125	0.014	***
Out of labor force in t-1	-0.099	0.075	
Unemployed in t-1	0.269	0.164	
Employed part-year part-time in t-1	0.079	0.120	
Employed part-year full-time in t-1	-0.049	0.070	
Employed full-year part-time in t-1	-0.270	0.099	***
Years employed entering t	-0.008	0.006	
Children's average math score in t-1	-0.312	0.656	
Children's lowest math score in t-1	0.172	0.605	
Children's average BPI score in t-1	0.139	0.649	
Children's lowest BPI score in t-1	0.260	0.611	
Black race	0.038	0.063	
Hispanic	0.100	0.073	
AFQT score in 00s	-0.249	0.121	**
Age in years	0.017	0.018	
Age squared	-0.007	0.007	
R's mother highest grade completed	0.007	0.009	
Rural residence	-0.096	0.059	
North central region	0.071	0.115	
West region	0.335	0.185	*
South region	0.060	0.144	
State total population in hundred millions	-0.211	0.598	
State sex ratio for white	0.610	1.060	
State sex ratio for black	-0.231	0.318	
State AFDC/TANF per family of three in 00s	0.006	0.029	
State expenditure on child support enforcement	0.002	0.016	
State unemployment rate for male	-0.025	0.030	
State unemployment rate for female	-0.008	0.038	
State average annual pay in 0000s	0.106	0.102	
State EITC credit rate for family of two children	-0.018	0.006	***
State average 4-year private college tuition in 0000s	0.082	0.122	
State average 4-year public college tuition in 0000s	0.454	0.283	
State average 2-year public college tuition in 0000s	0.780	0.822	
State average pupil-teacher ratio	0.004	0.011	
State expenditure per pupil in 0000s	0.187	0.371	
State average teacher salary in 0000s	-0.092	0.103	
State per-capita spirits consumption	0.385	0.143	***
State number of public library per thousand capita	0.431	0.902	
Time trend	0.054	0.036	
Time trend squared	-0.008	0.012	
Constant	-5.101	0.332	***
Mother permanent heterogeneity	-7.053	0.431	***

Note: Standard errors in parentheses.*** p<0.01, ** p<0.05, * p<0.1. Dollar amounts are in year 2000 dollars. Indicator variables for missing values of some variables are not presented.

Table A.6: Estimation Results: Relationship Status (single relative to married)

Variable name	Coeff	Std Err	
Years married entering t if married in t-1	-0.090	0.004	***
Cohabited in t-1	2.184	0.084	***
Years cohabited entering t if cohabited in t-1	0.013	0.017	
Single in t-1	4.999	0.051	***
Years single entering t if single in t-1	0.035	0.006	***
More than one marriage entering t	-0.257	0.047	***
Number of children under age 5 entering t	0.004	0.035	
Number of children above age 5 entering t	0.007	0.023	
Aquire any children in t-1	-0.121	0.065	*
Lose any children in t-1	-0.081	0.082	
Enrolled in t-1	0.152	0.050	***
Highest grade completed in t-1	-0.059	0.009	***
Out of labor force in t-1	-0.067	0.055	
Unemployed in t-1	0.268	0.124	**
Employed part-year part-time in t-1	0.057	0.083	
Employed part-year full-time in t-1	0.007	0.052	
Employed full-year part-time in t-1	-0.132	0.065	**
Years employed entering t	-0.018	0.004	***
Children's average math score in t-1	-0.225	0.457	
Children's lowest math score in t-1	-0.011	0.424	
Children's average BPI score in t-1	0.694	0.438	
Children's lowest BPI score in t-1	-0.062	0.419	
Black race	0.615	0.045	***
Hispanic	0.207	0.054	***
AFQT score in 00s	-0.250	0.084	***
Age in years	0.031	0.013	**
Age squared	0.001	0.005	
R's mother highest grade completed	0.016	0.006	**
Rural residence	-0.189	0.043	***
North central region	0.107	0.083	
West region	0.170	0.132	
South region	0.030	0.104	
State total population in hundred millions	-0.023	0.407	
State sex ratio for white	-1.097	1.003	
State sex ratio for black	-0.033	0.220	
State AFDC/TANF per family of three in 00s	-0.009	0.021	
State expenditure on child support enforcement	0.018	0.012	
State unemployment rate for male	-0.020	0.021	
State unemployment rate for female	0.020	0.027	
State average annual pay in 0000s	0.147	0.073	**
State EITC credit rate for family of two children	-0.008	0.005	*
State average 4-year private college tuition in 0000s	0.038	0.086	
State average 4-year public college tuition in 0000s	-0.241	0.202	
State average 2-year public college tuition in 0000s	0.394	0.534	
State average pupil-teacher ratio	-0.016	0.008	**
State expenditure per pupil in 0000s	-0.278	0.259	
State average teacher salary in 0000s	0.003	0.073	
State per-capita spirits consumption	0.151	0.101	
State number of public library per thousand capita	-0.076	0.636	
Time trend	0.027	0.026	
Time trend squared	0.001	0.008	
Constant	-2.695	0.209	***
Mother permanent heterogeneity	-4.532	0.355	***

Note: Standard errors in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$. Dollar amounts are in year 2000 dollars. Indicator variables for missing values of some variables are not presented.

Table A.7: Estimation Results: School Enrollment (enrolled relative to not enrolled)

Variable name	Coeff	Std Err	
Years married entering t if married in t-1	0.004	0.003	
Cohabited in t-1	0.238	0.094	**
Years cohabited entering t if cohabited in t-1	-0.038	0.019	**
Single in t-1	0.165	0.049	***
Years single entering t if single in t-1	0.013	0.004	***
More than one marriage entering t	0.174	0.044	***
Number of children under age 5 entering t	-0.021	0.033	
Number of children above age 5 entering t	0.070	0.020	***
Aquire any children in t-1	-0.251	0.064	***
Lose any children in t-1	0.194	0.076	**
Enrolled in t-1	3.787	0.031	***
Highest grade completed in t-1	0.090	0.009	***
Out of labor force in t-1	0.067	0.051	
Unemployed in t-1	0.211	0.113	*
Employed part-year part-time in t-1	0.304	0.067	***
Employed part-year full-time in t-1	-0.055	0.048	
Employed full-year part-time in t-1	0.050	0.053	
Years employed entering t	0.021	0.004	***
Children's average math score in t-1	0.011	0.438	
Children's lowest math score in t-1	-0.259	0.406	
Children's average BPI score in t-1	0.402	0.430	
Children's lowest BPI score in t-1	-0.136	0.419	
Black race	0.208	0.042	***
Hispanic	0.168	0.049	***
AFQT score in 00s	0.346	0.075	***
Age in years	-0.036	0.012	***
Age squared	-0.003	0.004	
R's mother highest grade completed	0.005	0.006	
Rural residence	-0.055	0.039	
North central region	-0.042	0.076	
West region	0.002	0.118	
South region	0.045	0.093	
State total population in hundred millions	-0.555	0.347	
State sex ratio for white	-2.019	0.986	**
State sex ratio for black	0.220	0.199	
State AFDC/TANF per family of three in 00s	0.046	0.019	**
State expenditure on child support enforcement	0.023	0.011	**
State unemployment rate for male	0.006	0.019	
State unemployment rate for female	0.009	0.025	
State average annual pay in 0000s	-0.027	0.065	
State EITC credit rate for family of two children	0.008	0.004	**
State average 4-year private college tuition in 0000s	0.012	0.077	
State average 4-year public college tuition in 0000s	0.062	0.181	
State average 2-year public college tuition in 0000s	-1.051	0.430	**
State average pupil-teacher ratio	-0.015	0.008	**
State expenditure per pupil in 0000s	-0.849	0.243	***
State average teacher salary in 0000s	0.122	0.067	*
State per-capita spirits consumption	0.009	0.090	
State number of public library per thousand capita	-0.970	0.548	*
Time trend	0.005	0.024	
Time trend squared	0.002	0.008	
Constant	-3.693	0.194	***
Mother permanent heterogeneity	0.090	0.402	

Note: Standard errors in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$. Dollar amounts are in year 2000 dollars. Indicator variables for missing values of some variables are not presented.

Table A.8: Estimation Results: Employment Status (full-year part-time employed relative to full-year full-time)

Variable name	Coeff	Std Err	
Years married entering t if married in t-1	-0.004	0.004	
Cohabited in t-1	-0.328	0.114	***
Years cohabited entering t if cohabited in t-1	-0.012	0.019	
Single in t-1	-0.461	0.062	***
Years single entering t if single in t-1	-0.005	0.006	
More than one marriage entering t	-0.111	0.050	**
Number of children under age 5 entering t	0.179	0.036	***
Number of children above age 5 entering t	0.054	0.021	**
Aquire any children in t-1	0.235	0.068	***
Lose any children in t-1	-0.093	0.083	
Enrolled in t-1	-0.164	0.056	***
Highest grade completed in t-1	-0.014	0.010	
Out of labor force in t-1	2.562	0.077	***
Unemployed in t-1	1.848	0.177	***
Employed part-year part-time in t-1	3.501	0.067	***
Employed part-year full-time in t-1	1.224	0.066	***
Employed full-year part-time in t-1	4.560	0.042	***
Years employed entering t	-0.050	0.005	***
Children's average math score in t-1	0.313	0.459	
Children's lowest math score in t-1	0.419	0.416	
Children's average BPI score in t-1	0.735	0.416	*
Children's lowest BPI score in t-1	-0.704	0.406	*
Black race	-0.326	0.052	***
Hispanic	-0.199	0.057	***
AFQT score in 00s	-0.123	0.086	
Age in years	0.051	0.015	***
Age squared	-0.002	0.005	
R's mother highest grade completed	0.034	0.007	***
Rural residence	0.019	0.042	
North central region	-0.160	0.084	*
West region	-0.209	0.132	
South region	-0.411	0.107	***
State total population in hundred millions	0.097	0.405	
State sex ratio for white	-1.056	1.029	
State sex ratio for black	0.262	0.211	
State AFDC/TANF per family of three in 00s	0.033	0.022	
State expenditure on child support enforcement	-0.023	0.011	**
State unemployment rate for male	0.012	0.022	
State unemployment rate for female	0.046	0.028	
State average annual pay in 0000s	0.141	0.071	**
State EITC credit rate for family of two children	-0.005	0.005	
State average 4-year private college tuition in 0000s	-0.069	0.086	
State average 4-year public college tuition in 0000s	0.388	0.202	*
State average 2-year public college tuition in 0000s	-0.288	0.515	
State average pupil-teacher ratio	-0.009	0.009	
State expenditure per pupil in 0000s	-0.603	0.253	**
State average teacher salary in 0000s	-0.030	0.075	
State per-capita spirits consumption	0.250	0.106	**
State number of public library per thousand capita	0.438	0.615	
Time trend	0.037	0.029	
Time trend squared	-0.009	0.009	
Constant	-3.266	0.222	***
Mother permanent heterogeneity	-0.880	0.391	**

Note: Standard errors in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$. Dollar amounts are in year 2000 dollars. Indicator variables for missing values of some variables are not presented.

Table A.9: Estimation Results: Employment Status (part-year full-time employed relative to full-year full-time employed)

Variable name	Coeff	Std Err	
Years married entering t if married in t-1	-0.015	0.003	***
Cohabited in t-1	0.112	0.074	
Years cohabited entering t if cohabited in t-1	-0.043	0.013	***
Single in t-1	-0.286	0.044	***
Years single entering t if single in t-1	0.003	0.004	
More than one marriage entering t	0.083	0.037	**
Number of children under age 5 entering t	0.048	0.029	*
Number of children above age 5 entering t	0.005	0.017	
Aquire any children in t-1	-0.235	0.053	***
Lose any children in t-1	0.122	0.058	**
Enrolled in t-1	0.022	0.041	
Highest grade completed in t-1	-0.041	0.008	***
Out of labor force in t-1	2.940	0.055	***
Unemployed in t-1	2.612	0.102	***
Employed part-year part-time in t-1	2.209	0.070	***
Employed part-year full-time in t-1	2.854	0.032	***
Employed full-year part-time in t-1	1.003	0.066	***
Years employed entering t	-0.050	0.004	***
Children’s average math score in t-1	-0.222	0.368	
Children’s lowest math score in t-1	0.221	0.342	
Children’s average BPI score in t-1	0.584	0.355	
Children’s lowest BPI score in t-1	-0.278	0.340	
Black race	0.012	0.037	
Hispanic	-0.066	0.044	
AFQT score in 00s	-0.415	0.069	***
Age in years	-0.018	0.011	
Age squared	0.007	0.004	*
R’s mother highest grade completed	0.007	0.006	
Rural residence	0.021	0.034	
North central region	0.014	0.070	
West region	0.140	0.108	
South region	0.017	0.086	
State total population in hundred millions	-0.330	0.323	
State sex ratio for white	-0.500	0.989	
State sex ratio for black	0.359	0.174	**
State AFDC/TANF per family of three in 00s	-0.004	0.017	
State expenditure on child support enforcement	-0.007	0.010	
State unemployment rate for male	-0.009	0.017	
State unemployment rate for female	0.035	0.021	
State average annual pay in 0000s	-0.025	0.059	
State EITC credit rate for family of two children	0.012	0.004	***
State average 4-year private college tuition in 0000s	-0.082	0.068	
State average 4-year public college tuition in 0000s	-0.221	0.161	
State average 2-year public college tuition in 0000s	-0.411	0.402	
State average pupil-teacher ratio	-0.011	0.007	
State expenditure per pupil in 0000s	-0.123	0.213	
State average teacher salary in 0000s	0.133	0.060	**
State per-capita spirits consumption	0.014	0.081	
State number of public library per thousand capita	-0.508	0.520	
Time trend	0.000	0.022	
Time trend squared	0.010	0.007	
Constant	-2.278	0.175	***
Mother permanent heterogeneity	-4.165	0.348	***

Note: Standard errors in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$. Dollar amounts are in year 2000 dollars. Indicator variables for missing values of some variables are not presented.

Table A.10: Estimation Results: Employment Status (part-year part-time employed relative to full-year full-time employed)

Variable name	Coeff	Std Err	
Years married entering t if married in t-1	-0.022	0.005	***
Cohabited in t-1	-0.271	0.128	**
Years cohabited entering t if cohabited in t-1	-0.045	0.024	*
Single in t-1	-0.763	0.073	***
Years single entering t if single in t-1	0.012	0.008	
More than one marriage entering t	-0.092	0.061	
Number of children under age 5 entering t	0.170	0.039	***
Number of children above age 5 entering t	-0.036	0.027	
Aquire any children in t-1	-0.065	0.076	
Lose any children in t-1	-0.275	0.118	**
Enrolled in t-1	-0.056	0.065	
Highest grade completed in t-1	-0.053	0.013	***
Out of labor force in t-1	4.311	0.078	***
Unemployed in t-1	3.684	0.139	***
Employed part-year part-time in t-1	5.295	0.072	***
Employed part-year full-time in t-1	2.316	0.076	***
Employed full-year part-time in t-1	3.337	0.073	***
Years employed entering t	-0.079	0.006	***
Children's average math score in t-1	0.270	0.541	
Children's lowest math score in t-1	0.083	0.493	
Children's average BPI score in t-1	0.612	0.503	
Children's lowest BPI score in t-1	-0.854	0.488	*
Black race	-0.249	0.062	***
Hispanic	-0.114	0.069	
AFQT score in 00s	0.120	0.108	
Age in years	0.026	0.017	
Age squared	0.000	0.007	
R's mother highest grade completed	0.036	0.009	***
Rural residence	-0.039	0.052	
North central region	-0.117	0.105	
West region	-0.222	0.163	
South region	-0.338	0.132	**
State total population in hundred millions	-0.071	0.565	
State sex ratio for white	1.356	1.097	
State sex ratio for black	0.405	0.241	*
State AFDC/TANF per family of three in 00s	0.011	0.026	
State expenditure on child support enforcement	-0.005	0.014	
State unemployment rate for male	-0.003	0.027	
State unemployment rate for female	0.070	0.034	**
State average annual pay in 0000s	0.035	0.092	
State EITC credit rate for family of two children	0.006	0.006	
State average 4-year private college tuition in 0000s	-0.095	0.110	
State average 4-year public college tuition in 0000s	0.206	0.253	
State average 2-year public college tuition in 0000s	-0.714	0.731	
State average pupil-teacher ratio	-0.027	0.011	**
State expenditure per pupil in 0000s	-0.372	0.331	
State average teacher salary in 0000s	0.005	0.093	
State per-capita spirits consumption	0.108	0.130	
State number of public library per thousand capita	-0.858	0.844	
Time trend	0.008	0.033	
Time trend squared	0.005	0.011	
Constant	-3.268	0.266	***
Mother permanent heterogeneity	-3.232	0.358	***

Note: Standard errors in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$. Dollar amounts are in year 2000 dollars. Indicator variables for missing values of some variables are not presented.

Table A.11: Estimation Results: Employment status (unemployed relative to full-year full-time employed)

Variable name	Coeff	Std Err	
Years married entering t if married in t-1	-0.020	0.007	***
Cohabited in t-1	0.095	0.168	
Years cohabited entering t if cohabited in t-1	-0.020	0.023	
Single in t-1	-0.025	0.107	
Years single entering t if single in t-1	-0.010	0.007	
More than one marriage entering t	-0.082	0.088	
Number of children under age 5 entering t	0.137	0.060	**
Number of children above age 5 entering t	-0.071	0.038	*
Aquire any children in t-1	0.167	0.109	
Lose any children in t-1	-0.025	0.133	
Enrolled in t-1	-0.101	0.100	
Highest grade completed in t-1	-0.063	0.017	***
Out of labor force in t-1	4.383	0.103	***
Unemployed in t-1	5.804	0.119	***
Employed part-year part-time in t-1	3.063	0.144	***
Employed part-year full-time in t-1	2.544	0.102	***
Employed full-year part-time in t-1	1.414	0.198	***
Years employed entering t	-0.078	0.007	***
Children's average math score in t-1	-2.114	0.728	***
Children's lowest math score in t-1	1.814	0.682	***
Children's average BPI score in t-1	0.882	0.712	
Children's lowest BPI score in t-1	-0.832	0.668	
Black race	0.230	0.086	***
Hispanic	0.003	0.107	
AFQT score in 00s	-1.330	0.179	***
Age in years	0.106	0.023	***
Age squared	-0.024	0.008	***
R's mother highest grade completed	0.028	0.011	**
Rural residence	0.166	0.076	**
North central region	0.255	0.163	
West region	0.189	0.256	
South region	0.114	0.200	
State total population in hundred millions	-1.283	0.834	
State sex ratio for white	0.558	1.885	
State sex ratio for black	-0.027	0.445	
State AFDC/TANF per family of three in 00s	0.058	0.038	
State expenditure on child support enforcement	-0.023	0.022	
State unemployment rate for male	0.067	0.034	**
State unemployment rate for female	0.110	0.045	**
State average annual pay in 0000s	0.050	0.146	
State EITC credit rate for family of two children	-0.011	0.008	
State average 4-year private college tuition in 0000s	0.084	0.154	
State average 4-year public college tuition in 0000s	-0.536	0.375	
State average 2-year public college tuition in 0000s	1.484	0.930	
State average pupil-teacher ratio	-0.006	0.015	
State expenditure per pupil in 0000s	-0.003	0.526	
State average teacher salary in 0000s	0.026	0.140	
State per-capita spirits consumption	0.036	0.186	
State number of public library per thousand capita	-1.678	1.154	
Time trend	-0.014	0.048	
Time trend squared	0.024	0.015	*
Constant	-4.842	0.391	***
Mother permanent heterogeneity	-4.893	0.494	***

Note: Standard errors in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$. Dollar amounts are in year 2000 dollars. Indicator variables for missing values of some variables are not presented.

Table A.12: Estimation Results: Employment status (out of labor force relative to full-year full-time employed)

Variable name	Coeff	Std Err	
Years married entering t if married in t-1	-0.016	0.004	***
Cohabited in t-1	-0.165	0.093	*
Years cohabited entering t if cohabited in t-1	-0.015	0.015	
Single in t-1	-0.524	0.054	***
Years single entering t if single in t-1	0.005	0.005	
More than one marriage entering t	0.003	0.045	
Number of children under age 5 entering t	0.206	0.031	***
Number of children above age 5 entering t	-0.131	0.020	***
Aquire any children in t-1	0.229	0.056	***
Lose any children in t-1	-0.163	0.074	**
Enrolled in t-1	-0.513	0.055	***
Highest grade completed in t-1	-0.078	0.010	***
Out of labor force in t-1	6.502	0.057	***
Unemployed in t-1	4.550	0.101	***
Employed part-year part-time in t-1	4.088	0.073	***
Employed part-year full-time in t-1	3.160	0.051	***
Employed full-year part-time in t-1	2.309	0.083	***
Years employed entering t	-0.124	0.004	***
Children's average math score in t-1	-0.798	0.409	*
Children's lowest math score in t-1	0.578	0.379	
Children's average BPI score in t-1	0.470	0.394	
Children's lowest BPI score in t-1	-0.595	0.378	
Black race	-0.122	0.046	***
Hispanic	-0.155	0.053	***
AFQT score in 00s	-0.150	0.084	*
Age in years	0.062	0.013	***
Age squared	0.004	0.005	
R's mother highest grade completed	0.031	0.007	***
Rural residence	0.073	0.040	*
North central region	-0.072	0.084	
West region	0.042	0.129	
South region	-0.153	0.105	
State total population in hundred millions	-0.007	0.407	
State sex ratio for white	0.028	1.059	
State sex ratio for black	0.090	0.212	
State AFDC/TANF per family of three in 00s	0.013	0.021	
State expenditure on child support enforcement	-0.025	0.012	**
State unemployment rate for male	0.032	0.020	
State unemployment rate for female	0.031	0.026	
State average annual pay in 0000s	0.079	0.072	
State EITC credit rate for family of two children	-0.015	0.005	***
State average 4-year private college tuition in 0000s	-0.098	0.082	
State average 4-year public college tuition in 0000s	-0.163	0.199	
State average 2-year public college tuition in 0000s	-0.359	0.502	
State average pupil-teacher ratio	-0.027	0.008	***
State expenditure per pupil in 0000s	-0.202	0.260	
State average teacher salary in 0000s	0.080	0.072	
State per-capita spirits consumption	-0.040	0.100	
State number of public library per thousand capita	-0.803	0.657	
Time trend	0.049	0.025	*
Time trend squared	0.000	0.008	
Constant	-2.901	0.208	***
Mother permanent heterogeneity	-2.754	0.464	***

Note: Standard errors in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$. Dollar amounts are in year 2000 dollars. Indicator variables for missing values of some variables are not presented.

Table A.13: Estimation Results: Family Size Change (gain any children relative to no change)

Variable name	Coeff	Std Err	
Years married entering t if married in t-1	0.037	0.003	***
Cohabited in t-1	0.636	0.098	***
Years cohabited entering t if cohabited in t-1	-0.015	0.011	
Single in t-1	0.484	0.063	***
Years single entering t if single in t-1	0.016	0.003	***
More than one marriage entering t	0.481	0.040	***
Number of children under age 5 entering t	0.172	0.044	***
Number of children above age 5 entering t	0.221	0.016	***
Aquire any children in t-1	0.794	0.062	***
Lose any children in t-1	0.908	0.045	***
Enrolled in t-1	0.279	0.055	***
Highest grade completed in t-1	-0.080	0.008	***
Out of labor force in t-1	-0.273	0.052	***
Unemployed in t-1	-0.033	0.111	
Employed part-year part-time in t-1	-0.214	0.090	**
Employed part-year full-time in t-1	-0.011	0.051	
Employed full-year part-time in t-1	-0.171	0.063	***
Years employed entering t	-0.024	0.003	***
Children's average math score in t-1	-0.948	0.717	
Children's lowest math score in t-1	0.465	0.656	
Children's average BPI score in t-1	1.967	0.709	***
Children's lowest BPI score in t-1	-0.400	0.640	
Black race	0.204	0.045	***
Hispanic	0.052	0.053	
AFQT score in 00s	-0.174	0.083	**
Age in years	0.191	0.020	***
Age squared	-0.035	0.005	***
R's mother highest grade completed	-0.010	0.006	*
Rural residence	0.065	0.038	*
North central region	0.119	0.087	
West region	0.137	0.133	
South region	0.082	0.103	
State total population in hundred millions	-0.087	0.348	
State sex ratio for white	0.363	0.990	
State sex ratio for black	0.237	0.226	
State AFDC/TANF per family of three in 00s	0.016	0.022	
State expenditure on child support enforcement	0.013	0.010	
State unemployment rate for male	-0.062	0.019	***
State unemployment rate for female	0.049	0.026	*
State average annual pay in 0000s	-0.055	0.066	
State EITC credit rate for family of two children	0.002	0.005	
State average 4-year private college tuition in 0000s	0.006	0.075	
State average 4-year public college tuition in 0000s	0.247	0.177	
State average 2-year public college tuition in 0000s	0.291	0.430	
State average pupil-teacher ratio	-0.004	0.008	
State expenditure per pupil in 0000s	-0.340	0.227	
State average teacher salary in 0000s	0.054	0.071	
State per-capita spirits consumption	-0.017	0.101	
State number of public library per thousand capita	0.628	0.756	
Time trend	0.035	0.033	
Time trend squared	-0.004	0.009	
Constant	-7.603	0.322	***
Mother permanent heterogeneity	-1.160	0.181	***

Note: Standard errors in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$. Dollar amounts are in year 2000 dollars. Indicator variables for missing values of some variables are not presented.

Table A.14: Estimation Results: Family Size Change (lose any children relative to no change)

Variable name	Coeff	Std Err	
Years married entering t if married in t-1	-0.065	0.004	***
Cohabited in t-1	-0.556	0.078	***
Years cohabited entering t if cohabited in t-1	-0.052	0.017	***
Single in t-1	-1.403	0.046	***
Years single entering t if single in t-1	0.021	0.006	***
More than one marriage entering t	-0.075	0.043	*
Number of children under age 5 entering t	0.144	0.024	***
Number of children above age 5 entering t	-0.166	0.022	***
Aquire any children in t-1	-0.311	0.050	***
Lose any children in t-1	0.957	0.063	***
Enrolled in t-1	-0.424	0.052	***
Highest grade completed in t-1	0.007	0.008	
Out of labor force in t-1	0.292	0.045	***
Unemployed in t-1	0.281	0.101	***
Employed part-year part-time in t-1	0.162	0.069	**
Employed part-year full-time in t-1	0.187	0.045	***
Employed full-year part-time in t-1	0.137	0.055	**
Years employed entering t	-0.005	0.005	
Children's average math score in t-1	-1.496	0.581	**
Children's lowest math score in t-1	0.971	0.558	*
Children's average BPI score in t-1	-0.619	0.516	
Children's lowest BPI score in t-1	0.623	0.503	
Black race	0.233	0.041	***
Hispanic	0.189	0.046	***
AFQT score in 00s	0.109	0.073	
Age in years	-0.029	0.011	***
Age squared	0.001	0.005	
R's mother highest grade completed	-0.007	0.006	
Rural residence	-0.015	0.037	
North central region	0.056	0.073	
West region	0.018	0.115	
South region	-0.104	0.093	
State total population in hundred millions	0.144	0.372	
State sex ratio for white	-2.337	0.984	**
State sex ratio for black	-0.158	0.188	
State AFDC/TANF per family of three in 00s	-0.018	0.018	
State expenditure on child support enforcement	-0.007	0.010	
State unemployment rate for male	0.016	0.018	
State unemployment rate for female	-0.003	0.023	
State average annual pay in 0000s	-0.073	0.068	
State EITC credit rate for family of two children	-0.010	0.004	**
State average 4-year private college tuition in 0000s	0.034	0.079	
State average 4-year public college tuition in 0000s	-0.377	0.186	**
State average 2-year public college tuition in 0000s	-0.452	0.441	
State average pupil-teacher ratio	0.005	0.007	
State expenditure per pupil in 0000s	-0.084	0.248	
State average teacher salary in 0000s	0.139	0.065	**
State per-capita spirits consumption	0.164	0.086	*
State number of public library per thousand capita	1.432	0.529	***
Time trend	-0.019	0.021	
Time trend squared	0.007	0.007	
Constant	-0.937	0.173	***
Mother permanent heterogeneity	0.242	0.272	

Note: Standard errors in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$. Indicator variables for missing values of some variables are not presented.

Table A.15: Estimation Results: Investment in Child

Variable name	Coeff	Std Err	
Child: math percentile score in t-1	0.013	0.008	
Child: behavior prob percentile score in t-1	-0.074	0.008	***
Years married entering t if married in t-1	0.530	0.044	***
Cohabited in t-1	-2.996	0.849	***
Years cohabited entering t if cohabited in t-1	0.421	0.167	**
Single in t-1	-7.963	0.542	***
Years single entering t if single in t-1	-0.143	0.077	*
More than one marriage entering t	1.692	0.461	***
Number of children under age 5 entering t	-2.702	0.252	***
Number of children above age 5 entering t	-2.011	0.194	***
Aquire any children in t-1	-2.109	0.432	***
Lose any children in t-1	-0.211	0.790	
Enrolled in t-1	-0.337	0.490	
Highest grade completed in t-1	1.446	0.096	***
Out of labor force in t-1	2.359	0.414	***
Unemployed in t-1	0.396	0.923	
Employed part-year part-time in t-1	1.868	0.573	***
Employed part-year full-time in t-1	1.666	0.451	***
Employed full-year part-time in t-1	2.044	0.480	***
Years employed entering t	0.185	0.046	***
Child: girl	2.787	0.313	***
Black race	-8.682	0.492	***
Hispanic	-3.224	0.550	***
AFQT score in 00s	9.916	0.864	***
Age in years	1.055	0.133	***
Age squared	-0.466	0.058	***
Child age	0.578	0.084	***
Child age squared	-0.039	0.009	***
R's mother highest grade completed	0.619	0.066	***
Rural residence	-0.809	0.372	**
North central region	0.285	0.754	
West region	0.561	1.145	
South region	-0.166	0.954	
State total population in hundred millions	-9.531	3.317	***
State sex ratio for white	-10.028	8.743	
State sex ratio for black	2.454	1.666	
State AFDC/TANF per family of three in 00s	0.332	0.191	*
State expenditure on child support enforcement	-0.166	0.105	
State unemployment rate for male	0.167	0.186	
State unemployment rate for female	-0.819	0.226	***
State average annual pay in 0000s	0.649	0.701	
State EITC credit rate for family of two children	-0.127	0.048	***
State average 4-year private college tuition in 0000s	2.999	0.778	***
State average 4-year public college tuition in 0000s	1.107	2.166	
State average 2-year public college tuition in 0000s	-0.142	3.944	
State average pupil-teacher ratio	-0.048	0.068	
State expenditure per pupil in 0000s	-2.017	2.387	
State average teacher salary in 0000s	0.134	0.623	
State per-capita spirits consumption	-1.945	0.916	**
State number of public library per thousand capita	9.558	4.683	**
Time trend	-2.131	0.218	***
Time trend squared	0.517	0.077	***
Constant	-295.966	6.469	***
Mother permanent heterogeneity	107.328	4.735	***
Child permanent heterogeneity	372.408	6.149	***

Note: Standard errors in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$. Dollar amounts are in year 2000 dollars. Indicator variables for missing values of some variables are not presented.

Table A.16: Estimation Results: Log Wage

Variable name	Coeff	Std Err	
Years married entering t if married in t-1	-0.005	0.001	***
Cohabited in t-1	0.062	0.012	***
Years cohabited entering t if cohabited in t-1	0.000	0.002	
Single in t-1	0.025	0.007	***
Years single entering t if single in t-1	-0.001	0.001	
More than one marriage entering t	0.025	0.007	***
Number of children under age 5 entering t	-0.014	0.005	***
Number of children above age 5 entering t	-0.014	0.003	***
Aquire any children in t-1	0.018	0.009	**
Lose any children in t-1	0.004	0.011	
Enrolled in t-1	-0.023	0.007	***
Highest grade completed in t-1	0.056	0.002	***
Out of labor force in t-1	-0.192	0.012	***
Unemployed in t-1	-0.159	0.026	***
Employed part-year part-time in t-1	-0.199	0.011	***
Employed part-year full-time in t-1	-0.112	0.007	***
Employed full-year part-time in t-1	-0.075	0.008	***
Years employed entering t	0.022	0.001	***
Children’s average math score in t-1	-0.031	0.060	
Children’s lowest math score in t-1	-0.007	0.056	
Children’s average BPI score in t-1	0.077	0.056	
Children’s lowest BPI score in t-1	-0.023	0.055	
Black race	-0.022	0.009	**
Hispanic	0.020	0.012	*
AFQT score in 00s	0.419	0.018	***
Age in years	0.017	0.002	***
Age squared	-0.006	0.001	***
R’s mother highest grade completed	0.004	0.001	***
Rural residence	-0.033	0.006	***
North central region	-0.021	0.011	*
West region	0.060	0.011	***
South region	0.011	0.011	
State unemployment rate for male	0.005	0.002	**
State unemployment rate for female	-0.011	0.003	***
State average annual pay in 0,000s	0.156	0.007	***
State EITC credit rate for family of two children	0.000	0.001	
Time trend	-0.011	0.003	***
Time trend squared	-0.001	0.001	
Constant	1.855	0.022	***
Mother permanent heterogeneity	5.682	0.093	***

Note: Standard errors in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$. Dollar amounts are in year 2000 dollars. Indicator variables for missing values of some variables are not presented.

Table A.17: Estimation Results: Log of Spouse/Partner Income

Variable name	Coeff	Std Err	
Years married entering t if married in t-1	0.006	0.001	***
Cohabited in t-1	0.004	0.029	
Years cohabited entering t if cohabited in t-1	0.007	0.007	
Single in t-1	-0.079	0.027	***
Years single entering t if single in t-1	0.019	0.009	**
More than one marriage entering t	0.089	0.014	***
Number of children under age 5 entering t	-0.012	0.009	
Number of children above age 5 entering t	-0.007	0.006	
Aquire any children in t-1	-0.004	0.015	
Lose any children in t-1	-0.012	0.023	
Enrolled in t-1	-0.071	0.016	***
Highest grade completed in t-1	0.047	0.003	***
Out of labor force in t-1	0.247	0.015	***
Unemployed in t-1	-0.016	0.043	
Employed part-year part-time in t-1	0.201	0.021	***
Employed part-year full-time in t-1	0.089	0.016	***
Employed full-year part-time in t-1	0.176	0.016	***
Years employed entering t	-0.002	0.002	
Children's average math score in t-1	0.124	0.106	
Children's lowest math score in t-1	0.069	0.098	
Children's average BPI score in t-1	0.043	0.100	
Children's lowest BPI score in t-1	-0.131	0.098	
Black race	-0.243	0.018	***
Hispanic	-0.098	0.020	***
AFQT score in 00s	0.372	0.030	***
Age in years	0.037	0.004	***
Age squared	-0.007	0.001	***
R's mother highest grade completed	0.025	0.002	***
Rural residence	-0.074	0.012	***
North central region	0.005	0.020	
West region	0.007	0.020	
South region	-0.019	0.020	
State unemployment rate for male	-0.018	0.005	***
State unemployment rate for female	0.005	0.007	
State average annual pay in 0000s	0.154	0.014	***
State EITC credit rate for family of two children	-0.002	0.001	*
Time trend	-0.002	0.006	
Time trend squared	-0.002	0.002	
Constant	9.483	0.041	***
Mother permanent heterogeneity	8.229	0.155	***

Note: Standard errors in parentheses.*** p<0.01, ** p<0.05, * p<0.1. Dollar amounts are in year 2000 dollars. Indicator variables for missing values of some variables are not presented.

Table A.18: Estimation Results: Child PIAT Math Percentile Score

Variable name	Coeff	Std Err	
Child: math percentile score in t-1	0.994	3.220	***
Child: behavior prob percentile score in t-1	-0.010	0.004	**
Cohabit in t	1.911	0.004	
Single in t	3.477	2.157	***
Cohabit in t*child age	-0.836	1.204	
Single in t*child age	-1.386	0.858	***
Cohabit in t*child age squared	0.063	0.478	
Single in t*child age squared	0.121	0.078	***
Cohabit in t*child girl	0.018	0.044	
Single in t*child girl	0.203	0.818	
First year becoming single in t	0.191	0.466	
Nonbiological dad in household in t	0.170	0.588	
Cohabit*nonbiological dad in hh in t	0.891	0.290	
Invest in child in t	0.014	0.883	***
Invest in child in t*cohabit in t	-0.015	0.004	
Invest in child in t*single in t	-0.002	0.012	
Acquire any children in t	-0.350	0.009	
Lose any children in t	0.198	0.451	
Enrolled in t	-0.286	0.488	
Out of labor force in t	0.062	0.278	
Unemployed in t	0.449	0.222	
Employed part-year part-time in t	0.352	0.757	
Employed part-year full-time in t	-0.256	0.468	
Employed full-year part-time in t	-0.275	0.278	
Pupil-teacher ratio in t	-0.049	0.285	
Expenditure per pupil in 0000s	-1.643	0.043	
Teacher salary in 0000s	0.056	1.273	
Child: girl	-0.952	0.263	***
Child: black race	-0.051	0.231	
Child: Hispanic	0.439	0.264	
Child: age	0.319	0.270	
Child: age squared	-0.079	0.253	***
AFQT score in 00s	1.389	0.023	***
Highest grade completed	-0.083	0.523	*
Age	-0.010	0.050	
Age squared	0.007	0.088	
Rural residence	0.074	0.035	
North central region	-0.216	0.195	
West region	-0.452	0.424	
South region	-0.326	0.540	
Time trend	0.260	0.505	***
Time trend squared	-0.077	0.085	**
Constant	13.535	1.782	***
Mother permanent heterogeneity	-3.832	2.102	*
Child permanent heterogeneity	-13.315	3.288	***

Note: Standard errors in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$. Dollar amounts are in year 2000 dollars. Indicator variables for missing values of some variables are not presented.

Table A.19: Estimation Results: Child Behavior Problems Index Percentile Score

Variable name	Coeff	Std Err	
Child: math percentile score in t-1	0.000	0.000	
Child: behavior prob percentile score in t-1	1.003	0.003	***
Cohabit in t	0.848	1.520	
Single in t	1.551	0.794	*
Cohabit in t*child age	-0.468	0.631	
Single in t*child age	-0.721	0.331	**
Cohabit in t*child age squared	0.045	0.062	
Single in t*child age squared	0.067	0.033	**
Cohabit in t*child girl	0.286	0.745	
Single in t*child girl	-0.234	0.334	
First year becoming single in t	-0.073	0.500	
Nonbiological dad in household in t	-0.227	0.272	
Cohabit*nonbiological dad in hh in t	0.456	0.844	
Invest in child in t	-0.024	0.004	***
Invest in child in t*cohabit in t	-0.008	0.011	
Invest in child in t*single in t	-0.006	0.007	
Acquire any children in t	0.773	0.343	**
Lose any children in t	0.048	0.444	
Enrolled in t	0.146	0.255	
Out of labor force in t	0.004	0.182	
Unemployed in t	0.731	0.723	
Employed part-year part-time in t	0.513	0.356	
Employed part-year full-time in t	0.149	0.250	
Employed full-year part-time in t	-0.195	0.257	
Pupil-teacher ratio in t	0.018	0.037	
Expenditure per pupil in 0000s	-0.879	1.175	
Teacher salary in 0000s	0.139	0.229	
Child: girl	0.090	0.189	
Child: black race	-0.566	0.232	**
Child: Hispanic	-0.356	0.241	
Child: age	0.604	0.199	***
Child: age squared	-0.060	0.019	***
AFQT score in 00s	1.016	0.415	**
Highest grade completed	0.019	0.044	
Age	0.017	0.078	
Age squared	-0.013	0.032	
Rural residence	-0.267	0.181	
North central region	-0.349	0.379	
West region	-0.224	0.484	
South region	-0.326	0.452	
Time trend	-0.001	0.111	
Time trend squared	0.004	0.031	
Constant	-9.476	2.972	***
Mother permanent heterogeneity	3.856	1.998	*
Child permanent heterogeneity	10.233	3.052	***

Note: Standard errors in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$. Dollar amounts are in year 2000 dollars. Indicator variables for missing values of some variables are not presented.

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